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Editor:
Mr. M S Quraishi
FRCS, FRCS (ORL, H&N)
Consultant ENT Surgeon
Hon Senior Lecturer in Surgical Oncology
Doncaster Royal Infirmary
Doncaster, UK
E-mail:
shquraishi@entmasterclass.com

ENT Masterclass®,
106 Nottingham Road,
Ravenshead,
Nottingham
NG15 9HL
England

www.entmasterclass.com

Welcome to Volume 5 Issue 1 of Journal of ENT Masterclass 2012

The ENT Masterclass® continues with another very successful calendar year and continues to provide a wide spectrum of postgraduate activities for trainee surgical residents and more recently appointed consultants, nurses and others related to the practice of Oto-Rhino-Laryngology, Head and Neck Surgery (ORL-HNS) in the United Kingdom and abroad.

During the year, activity included the 8th Annual National ENT Masterclass® which was held in London at the Royal College of Surgeons for the first time. This move was precipitated by the upgrading and modernisation of the post-graduate centre at Doncaster Royal Infirmary. The relocation allowed for a larger auditorium, and hence more delegates. There were an increased delegate interest from outside the UK, Germany, Ireland, Italy, South Africa, Malta and Saudi Arabia. There was an expansion of the Faculty members, mainly from London, but the old reliable "country" Faculty remained faithful and travelled on this occasion. There was superb support from the RCS and their audiovisual staff as well as ENT UK. The course while incurring additional expense remains free to all delegates. There was generous support from ENT UK on the hiring of the lecture facilities. The meeting was transmitted live as a free international WEBCAST as had been done for the 6th and 7th Masterclass in previous years.

Professor Valerie Lund CBE, current President of ENT UK was the "Guest of Honour" at the Annual ENT Masterclass and presented on the "management of sino-nasal malignant neoplasms". The 2012 ENT Masterclass Registrar's Gold Medal was awarded to Mr Ciaran Kelly, SpR Doncaster, for his presentation on "Minimal Access Parathyroid Surgery". Ms Emma Hoskison from Nottingham picked up the silver medal for her talk on comparison of voice handicap index with voice handicap index-10. *This issue of Journal ENT Masterclass* includes the registrar presentations' abstracts. This year saw another addition to the Masterclass stable: the First Advanced ENT Emergencies Masterclass which was held in June along with the 5th Thyroid and Salivary gland and the 3rd Radiology Masterclasses at the Dome Leisure Centre, Doncaster. In September the 5th National Tracheostomy and 6th National ENT Nursing Masterclasses were held.

The ENT "Cyber Textbook on Operative Surgery" has been very popular all over the world and we get hundreds of hits every month from over 50 countries. Feedback from UK trainees has also been very encouraging and there are plans to expand the video library even further from the present 160 videos.

The Journal of ENT Masterclass continues to be welcomed locally, nationally and even internationally late January and is has now reached its 5th year and on this occasion includes some twenty – articles , mainly local but continues to attract contributions from abroad. Our thanks again is extended to all who have helped continue to make this a worthy teaching contribution to the residents in their education and a source of referral for their final examinations. The Journal continued to be produced and circulated free.

This year our Editorial Board saw some changes in keeping with "change is necessary to improve ideas and stimulate forward momentum". We have lost Professor Simon Carney from Australia, Ken MacKenzie from Glasgow and Alec Blayney from Dublin and these have been replaced by S S Musheer Hussain from Dundee, Rory McConn-Walsh from Dublin, and Deepak Mehta from Pittsburgh USA. We continue to welcome comments from our readers as to how the Board can improve the quality, content and topics presented? On the website, www.entmasterclass.com there is a guest page where comments can be registered and through your feedback we strive to satisfy your needs!

The ENT Masterclass continues to thrive annually and thanks to the many people who give their time, thoughts, effort as well as their money to this very worthy cause!

Professor Patrick J Bradley, MBA, FRCS
Chairman of the Editorial Board
Journal of ENT Masterclass, Nottingham.

E-mail: pjbradley@zoo.co.uk

November 2012.

Breach of copyright - lessons learnt

Apology

Having launched the 4th Journal of ENT Masterclass in January 2012, the Editorial Board was approached by Mr Robert Whitaker that "*I have been informed by one of your readers that one of my images from www.instantantomy.net has appeared in one of the articles in "Journal of ENT Masterclass Vol 4 Number 1, 2011", seemingly without permission and certainly without adequate credit to us. ..... I have not seen the image myself but it does appear that there might have been a breach of copyright. I would be most grateful if you would investigate this matter with some urgency.*"

Definition:

Copyright infringement or breach of copyright is the unauthorized use of works under copyright, infringing the copyright holder's "exclusive rights", such as the right to reproduce or perform the copyrighted work, spread the information contained within copyrighted works, or to make derivative works. It often refers to copying "intellectual property" without written permission from the copyright holder, which is typically a publisher or other business representing or assigned by the work's creator.

The authors were contacted and the error seems to have occurred when the image (Figure 1: Anatomy of the thoracic duct) was taken from the web site and downloaded into a teaching presentation. The whole page of the web site had not been opened and hence the copyright notice which is visible had not been displayed. When the topic was offered for inclusion in the Journal, the original source was not required and hence the issue of copyright was not considered. This explanation was presented to Mr Whitaker in a written letter, with a profuse apology, and signed by all 6 authors.

Mr Whitaker responded: *"Thank you for your letter of 15th February and the enclosed letter from the authors of the paper. We accept the apologies of all concerned and happily give consent for the use of the image in the article retrospectively. An acknowledgement in the next issue of the journal would be appropriate quoting www.instantanatomy.net"*

We would point out that had the authors looked more fully at the website they would have seen a copyright declaration stating that all the material on the site is copyright. We get many requests for use of material and have yet to refuse the use of small amounts."

The Editors would like to acknowledge Mr Whitaker's retrospective consent to use the image in the article from www.instantanatomy.net and accepting the apologies from the authors.

As a result of the above, and in the light or potential legal proceedings that could arise from copyright infringement, the Journal of ENT Masterclass has instigated that all material submitted must be accompanied by a covering letter which must accompany the paper at the time of submission. The letter must be signed by ALL of the authors to indicate that they have read and approved the paper and indicate the part they have played in the writing of the paper. **If excerpts (e.g., text, figures, tables, illustrations) from copyrighted works are included, a written release must be secured by the author(s) prior to submission, and credit to the original publication be properly acknowledged.** The principal author should also indicate that he/she is prepared to take responsibility for the integrity of the content of the manuscript and the letter should outline any competing interests: where none have occurred this should also be clearly stated. Competing interests include affiliation with organisations described in the manuscript.

The obligation for preventing breaches of copyright remains with the submitting authors, and not with the publishing Journal. Best to avoid such confrontations by rigidly adhering to the "Instructions to Authors" provided by journals and should be used for guidance on every occasion when submitting any manuscript for consideration for publication.

Professor Patrick J Bradley
Chairman of the Board

Mr M Shahed Quraishi
Editor

The Annual ENT Masterclass lecture 2012 "The world of ENT publications: Experience, thoughts and commentary"

Professor Patrick J Bradley, MBA FRCS
Honorary Professor of Head and Neck Oncologic Surgery
The University of Nottingham.

E-mail: pjbradley@zoo.co.uk

We have all heard of the phrase "Publish or perish!" and none more so than recently, in the UK ENT training environment, when the SAC Chairman communicated his intent to implement changes as to the number of published papers a trainee CV would be expected to have, and the type of paper, when they present for CCT in ENT.

> In his letter of explanation and clarity[1], Mr T H Lesser, states that a minimum of 18 papers at CCT should have been undertaken in the last 5 years. Of these papers only six need to be first author and to ensure that these are proper papers, they should be in a journal with an impact factor of 0.5 or more. The other twelve papers could be papers or articles, in peer review journals where one is no longer first author and could include internet publications and articles about on educational topics or training manuals for junior doctors etc etc. With respect to audit, there has been an increased number of audits presented, (in the CV's reviewed in the recent past) and I think it reasonable that there should be 12 audits over the six year period, these should be published and completed. Each cycle of the audit counts as one audit and during this time ones' own practice should be audited at least twice. This may be an audit of your ability in outpatients or some surgical procedure that is undertaken. With respect to presentations the trainee whould be expected to have done both, local and national presentations or posters and that 6 is enough of these, i.e. only one a year. Should people not have undertaken the above requirements, they will not be excluded providing that they have done something else to compensate for it like a Masters of Education or an MBA or something else.

The phrase "publish or perish" appeared in a non-academic context in the 1932 book "Archibald Cary Coolidge: life and letters" by Harold Jefferson Coolidge[2]. In 1938, the phrase appeared in a college-related publication[3]. The original comment was made in the context that some of the US research-orientated academic establishments applying some pressure on and motivate their scholars to produce cutting edge research early in their careers to focus on research advancement. Should the reader be interested in the world of citation data, uses and abuses a recent book has become available for one's perusal[4].

Scientific Journal:

So what is academic publication? In academic publishing, a scientific/academic journal is a periodical publication intended to further the progress of science, usually by reporting new research. There are thousands of scientific journals in publication, many highly specialised. Scientific journals contain articles that have been peer reviewed, in an attempt to ensure that articles meet the journal's standards of quality, and scientific validity. Although scientific journals are superficially similar to professional magazines, they are actually quite different. Issues of a scientific journal are rarely read casually, as one would read a magazine. The publication of the results of research is an essential part of scientific method. If they are describing experiments or calculation, they must supply enough details that an independent researcher could repeat the experiment or calculation to verify the results. Thus each such journal article becomes part of the permanent scientific record. Usually, rigorous rules of scientific writing are enforced by the editors; however these rules

Table I: Types of Scientific Articles:

Letters or Communications – short descriptions of current research findings

Research notes

Articles

Complete descriptions of original research findings

Supplemental articles

Usually tabular data in numerical form

Review articles

Accumulation of many articles on a similar topic, "state of the art"

These may be entirely narrative or a summary estimates from the application of meta-analytical methods

may vary from journal to journal, especially between journals from different publishers. There are many different types of journal articles (Figure 1) and the exact terminology and definitions vary by field of scientific topic and the requirements of their specific journal.

The format of journal articles vary, but most follow the general IMRAD scheme recommended by the International Committee of Medical Journal Editors (ICMJE)[5]. Such articles begin with an abstract – in short; a summary and key findings. The introduction describes the background for the research including a discussion of similar research. The material and methods provides scientific details of how the research was conducted. The results and discussion describe the outcome and implications of the research, and the conclusion places the research in context and describes topics and makes suggestions / recommendations for further research.

Traditionally, the author of an article is required to transfer the copyright to the journal publisher. The publishers claimed that this is necessary in order to protect author's rights, and to coordinate permissions for reprints or other uses.

Electronic publishing:

Electronic publishing was unknown until the invention of the computer and its widespread usage World-Wide. A definition of such form of publication or Open-Access is the "presentation of scholarly scientific results in only an electronic (non-paper) format, online, to the reader without access restrictions or the requirement of a subscription or other fee". Not only are articles freely available but copyright is also retained by authors, and articles can be republished without permission or royalty, which is lost when a scientific article is currently published in a traditional scientific journal. Publishers have responded to this type of free electronic publishing, with offering an alternative with an author-pays model, asking the author to cover production and publication fees, whilst conforming to the requirements of open-access publication in terms of availability and re-use of articles[6]. Open access medical journals are being announced with abandon, their uptake encouraged and enforced by research funding bodies like The Wellcome Trust and the current Government[7,8]. Currently there are listed at least 35 "free medical journals" available in Otorhinolaryngology, the majority published in English[9].

Costing to the Readership:

Scientists and librarians have long protested the cost of journals, especially as they see these payments going to large for-profit publishing houses. To allow researchers and others online access to journals, many universities and third level education establishments purchase site licenses, permitting access from anywhere on campus, and in some cases, by university –affiliated users at home and elsewhere. Licenses, when purchased are composed of many journal titles, from a single publishing house and thus allowing for thousands of people access to each specific journal, as distinct a print subscription is the cost for one person per journal. Concerns about the cost and open-access have led to the creation of free-access journals such as the Public Library of Science[10] (PLoS) family and partly open or reduced-cost journals. However professional editors still have to be paid and PLoS relies heavily on donations from foundations to cover the majority of its operating costs.

Hierarchy of evidence:

Evidence hierarchies reflect the relative authority of various types of biomedical research. There is broad agreement on the relative strength of the principle types of research (Table II). Some evidence hierarchies place systematic reviews and meta-analysis above randomised controlled trials since these often combine data from multiple RCTs and possibly from other study types. Evidence hierarchies are integral to evidence based medicine.

Peer review:

Through peer review and the learned journal format are seen as a convenient way of ensuring that fundamental criteria are met – a means of quality control11. This quality is the scientific one, which consists of transparency and repeatability of the research for independent verification, the validity of the conclusions and interpretations drawn from the reported data, overall importance for advance within a given field of knowledge, novelty, and applicability. This process of peer review has now been transferred to many of the open-access journals, which hereto for was not initially applied. The system of peer review on books and chapters in edited books is considered relatively weak, compared to scientific journals, and results that their status is considered second-tier.

Table II: The Hierarchy of Evidence

1. Systematic reviews and meta-analysis
2. Randomised controlled trials with definitive results
3. Randomised controlled trials with non-definitive results
4. Cohort studies
5. Case-control studies
6. Cross-sectional surveys
7. Case reports

Peer review can be categorised by the type of activity and by the field or profession in which the activity occurs. Medical peer review has been used to refer specifically to clinical peer review, to the peer evaluation of clinical teaching skills for both physicians and nurses, to scientific peer review of journal articles, and to the secondary rating of the clinical value of articles in peer-reviewed journals. Pragmatically, peer review refers to the work done during the screening of submitted manuscripts and funding applications. This process encourages authors to meet accepted standards of their discipline and prevents the dissemination of irrelevant findings, unwarranted claims, unacceptable interpretations, and personal views. Publications that have not undergone peer review are likely to be regarded with suspicion by scholars and professionals.

The decision whether or not to publish a scholarly article, or what should be modified before publication, lies with the editor of the journal to which the manuscript has been submitted. Because of the vast amount of knowledge that is available and specific areas of expertise, the editors will employ a group of reviewers to comment on the suitability of the submitted manuscript. This process hopefully ensures that articles may be improved and increases the probability that weaknesses or methodological flaws will be identified. Reviewers are typically anonymous and independent, used to discourage an ”old boy network” and provide criticism if due. In general more than one review is sought to support the concept of consistency and minimise any biases. During this process the role of the referees is advisory, and the editor is typically under no formal obligation to accept the opinions of the referees. Choosing who is suitable as a referee is the task of the editor, and should not be selected from among close colleagues, students or friends of the author's. Referees are supposed to declare any conflict of interests that exist or might arise. It has been said that recruiting referees is a political art, because most are often editors themselves, not paid, takes time, and responses must be returned by a specific deadline.

Criticism of the peer review process is that it is too slow, and typically in the past has taken months for a submitted paper to appear in print. Allegation that editorial bias and suppressing dissent against “mainstream” theories have also been made. The use of anonymous peer reviewers lack accountability can lead to abuse by reviewers and may be biased and inconsistent. Thus other systems of peer review with various degrees of “openness” have been suggested – reviewers and authors identities are known to both parties.

Impact factor:

The importance of scientific papers or journals has and will always remain difficult to judge and the impact of these on users and customers is a very fickle concept12. The use of the Impact Factor (IF) as a term is familiar to most scientists and clinicians, which was introduced by Garfield e in the 195513 and is used as one of many methods available to evaluate published journals. The journal impact factor (IF) is published annually by the ISI (a private, profit orientated commercial Philadelphia-based organisation which was formerly termed the Institute for Scientific Information (ISI)14. Access to the ISI databank is not free of charge. According to Thompson Reuters website who bought the ISI and its successor Science Citation Index (SCI), “The Journal Citation Report (JCR) provides quantitative tools for ranking, evaluating, categorising, and comparing journals. The impact factor is one of these; it is a measure of the frequency with which the “average article” in a journal has been cited in a particular year or period.” In the recent report 2011 named 51 titles that were banned for over indulging in self-citation. Naturally the best way to engineer the impact factor is to publish worthy articles that will generate most citation. But editors can apply leverage by suggesting to authors that they actively cite the papers published in that journal – self-cite. The other more common technique is to include review articles in every issue, and is to cut down the number of papers (change to letters or commentaries) published in each issue thereby shrinking the denominator in the ratio and increasing the impact factor.

When calculating the Journal impact factor (JIF), one takes into account the overall number of citations the journal received in a certain year for the two previous years and divides them by the number of items the JCR considers “citable” and were published that year. The Thompson Reuters offers 5-year JIF as well, but the 2-year JIF is the decisive one.

Example:
JIF = (2011 citations to 2010 + 2009 articles) / (number of “citable” articles published in 2009 + 2010)

The JIF is not a means to make comparisons across disciplines. That is because every discipline has a different citation behaviour. Due to limited resources the JCR covers about 8,000 science and technology journals and about 2,650 journals in social sciences. Because the coverage has been created in the USA, the JCR has an American and English-language bias. The JIF does not consider letters, editorials, etc as citable items, but if they are cited the citation is considered as part of the journal's overall citation count. However JIF's also correlates with the number of

Table III: Impact Factor of Top 40 Otolaryngology Journals		
JOURNAL	**2010**	**2011**
JARO-J ASSOC RES OTO	3.038	2.837
HEARING RES	2.428	2.696
EAR HEARING	2.257	2.578
AUDIOL NEURO-OTOL	2.228	2.465
HEAD NECK J SCI SPEC	2.182	2.403
LARYNGOSCOPE	2.096	1.752
OTOL NEUROTOL	2.065	1.904
OTOLARYNGOL CLIN N AM	1.886	1.649
AM J RHINOL ALLERGY	1.881	2.302
CURR OPIN OTOLARYNGOL	1.578	.826
ARCH OTOLARYNGOL	1.571	1.63
OTOLARYNGO HEAD NECK	1.567	1.718
CLIN OTOLARYNGOL	1.561	2.393
DYSPHAGIA	1.355	1.389
ANN OTO RHINOL LARYN	1.344	1.048
INT J AUDIOL	1.266	1.396
EUR ARCH OTO-LARYNGOL	1.214	1.287
ACTA OTO-LARYNGOL	1.2	1.084
AM J OTOLARYNGOL	1.136	0.87
J VOICE	1.108	1.39
INT J PEDIATR OTOLARYNGOL	1.067	1.167
ORL J OTO-RHINOL LARY	0.84	0.914
J VESTIBUL RES-EQUIL	0.83	1.35
LOGOP PHONIATR VOCO	0.83	0.836
SKULL BASE-INTERD AP	0.804	0.657
RHINOLOGY	0.803	1.321
J AM ACAD AUDIOL	0.797	1.296
CLIN EXP OTORHINOLAR	0.728	0.915
FOLIA PHONIATR LOGO	0.726	1.115
LARYNGOL RHINO OTOL	0.725	0.967
AURIS NASUS LARYNX	0.711	0.761
J LARYNGOL OTOL	0.697	0.6
ENT-EAR NOSE THROAT	0.595	0.659
J OTOLARYNGOL-HEAD N	0.551	0.715
HNO	0.543	0.4
ACTA OTORHINOLARYNGO	0.427	1.084
B-ENT	0.202	0.504
SPRACHE-STIMME-GEHOR	0.111	0.098
MEDITERR J OTOL	0.108	
INDIAN J OTOLARYNGOL	0.038	
J INT ADV OTOL		0.136
Am J AUDIOLOGY		0.867

authors per article, because the more authors an article has the better the chances it will be self-cited.

The regular citation window of the JIF is two years. It favours fast-moving fields, where articles are cited quickly but also obsolesce fast. Journal in slower-moving fields where citations do not accumulate quite as fast will have higher JIFs in longer time frames. So for a clinical discipline such as ENT, where the citations are not be large enough to make reasonable comparisons or it may take longer than 2 years to disseminate and respond to publish works. The two measures differ also in amount of variability between years. The two-year IF can fluctuate by around 20% in value each year, whereas the five-year measure, while still showing changes over time, presents a much smoother variation.

One of the major criticisms of the IF relates to the erroneous and potential dangerous use to determine "author's impact". Some academic institutions use the IF as a convenient tool to evaluate in process of promotion or renewal of tenure. This suggests that the IF is taken as an indicator of a person's scientific worth (Table III). The intent of IF was created with the intent of comparing journals, not authors or individual articles. Sadly authors consequently feel significant pressure to submit papers to a journal with a high IF, whether or not that journal is the most appropriate platform for their work. Many believe that the higher the journal IF that published their paper, the more their paper will be cited, but this is a myth[17]. Certainly the actual impact on the community of an article is not necessarily related to the IF[12].

What about ENT Trainees in the UK:

Having put considered a topic, gathered the data, -- once the paper has been written, where or to which journal should the manuscript be submitted? Table IV list some of the factors to be considered before submission18. Because publishing is competitive, be sure to review the criteria discussed in the article, when submitting research or original papers. Have more than one journal identified in case your paper is rejected by your first or second choice. If your paper is rejected, don't take the rejection personally. Simply consider it as an opportunity to improve the paper and submit to another journal[13,19].

Table IV: Where to submit ones manuscript for publication?
1. Topic match
2. Acceptance / Rejection rate
3. Speed of peer review, decisions and publication
4. Distribution of and access to the journal
5. Impact factor

In the UK trends in ENT publications proliferated and were presented at BACO and published, starting in 1993[20] but the initial enthusiasm ceased in the early 2000[21-23]. These attempts at listing an annual publication lists or "league tables" stimulated competition between differing regional training programmes and between the "us" and "them" teaching hospitals. This exercise made interesting reading and reflects a change in training priorities. Sadly current trainees publishing seems to have become rare if not minimal, hence the need for the communication from the SAC Chairman in 2010.

Learning comes from reading, writing, communicating and publication and the sooner one commences with the reading of the published clinical and research literature on a regular basis, then one achieves a greater understanding of the natural process of diseases. This should/will stimulate audit and hence result in the application of the principles enshrined in Evidence Based Medicine, and result in the publication of one's own clinical practice!

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The child with a runny nose

Kim To MBBS, BSc (Hons), **Michael Kuo** PhD, FRCS, DCH
Department of Paediatric Otorhinolaryngology, Birmingham Children's Hospital, Steelhouse Lane, Birmingham, B4 6NH.

Corresponding author:
Kim To
E-mail: kto@doctors.org.uk
Correspondence address as above

Abstract
A runny nose is a common symptom among children of all ages. A runny nose is often dismissed as trivial and a nuisance, but recent studies show that allergic rhinitis affects up to 40% of children, causing significant effects on their quality of life, school attendance and performance. Allergic rhinitis is also a risk factor for the development of asthma and inappropriately managed allergic rhinitis can have consequences on asthma control. This review discusses the clinical assessment of the child with a runny nose and the current management of allergic rhinitis.

Key words
Rhinitis, allergy, children, management.

Introduction
Rhinitis is a highly prevalent condition among the paediatric population. It is defined as an inflammation of the nasal mucosa and is characterized by symptoms including rhinorrhoea, sneezing, nasal itching and nasal congestion. The symptoms occur on two or more consecutive days and lasts for more than one hour on most days[1]. According to the British Society for Allergy and Clinical Immunology (BSACI)[2], rhinitis can be classified as allergic, non-allergic and infective types. In children, allergic and infective rhinitis are by far the most common. This review concentrates on the assessment of the child with a runny nose and discusses the current management of allergic rhinitis.

Rhinitis in Children
It is estimated that up to 40% of children are affected by allergic rhinitis[3,4]. Despite this, rhinitis is still under-recognised because symptoms are often dismissed as being trivial. Many studies have shown that the impact of rhinitis to children and their families is underestimated. Rhinitis is associated with a reduced quality of life, affecting sleep, school attendance as well as academic performance[5]. In the older child, symptomatic allergic rhinitis has been shown to have a detrimental effect on examination performance [6].

Allergic rhinitis is caused by an immunoglobulin E (IgE)-mediated response to previously exposed allergens. Common allergens are pollen, house dust mite and animal dander. Non-allergic rhinitis has a number of causes, generally divided into the following categories: idiopathic, vasomotor, hormonal, medications, irritants, structural defects, food, primary mucus defect, primary ciliary dyskinesias, systemic inflammatory conditions, immunodeficiency and granulomatous conditions[2]. Individuals with non-allergic rhinitis with eosinophilia syndrome (NARES) have a negative skin test but nasal secretions have a high percentage of eosinophils[7]. This condition is associated with nasal polyposis, aspirin intolerance and asthma later in life.

Both allergic and non-allergic rhinitis are recognised risk factors for the development of asthma. These conditions often co-exist, hence the term "unified airway"[8]. Numerous studies have demonstrated that inadequately managed allergic rhinitis is associated with poorly controlled asthma and increased hospitalisation for acute exacerbations[9,10]. Therefore optimal management of these children should address both the upper and lower respiratory tract. The ARIA (Allergic Rhinitis and its Impact on Asthma) guidelines were introduced to highlight this interaction and the evidence-based management[11].

Infective rhinitis is primarily viral in origin. Most children will have on average 6-8 'colds' per year[2]. In one cohort of school-aged children, the most common reported symptoms aside from systemic upset with fever were nasal congestion, runny nose and cough. These symptoms lasted for at least 10 days and rhinovirus was detected in almost half of these children[12]. Acute rhinosinusitis is a recognised complication often caused by superimposed bacterial infection. Prolonged symptoms of infective rhinitis associated with facial pain,

nasal congestion and purulent rhinorrhoea should alert the clinician to the diagnosis [13].

The diagnosis of the child with the runny nose is diverse and a thorough clinical assessment is paramount to the otolaryngologist looking after children. In more complex cases, the multidisciplinary team including respiratory paediatricians and immunologists should be involved.

Clinical Assessment

A comprehensive history to delineate the underlying diagnosis must include the main symptoms affecting the child as well as a detailed past medical history, drug history, family history of atopy, presence of pets, parental smoking and whether the child attends school or daycare.

Rhinorrhoea can either be anterior or described as a postnasal drip. Bilateral symptoms, particularly if associated with a clear nasal discharge is suggestive of allergy while the presence of purulent discharge is more indicative of infection. Blood-tinged discharge may suggest a bleeding disorder, traumatic nose picking or a granulomatous disorder like Wegener's granulomatosis [2].

It is uncommon for rhinorrhoea to be unilateral and in such cases the clinician should be alerted of other diagnoses. An inquisitive child particularly in the 0-5 year age group may have a nasal foreign body[14]. Cerebrospinal fluid (CSF) rhinorrhoea should be excluded in a child with unilateral clear watery discharge. There is often a history of trauma but non-traumatic causes should be ruled out including congenital skull base defects, meningoencephalocoeles and tumours[15]. In unilateral choanal atresia, persistent rhinorrhoea may be the only symptom in the young child[16].

Sneezing with itching of the eyes, nose and palate are highly suggestive of allergic rhinitis[2]. In severe cases, parents may report noisy breathing, snoring, throat clearing and hyposmia. Establishing the pattern of symptoms and exploring possible triggers are fundamental in managing these children. The ARIA guidelines recently introduced a new classification according to frequency and severity[11]. Frequency can be described as intermittent (symptoms lasting less than 4 days a week or less than 4 weeks) or persistent (symptoms lasting at least 4 days a week or 4 weeks at a time). Severity can range from mild with no effect on the quality of life, through to moderate/severe disease that involves interruption to sleep, daily activities, school or the existence of troublesome symptoms.

Historically, allergic rhinitis has been classified as seasonal or perennial. This classification is helpful in directing management. In the UK, symptoms that occur during Spring are highly suggestive of tree pollen allergy whereas symptoms occurring in early Summer are suggestive of grass pollen allergy. Perennial allergic rhinitis describes symptoms that persist throughout the year often from indoor allergens although perennial pollens are a recognised cause.

Nasal obstruction due to nasal congestion is typically alternating or bilateral. Unilateral symptoms should raise suspicion of a foreign body, nasal polyp, tumour or septal deviation [2]. Symptoms of the lower respiratory tract including cough, wheeze and shortness of breath are important, owing to the association of rhinitis and asthma.

A past medical history or family history of atopy may support the diagnosis of allergic rhinitis. The 'atopic march' describes the natural progression of allergic disorders in children from atopic dermatitis to food allergies, allergic rhinitis and asthma[17]. It is important to ask about drug allergies, previous treatments and current medications in a child. Prolonged use of topical decongestants can cause rhinitis medicamentosa. Finally, the social history may identify possible allergens. Important aspects to explore include housing and environmental conditions, pets, parental smoking, schooling, diet and feeding[11]. The effect of the symptoms on the child's quality of life should also be explored.

General inspection of the child may reveal facial manifestations of allergic rhinitis. A child who mouth breathes due to severe chronic nasal obstruction typically exhibits the long face syndrome associated with dental malocclusions, a gaping mouth, chapped lips and allergic shiners. Evidence of atopy include the allergic salute from constant rubbing of the nose with the palm of the hand, Dennie-Morgan folds in the lower eyelids and atopic dermatitis. Other conditions associated with allergic rhinitis include allergic conjunctivitis, otitis media and rhinosinusitis[4,11].

Examination of the nasal passages should be no less detailed than in adults and should include inspection of the turbinates, septum, presence of nasal discharge, foreign bodies and nasal polyps. It is often easier to examine the nose of younger children with an otoscope rather than with a Thudicum speculum and headlight. Nasal polyps are rare in children and should always alert the clinician to investigate for underlying cystic fibrosis 18. Nasal crusting may indicate nose picking; rarer causes include Wegener's granulomatosis, sarcoidosis and topical steroid use[2]. Nasal airflow using a metal spatula should be assessed. Children with adenoid hypertrophy present with similar symptoms of nasal obstruction and rhinorrhoea. This should be excluded by the use of nasendoscopy if tolerated and by a lateral skull radiograph if not.

Skin prick testing is recommended as a first line investigation for allergy. It is inexpensive and results are available within 10-20 minutes. It has a high sensitivity and specificity when correlated with the clinical history. However, false negatives can occur if the patient is taking antihistamines, topical steroids or anxiolytics[19]. It should not be carried out on patients with widespread atopic dermatitis.

Allergen-specific IgE testing may be used when skin prick testing is not possible or when results are equivocal[20]. Again, results must be interpreted with the clinical history. It must be remembered that a positive test indicates sensitisation to an allergen only and it may not be the cause of the child's symptoms. A good history is vital to prevent unnecessary avoidance of allergens. Measurement of total serum IgE is not always reliable or consistent due to its variability with age in childhood[21].

Other tests may include full blood count and C-reactive protein in patients with suspected bacterial rhinosinusitis; nasal smear for eosinophils and nasal secretions for β-2 transferrin. In a large retrospective study by Skedros et al[22] β-2 transferrin was exclusively found in the CSF and was shown to have almost 100% sensitivity and 95% specificity for CSF rhinorrhoea. While some consider this to be the "gold-standard", the immunoelectrophoresis involved is cumbersome and expensive. More recently, the detection of beta-trace protein by immunoblot or nephalometry has been demonstrated to have equivalent sensitivity and specificity, while employing a quicker and cheaper methodology[23]. The use of CT imaging may help to diagnose patients with structural defects.

Management of Allergic Rhinitis in Children

The management of allergic rhinitis involves education, allergen avoidance, pharmacotherapy and immunotherapy[2]. Surgery is rarely necessary. Management guidelines for infants and preschool children are currently lacking. Furthermore, drug doses in preschool children have largely been extrapolated from studies in adults[11]. A better understanding of rhinitis in this age group will help to develop better treatments in the future.

Allergic rhinitis is a chronic condition. Therefore prior to initiating long-term therapy it is imperative to educate children and their parents about the condition. In addition discussion of treatments available and the potential side effects will improve compliance and parental satisfaction.

Allergen avoidance is recommended in children with allergic rhinitis. Data from SPACE (Study of Prevention of Allergy in Children of Europe), a multicentre trial in 3 European countries including the UK, showed that house dust mite avoidance measures can prevent sensitisation in school aged children[24]. A recent Cochrane review showed that mite-proof bedding alone is not effective and that a combination of physical and chemical methods are required[25].

In children with a clear allergy to animal dander, removal of the house pet is recommended. However, symptomatic improvement may not be observed for several months due to persistence of the allergen around the home. The avoidance of tobacco smoke can reduce the symptoms of rhinitis and prevent recurrent exacerbations of asthma in children[26].

There is evidence to support the use of hypertonic saline nasal irrigation in children. A number of randomised controlled trials have shown that nasal irrigation can significantly improve nasal symptoms and reduced the use of oral antihistamines. Hypertonic saline is superior to normal saline in symptomatic relief[27,28].

First line pharmacotherapy for children with allergic rhinitis include antihistamines and nasal steroids. In the young child, oral medication is preferred because it can improve compliance. Antihistamines provide relief of symptoms of sneezing, rhinorrhoea, nasal itching but less so for nasal obstruction[29]. Oral antihistamines can also provide relief for allergic conjunctivitis and dermatitis. Intranasal antihistamines such as azelastine are licensed for use in children from 5 years of age. They have a better efficacy than oral antihistamines but only have a localised effect[30].

First generation oral H1-antihistamines readily cross the blood brain barrier and cause unwanted sedative effects and impair learning and cognition[31]. These are no longer recommended in children. Second generation H1-antihistamines including cetirizine, loratadine, fexofenadine and desloratadine are licensed for use in children in the UK[2]. They are selective for peripheral H1-receptors and are less sedating. They are more potent and have a longer duration of action so can be given once or twice daily increasing the rate of compliance.

Although there have been several randomised controlled trials demonstrating the safety of cetirizine in children as young 6 months of age, it is currently only licensed for use in children older than 2 years of age with seasonal allergic rhinitis[32,33]. Similarly, fexofenadine is only licensed for use in children greater than 6 years of age with seasonal allergic rhinitis. Desloratadine is the only antihistamine that is licensed for use in children as young as 1 year of age[2].

Intranasal steroids are more effective than oral antihistamines in treating allergic rhinitis, and can reduce the symptoms of nasal obstruction[34]. They are often reserved for moderate to

severe disease. In the UK, they are not licensed for children under the age of 4 due to concerns regarding growth suppression. Nonetheless, intranasal steroids have been shown to be safe for long-term use but caution must be taken when using high doses or if the child is already taking concomitant steroids for asthma. Fluticasone, mometasone and budesonide have low systemic absorption and have a good safety profile in children[35]. On the other hand, beclomethasone has a high systemic bioavailability and can suppress growth 36. It should be reserved for short-term use. Second line treatments for allergic rhinitis include short courses of oral steroids and topical decongestants (< 7 days)[2].

Immunotherapy involves the repeated administration of allergen extracts with the aim of reducing severity of symptoms with repeated exposure. Its efficacy has been demonstrated in a large number of randomised controlled trials[37-39]. Currently only sublingual immunotherapy with grass pollen extract is licensed for children aged 5 or over who have failed to respond to optimal medical treatment[37]. Jacobsen et al.40 demonstrated that the effects can persist for at least 7 years and reduce the progression of rhinitis to asthma in a 10 year follow-up study.

There is currently insufficient evidence on the long-term outcomes for inferior turbinate reduction surgery in children with chronic nasal obstruction[41]. Surgery for concomitant co-morbidities such adenoidal hypertrophy may be indicated. In the broader diagnostic group of chronic paediatric rhinosinusitis, a meta-analysis has demonstrated symptomatic improvement in 69.3% of patients undergoing adenoidectomy while a physiological study demonstrated improvement in mucociliary clearance following adenoidectomy[42, 43].

Conclusions

Rhinorrhoea is a common symptom among children and can have a significant impact on their quality of life and learning potential. The management of a child with a runny nose requires a comprehensive clinical assessment. Although not all children with a runny nose have allergic rhinitis, it accounts for a large proportion of these children. Allergic rhinitis is a chronic condition and control can be achieved with appropriate education and good compliance with pharmacotherapy. This is especially important because it is a risk factor for the development of asthma. The mainstay of treatment includes education, allergen avoidance, pharmacotherapy and immunotherapy. More research is currently needed on the long-term outcomes of inferior turbinate reduction surgery in children.

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Assessment and treatment of paediatric laryngotracheal stenosis

Todd Wine MD, **Deepak Mehta** MD, FRCS.
Department of Otolaryngology, University of Pittsburgh School of Medicine
Children's Hospital of Pittsburgh of UPMC

Corresponding Author:
Deepak Mehta
Director, Aerodigestive Program
4401 Penn Ave
7th Floor Faculty Pavilion
Pittsburgh, PA 15224

Email: deepak.mehta@chp.edu

Abstract
Airway obstruction can occur at any one of multiple levels. Airway obstruction at the level of the oropharynx, supraglottis, glottis, subglottis, or trachea is a common concern among otolaryngologists caring for pediatric patients. Laryngotracheal airway obstruction presents with varied symptoms. The etiologies consist of congenital, inflammatory, infectious, neoplastic, and traumatic disorders. Treatment options and prognosis vary widely based on many factors. The focus of this article will be on the assessment and treatment of pediatric laryngotracheal stenosis occurring in the subglottis and trachea.

Key Words:
Subglottic stenosis, tracheal stensosis, cricotracheal resection, laryngotracheal reconstruction, slide tracheoplasty

Assessment
Pediatric patients with laryngotracheal stenosis present having a variety of symptoms. Usually, parents describe noisy breathing. They may specifically label this noise as a wheeze, but further characterization by an astute clinician often will identify this sound as stridor, which is noisy breathing typically occurring due to pathology in the large airways Other presenting symptoms may be dyspnea, recurrent croup, a history of difficult intubation, failed extubation, asthma, chronic cough, and frequent pneumonias. More commonly patients may present with a tracheostomy and would be seen for possible decannulation. The clinician should seek to determine the onset, progression, timing, exacerbating and alleviating factors, severity, and associated symptoms. Failure to extubate, cyanosis, apnea, frequent respiratory distress and poor weight gain signify more severe disease. [see below]. Sternal or subcostal retraction or recession implies a greater degree of obstruction. Important historical information includes gestational age at birth, number and duration of prior endotracheal intubations, history of difficult intubations, choking or coughing with feeding, voice problems (weak or hoarse cry), and history of any other hospital or surgical procedures.

The physical examination of a child with symptoms suggestive of airway obstruction can be very helpful in determining the severity of symptoms. The comfort level of the patient is assessed. The respiratory rate and presence of sternal, intercostal or subcostal retractions are noted. The phase of noisy respiration can also be helpful. Classically, supraglottic pathologies will exhibit inspiratory stridor, glottic pathologies will exhibit inspiratory stridor, but may be biphasic, and subglottic pathology may have biphasic stridor. Tracheal stenosis may have either expiratory (intrathoracic) or inspiratory or biphasic stridor (extrathoracic stenosis). Auscultation of the chest and neck provide further information regarding stridor and can also identify other respiratory signs, such as wheeze, which is defined as a continuous adventitial hissing sound with a frequency greater than 400 Hz[1]. Lastly, flexible nasolaryngoscopy is invaluable in the assessment of any child with airway obstruction. In addition to inspecting vocal cord mobility, it can identify other causes of airway symptoms such as pyriform aperture stenosis, glossoptosis, adenotonsillar hypertrophy, laryngomalacia, vocal cord

immobility, glottic web, and posterior glottic stenosis. Flexible nasolaryngoscopy (2.5 mm outer diameter) is well tolerated by infants and can be used to simultaneously also assess swallowing (functional endoscopic evaluation of swallowing).

To accurately diagnose laryngotracheal stenosis, direct laryngoscopy and bronchoscopy in the operating room are required. Working with an anesthesiologist experienced in pediatric airway management is of utmost importance. Direct laryngoscopy is performed and topical lidocaine is applied to the larynx and proximal trachea. Spontaneous respirations are maintained and general anesthesia is obtained using propofol infusion. Magnified direct laryngoscopy and bronchoscopy is performed using 00 telescopes and age appropriate ventilating bronchoscopes. Care is taken to note the length, distance from vocal cords, consistency (soft versus firm), shape (anterior, posterior, circumferential) and location of the stenotic segment (supraglottic, glottic, posterior glottis, subglottic, and tracheal). In addition, the arytenoids should be palpated to ensure cricoarytenoid joint mobility, the interarytenoid space should be inspected for laryngotracheal cleft, and flexible bronchoscopy should be considered to evaluate

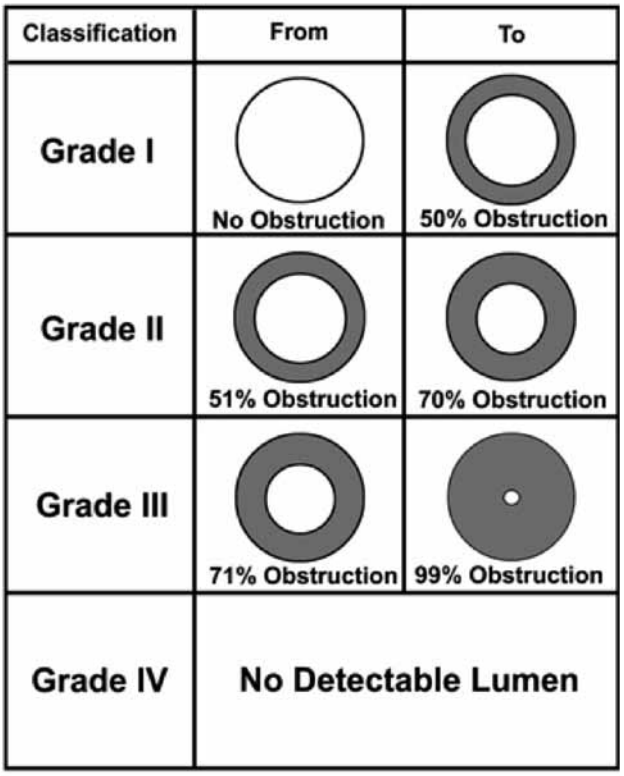

Figure 1: *Myer-Cotton grading scale for subglottic stenosis (previously published in Myer CM III, O'Connor DM, Cotton RT. Proposed grading system for subglottic stenosis based on endotracheal tube sizes. Ann Otol Rhinol Laryngol 1994;103:319; with permission.)*

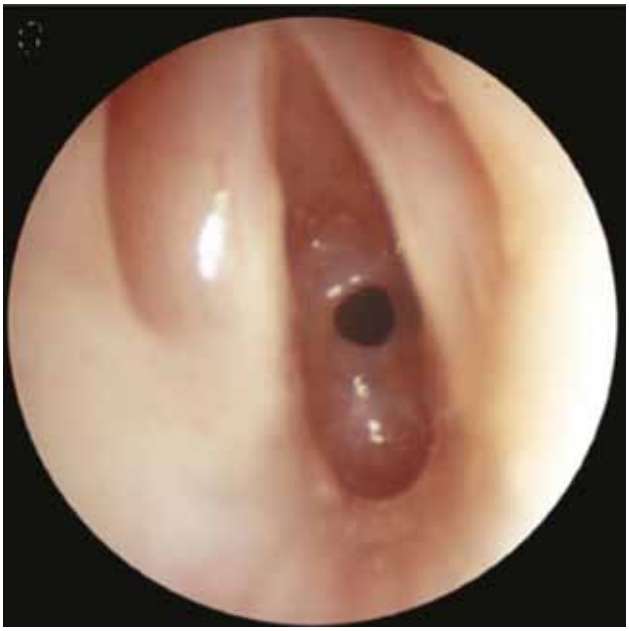

Figure 2: *Grade III subglottic stenosis*

for tracheomalacia. After photo documentation of the airway is performed, the stenotic segment is graded using endotracheal tubes. Objective sizing of the stenosis is invaluable as this allows appropriate prognostication and treatment planning. The most widely used system to stage subglottic stenosis was published in 1994 by Myer and Cotton (Figure 1)[2].

It is important to note that this system was designed for mature stenosis only. In clinical practice, soft stenosis may be sized with this system, however with decreased significance. Whereas this staging system is not ideal for soft stenosis, it is often the easiest and most understood way to measure the degree of stenosis.

In the evaluation of patients with laryngotracheal stenosis, it is imperative to evaluate and treat adjunctive co-morbidities that may exacerbate or prevent successful treatment of airway lesions. Examples include gastroesophageal reflux disease, obstructive or central sleep apnea, bronchopulmonary dysplasia, and aspiration. Thus, rigid esophagoscopy with biopsy is often performed at the initial airway evaluation to evaluate for evidence of esophagitis. Appropriate treatment for gastroesophageal reflux disease has been supported to prevent complications in LTR[3, 4, 5]. In addition to esophagoscopy, 24-hour dual-probe pH/impedance studies, gastroesophageal reflux scintigraphy, and gastric emptying scans can be useful in assessing the esophagogastric system[6]. In tracheostomized patients, the pulmonary status needs to be assessed as it will be ideal to have an optimal functioning of the lungs and role of pulmonologists to achieve this can be crucial.

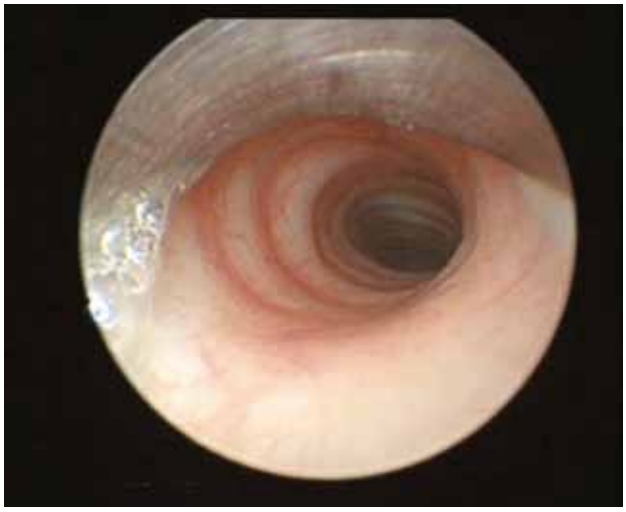

Figure 3: *Complete tracheal rings*

Radiologic assessment of laryngotracheal stenosis is generally not required. If complete rings (figure 3), severe tracheomalacia, or vascular compression are identified, chest imaging with computed tomography with contrast or magnetic resonance imaging are useful to rule out congenital cardiac defects.

In the assessment of any airway problem, the swallowing function of the patient must be considered as it can influence treatment options and treatment success. When the goal of airway surgery is decannulation, consideration of swallowing ability is of utmost importance, as a tracheostomy tube may be used to improve pulmonary toilet. Swallowing function is primarily assessed using functional endoscopic evaluation of swallowing and/or modified barium swallow, which are both done in conjunction with a speech and language pathologist. Additionally, aspiration can be assessed using a salivagram[7].

Treatment

Whereas treatment of airway stenosis can be challenging, it is often very rewarding. Allowing a child to breathe easier and/or achieve decannulation is a life changing experience for both the child and the parents. In the pediatric population, the vast majority of laryngotracheal stenoses are secondary to traumatic causes and subsequent wound healing and fibrosis. Congenital stenoses comprise the remainder. It is obvious that severity of stenosis impacts the therapeutic options. Stenoses presenting prior to mature scar formation offer opportunities to affect wound healing and therefore, the airway stenosis. As long as the stenosis is not mature, it is still malleable insofar as dilation (preferably balloon dilation +/- radial incision) can help reduce the severity of the stenosis. This may ultimately affect the therapeutic needs or options once the stenosis has matured.

The primary goal of laryngotracheal stenosis treatment is to improve airflow through the laryngotracheal system, thereby improving pulmonary function. If successful, this allows decannulation of a tracheostomy tube, the prevention of a tracheotomy, and/or improved respirations allowing decreased respiratory symptoms and improved quality of life. In our literature, decannulation rates and prevention of tracheotomy are the standard objective measures used to describe success[8,9], Optimizing the success of laryngotracheal surgery requires optimization of medical comorbidities, such as reflux disease, sleep apena and bronchopulmonary dysplasia.

Preoperative Optimization

Frequently, the patient with airway stenosis will have a history of prematurity, mechanical ventilation, and bronchopulmonary dysplasia. In assessing candidacy for airway surgery, the status of the respiratory system must be accurately determined by a pediatric pulmonologist. The respiratory physician must decide if the patient can tolerate decannulation from a respiratory perspective. If decannulation is not possible, surgical reconstruction will often be postponed to allow more time for maturation of the respiratory system.

Obstructive sleep apnea (OSA) is also optimized prior to considering airway reconstruction, as OSA may prevent successful decannulation post laryngotracheal reconstruction. The causes of upper airway obstruction should be addressed prior to airway reconstruction (i.e. adenotonsillectomy, supraglottoplasty, or maxillofacial surgery).

As stated earlier, the presence of extraesophageal reflux or eosinophilic esophagitis can decrease success in the laryngotracheal reconstruction[3-5]. As such; careful inspection for their presence is required prior to considering airway surgery. Assessment for reflux can be performed using rigid or flexible esophagoscopy with biopsy (can also identify eosinophilic esophagitis) and 24-hour dual pH/impedance probe. Reflux is treated with twice or thrice-daily H2 blockers, combined proton pump inhibition and H2 blockade, or motility agents such as erythromycin in the setting of persistent reflux after initial therapy or delayed gastric emptying. Persistent extraesophageal reflux despite maximal medical management may require a Nissen fundoplication prior to considering airway reconstruction.

Like any patient with aerodigestive disease, the swallowing function must be comprehensively assessed prior to undertaking airway reconstruction. Depending on the

clinical scenario, swallowing function is assessed in a variety of ways. The gold standard assessment is using modified barium swallow conducted by a speech pathologist using fluoroscopy. Functional endoscopic evaluation of swallowing can also be performed, but this does not evaluate the oral phase of swallowing. These assessments determine how the patient will be nourished and if further rehabilitation is required. In the most severe cases of dysphagia with florid aspiration, airway reconstruction is likely contraindicated, as a tracheotomy will be required for pulmonary toilet.

Lastly, prior to undergoing airway reconstruction, the microbiologic flora of the trachea should be sampled. If the cultures are positive for methicillin-resistant staphylococcus aureus (MRSA), treatment is recommended, both preoperatively and perioperatively because MRSA infection can be catastrophic and lead to graft failure. Treating MRSA proactively is supported by a recent study documenting zero postoperative MRSA infections and an overall infection rate equivalent to the non-MRSA infected patients. Growth of other bacteria can be utilized to guide perioperative antimicrobial therapy.

Subglottic stenosis

Treatment of subglottic stenosis is dependent on its severity and shape. Most grade I and low grade II stenosis can be observed and require periodic assessment via laryngoscopy and bronchoscopy to assure the lesion is not progressing as the child ages. These stenoses are usually mildly symptomatic and observational management with expectant airway growth and decreased symptoms over time is the normal occurrence. High-grade II, III and IV stenoses are all candidates for surgical therapy.

In the neonate, failed extubation due to subglottic stenosis can be treated a little differently than in older children. At this age, a reduction of the radius by 0.5 – 1 mm can drastically affect resistance to airflow. As such, treatments such as anterior cricoid split and endoscopic anterior cricoid split have been discussed as an alternative to tracheotomy. Anterior cricoid split is well described in the literature and has success rates ranging from 54 – 80%[11,12,13,14]. A newer, less invasive technique was recently published describing endoscopic anterior cricoid split. This procedure entails endoscopic incision of the anterior cricoid followed by balloon dilation (8mm balloon)[15]. The child is reintubated for 24 hours and then extubated. To increase the success of the anterior cricoid split, some have advocated laryngotracheal reconstruction with a thyroid ala graft in infants with subglottic stenosis[16,17]. The success of this operation has been reported as 80 - 90%.

Outside of the neonate, and in children greater than 12 months, the majority of open airway reconstruction is performed using costal cartilage augmentation as popularized by Cotton[18]. Laryngotracheal reconstruction (LTR) can be used for severe subglottic stenosis, grade II and above. Briefly, LTR involves anterior and/or posterior cricoid split with anterior and +/- posterior costal cartilage grafting. The cartilage is oriented with the perichondrium facing the airway allowing for faster mucosalization.

Single stage LTR involves decannulation of the tracheostomy tube at the time of reconstruction. This requires endoluminal stenting using an endotracheal intubation for approximately 5 – 7 days. Bronchoscopic assessment is performed prior to extubation and again in 7 – 14 days to reassess the reconstructed site. Occasionally, removal of granulation tissue or balloon dilation will be required to maximize the lumen of the airway and ensure appropriate healing. Typically, these patients will remain in the intensive care unit during the period of intubation and another 3-7 days depending on clinical course.

Double stage LTR uses a tracheostomy tube distal to the reconstruction and suprastomal stenting of the reconstructed site. These patients typically have shorter stays in the hospital and are discharged in 7 days or less. They return in 3- 8 weeks for stent removal and assessment of the reconstructed site.

The success rate with LTR is very good in the largest series ranges from 74 – 100% depending on the stage and procedure. When evaluating the operation specific success, a different picture emerges. In the largest series to evaluate operation specific success, grade III and IV subglottic stenosis are successfully reconstructed 55 and 53%, respectively. The overall success for grade III and IV stenoses were 79 and 88%, respectively. This prompted the advent of partial cricotracheal resection. It currently is considered the best option for severe grade III and IV with overall success rates 93%. Partial cricotracheal resection (CTR) was an established technique in the adult population dating back many decades. In the pediatric population, concerns regarding resection of cartilage and potential growth limitation purveyed. Savary and Monnier[23], published their results using this technique in 1999 and Cotton was short to follow in 2000[20, 21]. Currently, it is considered the best option for dealing with severe grade III and IV stenoses of the subglottis provided there is sufficient distance from the inferior limit of the vocal cords for the thyrotracheal anastomosis (approximately 5 mm). Perhaps the most difficult subglottic stenosis to correct is that associated with severe glottic, posterior glottic, or supraglottic stenosis. Treatment in this case

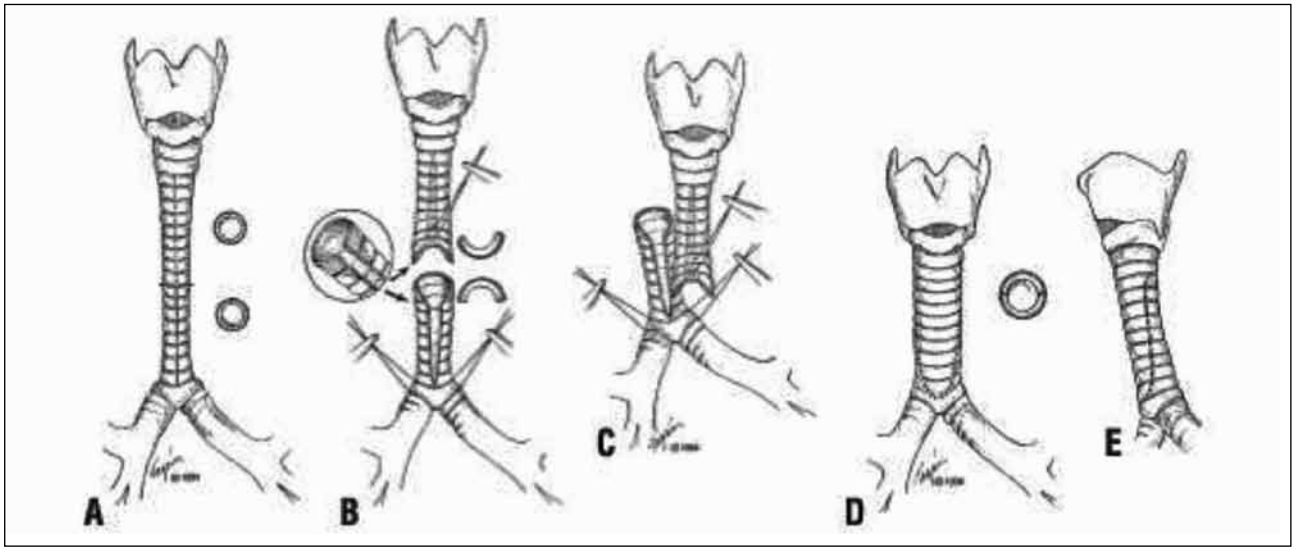

Figure 4: *Slide tracheoplasty. Depiction of steps. Note the posterior vertical incision on the proximal tracheal segment and the anterior vertical incision on the anterior segment (with permission, previously published).*[23]

involves CTR with additional open airway procedures. These have been less successful with overall success rates between 56 – 79%[22, 23, 24].

Tracheal stenosis

Treatment of tracheal stenosis is dependent on the severity, distance from larynx, location (cervical or thoracic), and length. Stenoses that are mild to moderate, short, and anterior may do very well with bronchoscopic treatment consisting of radial incision (using carbon dioxide laser) and balloon dilation with or without mitomycin C. Recurrent stenosis or severe stenoses can be treated with tracheal resection and primary anastomosis. Assessment of the location is imperative to determine if mediastinal exposure is necessary. Although tracheal resection can technically be performed when resected segment of trachea is 50% or less of the total tracheal length, resecting up to one third of the trachea is a much more conservative threshold. The longer the resection, the more likely it is that anastomotic complications will occur.

Long segment tracheal stenosis (greater than 50% of tracheal length), such as that occurring with complete tracheal rings is best treated with slide tracheoplasty. This technique was reported by Tsang, et al. in 1989 and later Grillo, et al. in 1994 and has revolutionized the management of long segment tracheal stenosis[25, 26]. This technique is now favored over other surgical treatments for long segment tracheal stenosis, including pericardial patches and cartilage grafts, due to improved success and decreased mortality. Its overall success is estimated to be around 90%[27, 28]. Slide tracheoplasty is performed by dividing the stenotic segment in half, incising the proximal segment posteriorly and distal segment anteriorly, and then advancing the two segments together such that they overlap (Figure 4). In effect, this will double the diameter and decreases the length of the trachea by 50% of the length of the stenosis. As such, this allows treatment of tracheal stenoses that involve the entire length of the trachea. Postoperatively, the goal is to extubate as soon as possible, and in one large series, extubation within 48 hours was possible in 53% of cases[29]. Postoperatively, tracheomalacia will exist and expiratory stridor is not uncommon. Postoperative endoscopy is unique in that the trachea appears to have a figure eight appearance due to the lateral anastomosis along the length of the trachea (figure 5).

Open surgery of the trachea poses risk to the recurrent laryngeal nerve, the blood supply to the trachea and anastomotic failure. A key tenet to tracheal surgery is to preserve the lateral blood supply to the trachea as this will protect the vascularity to the trachea and preserve the underlying recurrent laryngeal nerves. Mobility of the tracheal segments is achieved by anterior and posterior dissection, laryngeal release, and rarely hilar release.

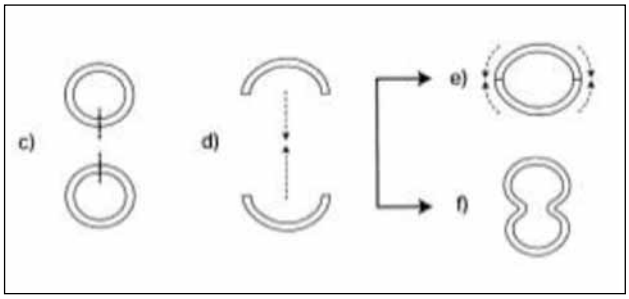

Figure 5: *Depiction of figure 8 deformity possible after slide tracheoplasty (with permission, previously published).*[22]

These maneuvers allow tension free anastomosis, which increases the chance of overall success. Cervical flexion and chin-to-chest sutures help preserve a tension-free anastomosis.

Conclusion

Providing the optimal care of the child with laryngotracheal stenosis requires a thoughtful assessment starting with a thorough history and diagnostic workup. The diagnostic workup requires flexible nasolaryngoscopy, direct laryngoscopy, and rigid bronchoscopy. Adjunctive assessments using swallow studies, esophagoscopy, and microbiologic assessment and identification of comorbidities are imperative. Understanding the various reconstructive options based on the individualized assessment will allow creation of the optimal plan, which is likely to maximize the chances of success.

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Indications and results of pinnaplasty in children

F David L Walker[1] PhD, FRCS (ORL/HNS)
Lyndsay Fraser[2] FRCS (ORL/HNS)
W Andrew Clement FRCS (ORL/HNS)[2]

[1] Victoria Hospital, Kirkcaldy, Fife
[2] Royal Hospital for Sick Children, Yorkhill, Glasgow

Corresponding Author:
David.walker7@nhs.net

Abstract

Pinnaplasty is one of the most common cosmetic operations carried out on children. Whilst many surgical techniques have been described, this article will consider patient selection and report on outcomes.

Patient selection is key to success and satisfaction of this procedure. The consensus opinion is that the patient should be of school age and be the person who is pressing for surgery. This makes agreeing outcomes easier and means that the patient can partake fully in the planning process.

More than 200 different techniques have been developed. These techniques can be broadly divided into cartilage sparing, cartilage cutting or a combination of methods. The outcomes reported for each technique are similar, generally good and patient satisfaction is high.

This article discusses the common potential early and late complications, their avoidance and management.

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Key Words

Pinnaplasty, Patient selection, Outcomes, Complications

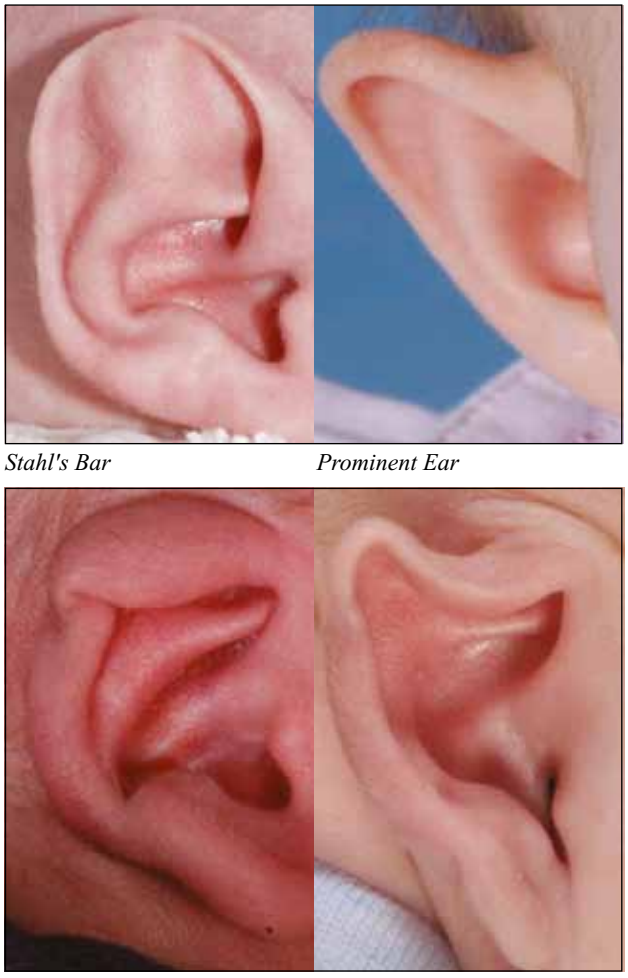
Introduction

Pinnaplasty (otoplasty) includes all operations to reshape the outer ear including the pinna and the conchal bowl. It is one of the most commonly undertaken cosmetic procedures in children with the incidence being reported in North America at around 5% of the Caucasian population[1]. More than 200 techniques have been described to correct prominent and folded ears[2] and whilst the individual techniques are too broad a subject to be discussed in any depth, the collective techniques and types employed are summarised below. Prominent ear correction is probably the most common form of pinnaplasty surgery but other types can include repair of lop, cup, rim kink, Stahl deformities and cryptotia (Figure I). Most importantly the surgical procedure chosen should be one that addresses "why the ear appears prominent". This is most commonly due either to a lack of superior crus or body of the antihelix or related to a prominent conchal bowl. Non surgical ear splinting can also be carried out whereby the pinnas of newborns are splinted using wire to correct cosmetic deformities without surgery and will be discussed below. Most of the literature however is concerned with correction of prominent ears. There are very few publications available on the remainder of ear deformities other than for cryptotia which if persistent requires more involved surgery for cosmetic correction. This paper will discuss the surgical correction of folded and prominent ears. As with all forms surgery and none more so than cosmetic surgery, the most important step is not the surgery itself but patient selection.

Patient Selection and Preoperative Planning

Reduction in prominent ears is a purely cosmetic procedure and there has been much recent debate on the appropriateness of children undergoing cosmetic surgery[3,4]. GMC Guidance and UK law permits doctors to undertake operations on children that do not offer immediate or

Figure I: *The Common Types of Pinna Deformity.*



Stahl's Bar *Prominent Ear*

Cup Ear *Rim Kink*

obvious therapeutic benefits so long as the surgical procedure is in the best interests of the child. An assessment of the "best interests of the child" must include religious, cultural and social beliefs of the child and family and also any social, psychological or emotional benefits resulting from the surgery[5]. Pinnaplasty is generally carried out because of the child's own self consciousness of their ears or as a result of teasing and bullying which can lead to truancy and psychosocial dysfunction[2,3,4]. Outcomes of pinnaplasty operations are generally good and most children report a reduction in the amount of bullying[4,6]. It is difficult to predict who will suffer psychological distress in the future and as such there is no evidence that pinnaplasty helps to effectively prevent bullying that has not as yet occurred[4]. Cosmetic procedures in adults are generally not undertaken within the NHS other than with proven psychological problems. In Scotland, National Guidelines have been drawn up on provision of cosmetic procedures and these can only be offered under the guidelines to children aged up to 18[7].

The timing of surgery must also be considered carefully but to date no agreed guidance has been published. It is generally felt appropriate that children of school age are considered for the surgery[3]. It is felt that by this age children are better able to take part in the decision making process and a survey of surgeons, parents and psychologists concurred finding that children aged 6 and over were best suited8. In addition there was also consensus that surgery should not be carried out unless the child wants the surgery and is the main driver requesting the procedure8.

Whether or not a patient is offered surgery will also be controlled by other factors. Of these the surgeon's ability should be paramount and they should not take on patients whom they feel they will not adequately be able to help. As with all surgery revision surgery is always more difficult and in a pinna, where there are sutures, loss of tissue planes and scarring, it can make the operation very difficult. It is best remembered that these are most often children and they will have to live with our poor outcomes for a very long time.

Preoperative photographs, as in all cosmetic procedures, are mandatory both for monitoring outcomes and in preoperative planning. These are used in different ways and the technique we employ is discussed below under outcome measures. In addition the outcomes and expectations must be agreed between the patient, their parents and the surgeon. Some surgeons also measure the angle of the pinna and various distances from the head in order to monitor outcomes postoperatively (see below under outcomes).

Pinna Splinting

Splinting of the pinna generally takes place when the child is a neonate, preferably within the first 6 weeks, with the earlier the intervention, the shorter period the splints are required and the better the outcomes. Splints are commercially available and patients require as little as 2 weeks splinting. This has been shown to be an effective technique[9] and removes the need for later surgery.

Surgical Techniques

If the patient does proceed to surgery the technique used is usually dependent on the surgeon's training and preferences in addition to the deformity that is to be corrected. The techniques are generally divided into cartilage sparing and cartilage cutting techniques. These are both approached via a post auricular incision where varying amounts of skin are excised. Incisionless techniques have been described which involve percutaneous sutures[10] but these are not widely practiced in the UK. The earliest pinnaplasties were carried out using a cartilage cutting technique[2]. A review of a modern cartilage cutting

technique, known as the Pitanguy technique[11] involving full thickness cuts being made parallel to the helical rim prior to using sutures to position the cartilage to correct the deformity, has shown these techniques to be effective. Cutting can also be used to sculpt the cartilage. The main risk of these techniques is in the creation of sharp edges in the cartilage which can be easily seen in the pinna and these must be avoided. Stenström[12] described a technique where the cartilage on the convex side of the ear is scored to reduce its strength causing the pinna to bend away from the scoring. This is generally used to recreate an antihelical fold.

Cartilage sparing techniques such as those of Mustarde[13] and Furnas[14] are based around the use of mattress sutures placed posteriorly deep to the skin to position the cartilage where required. The material of the suture is not important as it is the scarring resulting from the surgery which holds the cartilage in its new position giving the pinna its new shape. As with most things in medicine most surgeons rely on a combination of these techniques to achieve the results required.

Following pinnaplasty it is common for patients to wear some form of bandage or dressing for a variable period following the operation. This is to protect the wound whilst healing and prevent inadvertent reflection of the pinna forward or haematoma formation. The length of time this dressing is worn has been debated and there seems to be little difference in outcome or complication rate if the dressing is worn for a long or short time[15]. The authors currently recommend that a neoprene type head band is used for the first few days (3-5 days) to support the repair and to protect it from inadvertent trauma.

Outcomes, Complications and Outcome Measures

Complications following pinnaplasty are rare and overall satisfaction rates are high with reported rates between 85-95%[16,17,18] irrespective of technique used 19. Reported rates of revision surgery are consistent with this at up to 12%[16] of patients requiring revision. It is important to remember that different techniques generate different types of complication. Most obviously suture problems will only occur in operations when sutures are used. Given that most surgeons generally use a combination of techniques, comparing outcomes between techniques is therefore difficult. In addition all the cartilage scoring or excising techniques are often grouped together into "cartilage sculpting" techniques. Studies comparing suturing techniques with cartilage sculpting techniques have been done however and these have shown a significantly higher revision rate when using a Mustarde type technique 19,20, thought to be due to the sutures cutting through over time[16]. This can however be improved by using a perichondral flap[21]. Most studies are carried out on pinnaplasties for prominent ears and little good evidence is available for outcomes of other ear deformities.

Complications following pinnaplasty can be divided into either early or late. Early complications, occurring within the first 2 weeks, include haematoma, wound dehiscence, infection and skin or cartilage necrosis. Late complications include suture complications, suture extrusion, granuloma or abscess, keloid or hypertrophic scars, hypoaesthsia, recurrent deformity or patient dissatisfaction. These can occur after the first 2 weeks in the case of abscesses but may present after more than a year in the case of suture extrusion.

The worst early complications are haematoma and infection[22] and generally occur within the first 2 weeks. Haematoma can result in blood flow compromise, due to pressure effect, and can also make the patient more vulnerable to infection. These in turn can then lead to perichondritis, chondritis, cartilage necrosis and subsequent malformation. Other early complications within the first 2 weeks include skin necrosis and wound dehiscence. Early complications are reported generally at around 5% or less[16,17] but it was noted[16] that most studies did not mention most early complications such as bleeding or haematoma. A small amount of bleeding postoperatively is common in most operations and it may be that most authors did not report this as a complication. Whilst late complications are reported more commonly, overall late complication rates remain low[16]. The most common adverse outcome is patient dissatisfaction[2]. This may be due to recurrence of the deformity, undercorrection of deformity, overcorrection of the deformity or poor cosmetic outcomes of the contours of the pinna. An example of this is when a cut is made in the cartilage a sharp edge is noted in the contours of the pinna. Suture extrusion and keloid scarring are generally reported at up to 10%[16,19].

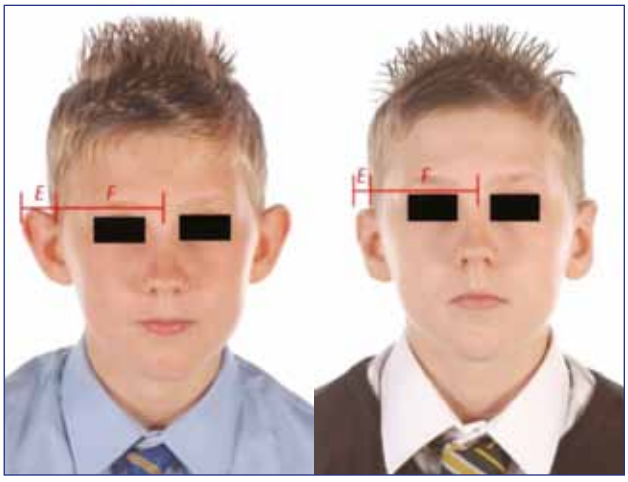
Outcome measures are not frequently used in pinnaplasty but generally patient satisfaction is assessed using questionnaires, telephone interviews or visual analog scales[23]. Some broadly used outcome measures such as the Glasgow Benefit Inventory (GBI) have been employed[24]. These are single questionnaires which are carried out postoperatively and assess patient symptom improvement. These have shown that pinnaplasty does have a positive impact on patients' symptoms and post procedure results[24].

Formal qualitative or quantitative assessment following pinnaplasty is difficult. Objective measures have been proposed by McDowell[25] and Wright[26] and these are

Table I: Suggested Otoplasty Goals [25,26].
All traces of protrusion in the upper one third of the ear must be corrected (some remaining protrusion in the middle third or lower portions may be acceptable, provided the superior aspect is thoroughly corrected; however the reverse does not hold true.
From the front view, the helix of both ears should be seen beyond the antihelix) at least down to the mid-ear and preferably all the way).
The helix should have a smooth and regular line throughout.
The postauricular sulcus should not be markedly decreased or distorted.
Protrusion should measure between 15 to 20mm from head to helix.
Protrusion of the two ears (i.e. distance from the lateral border to the head) should be within 3mm at any given point.

displayed in Table I. These are based around projection angles and distances of the pinna from various parts of the head, but perhaps because this is fairly difficult to perform and does not relate to the patient's view of their ears, they have not been widely adopted. We use a technique where the distance the pinna protrudes from the head, as shown on the frontal views of the pre and post operative planning photos, is represented as a proportion of the face. The change postoperatively is then represented as a change in proportion[27]. This technique is shown in Figure II. The distances E (ear) and F (face) are measured pre and postoperatively. The proportion that the ear makes of the face can then be calculated. In a successful operation the ear makes up a smaller proportion of the face. This has the advantage of addressing the view the patient see of themselves[27]. It does not however address the shape and smoothness of the contour of the pinna.

Figure II: *Facial Proportions in Assessment of Pinnaplasty Outcomes[27].*



Preoperative view *Preoperative view*

Conclusions

Pinnaplasty is a common operation most often carried out on children. There are a wide range of techniques employed suggesting that there is no one single best technique but, as with so much in surgery, it is dependent on the surgeon, their skills, patient selection and the precise problem being addressed. Outcome measures are similarly variable but it is important, irrespective of the technique, that a surgeon audits their own outcomes and measures their own complications with a tool they have confidence in so that they may better inform their patients preoperatively of the precise risks involved with the procedure.

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Further Reading:

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Management strategy for cervical adenopathy in children

Owen Judd MRCP, FRCS(ORL-HNS), DCH
Specialist Registrar in ENT
Department of Otolaryngology
Queen's Medical Centre
Nottingham, UK
owenjudd@doctors.org.uk

F Javed Uddin BSc(Hons), MRCS, FRCS(ORL-HNS)
Consultant ENT Surgeon
Department of Otolaryngology
Leicester Royal Infirmary
Leicester, UK
fj.uddin@yahoo.com

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Introduction
Cervical adenopathy can be defined as an enlargement of either a single or a group of cervical lymph nodes in the neck. In the healthy child, the majority of cervical lymph nodes are impalpable. When a single lymph node or a group of nodes become enlarged then parental and clinical anxiety manifests, and an explanation for such enlargement or increase in size is sought. Periods or episodes of cervical lymph nodal enlargement are common in childhood, and in the majority of cases are due to benign reactive lymphadenopathy, whilst serious pathology is rare. We present a strategy for the management of paediatric cervical lymphadenopathy in the following article.

Immunology
Lymph nodes consist of capsulated lymphatic cells or tissue, further sub-divided into a cortex and medulla with respective sinuses allowing flow of lymph fluid, an ultrafiltrate of the plasma, through the node from afferent to efferent vessels. The lymph nodes allow the immune system to 'monitor' the circulating plasma for antigens, and macrophages within the sinuses recognise and remove up to 99% of all antigens presented.

The cortex of the nodes contain primary and secondary lymphatic nodules or follicles. Within these follicles two layers of cells exist which act as the immunologically active centre of the node. A deep germinal centre is the site of activated B-cell proliferation, whereas the more superficial zone is the site of T-cell proliferation. The deepest structure within the node is the medulla. This is the site of B-lymphocyte differentiation into plasma cells, which when activated secrete immunoglobulins into the efferent lymph (Figure 1).

As the nodes develop and mature they increase in size, and dependant on their site in the body may become clinically detectable. They are very small and not usually palpable in

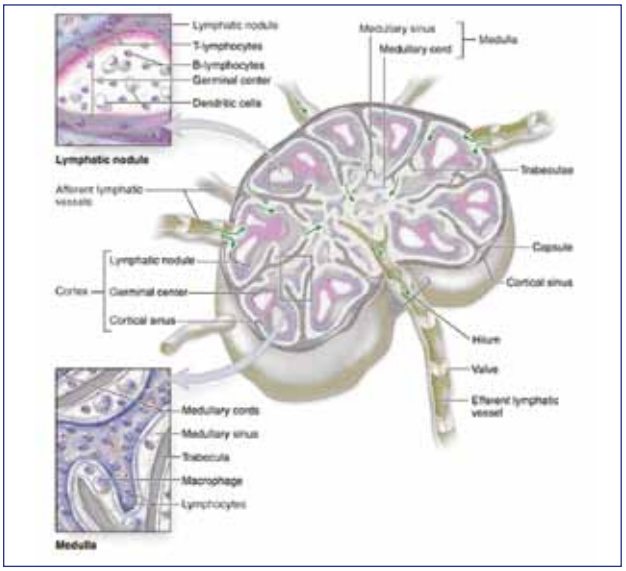

Figure 1: *The lymph node and its ultrastructure (from Michael McKinley and Valerie O'Loughlin, Human Anatomy ©2006, McGraw-Hill, reproduced with permission of The McGraw-Hill Companies).*

infancy, but then rapidly increase in size during childhood as the immune system develops, and begin to atrophy from adolescence onwards. Lymph nodes are therefore often larger in children and 38-45% of normal children will have palpable cervical lymphadenopathy at some stage in their development[1].

Aetiology

Cervical lymphadenopathy may result from:

- a local or systemic source of infection drained by the nodes (infective)
- activation of the node and thus multiplication of cells (inflammatory)
- infiltration by malignant cells (neoplastic).

Infection

When a child develops a viral or bacterial infection, whether short-lived and self-limiting or not, macrophages within the nodes initially react to the viral antigens presented as foreign. This will activate the production of B and T-lymphocytes and immunoglobulins in the node and consequently the node will increase in size. Therefore the most common cause of cervical lymphadenopathy in a child is reactive, secondary to a viral infection (upper respiratory tract infection or tonsillitis)[2].

The lymph nodes themselves may become primarily infected, and infiltrated by neutrophils laden with inflammatory cells causing the lymph nodes to enlarge. This form of lymphadenitis is most commonly caused by bacterial infection locally with streptococcal or staphylococcal species implicated in 40% to 80% of cases[2]. If untreated, this will often lead onto other nodes in close proximity, becoming matted together into one large mass and may even suppurate and form an abscess.

Other forms of localised or systemic infection may cause palpable cervical lymphadenopathy and these include: cytomegalovirus (CMV), Epstein-Barr virus (EBV), Bartonella species (cat scratch fever), toxoplasmosis, tuberculosis (TB), and atypical mycobacterial infections. Rarely, other infective processes may result in enlargement of cervical lymph nodes, such as typhoid fever, leishmaniasis, trypanosomiasis, schistosomiasis, filariasis, and fungal infections. These are common causes of paediatric cervical lymphadenopathy in developing nations. Uncommonly, HIV may be a cause of paediatric cervical lymphadenopathy[3].

Inflammatory

Lymphadenopathy may have a non-infective aetiology, and causes include Kawasaki disease, Kikuchi-Fujimoto disease, Rosai-Dorfman disease, sarcoidosis and Langerhans cell histiocytoses such as Hands-Schuller-Christian disease and Letterer-Siwe disease. Metabolic storage diseases such as Gaucher's disease may lead to node enlargement secondary to faulty metabolism in nodal macrophages and collagen storage diseases such as lupus and juvenile rheumatoid arthritis may present with lymphadenopathy.

Certain medications may lead to lymph node enlargement. These include phenytoin, pyrimethamine, allopurinol, phenylbutazone, and isoniazid. The lymphadenopathy usually resolves on cessation of the treatment.

Neoplastic

Malignant infiltration of nodes may present as cervical lymphadenopathy such as in lymphomas (both Hodgkin and non-Hodgkin's), leukaemia, neuroblastoma[2], rhabdomyosarcoma and rarely salivary gland neoplasms.

Management Strategy

In children, the aim is to exclude malignancy, as opposed to confirm the suspicion of malignancy as in adults. The strategy should encompass the following approach.

History

A thorough and structured history (Table 1) taken from the child and the parents/carers is paramount to attaining an accurate diagnosis[4]. Most episodes of cervical lymphadenopathy are self limiting and benign. However, it is essential not to miss the rare and more sinister causes

Table 1. Key features in the history of a child with cervical lymphadenopathy.

• the duration and speed of onset of the lymphadenopathy
• whether there has been any recent increase in size of the nodes (as opposed to fluctuation in nodal size which is usually due to a reactive cause)
• associated symptoms: a history of a recent upper respiratory tract infection, tonsillitis or skin lesions suggest a reactive node
• associated symptoms: the presence of weight loss, night sweats and fever points to a more sinister process
• contacts (TB, cats and farm animals)
• recent travel abroad
• prior or family history of cancer

such as malignancy[5]. Based on the history, the lymphadenopathy can be classified as acute, subacute or chronic.

Acute lymphadenopathy

This defines nodes that present rapidly and are present for less than 2 weeks. The history will often include infective or systemic symptoms such as a sore throat, a cough, otalgia and skin lesions. These usually point to simple self-limiting viral infections or a local bacterial infection. In the vast majority, these presentations can be managed expectantly and require no further investigation.

Subacute lymphadenopathy

This accounts for nodes that present more insidiously and last for 2-6 weeks. Rarer forms of infection may result in this picture. Bartonella infection, mycobacterial infection, and toxoplasmosis are examples. The nodes will often suppurate and classically in atypical mycobacterial infection, the overlying skin will become violaceous in a child who is otherwise well. Suppuration may ensue leading to scarring and an unsightly discharging sinus (figure 2).

Chronic lymphadenopathy

This is diagnosed if the enlarged nodes are present for more than 6 weeks[6]. Infective pathogens may be causative in these cases, but the overriding concern is malignancy. Malignant nodes are often accompanied by systemic symptoms such as weight loss, lethargy and malaise, night sweats and fevers. There is a higher risk a node may be malignant if it is situated in the lower levels of the neck[5]. Malignant risk factors also include nodes larger than 3cm (the size of a golf ball), mediastinal involvement, older children, hepatosplenomegaly and raised lactate dehydrogenase (LDH) levels[4].

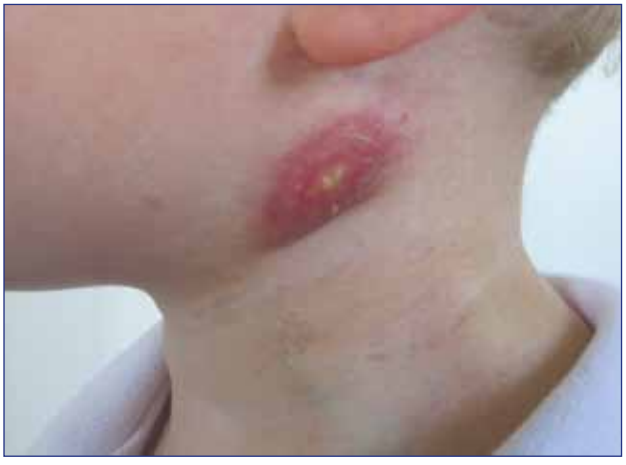

Figure 2: *A chronically discharging neck sinus from atypical mycobacterial infection.*

Examination

Examination of the ears, nose, throat, head and neck and upper aerodigestive tract is required to look for a primary infective source. The scalp should be examined carefully, as discrete skin lesions may be discovered, and are a common cause of reactive lymphadenopathy. The level and size of the dominant enlarged cervical node should be recorded. Examination findings of multiple, mobile, soft, tender nodes with or without identification of a local infective cause suggest benign disease. However, large, firm, rubbery, irregular, solitary nodes or those located in the supra-clavicular area suggest a possible malignant process. If the nodal examination suggests malignancy, one should examine the axillae and inguinal regions for evidence of systemic lymph node involvement and an abdominal examination for hepatosplenomegaly.

Investigations

Nodes that are small (< 1cm), mobile and fluctuate in size are consistent with reactive nodes and the child can be discharged and the parents advised to bring the child back if there is a persistent increase in size or number of nodes. Any suspicions that cervical lymphadenopathy is not a simple acute reactive condition should prompt further investigations such as blood tests and imaging.

Blood tests to include:

- Full Blood Count (FBC) and differential - to assess for infective aetiology and monitor therapy.
- Serology +/- Polymerase chain reaction (PCR) – useful to diagnose infective causes if suspected, such as CMV, EBV, toxoplasmosis, *Bartonella henselae* (cat scratch disease) and HIV if indicated.
- Skin tests – such as Mantoux or Heaf, looking for reactions indicative of tuberculosis.
- Lactate dehydrogenase (LDH) – can be useful if lymphoma suspected.

Imaging may assist in diagnosis via various modalities such as:

- Chest Radiograph (CXR) – essential to assess for mediastinal involvement in suspected malignancy or pulmonary involvement in diseases such as TB.
- Cervical Ultrasound (USS) – useful to confirm whether a mass is of lymph node origin, of cystic or solid consistency, and to comment on lymph node architecture and size. It may assist in ascertaining the likelihood of

suppuration or abscess formation. It can be useful to differentiate benign from malignant pathology in experienced hands and may help to avoid unnecessary surgical biopsy[6].

- Computed Tomography (CT) / Magnetic Resonance Imaging (MRI) – may be employed if the deeper neck structures require to be evaluated, for delineating possible deep neck space abscesses, or for staging in possible malignancy.

Fine needle aspiration (FNA) is controversial in children as it is non-specific, cannot reliably diagnose or exclude lymphoma, and there is a need for sedation or general anaesthetic. If aspiration is performed, it is useful to obtain material for microbiological assessment and well as cytological. In fact, FNA for suspected TB in a suppurating node has been shown to be as sensitive and specific as excision biopsy[7,8]. In some centres, aspirates may also be assayed via the polymerase chain reaction (PCR) to rapidly diagnose atypical mycobacterial infection, Bartonella and other infective conditions more quickly than simple culture[9].

For larger nodes (> 1cm in the under 1 year olds, > 3cm in the over 1 year olds), supraclavicular nodes or with a history of cancer, an excision biopsy should be performed. An excision biopsy is also often required for persistent lymphadenopathy of unknown diagnosis, or to subtype a suspected malignancy (Table 2). It is also a treatment of choice in certain atypical infective conditions.

Treatment

The management of cervical lymphadenopathy in children is dictated by the cause, the clinical state of the child and the local expertise. As a viral cause is usual in the majority of acute cases, an expectant conservative approach is appropriate in the first instance, in the absence of any other sinister features. Antibiotics may be required if a bacterial infection is suspected, such as streptococcal or staphylococcal species[2]. However, serology or PCR proven viral infections such as EBV and CMV often need only observation.

Table 2. Indications for excision biopsy of a cervical lymph node in children.

size	> 1cm in under 1 year old > 3cm in over 1 year old
site	Supraclavicular or nodes in the lower neck levels
prior cancer	Personal or family history of cancer
known cancer	For subtyping
diagnosis	Unable to reach diagnosis or for parental reassurance

Bartonella infection proven on serology or PCR does not require any treatment, as the vast majority of cases are self-limiting. However, if the patient is immunocompromised, antibiotics must be used to prevent disseminated disease. The treatment of choice should be discussed with the local microbiology department and is likely to comprise azithromycin and doxycycline[10]. Toxoplasmosis is treated in a similar manner in immunocompetent children. TB will usually be treated with antituberculous medication.

A typical mycobacterial infection however, is more difficult to treat without complications. Traditional treatment with serial aspirations, or incision and drainage is often unsuccessful and may lead on to complications such as chronically discharging fistulae[9,11]. Surgical excision is therefore generally advocated as the treatment of choice[11]. A watch-and-wait strategy or prolonged antibiotic therapy may be considered when surgical excision carries a high risk of facial nerve injury[11,12]. It has been shown, however that in immunocompetent children, complete resolution may occur by twelve months without the need for long-term antibiotics or surgical intervention[12].

Cervical lymphadenopathy caused by a connective tissue disorder, storage disorder or malignancy requires specialist paediatric referral for treatment.

Summary

A detailed initial clinical assessment of the child will result in one of three strategies to be employed.

i) Reassure - if the node is < 1cm with no suspicious features then discharge with advice to return if the nodes increase in number or size.

ii) Investigate and review – if the node is > 1cm (except in under 1 year olds) with no suspicious features, blood tests including serology, a CXR, USS[6], and subsequent review. Antibiotics may be used if indicated. If features are suggestive of tuberculosis or atypical infection, then FNA (with PCR if available) may yield a diagnosis and avoid unnecessary excision in some centres[9].

On review, if serology is positive, then discussion with microbiology and referral to a paediatrician for further management. In the presence of a persistent node with

negative investigations, an excision biopsy is usually required to reach a diagnosis and onward referral for specialist treatment.

iii) Excision biopsy – if the node is > 1cm (in under 1 year olds) or > 3cm (in over 1 year olds), or in the presence of systemic or additional symptoms or signs suggestive of malignancy (Table 2), blood tests including LDH, a CXR and a formal excision biopsy should be performed.

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Pharmacology in ENT

Julia Addams-Williams FRCS (ORL-HNS), PGCME.
Otology/Skull Base Surgery Fellow
Jaydip Ray MS, FRCS, PhD.
Consultant Otolaryngologist

Royal Hallamshire Hospital, Sheffield.

Address for correspondence:
Julia Addams-Williams
27 Melbourn Rd,
Crookes,
Sheffield.
S10 1NR

E-mail: addamswilliamsjh@doctors.org.uk

Abstract
A sound knowledge of pharmacology aids both the medical and surgical outcomes of patients with ear, nose and throat disorders. A number of agents are required for the preparation and optimisation of surgery. Many ear, nose and throat conditions are often best treated with medication alone. The main groups of drugs commonly used by otolaryngologists along with their indications are discussed.

Key Words
Antibiotics, Pharmacology, Head and Neck Surgery.

Introduction
A sound knowledge of pharmacology aids the medical and surgical management of patients. A significant number of ear, nose and throat conditions are often best treated with medication alone.

Antibiotics in ENT

Antibiotic Classifications
Antibiotics can be classified as *wide spectrum* or *narrow spectrum* or as *bactericidal* or *bacteriostatic* or according to their route of administration and chemical structure. The main antibiotic groups and mechanism of action are detailed in Table 1.

Table 1: Main Antibiotic Groups

Mechanism of Action	Groups	Effect
Interfere with the synthesis or action of folate	Sulphonamides Trimethoprim	Bacteriostatic
Interfere with the synthesis of bacterial cell wall petidoglycan (ß Lactams).	Penicillin Cephalosporins and cephamycins Carbapenems and monobactams	Bacteriocidal
Inhibition of protein synthesis	Tetracyclines, Chloramphenicol, Aminoglycosides, Macrolides, Lincosamides and Fuscidic acid.	Bacteriostatic
Inhibition of topoisomerase II (a DNA gyrase)	Fluoroquinolones e.g. ciprofloxacin	Bacteriocidal/ Bacteriostatic
Gylcopeptide antibiotics – inhibit cell wall synthesis	Vancomycin and teicoplanin	Bacteriocidal
Interaction with phospholipids of the cell membrane and disruption of its structure (Polymixin antibiotics)	Polymixin B and Colistin	Bacteriocidal

Antibiotic Resistance

Resistance usually occurs through genetic mutation within the bacteria. If a bacterium carries a number of antibiotic resistant genes, it can then be termed as being multi-resistant or a "superbug."

The Standing Medical Advisory Committee report recommends that the fewest number of antibiotic courses should be prescribed for the shortest possible periods[1].

Antibiotic Reactions

Common side effects include candidial infection of the vulvo-vaginal region or *Clostridium difficile* diarrhoea in patients already colonised.

The commonly used ß lactam antibiotics can cause IgE-mediated allergic reactions. Toxic epidermal necrolysis (TEN) and Stevens-Johnson syndrome are acute inflammatory skin reactions that can be triggered by antibiotic use[2].

Antibiotic prophylaxis in ENT

Operations can be divided into four classes with the increasing risk of post operative infection correlating to the level of intra-operative bacterial contamination as summarised below:

Clean – Operations in which no inflammation is encountered and the respiratory, alimentary or genitourinary tracts are not entered. There is no break in aseptic operating theatre technique.

Clean-contaminated - Operations in which the respiratory, alimentary or genitourinary tracts are entered but without significant spillage.

Contaminated - Operations where acute inflammation (without pus) is encountered or where there is visible contamination of the wound. Examples include gross spillage from a hollow viscus during the operation or compound/open injuries operated on within 4 hours.

Dirty - Operations in the presence of pus, where there is a previous perforated hollow viscus, or compound/open injuries more than 4 hours old.

Risk factors for post operative surgical infection include patient co-morbidities, type of operation and the wound class.

There is currently no strong evidence supporting the use of routine prophylactic antibiotics for ear surgery[3] or functional endoscopic sinus surgery.

Both the Cochrane review and the Scottish Intercollegiate Guidelines Network (SIGN) found no evidence supporting the use of antibiotic prophylaxis in tonsillectomy. However, up to 24 hour post operative prophylactic antibiotic cover is suggested for neck dissections and laryngectomy surgery. A summary of recommendations on antibiotic prophylaxis for common ENT procedures Table 2.

Antibiotics in Otology

Perichondritis: *Pseudomonas aeruginosa* is isolated in 95% of cases with other isolates including *Escherichia Coli* and *Staphylococcus aureus.*

Table 2: Prophylactic antibiotics in ENT Surgery

Type	Procedure	Antibiotic Prophylaxis
Otology:		
Clean Surgery	Tympanoplasty/stapedectomy	None[4]
Clean contaminated Surgery	Combined approach tympanoplasty/ modified radical mastoidectomy	None[4]
Clean Surgery	Ventilation tube insertion	Yes - perioperative antibiotic drops[5]
Clean Surgery	Cochlear implantation	Yes[6]
Rhinology:		
Clean contaminated	Septoplasty/septorhinoplasty	None[8]
Clean contaminated	FESS	None[9]
Head & Neck:		
Clean contaminated	Tonsillectomy	None[5, 10]
Clean	Excision of benign neck lumps	None[5]
Clean	Neck dissection	Yes – to be continued for 24 hours post surgery only[5]
Clean contaminated	Laryngectomy	Yes – to be continued for 24 hours post surgery only[5]

Otitis Externa: The commonest cause *Pseudomonas aeruginosa* and *Staphylococcus aureus*. Fungal infections are more likely in chronic cases. Topical treatments alone were effective

Malignant Otitis Externa: Here otitis externa progresses to osteomyelitis initially of tympanic plate with the potential to spread to the skull base and petrous portion of the temporal bone10. Main causative organism was *Pseudomonas Aeruginosa* in over 90% of cases. More recently polymicrobial infection noted with *klebsiella pneumoniae* and *fungi* and *Pseudomonas aeruginosa* grown in 30% of cases[11]. Ciprofloxacin is proposed as an initial treatment along with a third generation cephalosporin or aminoglycoside for three months.

Acute Otitis Media: SIGN guidelines concluded that children with uncomplicated acute otitis media should have watchful waiting without antibiotics from 48 to 72 hours. Amoxicillin is still the treatment of choice. Amoxillin-clavulanate and cefuroxime may be required in selected cases. *Streptococcus pneumoniae. Streptococcus pyogenes*, anaerobes and coagulase-negative *Staphylococcus* have been isolated in mastoiditis. Here broad spectrum antibiotic treatment is recommended (3rd generation cephalosporin)[12].

Infected Tympanic Membrane Perforation: The main organisms are *Pseudomonas aeruginosa* and staphylococcus aureus and quinolone antibiotics drops were more beneficial.

Antibiotic ear drops

A summary of antibiotic ears drops is found in Table 3. Topical antibiotic drops are widely used to treat infected tympanic membrane perforations or infected grommets despite risk of ototoxicity. The ENT-UK consensus report for the use of aminoglycoside containing ear drops in the presence of an open ear recommends[13].

- Baseline audiology before treatment.
- Obvious infection should be present.
- Topical aminoglycosides should be used for less than 2 weeks.
- Justification for their use should be explained to the patient.

Ototoxicity

Aminoglycoside Antibiotics

The aminoglycoside antibiotics are most vestibule-toxic of all drugs but can vary in their effects. Neomycin is preferentially ototoxic while streptomycin is primarily vestibule-toxic. Gentamicin affects both systems. There is a genetic link to aminoglycoside toxicity transmitted by women through mitochondrial inheritance.

Others

Azithromycin, clarithomycin and vancomycin have been associated with reports of possible ototoxic effects .

Table 3: Antibiotic Ear Drops

Name	Contents	Dose
Betnesol-N® Drops	Betamethasone sodium phosphate, neomycin sulphate.	2-3 drops, 3-4 times daily, 2 weeks
Otomize® spray	Dexamethasone, neomycin sulphate, glacial acetic acid.	1 metered spray, 3 times daily, 2 weeks
Sofradex® drops	Dexamethasone, framycetin sulphate	2-3 drops, 3-4 times daily, 1 week
Locorten-Vioform® drops	Flumethasone pivalate, clioquinol	2-3 drops, twice daily for adults and children over 2 years of age
Gentisone HC® drops	Hydrocortisone acetate, gentamicin	2-4 drops, 3-4 times daily, 1 week
Otosporin® drops	Hydrocortisone, neomycin sulphate	3 drops, 3-4 times/ day, 1 – 2 weeks for adults and children over 3 years of age
Chloramphenicol® drops	Chloramphenicol in propylene glycol	2-3 drops, 2-3 times daily, 1 – 2 weeks
Genticin® drops	Gentamicin	2-3 drops, 3-4 times daily, 1 week
Predsol-N® drops	Prednisolone sodium sulphate, neomycin sulphate	2-3 drops, 3-4 times daily, 2 weeks

Antibiotics in Rhinology

Acute-Chronic Rhinosinusitis: In acute maxillary sinusitis penicillin or amoxicillin or co-amoxyclav is recommended for 7-14 days. The EPOS guidelines suggest the long term use of low dose macrolides such as erythromycin or clarithromycin in cases of chronic rhinosinusitis for 3 -4 months.

Regimen for MRSA colonisation of nose:

Staphylococcus aureus colonises the skin, particularly the nasal passages and warm moist areas. Chlorhexidine 4% body-wash / shampoo; Muporicin 2% (Bactroban®) three times daily in nostrils for 5 days gives 50-60% long term clearance.

Periorbital cellulitis: Mainly due to mixed organisms *(Haemophilus Influenza, Streptococcus milleri, Strep pyogenes, Strep pneumoniae, Staphylococcus aureus)* and anaerobes. Cefuroxime100mg/kg/day and metronidazole 7.5 mg/kg with or without Flucloxacillin.

Fungal sinusitis: *Mucorales, Aspergillus fumigatus and A. flavus* are common. Intravenous Amphotericin (can be toxic; monitor renal function) used for acute/chronic/ granulomatous invasive fungal sinusitis. Newer drugs include Azoles and Capsofugine.

Vestibulitis: Topical treatment with mupirocin (Mupirocin 2%, benzyl/cetyl/stearyl alcohol) or naseptin® (chlorhexidine hydrochloride 0.1%, Neomycin sulphate 0.5%, arachis (peanut)) oil (contraindicated in peanut allergy).

Antibiotics in the oral cavity:

Sore throats: A Cochrane review found reduction in duration of symptoms and of non-suppurative and suppurative complications with antibiotics.

Tonsillitis: *β-Haemolytic streptococcus*, *Strep Pneumoniae, Haemophilus* Influenza common pathogens. SIGN guidelines recommend a 10 day course of penicillin or Macrolide (Erythromycin) in penicillin allergy.

Peritonsillar abscess/quinsy: Combination of drainage and antibiotic. Benzylpenicillin and metronidazole is routinely prescribed at first intravenously then orally for 10 days.

Epiglottitis: Second or third generation cephalosporin is recommended with penicillin and/or metronidazole.

Parapharyngeal/retropharyngeal abscess: Cephalosporin, metronidazole , clindamycin combined with surgical drainage unless the collection is small.

Acute suppurative Parotitis: Commonly *Staph Aureus.* Co-Amoxyclav and flucloxacillin recommended.

Facial Cellulitis: Caused by *Streptococcus, Staphylococcus and Haemophilus.* Penicillins or macrolides recommended.

Necrotising fasciitis: Pathogens include *Strep Pyogenes, Strep Aureus, Clostridium Perfingens.* Combination of surgical debridement and broad spectrum antibiotics (pipercillin/tazobactam plus clindamycin). Surgical debridement may be essential.

Acute lymphadenitis/abscess in children/adults: Commonly Staphylococcus aureus. Flucloxacillin (or cephalosporin) and metronidazole[14, 15].

Non-tuberculous mycobacterial lymphadenitis in children: Organisms include *Mycobacterium Avium, M. Intracellulare, M. Bovis, M. Kansasii.* Quinolones like ciprofloxacin (risk of arthropathy in children). Multi-agent regimes include clarithromycin and ethambutol, isoniazid or rifabutin for several months with surgical intervention if needed[16].

Fungating Head and Neck Tumors: Metronidazole can be used topically to reduce foetor produced by anaerobic organisms.

The future of antibiotics

Multiresistant organisms now pose a major health problem causing an estimated 25,000 deaths per year in the European Union alone[17]. Therefore new antibiotics to treat resistant bacteria are urgently required.

Glucocorticoid Steroids

Glucocorticoids are anti-inflammatory and immunosuppressive through reduced vasodilation and an effect on immune mediators and cellular events. Therapeutic steroids along with endogenous glucocorticoid steroids have a negative feedback action on the hypothalamus and anterior pituitary gland reducing the production of endogenous steroids.

Cautions: Potential hazards of glucocorticoid are:

- Adrenal insufficiency
- Iatrogenic Cushing's
- Increased susceptibility to infections.
- Euphoria/depression.
- Gastrointestinal effects.

- Ophthalmic effects.
- Patients with renal impairment.
- Pregnancy and breast feeding.
- Reduced healing.
- Aseptic femoral head necrosis.

They should be applied topically where ever possible to minimise systemic absorption and to reduce the risk of complications. Maintenance dose should be kept as low as possible when long term therapy is required. Gradual withdrawal of corticosteroids if the patient has:

- Received > 40 mg prednisolone (or equivalent) daily for more than 1 week.
- Given repeat evening doses
- Recently received repeated courses (particularly if taken for longer than 3 weeks).
- Taken a short course within 1 year of stopping long term therapy.
- Other possible causes of adrenal suppression.

Table 4 summarises the equivalent anti-inflammatory doses of corticosteroids.

Topical Aural Steroids

Most topical ear drops containing steroids are available in combination with various antibiotics.

Table 4: Equivalent anti-inflammatory doses of corticosteroids.

Prednisolone 5 mg
= Betamethasone 750 mcg
= Dexamethasone 750 mcg
= Hydrocortisone 20 mg
= Methylprednisolone 4 mg
= Prednisolone 5 mg
= Triamcinolone 4 mg

Topical Nasal Steroids

The European position paper on rhino-sinusitis and nasal polyps concluded that topical intranasal steroids have an effect on chronic rhino-sinusitis without polyps and bilateral nasal polyps and its associated symptoms. Intra-nasal steroids have a limited bioavailability when used at the recommended doses resulting in a low rate of adverse side effects. Some experience nasal dryness, epistaxis, glaucoma and headache. A summary of topical nasal steroid treatment options is shown in Table 5.

Common ENT conditions requiring oral steroid treatment

Bell's Palsy: Early treatment of Bell's palsy (within 72 hours) with 25mg of prednisolone twice daily for 10 days significantly improves the chances of complete recovery at 3 and 9 months. No evidence of benefit found with acyclovir alone or in combination with prednisolone[18].

Acute Sensorineural Hearing Loss: The value of oral steroids in the treatment of idiopathic acute sensorineural hearing loss according to a Cochrane review is uncertain. Usually a dose of 1mg/kg body weight/day of prednisolone for 10 days in unilateral sensorineural hearing loss cases[19]. The use of intratympanic dexamethasone is also reported to have some benefit[20].

Nasal Polyposis: The European position paper on rhino-sinusitis and nasal polyps concluded that systemic steroids are effective in reduction of polyps and associated symptoms, as well as smell unlike intranasal steroids.

Sodium Cromoglycate

Sodium cromoglycate intranasal sprays provide prophylaxis of allergic rhinitis. by inducing phosphorylation of a mast cell protein leading to an inhibition of anti-IgE –induced histamine release.

Ipratropium Bromide

This drug acts by blocking muscarinic receptors and is used topically in the treatment of rhinorrhoea. It can only be used in adults and children over 12 years.

Montelukast

Montelukast blocks type 1 cysteinyl-leukotriene receptors in the respiratory mucosa. Reported to be effective treatment for patients with seasonal allergic rhinitis or perennial rhinitis, with or without asthma.

Nasal decongestants

Nasal decongestants contain sympathomimetic drugs that produce vasoconstriction. They should not be taken for more than 7 days due to risk of rebound nasal congestion on withdrawal (rhinitis medicamentosa) resulting in nasociliary loss, squamous cell metaplasia, epithelial oedema, epithelial cell denudation and goblet cell hyperplasia. Management includes stopping the decongestant and commencing topical corticosteroids . In young children, side effects include sleep disturbances, hallucinations and restlessness. Avoid in patients on monoamine-oxidase inhibitor drugs due to the risk of a hypertensive crisis.

Table 5: Topical Nasal Steroids				
Drug	**Brand Name**	**Indications**	**Dose**	**Age of patient**
Beclomethasone dipropionate	Beconase®	Allergic and vasomotor rhinitis	100mcg (2 sprays) into each nostril twice daily, reduce to 1 spray each nostril twice daily when symptoms are controlled	6 or more years
Betamethasone Sodium Phosphate	Betnesol® Vistamethasone®	Non-infected inflammatory nasal conditions	3 drops each nostril three times/day	
Budesonide	Rhinocort aqua®	Allergic/vasomotor rhinitis and nasal polyposis	200mcg (2 sprays) into each nostril once daily, reduce to 1 spray each nostril once daily when symptoms are controlled	12 or more years
Flunisolide	Syntaris®	Allergic/perennial rhinitis, nasal polyposis	Adults: 50mcg (2 sprays) each nostril twice daily. Child 4- 11 years: 25mcg (1 spray) each nostril up to three times/day.	4 or more years
Fluticasone Propionate	Flixonase®	Allergic/perennial rhinitis, nasal polyposis	Adult: 100mcg (2 sprays) each nostril once daily. Child 4- 11 years: 50mcg (1spray) each nostril once daily	4 or more years
Fluticasone Propionate	Flixonase Nasule®	Nasal polyps	200mcg (approx 6 drops) each nostril twice daily.	16 or more years
Fluticasone Furoate	Avamys®	Allergic/perennial rhinitis, nasal polyposis	Over 12 years: 55mcg (2 sprays) each nostril once daily. 6-12 years: 27.5 mcg (1 spray) each nostril once daily	6 or more years
Momethasone Furoate	Nasonex®	Rhinitis/nasal polyposis	Over 12 years: 100mcg (2 sprays) each nostril once daily. 6-11 years: 50mcg (1 spray) each nostril once daily.	6 or more years
Triamcinolone Acetonide	Nasacort®	Allergic rhinitis	Over 12 years:110 mcg (2 sprays) each nostril once daily. 6 to 11 years: 55 mcg (1 spray) each nostril once daily.	6 or more years

Antihistamines

The first generation antihistamines often cause drowsiness, where as the second generation antihistamines do not usually cross the blood brain barrier to cause this side effect. A summary of oral antihistamines can be found in Table 6. The intranasal antihistamine azelastine hydrochloride can be used for the treatment of allergic rhinitis. It can be used in adults and children over 5 years of age.

Acid Secretion Therapy

Proton Pump Inhibitors

These drugs act by blocking the proton pump within parietal cells leading to a decrease in gastric acid secretion.

H2 receptor antagonists

Histamine H2-receptor antagonists reduce gastric output by inhibiting histamine at all H2 receptors.

Table 6: Summary of Antihistamines			
Drug	**Brand Names**	**Indication**	**Age of use**
Non Sedating antihistamines			
Acrivastine	Non proprietary	Allergy such as hayfever, chronic idiopathic urticaria	Over 12 years
Cetirizine Hydrochloride	Non proprietary	Allergy such as hayfever, chronic idiopathic urticaria	Over 2 years
Desloratadine	Neoclarityn®	Allergic rhinitis and urticaria	Over 1 year
Fexofenadine Hydrochloride	Telfast®	Seasonal allergic rhinitis, chronic idiopathic urticaria.	Over 6 years
Loratidine	Non proprietary	Allergy such as hayfever, chronic idiopathic urticaria	Over 2 years
Levocetirizine hydrochloride	Xyzal®	Allergy such as hayfever, urticaria.	Over 2 years
Mizolastine	Mizollen®	Allergy such as hayfever, urticaria.	Over 12 years
Rupatadine	Rupafin®	Allergic rhinitis, chronic idiopathic urticaria.	Over 12 years
Sedating Antihistamines			
Alimemazine Tartrate	Non proprietary	Urticaria, pruritus, premedication.	Over 6 months
Chlorphenamine maleate	Piriton®	Allergy such as hayfever, urticaria, anaphylaxis.	Over 1 month
Clemastine	Tavegil®	Allergy such as hayfever, urticaria.	Over 1 year
Cyproheptadine hydrochloride	Periactin®	Allergy such as hayfever, urticaria.	Over 2 years
Hydroxyzine hydrochloride	Atarax® Ucerax®	Pruritus	Over 6 months
Ketotifen	Zaditen®	Allergic rhinitis	Over 3 years
Promethazine hydrochloride	Phenergan®	Nausea and vomiting, allergy, urticaria, anaphylaxis	Over 2 years

Treatment of Laryngo-pharyngeal Reflux

A prospective cohort study found that twice daily 4 months treatment with proton pump inhibitors is more effective[21]. A liquid alginate suspension Gavison advance® 4 times daily helps reduce symptoms.

Antivirals

There is a lack of evidence to support any benefit of acyclovir to treat sudden idiopathic sensorineural hearing loss, Bell's palsy and Ramsay Hunt syndrome.

Anti-fungal Agents

Antibiotic Antifungals

Amphotericin binds to cell membranes of fungi and interferes with transport functions. Nystatin is applied topically to the gastrointestinal tract or skin.

Synthetic Antifungals

Miconazole, fluconazole, ketoconazole and clotrimazole are examples. These azoles block the synthesis of ergosterol in fungal cell membrane.

Pilocarpine
Pilocarpine, a cholinergic agonist, can be used to stimulate salivary secretion in abnormal salivary gland flow (xerostomia).

Local anaesthetics
Two main classes are (a) Amides (lignocaine, bupivacaine) and (b) Esters (cocaine)

Local anaesthetics reversibly block transmission of action potentials by blocking of sodium channels. Their activity is pH dependent (higher activity at a higher pH) can be injected or applied topically. Areas of infection and inflammation carry a lower pH rendering the local anaesthetic less effective.

Complications
Local anaesthetics should not be injected into inflamed tissue due to risk of increased systemic absorption. Toxicity (usually due to intravascular injection) manifests with:

- Central nervous system effects (agitation, light headedness, sedation, paraesthesia, twitching, convulsions and coma).
- Cardiovascular system effects (myocardial depression, bradycardia, hypotension and cardiac arrest).

Allergic reactions commoner with the ester type local anaesthetics than amides.

Local Anaesthesia with Adrenaline
Local anaesthetic act directly on vascular smooth muscle causing vasodilation, resulting in increasing surgical blood loss. The addition of adrenaline to the local anaesthetic agent prolongs the anaesthetic effect. Contraindicated in the sites of end arteries.

Lidocaine Hydrochloride
Maximal dose is 5 mg per kg body weight or 7 mg per kg body weight with adrenaline. The plasma ½ life is 2 hours.

A lidocaine with phenylephrine topical spray (5% lidocaine, 0.5% phenylephrine hydrochloride) is available for nasal anaesthesia before surgery or endoscopy. A maximum of 8 sprays can be applied in children over 12 years and adults.

Bupivacaine Hydrochloride
Maximal dose is 2 mg per kg body weight or 3 mg per kg body weight with adrenaline. The plasma ½ life is 3 hours.

Cocaine
Cocaine produces rapid vasoconstricion action of mucus membranes by preventing the reuptake and binding of free catecholamines to their receptors at adrenergic terminals22. It can sensitise the myocardium to adrenaline activity. Maximal dose 1.5mg per kg body weight and should not exceed 100 mg and a concentration of no more then 10% should be used. Duration of action is 30 – 60 minutes.

Moffett's solution
Moffett's solution contains a combination 2ml 8% cocaine, 2 ml 1% bicarbonate and 1 ml of 1 in 1,000 adrenaline. The bicarbonate increases the pH of the solution therefore increasing the cocaine potency.

Hyoscine
Hyoscine is a competitive antagonist of acetylcholine at muscarinic receptors. Transdermal hyoscine patches used in treatment of the drooling child. Side effects include dryness of eyes and mouth. Hyoscine also used to reduce respiratory secretions especially at the end of life.

Commonly used Vestibular Drugs

Betahistine dihydrochloride
Has been mainly prescribed to reduce the impact of vertigo symptoms in Meniere's disease and in other patients with rotatory vertigo. The antagonist effect at H3 receptors causes a rise in the level of neurotransmitters, some of which (e.g. serotonin) can inhibit the vestibular nuclei. Betahistine has a significant effect on the frequency, severity and duration of vertigo attacks. May need to given iv or rectally, when the patient is vomiting during the early phase of an attack.

Prochlorperazine
A dopamine (D2) receptor antagonist that is used as an anti-emetic for vertigo and nausea. Hypersensitivities to this drug can present as dyskinesia and seizures.

Cinnarizine
Cinnarizine is mainly used in patients with motion sickness and vertigo. It has an effect on the signalling between the vestibular part of the inner ear and the hypothalamus.

Botulinum Toxin
Produced by the bacteria clostridium botulinum and causes an irreversible blockage of the pre synaptic release of acetylcholine. Used extensively for patients with spasmodic dysphonia. Other dystonic and spasmodic disorders of the head and neck region where botox is used include hemifacial spasm, oromandidular dystonia and pharyngoesophageal hypertonicity in laryngectomy patients.

Injection of botox into the submandidular and parotid glands under ultrasound guidance in the drooling child to reduces salivary flow[23]. Contraindicated in patients with muscle activity disorders such as myasthenia gravis.

Conclusions

This paper has discussed in detail a number of the common drugs used within ear, nose and throat surgery. This includes their mechanisms of action, indications and potential complications. It is important for otolaryngologists to have a sound working knowledge of commonly used drugs in order to optimise patient outcomes and reduce potential harm.

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Evaluation and management of recurrent parotid salivary gland neoplasms (RPSGN)

Professor Patrick J Bradley, MBA FRCS
Honorary Professor of Head and Neck Oncologic Surgery
The University of Nottingham.

Abstract:

The parotid salivary gland can be affected by a heterogenous group of benign and malignant neoplasms. The majority (80%) are benign, but the malignant group (20%) exhibits a low-grade (25%) and high-grade (75%) sub-group. The primary management of the majority of patients is by complete surgical excision. Loco-regional recurrence may manifest well beyond the usual 5-years, and the risk is associated with the stage of disease at presentation, histological aggressiveness and incomplete excision (positive surgical margins). Treatment of recurrent disease is fraught with surgical difficulties cosmetic deformity, facial nerve paralysis, and high risk of further recurrences. The use of adjuvant treatment for recurrent disease includes radiotherapy, with chemotherapy in malignant disease, in an attempt to achieve loco-regional disease free status.

Key Words:

Parotid Salivary Gland Neoplasms, Benign Neoplasms, Malignant Neoplasms, Recurrent Neoplasms, Management, Surgery, Radiotherapy, Chemotherapy.

Introduction:

Tumour recurrence following treatment is a most devastating diagnosis, either loco-regional or distant metastases. The implications of such a diagnosis may be interpreted that the initial management had not been performed with due diligence. The patients' psychological response includes depressive symptoms, anxieties and fears of hopelessness, leading to lodging a claim of litigation[1]. The patients' perception of their disease process has commenced during the initial consultation, and evidence has demonstrated that patients recall of the advice and risks of surgery is very poor[2-5]. It is important to explain in detail with each patient verbally and in writing, about the stage and nature of their disease at presentation, the options of treatment, and the likely outcome of such treatments[6].

Presentation and incidence of primary parotid salivary gland neoplasms (PSGN);

The majority of primary PSGN present as a painless mass of lump. The differences of identifying a benign from a malignant process are not obvious to the patient or the examining clinician. Factors suggestive of malignancy such as facial nerve paresis or paralysis are only present in 9 – 25% of parotid malignant neoplasms. The presence of palpable cervical lymphadenopathy is reported in 13 – 25% of patients. Be aware that Warthin's tumour (WT) may present acutely with a facial nerve paresis or paralysis[7]. Fixity to the adjacent structures or skin ulceration is always an ominous sign. Pain is an unreliable predictor, as acute and chronic inflammation can be painful, including rapidly progressive malignancies. Duration and stability of the mass is also unreliable predictors of malignancy. Therefore

it is best to assume that that any parotid salivary gland mass is malignant until proven otherwise.

While the majority of primary PSGN (75 – 80%) are benign in nature, only a small number of cases are malignant (20 – 25%). The incidence of benign parotid neoplasms is not registered but recent research in Nottingham suggests that the incidence ranges 5.3 – 6.2, and that for malignant neoplasms 0.4 – 0.7 per 100,000 population per year[8]. Primary salivary gland malignancy for England registered over the period 2001 – 2006 has been published by the Oxford Cancer Intelligence Unit (OCIU)[9], and reports an increased incidence of 37%, with the age standardised rates (per 100,000 population) ranged 0.48 - 1.07 (average 0.77).

Prevention by identifying the high risk tumour:

Benign Neoplasms:

The current World Health Organisation Classification[10] and the Armed Forces Institute of Pathology Classification[11] of salivary gland neoplasms are almost in agreement and record 13 types of benign neoplasms. As the majority of these lesions are broadly "adenomas" with the pleomorphic salivary adenoma being the dominant specifically benign tumour. In this article the benign salivary adenomas will be referred to by the term "adenoma" and will be discussed together. The other specific benign lesion is the Warthin's (adenolymphoma) tumour.

Benign Salivary Adenoma

Pathology:

The primary management of parotid salivary adenoma (PSA) must include the use of a needle biopsy (FNAC or core biopsy) to confirm the benign clinical diagnosis. The use of imaging remains controversial but MRI is probably the better of the current diagnostic imaging methods available. If left untreated a small proportion will undergo malignant transformation (3-10%)[12].

Primary Surgical Treatment:

The initial surgery for a PSA should aim to achieve tumour clearance within the confines imposed by the facial nerve[13,14]. Many surgical procedures have been described in an attempt to ensure "complete excision" of PSA[15 - 18]. Currently, a tumour of >4 cms located in the lower pole lateral lobe of the parotid gland would undergo a lower lobe lateral parotidectomy (with facial nerve trunk identification) or an extracapsular excision of the tumour mass. If the tumour is <4 cm then a classical lateral parotidectomy is to be recommended. Tumour that are located deep to the facial nerve, or involving the parapharyngeal space, it is recommended that the facial nerve trunk be identified and the mass deep to the nerve be excised, the elevated lateral lobe should be preserved and returned to minimise any cosmetic deformity[19].

Warthin Tumour

Incidence and Pathology:

Warthin tumour (WT) is the second most common benign epithelial tumour accounting for 10 – 15% of the benign neoplasms[20]. Epidemiological studies have demonstrated a strong association with cigarette smoking, hence a higher male:female incidence ration varying from 1.6: 1 to 10:1 with smokers having a x8 times more likely to develop WT than non-smokers. WT almost exclusively involves the parotid gland and peri-parotid lymph nodes. WT may occur bilaterally (4 – 10%), either metachronously (90%) or synchronously (10%), and as multiple lesions in the same gland (13%). An association with carcinoma arising from the epithelial components has been reported in a small number of cases, and the lymphoid component may transform into a malignant lymphoma of WT.

Primary Surgical Treatment:

Surgical excision is the treatment of WT, although the extent of the parotidectomy remains controversial. Reports have suggested enucleation, partial or selective parotidectomy, and superficial or lateral parotidectomy or total parotidectomy as the treatment of choice.

Prevention of recurrence is by identifying the high risk benign tumour:

PSA are thought to be solitary lesions. The size of PSA may range from 2 – 5 cms in size, though very large tumours have been reported. They have a capsule of varying thickness, which may be partially or completely absent, particularly in the predominantly mucoid type. As the tumours increase in size the outer surface becomes bosselated, and on histology these areas demonstrate finger-like projections of adenoma tissue extending into and through the capsule into the surrounding tissues[21].

WT because of its multifocal nature of origin may present at a later time following a local excision of a tumour, and thus is considered to be "new disease" should it recur at a later date.

Recurrent PSA:

After complete excision of the benign adenoma using a parotidectomy technique, the reported local recurrence rates are in the range of 1 – 5% (over the life-time of the surgeon!)[15, 21-26]. Many causes have been proposed as to PSA recurrence (Table I). Some evidence suggests that the

Table I: Causes of Recurrent Parotid Salivary Gland Adenoma
Multicentricity
The base area
Tumour rupture
Extension of tumour
Misdiagnosis
Error of diagnosis
Incision biopsy
Enucleation
Implantation
Poorly designed incisions

tumour characteristics itself are responsible for some recurrences, but the majority of the recurrence can be explained by the expertise of the surgeon and the surgical technique used.

There are two types of PSA recurrence – the uni-focal and the multi-focal[21];

- The uni-focal lesion is usually associated with surgery in error, as a "lymph node".
- However PSA that have undergone some form of parotidectomy, with or without identification of the facial nerve, the recurrence of disease is multi-focal nodular disease distributed throughout the whole of the surgical area, thus supporting that the tumour capsule had been ruptured, resulting in tumour spillage.

Malignant Neoplasms:

While the parotid gland is the most common site for salivary cancer, only 20 – 25% are malignant. Salivary gland cancers are a heterogenous group of cancers with more than 24 different cancer subtypes described[10, 11, 28]. Because of their rarity and significant diversity prevents individual therapy to be discussed, but a broad application of standardized therapy is tabulated (Table II). The use of FNAC biopsy and radiological imaging provides advantages that guide tumour evaluation, staging, and pre-treatment planning. The routine use of FNAC, because of the diversity of the tumour types, allows an experienced cytopathologist to determine whether the mass is likely to be benign or malignant based on cellular density, morphology, uniformity, and the presence of mitotic figures for an overall accuracy of 80% in determining benign versus malignant disease[19]. The most likely types are in order of presentation[8,29]: mucoepidermoid[30] (28.5 – 14.5%), adenoid cystic[31] (13.4 – 14.3%), acinic cell[32] (15.6 – 17.8%), adenocarcinoma[33, 34] (NOS) (13.4 – 22.0%) and others. Histopathology examination can allow for grading of the primary parotid cancers into low-grade (20 – 25%) and high-grade (75 – 80%)[28, 35] and has found to be a significant predictor of outcome, as well as TNM staging, both should be accurately determined prior to discussion treatment options with a patient[27, 36], .

Prognostic Factors determining Outcome of Malignant PSGN:

One review[37] on prognostic factors of malignant salivary gland neoplasms, which has determined patient's outcome has identified that local control can be predicted by clinical T stage, bone invasion, site, resection margin, and treatment used. Regional control is depended on N stage, facial nerve paralysis, and treatment used. The relative risk with surgery alone, compared with surgery plus post-operative radiotherapy, was 9.7 for local recurrence and 2.3 for regional recurrence. Distant

Table II: General categories of management of primary salivary gland carcinoma[35]

Surgery Alone	Surg and RT	+ Neck Dissection	Systemic CT
Negative margins	Close (<2mm) Positive margins	All cN cN0 but high grade cN0 but high grade	Metastatic or unresectable
Low-grade histology	High-grade histology	(angioinvasion) cN0 but high T stage	disease
Low-risk (non angioinvasion, non-infiltrative)	High-risk (Highly infiltrative)	(T3 or T4)	
Histologic subtype	Histologic subtype		
Low T stage (T1 or T2)	High T stage (T3 or T4) pN+ ? perineural invasion		

metastases were independently correlated with T and N stage, sex, perineural invasion, histologic type, and clinical skin involvement. Overall survival depended on age, sex, T and pN stage, site, skin and bone invasion. Another method[38] advocates the use of prognostic indices for determining patients outcome following treatment which have been validated using the Dutch Head and Neck Oncology Cooperative Group Database and by a Belgian-German database. The findings have confirmed that the prognosis of a parotid carcinoma patient can be quantified by using a weighted combination of the parameters such as age, pain, clinical T (cT) classification, clinical N (cN) classification, skin invasion, facial nerve dysfunction, perineural growth, and involved surgical margins.

The Use of Radiotherapy and Chemotherapy to Minimise Recurrent of Malignant PSGN:

- Patients diagnosed with low-grade malignant PSGN surgery alone is an effective treatment, and the use of adjuvant treatment is not indicated[27, 39-42].

- Patients diagnosed with high-stage and high-grade disease inclusion of adjuvant radiation with/without chemotherapy is indicated[27, 43]. A meta-analysis of 19 studies of post-operative radiotherapy for parotid cancer, patients with advanced T3/4 disease, node positive disease, or high-grade histopathology demonstrated x3 times reduced odds of death compared to patients who did not receive radiation[39]. Chemotherapy is sometimes given in a concurrent fashion with adjuvant radiotherapy in selected high grade tumours such as salivary duct carcinoma, adenocarcinoma NOS, and solid type adenoid cystic carcinoma due to the higher than average risk of distant metastasis[27].

Evaluation and Assessment of Recurrent PSGN

- In PSA, abandonment of the enucleation techniques in favour of more extended parotidectomy surgery has reduced the incidence of recurrences. Recurrences of PSA are due to the obvious or underestimated occurrence of tumour spillage, incomplete excision, and violation of the pseudocapsule of the tumour that occur during surgery, and are considered the only proven likely reasons22. The mean time to recurrence is 9 – 15 years[12, 23, 25].

- In the malignant group of PSGN several factors such as grade of tumour, stage of disease, parapharyngeal space invasion, extra-parenchymal extension, incomplete excision, positive margins, facial nerve palsy, skin infiltration age>60 years and male gender[37, 38 , 44].

Checklist Essential Questions:

1. Patient desires and long term goals?
2. Age of patient?
3. When and what was the initial treatment? Duration in hospital? Status of facial nerve after surgery?
4. Where was the surgery performed? Can the clinical notes be obtained? Can the histopathology slides be obtained and reviewed?
5. How much time passed before the recurrence was noted?
6. Has the recurrence increased in size, shape or location?
7. Where is the location of the recurrence?
8. Size of parotid tumour recurrence?
9. Number of prior surgical procedures?
10. Any type of additional treatment such as radiotherapy?
11. Size of parotid tumour recurrence?
12. Is the recurrence solitary or multifocal?
13. Is the facial nerve functioning or is it weak?
14. Is the patient willing to sacrifice their facial nerve?

Efforts should be made to obtain the patients previous medical records, previous scans and pathology slides for review. It is well known that changes of diagnosis are likely to be made when pathology specimens are reviewed by pathologists who have specialist expertise such as within the area of salivary gland diseases and neoplasms[13, 27, 45].

Physical examination will reveal signs of the surgical scar or scars in the parotid region and/or the neck, previous evidence of local radiotherapy, facial nerve function or dysfunction, evidence of other cranial nerve paralysis, evidence of local masses or swellings as well as palpation of the ipsilateral and contralateral necks, skin fixation or ulceration, fixity of the mass to the mandible, temporal bone or skull base.

Radiological imaging must be performed and compared to any previous images taken, as the extent of the disease is usually underestimated by clinical evaluation. Distortion of the normal anatomy may have resulted due to the surgery or even by the recurrent disease. Any areas of suspicious recurrent disease should be followed and proven by liberal use of image guided biopsy. The chest should be imaged and currently patients who have suspected recurrent loco-regional malignant disease will

be recommended to have a PET-CT of the body. This process should be followed even in patients who have evidence of recurrent benign "adenoma" disease, as in patients who have multiple recurrences are a risk of developing the rare entity recognised as "metastasising pleomorphic adenoma" and may manifest chest metastases[46].

Treatment options:

Recurrent PSA:

- In uni-nodular cases proven by MRI imaging is usually found after initial surgery performed was less than a superficial parotidectomy. Then the surgery to be undertaken for the recurrence will be a revision lateral or total parotidectomy with facial nerve dissection and preservation. If a standard superficial parotidectomy had been performed previously and there is a single focus (most unusual!), surgery may be limited to a local resection[21,24].

- When the recurrence is proven multi-nodular then revision surgery should be tailored to each single patient in an attempt to obtain a margin of healthy salivary tissue. Delineation of the recurrent tumour is best depicted by MRI, which demonstrates the multi-nodular nature of the disease and potential deep-lobe or parapharyngeal space extensions. MRI can also document the amount of salivary tissue that remains following their previous surgery. However, MRI can also be inadequate for identifying all nodules, and frequently the surgeon's or the pathologist's microscope reveals many more nodules than suspected from clinical assessment[12, 22, 24]. The optimum surgery to be undertaken should be a total parotidectomy making note to excise any previous scar or scars. Local control after surgery for recurrent pleomorphic adenoma ranges between 65 – 85% [47].

Recurrent PSA may be dissected away from the facial nerve in the vast majority of cases, although the dissection is made considerably more difficult by scarring from prior operations. The use of a nerve monitor, magnifying loops or microscope, and identifying the facial nerve trunk in a retrograde manner may all be helpful. The rate of immediate partial or complete facial nerve paresis has been reported occurring in 16 – 21%[23, 25], with permanent palsy seen in 16 – 21% [21, 24]. Should the patient have had a previous facial nerve palsy following a previous operation, then the likelihood of a permanent palsy is certainly more than 50% following any subsequent surgery[21]. Another option is to consider facial nerve resection and grafting and needs to be discussed with each patient prior to embarking on surgical exploration [26]. The effect of facial nerve excision and grafting never results in a normal nerve and the resultant cosmetic deformity may have a significant and profound effect on subsequent quality of life[48].

Use of Radiotherapy:

- Patients with a uni-focal recurrent PSA then revision surgery in the form of a lateral or total parotidectomy should be sufficient to ensure a cure[21, 24].

- Patients with multi-nodular recurrent PSA then surgical management with postoperative radiotherapy has reported local control rates of 79 – 95%[37]. However second recurrences of PSA after revision surgery alone, are seen in 43 – 75% of cases at 15 years[23, 24]. Certainly surgeons and radiotherapists would concur that after a second recurrence, most would advocate the addition of adjuvant radiotherapy. In a series of 72 patients treated with surgery and post-operative radiotherapy for recurrence, none (12.5%) failed to achieve definitive local control[49]. It has been summarised that despite variation in surgical procedures and radiotherapy doses that data suggests that tumour control rates of 80 -95% in patients with recurrent parotid pleomorphic adenoma treated surgically and irradiated over 30 years[37,39]. It is likely that is radiotherapy is given for macroscopic residual disease (62 – 76%) will result in a lesser control than microscopic disease[50].

Malignant RPSGN; Loco-regional disease:

Treatment options: clinical evaluation

All malignant RPSGN that recur are by their nature classified as high-risk tumours and will require extensive multimodal therapy. Confirm and review all of the pathology specimens available past and current. Agree the histotype of disease being treated, and seek "second opinions on the pathology" should any doubt of the accuracy persist[29, 45]. Presentation of such cases to a Head and Neck Cancer MDT is essential to discuss, agree and coordinate the treatment plan. The main focus of discussion is whether the patient is a candidate for surgery with curative intent (Table III). Poor surgical candidates include patients that have gross tumour still present after resection, who have carotid artery encasement, intracranial disease, poor performance status, multiple co-morbidities, and/or distant metastases. Palliative radiation or re-irradiation with or without chemotherapy can be considered if the patient's has significant loco-regional pain or morbidity from tumour growth. Information about the availability of potential entry into national or international clinical trials may be available[27].

Table III: Management of recurrent parotid salivary gland malignancy[27]			
Classification	**Surgery**	**Radiation**	**Chemotherapy**
Resectable (PET CT; MRI)			
	Radical parotidectomy +/- temporal bone / mandible; RND or MRND; VII grafting Soft tissue repair +/- flap surg	RT or Re-RT ? Neutron Rx	Cisplatin, Single or Combined CT Cetuximab
Unresectable (PET CT; MRI)			
Locoregional (Stage T4b)	NA	as above	as above
Distant Metastasis	NA	Palliative RT (local pain, T mass)	Consider CT, Join Clin Trial

Use of surgery for loco-regional malignant RPSGN

Surgery for loco-regional malignant RPSGN requires an aggressive approach that seeks tumour excision at the expense of functional preservation 27, 51. Depending on the tumour location attempts at preserving functionally important structures such as skin, bone, cranial nerves, and the ear canal may increase the risk of a second unresectable recurrence 27. Radical surgery is appropriately selected cases, and achieving a negative surgical tumour margin, followed by appropriate adjuvant therapy can achieve 5-year disease free survival of greater than 60% in many cases[52]. Neck dissection should be performed if it has not already been done, and should address all at-risk levels and renewed attention to the previously dissected sites 53. Most patients will require functional restoration of any facial nerve weakness with either a static sling or nerve grafting with or without regional flap or free flap transfer.

Use of radiotherapy:

Radiation therapy for recurrent salivary gland cancer is challenging because most salivary glands that recur will already have received primary adjunct therapy following primary surgery. Since the latency between primary therapy and recurrence is usually more than 3 years, most patients will be candidates for re-irradiation. Techniques such as intraoperative radiotherapy[54, 55], when available have shown promising results with better outcomes with respect to maximizing local disease control. The use of gamma knife stereotactic radiosurgery will likely play an expanding role in the future management of these difficult cases, especially when the skull base area is involved[56].

Use of chemotherapy:

Chemotherapy has been poorly studied in the setting of recurrent and/or metastatic salivary carcinoma[57], but has been used in an experimental environment[58, 59]. A number of phase I and II trials have investigated systemic therapy[60] with mixed results. To date there has been no randomised phase III trials, mainly because of the diverse histopathologies of salivary gland malignancies[27].

Distant Metastases of PSGN;

Benign Disease

Metastasizing PSA is a very rare histological entity that inexplicably metastasizes. Often there is a long time interval between the surgery of the primary tumour (most frequently associated with PSA) and the diagnosis of the metastases. Most patients suffered two or more recurrences before developing a metastatic focus, and this suggests that surgical procedures and multiple recurrences may facilitate the entry of neoplastic cells into the blood stream. The histologic features are within the spectrum of features that typify pleomorphic adenoma. The primary neoplasm is typically a single, well-defined mass. Recurrences, which may be multiple, have been reported to occur for as many as 6 – 52 years after excision of the primary neoplasm[46].

Malignant Disease

Patients with malignant PSGN the incidence of failures at distant sites is high with rates reported between 20 – 50%[37, 61]. Overall, patients who experienced a distant failure represents 76.4% of those who died of the disease, suggesting that distant control represents a major problem in parotid gland cancer[62]. These high figures reflect the different histotypes, tumour size and site[63]. The predominant sites for metastases include the lungs, bones, and liver. Adenoid cystic carcinoma is the most common salivary gland carcinoma associated with metastases[64]. The literature demonstrates that advanced clinical stage and surgical margins involved are associated with a high

incidence of distant metastases and loco-regional failure, confirming the importance of aggressive initial surgery with combined treatment. Up to 25% will develop distant metastases with primary tumour control, and may be detected many years after the standard 5-year "alive and well"[37, 41, 54].

Options of treatment for patients who present with or develop distant metastases is limited with no reliable treatment available[65 – 67]. The identification of molecular targets in salivary gland malignancy is considered crucial for improving patient outcomes. There is a need to investigate a decrease in distant metastases through further clinical trials and possibly including chemo or molecular therapies into the primary treatment of high-risk salivary gland cancers[68, 69].

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Endoscopic surgery for sinonasal malignancy in the anterior skull base

Joanne Rimmer FRCS(ORL-HNS)
Valerie J Lund CBE MS FRCS FRCSEd
Royal National Throat Nose & Ear Hospital, London

Author for correspondence:
Joanne Rimmer
Royal National Throat Nose & Ear Hospital
330 Gray's Inn Road
London
WC1X 8DA

Abstract
Malignant tumours of the sinonasal tract are rare and histologically diverse, often with a long natural history. Surgical resection is the mainstay of treatment, and has been traditionally performed via an external approach. With the evolution of endoscopic sinus surgery, tumours of the nose, sinuses and anterior skull base may be amenable to endoscopic treatment. This review addresses the principles and techniques of endoscopic tumour resection. Advantages include improved visualisation with lower morbidity and mortality rates. Recent published series are reviewed and the outcomes discussed. Endoscopic surgery for sinonasal malignancies appears to be a safe alternative to traditional open approaches in selected tumours of appropriate extent, with comparable survival data in the literature to date.

Key words
Sinonasal, Malignant, Tumour, Endoscopic

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Introduction
Sinonasal malignant tumours are rare, accounting for 1% of all malignancies and 3 to 5% of all head and neck malignancies[1,2]. The annual incidence is approximately 0.5 to 1 new cases per 100,000 people, but rates as high as 2.6 per 100,000 people per year have been reported in Japanese men[3]. They can occur at any age, although 75% occur in those over 50 years of age4. They are more common in men, with a male:female ratio of 1.2-2.7:1.

The histology of malignant sinonasal tumours includes a diverse range of pathologies[5]. The World Health Organisation classification of tumours of the nasal cavity and paranasal sinuses divides them into nine groups (Table 1)[6]. The most common are primary epithelial tumours including squamous cell carcinoma and adenocarcinoma, followed by non-epithelial malignancies such as lymphoma[7]. The prevalence of different malignancies is variably reported in the literature depending on the series. Squamous cell carcinoma is accepted to be the most common sinonasal malignancy[8], but adenocarcinoma was the most frequent in Howard et al's series of 308 craniofacial resections[5]. In their series of 120 patients, Hanna et al found olfactory neuroblastoma was the most common diagnosis[9] (Figure 1). These differences probably reflect local referral patterns.

Table 1: World Health Organisation classification of tumours of the nasal cavity and paranasal sinuses[6]

1. Malignant epithelial tumours
2. Neuroendocrine tumours
3. Benign epithelial tumours
4. Soft tissue tumours
5. Tumours of bone and cartilage
6. Haematolymphoid tumours
7. Neuroectodermal tumours
8. Germ cell tumours
9. Secondary tumours

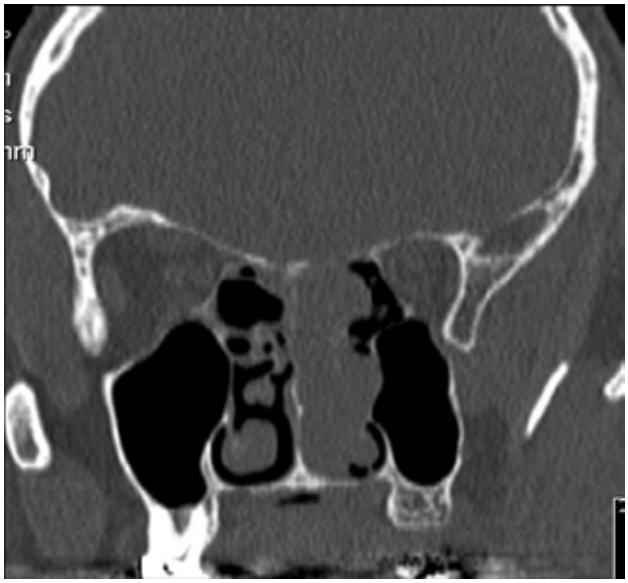

Figure 1a (original): *Coronal CT of olfactory neuroblastoma amenable to endoscopic resection*

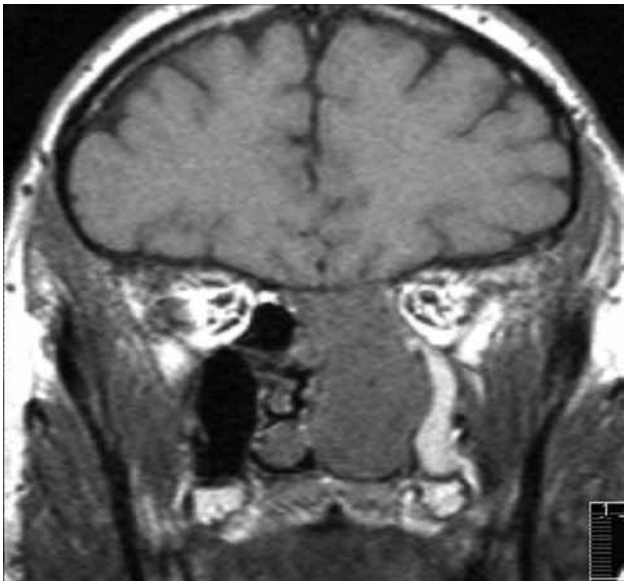

Figure 1b (original): *Coronal T1-weighted MRI with gadolinium of olfactory neuroblastoma amenable to endoscopic resection*

Whilst it remains unclear whether smoking is a significant risk factor for sinonasal malignancy, there is a definite association between hardwood dust exposure and adenocarcinoma of the sinuses[10]. Various chemicals have been implicated in the development of sinonasal malignancy, in particular squamous cell carcinoma, including thorium. nickel compounds and textile fibres[8].

Sinonasal tumours tend to present at an advanced stage as their early symptoms mimic those of chronic rhinosinusitis[11]. Many are aggressive and overwhelm the patient within a short time. Those that do survive can have a long natural history, sometimes with local and/or regional recurrences after many years. Long-term follow-up is therefore essential, both in terms of the patients themselves and for outcome reporting as five-year survival does not equate to cure. This can be done with serial magnetic resonance imaging scans and endoscopic examination with biopsy if needed.

Traditional craniofacial resection

The definitive treatment for most sinonasal malignancies is surgical resection, +/- radiotherapy (+/- chemotherapy) depending on the tumour histology[12]. The accepted "gold standard" surgical treatment for tumours affecting the anterior skull base is craniofacial resection (CFR), which allows en bloc resection of the ethmoid complexes with the cribriform plate and olfactory bulbs[13]. Prior to the introduction of this technique, five-year survival rates were very poor, mainly due to local recurrence as a result of inadequate surgical resection[14]. A large series of 308 patients over 25 years reported disease-free survival rates of 59% at five years, 40% at 10 years and 33% at fifteen years[5]. The average operating time was 3.5 hours with a mean stay in hospital of fourteen days and a low complication rate. Perioperative mortality was less than one per cent. An international collaborative report of 1193 patients from multiple institutions reported a higher postoperative mortality rate of 4.7%, with a 36.3% rate of complications[15]. Patient comorbidities, prior radiotherapy and the extent of intracranial tumour involvement were independent predictors of mortality and morbidity.

Endoscopic resection

Since its inception and first use in inflammatory sinonasal disease, the role of endoscopic sinus surgery has gradually expanded to include orbital decompression, the repair of cerebrospinal fluid (CSF) leaks and anterior skull base defects and resection of benign sinonasal tumours. From there it was perhaps inevitable that the next step would be its use in the treatment of sinonasal malignancies. Technological developments have facilitated this, including high-definition cameras, intraoperative navigation and better haemostatic agents and techniques[16]. The introduction of the pedicled nasoseptal flap as well as other vascularized tissue flaps has provided more reliable methods of skull base repair, reducing CSF leak rates[17].

Several centres across the world have now reported their series of endoscopic resections of sinonasal malignancies, and it appears to be a safe procedure that in selected patients gives comparable results to the more traditional open approaches[12,18-20]. The rare nature of these tumours means that most series are small in number, and the length

of follow-up following endoscopic treatment is currently shorter than that reported in CFR series, which remains the benchmark with which other treatment modalities are compared.

Endoscopic resections may be classified as entirely endoscopic approaches (EEA) or combined with a craniotomy as a cranioendoscopic approach (CEA)[21]. This latter alternative to the traditional CFR avoids facial incisions but still allows wider access to the cranial cavity. An alternative classification is to divide the ventral skull base into "surgical modules" based on their orientation in the sagittal and coronal planes, and to choose the surgical corridor that gives the best access to the tumour[22]. The sagittal plane extends from the frontal sinus to the body of the second cervical vertebra in the midline, and includes transcribriform and transclival approaches. The coronal plane is divided into anterior, middle and posterior to mirror the anterior, middle and posterior cranial fossae.

The overriding principle of endoscopic resection of sinonasal tumours must remain that of complete tumour resection with curative intent[11]. Traditionally en bloc resection was regarded as the "ideal" oncologic treatment but the evidence for this is lacking in the anterior skull base and is often difficult to achieve even with a completely open approach to the skull base, including CFR, due to the surrounding critical neurovascular structures[16]. It is the complete removal of the tumour with a negative final resection margin that is most important, rather than the method of removal[12]. There is no evidence in the literature that endoscopic piecemeal resection carries any risk of tumour seeding, and whilst positive margins are associated with increased local recurrence, these rates do not differ significantly between open and endoscopic approaches[23].

Technique

In endoscopic resection, tumour debulking is often required initially, both for access and to define more precisely the site of tumour origin. A wide field resection is then performed, with subperichondrial and subperiosteal dissection of mucosa as well as the underlying cartilage and bone if needed. Depending on the site of origin of the tumour, this may include a medial maxillectomy with resection of inferior and middle turbinates plus a complete fronto-ethmo-sphenoidectomy, with partial resection of the septum if indicated to obtain negative margins. Dura and periorbita may need to be removed if adjacent to or involved by tumour, to ensure negative margins. Tumour adjacent to or just involving the periorbita may still be resected endoscopically but if it penetrates the periorbita and involves the orbital contents then orbital clearance will usually be required (assuming the patient is otherwise curable), necessitating an open approach. Margins should ideally be confirmed with intraoperative frozen sections.

The resultant skull base defect should be repaired in layers, and a wide variety of materials have been used for this purpose, both autologous and synthetic. Temporalis fascia or fascia lata is often used as an underlay intradural graft, with a further layer placed extradurally but intracranially; there are synthetic alternatives available. A final onlay layer of tissue may then be placed intranasally. Nasal mucosa may be used, for example from the middle turbinate, but care should be taken that the donor site is free from tumour. For larger skull base defects surgeons are now turning to pedicled flaps, such as the nasoseptal flap, for a more reliable repair and prevention of CSF leak[17]. Various synthetic tissue glues are used to hold these layers in place, and then nasal packing is used to support the repair; this may be absorbable or may need to be removed at a later date according to the surgeon's preference.

Limits and contraindications

The limits of endoscopic resection differ between surgeons and are constantly evolving, but the senior author's limits of resection include extension through the dura to include the falx cerebri or frontal lobe, in which case CFR is the preferred alternative, and if tumour within the frontal sinus extends lateral to the midpoint of the orbit. As mentioned above, if tumour penetrates through the orbital periosteum then orbital clearance is required. There is no evidence that sacrificing the eye improves survival if only the periorbita is involved[24].

Absolute contraindications to entirely endoscopic resection of sinonasal malignancies include:

- orbital involvement requiring exenteration
- involvement of anterior or lateral wall of maxilla or facial soft tissues
- anterior and/or lateral involvement if the frontal sinus
- involvement of dura or brain lateral to the mid-orbital point or lateral to the optic nerve
- invasion of brain parenchyma (Figure 2)

Relative contraindications include:

- vascular invasion including cavernous sinus and internal carotid artery
- invasion of the optic chiasm
- posterior fossa invasion
- tumour extension below the level of C2 vertebra

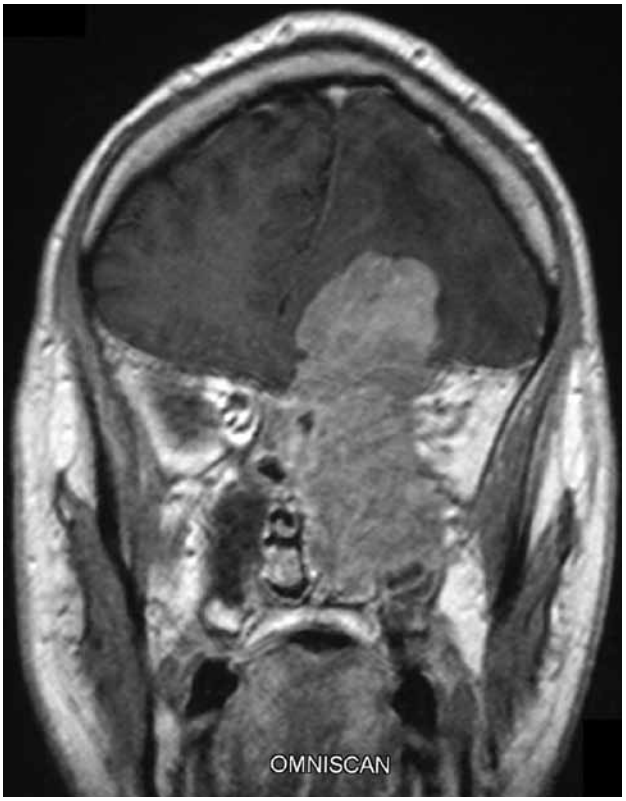

Figure 2 (original): *Coronal T1-weighted MRI with gadolinium showing extensive intracranial extension of sinonasal undifferentiated carcinoma not amenable to endoscopie resection*

It should be remembered that endoscopic treatment may also be undertaken with palliative intent, for example to debulk and reduce obstruction, bleeding or pain[25].

Advantages

The advantages of endoscopic resection over external approaches include: shorter operating time and hospital stay; lack of facial incisions; reduced blood loss; reduced morbidity and mortality; improved visualisation of the tumour, its origin and limits; reduced soft tissue dissection and brain retraction; preservation of adjacent critical neurovascular structures; no delay in commencing postoperative radiotherapy[25-27]. A small longitudinal study of eleven patients who underwent entirely endoscopic resection of anterior skull base tumours showed a significant improvement in symptom scores and a small gain in quality of life years, suggesting that patients find it a satisfactory approach[28].

Disadvantages

Obviously endoscopic resection is not appropriate for all sinonasal tumours, and if a tumour is deemed unresectable by a traditional open approach then an endoscopic resection will not be possible. The inability to resect en bloc does not seem to be a true disadvantage when compared to other techniques, as discussed above, but there may be difficulty obtaining definite clear margins[14]. Very vascular tumours may prove difficult to resect if bleeding impairs the surgical field[27]. The current lack of long-term follow-up data has also been criticized[11].

Outcomes

Lund et al's series of 49 patients treated with entirely endoscopic resection had an overall five-year survival of 88%, with disease-free survival of 68%[29]. A retrospective review of 120 patients included those managed by an EEA (77.5%) or CEA (22.5%)[9]. There was an 11% overall complication rate, with CSF leak in 3%, but no significant difference between the two groups. Local recurrence occurred in 15%, regional disease in 6% and distant metastasis in 5%, again similar between the two groups. Overall and disease-free survival rates were 80% and 87% at 5 years, and 50% and 80% at ten years respectively, again with no significant difference between the EEA and CEA groups.

The largest series of these cases in the literature (184 patients) reports a mean hospital stay of 3.7 days for EEA and 15.4% for CEA with a reduced complication rate compared to CFR of 8.7%; these were predominantly CSF leaks[21]. Overall disease-free survival was 81.9% at five years, but there was a significant difference between the two groups, with a five-year disease–free survival of 91.4% in the EEA group compared with 58.8% in the CEA group. However, this more likely reflects the differing tumour types and stages that each approach was used for, as when the different tumours were analysed separately there was no significant survival advantage for the EEA group. Despite this, survival rates remain comparable with those of CFR.

A pooled data analysis of 226 patients from 15 series comparing endoscopic treatment with CFR found no significant difference in survival for low stage tumours (T1/T2) but there was insufficient data for high stage tumours treated endoscopically, reflecting patient selection[30].

In a more recent review of 115 cases of sinonasal melanoma, 31 were treated with endoscopic resection with or without postoperative radiotherapy (Figure 3)[31]. Whilst radiotherapy had no effect on prognosis, those treated endoscopically had better outcomes than those treated via an open approach; this did not reflect the disease extent, as all patients were offered endoscopic surgery irrespective of staging, but may reflect the positive effect of reduced morbidity in an immunologically sensitive tumour. A

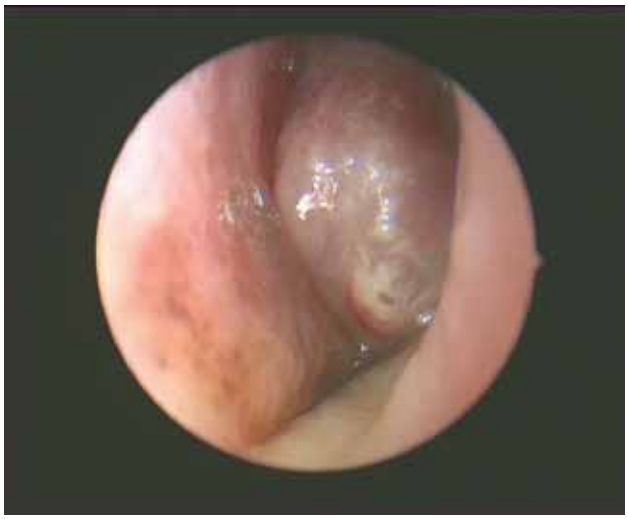

Figure 3 (original): *Mucosal melanoma amenable to endoscopic resection*

recent series of 44 patients treated with endoscopic resection for sinonasal adenocarcinoma showed comparable results to CFR, with overall and disease-free survival rates of 63% and 60% respectively at five years[32].

European Position Paper

The European Position Paper on endoscopic management of tumours of the nose, paranasal sinuses and skull base was published in 2010, providing an evidence-based review of endoscopic techniques in the context of other available treatments[7]. As well as giving algorithms for the management of such diseases, it gives guidance for outcome measurements for research and encourages the prospective collection of data to increase our knowledge of these rare tumours that require lifelong follow-up. It can be downloaded for free at www.rhinologyjournal.com.

Conclusion

The limits of endoscopic skull base surgery are constantly evolving. Although current series of endoscopic resections are smaller than those of CFR, and have shorter follow-up times, outcomes appear equivalent in appropriately selected patients. Hospital stay is reduced along with morbidity and mortality. Endoscopic surgery therefore has its place in the management of sinonasal malignancies, but surgical teams should be able to offer endoscopic, open and combined approaches as required and have the requisite expertise in imaging, histopathology and an understanding of the natural history of these rare conditions. Longer follow-up data and larger cohorts of patients will further strengthen the evidence for the management of these rare tumours.

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Blunt & Penetrating Trauma of the Neck

Andrew J Nicol, MBChB, FCS (SA), PhD
Associate Professor, Trauma Surgeon and Head of Trauma Centre
Johannes J Fagan, MBChB, MMed, FCORL
Professor, Chairman, Division of Otolaryngology

University of Cape Town, Cape Town, South Africa

Address for Correspondence
Professor JJ Fagan, Division of Otolaryngology, University of Cape Town
H-53 OMB, Groote Schuur Hospital, Observatory 7925, Cape Town, South Africa
fagan@iafrica.com; johannes.fagan@uct.ac.za

Abstract
Introduction: The initial assessment and management of the trauma victim may be the key to a favourable outcome

Initial resuscitation: This centers on principles of the Advanced Trauma Life Support (ATLS), with specific measures relating to the traumatised airway, major cervical vessels and pulmonary complications

Penetrating neck trauma: Massive bleeding, expanding haematomas or large tracheal wounds require immediate surgery. Debate revolves around how to manage the stable patient. Modern imaging, flexible endoscopy and endovascular intervention have improved our ability to assess injuries and have led to a migration from mandatory surgical exploration towards more selective and conservative management. This controversy is discussed in some detail.

Blunt neck trauma: The principles around management of blunt cervical injury are discussed

Key Words:
Cervical trauma, Blunt, Penetrating, neck trauma, gunshot neck, stab neck

Introduction
Patients must be correctly assessed and managed at the scene of trauma, during transport, and on arrival at the accident and emergency unit as trauma to the neck may be rapidly fatal due to bleeding, airway compromise, pulmonary complications and cervical spine injury. Delayed major complications such a major sepsis, stenosis of the upper airway, cervical spinal injury and consequences of vascular injuries e.g. false aneurysms and arterio-venous (AV) fistulae may result from overlooking penetrating injuries.

Initial Resuscitation
Conditions that can cause death within the ensuing minutes are excluded. Resuscitation is done in accordance with the principles of Advanced Trauma Life Support (ATLS)[1]. A hard cervical collar is fitted and spinal precautions employed until spinal injury has been ruled out.

An airway is secured in the presence of massive bleeding, a rapidly expanding haematoma, airway obstruction, respiratory distress, and for the unconscious patient with a Glasgow coma score of ≤8 who is unable to protect the airway. The majority of patients can be safely intubated with rapid sequence induction and direct laryngoscopy 2. The airway may be directly intubated through an open tracheal wound. Blind, awake intubation is inadvisable with penetrating neck wounds as patients are often intoxicated and combative; deaths have been attributed to blind intubation[2, 3]. When endotracheal intubation is not possible, cricothyroidotomy is preferred to tracheostomy due to its speed and simplicity.

Bleeding is controlled with digital pressure or a 20-FG Foley urinary catheter inserted into the wound with the balloon inflated with water[4]. The patient must be kept recumbent and the neck wound covered with an occlusive dressing to prevent air embolism. Neurogenic shock due to spinal cord injury should be excluded should the patient remain hypotensive.

Anteroposterior, lateral and open mouth cervical spine x-rays are done to exclude spinal injury; prevertebral air suggests a pharyngeal or oesophageal injury, or a pneumothorax. Chest x-ray (AP and Lateral) is done to exclude mediastinal air, pneumo- or haemothorax, and a widened mediastinum (intrathoracic great vessel or oesophageal injury).

The entrance and exit wounds of gunshot wounds must be identified as the tract suggests the anatomical structures that might be injured. In the absence of an exit wound, use x-rays to locate the bullet and determine the course of the tract. Avoid probing the wound as this may cause massive bleeding from a vascular injury. Note whether saliva, lymph or cerebrospinal fluid etc. is draining from the wound. Palpate the neck for subcutaneous emphysema, and note "hard signs' of vascular injury such as bleeding, expanding haematoma, pulse deficit (feel for a superficial temporal artery pulsation) and a bruit on ausculation. A neurological examination looking for Horner's syndrome, and cranial nerve, spinal cord and brachial plexus injuries is undertaken.

A full history is taken including questions relating to oesophageal injury and vagal or recurrent laryngeal nerve injury. Female patients of child-bearing age must undergo pregnancy tests prior to further radiological examinations.

Penetrating neck trauma

Massive bleeding, expanding haematomas or large tracheal wounds require immediate surgery. Debate revolves around how to manage the stable patient. Modern imaging, flexible endoscopy and endovascular intervention have improved our ability to assess injuries and have led to a migration from mandatory surgical exploration towards more selective and conservative management. Mandatory exploration for all penetrating trauma that breaches the platysma was the standard of care but was associated with 30–89% negative explorations rates[5,6,7,8] Proponents of selective exploration point to the high rates of negative explorations and excellent specificity of angiography, oesophagography, oesophagoscopy and flexible laryngotracheobronchoscopy to exclude significant injury; and that many injuries such as thyroid, pharyngeal, and selected venous trauma can be managed conservatively. Prospective studies have confirmed the safety of a selective conservative approach[9, 10, 11, 12]; other studies demonstrate that clinical examination and adjunctive investigations can exclude significant injury[13, 14, 15]. Our own prospective study on 203 patients found that 78% of penetrating neck injuries can be managed non-operatively with no missed clinically relevant injuries[16]. Therefore the question today is not whether penetrating neck injuries can be managed non-operatively, but what are the indications for investigations, and what investigations should be done! The investigations that are required for a selective conservative approach are summarized in *Table 1* and are dependent upon the symptoms and signs elicited.

Table 1. Investigations required relating to symptoms and signs, only in haemodynamically stable patients

Angiography (CTA)	Haemorrhage controlled with Foley catheter	Neck haematoma Pulsatile haematoma Pulse deficit Bruit Widened mediastinum Transmediastinal injury Unexplained neurology Retained knife blade
Swallow or endoscopy	Dysphagia Odynophagia Haematemesis Haemoptysis	Saliva leaking from wound Prevertebral air on lateral x-ray Widened mediastinum Transmediastinal injury Blood in nasogastric tube Pneumomediastinum
Laryngoscopy	Hoarseness	Aspiration
Bronchoscopy		Severe subcutaneous emphysema Large air leak Pneumothorax not expanding

Zones of the neck

Trauma surgeons divide the neck into 3 zones to assist with evaluation of penetrating neck injuries as a guide to structures at risk of injury. Most key vessels and viscera are situated anterior to the sternocleidomastoid.

Zone I is situated in the base of the neck and is demarcated by the thoracic inlet inferiorly and the cricoid cartilage superiorly; it contains large vessels (subclavian artery and vein, brachiocephalic vein, common carotid artery, aortic arch, internal and external jugular veins), trachea, oesophagus, the thoracic duct on the right side and the apex of the lung.

Zone II encompasses the midsection of the neck and extends from the cricoid cartilage to the angle of the mandible; structures at risk of injury include the carotid and vertebral arteries, internal and external jugular veins, larynx, pharynx oesophagus, cranial nerves X-XII, and sympathetic trunk.

Zone III extends above the angle of the mandible to the base of the skull and contains the parotid gland, oesophagus, internal and external carotid arteries and its branches, jugular vein, cranial nerves IX-XII, sympathetic trunk and pharynx.

Selective conservative management

Patients managed conservatively must be haemodynamically stable, without active bleeding or an expanding haematoma. The appropriate investigations related to their symptoms and signs should have been completed. Patients are admitted to a high care unit and undergo serial examinations at 4-hourly intervals. They are kept nil per os and have regular haemoglobin checks. After 24-hours patients can be fed if they remain apyrexial and stable; they are discharged home after 35-hours of observation. Temperature spikes must be investigated and the aetiology determined[17].

Retained sharp objects

Retained foreign bodies e.g. knives must be removed in theatre under general anaesthesia. Anteroposterior and a lateral x-rays are used to identify vital structures that may have been injured. CT scan is useful to determine the relationship to oesophagus, trachea and blood vessels and can guide further investigations[18].

Vascular injury

The authors' practice is that all high velocity gunshot wounds undergo surgical exploration; angiography is only done in stable patients with a large haematoma, bruit, pulse deficit, widened mediastinum, or when bleeding requires tamponade with a Foley catheter. ***Four vessel arch angiography*** with selective catheterization is the gold standard for suspected vascular injury but ***helical CT angiography (HCTA)*** is largely replacing conventional angiography and has 90–100 % sensitivity and specificity to detect arterial injury[19, 20, 21]. Bullet fragments and arterial pulsation may cause artefacts that resemble intimal tears; intimal tears should be imaged with conventional angiography prior to exploration. Colour flow Doppler (CFD) has been used, but is operator-dependent and expertise may not always be available[22, 23].

The common carotid artery is the most frequently injured artery[8]. Vascular continuity should be restored if possible in the absence of focal neurological deficits. In a comatose patient and/or central neurological deficit the surgeon has to decide whether to repair or ligate the common or internal carotid artery[24]. Small false aneurysms, intimal defects and intimal flaps have been managed conservatively, but the safety of such a conservative approach has not been established.[25, 26]. Patients managed conservatively must be followed with angiography.

Vertebral artery injury may present with acute (occasionally torrential) bleeding or with late complications (bleeding, thrombosis, false aneurysm, AV fistula and stroke). An AV fistula may present with a haematoma, thrill, bruit, neurological deficits or cardiac failure. Most vertebral artery injuries can be managed by angiographic embolization. Should it be discovered at surgery, the vessel is ligated. Inside the vertebral canal the artery can be ligated with ligaclips, or bleeding can be tamponaded with bone wax followed by angiographic embolization. Endovascular management of arterial trauma is being used more often. Graft-covered stents are increasingly used to seal post-traumatic false aneurysms and AV fistulae of essential arteries (common carotid, internal carotid, subclavian). Long-term reports of graft patency are still awaited. Traumatic AV fistulae of non-essential vessels in stable patients including the vertebral artery with adequate contralateral flow are best managed with selective embolization.

Hypopharyngeal injury

All isolated pharyngeal injuries are managed non-operatively at the authors' institution. Hypopharyngeal injury should be suspected with injuries of Zones I & II, particularly in the presence of odynophagia, dysphagia, dysphonia, haemoptysis, haematemesis and surgical emphysema. Flexible nasopharyngoscopy may reveal oedema, blood in the pharynx, or a perforation. Oesophagography is unreliable, but direct pharyngoscopy is accurate[27]. Perforations with

minimal leakage of contrast material may be managed conservatively[28]. The neck wound is not sutured, but is left open to drain into a bag. A contrast study is repeated on Day 7 to determine whether the leak has sealed[16].

Oesophageal injury

Penetrating oesophageal injury is uncommon. The complication rate is directly related to the time delay between the trauma and definitive management; it is therefore important to minimise this time delay. Clinical evaluation has a reported sensitivity of 80%, specificity of 64% and accuracy of 72%[29]. Haemodynamically stable patients with symptoms or signs as listed in *Table 1* should undergo water-soluble contrast oesophagography, the sensitivity of which is ca. 93%[30]. If an obvious leak is not apparent then barium is administered. In the unconscious, stable intubated patient the contrast can be passed by nasogastric tube which is pulled back into the pharynx to image the oesophagus. When a strong clinical suspicion of oesophageal perforation persists in the presence of a negative oesophagogram, flexible oesophagoscopy is done. Oesophagoscopy may be performed under general anaesthesia in patients taken to theatre for other reasons. The combination of oesophagography and oesophagoscopy has a sensitivity of almost 100%[29]. Although CT scan may be employed as a screening tool to determine the need for oesophagography, it is the authors' experience that CT scan is not reliable for detecting oesophageal injury. The oesophagus is repaired in a single layer with wide drainage, even with diagnosis is delayed. With concomitant tracheal injury, sternocleidomastoid or strap muscle is interposed to reduce the risk of a tracheo-oesophageal fistula. 'Damage control' is employed in septic patients i.e. proximal oesophagostomy, stapling of the distal oesophagus and external drainage to control sepsis. Once the patient has been stabilized, feeding jejunostomy and gastrostomy are performed. Even oesophagectomy may later be required, followed by reconstruction.

Tracheal injury

Tracheal injury may present as a "blowing wound", surgical emphysema, haemoptysis or hoarseness, and may be complicated by pneumomediastinum or tension pneumothorax. It is relatively uncommon and like laryngeal injury is often associated with oesophageal, vascular or spinal injury. The priority is to secure the airway. Minor tracheal injuries can be managed expectantly. The trachea can sometimes be directly intubated through a tracheal wound in the neck. That nasotracheal or orotracheal intubation should be avoided as it may aggravate an existing tracheal injury or cause a false passage is being overly cautious [31]. Tracheobronchial disruptions can be bypassed using a rigid bronchoscope, or by intubating over a flexible bronchoscope. Tracheotomy may expedite recovery with massive surgical emphysema. Communication with the pleural space and a large air leak following placement of an intercostal drain, indicates a need for surgical intervention. Tracheal repair is done with interrupted sutures. When there is an adjacent oesophageal injury, the repair is bolstered by a local muscle flap. A tracheotomy or an endotracheal tube may be used to initially protect the tracheal repair.

Laryngeal injury

Laryngeal injury may result from blunt or penetrating trauma. It is often associated with oesophageal, vascular or spinal injury. It may present as odynophagia, dysphonia, stertor, stridor, haemoptysis, stridor and airway obstruction. The priority is to secure an airway.

Tracheotomy is appropriate to protect the injured larynx when it is not possible to safely pass an endotracheal tube. The larynx is evaluated by listening to the voice quality, assessing the adequacy of the airway, examining the larynx by fiberoptic examination, and if concerns exist about the possibly of a displaced fracture of the thyroid cartilage requiring surgical reduction and fixation, a CT scan.

Blunt neck trauma

Blunt cervical trauma from motor vehicle accidents has declined since the introduction of seatbelts and airbags. Other causes include sporting injuries and interpersonal violence. Apart from cervical spinal injuries, the larynx is most commonly injured. Any unexplained neurological abnormality in a patient should be investigated with CT angiography to exclude blunt cerebrovascular injury (BCVI). Screening for BCVI should be considered in patients with any of the following: diffuse axonal injury, petrous bone fractures, cervical spine fracture, fracture through the foramen transversarium and Le Fort II & III fractures[32].

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Narrow band imaging in endoscopic evaluation of head and neck mucosal cancer

Cesare Piazza, Assistant Professor, **Francesca Del Bon**, Staff Member, **Piero Nicolai**, Professor and Chief
Department of Otorhinolaryngology – Head and Neck Surgery, University of Brescia, Brescia, Italy

Corresponding author:
Cesare Piazza
Department of Otorhinolaryngology – Head and Neck Surgery
University of Brescia
Piazza Spedali Civili 1
25123 Brescia
Italy

E-mail: ceceplaza@libero.it

Abstract
Narrow band imaging is a novel endoscopic technique that allows detailed evaluation of the microvascular architecture of upper aerodigestive tract epithelium, looking for the specific neoangiogenic patterns associated with precancerous and early neoplastic transformation in the oral cavity, pharynx, and larynx, in both the pre- and post-treatment scenario.

Key Words:
Narrow band imaging, Upper aerodigestive tract, Cancer, Endoscopy, Diagnosis, Surveillance.

Introduction
The term "biologic endoscopy" (BE) is a common term that designates different endoscopic techniques, some originating more than 40 years ago (such as toluidine blue staining), while others (e.g., narrow band imaging, autofluorescence, and confocal microendoscopy) have been developed more recently[1]. Different from standard white light (WL) endoscopy, which simply observes the macroscopic appearance of mucosal lesions, BE techniques provide deeper insight into the behaviour of a target lesion (to obtain a so-called "optical biopsy") and allow visualisation of lesions that are not otherwise visible. Even though the gold standard for definition of the nature of a lesion remains histopathologic examination of a formalin-fixed, paraffin-embedded tissue sample, BE attempts to reduce the number of unnecessary biopsies, and minimise the number of false negatives. Moreover, it allows more comprehensive surveillance of patients at high risk for developing mucosal lesions of the upper aerodigestive tract (UADT), and permits earlier detection of lesions that might be overseen with classic WL evaluation.

Narrow band imaging (NBI) is the latest addition to BE techniques, and represents a conceptual revolution in this arena since its main focus is not on evaluation of the neoplasm itself, but on its vascularisation. By addressing the neoangiogenic patterns inside and surrounding a target lesion, NBI can effectively overcome most of the limits described for supravital stains and autofluorescence, with a significant reduction in the number of false positives. From a technical point of view, NBI applies narrow-band spectrum filters to enhance the visualisation of mucosal and submucosal microvascular patterns, based on the principle that light has different depths of penetration depending on its wavelength. NBI filters select blue and green lights (wavelengths of 415 and 540 nm, respectively), corresponding to the peaks of absorption of hemoglobin. These filtered wavelengths penetrate the superficial layers of mucosa, thus highlighting the capillary network, and deeper levels, by enhancing the submucosal vessels. Additionally, optimal image definition for both conventional WL and NBI endoscopy is achieved using a High Definition Television (HDTV) camera, which gives

1080 lines of resolution, thus allowing a signal definition that is 4.26 times better than standard endoscopy[2].

Specific neoangiogenic patterns suggestive for premalignant or neoplastic lesions are the presence of well-demarcated brownish or darker areas in a context of green-blue appearing normal mucosa, with scattered thick dark spots, increased microvascular density, and winding or earthworm-like vessels in the form of abnormal intraepithelial papillary capillary loops (IPCL) inside or surrounding them. The presence of afferent hypertrophic vessels pointing towards the lesion itself and branching out in vascular loops adds further elements to this endoscopic scenario[3-7].

The aim of the present review is to summarize the most recent findings regarding NBI in the evaluation of head and neck cancer patients.

NBI in the evaluation of the oral cavity, oropharynx, and hypopharynx

First used in gastroenterology[8-11], NBI was subsequently extended to cancer evaluation of the UADT with very encouraging results. In particular, Muto[12] first recognised the potential advantages of NBI in otolaryngology: during endoscopic post-treatment surveillance of patients treated for oesophageal cancer, he was able to identify 34 metachronous lesions in the oral cavity, oropharynx, and hypopharynx (only 5 of which were also evident by WL endoscopy). The same group of researchers subsequently performed a multicentre, prospective, randomised, controlled trial recruiting 320 patients affected by oesophageal squamous cell carcinoma, and endoscopically searched for synchronous head and neck tumours[13]. Patients were randomly assigned to undergo to primary WL followed by NBI endoscopy or primary NBI followed by WL evaluation in a back-to-back fashion. This study showed that NBI was able to detect superficial cancer of the UADT more frequently than WL endoscopy (100% vs. 8%), with a statistically significant higher sensitivity (Se) and accuracy (Ac). The actual time difference between the two examinations ranged between 20 and 42 seconds, which is obviously clinically acceptable.

The same diagnostic benefits of NBI were also seen in the specific evaluation of oral and oropharyngeal tumours, in both the preoperative staging setting, and in post-therapeutic follow-up, with reported Se, specificity (Sp), positive (PPV), negative predictive values (NPV), and Ac of 96%, 100%, 100%, 93%, and 97%, respectively. Overall, 27% of patients had some form of diagnostic improvement (with influence on the treatment strategy adopted) by application of NBI in association with HDTV[14]. Along the same lines, Matsuba demonstrated that the routine application of NBI with high-resolution magnifying endoscopy (ME) was able to upgrade the T category in 20% of their oropharyngeal and hypopharyngeal cancers (4% from T1 to T2 and 16% from T2 to T3)[15]. NBI-ME, in fact, identified abnormal neoangiogenic patterns then confirmed to be squamous cell carcinoma located up to 2 cm from the boundaries of the tumour as previously detected by conventional WL endoscopy. This obviously translated into a better determination of intraoperative surgical margins and radiation fields.

In their well-designed study, Lin and colleagues16 recently demonstrated how "thick dark spots" within a well-demarcated brownish area with proliferation of dilated and

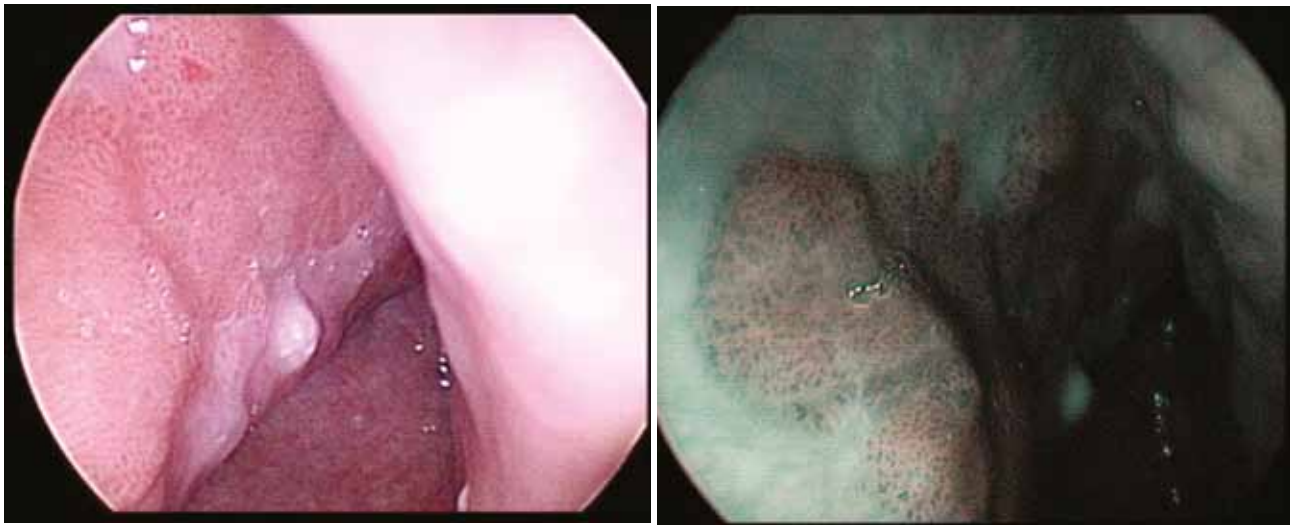

Figure 1: *Left piriform sinus erythroplakia under WL (a) and NBI (b). Note the abnormal microvascular "thick dark spots" inside a well-demarcated lesion, typical for epithelial precancerous or neoplastic evolution. Laser excisional biopsy under microlaryngoscopy revealed carcinoma in situ.*

abnormal IPCLs, universally considered as an NBI hallmark of epithelial precancerous or neoplastic evolution17, are not equally observed through out the entire UADT. In fact, such NBI findings are typical of areas in which a non-keratinised, thin, stratified squamous epithelium is found. Lin[16], in fact, observed a statistically significant correlation between the NBI diagnosis of carcinoma in situ and T1 by "thick dark spots" located in anatomical areas with such an epithelium (namely, floor of the mouth, ventral tongue, soft palate, tonsillar pillars, palatine tonsil, base of tongue, posterior oropharyngeal wall, and hypopharynx). Lymphoid hyperplasia may obscure these early endoscopic findings in the palatine tonsil and base of tongue, especially in cases of very superficial intraepithelial lesions. Other oral cavity areas are covered by keratinised, thick, stratified squamous epithelium (including gingiva, hard palate, vermilion border, and dorsal surface of the tongue) or non-keratinised, very thick, stratified squamous epithelium (such as retromolar trigon, labial, and buccal mucosa). In such locations, "dark spots" may be initially masked by the thickness of the epithelium itself (up to 5 times thicker than that of non-keratinised, thin lining).

NBI in evaluation of the larynx

Watanabe7 first reported that the use of NBI in the assessment of 34 patients suspected of having cancer of the larynx led to early detection of abnormal microvascular changes, and was also useful in distinguishing between low- and high-grade dysplasias (Se and Sp of 91% and 92%, respectively). In a larger series of 279 patients undergoing treatment (n=96) or followed-up (n=183) for laryngeal cancer, Piazza[5] confirmed these findings, with an overall Se, Sp, PPV, NPV, and Ac of 98%, 90%, 86%, 88%, and 92%, respectively. In particular, when used in conjunction with HDTV, NBI was useful for intraoperative tumour upstaging (n=26) and provided better definition of surgical margins (n=9) during transoral laser resection, while during post-treatment surveillance it allowed early detection of recurrences (n=13) and metachronous tumours (n=2).

According to Lin[16], the non-keratinised, thin, stratified squamous epithelium covering the epiglottis and vocal cords allows perfect visualisation of the pathognomonic "thick brownish spots" easily observed by NBI in premalignant and malignant lesions of the UADT. As a confirmation of this, Ni[18] performed an interesting study on 104 laryngeal lesions (45 benign and 59 malignant), correlating the NBI appearance of the morphological changes of the IPCL with definitive histopathologic diagnosis. They observed that polyps invariably present IPCLs that are almost invisible (Type I pattern), similar to those observed in laryngitis, where only enlargement of oblique and arborescent vessels is usually detectable (Type II). Squamous cell hyperplasia and mild dysplasia may partially obscure such a benign vascular architecture (Type III). When IPCLs become clearly visible, but with a regular arrangement and low density (Type IV), definitive diagnosis can range from squamous cell hyperplasia to mild and moderate dysplasia. In Type V patterns, the IPCLs are significantly dilated, of high density, with speckled features and various shapes (Type Va), partially destroyed with an earthworm appearance (Type Vb), or associated to necrotic tissue and with an even more bizarre distribution (Type Vc).

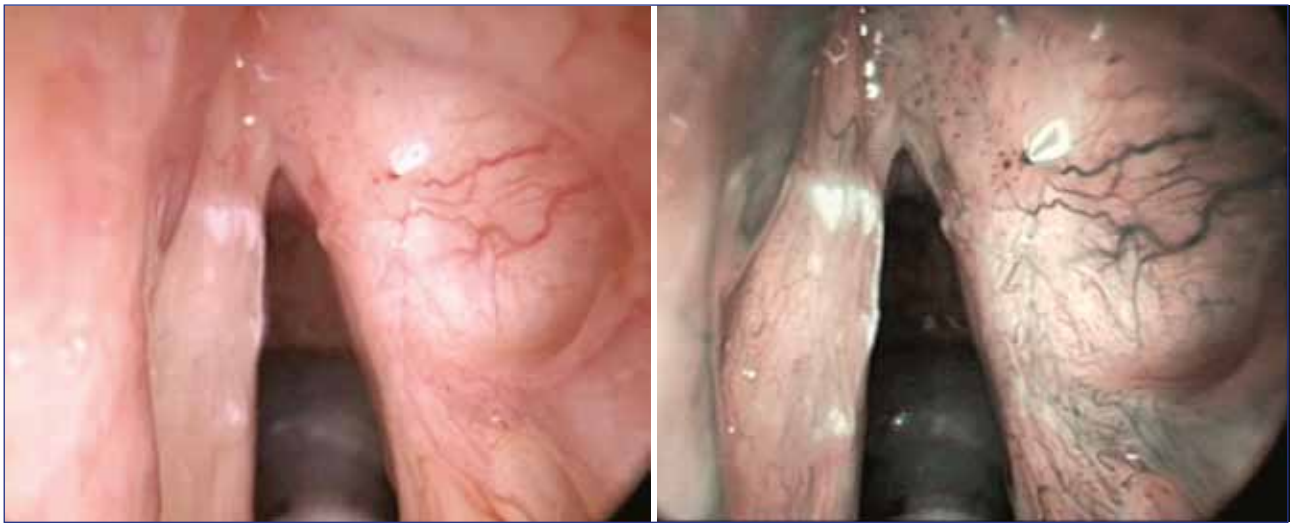

Figure 2 : *This patient was treated by endoscopic laser resection (Type II right cordectomy with ventriculotomy) for T1a glottic cancer 2 years before. During endoscopic follow-up, subtle erythroplakia of the anterior third of the right vocal fold was observed (a). NBI evaluation (b) enhanced the typical vascular pattern of "thick dark spots" and a second endoscopic resection revealed recurrent microinvasive carcinoma.*

Type V patterns have been associated with invasive carcinoma in 84% of patients, being the remnants mild to severe dysplasia or carcinoma in situ. However, Types Vb and Vc were associated with a definitive diagnosis of invasive cancer in 100% of cases. In conclusion, the authors found a Se, Sp, PPV, NPV, and Ac for NBI of 89%, 93%, 91%, 92%, and 90%, respectively. These rates were statistically better than those observed after WL evaluation with respect to Se, NPV, and Ac.

NBI in nasopharyngeal evaluation

The nasopharynx has been the last UADT site to be systematically evaluated by NBI for screening, early diagnosis, and post-treatment follow-up of nasopharyngeal carcinoma (NPC). Apart from one case report by Lin and Wang published in 2011 about NBI early detection of a NPC recurrence after RT[19], the nasopharynx received formal insight only with subsequent investigations. Vlantis[20] first described the normal appearance of nasopharyngeal mucosa under NBI evaluation as a regular follicular pattern of pale follicles with thin, dark borders and a pale-to-dark ratio of 90%. In some patients submitted to routine nasopharyngeal endoscopy, the authors observed a reversal of the normal NBI pattern, with dark centres surrounded by pale borders and a pale-to-dark ratio of 50% and speculated that these dark follicles could be abnormal capillary loops, representing an early event in the evolution of NPC.

A step forward was made by Wang[21] investigating the use of NBI as a potential screening method for detection of NPC in a high-risk population with well-known risk factors (nasopharyngeal endoscopic abnormalities, elevated serum Epstein-Barr Virus titer, positive family history, and neck lymph nodes metastasis from unknown primary) in a geographic area with one of the highest prevalences of this type of cancer. Based on renown abnormal NBI features (brownish spots and irregular microvascular patterns, observed in the nasopharynx less frequently than in other UADT sites), as well as on other aspects herein described for the first time (absence of light crests on the surface of lymphoid follicles, side-differences), the authors reported false positive and false negative rates of 8.3% and 2.3%, respectively. The high Sp (93%) of NBI coupled with an even higher Se (97%) were also extremely encouraging, especially compared NBI with other NPC screening methods (both serologic and radiologic), even in the absence of other considerations like a less time-consuming procedure, lower costs, and no side effects. The same conclusions were drawn by an independent group of researchers applying an NBI screening protocol to a larger group of 211 nasopharyngeal lesions (23% of which was diagnosed as NPC) observed among a high-risk population[22]. The diagnostic accuracy of NBI was compared to that of standard WL endoscopy: the former showed a statistically significant higher Se (94% vs. 71%) and NPV (98% vs. 92%). False-negative and false-positive rates for NBI were 4.5% and 3.6%, respectively. These authors, as well as others[23], also underlined some practical limitations of NBI in the nasopharynx, the most noteworthy of which are the occasional presence of a thick keratin layer, mucus or secretion coating covering the target area thus masking the underlying microvascular abnormalities, and the possible local bleeding obscuring the field of visualisation.

NBI in unknown primary detection

The adjunctive value of NBI, not only in evaluating the nature of a target lesion (already visible by WL), but also in looking for unknown primaries (Tx) has been noted by several authors. In the last decade, the routine use of PET in diagnostic work-up of these patients has improved the detection rate of Tx already submitted to standard investigation modalities (CT, MRI, and WL endoscopy) by 25%[24]. Such data are still lacking for NBI due to the paucity of papers addressing this tool in the evaluation of Tx patients. However, Hayashi[25] was able to identify 16 primary cancers (10 in the hypopharynx and 6 in the oropharynx) by NBI alone among 46 patients with Tx previously evaluated by CT, MRI, PET, laryngoscopy, and gastrointestinal endoscopy. A similar finding was reported by Sakai[26], observing an increase in primary tumour detection in patients with lymph node metastases from Tx using NBI in conjunction with specific manoeuvres (head torsion, Valsalva manoeuvre, and Killian position). The detection rate of Tx improved from 40% by WL endoscopy in a conventional straight head position to 71% by NBI with these adjunctive manoeuvres. Moreover, in a series of 28 subjects with Tx already evaluated by CT and WL endoscopy, Shinozaki was able to identify the primary lesion by PET in 2 patients (lower gum and palatine tonsil) and by NBI in 3 cases (2 lesions in the palatine tonsil and one in the piriform sinus)[27].

NBI in post-treatment surveillance

Interestingly, the first diagnostic application of NBI was in the setting of post-treatment surveillance of patients treated for oesophageal cancer, showing its high value in detection of synchronous and/or metachronous head and neck cancers, especially at the level of oropharynx and hypopharynx[12]. This was subsequently confirmed by several groups from different institutions and countries. Watanabe[28] found a 2-fold increase in detection of second UADT tumours in patients with oesophageal cancer by NBI compared to standard WL screening, with a statistically significant difference for Se (98% vs. 51%), NPV (100% vs. 97%), and Ac (99% vs. 96%) between the two methods. The increase in the detection rate of second pharyngeal cancers was even

greater according to Nonaka[29], who diagnosed metachronous lesions in 11% of patients screened by NBI vs. 1% in those followed by conventional methods ($p<0.0001$).

Especially in the post-treatment scenario, a critical issue of a diagnostic method should be considered its genuine specificity in differentiating between persistences/recurrences, metachronous lesions, and iatrogenic changes. Nonaka[29] found that, although IPCLs can be modified by inflammation, it is generally possible to distinguish these from those of neoplastic lesions based on their poorly defined margins and relatively low density. Our group confirmed these findings demonstrating that, after an adequate learning curve, NBI can efficiently distinguish neoplastic neoangiogenic patterns from abnormal vascularisation arising from acute or chronic inflammation as well as post-RT changes[30]. In fact, in our series there was no statistically significant difference between the NBI false positive rate after RT or chemo-RT compared to a cohort of untreated patients. Therefore, even in this clinical setting, NBI maintained extremely high values of Se, Sp, PPV, NPV, and Ac (100%, 98%, 92%, 100%, and 98%, respectively). Moreover, the high Sp of NBI after RT or chemo-RT helps to significantly reduce the number of unjustified biopsies that, in an irradiated field, can lead to severe complications. Our results are in agreement with those reported by Lin[31], concluding that prior RT apparently does not affect the detection of recurrent or second tumours in the UADT. These authors also observed a statistically higher Ac of NBI in respect to WL endoscopy for detection of second tumours in the oropharynx (100% vs. 69%) and hypopharynx (100% vs. 39%), especially when considering precancerous lesions and carcinoma in situ, while they failed to demonstrate superiority of NBI technique in oral cavity evaluation. Possible reasons for this are the good accessibility of this anatomical site to optimal visualisation and manipulation even under conventional light, the intrinsic limitations for endoscopic inspection of such a complex three-dimensional structure, the presence of keratinised and non-keratinised thick or very thick squamous epithelium covering the vast majority of the oral subsites and limiting the precocious observation of the typical "thick dark spots", and possible confounding effects of the room light in respect to the filtered NBI wavelengths. Apparently in contrast with such findings are those reported by Chu[32], who in a cohort of 101 patients previously treated for oral cavity cancer, found 26 second primary lesions during NBI post-treatment surveillance, 77% of which were still located in the oral cavity and diagnosed as carcinoma in situ in 65% of cases. The authors compared these data with those obtained in a cohort of oral cavity tumours followed-up without NBI, finding a statistically significant difference in the number of second tumours detected in the head and neck area (18% vs. 9%), early-stage lesions (96% vs. 63%), and, consequently, fewer patients needing adjuvant RT or chemo-RT after salvage treatment (12% vs. 50%).

As previously stated[21], the pseudostratified ciliated columnar epithelium covering the nasopharynx renders NBI observation of the typical "thick dark spots" less frequent in primary NPC. As confirmed by Wang and coauthors[33,34], this is not the case in the nasopharynx after RT, due to the shrinkage of nasopharyngeal lymphoid hyperplasia and progressive actinic-induced transformation of such an epithelium into a squamous hyperplastic one. In fact, in a group of 106 patients treated by RT for NPC these authors used NBI to identify 22 suspicious lesions that were invisible under WL endoscopy based on the observation of "brownish spots". At close observation, this microvascular appearance was further distinguished in scattered spots with tadpole tail pattern, round pattern, and irregular pattern. While the first two patterns were never associated with recurrent disease, the irregular one was neoplastic in 44% of cases (2 dysplasia and 2 carcinoma). At histopathologic examination, these lesions were also those with the greatest thickness.

Conclusions

NBI is gradually emerging as an interesting BE technique for pre- and post-treatment evaluation of UADT cancers, and in the search for synchronous lesions, and unknown primaries. Its high diagnostic accuracy, favourable cost-effectiveness ratio profile, and absence of adjunctive discomfort for patients make it a widely adopted diagnostic tool.

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Current management of obstructive sialadenitis

Jeroen Meulemans, MD[1,2] Greet Hens, MD PhD[2] **Vincent Vander Poorten,** MD PhD[2,3]
[1]Department of Otorhinolaryngology and Head and Neck Surgery, Heilig-Hart Hospital Roeselare, Belgium
[2]Department of Otorhinolaryngology and Head and Neck Surgery, University Hospital Leuven, Belgium
[3] European Salivary Gland Society (ESGS)

Corresponding author
Vincent Vander Poorten
Department of Otorhinolaryngology, Head and Neck Surgery
University Hospital Leuven, Kapucijnenvoer 33, 3000 Leuven, Belgium Vincent.Vanderpoorten@uzleuven.be

Abstract
Obstructive sialadenitis is the most common non-neoplastic disorder of the salivary glands and is most frequently caused by salivary calculi (sialolithiasis) and stenosis. Treatment has dramatically changed in the past 20 years, shifting from resection of the salivary gland towards a minimally invasive gland sparing approach. Including sialoendoscopy, shock wave lithotripsy, interventional radiology, sialoendoscopy assisted "combined approaches"(trans-oral removal of submandibular stones and external removal of parotid calculi) and sialoendoscopy assisted stenosis management. These are all recently validated minimally invasive therapeutic modalities. When appropriately combined, a surgical adenectomy can be avoided in up to 95% of obstructive sialadenitis cases.

Key Words:
Sialadenitis, Sialolithiasis, Sialoendoscopy, Lithotripsy.

Disclosure
The authors have no financial interest to declare in relation to the content of this article.

Introduction
Obstructive sialadenitis is the most common non-neoplastic salivary gland disorder. Patients usually present with a history of recurrent painful periprandial swelling ("mealtime syndrome"), often complicated by surinfection, resulting in fever and purulent discharge out of the papilla[1]. Sialolithiasis is the major underlying cause of obstructive salivary gland pathology, responsible for 66% of cases[2]. The incidence of sialolithiasis is not exactly known. Escudier and McGurk[3] estimated the population incidence of symptomatic sialolithiasis in England as 59 cases per million population per annum, and the prevalence as 0.45%. Sialolithiasis has a peak incidence between 30 and 60 years of age[4] and affects the submandibular (80-90%) more frequently than the parotid gland (5-10%) and the sublingual and minor salivary glands (0-5%)[5]. Regarding the pathogenesis of sialolithiasis, it is currently believed that microscopic stones (sialomicroliths) accumulate during secretory inactivity in normal salivary glands, causing obstruction and subsequent production of atrophic foci. Micro-organisms ascend the main salivary duct during secretory inactivity and proliferate in the atrophic foci. This causes spread of inflammation, leading to swelling and fibrosis that can compress large ducts. This eventually results in stagnation of secretory calcium-rich material that precipitates onto degenerating cellular membranes to form a sialolith[6]. The second cause of obstructive sialadenitis are duct anomalies (strictures and kinks) , which frequently involve the parotid ductal system (75.3%)[8]. Other causes of obstruction include mucus plugs, foreign bodies, sialodochitis, compression by a tumor or reactive intraparotid lymph nodes, intraductal

polyps, formation of granulation tissue associated with immunological disorders such as Sjögren's syndrome or radioiodine induced damage to salivary glands[1]. This review focuses on the current diagnosis and treatment of sialolithiasis and stenosis/strictures, being the most common causes of obstructive sialadenitis.

Diagnostic Radiographic Imaging

Useful diagnostic modalities include conventional sialography, CT, MR and MR sialography, and ultrasonography. Conventional sialography, in which the salivary ducts are visualised by retrograde injection of radiopaque dye, is still considered the gold standard, as it provides clear images of intraductal stones and ductal morphology. Disadvantages include radiation exposure and the invasiveness of the procedure, with a substantial rate of procedural failure and complications such as ductal wall perforation, infection and anaphylactic shock. Non-invasive techniques include CT and MRI. These are superior in demonstrating the relationship of the ductal system to the surrounding parenchyma and may reveal some obstruction aetiologies such as sialolithiasis, but they often fail to detect many other potential obstructive pathologies such as noncalcified sialoliths, stenosis and mucus plugs. This shortcoming is largely overcome by MR sialography, in which T2 weighted images are acquired during stimulated salivary flow, using the saliva itself as a contrast medium to visualise the ductal architecture and the presence of calculi and stenosis. Becker et al state that MR sialography is superior to conventional sialography in patients with acute or recurrent salivary gland swelling[12]. This technique, however, is expensive, time-consuming and suffers from typical MRI inconveniences such as motion artefacts and intolerance by claustrophobic patients and patients with ferromagnetic implants[9,13,14]. High resolution ultrasound is currently the first-line examination for obstructive salivary gland pathology. It is cheap, widely available and provides accurate detection of calculi within the gland itself, the hilum or the proximal main duct. (Fig. 1) Calculi in the distal duct and stenosis, however, are frequently missed[12,14].

Classical Management of Obstructive Sialadenitis

Classical treatment of lithiasis induced acute sialadenitis combines antibiotics and non steroidal anti-inflammatory drugs with measures to increase salivary flow (e.g. massage, hydration, sour candy), hoping for a spontaneous stone expulsion. When these methods fail or when episodes of obstructive sialadenitis recur, until 2 decades ago, the treatments of choice were intra-oral sialolithotomy for distal stones (with risk of post-operative ductal stenosis) and sialadenectomy for proximal, hilar or intraparenchymal

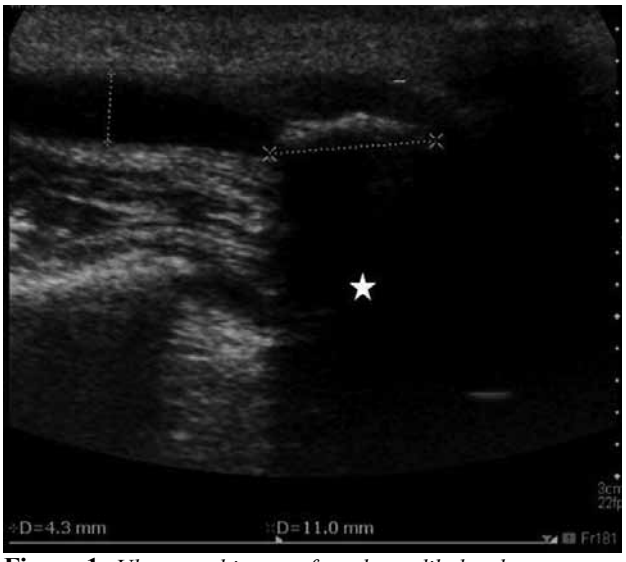

Figure 1: *Ultrasound image of a submandibular duct stone. Note the dilated duct (vertical line: 4.3 mm), the stone (horizontal line: 11 mm) and the retro acoustic shadow to the stone (white star)*

stones (risking nerve injury, unsatisfactory aesthetics and persistent symptoms due to remnant stones)[1]. In contrast to the former belief that a chronically ill gland is no longer able to regain normal function, Marchal et al observed normal histopathological findings in half of the submandibular glands that were removed because of sialolithiasis. This finding supports the emerging practice of a minimally invasive, gland preserving approach, even in cases of long-standing sialolithiasis[15].

Current Management of Obstructive Sialadenitis

Over the past 20 years, new minimally invasive gland-preserving techniques have been introduced, mainly in Europe[16-19]. These include extra-and intracorporeal shockwave lithotripsy, sialoendoscopy, interventional radiology, trans-oral submandibular stone removal and sialoendoscopy assisted parotid and submandibular sialolith extraction.

Shock Wave Lithotripsy

Shock wave lithotripsy fragments stones in smaller portions thus facilitating the fragments flushing out of the ductal system. The shockwaves can be generated by extracorporeal (electromagnetic or piezoelectric) sources or intracorporeal (laser endoscopic) sources. Extracorporeal shock wave lithotripsy (ESWL) is performed under ultrasound guidance, allowing localization of the sialolith, targeting of the shock wave and visualization of the fragmentation process[20]. ESWL as a noninvasive modality for treating sialolithiasis was first introduced by Iro et al in 1989[16]. Results regarding effectiveness of ESWL are difficult to compare because of differences in the outcome

criteria used[20]. In 2004, Zenk et al reported a 10-year experience with ESWL for submandibular stones in 197 patients. ESWL followed by duct bougienage, massage and basket extraction of stone fragments resulted in 35% of patients either free of stones or without symptoms on long-term follow-up. Another 15% had a significant symptom improvement, requiring no further therapy. The remaining 50% had residual stones without complaints at 1 year follow-up, but after that, needed further treatment because of recurrence of symptoms[21]. In a five-group multi-institutional experience of 4691 patients with salivary calculi over a 14-year period, ESWL was the primary treatment in 2102 patients. Complete success (both stone and symptom free) was achieved in 50.9%, depending on the gland involved (submandibular: 40.8% and parotid: 69.8%)[22]. The high incidence of residual stone debris in the ductal system is the main disadvantage of ESWL, as it is believed that this debris acts as a nidus for further calcification resulting in new sialolithiasis related obstruction[9,15]. Another problem is the limited availability of ESWL and the need for multiple sessions. Since ESWL is more effective for parotid than for submandibular stones, and since success rate is inversely proportional to stone size, this treatment is considered for parotid calculi between 3 and 7 mm[21,23].

Sialoendoscopy

Visualization of the parotid and submandibular ductal system using a small endoscope was first described by Katz in 1990[17]. Initially used for diagnostic purposes in suspected obstructive salivary gland pathology, sialoendoscopy is now considered an important treatment modality in obstructive sialadenitis[18]. It can be done in a day-care setting under local or general anaesthesia. Following progressive dilatation of the papilla, a semi rigid endoscope is inserted with simultaneous endoluminal irrigation. However, the performance of this technique is characterized by an important learning curve of about 50 procedures[24], but once mastered, sialendoscopy allows an almost complete ductal exploration, including secondary, tertiary and higher generation branches and provides direct and reliable information about ductal pathological conditions, reducing the need for radiological investigations[9]. When a sialolith is encountered, in many instances immediate intervention is possible. The sialolith can be removed in one piece using a mini grasping forceps or most frequently a basket, or these tools can be used for piecemeal removal of stone fragments after mechanical fragmentation or after intracorporeal laser fragmentation, which unfortunately takes a long treatment time[25]. Absolute contra-indications include acute sialadenitis and complete distal obliteration of the duct that is impenetrable by the endoscope[1,25]. Success rates for endoscopic stone removal range from 82% to 90%[19,26-29]. The results of sialoendoscopic stone extraction are directly related to the stone size/duct diameter ratio. This parameter determines the "floating character" of the sialolith, with a "floating" stone being usually amenable to sialoendoscopic removal. (Fig 2, 3 and 4). The smaller the stone, the more probably the stone will be floating after all. Therefore, Marchal recommends sialoendoscopy with basket extraction for small stones (less than 4 mm for submandibular and less than 3 mm for parotid stones). If stones are fixed, then ESWL followed by sialoendoscopic basket extraction or a combined endoscopic – external (transoral or transcutaneaous) approach is indicated[9,30,31]. Endoscopic stone removal is usually impossible for intra-glandular sialoliths[27]. Strictures on their turn, can also be visualized by sialoendoscopy and treated with subsequent balloon dilation. A classification linking obstructive pathology to different treatment options was published in 2008 and has been used by many authors in the meantime[32].

Interventional Radiology

First reported by Kelly et al.[33], fluoroscopy-guided stone retrieval is another technique indicated for parotid stones and mobile stones in the middle and proximal submandibular ductal system[34]. The main disadvantage is the exposure to ionizing radiation.

Trans-oral Surgical Removal of Submandibular Stones

Trans-oral removal is currently considered the treatment of choice for large distal and proximal stones and for impacted intraparenchymal stones that are bimanually

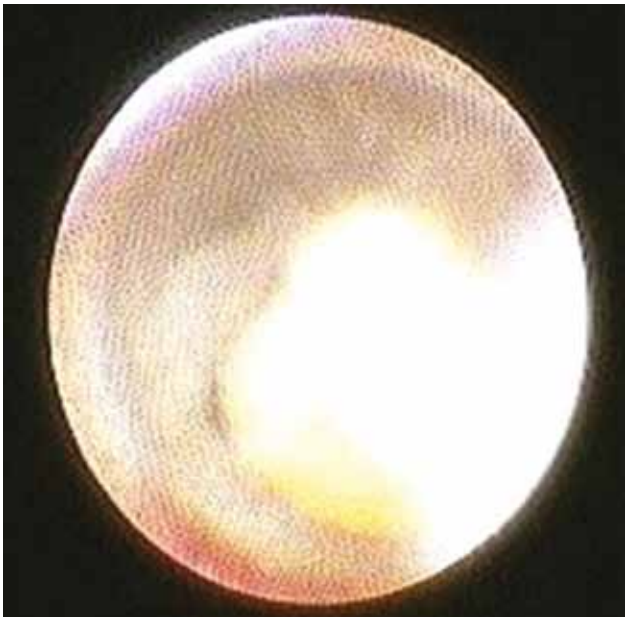

Figure 2: *Floating stone in the submandibular duct*

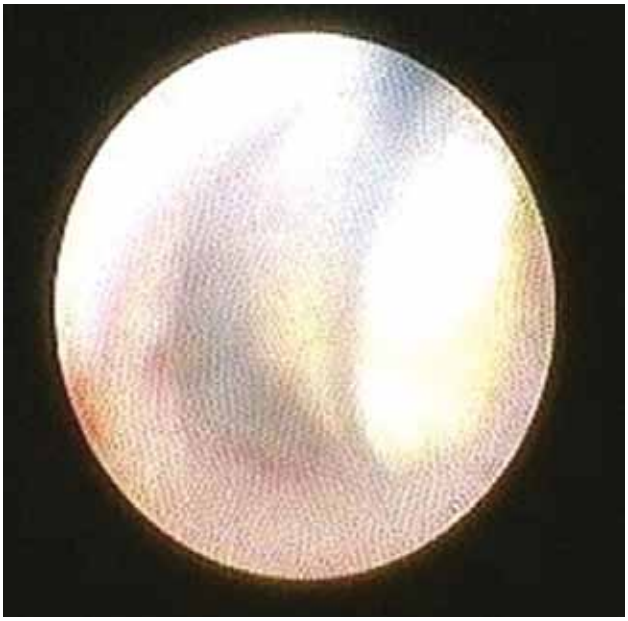

Figure 3: *Floating stone caught in the basket*

palpable and have a diameter of at least 8 mm, making the sialolith less suitable for ESWL or sialoendoscopy. Stones can be approached by an extending duct incision from the papilla to the stone, followed by hilar marsupialization ("ductal slitting") or by making an incision directly over the stone, followed by ductal stitching. Success rates up to 98% are described in the literature[1,23,31,35].

Endoscopically Assisted Extraction of Sialoliths

New endoscopically assisted procedures include both intra-and extra-oral techniques. Intra-oral endoscopically assisted sialolithotomy ("ductal stretching technique") is suitable for submandibular stones and consists of trans-oral stone release by an extended dissection under endoscopic control[1,31,36]. Endoscopy is performed for 2 purposes: to better locate the stone in the hiloparenchymal area before incision and to check for residual intraparenchymal calculi through the hilar incision[37]. Combined endoscopic and transcutaneous/rhytidectomy approach for parotid stones is indicated for large proximal refractory stones, unsuccessfully treated by ESWL or sialendoscopy[30,31]. Once the stone is endoscopically visualized, trans-illumination marks its exact location on the outer skin before exposure through a small skin incision or a rhytidectomy incision, preserving the buccal branch of the facial nerve[36]. After duct incision and stone removal, the duct is repaired with or without a vein graft patch. This technique has success rates of 92%[31].

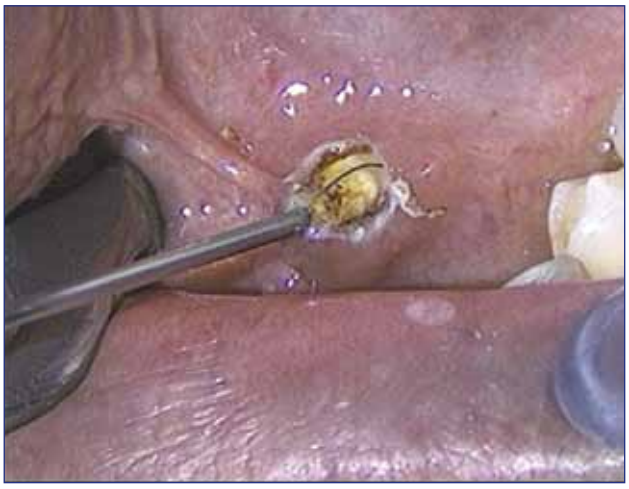

Figure 4: *Removal of the stone-in-basket following papillotomy of the Wharton's duct*

Conclusion

Sialolithiasis, the most common cause of obstructive sialadenitis, can currently be treated by a variety of minimally invasive techniques. The choice which technique or which combination of techniques to use and in what sequence, depends on stone size, stone location within the duct, duct diameter (duct diameter is inversely related to the branching generation but can also change due to retro-obstructive dilatation), stone mobility and number of stones. In the literature, a variety of treatment protocols have been proposed[1,9,38,39]. In general, small stones (up to 4-5 mm) that are mobile in the main duct of the gland will be amenable to sialoendoscopic basket removal. Stones that are fixed will need either ESWL or intraductal lithotripsy with subsequent sialoendoscopic basket fragment removal, or a combined approach (combined sialoendoscopic intra-oral approach for submandibular stones and combined sialoendoscopic transcutaneous approach for parotid stones). To conclude, maximum success can only be obtained by the appropriate combination of these new techniques by an experienced specialist. Altogether, up to 95% of salivary glands affected by sialolithiasis can nowadays be spared from a surgical adenectomy[22].

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Endoscopic laser surgery for early glottic cancer: A contemporary review of decision-making and treatment choices

Stephanie L. Koonce, M.D. §
George Garas, M.R.C.S. †
Michael L. Hinni, M.D. ¥
David G. Grant, F.R.C.S.

§Department of Surgery, Mayo Clinic Florida, Jacksonville, FL, USA
†Department of Otolaryngology, Head and Neck Surgery, Queens Medical Center, Nottingham Universities Hospital's Trust, Nottingham, England
¥ Department of Otolaryngology, Head and Neck Surgery Mayo Clinic Arizona, Scottsdale, Arizona, USA

Corresponding Author:
David Grant, Department of Otolaryngology, Head and Neck Surgery, Queens Medical Center, Nottingham

Abstract

Introduction: Within the multidisciplinary team (MDT) discussions involving the choice of treatment for primary and recurrent early stage glottic carcinoma can be complicated. Treatment modalities include either radiotherapy or surgery, with the options of open partial laryngeal surgery or endoscopic laser surgery available. Many believe endoscopic partial laryngeal surgery to be a superior treatment choice oncologically, but there remains intense debate and indeed some confusion regarding functional results particularly in comparison to radiotherapy. This article is a contemporary review of both oncologic and functional outcomes of endoscopic laser surgery in the management of early laryngeal cancers.

Method: A systematic review of contemporary literature limited to the 2007 to 2012 was performed via PubMed; EMBASE; BIOSIS Previews; Medline; ISCTRN and additional sources for published studies regarding oncologic and vocal outcomes of treatment options for early stage glottic carcinoma.

Results: Local control rates and voice outcomes are equivalent between radiotherapy and endoscopic surgery for early stage glottic carcinoma. However, evaluation of voice is not uniform amongst the studies, and most are not highly powered. Endoscopic surgery does appear to have a higher laryngectomy free rate in comparison to radiotherapy.

Conclusion: Radiotherapy and endoscopic surgery remain appropriate treatment options for early glottic cancer; however, endoscopic laser surgery has obvious clinical and therapeutic advantages and may be considered the gold standard. The TNM staging system, however, cannot be used as a prescription for treatment, and ultimately the choice between radiotherapy and surgery should be personalized and individualized to the patient with evaluation by the head and neck surgeon central to that process.

Key Words

Glottic cancer, transoral laser microsurgery, endoscopic, laser, laryngeal

Introduction

According to the World Health Organization's Globocan project, cancer of the larynx is uncommon with an estimated worldwide incidence of over 150,000 and overall annual mortality of approximately 81,000 people[1]. In comparison, lung cancer has an incidence of 1.6 million cases and mortality of 1.3 million[1]. A popular view of the current standard of care treatment for advanced laryngeal cancer (T2-T4, N1-N3) is concurrent chemo-radiotherapy or total laryngectomy[2]. The choice of partial laryngeal surgery for primary or recurrent

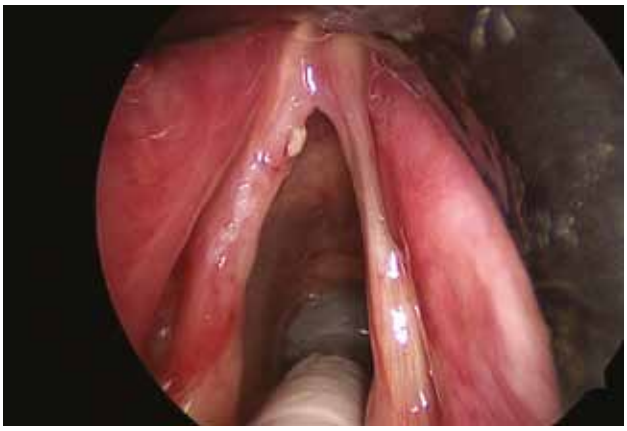

Figure 1a

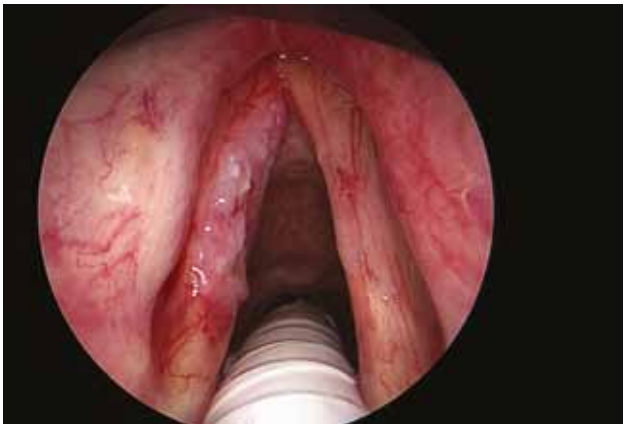

Figure 1b

advanced tumors, either open or endoscopic, is more controversial[3,4]. The optimal treatment of early laryngeal cancers (T1 or T2 tumors with no nodal metastases) is less well defined, although some believe endoscopic partial laryngeal surgery is now the accepted standard of care[5,6].

Early Glottic Cancer

Laryngeal cancer is anatomically divided into the supraglottic, glottic, and subglottic regions. Each site has distinctive characteristics. Supraglottic cancer, involving the false cords, aretynoids, and epiglottis, readily spreads via a rich vascular and lymphatic supply to the regional nodes and beyond[7]. This potential informs treatment choices in regard to management of the neck, and in particular the N0 neck. In contrast to supraglottic tumours, cancers of the glottic or vocal cord rarely metastasize to regional nodes or distant sites and instead often remain confined to the larynx given the paucity of a glottic submucosal lymphatic network. The delineation therefore between surgical and non-surgical treatment for early stage supraglottic laryngeal cancer is more polarized[6,7,8]. The choice between radiotherapy and endoscopic laser surgery for early stage (Tis, T1 and T2) glottic cancer is often the subject of intensely debate at multi-disciplinary team meetings. One reason for this is the experienced head and neck surgeon recognizes the heterogeneous nature of primary tumours and the extent of disease that can exist within the limited T stage nomenclature. For example, T1a tumors can range from somewhat superficial warty exophytic lesions in the mid cord ideally suited for laser excision to more endophytic, invasive tumors involving the entire vocal cord [Fig 1]. Similarly T1b and T2 lesions can be small or large, early or extensive and superficial or densely endophytic [Fig 2].

The choice of treatment therefore depends very much on an accurate surgical endoscopic assessment of the larynx including palpation and photo documentation. Generally CT imaging is not particularly useful for early lesions, and it is the clinical examination that is most revealing. The TNM staging system cannot be used as a prescription for treatment, and ultimately the choice between radiotherapy and surgery should be personalized and individualized to the patient and their individual tumour not simply T stage. In this paper we review the oncologic and functional outcomes of those treatment choices and examine the role of endoscopic laser surgery in detail to assist in clinical decision-making for primary untreated glottic cancer.

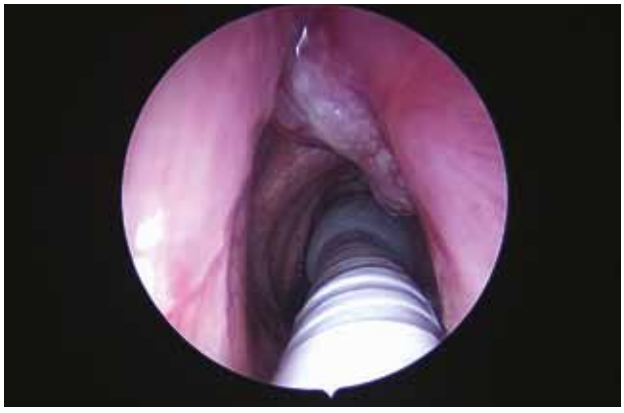

Figure 2a

Figure 2b

Oncologic Outcomes

Treatment options for early glottic cancer are external beam radiation therapy or surgery. Surgery can be open partial laryngeal surgery or endoscopic surgery, which usually employs the CO^2 laser. Open partial laryngeal surgery for previously untreated cancer is less common in the United Kingdom with endoscopic partial laryngeal surgery considered by many to be superior.

Epidemiological studies show that overall five-year survival rates for cancers confined to the larynx with good vocal cord mobility (stage I and II) range from 74-90%; once the cancer has spread to lymph nodes (stage III and IV) the survival rates fall to just over 50%[10]. Laryngeal cancer demands utilization of treatment approaches offering optimal levels of local tumor control given these survival rates. Radiotherapy has historically been the treatment of choice for early stage laryngeal cancer secondary to the presumed higher morbidity associated with traditional open surgical intervention. However, radiotherapy is a one-shot treatment option. Failure oft times leads to invasive surgical salvage possibly requiring laryngectomy[11- 13]. Endoscopic laser surgery or transoral laser microsurgery (TLM) has been established as a viable treatment option for glottic T1a and b tumors providing maximum tissue preservation with excellent levels of disease control. The optimal treatment for T2 tumors remains more controversial. Reported local disease control rates for TLM range from 71 to 97% with an average of 87.8%[12 - 20].

Reported radiotherapy local control rates average 84% (73-100%)[12,13,19]. For the purposes of laryngectomy free survival we can consider three groups of patients: those receiving endoscopic surgery alone, those with failed endoscopic surgery who are salvaged with radiotherapy, and those who receive only radiotherapy. TLM is a slightly more forgiving treatment, allowing for second and even third look operations if required while providing laryngectomy free rates averaging almost 96% (90-100%)[11-18]. Radiotherapy has an average reported larynx preservation rate of 85%[11-13]. The contribution of salvage radiotherapy to the laryngectomy free survival rates of TLM should not be forgotten, however as an approach, i.e. laser first, TLM is successful compared to radiotherapy alone. In a retrospective study of 100 patients with T1a glottic carcinoma, 49 of whom received TLM and 51 of whom received radiotherapy, five year laryngectomy free rates were 95% for TLM and 77% for radiotherapy[12]. All patients with recurrence after primary radiotherapy proceeded to laryngectomy. Patients who recurred after TLM (n=13) underwent either repeat endoscopic surgery (n=4) or radiotherapy (n=9) with 2 patients requiring total laryngectomy after salvage radiotherapy[12]. A prospective study of 274 patients all undergoing endoscopic surgery reported 39 recurrences treated with radiotherapy, 8 of which went on to total laryngectomy for a total laryngectomy free rate of 97%; no patients who underwent repeat TLM for recurrence (n = 36) progressed to laryngectomy[14].

Pathology and margins

The optimal method of endoscopic resection and pathological assessment remains controversial. Original TLM techniques were en bloc and most resembled a wide local excision utilizing the CO2 laser. TLM has evolved to a more piecemeal excision with the goal of maximal tissue sparing in order to preserve function. Some surgeons advocate this piecemeal excision, dividing the tumour to assess deep and lateral margins thus mapping the extent of tumour with frozen section control. This technique allows for maximum tissue preservation while assuring adequate local control of tumor. Final pathology results may necessitate a second or even third look operation for re-excision of positive invasive margins[21]. Once one has completed a third procedure without obtaining negative margins, alternative treatment modalities should be pursued. The concern is, of course, that by allowing an adequate period of time for the tissue to recover in order to take new margins, one is allowing the cancer to spread. The idea that one is allowing deepening invasion of the carcinoma is perhaps not apposite in this particular anatomical location given the paucity of spread.

A consensus on negative margins has not yet been reached for laryngeal cancer. A clear margin of <5 mm has been proposed in head and neck cancer, but laryngeal cancer was not included in the survey[22]. Batkasis[23] noted laryngeal cancer required a smaller negative margin compared to other head and neck cancers. Building upon that, Anasarin et al14 prospectively studied 274 patients with T1 or T2 laryngeal carcinoma undergoing en bloc TLM defining a negative margin as tumor > 1mm from margin, close margins as disease within 1 mm of the margin, and positive margins as disease at specimen edge. Their disease free survival rate in patients defined as negative margins was similar to compared studies of early glottic cancer suggesting a margin of >1mm is adequate for resection.

True margin status is not always easy to determine. Heat artifact, lack of tissue orientation, and small specimen size can make the margin results difficult if not impossible to accurately report. Coagulation from laser interferes with pathologist ability to identify clear margins[24]. Pathology reports may come back as suspicious or cannot rule out

positive when in fact the margin is negative. This is problematic given the impact on surgeon, patient, and adjuvant treatment. The debate also continues on optimal management of positive, close, and suspicious margins. Does one advocate more aggressive adjuvant treatment, re-excise the reported positive margins, or trust that the margins seemed clear and the orientation was off resulting in erroneous pathologic conclusion? Some surgeons advocate no further treatment acutely but instead employing close monitoring of the tumor site. The glottis is unique in that its location allows ease of observation for recurrence and revelation of early symptoms, which allows employment of this strategy. Conflicting reports exist regarding the impact of positive margins on recurrence rates with some authors noting no statistical difference in five-year disease free survival rates in patients with positive margins[18,25].

Monitoring patients rather than pursuing further treatment at the time of histologically positive margins does not appear to adversely affect disease free survival. Anasarin et al[14] clinically monitored patients with reported negative or close margins, pursued re-excision with TLM in patients with one positive margin, and scheduled radiotherapy for those with 2 or more positive margins or positive margin after re-excision. Their disease free survival was comparable to other studies[14]. Studies examining second look surgery in patients with initially reported suspicious or positive margins demonstrate histologically positive residual carcinoma at margin in 28% to 44% of patients[21,26].

Voice outcomes

Given the equivalent local control rates of TLM and radiotherapy, the focus of laryngeal surgery has shifted from being purely oncologic to include voice outcomes and quality of life. The difficulty arises in validity of assessment of post-treatment voice and lack of standardization in evaluation of vocal outcomes. Patients with laryngeal cancer will rarely have a "normal" voice at presentation secondary to the epidemiology and symptomatology of the disease. Additionally, an appropriate correlation between subjective and objective voice quality has not been established[27]. While the European Laryngological Society uses a validated protocol to assess pathologic voice conditions measuring five components (perceptual analysis, subjective rating, acoustics, aerodynamics, and videostroboscopy), the majority of published studies employ only one or two measures[28]. The grade, roughness, breathiness, asthenia, strain (GRBAS) scale and voice handicap index (VHI) are the two most common measurements of voice currently in use. The bulk of current studies show no statistically significant difference between radiotherapy and TLM in either subjective or objective voice quality[27,30-33]. However, the power of all current studies is small with the largest n = 299.

In a retrospective study of 34 patients directly comparing radiotherapy (n=16) to TLM (n=18) with a primary outcome of voice quality, Sjogren30 noted that 53% of patients in the radiotherapy group had mild to moderate vocal dysfunction compared to 61% in the laser surgery group, but this was not statistically significant. Patients who underwent laser surgery had breathy voices, while radiotherapy patients had voices that were equally breathy and rough. In self-assessment (VHI), both groups rated their voices as mildly deviant with no statistically significant difference. Peeters et al[34] compared 52 patients with T1a glottic carcinoma treated with TLM to 40 patients treated with radiotherapy and noted a statistically significant better VHI score in the laser group. These results are biased by the fact that patients who underwent radiotherapy were deemed not eligible for endoscopic surgery at presentation. Current literature reveals one meta-analysis of VHI scores for 299 patients with T1 glottic carcinomas treated with radiotherapy (91 patients) or laser surgery (208 patients). Irradiated patients had a mean total VHI score of 18.5, while TLM patients had a mean score of 12.9. Both scores demonstrate only mild to moderate dysfunction and the difference was not statistically significant[33].

Post-operative voice quality is also related to the location and amount of tissue one removes. Thus the balancing act becomes one of obtaining adequate clear margins versus voice preservation. Voice quality logically suffers with increasing resection. Resection of vocal muscles and involvement of the anterior commissure appear to result in the worst voice outcomes with TLM[35,36]. Patients undergoing TLM submucosal and subligamental resection had superior vocal outcomes with almost normal voices when compared to controls[18,35-37]. Vocal dysfunction after TLM is at least partially correctable by speech therapy. Van Gogh38 looked at 23 pts treated with either TLM or radiotherapy and demonstrated improvement in subjective and objective measurements of voice after speech therapy in both groups. Quality of life remains quite high post-TLM with the majority of patients surveyed believing life was the same or better after surgery[35,36].

Conclusions

TLM is a proven effective modality for Tis and T1a and T1b laryngeal carcinoma providing comparative local control rates and superior laryngectomy free rates compared to radiotherapy. The optimal treatment of T2 carcinoma remains less well defined. Vocal outcomes

appear equivalent between the two modalities. Increasing tissue removal including involvement of the anterior commissure and vocal muscle is related to worsening vocal outcomes. The main limitation to TLM is appears to be pathological tissue handling and margin status. Assessment of margin status is challenging in this anatomical location secondary to the small specimen size and lack of specimen orientation. Margin status should influence follow up but may not indicate recurrence risk. An appropriate equipoise between radiation therapy and TLM should be developed for early stage laryngeal carcinoma that is individualized for each patient.

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Neuralgias and other uncommon causes of neck pain

A. Yashar Tashakkor; **Desmond A Nunez,** FRCS (ORL) MD
Division of Otolaryngology, University of British Columbia.

Corresponding author
Desmond A Nunez, FRCS (ORL) MD
Associate Professor and Head,
Division of Otolaryngology, University of British Columbia
Vancouver General Hospital
Gordon & Leslie Diamond Health Care Centre
4th Floor-2775 Laurel Street
Vancouver, British Columbia
Canada V5Z 1M9

Email: otol@interchange.ubc.ca

Abstract

Background
Otorhinolaryngologists are accustomed to assessing patients presenting with pain in the face, head, ear or neck. However, rare pain syndromes in this region can be difficult to diagnose.

Aim
This article aims to discuss six uncommon neuralgias in an effort to enhance clinician recognition and patient care.

Methods
Literature data bases including MEDLINE, PubMed, American College of Physicians Journal Club and the Cochrane Database of Systematic Reviews were systematically searched for a combination of terms pertaining to neuralgia and Otorhinolaryngology. Reference lists from identified relevant articles were also searched.

Results
The clinical presentations, pathophysiology, diagnostic criteria and treatment of Carotidynia, Occipital neuralgia, Hyoid bone syndrome, Glossopharyngeal neuralgia, Mastoid process syndromes, and Eagle syndrome are described.

Conclusion
Knowledge of these rare disorders is essential for identifying the correct diagnosis and preventing unnecessary and potentially harmful investigations and treatments.

Key words
Neuralgia; Ear, Head, Neck.

Introduction
Pain is a common presenting complaint in an otorhinolaryngology clinic. Migraine, trigeminal neuralgia (TN), Temporomandibular myofacial, atypical facial and referred pain from malignancy of the aero-digestive tract are entities well known to otolaryngologist. Rarer craniofacial and neck neuralgias can be diagnostically challenging. Neuralgias are characterized by unilateral pain in the head and neck. The pain ranges from dull to sharp in quality and may be transient or persistent. Despite the rarity of some neuralgias and related pain syndromes, clinicians must consider them as differential diagnoses for atypical pain. Accurate diagnosis prevents unnecessary treatments, ranging from antibiotics for presumed infections to surgical interventions such as tonsillectomy or rhizotomy.

Methods
The data bases MEDLINE, American College of Physicians Journal Club, PubMed, Cochrane Database of Systematic Reviews, Cochrane Methodology Register, Cochrane Controlled Trials Register, Database of Abstracts of Reviews and Effects, Health Technology Assessment Database, Biosis Previews and Embase were systematically searched for relevant articles pertaining to neuralgia in Otorhinolaryngology up to February 28th, 2012. Key words and related Medical Subject Headings (MeSH) terms for neuralgia, head, neck, ENT, and Otolaryngology were used. Reference lists from identified relevant articles were also searched. Where possible articles published in the last 6 years were preferentially referenced to determine the clinical presentation, pathophysiology, diagnostic criteria and treatment for five rare pain syndromes: 1)

carotidynia, 2) Occipital neuralgia 3) Hyoid bone syndrome, 4) Glossopharyngeal neuralgia and 5) Mastoid process syndrome, 6) Eagle syndrome (see Table 1 summary).

Carotidynia

Definition, Aetiology and Pathophysiology

Carotidynia is a rare, idiopathic self limiting neck pain syndrome. The aetiology is unknown[1] but pathological evaluation has demonstrated non-specific low grade chronic inflammatory changes, prominent small vessel proliferation, and an oedematous fibromyxoid stroma of the carotid artery[2]. An idiosyncratic response to fluoxetine and reactive vasculitis are among proposed causes[3-4].

Clinical Presentation

The patient presents with an acute onset of unilateral mild to severe neck pain, exacerbated by head movements and sometimes radiating to the side of the face[5-6]. Carotidynia is a self limiting entity, persisting for less than two weeks with rare recurrence. There are no systemic or constitutional symptoms[6].

Investigations

Imaging and laboratory investigations should rule out differential diagnoses including vascular, infectious, neoplastic, neuromuscular, and dental aetiologies[2]. Laboratory investigations are usually normal in carotidynia however radiological investigations demonstrate fairly consistent findings, in keeping with an inflammatory process of the carotid vessel wall. Ultrasound and Computed Tomography (CT) scan shows layered thickening of the carotid artery wall with hypoechoic inner layer and isoechoic outer arterial layer, located at the region of tenderness[5, 7-8]. Amaravadi et al reported a short segment of increased [18F] fluorodeoxyglucose activity corresponding to the region of soft tissue thickening within the carotid sheath, using Positron Emission Tomography (PET)[9]. Magnetic Resonance (MR) Imaging studies report homogenous enhancement of the carotid sheath, eccentric arterial wall thickening, periarterial fat involvement and preserved arterial lumen[8, 10-13]. Radiological findings settle after symptom resolution[5, 8].

Treatment

Conservative treatment with heat, rest and anti-inflammatories such as NSAIDs can supplement patient reassurance[2, 11]. Relapsing cases may benefit from oral steroids[2].

Occipital Neuralgia

Definition, Aetiology and Pathophysiology

Occipital neuralgia is a syndrome of paroxysmal stabbing pain, in the distribution of the occipital nerves. Chronic entrapment of the occipital nerves by the posterior neck and scalp muscles is the most accepted aetiology[14-15]. Suggested mechanisms include injury to these nerves through chronic instability, acute whiplash injuries, trauma, or inflammation[14], iatrogenic trauma and compression of the nerves by adjacent arteries[16-18].

Clinical Presentation

Occipital neuralgia patients present with sudden onset headaches in the occipital distribution. The pain is stabbing, sharp or shooting in quality, can be severe and typically unilateral in the nuchal region, with frequent radiation towards the vertex[19]. Some patients report onset of pain in association with specific manoeuvres such as brushing the hair, exposure to cold or neck movements. Further, intermittent or concurrent episodes of diminished sensation or dysesthesia in the affected areas are sometimes reported[20]. Deep palpation over the affected region can lead to painful paroxysms or worsening of ongoing symptoms. Paresthesia and a positive Tinel's sign along the affected nerve's distribution are common findings. Cervical movement may be restricted and induce occipital muscle spasm. Neurological examination is otherwise unremarkable and focal neurological deficits should prompt investigation for other aetiologies.

Investigations

The current International Classification of Headache Disorders-2 (ICHD-2) specifies the following diagnostic criteria for occipital neuralgia: 1) Paroxysmal stabbing pain, with or without persistent aching between paroxysms, in the distribution(s) of the greater, lesser, and/or third occipital nerves; 2) Tenderness over the affected nerve; 3) Pain is eased temporarily by local anaesthetic block of the nerve[20]. MR Imaging is warranted in the presence of focal neurological findings, in order to confidently rule out alternative diagnoses[19].

Treatment

Occipital nerve blocks with lignocaine, bupivicaine or a corticosteroid can be effective for several weeks. Glucocorticoids, Carbamazepine, antidepressants, Non Steroidal Analgesics, implantable nerve stimulators and radiofrequency ablation have all been tried with varying degrees of success[16, 21]. Bogduk et al conclude that surgical nerve root decompression is the definitive treatment[15].

Table 1: Summary of discussed entities.

	Pathophysiology/ Epidemiology	Clinical Presentation	Diagnosis	Medical Treatment	Surgical Treatment
Carotidynia	Uncertain; idiopathic or subset of vasculitis.	Acute onset of unilateral neck pain, particularly on the carotid bifurcation: radiating to the eye, mandible, or teeth. Pain exacerbated by swallowing, coughing, chewing, yawning or contralateral head movements. Intensity of pain ranges from mild to severe. Self limiting entity, persisting for less than two weeks with rare recurrence.	Radiological imaging shows nonspecific perivascular inflammatory process.	Heat, Rest, NSAIDs, Reassurance; Oral steroids if relapsing.	Not Applicable.
Glossopharyngeal Neuralgia	Two subsets; 1) "idiopathic": vascular compression of CN IX; 2) "secondary": demyelinating lesions, trauma, intracranial, skullbase, head and neck tumours. Incidence of 0.7 cases per 100,000; 2% of patients with GN have VGN; rare in paediatrics; no gender predilection	Typically unilateral, severe, sharp pain in the anatomical region innervated by CN IX and X; Paroxysms incited by swallowing, talking, coughing, chewing, yawning, certain tastes, or touching the neck or external auditory canal; Episodes last seconds to minutes, but may occur in rapid and continuous successions. Several hundred paroxysms can be experienced daily, in addition to dull, low grade and constant pain intermittently. With CN X involvement, paroxysmal episodes may be associated with seizures or cardiac syncope, usually attributed to bradycardia or asystole	Clinical presentation and symptom resolution after local anaesthetic blocks.	Carbamazepine, ± phenytoin or baclofen; local anaesthetics.	Microvascular decompression, ablation of CN IX nerve roots, surgical removal of styloid process, or dissection and avulsion of CN IX; may require pace maker insertion.
Hyoid Bone Syndrome	Uncertain; histopathologic evidence supports focal muscular degenerative changes.	Chronic or recurrent anterior neck pain in the area of the carotid sinus, at or near the tip of the greater cornu of the hyoid bone, as well as sore throat and foreign body sensation. Passive neck movements, neck extension, lateral flexion to the opposite side and swallowing may induce dizziness or syncope while exacerbating severity of this, typically unilateral, sharp or dull pain. Ipsilateral otalgia and referred pain to the temporal region, sternocleidomastoid muscle, posterior pharyngeal wall, supraclavicular region, clavicle, upper half of the breast, or shoulder is common. Examination reveals focal tenderness localised to the hypopharynx and the greater cornu of the hyoid bone, reproduced by lateral motion of the greater cornu.	Diagnosis of exclusion; clinical presentation and symptom resolution after local anaesthetic blocks.	Rest, NSAIDs, reassurance; If persistent: local anaesthetics ± steroids.	Surgical excision of the greater cornu of hyoid bone.
Mastoid Process Syndrome	Unknown.	Prominent tenderness in the region of the insertion of the sternocleidomastoid muscle to the mastoid process, over the mastoid tip. Head and neck movements often exacerbate symptoms, but physical examination is otherwise unremarkable. Chronic and fluctuating condition, no reported recurrence.	Clinical presentation and symptom resolution after local anaesthetic blocks.	NSAIDs; Diclofenac sodium; local anaesthetics.	Not Applicable.
Occipital Neuralgia	Chronic entrapment of the occipital nerves by neck and scalp muscles is the most accepted aetiology; Other hypotheses include nerve injury through chronic instability, acute whiplash injuries, inflammation, iatrogenic trauma as well as structural compression of the nerves by the occipital arteries.	The pain is stabbing, sharp or shooting in quality, can be severe and typically unilateral in the nuchal region, with frequent radiation towards the vertex. Sometimes onset of pain in association with specific manoeuvres such as brushing the hair, exposure to cold or neck movements; intermittent or concurrent episodes of diminished sensation in the affected areas. Deep palpation over the affected region can lead to painful paroxysms or worsening of ongoing symptoms. Paresthesia. Cervical movement may be restricted and induce occipital muscle spasm. Neurological examination is otherwise unremarkable. 1) Paroxysmal stabbing pain, with or without persistent aching between paroxysms, in the distribution(s) of the greater, lesser, and/or third occipital nerves. 2) Tenderness over the affected nerve. 3) Pain is eased temporarily by local anaesthetic block of the nerve. Local anaesthetics ± steroids; If persistent: carbamazepine Not Applicable	1) Paroxysmal stabbing pain, with or without persistent aching between paroxysms, in the distribution(s) of the greater, lesser, and/or third occipital nerves. 2) Tenderness over the affected nerve. 3) Pain is eased temporarily by local anaesthetic block of the nerve.	Local anaesthetics ± steroids; If persistent: carbamazepine	Not Applicable.
Eagle Syndrome	Uncertain; ossifying hyperplasia of the stylohyoid process, secondary to osteitis, periostitis, or tendonitis. External trauma, regional surgery, chronic irritation, and degenerative or inflammatory changes of muscle attachments are potential causes.	Presenting symptoms include neck pain, foreign body sensation in the oropharynx, persistent sore throat, dysphonia, facial and jaw pain, dysphagia, referred pain to the ipsilateral ears or mastoid region, and dull and achy pain with opening of the mouth or neck movement. Impingement of the internal carotid artery presents with pain over the entire head from the ophthalmic region to the occiput; external carotid artery impingement presents with uniform pain in the neck and the eye with exacerbation secondary to turning of the head. External palpation of the styloid process or the tonsillar fossa can ignite pain. The elongated or calcified styloid processes may be palpable.	Clinical presentation and styloid process 3.0 cm or longer in length on a 3-dimensionaly rendered structural CT.	Oral analgesics, local injection of steroids or treatment with carbamazepine, provide temporary relief.	Intraoral or extra-oral, amputation of the elongated styloid process.

1) Paroxysmal stabbing pain, with or without persistent aching between paroxysms, in the distribution(s) of the greater, lesser, and/or third occipital nerves. 2) Tenderness over the affected nerve. 3) Pain is eased temporarily by local anaesthetic block of the nerve.

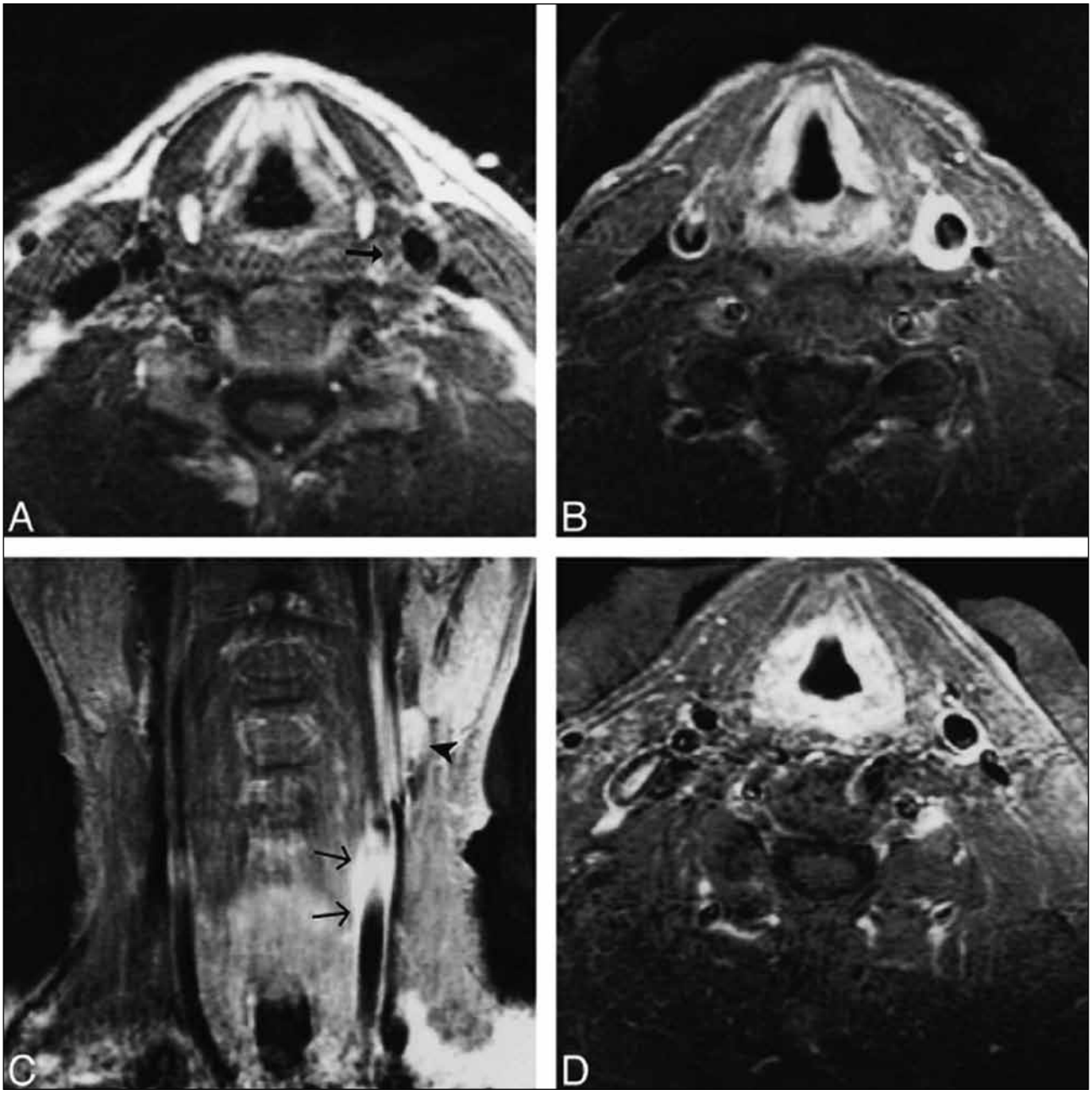

Figure 1: *Axial contrast-enhanced T1-weighted MR images of a patient with left-sided carotidynia reproduced with permission of BS. Burtona, MJ. Symsa, GW. Petermanna and LPA. Burgessa: MR Imaging of Patients with Carotidynia. AJNR Am J Neuroradiol. 21(4):766-769. 2000 © by American Society of Neuroradiology.*
A: *Axial T1-weighted image (700/16/2 [TR/TE/excitations]) at the level of the distal common carotid artery illustrating abnormal soft-tissue signal surrounding the left carotid (arrow).*
B: *Axial contrast-enhanced T1-weighted image (550/16/2) with enhancement of the tissue surrounding the carotid artery.*
C: *Coronal contrast-enhanced T1-weighted image (550/16/2) with enhancement extending to the level of carotid bifurcation (arrows).*
D: *Axial contrast-enhanced T1-weighted image (500/12/2) obtained after symptom resolution months later, no longer shows enhancement of the tissue around the carotid artery.*

Hyoid Bone Syndrome

Definition, Aetiology and Pathophysiology

Hyoid Bone syndrome (HBS) is an anterior neck pain syndrome related to the attachments of the Hyoid Bone. Histopathologic evidence of focal degenerative changes in the middle pharyngeal constrictor muscle fibers at its insertion into the greater cornu of the hyoid bone has been

reported in HBS, though in a patient who had undergone local injection therapy[22]. The hyoid bone is attached to fascia and muscles involved in swallowing, respiration and phonation. Their frequent use, and the hyoid bone's mobility makes them prone to damage and degenerative changes, especially at the point of muscle insertion at the greater cornu of the hyoid bone[23]. Glossopharyngeal nerve innervation of the digastric muscle intermediate tendon and surrounding fascial sling could explain the ipsilateral pain radiation secondary to a tenosynovitis[24].

Clinical Presentation

Hyoid bone syndrome (HBS) presents with chronic or recurrent anterior neck pain in the area of the carotid sinus, at or near the tip of the greater cornu of the hyoid bone, as well as sore throat and foreign body sensation[25]. Passive neck movements, neck extension, lateral flexion to the opposite side and swallowing may induce dizziness or syncope while exacerbating severity of this, typically unilateral, sharp or dull pain[24-25]. Ipsilateral referred otalgia, temporal region, sternocleidomastoid muscle, posterior pharyngeal wall, supraclavicular region, clavicle, upper half of the breast, or shoulder pain is common[22, 25]. Physical examination reveals focal tenderness localised to the greater cornu of the hyoid bone[23]. Lateral motion of the bone towards the affected side and maintenance of pressure on the affected greater cornu will exacerbate pain and may reproduce the pain radiation[23, 25].

Investigations

Laboratory and radiological investigations are typically unremarkable[22-23, 25]. Symptom resolution after local anesthetic injection at the site of pain localization, the hyoid bone greater cornu is diagnostic[25].

Treatment

The initial approach to treatment is conservative including reassurance, rest, and the use of systemic or topical NSAIDs which have proved successful in over 60% of patients[23]. Persistent symptoms are managed by local anesthetic injections with or without steroid[24]. If conservative measures fail, surgical excision of the greater cornu of the hyoid bone is a relatively successful invasive alternative[22].

Glossopharyngeal Neuralgia

Definition, Aetiology and Pathophysiology

Glossopharyngeal Neuralgia (GN) is a potentially life-threatening neuropathic condition, characterised by severe, sharp pain in the anatomical region innervated by cranial nerves (CN) nine and ten[20, 26]. GN may be "idiopathic" or "secondary"[1]. Idiopathic cases are believed to be caused by vascular compression of the glossopharyngeal nerve at the nerve root entry zone by the vertebral or posterior inferior cerebellar artery[27- 28]. Secondary causes include demyelinating lesions, trauma, tumours of the cerebellopontine angle, cranial base, head and neck[29-31]. GN is often misdiagnosed as Trigeminal Neuralgia, the principal differential diagnosis[27]. Trigeminal Neuralgia occurs in up to 12% of GN patients[32]. GN may be associated with significant morbidity leading to depression, suicidal ideation, as well as weight loss and malnutrition secondary to severe dysphagia1[33].

Clinical Presentation

GN is primarily an adult condition with an incidence of 0.7 cases per 100,000, and no gender predilection based on historical data[34-35]. Pain originates in the posterior pharynx and involves the ear, base of tongue, tonsillar fossa or area below the angle of the jaw[20, 27, 33]. Paroxysms are frequently incited by swallowing, talking, coughing, chewing, yawning, certain tastes, or touching the neck, ear or external auditory canal[1, 32]. Bilateral involvement occurs in up to 2.5 percent of patients[36]; episodes usually last seconds to minutes[37]. Several hundred paroxysms can be experienced daily, in addition to dull, low grade and constant pain. Patients often wake from sleep during paroxysms. Episodic pain from GN can occur in clusters with active symptoms lasting weeks to months, alternating with often longer remission periods[32]. The frequency and severity of pain progressively increase as remission duration decreases. Vagal nerve involvement leads to paroxysmal cardiac syncope or seizures attributed to bradycardia or asystole[26, 38]; this potentially life threatening variant is referred to as vagoglossopharyngeal neuralgia (VGN)[28, 32].

Investigations

Radiological investigations, including MR imaging, is indicated in all suspected cases to rule out alternate diagnoses, such as a tumour[38-39]. Frequent electro-cardiograms may assist in diagnosis of VGN.

Treatment

Carbamazepine, alone or in combination with other drugs such as phenytoin or baclofen is the initial treatment for GN[37]. Medication becomes less effective with time. Application of local anaesthetics to the oropharynx can be diagnostic and provide temporary relief. Life threatening arrhythmias associated with VGN require management by a cardiologist such as insertion of a pace maker[27]. GN has been successfully treated with microvascular decompression, rhizotomy or percutaneous radiofrequency ablation of the glossopharyngeal nerve root[28, 40-41].

Mastoid Process Syndrome

Definition, Aetiology and, Pathophysiology

Mastoid Process Syndrome (MPS) is an ear and mastoid pain syndrome. The aetiology is unknown. Hefer et al (1997) first reported MPS as a pain syndrome presenting with tenderness localized over the mastoid process without any other evidence of pathology in the head and neck[42]. Hagr et al (2011) described a similar entity characterized by localised pain over the anterolateral tip of the mastoid, which they called ATOM[43]. These conditions present with prominent tenderness at the insertion of the sternocleidomastoid muscle to the mastoid process of the temporal bone[42-43]. Head and neck movements often exacerbate the symptoms, but physical examination is otherwise unremarkable[43]. This mild or severe pain of unknown pathophysiology can be chronic[43].

Investigations

Radiologic and laboratory investigations are normal. Hagr et al demonstrated an effective and relatively safe diagnostic and therapeutic role for a single local injection of lidocaine 1% without epinephrine[43].

Treatment

A combination oral and topical diclofenac for ten days can resolve the condition[42]. Topical injections of local anaesthetic would be an alternative.

Eagle Syndrome

Definition, Aetiology and Pathophysiology

Eagle's syndrome causes neck pain secondary to elongation of the styloid processes, or calcification of the stylohyoid or stylomandibular ligaments[44-45]. There are two subtypes. The first "classic" type characterized by the elongation of one or more of the styloid processes or calcification of the stylohyoid complex, results in irritation of cranial nerves V, VII, IX or X which are adjacent to the styloid process[46]. The second "carotid artery" subtype is unrelated to prior surgery, and is associated with an elongated styloid process directly impinging the carotid artery[44]. The exact cause of Eagle's syndrome remains controversial. A reactive ossifying hyperplasia of the stylohyoid process, osteitis, tendonitis, or periostitis post surgery (e.g. tonsillectomy), chronic irritation of the stylomandibular ligament, insertion tendinitis, degenerative or inflammatory changes of muscle attachments have all been proposed as possible causes[1, 47].

Clinical Presentation

The classic subtype of ES is widely associated with a history of a preceding tonsillectomy[48]. Cranial nerve irritation is believed to be secondary to post-operative scar tissue binding the oropharyngeal mucosal surface to the tip of the elongated process[44]. Presenting symptoms include foreign body sensation in the oropharynx, persistent sore throat, dysphonia, facial and jaw pain, dysphagia, referred pain to the ipsilateral ear or mastoid region, and dull and achy pain with opening of the mouth or movement of the neck[1, 44]. On examination, external palpation of the styloid process or the tonsillar fossa can trigger pain[1]. The elongated or calcified styloid processes may be easily palpable on the surface of the tonsillar fossa as a hard, pointed structure.

In carotid artery ES symptoms are due to mechanical stimulation of the sympathetic nerves on the carotid artery wall[44]. Mineralization of the stylohyoid complex is typically absent in this setting[46]. Impingement of the internal carotid artery presents with pain over the entire head from the ophthalmic region to the occiput[44]; external carotid artery impingement presents with uniform pain in the neck and the eye with exacerbation secondary to turning of the head[44]. A slight deviation of the styloid process can cause arterial impingement and consequent symptoms[46].

Investigations

Radiological investigations diagnose comparatively high prevalence rates of elongation or mineralization of the styloid process of 4% to 28% [44], the majority of which are asymptomatic. The length of the styloid process can be quantitatively measured with panoramic radiograms, cephalograms or computed tomography (CT). 3-dimensionaly rendered structural CT is the current proposed for diagnostic gold standard for Eagle's syndrome[1]. The styloid process normally measures 2.0-3.0 cm in length and is considered elongated if greater than 3.0 cm in length[46, 49].

Treatment

Medical treatment consists of oral analgesics, local injection of steroids or treatment with carbamazepine, all of which can provide temporary relief[46-47]; however the long term results are suboptimal[50-51]. Surgical amputation of the elongated process undertaken via an intraoral or extraoral approach leads to long term cure[46-47].

Conclusions

The pathologies discussed are seldom encountered by Otolaryngology, head and neck specialists and when seen can be easily misdiagnosed or appropriate management delayed. Inappropriate and invasive investigations or treatments place patients at risk. Delayed diagnosis exacerbates morbidity and in rare instances can be fatal. Therefore, knowledge of these pathologies as well as their inclusion in the list of potential diagnosis in patients with atypical pain is recommended.

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Evaluation of dysphagia: a contemporary approach

Vinidh Paleri MS FRCS (ORL-HNS)[1]
Patrick J. Bradley MBA FRCS[2]

[1] Consultant Head & Neck and Thyroid Surgeon
Otolaryngology-Head and Neck Surgery
Newcastle upon Tyne Hospitals NHS Trust

[2] Honorary Professor Head and Neck Oncologic Surgeon,
The University of Nottingham
Emeritus Consultant ORL-HNS
Nottingham University Hospitals

Correspondence to:
Vinidh Paleri MS FRCS(ORL-HNS)
Consultant Head & Neck and Thyroid Surgeon
Otolaryngology-Head and Neck Surgery
Newcastle upon Tyne Hospitals NHS Trust

Honorary Clinical Senior Lecturer
Northern Institute for Cancer Research
Newcastle University
Email:vinidh.paleri@nuth.nhs.uk

Abstract
Dysphagia is a presenting symptom for several disease processes. With approximately 50 percent of all dysphagia cases seen in ENT clinics, a structured approach to diagnosis is necessary to formulate a management plan. The use of this described approach will aid with decision making determining which patients to treat and who to refer appropriately to the gastroenterologist, neurologist or oesophageal surgeon. This is especially relevant given the burgeoning role of newer diagnostic modalities in routine assessment.

Key words
Dysphagia, investigation, transnasal oesophagoscopy

Introduction
Dysphagia is a common presenting symptom for disease processes in several body systems. Dysphagia should be differentiated from the globus sensation or "feeling of something in the throat" Table I. But both of these symptoms deserve to be thoroughly investigated, examination and endoscopy, should they persist for a prolonged period of time (4 weeks) as reassurance of a non-organic cause will minimise the anxious patient. A systematic approach to evaluation is necessary in order to achieve a diagnosis and institute management. This review assumes a prior knowledge of the physiology of swallowing and the anatomy of the upper aerodigestive tract. This article will identify the authors approach to the evaluation of dysphagia, incorporating the transnasal oesophagoscopy into a modern practice.

Table I: Working definitions of globus and dysphagia

Globus sensation: is a passive symptom usually present at rest and frequently relieved by the act of swallowing,
Dysphagia (***dys*** – Greek; alteration or interference with, ***phagia*** – swallow): is an active symptom precipitated or initiated by the act of swallowing

Clinical assessment

History
The history can define the cause of dysphagia or direct investigation in 80 to 85% of patients. For instance, an

intermittent sensation of lump in throat that is long standing and associated with no history of weight loss in a young woman is almost always globus. Dysphagia that is progressive with weight loss needs urgent investigation. Table II provides a list of entities that need to be assessed in the history. In addition, the value provided by a comprehensive medical history cannot be underestimated. Long standing anaemia in a woman older than 50 years old will point to a post cricoid web. Slowly progressive limb muscle weakness could indicate an underlying neurogenic cause of dysphagia (e.g. inclusion body myositis, motor neurone disease).

Symptom scales and patient reported outcome measures:

It is considered good practice to routinely collect patient reported swallowing outcome measures. These measures fall into two groups: instruments that assess functional impairment of swallowing as a specific function and others that assess the swallowing-related quality of life. The existence of several scales is testimony to the fact that no ideal instrument exists and recommending any instrument is outside the scope of his discussion. However, it is worth noting that some scales have been validated for use in specific circumstances, e.g: head and neck cancer, and the vast literature on the subject needs to be consulted to decide on the choice of the instrument.

Clinical examination:

A general clinical examination should be part of the examination for the reasons mentioned above. A thorough neurologic examination of the cranial nerves is especially pertinent in patients presenting with dysphagia.

Comprehensive otolaryngologic assessment of the oral cavity, pharynx, larynx and where possible the oesophagus, can be performed in the outpatient clinic and a firm diagnosis made in the majority of cases.

Table II: Essential information acquired from patients history.

1. nature of dysphagia (solids, semisolids, liquids)
2. duration of dysphagia
3. timing of dysphagia (continuous vs intermittent)
4. rate of progression (weeks, months or years)
5. weight loss
6. other symptoms: aspiration, regurgitation, coughing, choking, dysphonia, dyspepsia, haemoptysis, haematemesis, referred otalgia
7. substance abuse: alcohol, tobacco

A structured approach to oral cavity examination is described elsewhere[1]. Subtle clues on oral cavity and oropharynx examination can point to the diagnosis. The presence of angular cheilitis and a bald tongue indicates anaemia and an underlying postcricoid web to explain the dysphagia. The three areas of the oropharynx (soft palate, both tonsils/tonsillar fossae) that can be seen through the mouth are next assessed. It should be noted that the tongue base surface is best examined during a flexible nasolaryngoscopy. Deep seated tongue base lesions, and some infiltrative tonsillar lesions may not be easily seen and unless a high index of suspicion is maintained, can be missed.

Flexible nasolaryngoscopy:

This examination is an integral part of dysphagia assessment that can be combined with several other swallowing tests that are more widely used in the assessment process by speech and language therapists, e.g FEES (flexible endoscopic evaluation of swallowing), FEESST (FEES with sensory testing). Table III lists some of the abnormalities in each site that can indicate underlying disease processes. The direct cause of dysphagia from pathology at each site is different. For instance, nasopharyngeal tumours can do this by affecting the cranial nerves, a supraglottic tumour through referred otalgia and postcricoid tumours by direct obstruction. It should be recognised that the postcricoid area cannot be satisfactorily assessed with the flexible nasolaryngoscope.

Transnasal oesophagocopy (TNO) has transformed the outpatient evaluation of dysphagia and firmly brought the diagnosis into the otolaryngologist's domain.

Traditionally, following otolaryngological assessment in the clinic, patients often needed a contrast swallow and/or rigid endoscopy under general anaesthesia to assess the upper oesophagus. Complete endoscopic evaluation of the

Table III: Abnormalities "to look out" for during flexible nasolaryngoscopy

1. Nasopharynx: Ulcers and mass lesions, sometimes very subtle
2. Oropharynx: ulcers and mass lesions on the superior surface of the soft palate, the tongue base and vallecula, some of which can be very subtle
3. Hypoharynx: ulcers and mass lesions in any of the hypopharyngeal subsites, pooling of saliva in the pyriform fossae, prominent osteophytes
4. Larynx: mass lesions in the supraglottis, vocal cord immobility or paresis

oesophagus with the rigid endoscope is to be discouraged owing to the technical difficulties in safely examining the lower end of the oesophagus. If no pathology was seen in the upper aerodigestive tract, patients were referred to gastroenterologists to complete the diagnostic pathway.

It is well recognised that pharyngeal level obstructive symptoms can be caused by disease at any level in the oesophagus. New entities such as eosinophilic oesophagitis, a cause of non-obstructive dysphagia, can also present to the otolaryngologist. With increasing expertise in TNO, in the best case scenario, diagnosis can often be achieved following a single appointment. Even if a firm diagnosis has not been made, it is very often the case that otolaryngologic causes of dysphagia can be excluded following one clinic visit, saving follow up appointment slots, radiologic investigations and bed days. It is very uncommon for patient intolerance to be a reason for abandoning the procedure.

There are several indications for TNO apart from dysphagia and expertise in the procedure can be relatively easily acquired by otolaryngologists who routinely practice flexible nasolaryngoscopy. Thus patient benefits are rapidly realised. The technique is endorsed by the American Bronchoesophagological Association (ABEA) in a recent position paper[2].

Figure 1 identifies the place of TNO in the diagnostic pathway.

In patients seen in the clinic with a complaint of dysphagia, a TNO will give all the information obtained by a flexible nasolaryngoscopy, and if resources are available, one endoscopic assessment is all that is necessary. Identifying pathology in the upper aerodigestive tract that needs biopsy usually indicates the need for an endoscopic assessment under general anaesthesia, although there are channelled TNOs that enable biopsy in clinic. It has been shown that the accuracy of clinical staging of tumours with the TNO is equivalent to that of rigid endoscopic assessment. Clearly, in scenarios where transoral resection of upper aerodigestive tract tumours is contemplated, a formal rigid endoscopic assessment will be warranted to assess resectability. When pathology is diagnosed or suspected in the oesophagus, gastroenterology referral is warranted.

A constant refrain that is expressed about using the TNO is the concern about missing postcricoid lesions. However, published experience does not support this concern[3]. There is no doubt that careful attention to technique is essential and as only a short time may be spent in this area while withdrawing the endoscope, the facility for freeze frame and slow motion playback should be available. In cases where intubation of the oesophagus is not possible other techniques must be resorted to examine the postcricoid region.

The other concern is that gastroenterologists will object to invasion of their territory. However, the three most frequent pathologies identified when TNO is performed in patients with ENT symptoms are oesophagitis, hiatus hernia and Barrett's metaplasia, all of which will need referral to the upper GI team for treatment.

Neck examination:

The clinical assessment is completed by a neck exam. Certain findings such as lymphadenopathy and thyromegaly can give a pointer to the diagnosis. Reduced laryngeal crepitus can be seen when posterior pharyngeal and postcricoid lesions push the larynx forward.

Investigations:

The type of investigation to further delineate the cause of the swallowing problem should be guided by the findings from clinical examination. Investigations as appropriate for neck lumps will not be discussed.

Blood tests: Including tests for anaemia, a full autoimmune screen may be necessary in cases where a systemic cause is suspected, e.g, scleroderma.

Contrast swallow: Incorporating TNO into practice reduces the need for a contrast swallow. However, when a pharyngeal pouch or oesophageal dysmotility is suspected, this is an invaluable test.

Rigid endoscopy: When TNO is introduced into the diagnostic pathway, the number of patients subjected to an examination of pharynx and upper oesophagus under general anaesthesia reduces significantly. In the authors practice, this is currently limited to patients who have a known upper aerodigestive tract malignancy or those who were unable to tolerate a TNO and need further evaluation under general anaesthesia.

Videofluoroscopy: This is a dynamic fluoroscopic imaging procedure used to characterise oropharyngeal dysphagia. Real time visualisation of the integrated movements that take place during the oral preparatory, oral and pharyngeal stages of swallowing helps identify structural and functional abnormalities contributing to dysphagia. This helps with diagnosis and also to target therapy. It must be noted that this is a multidisciplinary assessment tool, performed in conjunction with speech and language therapists and radiologists.

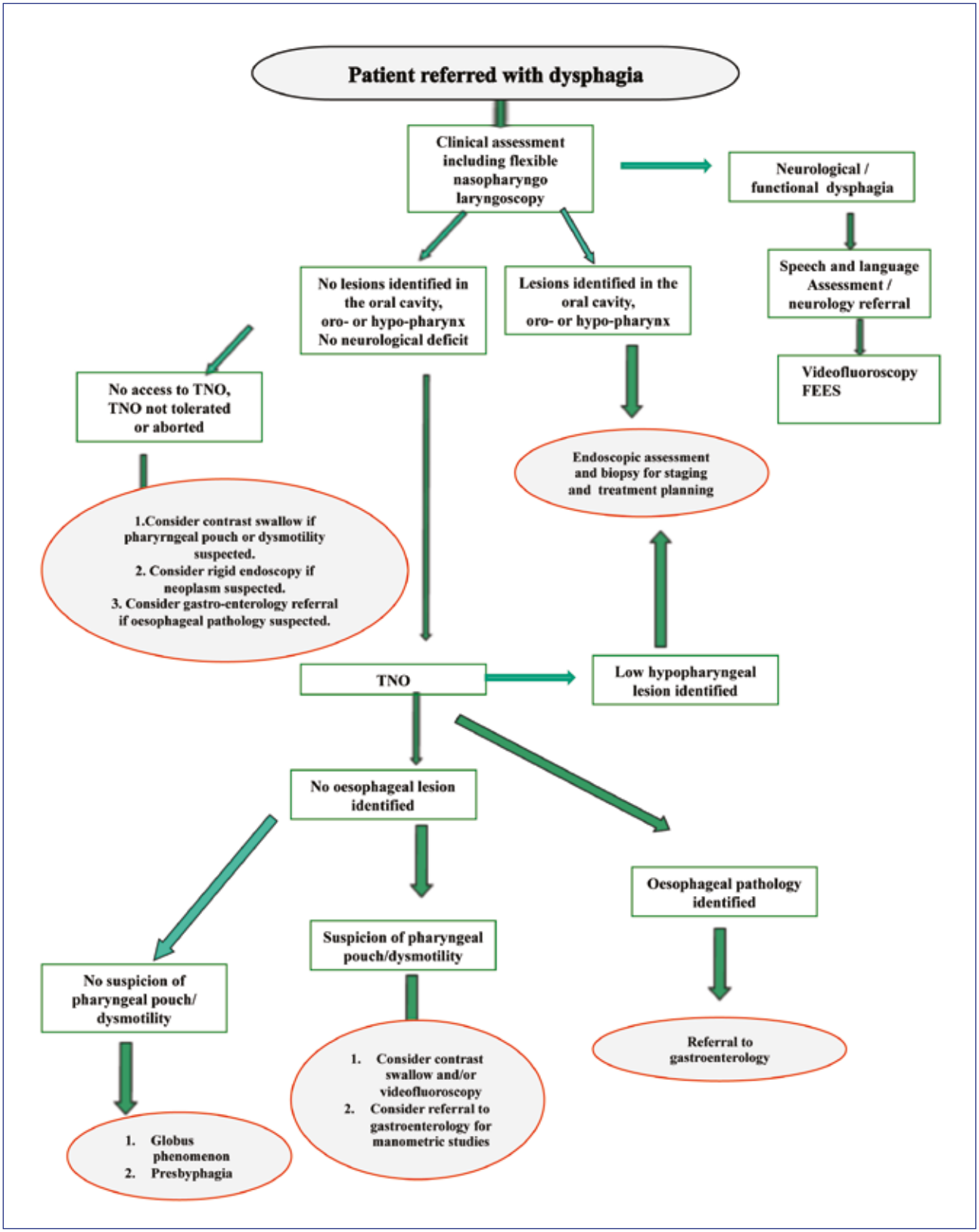

Figure 1: *A suggested algorithm for the diagnostic pathway in patients presenting with dysphagia. Where facilities are available, the flexible naso-pharyngo-laryngoscopy step can be eschewed and one can proceed directly to transnasal oesophagoscopy (TNO), which permits examination of all structures usually seen with the former endoscope.*

Patients are asked to swallow food of varying volumes and viscosities during the fluoroscopy and the findings are scored with the Swallowing Performance Status Scale (SPS)[4], which combines the clinical and radiographic data to provide an estimate of the presence and severity of dysphagia and aspiration risk.

Oesophageal manometry:

This diagnostic procedure is usually performed by gastroenterologists, apart from a few specialist centres where otolaryngologists offer this service. Oesophageal manometry is indicated for the evaluation of dysphagia not definitively diagnosed by means of endoscopy and/or radiology, with this being the most accurate method to diagnose primary oesophageal motility disorders[5] (achalasia and diffuse oesophageal spasm).

Management:

Following the assessment plan above, a full diagnosis can be made and appropriate treatment instituted based on the pathology. The differential diagnostic entities may need specialised

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HPV-associated head and neck carcinoma

Oliver Kaschke, MD, Prof.
André Zakarneh, MD
Department for ENT, Facial & Neck Plastic Surgery
St. Gertrauden Krankenhaus
Berlin, Germany

Ulrich Keilholz, MD, Prof.
Department for haematology-oncology
University Medicine Charité
Campus Benjamin Franklin
Berlin, Germany

Corresponding Author:
Oliver Kaschke
Department for ENT, Facial & Neck Plastic Surgery, St. Gertrauden Krankenhaus
Paretzer Str. 12, D-10713 Berlin, Germany

E-mail: oliver.kaschke@sankt-gertrauden.de

Abstract
Over the recent decades there has been an increase in the incidence of oropharyngeal squamous cell carcinoma (OSCC) while the incidence of larynx-hypopharynx carcinoma has decreases. Nevertheless, head and neck squamous cell carcinoma (HNSCC) remain the 6th most common cancers worldwide. Beside the classical risk factors for HNSCC smoking and alcohol, it was recently shown that 25 to 60 % of OSCC are associated with a human papilloma virus (HPV) infection. There has not been demonstrated any additive risk factor effect due to alcohol abuse verifiable in HPV-positive patients because the progression-free survival was not changed significantly. But in the overall-survival rate a negative effect of alcohol abuse must be assumed.

The process of the viral infective process remains unclear. There is supporting evidence, that oral HPV-infection in women and presumably in men are directly related to sexual behaviour. The infection induces an accumulation of genetic changes followed by inactivation of tumour suppressor genes and activation of proto-oncogenes. The expression of the viral proteins, E 6 and E 7, are important for the HPV-carcinogenesis, because these proteins inhibit tumour-suppressor-protein p53 and retinoblastoma protein (Rb).

HPV-positive patients have an improved prognosis due to a better response to therapy, especially seen in patients with gene over-expression of immunological proteins in the antigen presentation and it is suggested that they achieve a greater benefit from radiotherapy. A better outcome for patients treated with radiotherapy in combination with biological targets compared to radio-chemotherapy alone has recently been shown and may offer a more optimistic outcome for the employment of this advantageous treatment strategy.

Key words
Oropharyngeal carcinoma, HPV-infection, risk factors, progressive-free survival, overall-survival rate,

Introduction
Head and neck squamous carcinoma (HNSC) is the 6th most common cancers with 650.000 new cases detected annually worldwide[1]. The estimated incidence for Germany, other west-European countries as well as the U.S.A. ranges at 15/100.000 per year. There has been registered an increase of oropharyngeal squamous cell carcinoma (OSCC) in the recent decades, while the incidence of larynx-hypopharynx carcinoma decrease. Basically high incidences have in the past been observed in regions associated with a high consumption of tobacco and alcohol. In general changes of incidences reflect in- and decreases of risk factors as well as changes in the incidences of individual sub-locations. The 5-years survival rates vary between 20 to 90% depending of the stage of disease at presentation and location of the primary tumour in the oropharynx.

Recently published data of age-adjusted incidences of head and neck carcinomas separated for the sub-locations larynx, oro-pharyngeal and hypo-pharyngeal were mainly controlled in the U.S. and were evaluated as decreased in

comparison to the year 2000[2]. In Germany, there has been a decrease of 40% of patients with laryngeal cancer since 1980, as distinct from an increased number of oro-pharyngeal carcinomas which has commenced in the early 1990's. Since this increased incidence has been registered the age-adjusted disease- and mortality-rates in men are declining, whilst that of woman has remained stable. This decrease has been explained by the decline of cigarette smoking over the last 40 years. Nevertheless, during the same time period the 5year-survival rate are not changed, while the mortality rate has decreased, which suggest that there has been a reduction in the number of new diseases[3].

HPV-associated carcinoma

In 1985 HPV-16 DNA was detected in oro-pharyngeal carcinoma by Southern Blot-technique for the first time[4]. Over the following years, studies were published with high scatter ranges according the prevalence of HPV-DNA in OSCC in different countries. The scatter range in published studies from the U.S.A. ranged between 40 - 80%, whereas data of 30-40% were published from Germany. Recently published data from Scandinavia describe results of more than 90%[5,6,7,8].

In different sub-locations of head and neck carcinoma oncogenic HPV seems to be responsible for the given different part to initiate the malignant disease. A pooled analysis of studies showed that the rate of HPV-association in head and neck carcinoma ranges descendent as followed: oropharynx→Larynx/hypopharynx→oral cavity. In summary of all locations it is estimated that 15-25% of all head and neck carcinoma are associated with an HPV-infection of p16 or p18[9].

The role of oncogenic activity of HPV in the carcinogenesis has been well investigated[10, 11]. The basic knowledge is of an incomplete inverse correlation with mutations of a genome segment TP53 that encodes the p53-protein. In head and neck carcinoma 60-80% of the tumours have TP53 mutations. A viral replication regulates the expression of viral protein segments E6 and E7. These proteins of HPV16 inactivate the cellular tumour suppressor protein p53 and Rb. This is followed by a massive damage of the regulation of DNA-synthesis and a loss of control of cellular cycles[12-15]. This is followed by an abnormal numbers of centrosomes and further chromosomal aberrations.

HPV-DNA detection, measurement of p16 expression and the epidermal growth factor receptor (EGFR) are accepted as molecular prognostic indicators for OSCC. These predictors were investigated according their presence in 106 cases of OSCC. The 5-year disease-free-survival and overall survival was analysed in relation to these markers. Remarkable and highly significant was the combination of p16 and EGFR expression status. The 5-years-DFS was significantly better in p16-positive/EGFR-negative tumours versus P16-negative/EGFR-positive OSCC. It could also be shown that p16 remained a highly significant prognostic marker for DFS showing a 7.5-fold increased risk for relapsed in patients with p-16-negative tumours. It was concluded that HPV-DNA-positive/p16-positive tumours tended to have decreased EGFR expression[16].

HPV-infection

Most of the 120 established human papilloma viruses (HPV) infect cutaneous epithelium (β-group). Oral and ano-genital mucosa are typically infected by 30-40 types of HPV that are subsumed in the β-group. Oncogenic or high-risk HPV-types are HPV 16 and 18. Usually immune competent individuals eliminate the HPV-infection by their immune system, however it can persist in nearly 10% of the cases for years and can later transform into a pre-neoplastic lesion and can finally develop an invasive tumour disease[17].

In contrast to large data according the transmission of genital HPV infections by sexual contacts relatively few is known about the ways of oral HPV-infections. There is no evidence about the mean latency between infection and expression of an HPV-associated oro-pharyngeal squamous cell carcinoma (OSCC).

Risk factors

The increase of incidence HPV-associated OSCC correlates perhaps with modern changes in sexual practices. HPV-DNA could be detected in a higher percentage in the oropharynx mucosa of women who had coincidently a genital HPV-lesion. An oral sexual practice could not be brought in direct coherence with an extension of genital to oral infection18. In contrast a study of Herrero et al[19] with a large number of HPV-associated OSCC reported that oral sexual practices were 3 times higher in HPV-positive OSCC patients than those who had a HPV-negative OSCC. In registered tumours between 1958 and 1996 in Sweden the connection between secondary carcinoma in men when a cervix carcinoma in their wives occurred before were controlled. The result showed that there was a significant higher risk for the development of OSCC in men[19]. Despite the deciphering of HPV as a risk factor for OSCC exists nearly no population-based studies about the oro-pharyngeal transmission of HPV has been reported. There is no sufficient evidence that oral HPV-infection in women and probably also in men is directly dependent to sexual behaviour.

It is well established that an exposure to exogenous carcinogens, diet, oral hygiene, infections, positive tumour as well as family history are acknowledged risk factors for the development of a head and neck tumours. Cigarette smoking and other tobacco consuming and also consume of alcohol are the most acquainted and most dominant risk factors, especially for oro-pharyngeal and hypo-pharyngeal carcinoma as well as larynx cancer. The total number of new diseases are estimated with 85% due to tobacco consume. A synergistic effect of alcohol and tobacco in the carcinogenesis and a dose-effect-connection could be shown without any doubt [21].

The association between HPV and smoking in the carcinogenesis of OSCC is discussed controversial. A recently published analysis of original studies results according HPV and smoking are summarized (Table I). The quota of patients without severe tobacco consume is higher in the group of HPV-associated OSCC. Nevertheless a larger group of patients with HPV-associated OSCC with low tobacco consume had an additional risk [22]. HPV as a risk factor for OSCC is established in non-smokers. In some published studies according this topic was no additive or synergistic effect demonstrable due an additional nicotine abuse[23]. In a study with the largest number of patients a hazard ratio of 56.2 for OSCC was shown in case of positive HPV-serum-antibodies and tobacco smoking in the medical history19. Another study demonstrated nearly the same hazard ratio for OSCC in HPV- negative and HPV-positive patients when nicotine and alcohol abuse was stated 21. The following theoretical statements substantiate a possible promotor-effect:

- Smoking is a possible co-effect, the single infection by oncogenic HPV does not induce a malignat disease mostly
- Smoking increases the susceptibility for an oral HPV-infection
- Smoking impairs the immune-answer against HPV-infection
- Smoking leads to TP53-mutations, HPV E6 inhibits p53, the restoration of intact p53-function is probably blocked.
- Smoking leads to DNA-breaks, an integration of virus-DNA is facilitated

Additionally to the higher probability of occurrence for OSCC in HPV-infection and smoking in the anamnesis it could clearly be shown that smoking has an influence on the survival rates after therapy[24].

Prognosis

In most of the studies HPV-associated carcinomas have better prognoses than HPV-negative tumours. The RTOG-0129-study included 743 patients OSCC in stage III and IV. Patients obtained accelerated, hyper-fractioned radiotherapy ("concomitant boost") and cisplatin or a standard-fractioned radiotherapy and cisplatin. Sixty four percent of the 743 patients were HPV-positive. Their risk of mortality was reduced for 58% in comparison to HPV-positive patients and the 3-years-survival-rate was significantly better (82,4 vs. 57,1%; 0,001). The total survival rate was not different between hyper- and standard-fractioned radiotherapy added by cisplatin (70.3 vs. 64,3%)[25].

Another prospective study demonstrated in advanced OSCC stage III and IV that HPV-positive carcinoma

Table I: Smoking and HPV[3, 21] – independent risk factors or synergy in head and neck carcinoma?

HPV-positive		HPV-negative		
non-smoker (%)	smoker (%)	non-smoker (%)	smoker (%)	Study pop./author
Independent effect				
17	79			63 cases/Snijders 1996
	81		86	167 cases/Paz 1997
	63		67	253 cases/Gillison 2000
15	34	5	46	485 cases/Applebaum 2007
52	47			240 cases/Gillison 2008
Additive or synergistic effect				
50	9			187 cases/Fouret 1997
24	76			1670 cases/Herrero 2003
	13		44	201 cases/Smith 2004
	22		26	201 cases/Smith 2010

Table II: Baseline characteristics of patients with OSCC[26, 27].	
Variable	**N = 114**
Sex - no. (%)	
Male	83 (73)
Female	31 (27)
Age	
Median age - yr	63
Primary tumor site - no. (%)	
Tonsils	60 (53)
Base of tongue	54 (47)
p16 expression in primary tumor - no. (%)	
Positive	73 (64)
Negative	41 (36)
AJCC Stage - no. (%)	
I/II	41 (36)
III/IV	96 (84)
Previous Treatment - no. (%)	
Operation	14 (12)
Operation and radiotherapy	34 (30)
Operation and chemoradiation	21 (18)
Chemoradiation	34 (30)
Radiotherapy	9 (8)
Tobacco exposure - no. (%)	
Never smoked	22 (19)
Former smoker	22 (19)
Current smoker	70 (61)
Alcohol exposure - no. (%)	
Never	60 (53)
Regularly	60 (53)
Alcoholism	23 (20)

patients had a better response to an inductive chemotherapy (82 vs. 55%; p=0,01) as well as radio-chemotherapy (84 vs. 57%; p=0,007) in comparison to HPV-negative patients. Inductive chemotherapy consisted of 2 cycles paclitaxel and carboplatin followed by paclitaxel weekly and simultaneous fractioned radiotherapy[26].

In our own study it was shown that in a group of 114 patients a better prognosis occurs in HPV-associated OSCC. Between 2005 and 2009, 114 patients with oropharyngeal squamous cell carcinomas were diagnosed, 60 arising from tonsils and 54 from the base of tongue. Patients received surgery, chemoradiation or radiotherapy according to the stage of disease. Histological slides were retrieved and stained for p16 as indicator of HPV associated disease. Tumour p16 expression was evaluated by immunohistochemical analysis with a mouse monoclonal antibody. Positive p16 expression was defined as diffuse nuclear and cytoplasmic staining in 30% or more of the tumour cells. Proportional-hazard models and log-rank tests were used to compare risks of progression and death among patient subgroups.

Eighty-one percent (81%) of all 114 patients were smokers. 64% of tumours stained positive for p16 (tonsils 73%, base of tongue 54%) (Table II). After a median follow up of 28 months 31 of the included 114 patients showed disease progression and 39 died, 7 of them not tumour-related. With respect to the p16-status 22% of the p16-positive (16 0f 73) and 56% of the p16-negative patients (23 of 41) died. Three-year progression-free survival-rates (PFS) were 79% and 52% in patients with P16+ vs. p16- tumours (p=0,001). The overall-survival-rates differ even more distinctly with 78% vs. 39% (p<0,001). These results strongly emphasize the predictive value of the p16 immunochemistry and they confirm the theory of two tumour entities. In Cox regression analysis, only stage and p16 were independent prognostic factors. For progressive-free survival (PFS) p16 had a hazard ratio (HR) of 0.44% (95% CI, 0.25 to 0.78) (Figure 1) and also for overall-survival rate (OS) a HR of 0.44% (95% CI, 0.24 to 0.78) (Figure 3). Referring to the known coherence between the PFS and OS and smoking with alcohol abuse we could confirm the risk of development of OSCC, which was significant higher in HPV-negative patients[27, 28]. In the PFS there was no additive risk factor effect due to alcohol

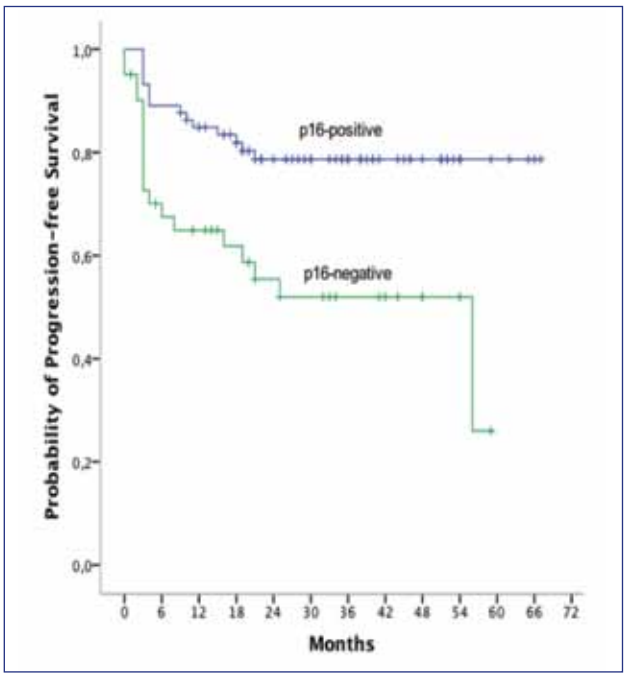

Figure 1: *Progression-free survival (PFS) according p16*

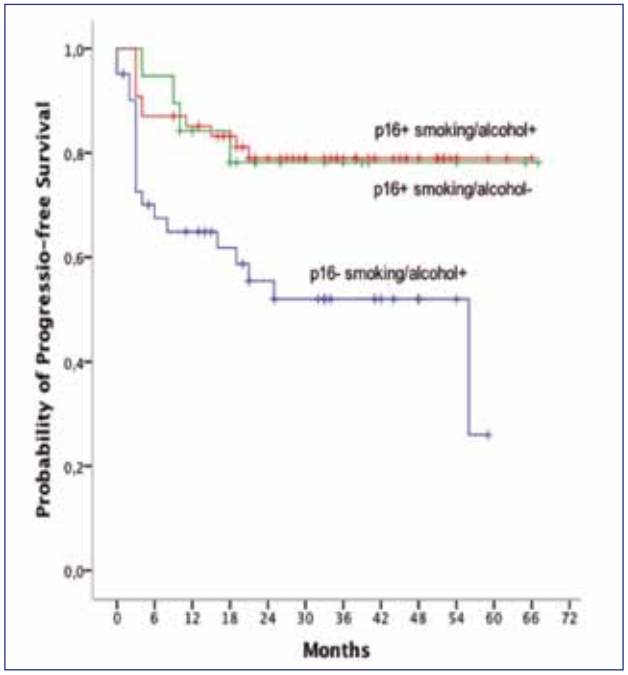

Figure 2: *Progression-free survival (PFS) according to p16-association and smoking/alcohol (p16+ smoking/alcohol+ = HPV-infection in smokers with alcohol abuse; alcohol- = non-smokers and no alcohol abuse; p16- smoking/alcohol+ = no HPV-infection in smokers with alcohol abuse)*

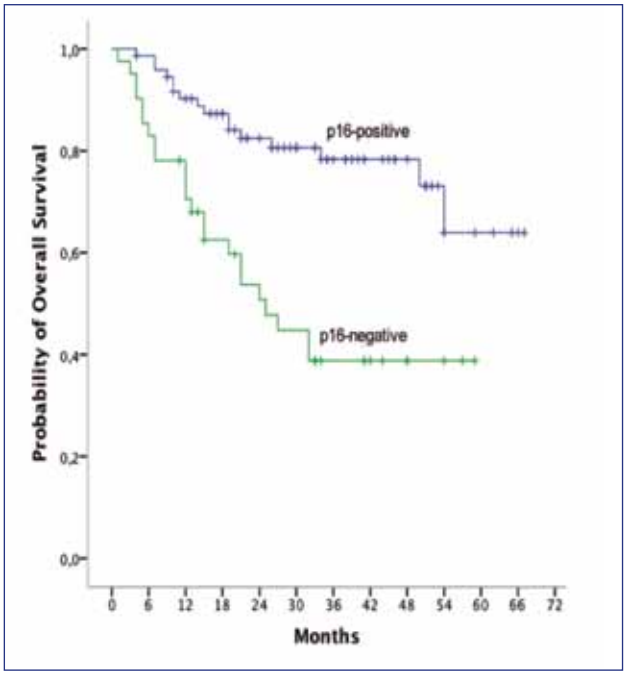

Figure 3: *Overall-survival (OS)rate according p16 infection*

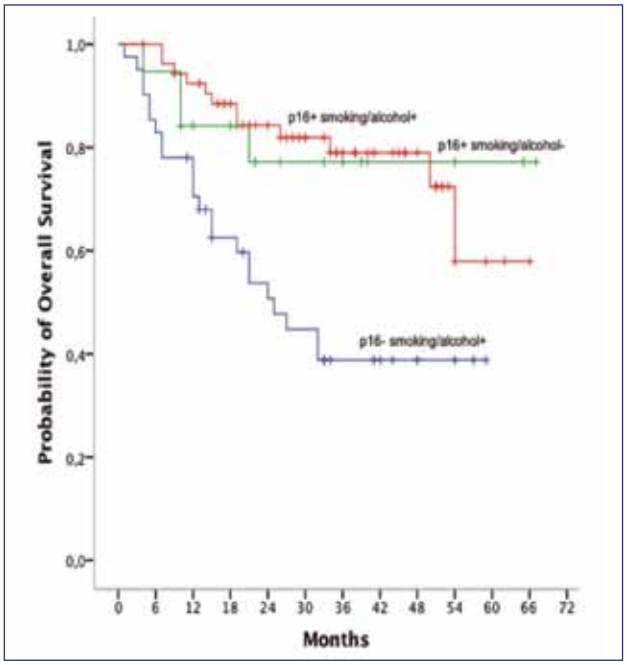

Figure 4: *Overall-survival (OS) rate according p16-infection and smoking with alcohol abuse (p16+ smoking/alcohol+ = HPV-infection in smokers with alcohol abuse; alcohol- = non-smokers and no alcohol abuse; p16- smoking/alcohol+ = no HPV-infection in smokers with alcohol abuse;)*

abuse verifiable in HPV-positive patients (Figure 2). But in the OS rate a negative effect by alcohol abuse was detectable (Figure 4).

In another study it could be shown in a study of 87 patients with carcinoma in the base of tongue that the PFS and OS was significantly better in HPV-positive patients compared to HPV-negative tumours[29].

Targeted Therapy

Prognostic relevance of HPV probably surmounts many known risk factors, for instance regional metastases. Until now, no molecular markers are established for use in routine clinical practice. Future therapy concepts may vary for the subgroups of patients especially patients with HPV-associated OSCC may have a therapeutical benefit of a less aggressive treatment.

Beside HPV-DNA and p16-expression the EGFR have been suggested as molecular prognostic factors. In many solid tumours and in nearly 90% of head and neck carcinoma a strong expression of EGFR can be validated by immunhistochemistry[3].

In a retrospective study of 78 patients with progressive OSCC were treated by radio-chemotherapy and anti EGFR-monoclonal antibody therapy, nearly one third (29%) were HPV-positive. The disease control after 22 months showed that HPV-positive patients treated by EGFR-inhibitors combined with radiotherapy had a better overall-survival rate than HPV-positive patients treated by

radio-chemotherapy only. This difference was not seen in HPV-negative patients. This study may be one of the first that marks an outlook on possible targeted-aimed therapies in HPV-positive patients. The correlation between HPV-infection and EGFR expression is still unclear. So far, there have been no validated prospective studies (and it will be very difficult to achieve them!) that can highlight differences of the clinical benefits, when patients with HPV-positive or HPV-negative OSCC treated in the same way.

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What and when to suspect early oral cancer

Sat Parmar BChD, BMed.Sci, BMBS, FDSRCS, FRCS
Jinal Patel BDS, MFDS
Department of Maxillofacial Surgery
University Hospital Birmingham

Introduction

Oral Cancer (OCC) is the 6th commonest cancer worldwide[1]. The incidence varies and in certain parts of Asia[2] (India and Sri Lanka) and is the most prevalent site of cancer in that population. The most common malignant lesions in the oral cavity are squamous cell carcinomas.

OCC is usually associated with the consumption of tobacco and alcohol but the importance of other carcinogens and in particular its association with the Human Papilloma Virus (HPV) is being increasingly recognized. Really oropharyngeal cancer (OP) but some suggest that may be the same for OCC

The incidence of OCC increases with age. It is a disease that usually occurs in patients over the age of 403. However, in high prevalence regions and increasingly in the Western World there appears to be a trend of oral cavity cancers occurring in younger patients. Many of these patients do not have the traditional risk factors[2]. In general, the incidence is higher amongst males then females due to the higher consumption of tobacco and alcohol.

There appears to be a wide variation in disease specific mortality from OCC both nationally and internationally. This may be explained by variations in ethnicity, socioeconomic class, the prevalence of risk factors and the stage of presentation[4].

Cure and survival rates have improved due to advances in surgical and the use of adjuvant treatment techniques – radiotherapy, chemotherapy and biotherapy.

The earlier the stage that oral cancer is diagnosed and treated, the prognosis is better for the patient than if the diagnosis is made at an advanced stage of disease! Thus all health practitioners involved in examining and assessing the oral cavity must be aware of the signs and symptoms of oral cancer.

Pre-Malignant Lesions

Some OC lesions have a higher incidence of malignant transformation then the normal oral mucosa and are these are referred to as pre-malignant. However, calling all of these lesions pre-malignant may not be appropriate, as not all the lesions progress to cancer and in fact many of the common oral cavity lesions have a fairly low risk of malignant transformation.

The majority of OCC arise within “normal” mucosa and without a preceding abnormal lesion. Thus usage of the

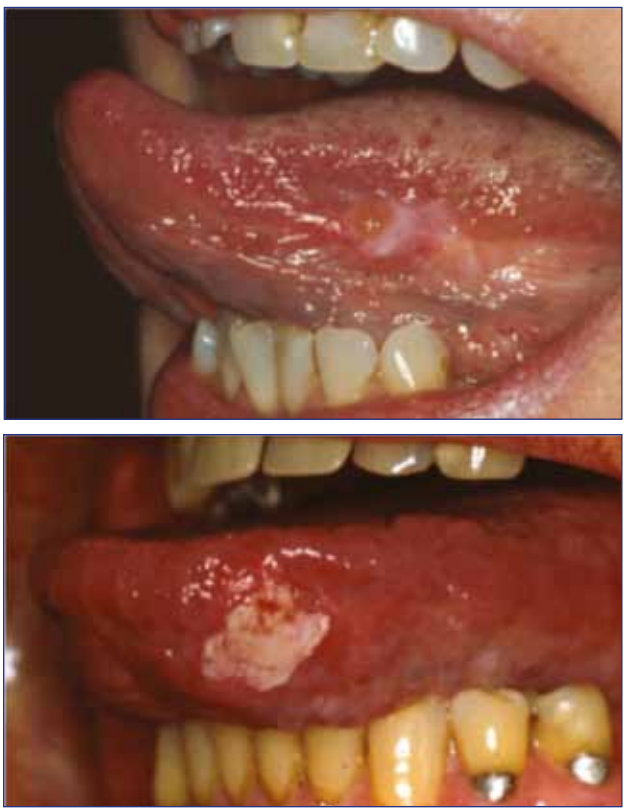

Figure 1: *The white lesion on the top a) is homogenous and is less likely to be malignant then the white lesion on the bottom b) associated with red patches and contact bleeding.*

term potentially malignant lesion or potential malignant condition is preferred to that of a pre-malignant lesions or conditions.

Lesions are well localized, that is with a clear margin between the abnormality and the normal mucosa and include white, red or mixed patches. Conditions are more generalized in the oral cavity and may also include systemic involvement. A condition is a generalized pan-oral cavity manifestation of a mucosal abnormality – lesions or discolouration. Some of these conditions have characteristic observable and behavioural natural history such as: erosive lichen planus, submucous fibrosis, discoid lupus erythematosis, tertiary syphilis, actinic keratosis and iron deficiency anaemia.

Malignant transformation rates for both are very variable with a reported rate between 0.3 and 16%.

Potentially Malignant Lesions

Leukoplakia[6] has been defined as "a white lesion that cannot be rubbed off and cannot be characterized histologically or clinically as any other lesion"[Figure 1]

It is only a descriptive term and does not relate to malignant transformation rates. Only by a thorough clinical examination, biopsying the lesion and assessing the degree of epithelial dysplasia, can the true malignant potential of a lesion be estimated.

Clinical examination must make note of the:

- sex of the patient
- location of the lesion in the oral cavity
- homogeneity of the white patch
- presence of red areas within the white lesion (speckle erythroplakia) or red lesions (erythroplakia)

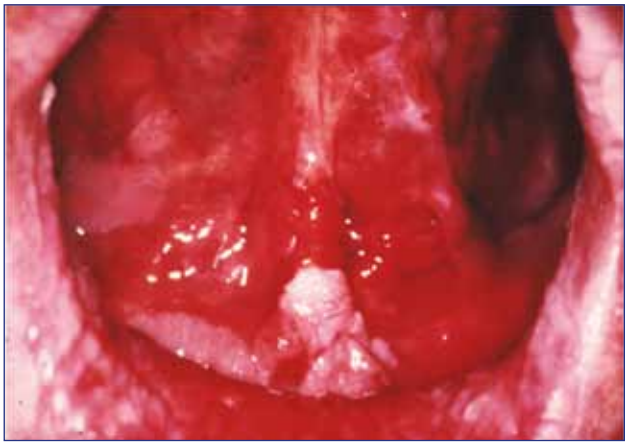

Figure 2: *Area of erythroplakia in the floor of the mouth. This appearance is very suspicious for oral cancer*

- presence of the lesion on a background of a potentially malignant condition eg submucous fibrosis
- duration of the lesion

Areas of leukoplakia in the floor of the mouth, lateral tongue and lower lip are more likely to demonstrate areas of dysplasia within them then areas in other parts of the mouth. They are also more likely to proceed to malignancy[5]. Females appear to be at higher risk of malignant transformation in white patches. The rate of progression of malignancy has been reported as between 3.6% to 17.5%.6,7 In 19.9% of areas of leukoplakia patches may demonstrate areas of dysplasia and 3.1% show invasive squamous cell carcinoma[5].

Red lesions or speckled leukoplakia [Figure 2] (a white lesion with red areas in it - erythroleucoplakia), although less common, have a higher malignant potential then a homogenous white patch. Up to 51% of red patches demonstrated some invasive squamous cell carcinoma on biopsy[8].

Candida can cause hyperkeratosis and therefore leukoplakia. Lesions that are colonized by candida or those that show dysplasia on biopsy also have an increased risk of malignant transformation.

Proliferative Verrucous Leukoplakia (PVL) is an area where oral cavity mucosa has transforms through stages of leukoplakia, verrucous hyperplasia and verrucous carcinoma and then into invasive squamous cell carcinoma. The majority of these patients are non-smokers and the condition is diagnosed more common in women. There is a strong association with candidal infection [Figure 3].

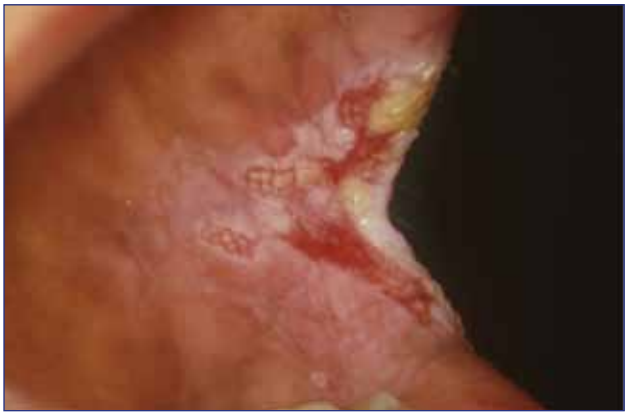

Figure 3: *An ulcerative erosive lesion at the commissure of the mouth. The lesion has worrying characteristics – Chronic Hyperplastic Candidasis. On biopsy the pathology showed some dysplasia with superimposed candidal infection. After treatment with antifungals, a repeat biopsy may need to be carried out if the lesion does not fully resolve.*

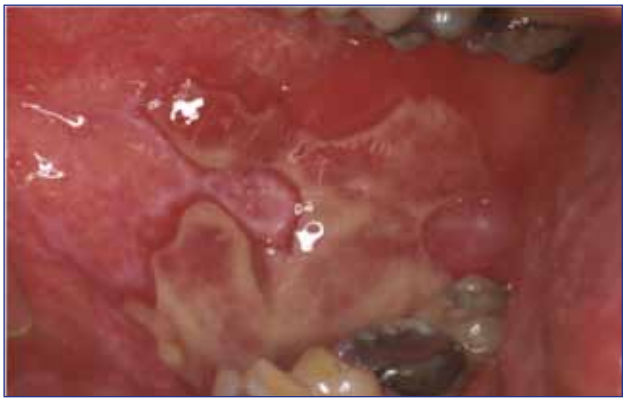

Figure 4: *Right buccal mucosal florid lichenoid reaction of unknown aetiology – Lichen Planus / Lichenoid reaction*

The disease is often characterized by resistance to treatment, recurrence, multifocal proliferation and a progression risk to cancer has been reported in up to 87% of patients[9].

Potentially Malignant Conditions

Lichen Planus is a T- cell mediated autoimmune disease in which the basal cell layer of mucosa and or skin is affected [Figure 4].

Different types of lichen planus are described below:

1) Reticular
This form is usually asymptomatic and is characterized by lacy white interlacing lines called Wickhams striae. This form usually occurs on the buccal mucosa, attached gingivae and tongue. Biopsy is not usually required to confirm the diagnosis.

2) Atrophic
This form is usually located on the tongue and represents a loss of the filliform papillae of the tongue

Figure 5: *Paan contains* **a)** *tobacco, slaked lime, areca nut and tobacco and* **b)** *the characteristic staining seen in a patient who consumes Paan*

3) Erosive
This form is characterized by intense pain and mucosal inflammation and ulceration. When it affects the gingivae it is often called desquamative gingivitis.

4) Plaque type
This form is characterized by elevated, irregular white plaques.

Biopsy is usually required to confirm the diagnosis in all types of lichen planus except the reticular form which can usually be diagnosed clinically.

There is no agreement among clinicians on the risk of malignant transformation among the variety of different lesions caused by lichen planus[10]. Transformation rates vary between 0-5.6%. This appears to be higher in the erosive form and the risk of malignant transformation of the reticular type is negligible.

Oral Submucous Fibrosis usually presents with progressive difficulty in opening the mouth (trismus). It is usually seen in the South East Asian cultures. The buccal, palatal and soft palate mucosa becomes pale, thickened and inelastic. Subsequently, tight bands appear in the buccal mucosa. It is thought to be related to the consumption of paan [Figure 5] (that contains areca nut, slaked lime and tobacco). There may also be a relation to the consumption of chllies.

The diagnosis is most frequently made by clinical examination.

This condition has definite malignant potential with epithelial dysplasia rates of 7-26% and malignant transformation rates of up to 7% over 15 years[11].

Symptoms of Oral Cancer

All the below must raise the suspicion of oral cancer:

- A non-healing ulcer usually on the lateral border of the tongue or floor of mouth,
- A non-ulcerative swelling or mass in the tongue.
- White, red, speckled or pigmented lesions
- Difficulty with swallowing (Dysphagia)
- Difficulty with articulation (Dysarthria)
- Mobile teeth in a patient with good oral hygiene
- Non-healing tooth socket
- Numbness in the tongue or inferior alveolar nerve or infra-orbital nerve area

Different presentations of squamous cell carcinoma of the oral cavity

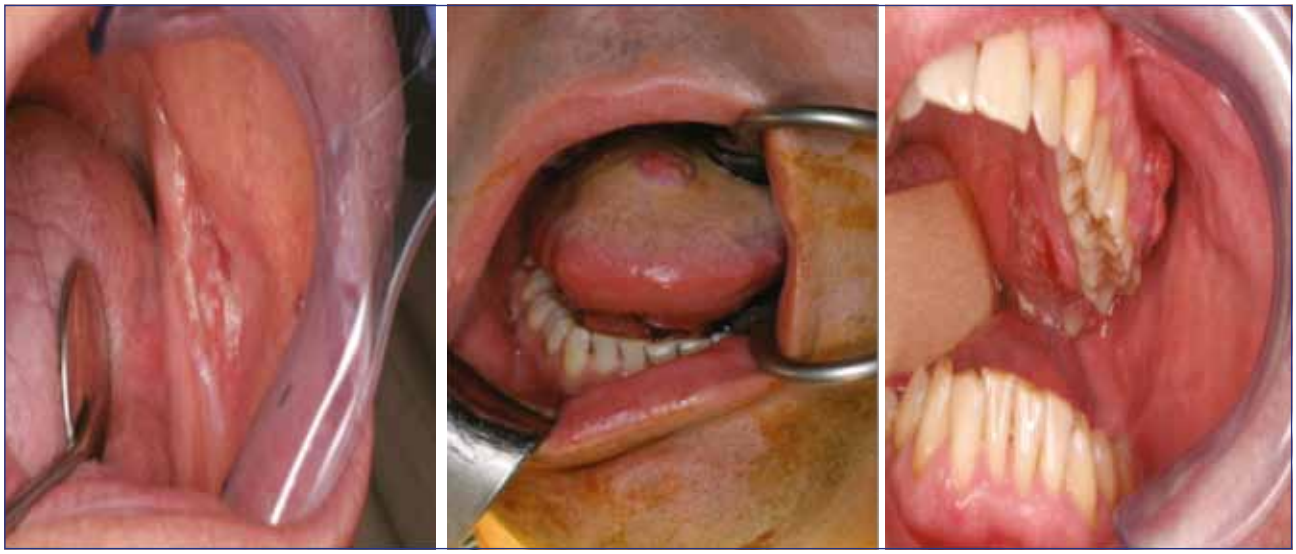

Figure 6: *Picture on the left shows a) an area of ulceration, red patches with leukoplakia and induration in the left retromolar area. Picture in the middle b) shows a lesion that appears small on the dorsal aspect of the tongue, but the high stage of the tumour is only appreciated on palpating the tongue and noting the induration of the tongue.Picture on the right c) shows an ulcerative and exophytic area lesion of the left maxillary tuberosity. The lesion bleeds on minimal contact. This lesion is obviously malignant*

- Foetor – usually associated with large tumours.
- Referred otalgia
- The presence of cervical lymphadenopathy

Worrying features in a white patch

Each white patch should be assessed carefully. When a white patch is seen, each should be assessed for:

- The density or thickness of the mucosal patch
- Presence of ulceration
- A red patch or speckling (white and red) of the patch
- A sudden change in the patch eg increase in size or appearance
- The location of the patch in the mouth – usually tongue, floor of mouth
- The presence of cervical lymphadenopathy (singly or multiple)

The presence of any of the above increase the likelihood that the white patch may be malignant [Figure 6].

Biopsies of the Suspicious lesions [Figure 7]. Toludine blue is a vital dye that binds to DNA and sulfated mucopolysaccharides in all tissues.

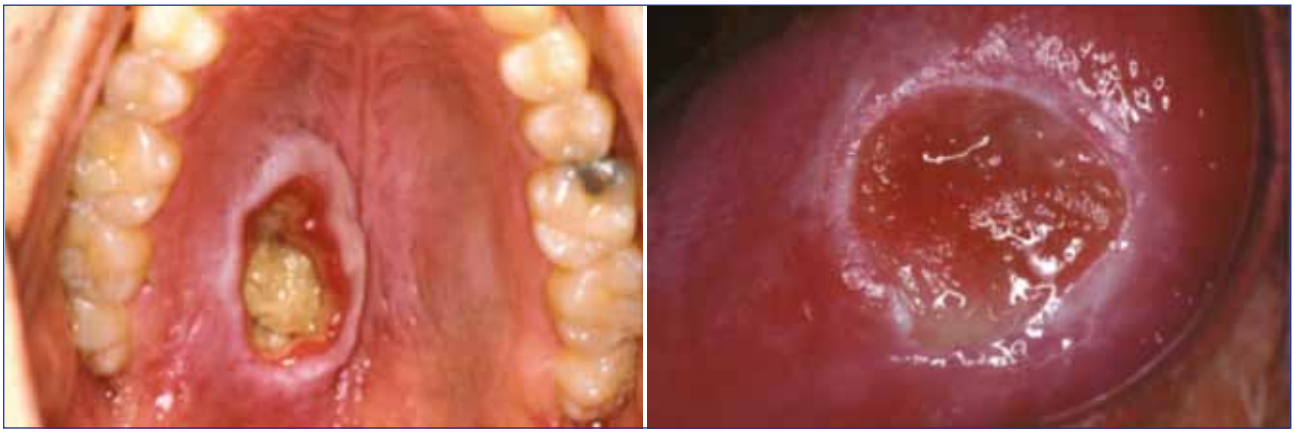

Figure 7: *A biopsy is usually required to rule out the lesion being malignant. Picture on the left a) shows acute necrotizing sialometaplasia – this is a condition that occurs exclusively in smokers. Ulceration occurs in the palate due to damage to the minor salivary glands by smoke. Picture on the right b) shows a traumatic ulcer of the tongue. The edges are not rolled and the erosion is shallow. A source of trauma must be found to make this diagnosis. If the lesion does not get better after removal of the source of the trauma then a biopsy must be carried out.*

As the levels of both are higher in cancers and dysplastic tissue, the toludine blue may aid the surgeon to biopsy the site that is most likely to be malignant.

In a large lesion, multiple biopsies may be required to ensure that severe dysplasia or malignancy is not missed.

Each biopsy must be to the underlying muscle allowing the histopathologist to estimate the depth of invasion of the tumour.

The depth invasion by the tumour is good indicator for the risk of nodal metastasis.

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Current concepts on the aetiology of head and neck cancer

Remco de Bree, MD PhD[1] and **Boudewijn J.M. Braakhuis**, PhD[1]
[1]Department of Otolaryngology / Head and Neck Surgery,
VU University Medical Center, Amsterdam, The Netherlands.

Correspondence:
Remco de Bree, MD, PhD
Department of Otolaryngology
Head and Neck Surgery
VU University Medical Center
De Boelelaan 1117, 1081 HV Amsterdam
PO Box 7057, 1007 MB Amsterdam
The Netherlands

E-mail : r.bree@vumc.nl

Abstract
Tobacco smoking and excessive alcohol intake are important causative factors in the development of head and neck squamous cell carcinoma (HNSCC). Their effects are multiplicative when combined. Susceptibility to the carcinogenic effects of tobacco and alcohol varies widely between individuals and has an hereditary component. Infection with human papilloma virus (HPV) is recognized as aetiological factor for HNSCC, especially oropharyngeal carcinoma. HPV-related oropharyngeal carcinoma is a distinct disease entity. A poor nutrition, gamma-radiation and occupational hazards have also been identified as risk factors. Other aetiological factors have been mentioned in the literature, including pollutants, occupational agents and other infections, but further confirmation is needed due to conflicting results and small study populations.

Key Words
Head and neck cancer, aetiology, risk factors.

Introduction
Head and neck cancers include cancers of the upper aerodigestive tract (UADT) (including the oral cavity, nasopharynx, oropharynx, hypopharynx and larynx), the paranasal sinuses, salivary glands and thyroid gland. Different histopathological cancer types may have different aetiology. Since it is by far the most common type, the focus of this paper is on mucosal head and neck squamous cell carcinoma (HNSCC).

Cancer pathogenesis requires an environment that promotes the development of an increasing number of genetic aberrations, related to decreased inherent genetic repair and protective mechanisms. Inherited mutations in several protective genes have been associated with increased cancer risk. Mutagenic environmental factors can induce genetic mutations in cells which can transmitted to subsequent cell daughter cell populations. Accordingly, cancer results from an imbalance in factors promoting the development and accumulation of genetic events and those that prevent, exclude or repair genetic damage.

Tobacco, alcohol and human papilloma virus (HPV) have all been linked to an increased risk of HSNCC. Each of these carcinogens promotes progression to HNSCC by contributing to the accumulation of genetic aberrations, the rate and accumulation of which is dependent on a balance between carcinogen dosage and host susceptibility. Although different environmental carcinogens may lead to one histological tumour type, tumours arising from traditional risk factors like tobacco and alcohol are characterized by genetic alterations that differ from those observed in HPV-induced carcinomas[1]. Tobacco and alcohol accounts for the vast majority of cases and their effects are multiplicative when combined.

Tobacco
The risk of HNSCC is strongly related to tobacco smoking. In a meta-analysis the pooled increased risk estimate for

smoking was 3.4[2]. A pooled analyses of 15 case-control studies showed that among never drinkers, cigarette smoking was associated with an increased risk of head and neck cancers of 2.1[3]. This risk is higher for cancers of the hypopharynx and larynx than that of oral and oropharyngeal cancers[4]. The risk increases with amount and duration of smoking, the latter being more important. The risk remained elevated for a decade after smoking cessation but declined thereafter[5].

Furthermore, the risk is higher in individuals who started smoking at earlier stage. Tobacco smoking was suggested to have an independent effect from alcohol drinking for laryngeal and hypopharyngeal cancer but not for oral and oropharyngeal cancer. A possible reason is that a potential smoking effect on the oral cavity may require exposure to alcohol consumption[4]. The risk of HNSCC is increased in smokers of all tobacco products, with the users of unfiltered cigarettes reporting higher risks than users of filtered cigarettes and with some studies finding higher associations in pipe and cigar than in cigarette smokers[5]. A clear dose-response relationship for the development of laryngeal cancer has been found in all inhalation subgroups, i.e. not only for deep inhalers, but also for those puffing on a cigarette, though a reduced risk has been shown for light inhalation in comparison to deep inhalers[6]. Among never smokers, ever exposure to involuntary smoking was associated with an increased risk of UADT cancers[4]. Individuals who both smoked and consumed alcohol had double the risk of UADT cancer in comparison with those who only smoked (relative risk 6.93)[1]. A more recent meta-analysis of the Head and Neck Cancer Epidemiology Consortium found also a risk for head and neck cancer of approximately 6 times greater among ever tobacco users and alcohol consumers than among never smokers and non-drinkers[7].

Tobacco smoke is an aerosol containing vapour and particulate components with more than 4000 chemicals of which at least 60 are carcinogenic. The activity of carcinogens is generally exerted through DNA adducts. Tobacco causes oxidative stress to tissue, i.e. the sustained presence of reactive oxygen species, which initiate free radical reactions. Reactive oxygen species can damage proteins, lipids, carbohydrates and DNA. Minor DNA damage may result in mutations that may be part of the causal chain for malignant transformation, while sustained DNA damage may result in further perturbations of cell-cycle control[8]. Once absorbed, most carcinogens require activation by cellular enzymes to promote carcinogenesis and their effects can be offset by detoxifying enzymes. Dysfunction of these enzymatic pathways has been associated with an increased risk for HNSCC.

Smokeless tobacco includes chewing tobacco, oral snuff and betel quid with tobacco and is associated with a two- to sixfold increased risk of oral cancer. In the developing world, use of tobacco and areca nut, either alone or in combination, accounts for the vast majority of oral cancers. A betel quid generally contains betel leaf, areca nut and slaked lime and may contain tobacco. Betel quid with or without tobacco is considered carcinogenic to humans. A meta-analysis indicated that betel quid chewing without tobacco, adjusted for smoking has an odds ratio of 3.5 for the development of oral cancer. Nitrosamines which are considered carcinogenic, are produced by nitrosation of the alkaloids in dried stored nuts and in the presence of nitric oxide generated by bacteria. Endogenous nitrosation is significantly higher in subjects with poor oral hygiene. Besides nitrosamines chewing of betel quid also releases large amounts of reactive oxygen species which are both major genetoxic agents. Clear dose-response relationship between quid use and the risk of oral cancer have been demonstrated[8].

Alcohol

Pooled analyses of 15 case-control studies showed that non-smokers who have three or more alcoholic drinks a day have double the risk of developing HNSCC compared with non-drinkers[3,9]. The risk of HNSCC rises steeply with the intensity of alcohol drinking, but appears to be limited to cancers of the pharynx and larynx[3]. The relation with duration of alcohol consumption is less consistent. Likewise, the pattern of risk after stopping drinking is unclear, and seems to appreciably decrease only after 15-20 years since stopping[5]. Several studies considered the effect of different types of alcoholic beverages, and cancer risks were generally increased regardless of the beverage consumed[5,10]. The effect of the combined exposure to alcohol and tobacco is compatible with a multiplication in HNSCC risk. Individuals with heavy consumption of both alcohol and tobacco may experience risks as high as 300 times those of nonexposed individuals[5].

Carcinogens in alcohol requires its metabolism to an active intermediate acetaldehyde by different enzymes. Acetaldehyde exerts its carcinogenetic effect primarily by direct binding to DNA, but also alters methyl transfer resulting in genetic hypomethylation, which in turn affects the transcription of multiple genes. Acetaldehyde is normally inactivated by conversion to acetate by acetaldehyde dehydrogenase (ALDH). In addition, reactive oxygen species are generated during alcohol metabolism, which also have mutagenic effects. Factors promoting accumulation acetaldehyde, including increase alcohol consumption, increased alcohol metabolism, or decreased

conversion to acetate (e.g. deficiency of ALDH2 as is common in Asians) result in increased rates of cancer formation.

Alcohol also promotes cytochrome P450 activity which increases activation of procarcinogens (both for tobacco and alcohol). Moreover, alcohol can also act as a solvent to facilitate entry of carcinogens into cells, especially in the UADT. The fact that heavy drinkers who are heavy smokers have a high increased risk of oral cancer compared to those who neither drink or smoke, may be due to increased mucosal absorption of the carcinogens in tobacco from chronic inflammation and hyperaemia as well as increased solubility of the carcinogens in alcohol compared with aqueous saliva. Alcohol is also high calorific. It lessens the protective effect of beneficial foods such as fruits and vegetables by depressing hunger. Finally, ethanol is hepatotoxic, reducing the effectiveness of enzyme systems central to the detoxification of carcinogens, especially the gluthione-S-transferase and cytochrome 450 systems[8].

Human papilloma virus

Although the most important risk factors so far identified are tobacco and alcohol a subgroup of HNSCC, particularly those of the oropharynx, is caused by high-risk types of human papilloma virus (HPV). While the prevalence of traditional risk factors, most notably smoking is decreasing, an increase in oral and oropharyngeal HPV infections is observed. HPV infection in the oropharynx is thought to be sexually transmitted. The risk of developing oropharyngeal cancer is associated with a history of six or more lifetime sexual partners, four or more lifetime oral sex partners and (for men) an earlier age at first sexual intercourse11. Exposure to tobacco or alcohol does not seem to act synergistically with HPV to further increase the risk of oropharyngeal risk in HPV-exposed individuals. It therefore seems probable that there are two distinct pathways for the development of oropharyngeal cancer; one is predominantly driven by carcinogenic effects of tobacco or alcohol and another by HPV-induced genomic instability[12]. It has been shown that HNSCC arising by environmental carcinogens are characterized by genetic alterations that differ from the ones observed in HPV16-induced HNSCC[1]. An association of a history of warts and reduced risk of UADT cancers has been reported. However, several other studies did not find this association[13]. HPV-associated oropharyngeal cancer affects younger patients and respond better to treatment, including radiotherapy and chemotherapy, than HPV-negative oropharyngeal cancers[12]. HPV-induced HNSCCs are associated with a more favourable clinical outcome[14].

HPV is a strictly epitheliotropic, circular double-stranded DNA virus that is known to play a crucial role in development of cervical cancer and is also involved in HPV-mediated carcinogenesis of HNSCC. There are more than 100 subtypes of HPV, some of which are involved in carcinogenesis and have been designated as high-risk HPVs. HPV DNA integrates into the human genome at random sites. The virus contains two oncogenes, E6 and E7, the expression of which inactivates cellular p53 and retinoblastoma tumour suppressor proteins, respectively, causing perturbation of cell cycle regulation in the infected cells, which is considered to be the onset of HPV-mediated carcinogenesis. HPV-type 16 is in particular involved in HNSCC[12,14].

Radiation

It is generally accepted that gamma-radiation may induce development of cancer. Because of the low incidence (1-2 laryngeal or pharyngeal tumours per 1000 irradiated patients) and long latency period (for solid tumours presumed to be at least 10 years), demonstration that a specific radiation causes a certain a certain cancer is difficult. Causation can be assumed because cancer occurred at sites in which cancer is not common or where radiation scars are present. In cell culture systems it has been shown that radiation, by itself, induce a type of genomic instability of cells. This enhances the rate at which mutations and other genetic changes arise in descendants of the irradiated cell after many generations of replication. Criteria described to diagnose radiation-induced tumours are a tumour within the radiation volume, minimal 3 years after last irradiation, absence of a maximum latency period, administered dose more than 2 Gy, and exclusion of a metastatic process, a recurrence or development of a second primary tumour. Unfortunately, most studies are based on small populations and other risk factors such as alcohol and nicotine are frequently present, playing a dominant and inseparable role in the carcinogenesis of HNSCC[15]. Using the Surveillance, Epidemiology, and End Results (SEER) database it has been shown that radiotherapy of oral cancer is a risk factor for second primary tumours within but also outside the head and neck[16].

Susceptibility

Susceptibility to the carcinogenic effects of tobacco and alcohol varies widely between individuals and has a hereditary component. Since most people who smoke and drink do not develop HNSCC, a genetic predisposition appears to be important. First-degree relatives of HNSCC patients have a 1.7-3.5 fold increased risk of developing HNSCC[17,18]. This higher rate of cancer was even larger in siblings (relative risk 14.6)[17]. So far, functional assays,

based on the measurement of DNA or chromosomal damage processing have successfully been employed in cancer risk studies. Most studies have been performed on the increased chromosomal damage in metaphase cells after challenging cultured peripheral blood lymphocytes with DNA damaging agents. Especially, DNA damage induced during the G2-phase of the cell cycle appears to be related to cancer development. In this type of assay the response to DNA damage is measured by scoring the number of persistent chromatid breaks in metaphase cells. This score is considered a measure for the chromosomal instability which is often referred to as 'mutagen sensitivity'[5]. HNSCC patients are consistently more sensitive to chromosomal damage than a group of control persons, as for gamma radiation[20,21], BPDE[22] and for bleomycin. This latter compound has extensively been studied in HNSCC patients and convincing results from multiple groups have been obtained. It was found that in the normal population a considerable variation exists in bleomycin sensitivity, reflecting a normal distribution. The results also indicated that bleomycin sensitivity can reproducibly be measured at multiple sampling times and does not appear to be influenced by removal of the tumor, smoking, alcohol abuse, age or gender of the subject[23]. A high mutagen sensitivity phenotype is a profound risk factor for tobacco users[24,25] and a very high mutagen sensitivity is related to the development of second primary tumors in the upper aero-digestive tract[26,27]. Importantly, mutagen sensitivity has a high heritability estimate as was shown with family and twin studies[22,28].

Variant forms of certain genes can also contribute to the variation between individuals with regard to HNSCC risk. This variation, also known as genetic or single nucleotide polymorphism (this latter often abbreviated to SNP) has been described to be important for genes involved in detoxification, DNA-repair and cell cycle control. Variants of specific SNPs have found to be significantly associated with HNSCC[29] Conditions carrying increased risk of HNSCC include DNA repair deficiency syndromes such as Fanconi anaemia. The causative genes involved in this syndrome function in DNA repair and surveillance of genetic stability, which explains a higher rate of cancer development in affected patients. Fanconi anaemia patients have a 500- to 1000-fold increased risk of developing HNSCC. Since major life-threatening symptoms of Fanconi anaemia can be managed successfully, development of HNSCC is now becoming a major cause of mortality in these patients[30].

Diet

A poor diet is a significant risk factor for HNSCC. Fruit and vegetables reduce the risk of oral cancer. Vitamin A and related carotenoids, vitamin C and E, and selenium appear to be particularly protective against epithelial cancers, and much of the effect is attributed to their antioxidant activities. Antioxidant act by reducing free radical reactions that can cause DNA mutations and changes lipid peroxidation of cellular membranes. Other protective roles of micronutrients include modulation of carcinogen metabolism, maintenance of appropriate cell differentiation, inhibition of cell proliferation and oncogene expression, maintenance of immune function and inhibition of formation of endogenous carcinogens[8,10].

Other factors

Whereas clinical evidence is available on the role of tobacco, alcohol and HPV, less information is available on other factors such as pollutants, occupational agents and other infections. Poor dental hygiene is suggested to play a role in the development of HNSCC, because of increased microbial load and chronic trauma from ill-fitting dentures and sharp restoration[8]. It is likely that chronic irritations from dental factors may facilitate exposure to carcinogens, so this may act as a cofactor in high-risk individuals only[10].

There has been some controversy about the risk of alcohol containing mouth washes for the causation of oral cancer10. Although it has not been demonstrated that alcohol-containing mouth washes harbours a risk for oral cancer, there is a plausible biologic al basis for risk, especially in smokers[8].

Indoor air pollution, e.g. burning coal and wood smoke, has been identified as a risk factor for HNSCC[8]. The role of Candida albicans, previous herpetic infections, cannabis, regular aspirin use in the development of HNSCC is not clear yet[8,10,14].

Evidence of an association between occupations and UADT cancer among specific (male) workers employed in the construction industry have been found[31].

Other head and neck tumors

Other types of head and neck cancer have their own specific aetiology. There is very strong evidence that Epstein Barr virus (EBV) has a major role in the development of undifferentiated nasopharyngeal carcinoma. A high intake of salted meat and fish has been shown to be an important cofactor in the development of nasopharyngeal carcinoma. Other factors possibly associated with the development of nasopharyngeal cancer are low fresh vegetables and fruits, alcoholic consumption, herbal product use, tobacco smoking and exposure to wood dust or formaldehyde. It is plausible that genetic

variations and environmental risk factors could act together to determine the pathogenesis of nasopharyngeal cancer[32,33].

Thyroid cancer is the most common form of solid neoplasm associated with radiation exposure. There has been a considerable increase in occurrence of papillary thyroid cancer after the Chernobyl power plant explosion, particularly in patients who were children or adolescent at exposure[34].

Conclusion

The most important risk factors for the development of HNSCC are tobacco use and alcohol consumption, which seem to have a synergistic effect. A subgroup of HNSCC, particularly those of the oropharynx, is caused by high-risk types of human papilloma virus (HPV). Besides these exogenous risk factors, certain inherited disorders and more general susceptibility predispose for HNSCC. Several other factors may be involved in the development of head and neck cancer.

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Essential principles in hearing evaluation of adults

M Shakeel MRCS, **SSM Hussain** MSc, FRCS FRCS Ed

Correspondence:
S S Musheer Hussain
Consultant Otologist & Neurotologist
Department of Otolaryngology-Head and Neck surgery
Ninewells Hospital and Tayside Childrens' Hospital
Dundee DD1 9SY

Email: musheer.hussain@nhs.net

Abstract
This article describes the principles involved in the hearing evaluation of adults. Pure tome audiometry remains the gold standard and the paper looks at the methodology and the pitfalls involved in the test. We discuss the role of masking and how to mask. Common terms used in audiometry are defined. A brief review is presented of speech audiometry, auditory evoked potentials and otoacoustic emissions. Test for non organic hearing are included.

Key Words
Principles; audiology; adults, hearings, non organic hearing loss.

Introduction
Hearing assessment involves measuring the degree and type of deafness. The ear that is being tested is called the test ear (TE) and the other ear is called the non-test-ear (NTE). Pure tone audiometry (PTA) remains the gold standard. PTA measures both the degree as well as the type of hearing loss.

Pure tone Audiometry:
This is the most commonly used method of assessing some one's hearing. A pure-tone audiometer delivers tones of variable frequency and intensity to the ear through earphones. The intensity ranges from 0 to 120 decibels and the frequency range is from 125 Hz to 8000 Hz. The results are charted on a graph called the Audiogram. The best hearing ear is tested first. The threshold is defined as the lowest intensity at which the patient responds to sound at least 50% of the time. The normal threshold value at each frequency is said to be 0 dB hearing level (HL).

Technique:
There are various methods to perform the PTA but Westlake and Hughson method is commonly employed. The first step is familiarisation of the patient with a 1000 Hz test tone and making a ballpark estimate of approximately where the threshold might be. This is achieved by presenting a test tone lasting 1 to 2 seconds at 30 dB HL if the patient seems to be normal, or at 70 dB HL if he appears to have a hearing impairment. If the patient does not respond to the first tone, then its level would be raised in 10 dB steps until the tone is heard. The steps for threshold search are listed in table 1.

Example:

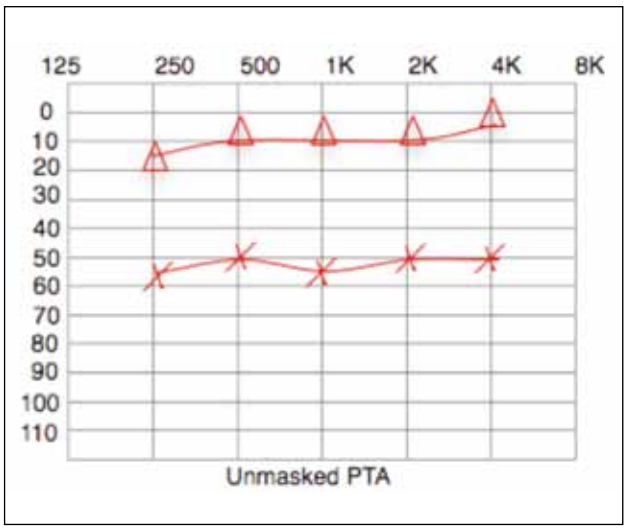

Figure1: *Apparent Left side conductive hearing loss, the bone conduction appears normal*

Related principles:

Occlusion effect:

A stronger signal reaches the cochlea when bone conduction is tested with the ears blocked by the earphones, compared to uncovered ears. This produces a low frequency enhancement for bone-conducted signal. This gain is called the occlusion effect.

Importance of occlusion effect:

Occlusion effect occurs when there is a blockage in the cartilaginous portion of the ear canal and it does not occur if the bony canal is blocked. The occlusion effect is absent when there is conductive hearing loss. This occlusion effect is the underlying principle of the Bing test. Occlusion effect occurs for frequencies up to 1000 Hz and the largest gain is obtained at low frequencies.

Signal cross over:

When a tone is presented to the TE, it is heard by the NTE as well, this occurs because of the transmission of the sound across the head to the other ear. This phenomenon is called signal cross over.

Interaural attenuation (IAA):

The energy used in the transmission of the sound from the TE to the NTE results in a reduced sound intensity at the NTE than the sound intensity presented to the TE. The number of dB lost in the process of signal crossover is called interaural attenuation. The IAA is 40 dB for air conduction and is a function of the frequency. The IAA for bone conduction is zero.

Masking:

It is the noise that is applied to the NTE in order to prevent it from picking up the sound presented to the TE.

In actual practice, the masking noise goes to the NTE, and the test signal goes into the TE. The masking noise is delivered by air conduction, regardless of whether the TE is being tested by air or bone conduction.

The masked thresholds are tested in the opposite order, bone conduction before air conduction. This is done because the rule for determining when masking is needed for air conduction depends upon knowing the true bone conduction thresholds.

Masking is required in the following conditions:

1. Air conduction audiometry shows greater than 40 dB difference in the two ears

2. The difference in air conduction threshold between the TE and the bone conduction in the NTE is more than 40 dB

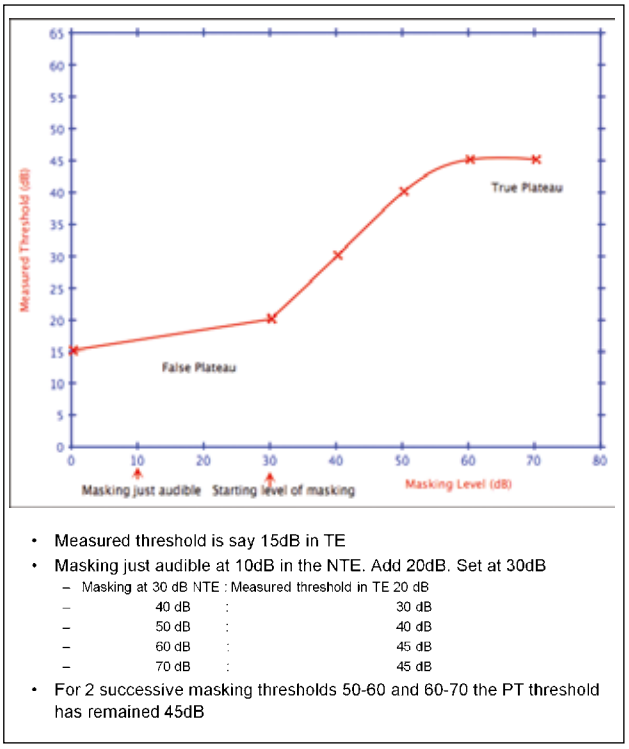

Figure 2: *Plateau method as described by Hood*

3. When the air conduction threshold of the TE and the bone conduction threshold of that same ear differ by more than 10 dB then the bone conduction threshold should be retested with masking in the NTE

How to apply masking?

In clinical practice we mask the ipsilateral NTE so that only the ear being tested TE is actually hearing the test signal. Central masking can occur when the signal and noise are presented to different ears. The noise in one ear can interfere with the ability to hear a tone in the other ear because they interact in the central auditory nervous system. This causes a threshold shift in the test ear of 5 dB.

Effective masking calibration and initial masking levels

The difference in decibels between the level of a given tone and the level of the noise that just masks that tone is often called the effective masking level or the minimum effective masking correction. For example, if it takes 30 dB HL to just mask 25 dB HL tone; the MEMC in this case is 5 dB. While applying initial masking level for air conduction we must add a 10 dB safety factor because the MEMC is an average. So if the air conduction threshold of the NTE is 25 dB HL, we will use a 40 dB HL of masking noise as the initial masking level. When applying the initial masking level for bone conduction we need to add

15 dB HL to account for occlusion effect. Hence, to mask a 35 dB HL, we need to add 5 dB MEMC + 10 dB safety factor + and 15 dB occlusion factor = 65 dB HL.

The Plateau method

Sometimes called the threshold shift method, it is a widely accepted strategy for finding the true masked threshold of the test ear, described by Hood (Figure 2).

Undermasking

The amount of noise is not sufficient to exclude the NTE from the TE and the tone is being heard by the NTE (Figure 3).

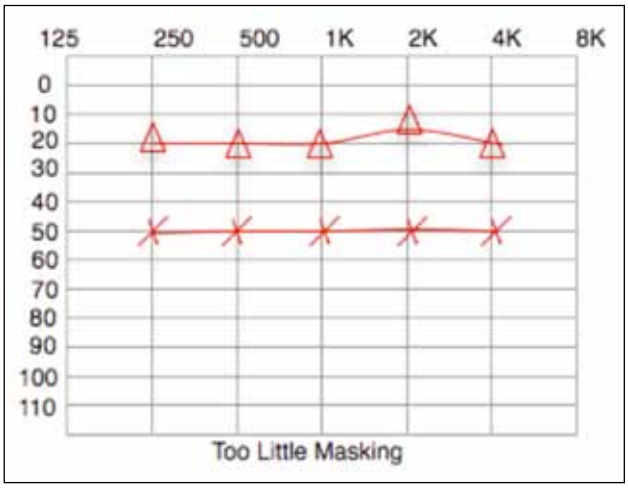

Figure 3: *Left SND 50dB Masking level used Right 20dBw*

Over masking

In this situation so much noise is presented to the NTE that it crosses over and masks the test ear (Figure 4).

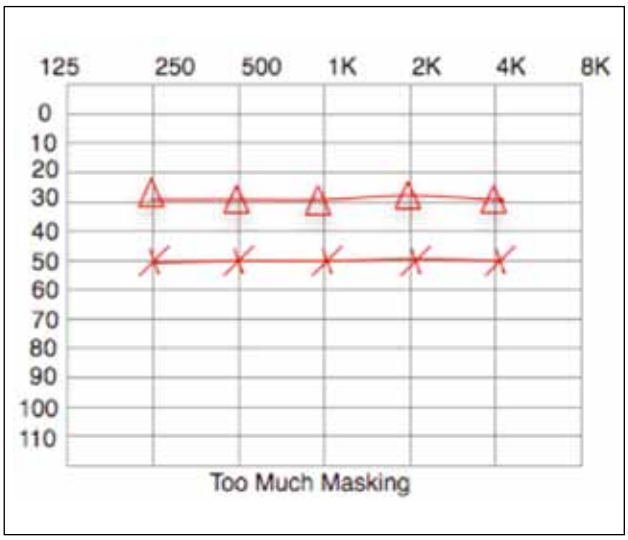

Figure 4: Left CD 50 dB Masking level used Right 80 dB

Masking dilemma

In this unique situation, overmasking occurs at the initial masking level. This problem occurs when the unmasked audiogram reveals large air bone gaps in both ears (Figure 5). In the example shown, both ears need to be tested with masking even though overmasking would occur at the initial masking levels.

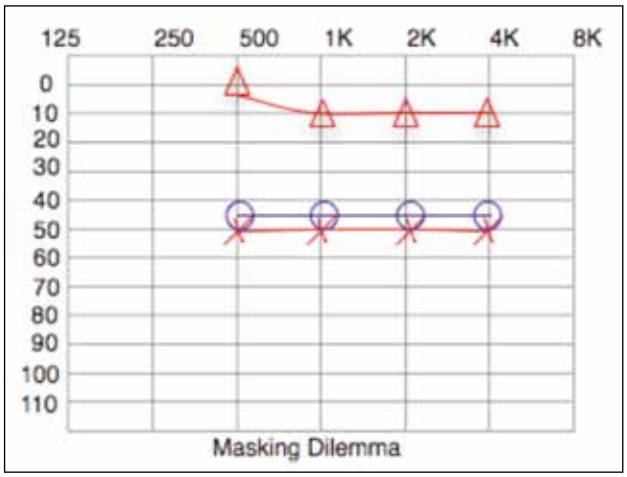

Figure 5: *Masking dilemma*

Air conduction versus bone conduction:

Air conduction tests the whole hearing system: both the conductive as well as the sensorineural systems. The bone conduction on the other hand tests the sensorineural system only and bypasses the conductive system.

Air bone conduction gap:

The difference between the air-conduction threshold (AC) and the bone conduction threshold (BC) at the same frequency is called an air-bone-gap (ABG). It represents the part of the hearing loss coming from the conductive mechanism.

If the ABG is zero, the total hearing loss is secondary to problem in the sensorineural mechanism and the conductive mechanism is normal. This is called sensorineural hearing loss. In this condition, the air and bone conduction thresholds are equal, or very close to one another.

For all practical purposes the air bone gap should be 10 dB before it is considered to be significant. This is based on the fact that most air and bone conduction thresholds are within +/-10 dB of each other.

Sensorineural hearing loss can result from a lesion of cochlea and or cochlear nerve and these two cannot be differentiated on the basis of a pure tone audiogram. The damage to the basal turn of cochlea results in high frequency hearing loss and lower frequencies are affected as the apical parts of the cochlea are damaged. The outer hair cells are more susceptible to damage than the inner hair cells.

Noise induced SNHL

Temporary threshold shift (TTS):
The short term decrease in hearing sensitivity, after exposure to loud noise like loud music, is sensorineural and is called temporary threshold shift. The TTS can be produced by sound levels greater than 80 dB SPL.

Permanent threshold shift (PTS):
When the TTS does not recover completely, PTS occurs that is hearing sensitivity does not return to normal.

The noise induced hearing loss is associated with a notch-shaped high frequency SNHL that is worst at 4KHz. As noise exposure continues, the notch widens to include a wider range of frequencies.

Presbycusis:
Deterioration in hearing capacity with advancing age is called presbycusis. Difficulty with speech recognition is the most common complaint of presbycusis.

Recruitment:
It is a condition of abnormal growth of the loudness of sound and is seen in sensory or cochlear loss. Quiet sounds cannot be heard by the patient but loud sounds are uncomfortable for the patient. This can result in loss of speech discrimination and intolerance of loud sounds.

Speech audiometry:
Pure tone audiometry does not tell us about the ability of the patient to hear and understand speech. This task is accomplished by testing the patient with speech stimuli and this process is called speech audiometry. A series of words from say a tape recorder are presented via headphones to the patient. The words are phonetically balanced to encompass the whole speech range from 500 Hz to 2000 Hz and the intensity is varied.

Speech detection threshold (SDT):
The lowest level at which the presence of a speech signal can be heard 50% of the time is called SDT.

Speech recognition threshold (SRT):
The lowest level at which a speech signal is intelligible enough to be recognized 50% of the time is the SRT.

Speech recognition scores are generally between 90 to 100% in normal hearing patients. With conductive hearing loss the speech recognition scores are between 80 and 100%. SNHL can give speech recognition scores between 0 and 100% depending on the aetiology and degree of loss. Abnormally low speech recognition scores are associated with retrocochlear or neural lesions.

Speech audiometry is a valuable method of assessing the actual disability produced by the impairment in hearing, and it can be used to predict the usefulness of hearing aid. This also has a role in preoperative assessment.

Auditory evoked potentials
The electrical responses of the nervous system that are elicited by a sound stimulus are called auditory evoked potentials.

Electrocochleography (ECochG)
It is the measurement of electrical potentials that are derived from the cochlear hair cells and the auditory nerve.

The most important aspect of this investigation is the electrode placement. The best quality responses are obtained with an electrode placed on the cochlear promontory. This transtympanic approach involves penetration of the tympanic membrane by the needle electrode and this is the biggest limitation of this investigation.

However, the noninvasive extratympanic approach is perfectly useful and in this technique the electrode is placed as close to the tympanic membrane as possible.

The ECochG is not routinely recommended to measure hearing thresholds.

Auditory brainstem response (ABR)
The electrical impulses that are generated in the mid-brain and brainstem in response to sound are detected by the surface electrodes. This gives a rough estimation of hearing threshold. ABR is not affected by general anaesthetic or by the patient's state of arousal. ABR can helps in distinguishing cochlear deafness from retrocochlear deafness. More importantly, it can be used for intraoperative monitoring during vestibular schwannoma excision.

Cortical electrical response audiometry:
Surface electrodes detect the electrical activity occurring in the vertex in response to sound. It is a very good objective measurement of hearing threshold in cooperative patients. It is mainly used in evaluation of non-organic or psychogenic hearing loss.

Otoacoustic emissions:
These are the sounds generated by the outer hair cells, transmitted backward through the middle ear and into the ear canal where these can be picked by a microphone. The OAE are useful as they are noninvasive and are sensitive to damage to outer hair cells. The OAE are very sensitive to the presence of hearing loss and is used in neonatal screening.

Clinical assessment of amount of hearing loss
In a sound-proof room, human voice at ordinary intensity

is audible at a distance of 70 feet. In an ordinary room, human voice at ordinary intensity is audible at a distance of 20 feet. The voice test can be performed in 2 ways: constant distance, variable intensity and constant intensity, variable distance. Each ear is tested separately by turning the patient first to one side and then to the other. The test is described in table 2.

Clinical assessment of type of hearing loss

The tuning fork tests are used to assess the type of hearing loss. The most commonly used tuning is the one with 256 double vibrations per second.

Tests for Non-organic hearing loss

These tests are used for patients who claim to have no hearing on one or both sides, or greatly reduced hearing. Bilateral hearing loss is more difficult to investigate as the clinical tests rely on the presence of one good ear. The commonly used tests are described.

Tests for non-organic hearing loss

Voice tests for Malingering:

Lombard's test

This test is based on "Lombard's principle" which states that a person will raise his or her voice when speaking in noisy environment. During this test, the patient is asked to read a book aloud and not to stop reading when noise is introduced into his good ear by the Barany noise apparatus. As soon as the noise begins, a patient whose opposite ear is deaf will at once raise his voice but in a malingerer, claiming one sided deafness which is not real will continue to read book in an even tone.

Hummel Double conversation test:

This test is based on the principle that when two different voices are introduced into two ears it creates confusion for the patient. If one ear is deaf then the patient is not confused by two different questions being projected to two ears since one ear is deaf, where as in a malingering it causes a lot of confusion and the malingerer will not respond.

Erhardt's test

This test is also known as loud voice test. This test is based on the fact that occlusion of the external auditory canal causes attenuation of around 30 dB. In this test, the normal ear is occluded with a finger and sound is projected in to this ear. A normal person should still be able to hear this sound which is dampened by occlusion but still audible. However, the malingerer will deny hearing any sound at all even when it is loudest.

Delayed speech feedback test

The patient is advised to read aloud from a book. His voice is recorded and played back to him via earphones with a 200 millisecond delay. The good ear is not stimulated. If there is a genuine deafness he will be able to read without any difficulty but a malingerer will struggle and will change his reading pattern e.g. he will stammer or slow down or raise his voice.

Tuning fork tests for malingering

Stenger test

This test is based on the Stenger effect, which states that if a sound is presented to both ears, the patient hears it only in the ear where it is louder. This test was described in 1900 by Stenger as a tuning fork procedure for unilateral feigned hearing loss. Two tuning forks of same frequency are used. The patient is asked to close their eyes. The first tuning fork is presented to the good ear at 15 cm and the patient will hear it. Remove the first tuning fork and the second tuning fork is then presented to the bad ear at 5 cm, the patient denies hearing it. Now, while the second tuning fork is still in place, reintroduce the first tuning fork at 15 cm from the good ear. If the patient has got a genuine hearing loss, he will notice the first tuning fork and if he is feigning the hearing loss, he will only hear the second tuning at the bad ear and claim that he does not hear anything.

Teal test

The patient admits to hearing bone conduction in his deaf ear. The vibrating tuning fork is applied to the mastoid process of his deaf ear and patient admits to hearing it. The patient is then blindfolded and is advised that the test is going to be repeated. However, this time a non-vibrating tuning fork is applied to the mastoid process of his deaf ear and at the same time a vibrating tuning fork is put against the external auditory meatus of the same ear. If the patient is really deaf he will not hear the tuning fork. On the other hand, If the patient is malingering he will hear the tuning fork through air conduction, but think that it is being heard through the bone.

Chimani Moos test:

This test is a variation of Weber's test. When the tuning fork is placed on the vertex, the patient claims to hear it in the good ear and not in the deaf ear. The external auditory meatus of the good ear is then occluded. A genuine deaf patient will still localize the tuning fork to the good ear but a malingering patient will deny hearing the sound at all.

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Management of tympanic membrane retractions

Ameera Abdelrahim MRCS
Specialist Registrar in ENT

James Rainsbury MSc FRCS (ORL-HNS)
Specialist Registrar in ENT

Richard Irving MD FRCS
Consultant Otologist & Neuro-otologist

ENT department, Queen Elizabeth Hospital, Edgbaston, Birmingham

Abstract
Tympanic membrane retraction is a common problem that presents a challenge to otologists because of the difficulty in predicting progression and the lack of evidence about management. In this article we discuss the aetiology and classification of tympanic membrane retraction, and review the current evidence for different approaches to managing them.

Key Words
Chronic otitis media, tympanic membrane, retraction pocket, atelectasis

Introduction
A tympanic membrane (TM) retraction (retraction pocket, inactive squamous chronic otitis media) is an invagination of all or part of the TM into the middle ear. The term atelectasis is also used for retraction of the pars tensa.

Otologists face a number of challenges in managing this problem: classification systems rely on clinical observation and their reliability and reproducibility have been questioned; the natural history of retraction pockets is unpredictable, in particular, whether or not they will progress into cholesteatoma and over what time period this is likely to happen; and there is no real consensus on the management of TM retractions, with a lack of randomised controlled trials (RCTs) and studies with long term follow-up.

Classification
The commonest classification systems used are those of Sade[1] (pars tensa) and Tos[2] (pars flaccida). Both are graded I – IV (See Tables 1 and 2, and Figures 1 and 2). Charachon[3] proposed Stages 1 -3, according to whether the retraction pocket was mobile or fixed, and whether or not it was "controllable". Much debate has surrounded these classification systems due to their poor intra- and inter-observer variability[4].

The Erasmus system[5] (stages I-V) was developed for paediatric patients. Although based on Sade's original classification, it recognises that adherence of the TM to the ossicular chain may be a more difficult situation to approach surgically than adherence to the promontory since (a) it is preferable to avoid manipulation of the ossicular chain, and (b) atelectasis onto the incus may lead to necrosis of the long process. It also includes cholesteatoma in the classification, which is seen in

Table 1: Sade grading system for pars tensa retractions[1]. (see also Figures 1 and 2)

Grade	Extent of retraction pocket
I	Mild retraction of pars tensa
II	Pars tensa touches incus or stapes
III	Pars tensa retracted onto promontory, but not adherent to it
IV	Pars tensa adherent to promontory

Table 2: Tos grading system for pars flaccida retractions[2]. Stage III and IV are often grouped together because of difficulty in distinguishing them form one another.

Grade	Extent of retraction pocket
I	Attic dimple
II	Pars flaccida adherent to neck of malleus. Full extent of pocket seen.
III	Possible erosion of scutum. Full extent of pocket partly hidden
IV	Definite erosion of scutum. Full extent of pocket not seen.

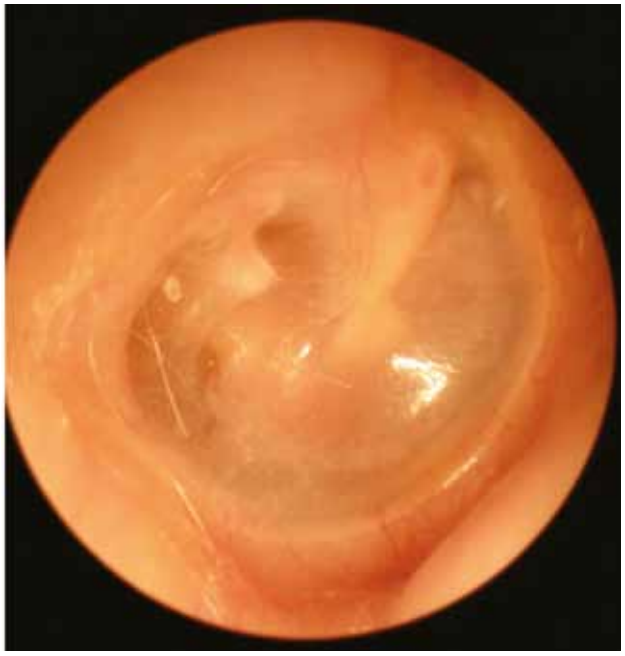

Figure 1: *Otoendoscopic pictue of a Grade II Sade retraction of the pars tensa in a right ear. The tympanic membrane is touching the head of the stapes and there is erosion of the long process of incus*

advanced stages when a retraction pocket starts to retain keratin debris (Figure 3).

A recent endoscopic evaluation of staging systems by James et al[6] showed poor correlation between retraction stage and hearing threshold and only moderate intra- and inter-observer reliability. They suggest that endoscopic evaluation and documentation would provide an objective record and that more valid methods of assessment are needed alongside clinical correlation to inform management. Endoscopic images are limited by being two-dimensional which makes assessment of the depth of a retraction difficult. Advantages of endoscopy are that serial images may be stored on electronic image databases, similar to those used for radiological studies in many hospitals, possibly providing better reliability; and that the extent and contents of deeper retractions may be assessed better from a viewpoint closer to the drum.

Kakehata et al[7] compared assessment of retraction pockets with a 1mm micro-endoscope to standard otomicroscopic examination. They found that 59% of pockets were deeper than the standard examination revealed and that extension of the retraction pocket was under-estimated. Therefore they suggested re-assessment of Tos grade III and IV retractions using a microendoscope and further assessment using water enhanced CT. Furthermore, careful follow-up of patients with deep retraction pockets is advocated to assess for transformation into cholesteatoma.

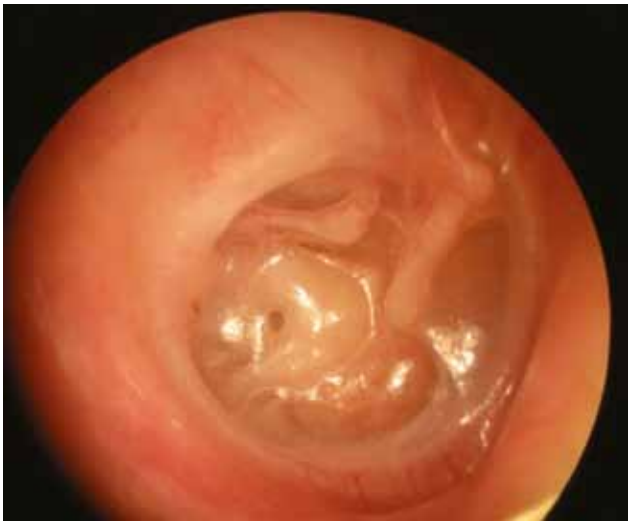

Figure 2: *Otoendoscopic picture of a Grade III/IV Sade retraction of the pars tensa in a right ear. The drum is draped over the ossicular chain (the stapedius tendon and long process of incus are clearly seen postersuperiorly) and promontory. Pneumatic otoscopy may help distinguish between grades III and IV by demonstrating whether or not the drum is adherent to the promontory.*

Incidence and prevalence

The incidence of retraction pockets in 5-16 year olds is reported to be 14 - 25% of healthy ears with type II Tos classification being the commonest. Severe retraction types III/IV are noted in 5%[8]. A recent large cross-sectional study by Maw et al9 reports on findings of middle ear disease in 9-10 year olds. The prevalence of the disease in this group of patients was 9.6% in the pars flaccida and 7.9% in the pars tensa. Most of the retractions were mild (Grade I/II).

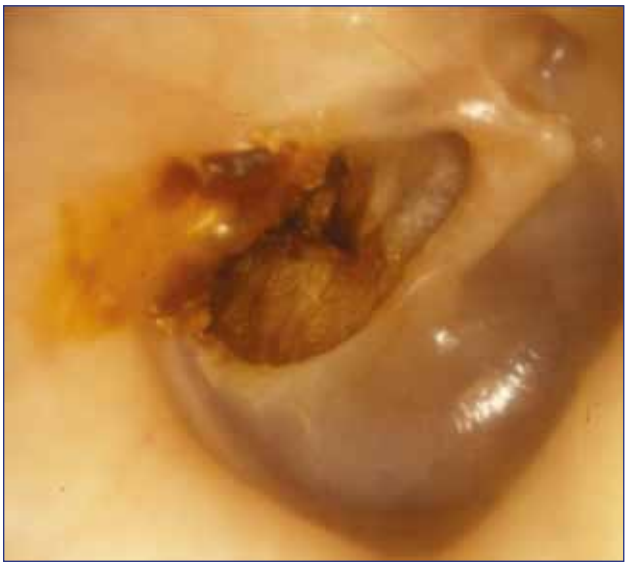

Figure 3: *Otoendoscopic picture of a posterosuperior retraction pocket that has progressed into a cholesteatoma (right ear).*

Aetiology and pathogenesis

The most likely cause of tympanic membrane retraction pockets is eustachian tube dysfunction and recurrent episodes of acute otitis media or otitis media with effusion (OME). It is likely that adult disease is a consequence of childhood otitis media related sequlae[9]. The structural changes in the tympanic membrane following infection or effusion are a pre-requisite to the development of a retraction pocket and cholesteatoma formation. Shunyu et al[3] performed immunohistochemical and histological assessment of 50 surgically excised pars tensa retraction pockets and found a number of common features: subepithelial chronic inflammation; proliferation and hyperkeratinization of the outer epithelial layer; epithelial cones with proliferating cells in the basal epithelial layer; and loss of the middle double collagen layer. Loss of the inner mucosal layer was another, less common finding. This group noted a trend for an increasing incidence of basal epithelial cones, middle collagen layer loss, and inner mucosal layer loss as the retraction progressed.

Sudhoff and Tos[8] address the progress of retraction pockets into cholesteatoma and conclude that most will never evolve into cholesteatoma, but that disruption of the self cleansing mechanism and migration of keratin are risk factors for progression. These are influenced by conditions which increase epithelial turnover, desquamation or accumulation, such as recurrent otitis media, otitis externa or wax impaction. The incidence of retractions correlates with the number of episodes of recurrence of such events.

Presentation and assessment

Many TM retraction pockets are asymptomatic, detected incidentally or diagnosed in contralateral ears of patients with cholesteatoma. Patients may present with symptoms of hearing loss or recurrent otorrhoea. Examination should focus on assessment of: location (pars tensa or flaccida; which quadrant of pars tensa), extent (into attic, facial recess, hypotympanum – these may influence the operative approach), severity (grade; erosion of ossicular chain, scutum, or medial ear canal), and associated pathology (crusting, keratin, and granulation). Pure tone audiometry and tympanometry should be performed, or alternatively an age-appropriate hearing test in young children. Audiometry may be normal or show a conductive loss, while tympanometry may show negative middle ear pressure or effusion (Jerger type B or C). CT is a useful adjunct in those patients where there is uncertainty about the depth of retraction or the presence of cholesteatoma.

Management

The aims of treatment are to improve or preserve hearing, and to prevent ossicular erosion or progression to cholesteatoma. Unfortunately, there is no real consensus on the best management of TM retractions, since not only there is a lack of RCTs or studies with long term follow-up, but much of the published data include patients with cholesteatoma. Whilst the management of cholesteatoma is predominantly surgical, the decision is not clear-cut with TM retractions. There are a variety of approaches to management of retraction pockets, as outlined below with reference to the best and/or most current evidence for each.

Conservative

Regular follow-up is appropriate for patients with asymptomatic, mild retraction (Grade I/II). Patients with severe retraction (Grade III/IV) should be monitored carefully to assess for progression. Challenges arise from the variability in the staging systems and the limitations of different types of examinations of the tympanic membrane as discussed earlier. In practice, many clinicians may not formally grade retraction pockets, but instead make decisions about surgical management based on whether or not the patient is symptomatic or if the pocket shows signs of progression.

Children with mild retraction (Grade I/II) may develop complete resolution at 3 months. Those with severe retraction (Grade III/IV) and recurrent episodes of otitis media are more likely to progress and therefore would require long-term monitoring, and indeed the changes may persist into adulthood[9].

There is no consensus about the frequency or duration of follow-up in patients with stable asymptomatic retractions. With pressures on outpatient clinics, many otologists may advocate discharging these patients back to their GP after observing them for a year, with instructions to refer back if symptoms change.

Auto-inflation (Otovent balloon)

The Otovent balloon has successfully been employed in the management of recurrent otitis media in children, although it is limited to those who are old enough co-operate with using it. A Cochrane review on auto-inflation devices for otitis media concluded that it would be a reasonable option whilst awaiting natural resolution of otitis media in view of its low cost and the absence of adverse events[11]. In theory, this could also be applied to those with mild retractions in view of the non-invasive nature of the intervention, although the evidence is lacking.

Medical

Nasal steroid sprays have been used for the treatment of eustachian tube dysfunction. However a recent RCT[12] of 91 patients (adults and children) found no benefit in the use of aqueous triamcinolone versus placebo over a

6-week period. Furthermore, another RCT13 of 4-11 year olds treated for otitis media with intranasal steroids in primary care found it unlikely to be a clinically effective treatment. They noted high rates of natural resolution at 1-3 months. However, neither study looked specifically at the subgroup of patients with significant nasal symptoms, so it may still be reasonable to give this group a trial of medical therapy.

Surgical

The role of surgery in management of tympanic membrane retractions remains an area in need of robust research to inform clinicians of the benefit of surgical management and the optimal time for intervention. Since evidence for effectiveness of surgical treatments of retraction pockets is lacking, patient selection is important to minimise harm.

We consider it reasonable to offer surgery to those with persistently or recurrently discharging ears, conductive hearing loss, or where serial clinical examination shows progression of the retraction or accumulation of keratin. The ventilation status of the other middle ear should be taken into account, since the chances of failure are probably higher where the contralateral ear is poorly ventilated. In children, eustachian tube function is likely to improve with growth so the less aggressive surgical options are generally favoured.

Ventilation tube insertion

The insertion of ventilation tubes (VT) is probably one of the commonest methods of surgical management. Cassano[14] reviewed a series of 45 ears with mild retraction (treated with medical therapy or VT insertion) and severe retraction (treated with reconstruction), and compared these with 40 untreated control patients. Minimum follow-up was 2 years. Resolution occurred in 94% of ears in the mild retraction group, regardless of whether they were treated medically or with VTs. Earlier studies[15,16] found that the recurrence of retraction following extrusion of VT was high, presumably because of ongoing eustachian tube dysfunction, even when a long-term VT (T-tube) was used.

Retraction pocket excision

Although not our practice, some authors cite excision of the pocket with VT insertion as a quick alternative to tympanoplasty that has fewer associated risks and a similar success rate. Re-excision or tympanoplasty is an option in recurrent cases. These groups found little or no recurrence in approximately 65% of adults and children, but that predicting which ears would fail was difficult[17-19].

Adenoidectomy

A Cochrane systematic review[20] of adenoidectomy for otitis media in children concluded that the benefits of adenoidectomy on tympanic membrane retraction was unknown. Recent data from the MRC Multicentre Otitis Media Study Group (2012) TARGET trial[21] showed adjuvant adenoidectomy in patients requiring ventilation tubes for glue ear doubled the benefit from short-stay ventilation tubes in the second year and reduced the need for revision surgery. Although tympanic retraction is probably a consequence of OME, it is hard to extrapolate these benefits to the treatment of TM retraction.

Tympanoplasty

In tympanoplasty, the diseased segment of ear drum is excised and the defect is grafted to repair the resultant perforation and prevent re-retraction. Simultaneous ossiculoplasty may be carried out if required. Various graft materials have been used, including fascia, perichondrium and cartilage, with the aim of striking a balance between a good hearing result (thin graft) and a lower risk of re-retraction (thicker graft). However, a recent systematic review[22] in 1475 patients assessing cartilage versus fascia tympanoplasty concluded that a comparable hearing result is achieved from either, although only 10% of cartilage tympanoplasties required revision, compared to 19% of fascia tympanoplasties. Ferrara[23] reports a retrospective study of 54 ears in children with severe retraction who underwent perichondrium or fascia tympanoplasty. None suffered deterioration in their hearing but 29.6% had recurrence of severe retraction over a 7-year period. Our preference is to use a composite graft of perichondrium with split cartilage (conchal or tragal). An island of cartilage is fashioned with a cuff of perichondrium attached that is run up the canal wall to help keep the graft in place (Figure 4).

Another Cochrane systematic review[24] noted low number of RCTs in this area, of which only 2 qualified for inclusion, with a total of 71 patients. The first[25] assessed cartilage tympanoplasty versus conservative management on disease progression and hearing outcomes. The intervention group did better with no disease progression but the numbers were too small to reach statistical significance. The second[26] compared cartilage tympanoplasty with and without ventilation tubes. No additional benefit to hearing outcomes was achieved from the use of ventilation tubes. The cartilage grafts were successful in both groups in achieving reconstruction of the TM with good functional and anatomical results.

Many surgeons advocate the use of cortical mastoidectomy with tympanoplasty to improve middle ear ventilation and reduce the surface area of inflamed mucosa. There is no published evidence for or against this, and in our experience, a combined approach may be useful in dealing with deep retraction pockets that do not easily lift out of the facial

recess or mastoid antrum, in recurrent perforations, or in ears that have evidence of mastoid opacification (without bone erosion) on CT.

Eustachian tuboplasty

Chronic eustachian tube dysfunction probably plays a role in many patients with chronic otitis media and all the surgical treatments outlined above address only the end result, rather than the underlying problem. After a vogue for eustachian tuboplasty in the 1970s and 80s, the results of which were disappointing, there have been a number of more recent studies showing moderate success of laser and balloon dilatation eustachian tuboplasty[27, 28]. However, the sample sizes in these studies is small and follow-up is relatively short (maximum 1 year) so further research is needed to establish the place of this type of surgery in management of retraction pockets.

Conclusion

Good documentation of retraction pockets with serial audiological and otoendoscopic evaluation may provide a more reliable method of assessing progression of disease in this group of patients.

Many children with mild retraction pockets improve spontaneously over a 3-month period and conservative treatment is appropriate for these. The benefits of medical therapies are variable and difficult to recommend. Patients with moderate-severe staging are more likely to progress and therefore require careful monitoring and follow-up; these changes are also more likely to persist into adulthood.

For cases considered appropriate for surgery we recommend elevation or excision of the pocket and cartilage tympanoplasty, combined with ossiculoplasty if necessary.

Further randomised studies are needed to compare surgical and non-surgical management of retraction pockets, different surgical techniques, reconstruction materials and the use of concomitant cortical mastoidectomy. Studies should use ideally a validated method of staging retraction pockets to reduce bias caused by the poor inter- and intra-observer reliability found in current staging systems, but in the absence of such a system, they should use multiple, blinded assessors to grade the degree of retraction pre- and post-intervention[18].

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Temporal bone fracture

R.Wormald F.R.C.S (ORL-HNS
Fellow ENT Surgery, Princess Margaret Hospital, Perth, Western Australia

R.McConn-Walsh F.R.C.S (ORL-HNS)
Consultant Otolaryngologist, Department of Neuro-Otology, Beaumont Hospital, Dublin, Republic of Ireland

Correspondence:
Robert Wormald
Department of Otolaryngology, Princess Margaret Hospital, Roberts Road, Subiaco, WA 6008
r_wormald@yahoo.com

Abstract
Fractures of the temporal bone are uncommon. However, they can be associated with significant morbidity including hearing loss, vertigo, facial nerve palsy, CSF leak and other intra-cranial injuries. Diagnosis is based upon clinical findings and appropriate investigations. CT imaging of the temporal bone is the most appropriate first-line investigation. Management is directed by the clinical and radiological findings.

Key words
Temporal bone; fracture; facial nerve; SNHL, haemotympanum

Introduction
The anatomy of the temporal bone is extremely complex; it contains many vital structures such as the cochlear and vestibular end organs, the facial nerve, the jugular bulb and the internal carotid artery and is intimately related to other cranial nerves; the glossopharyngeal, vagus and spinal accessory nerves. Fracture of the temporal bone can therefore lead to disruption of any of these structures.

The temporal bone is a very hard bone and because of its anatomical position is relatively resistant to injury. Temporal bone fractures are therefore uncommon and represent approximately only 20% of all skull fractures[1]. Trauma to the temporal bone will often, however, be associated with other injuries; 90% are associated with intracranial and 9% the cervical spine [2].

Temporal bone fractures most commonly occur in young adults, usually arising from blunt trauma such as motor vehicle accidents, “falls” or assault. Penetrating trauma to the temporal bone is less common, although it has been reported in the United States that gunshot wounds account for up to 50% of temporal bone trauma[3,4].

Classification
Traditionally temporal bone fractures have been classified as either longitudinal (80%), transverse (20%) and mixed[5,6].

- longitudinal fractures extend from the squamous portion of the temporal bone, down the external auditory canal and parallel with the long axis of the petrous temporal bone. The fracture line will usually lie anterior to the otic capsule. Longitudinal fractures are often the result of a blow to the tempero-parietal region.
- transverse fractures run perpendicular to the long axis of the petrous bone towards the internal acoustic meatus and will more commonly involve the otic capsule. Transverse injuries are more often associated with a higher energy injury, usually to the frontal or occipital region, and have a higher incidence of an associated brain injury.

Ghorayeb et al[7] used CT imaging to look at 150 temporal bone fractures and demonstrated that the fracture line more commonly ran obliquely through the temporal bone rather than in purely longitudinal or transverse direction. Alternative classification systems have thus been suggested. Dahiya et al[8] recommended that fractures should be classified according to whether the injury does or does not involve the otic capsule. In a fracture involving the otic capsule disruption to the cochlea and semi-circular canals will occur and otological sequelae will be expected. It has been estimated that only 5% of temporal bone fracture involve the otic capsule[8]. The relative frequency of other neurological, neuro-otological and skull base complications is not predicted by this classification system. A more recent report[9] suggest that the temporal bone be classified according to what portion of the temporal bone is involved as diagnosed by CT scan (squama, tympanic, mastoid, and petrous) and it was found that the symptoms and signs found were more likely optimal and relevant to clinical practice

Clinical Features

Firstly, it must be remembered that some patients will have sustained a significant head or other concomitant injury, making early identification of a temporal bone fracture difficult. Many patients will have been intubated and sedated and clinical assessment and decision-making will need to be held until the patient is awake, particularly when it comes to the difficult decision process regarding management of facial nerve injury.

In conscious patients early symptoms include pain, hearing loss, nausea and vomiting, vertigo and facial palsy. A full examination of the ear, nose and throat and all cranial nerves is mandatory. Clinical signs to look out for include Battle's sign (post-auricular ecchymosis arising from bleeding from the mastoid emissary vein), the "raccoon" sign (peri-orbital ecchymosis usually arising from a fracture involving the frontal or middle cranial fossa) and lower motor neuron facial palsy. Nystagmus may be present. Otoscopy should look for blood, a tear or a deformity in the tympanic membrane or external auditory canal. A hemotympanum is often seen. Otorrhoea may be present which may be bloody or more ominously clear where it may indicate a CSF leak. Tuning fork tests may be performed as a screening tool to assess for the presence or type of hearing loss.

Investigations

Specific investigations relating to temporal bone fracture are performed once the patient is stabilized and more life-threatening injuries have been managed.

Imaging

Computed Tomography (CT) scans of the head to rule out a significant intracranial injury are usually the first line investigation in patients who have received a head injury. If a temporal bone fracture is suspected then a high-resolution, fine cut (1mm) CT scan of the temporal bone is the gold-standard in delineating the nature of the injury. Although MRI is not recommended as an initial or routine examination of temporal bone fractures, it can be a useful adjunct to CT imaging, particularly when there is suspicion of an intracranial injury.

Other investigations such as angiography have not routinely been indicated. However, a recent retrospective study looking at the role of angiography in patients with temporal bone fractures concluded that in the presence of an abnormal CT scan and evidence of an intracranial injury, angiography is essential to detect vascular injuries that require aggressive management[10].

Audiometry

Audiological testing should be performed on all patients as early as possible. This may be difficult if the patient has sustained other injuries. Audiological testing this should include tympanometry as well as pure-tone audiometry. Pure tone audiometry can determine if a patient has sustained a conductive, sensorineural or mixed hearing loss and can be useful to explain and counsel the patient regarding the injury and the possibilities for hearing rehabilitation.

The need for electric response audiometry is rarely indicated in an unconscious adult patient as it is unlikely to affect patient management. However, in the young child it may be critical to determine the patient's hearing thresholds.

Facial Nerve testing

Clinical assessment of facial nerve function is paramount, particularly the speed of onset (sudden vs. delayed onset) and severity of injury. The use of electrical tests (such as electroneurography, ENoG) to measure and record facial nerve function is of debatable benefit. When ENoG demonstrates that there is more than 90% degeneration of the compound action potential at 14 days, full recovery is unlikely and surgical exploration or decompression of the facial nerve may be indicated[11]. However, electroneurography is not readily available in most otolaryngology departments. Most clinicians will make management decisions, regarding the need for facial nerve exploration, based upon history and clinical judgment.

Cerebrospinal Fluid Leak

A CSF leak can present as a clear, or blood-stained, otorrhoea or rhinorroea. The presence of a CSF leak can be confirmed by testing any fluid for β2 transferrin. Suspicious fluid can be easily collected in a sterile container. This is nearly 100% sensitive and requires only 0.2mls of collected fluid for analysis[12].

Complications

There are a number of complications[13] that can occur following temporal bone trauma.

Complications of Temporal Bone Fracture	
Common	**Uncommon**
CHL (>50%)	SNHL (<20%)
Tympanic membrane perforation	
Haemotympanum	Ossicular chain disruption
Vertigo	
Facial Nerve palsy (50% transverse, 20% longitudinal fractures)	
CSF leak	

Hearing Loss

A conductive hearing loss is the most common pattern of hearing loss following temporal bone fracture and is reported to occur in approximately 50% of patients[13]. Most frequently it is secondary to haemotympanum, but may also occur after tympanic membrane rupture or ossicular chain discontinuity[8].

Sensorinueural hearing loss (SNHL) is seen less commonly (<20%) than a conductive loss. SNHL is seen most commonly in patients who have a fracture involving the otic capsule but can occur secondary to concussion of the cochlea. Management of patients with SNHL is guided by the severity of hearing loss and the hearing threshold in the other ear. Tos et al[14] looked at a series of 248 patients and reported that SNHL after temporal bone fracture generally does not recover. Most patients with a SNHL will be managed conservatively. Theoretically cochlear implantation is an option in those patients with bilateral profound sensorineural hearing loss. Results, to date, have been mixed and largely confined to case reports and small case series. Trauma to the otic capsule can lead to loss of spiral ganglion cells as well as labyrinthitis ossificans leading to implant failure[15,16] .

Haemotympanum

A haemotympanum is commonly seen after a temporal bone fracture, whatever the fracture pattern. It will present as a bright or dark red tympanic membrane and the diagnosis will usually be clear from the history of trauma. When seen in an unconscious patient, with an undiagnosed temporal bone fracture, it is an indication for directed imaging of the temporal bone.

If the patient is conscious and cooperative a tympanogram and a pure tone audiogram should be attained. It can provide additional useful information such as the pattern of any hearing loss and can provide some reassurance to the patient that their hearing is likely to improve.

If the haemotympanum is causing a conductive hearing loss, it is useful to repeat a PTA several 4-6 weeks later once the haemotympanum has resolved. Until the haemotympanum has cleared it is difficult to outrule any disruption to the ossicular chain that may not be apparent on imaging. Nearly 75% of patients with a haemotympanum will return to normal hearing within 6 weeks[14].

Ossicular Chain Disruption

Disruption of the ossicular chain, resulting in a conductive hearing loss, can occur following temporal bone fracture. A number of different injuries patterns exist and these include (listed in relative frequency) incudostapedial dislocation, malleus-incus dislocation, fracture of the stapes crura, fixation of the ossicles in the attic and incudomalleolar separation. Less common injuries include delayed necrosis of the long process of the incus, dislocation of the stapes footplate and dislocation of the malleus. Initial management is simple observation with repeat audiometry at approximately 2-3 months. Patients with a persistent conductive hearing loss can be managed conservatively with a hearing aid or offered surgical exploration and ossicular chain reconstruction. Careful pre-operative assessment and patient counseling is critical; the Belfast rule of thumb or Glasgow benefit plot can be used to determine if the patient is likely to gain any benefit[17,18].

Patients with conductive hearing loss are reported to do better with surgery than patients with a conductive hearing loss secondary to middle ear disease[14].

Vertigo

Vertigo is reported to occur in up to 78% cases of temporal bone trauma, with or without a temporal bone fracture[11,13]. Nystagmus may be seen although its severity (1st to 3rd degree) and directional preponderance can be extremely variable. Traumatic Benign Paroxysmal Positional Vertigo is reported to be the most common cause of post-traumatic vertigo (61%)[19,20]. It will present with severe rotatory vertigo precipitated by head movements. Dix-Hallpike testing will reveal a geotropic rotatory nystagmus towards the affected ear. Traumatic BPPV is less responsive to repositioning techniques than idiopathic BPPV, possibly because of bilateral disease[20]. However, like its idiopathic counterpart, its natural history is for complete resolution over time in most patients.

A perilymph fistula is another possible outcome following temporal bone trauma. In this scenario a fracture will extend into the vestibular labyrinth leading to a perilymph fistula. The existence of perilymph fistula is debated, particularly as presenting symptoms are variable and there are is no clear consensus on appropriate management. Symptoms will usually include severe and persistent vertigo exacerbated by movement and a SNHL. A high index of suspicion is required to diagnose a fistula and it can be easily missed on CT imaging. Initial management is conservative with anti-emetics, bed rest and avoidance of straining. The majority of patients will settle with conservative management, but surgical exploration can be justified when symptoms persist. Glasscock et al[21] reported that 25% of patients with a perilymph fistula gain some improvement in hearing, with more patients gaining better control of their vestibular symptoms. Vestibular rehabilitation is useful for all patients whose symptoms do

not settle, irrespective of surgery as it is felt to encourage central compensation.

Facial nerve palsy

Facial nerve palsies are seen in approximately 50% of transverse and 20% of longitudinal fractures[13]. They are seen more commonly in fractures involving the otic capsule. As mentioned, the diagnosis of a facial nerve palsy may be delayed because of other associated injuries that the patient may have sustained. In a patient who has sustained a significant brain injury, this delay may extend days or weeks after the event, thus making management decisions extremely difficult.

The critical points guiding management decisions are the timing of onset (sudden vs. delayed), the severity of the facial nerve palsy and the results of CT imaging.

The policy in our institution is to surgically explore those patients presenting with either an immediate onset or complete (House-Brackmann Grade 6) facial palsy. Surgical exploration is performed based upon the presumption that the nerve has been transected and that immediate anastomosis or cable grafting of the nerve will then be performed. Evidence for surgical exploration is controversial as there is little evidence of improved patient outcome and there is potential for increased patient morbidity. Outcome following surgical repair is variable, but it is generally accepted that, at best, a House -Brackmann Grade 3 or 4 facial nerve function might be attained. Surgical exploration requires considerable surgical expertise and in reality is rarely performed. Thus most institutions adopt their own policy with regards to surgical exploration.

In those patients that have an incomplete palsy or who develop a delayed complete palsy, a policy of watchful waiting is employed. Patients will be given a one-week course of high dose cortico-steroids (prednisolone 1mg/kg), if there are no contraindications. There is no high-quality evidence that they improve outcome. Approximately 90% of patients will make a full recovery with conservative methods alone[22].

Cerebrospinal fluid leak

CSF leak occurs in approximately 33% of patients following temporal bone fracture, but will resolve spontaneously in 81% within 5 days[13]. They are commonly seen in longitudinal fractures, less commonly in transverse fractures.

A CSF leak will usually present as CSF otorrhoea, but less commonly may present as CSF rhinorrhea especially when the tympanic membrane is still intact. The presence of a CSF leak can be confirmed by testing for β2-transferrin.

Initial treatment involves conservative management only with bed rest, head elevation and avoidance of straining, usually for 5-7days. Prophylactic antibiotics are not required, particularly as this is felt to mask any ascending infection. If the leak does not resolve within 1 week with these conservative measures, then placement of a lumbar drain to reduce CSF pressure would be the next most appropriate step. These should be left in situ for a further 5-7 days. In the minority of cases where a leak persists despite these conservative measures, surgical closure of the defect is essential to prevent meningitis. The risk of meningitis, with a persistent CSF leak is estimated to be 20% per annum. The next step is therefore to identify and define the anatomical defect, so that an appropriate surgical approach can be employed. High-resolution fine cut CT imaging usually provides the most useful anatomical information, but other imaging modalities can be useful including MRI or a MRI cisternogram.

Although imaging is useful and will prepare the surgeon, exploration and repair of the defect is mandatory when a leak does not settle, with the aim being to prevent ascending infections. The different surgical approaches that can be employed include transmastoid, middle cranial fossa or even a combined approach. The approach employed will often be dictated by the site and size of the defect as well as by local expertise. There is little in the literature to advocate one approach over another. Generally, smaller defects are repaired via a trans-mastoid approach, whilst larger defects require a middle cranial fossa or combined approach. Ideally all defects should be discussed in a multi-disciplinary setting with neuro-radiologists, neuro-otologists and neuro-surgeons before a decision is made. Even in cases where a trans-mastoid approach is employed, neurosurgical cover should be available should a craniotomy be required. Details regarding the surgical technique vary, but in our institute we perform a layered repair using cartilage, fascia and Tisseal® glue.

Summary

- Although temporal bone fractures are relatively uncommon, they can be associated with significant morbidity; hearing loss, vertigo, facial nerve palsy, CSF leak and other intra-cranial injuries.

- Diagnosis is based upon clinical suspicion, thorough examination and appropriate investigations. CT imaging of the temporal bone would usually be the minimal essential examination.

- Following resuscitation and ATLS protocols, management is then directed by the clinical and radiological findings and can involve difficult decisions, particularly when the facial nerve is injured and/or where there is considerable risk of iatrogenic injury.

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Menière's disease – a review

O Judd* MRCP, FRCS(ORL-HNS)., DCH, **P A Rea†** MA FRCS(England) FRCS(ORL-HNS)

* Specialist Registrar, Department of Otolaryngology, Queen's Medical Centre, Nottingham, UK. Email – owenjudd@doctors.org.uk

† Consultant ENT Surgeon, Leicester Balance Centre, Department of Otolaryngology, Leicester Royal Infirmary, Leicester, UK. Email – peter.rea@uhl-tr.nhs.uk

Key words

Menière's, Vertigo, Vestibular, Endolymphatic, Hydrops

Definition

In 1861, the French Physician Prosper Menière described a series of patients with the symptom complex of hearing loss and episodic vertigo. This has since become known as Menière's Disease. In a small group of patients with these symptoms there is an identified cause, the symptom complex is then known as Menière's Syndrome. More commonly, the aetiology is unknown and is termed Menière's Disease (MD).

In 1972, The American Academy of Otolaryngology-Head and Neck Surgery Committee on Hearing and Equilibrium (AAO HNS CHE) set criteria for diagnosing MD. The disease was diagnosed by the presence of a progressive fluctuating sensorineural hearing loss, episodic vertigo lasting twenty minutes to twenty-four hours without loss of consciousness, tinnitus and/or aural fullness. The disease needed to be characterized by periods of exacerbation and remission[1].

These criteria were further refined in 1985 and finally in 1995 categorized MD into four types1, namely;

1. **Certain** - Definite disease with histopathological confirmation of endolymphatic hydrops.

2. **Definite** - Requires two or more definitive episodes of vertigo with hearing loss plus tinnitus and/or aural fullness. All other possible causes being excluded.

3. **Probable** - Only one definitive episode of vertigo, hearing loss and tinnitus and/or aural fullness with all other causes excluded.

4. **Possible** - Definitive vertigo without documented hearing loss.

The American Academy also defined two sub categories of MD:

Cochlear MD (hearing loss without vertigo)

Vestibular MD (vertigo without hearing loss).

Despite these criteria being widely accepted, they are not always used or quoted in the published literature[2].

Pathophysiology

Certain MD may be diagnosed only in the presence of the classic histological endolymphatic hydrops. This is a ballooning of Reissner's membrane and dilatation of the endolymphatic spaces.

Aetiologies

There are a number of controversial theories regarding the aetiology of attacks of MD. If one can be proven, the disease can be termed Menière's Syndrome. In reality, most theoretical causes have been postulated following post-mortem examination and thus are unlikely to be proven in life.

These theories include;

a) fibrotic obliteration of the endolymphatic sac or duct resulting in impaired endolymph absorption,

b) dysregulation of osmotic pressure differences between the endolymph and perilymph resulting from altered metabolism of membrane surface glycoproteins such as HLA. This is a postulated autoimmune reaction and it is thought might account for a third of cases[3,4].

c) transient episodes of ischaemia and consequent metabolic acidity resulting in an enhancement of osmolarity and consequently the formation of hydrops[5].

d) obstruction of a narrowed endolymphatic duct causing hydrops which is then cleared by a combination of the

secretion of hydrophillic proteins within the sac and a hormone, saccin. The sudden restoration of longitudinal flow of the perilymph initiates the attacks of vertigo[6].

e) longitudinal endolymph flow only occurs in response to volume excess and therefore endolymph draining too rapidly from the cochlear duct (pars inferior) causes attacks of vertigo. The endolymph overfills the endolymphatic sinus and overflows into the utricle (pars superior), stretching the cristae of the semicircular canals, causing the attacks of vertigo[7].

Symptoms

The presentation of early Menière's can be enigmatic. Episodes of pure vertigo, hearing loss, tinnitus, or aural fullness may occur in isolation. A classical attack may begin with vertigo or be preceded by the onset of fullness in the affected ear, in association with a low frequency tinnitus often described like an engine. Hearing loss may be associated with this. It may last many hours or longer. Disabling vertigo then follows lasting typically 10 minutes to eight hours. It is often associated with vomiting and often diarrhoea. These attacks tend to occur in clusters with vertigo free periods of months or even years between them.

Be clear when taking the history to seek migrainous symptoms such as focal headache and phonophobia or photophobia which may suggest migraine as an alternate (or supplementary) diagnosis. Migraine occurs in 40-50% of patients with MD. BPPV is also reported in 20% of patients with MD. Any associated vestibulopathy is usually mild because of the progressive nature of the condition. Many patients will be understandably fearful of when the next attack may occur, and anxiety can be a significant difficulty. Note the number of additional of conditions that may affect the patient with a primary diagnosis of MD.

Natural history

Menière's disease is most common in middle age, and affects women more often than men.8 It has a prevalence of 190 per 100,000 although it is very rare in the paediatric population. New onset MD does occur in the elderly.8 Classically MD is associated with a fluctuating but ultimately progressive low frequency sensorineural hearing loss. The loss typically arrests at approximately 60-70dB and total hearing loss is uncommon.

The disease is most commonly unilateral but can become bilateral in up to 50% of cases. It may be bilateral in approximately 10% of patients at presentation[8]. Although the disease is characterized by spontaneous exacerbations and remissions, it also carries with it a “burn out” phenomenon, which may present with a reduction in vertiginous symptoms and a stable hearing loss and tinnitus. The time for this to occur is extremely variable, sometimes months, sometimes 30 or more years.

In a small group of patients at the end of their disease process drop attacks occur (Tumarkin drop attacks). The patients may collapse to the floor without warning symptoms. Although uncommon it is frightening for the patient. It is of some reassurance that this usually heralds the end of their MD and the disease usually burns out within a year of such attacks.

Differential Diagnosis

As MD can present with varying frequency and intensity of attacks, there is often a wide differential diagnosis[8]. This includes;

a) **Migraine** – presents with a significant overlap of symptoms often making the distinction difficult. Vestibular migraine may not present with the severe headache associated with classical and common migraine. A past or family history of migraine may help in the diagnosis.

b) Anxiety Disorder – Often somatisation of anxiety can present with pressure in the ears along with tinnitus and vertigo.

c) Chronic Otitis Media – with or without cholesteatoma can mimic the symptoms of MD – especially hearing loss and tinnitus, and with vertigo if there is irritation of the labyrinth.

d) Acoustic neuroma and Cerebellopontine angle tumours may present with unilateral symptoms typical of MD.

e) Superior Semicircular Canal Dehiscence Syndrome (SSCDS) – a rare condition with many of the hallmarks of MD often with autophony as a cardinal symptom.

f) Perilymph Fistula – caused by trauma, congenitally or iatrogenic may present with sudden sensorineural hearing loss and vertigo.

g) Cogan Syndrome – A rare syndrome of postulated autoimmune aetiology that presents with episodic vertigo, fluctuating sensorineural hearing loss and interstitial keratitis.

h) Vogt-Koyanagi-Harada Syndrome – similar to Cogan with depigmentation, uveitis and aseptic meningitis.

i) Autoimmune inner ear disease – a postulated cause of MD.

Menière's - like symptoms may also accompany many multisystem disorders such as Diabetes, hyperlipidaemia,

thyroid disease, Paget's, lupus, syphilis, Cogan's and leukaemias.

A number of sub-types of MD can be usefully distinguished:

a) Vestibular variant MD – characterized by episodic vertigo, without hearing loss or tinnitus.

b) Cochlear variant MD – characterized by progressive hearing loss, tinnitus and aural fullness, without vertigo.

c) Otolithic crisis of Tumarkin – drop attacks caused by sudden loss of extensor tone, without loss of consciousness. There is usually an immediate recovery.

d) Delayed MD – characterised by an early hearing loss followed by typical MD symptoms in later life.

e) Lermoyez syndrome – a variant presenting as increasing hearing loss, tinnitus and fullness followed by acute vertigo, after which there is sudden recovery. It is the very rapid improvement in hearing after the vertigo begins which is characteristic.

As can now be appreciated, the diagnosis of MD can be uncertain, and as such many diagnostic tools have been utilised.

Diagnosis

As patients with MD often have a normal examination in the outpatient setting (unless they have an attack), the diagnosis is often made on the grounds of a detailed history

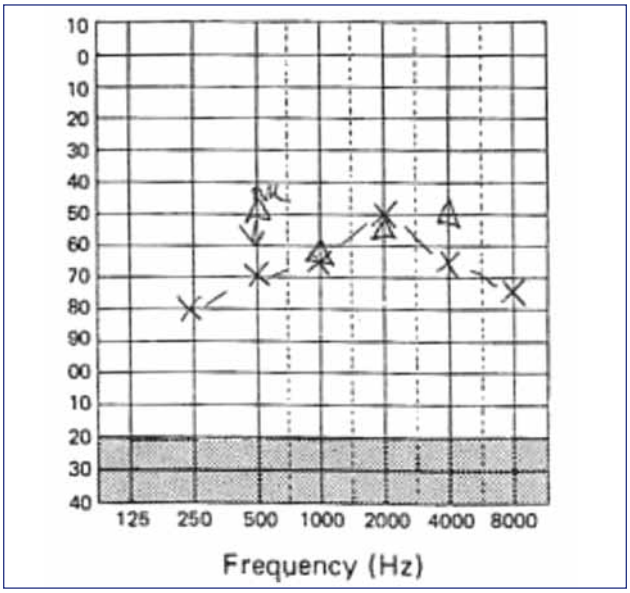

Figure 1: *A Pure Tone Audiogram depicting the low frequency sensorineural loss typical in MD.*

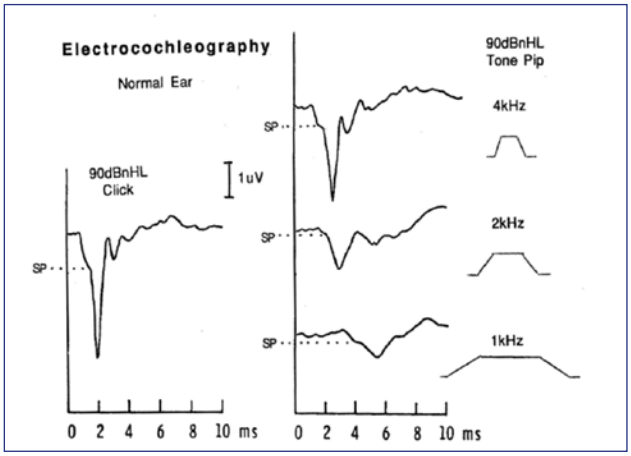

Figure 2: *A normal ECochG trace.*

and evidence of a progressive sensorineural hearing loss, according to the American Academy criteria[1]. The presence of a low frequency unilateral sensorineural hearing loss is the most important clinical finding. (Figure 1)

Diagnostic tests aim to both eliminate other potential differentials and help confirm hydrops. Imaging in the form of an MRI scan can help eliminate central causes such as Cerebellopontine angle lesions from the list and CT imaging can help exclude patients with Chronic Otitis Media with and without cholesteatoma and SSCDS. Blood screening can identify patients with diabetes, hyperlipidaemia, thyroid disease, Paget's, lupus, syphilis and leukaemias and immune screens can identify those at risk of autoimmune disease. Once other potential differential diagnoses have been excluded, idiopathic MD can be postulated.

Objective audiometric and electrophysiological tests are available for confirmation of hydrops. The most important are serial pure tone audiograms to confirm fluctuating sensorineural hearing thresholds. Electronystagmography or Videonystagmography along with caloric tests can be used to establish labyrinthine involvement. They are not however diagnostic of Menière's and may not be required. Calorics can be especially helpful if ablative procedures are being considered, to ensure good vestibular function in the contralateral ear.

The most specific test for MD remains the Electrocochleagram or ECochG, although its sensitivity is poor. This test records evoked neuroelectrical activity in the cochlea and proximal cochlea nerve via an electrode placed on or near the tympanic membrane or transtympanically onto the promontory (Figure 2). The amplitudes of the resulting summating potential can establish the likely presence of endolymphatic hydrops[9]. (Figure 3) A more

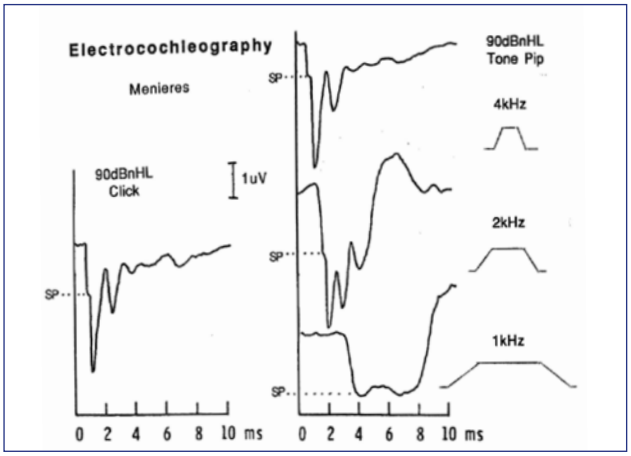

Figure 3: *An ECochG trace showing an increased summating potential indicative of Endolymphatic Hydrops.*

Figure 4: *The Meniett low pressure pump device.*

sensitive but poorly specific test is Vestibular Evoked Myogenic Potentials (VEMPS), in which an auditory stimulus elicits a myogenic response in the ipsilateral sternomastoid muscle[10]. This is useful in the evaluation of MD. Recent studies have shown that Ocular and Cervical VEMPS demonstrate involvement of the otolith organs in MD and this may prove useful for future diagnostic techniques[11].

Management

Many of the management strategies for MD remain controversial. These strategies often take the form of a treatment ladder – using low risk strategies initially but progressing to more interventional or ablative procedures in those not responding.

Dietary and lifestyle advice is popular and effective. Avoiding postulated precipitating foodstuffs such as salt, caffeine and alcohol can often help. Salt restriction should be to around one to two grams per day[8].

Drugs can be used in patients with MD and may be for symptomatic relief of vertigo and nausea, or prophylaxis.

Symptomatic medication may include prochlorperazine, a phenothiazine dopamine antagonist, which acts as an antiemetic and relieves the symptoms of vertigo. It may also include other antiemetics such as cinnarizine, an antihistamine with vestibular sedative effects. Newer symptomatic medication has been developed such as the combination drug, Arlevert®. This is a combination of two antihistamines, Cinnarizine and dimenhydrinate.

Prophylactic treatment may include drugs such as Betahistine, an H3 histamine antagonist that also has H1 histamine agonist activity. It causes labyrinthine vasodilatation via H1 receptors, thought to alleviate endolymphatic hydrops and also acts as a vestibular sedative through its action to increase serotonin levels. Bendroflumethazide, a thiazide diuretic is also used in MD to reduce fluid retention in endolymphatic hydrops.

Should dietary changes and medications be unsuccessful in treating the disease, various surgical options are available. These may include destructive and non-destructive procedures. Non-destructive treatment includes ventilation tube insertion, such as grommets, thought to improve pressure changes in the middle ear. The ventilation tube also allows use of a pressure therapy device, a pressure pump such as the Meniett employed in mild MD. (Figure 4) Its use has proven to be effective in recent studies[12].

Intratympanic steroids may be used in an attempt to reduce inflammation and improve middle ear vascular flow. The positive effect of their use, in certain cases, supports an autoimmune aetiology to the disease[4]. They have the advantage of being very low risk. It allows a concentration of Dexamethasone within the labyrinth several hundred times higher than with systemic therapy and reduces the systemic side effects. A recent Cochrane review identified one high quality randomised controlled trial supporting their use, although there are a number of other studies suggesting short to medium term benefit[13].

Endolymphatic sac decompression may provide relief in some patients, although the Danish sham study in 1981 is often quoted to show a significant placebo effect[14]. Most publications suggest about 80% of patients experience a reduction in vertigo attacks following sac surgery and 50% experience a resolution of their attacks[15]. (Figure 5 and 6)

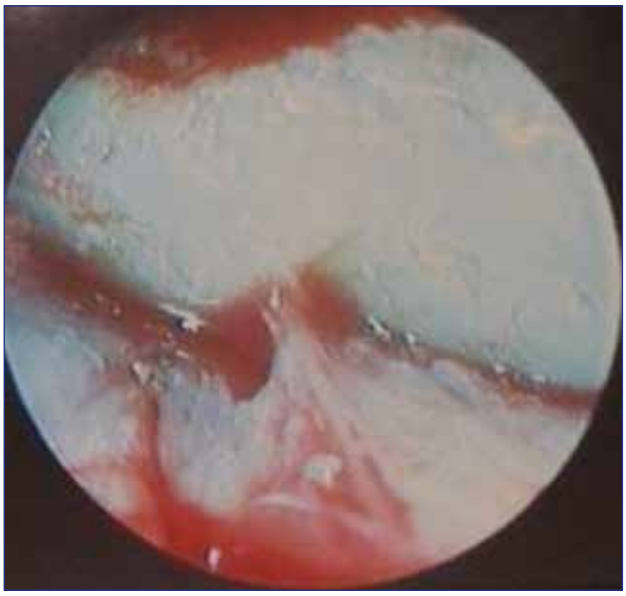

Figure 5: *Endolymphatic sac exposed during endoscopic decompression.*

In patients whose symptoms are severe and debilitating, more ablative procedures may be required. These aim to remove the threat of severe vertiginous episodes, but may pose a degree of risk to hearing and balance.

Intratympanic Gentamicin injections, known as chemical labyrinthectomy, aims to ablate the vestibular apparatus while preserving hearing. Gentamicin is selectively vestibulotoxic. This has become a very valuable treatment for severe MD. It is usually performed under local anaesthetic. Gentamicin 40mg/ml is injected through the tympanic membrane with a spinal needle. Patients typically need between one and three injections to complete the chemical labyrinthectomy. They should be aware there is a small risk of unsteadiness typically between the third and eighth day post treatment. Rarely severe dizziness can occur but it is usually self limiting. 96% of patient gain useful reduction in vertigo attacks and 80% experience resolution of the vertigo. It is not a treatment for hearing loss or tinnitus. Indeed 20% of patient experience some loss of hearing and 5% a total loss of hearing in the treated ear. A recent Cochrane systematic review has supported the use of Intratympanic Gentamycin as beneficial[16].

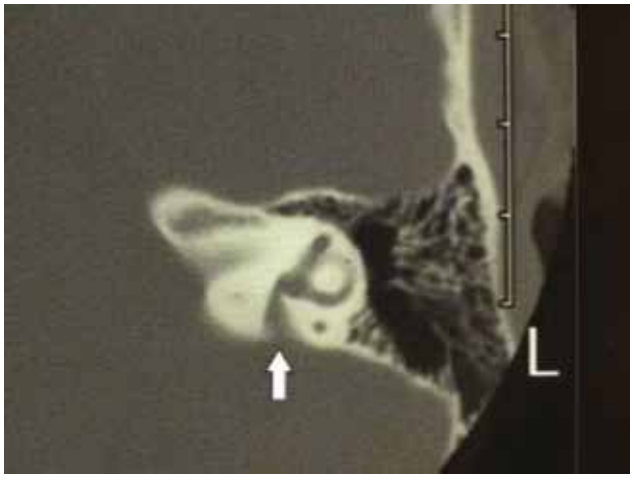

Figure 6: *CT Temporal bone showing an enlarged vestibular aqueduct. This is not seen in patients with MD but the image demonstrates the position of the endolymphatic sac and duct and can be compared to the operative image in figure[5].*

Surgical destruction of the labyrinth with a surgical labyrinthectomy destroys the hearing as well as aiming to abolishing the vertigo. Thankfully it is very rarely needed now gentamicin therapy is available. It can lead to significant imbalance.

Vestibular nerve section has a valuable place in a very small number of patients with intractable MD who require hearing preservation and are resistant to other less invasive procedures.

Summary

Menière's disease can be one of the most challenging yet rewarding of conditions to manage. The key to successful treatment is establishing a clear diagnosis within the range

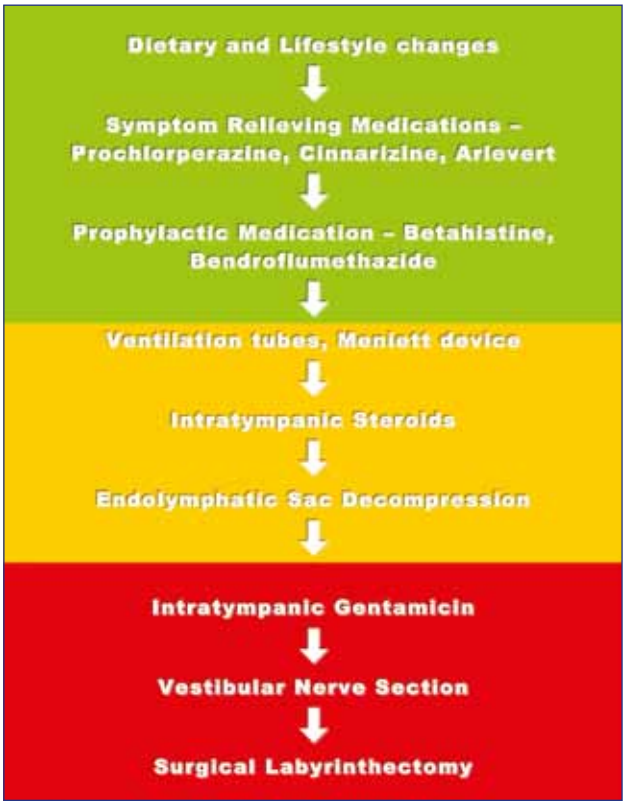

Figure 7: *The Menière's Treatment Ladder. Treatments are tailored to each individuals needs*

of differential diagnoses, and being aware of the other conditions that often co-exist. Reassuring patients there is a clear "treatment ladder" available to them, tailoring treatments to each individuals needs, and retaining their confidence if new therapies are required is essential for a successful outcome. (Figure 7)

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Bone anchored hearing devices: An update

Mr Patrick Sheehan M.Phil, FRCS (ORL-HNS)*
Ms Ann-Louise McDermott FDSRCS, PhD, FRCS (ORL-HNS)*

* Departments of Otolaryngology, Head and Neck Surgery,
The Birmingham Children's Hospital and Royal Manchester Children's Hospital.

Address for correspondence
Miss AL McDermott
Department of Otolaryngology, Head and Neck Surgery
The Birmingham Children's Hospital
Steelhouse Lane
Birmingham
B46NH

Email:
ann-louise.mcdermott@bch.nhs.uk

Abstract:

Since the introduction of the bone anchored hearing aid over three decades ago, the indications and need for these implants have steadily widened. Advances in technology have resulted in more sophisticated sound processors and implant systems making rehabilitation of more severe hearing losses possible. The financial costs of this advanced technology has increased.

Patients who require a bone anchored hearing device (BAHD) should ideally be treated in a centre where there is a Multidisciplinary team (MDT) involved in their investigation, counselling and treatment. The management of paediatric and adult patients is different and again, a paediatric multidisciplinary team approach is vital as many potential implant reciepients may have special needs and/or learning difficulties.

The scope of this article is to provide the clinician with an up to date overview of the current Bone Anchored Hearing Devices.

Key words

Bone conduction, Implant, Bone anchored hearing aids, BAHA, BAHD

Introduction

In 1977 Branemark first described the concept of osseointegration[1]. Then in 1981, Tjellstrom et al successfully implanted three patients with a bone anchored hearing system[2,3,4]. This was the first description of a combination of osseointegration and direct bone conduction with a hearing aid. By 1987 the bone anchored hearing aid system had become commercially available.

The Bone Anchored Hearing Aid consisted of a titanium implant (fixture) and abutment secured to the skull by osseointegration. This resulted in not only a significant advance in terms of cosmesis and comfort but also in terms of improved sound transference[5].

BAHA and Baha® are all terms seen in the literature but the recent introduction of new bone conduction technologies has resulted in the need for new terminology. For the purposes of this article the authors have chosen Bone Anchored Hearing Devices (BAHD) to encompass all the available implant systems.

The BAHD can be divided into those with and without a percutaneous abutment.

- **Percutaneous abutment bone anchored systems.**

The sound processor is fitted directly to the percutaneous abutment. Cochlear™ Baha® systems and Oticon Medical Ponto System. Figures 1 & 2. Both of these systems provide a range of sound processors that meet the audiological needs of patients with bone conduction thresholds ranging from 10-70dBHL.

Figure 1. Cochlear™ Baha® systems: *The titanium fixture is held within the calvarial bone by osseointegration. The Baha® sound processor attached to the percutaneous abutment. Images reproduced with the kind permission of Cochlear Ltd*

Figure 2: *The Ponto Bone Anchored Hearing System. This system has a percutaneous abutment and osseointegrated fixture. Images reproduced with the kind permission of Oticon Medical*

- **'Abutment-free' bone anchored hearing systems.**

The abutment free bone anchored implant systems are Sophono and Bonebridge™ by MEDEL .The sound processor for each of these is held in place by magnets and so avoiding a protruding abutment through the skin. Figures 3a,b. The magnet system will have implications for future Magnetic Resonance Imaging (MRI) in these patients. In the case of the Bonebridge™, the implant is active and the implantable component contains the Bone conduction-Floating Mass transducer. (BC-FMT) which is placed in the temporal bone, ideally in the mastoid antrum. Neither of these implant systems are yet available for patients under 5 years of age. The Bonebridge™ is currently under review for use in patients under the age of 18 years.

Further advances in both abutment and transcutaneous design are currently under development making the future for hearing rehabilitation very exciting.

Indications for a Bone Anchored Hearing Device (BAHD).

As the technology has advanced so have the clinical indications for a BAHD. Table 1. Initially cases with pure conductive hearing losses and good bone conduction

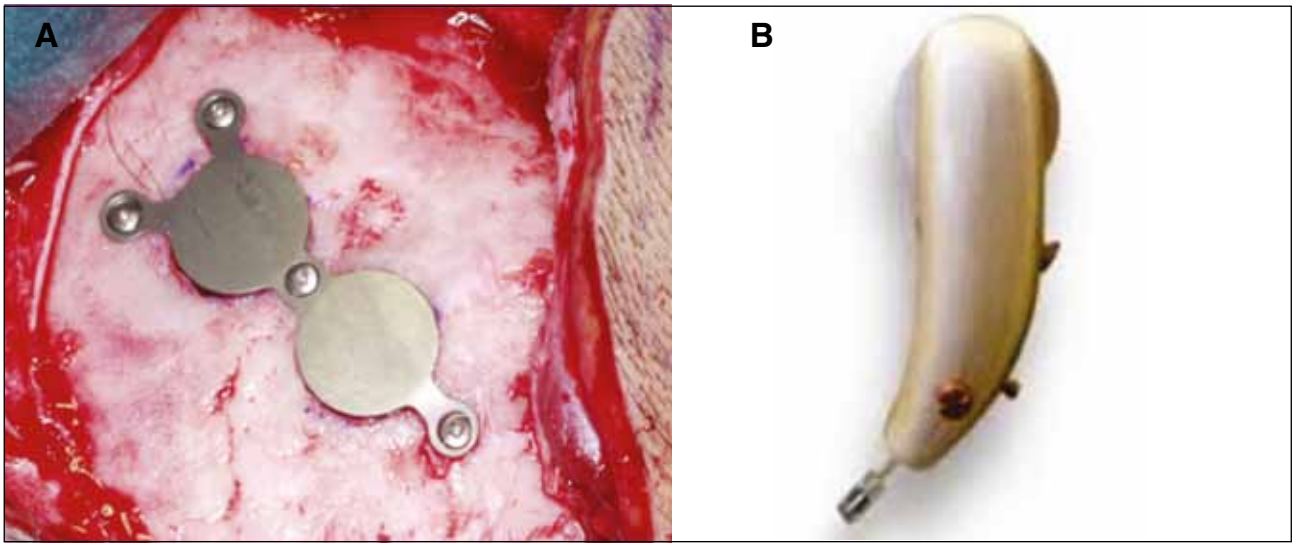

Figure 3a & 3b: *Sophono. The Alpha1(M) Bone Anchored Hearing System. The sound processor is retained in situ by magnetics. The surgically implanted device has hermetically sealed magnets in a titanium case. Images reproduced with the kind permission of Sophono Inc.*

Table 1. Clinical Indications for a Bone Anchored Hearing Device.
Congenital Aural atresia
Congenital Microtia
Trauma to the external ear
Chronic Suppurative Otitis Media
Persistent Otitis Media with Effusion (selected cases such as Down Syndrome)
Chronic Otitis Externa
Otosclerosis
Failure with conventional hearing aids
Unilateral hearing loss (conductive and sensorineural)

thresholds were implanted but recent studies have reported good results with both sensorineural and mixed hearing losses. Furthermore the role of a BAHD in unilateral hearing loss of both a conductive and sensorineural nature has also been reported to be very beneficial although this remains somewhat controversial[6-9]. There is now increasing evidence in both adults and children that a BAHD for unilateral hearing loss provide a subjective improvement in sound localisation ability[10,11]. Difficulties still exist across the UK in obtaining funding for BAHD surgery in those with a unilateral hearing loss.

Patient assessment

It is usual for patients to have tried various conventional forms of hearing aid before being referred for a BAHD. Depending on the age of the patient, possible learning difficulties and medical co-morbidities, the nature of the audiological assessment will vary.

The basic audiological requirements are Pure Tone Audiometry (PTA) together with speech audiometry. An additional test is the use of the Bone anchored hearing device worn on a head band. The authors would recommend a patient has sufficient time to try the test band in their home, work, school and social situations before committing to BAHD surgery. Patients with a unilateral hearing loss provide a more challenging assessment and an extended period to trial the BAHD headband is recommended. This will allow more realistic expectations of the device[12].

In the case of many children, PTA may not be possible and alternative age appropriate testing will be required. Speech audiometry is rarely possible with paediatric cases. This makes the outcome of the BAHD headband trial very important when making a decision to proceed.

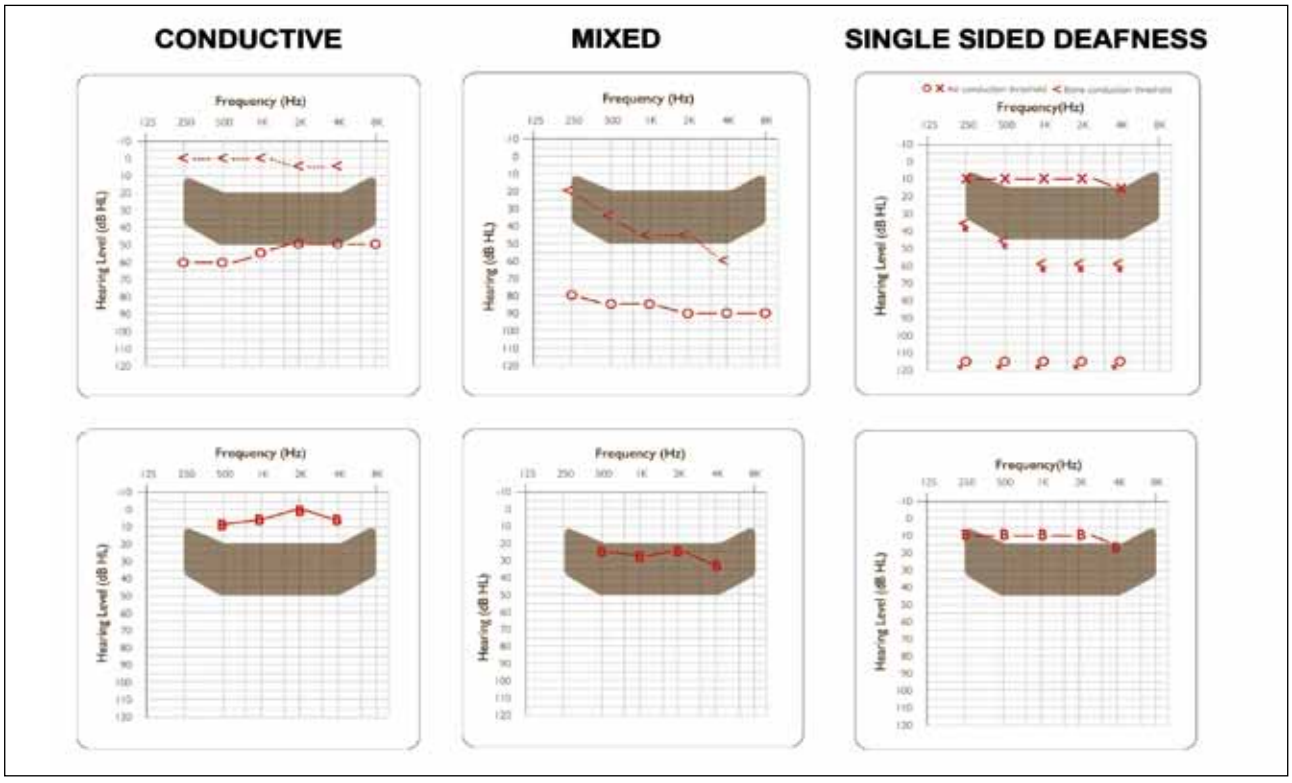

Figure 4: *Cochlear™ Baha® systems. Audiological fitting range. Images reproduced with the kind permission of Cochlear Ltd*

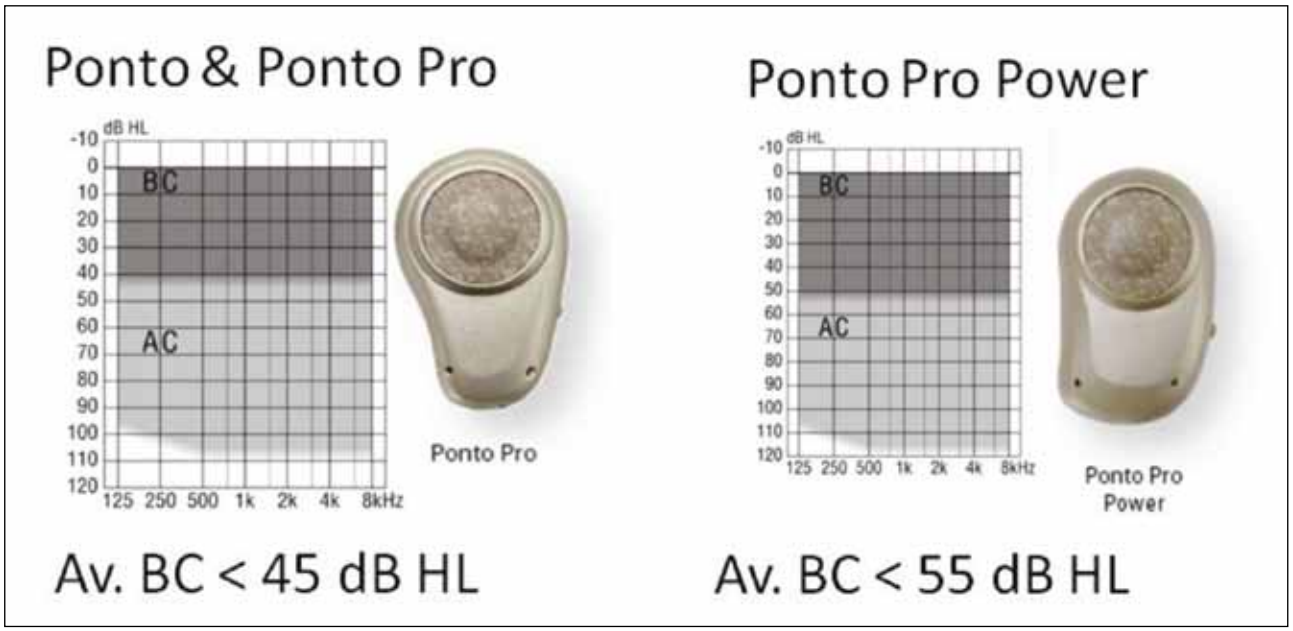

Figure 5 : *The Ponto Bone Anchored Hearing System. Audiological fitting range A variety of different sound processors are available but hearing loss with BC <55dBHL are suitableImages reproduced with the kind permission of Oticon Medical*

For paediatric patients the authors would recommend a minimum 3 month period with the test band prior to any decision for surgery. Any child below the age of three years should also be managed with a BAHD headband until of an age suitable for surgery.

It is important to remember that the bone conduction threshold is the most relevant threshold in the assessment.

The assessment should also consider the psychological issues of the patient and carer. Expectations should be managed accordingly and detailed information given as to the maintenance and care of the BAHD long term.

With the introduction of transcutaneous active and passive devices, the requirement for detailed assessment and MDT approach to BAHD will become more relevant in the future.

Audiological fitting range

The audiological fitting range for each BAHD is shown in Figures 4-7

Surgical considerations

- **Percutaneous abutment implant systems:**

For adults and older children the surgical procedure has traditionally been performed in one stage with both the placement of the titanium implant and the abutment at the same procedure.

Children are reported to have a higher rate of fixture loss including trauma[13]. Therefore a spare "sleeper" fixture is placed at the time of the initial surgery. If the child later looses their fixture, the sleeper fixture has fully osseointegrated and can be loaded immediately with the sound processor. A review of the literature for complications including trauma, involving a BAHD revealed just a handful of cases[14].

For young children, many BAHD centres use a two stage surgical procedure where the fixtures (including a sleeper fixture) are placed at the first surgery. Once a suitable period of osseointegration has occurred (typically 12 weeks), the second stage surgery is performed to uncover one of the fixtures and attach the abutment. Placement of the sleeper fixture on the contralateral side has been reported allowing a later choice for a bilateral BAHD[15].

The soft tissue reduction is most often carried out at the second stage. This has the advantage of allowing earlier osseointegration to be unhindered by parent/child factors during the previous 12 weeks. The BAHD sound processor is typically fitted within a week of the second stage surgery.

Many different surgical techniques have been described but the use of the linear skin incision[16] and the dermatome split thickness skin graft[17] are still the most commonly used.

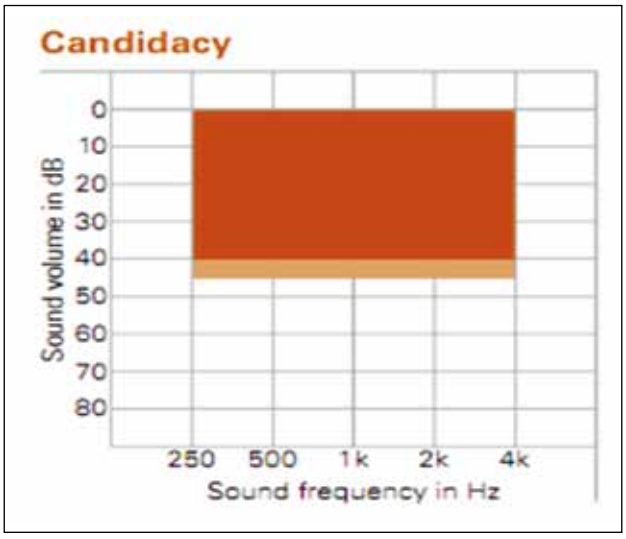

Figure 6: *Sophono. The Alpha1(M) Bone Anchored Hearing System. Audiological fitting range. Images reproduced with the kind permission of Sophono Inc.*

Soft tissue reduction around the abutment has been advocated to maintain the peri-abutment skin health and reduce the interference with sound conduction from the BAHD sound processor to the cochlear. Skin reaction and skin overgrowth are recognised problems for patients with a percutaneous abutment. The Holgers peri-abutment soft tissue classification was introduced in 1988 to allow clinicians to compare results and is still in use today. The Holgers classification18 is a scale of 0-4 where 0 indicates healthy skin whereas Grade 4 is a severe infection with loss /removal of the implant. The authors would recommend a longer abutment in patients who have persistent peri-abutment skin problems as this often allows the skin to settle and avoids the need for any revision surgery[19].

In paediatric practice, the soft tissue complication rates are higher than those reported in adults[20,21]. Weight gain, hygiene issues and lack of care of the skin area around the abutment and socioeconomic factors have been suggested as factors contributing to fixture loss and increased soft tissue problems in children[22].

In many centres the procedure is performed as 'daycase' surgery using local anaesthetic. The fitting of the BAHD has traditionally been three months following fixture implant surgery, allowing time for osseointegration. 4mm titanium fixtures are reported to be more stable but in children it is still common practice in some centres for 3mm fixtures to be used. There has not been any significant increase in fixture loss with these smaller fixtures[21].

In 2011, a new implant design was launched. The implant was wider, smaller threads and coated with TIOblast™ to enhance osseointegration. The initial results in adults have been promising and the implants have been demonstrated to be more stable and the sound processor can be fitted at least 6 weeks earlier than previously recommended[23-25]. An improved wider implant is now available from both the percutaneous implant manufactures.

Concern has been expressed with BAHD surgery in children of a very young age (less than 3 years) due to the inadequate thickness of the calvarial bone. Some authors have suggested pre-operative imaging in the form of computerised tomography (CT). The authors do not perform pre-operative imaging. Factors such as skull contour, existing pinna (in the case of microtia) and plans for later reconstructive ear surgery, determine the site of the implant and these are not appreciated by imaging. Furthermore CT Scanning subjects the child to additional investigations and radiation exposure, which in the authors' view are unnecessary[18]. Inadequate bone thickness at the time of surgery can be dealt with by using bone dust to augment calvarial bone around the fixture[26], GOR-TEX® membrane around the fixture for 3 months, and/or an extended period for osseointegration before fitting the sound processor[27].

- **'Abutment-free' bone anchored hearing systems.**

Two 'abutment-free' bone anchored hearing systems are now commercially available in the UK.

In the case of Sophono, the Alpha 1(M) implant system is currently available for patients 5 years and older. The principle of this bone conduction device is magnetic coupling and acoustic transmission between an implanted hermetically sealed internal magnet and an external magnet attached to the Alpha 1(M) Sound processor. This is a 'passive' sound transmission implant system.

A single surgical procedure is necessary. A template is used to mark the position of the incision and implant site. The soft tissues including the periosteum are raised. 2mm deep bone beds are prepared and the hermetically sealed magnet is anchored in place and retained with titanium screws. Figure 3a. The sound processor can be fitted within 3-4 weeks once healing has occurred. No soft tissue reduction is necessary in many patients and the early results appear promising[28]. Some early discomfort as a result of excess pressure from the external base plate have been noted. The Alpha 1(M) sound processor is only sufficiently powerful for mild conductive hearing losses at

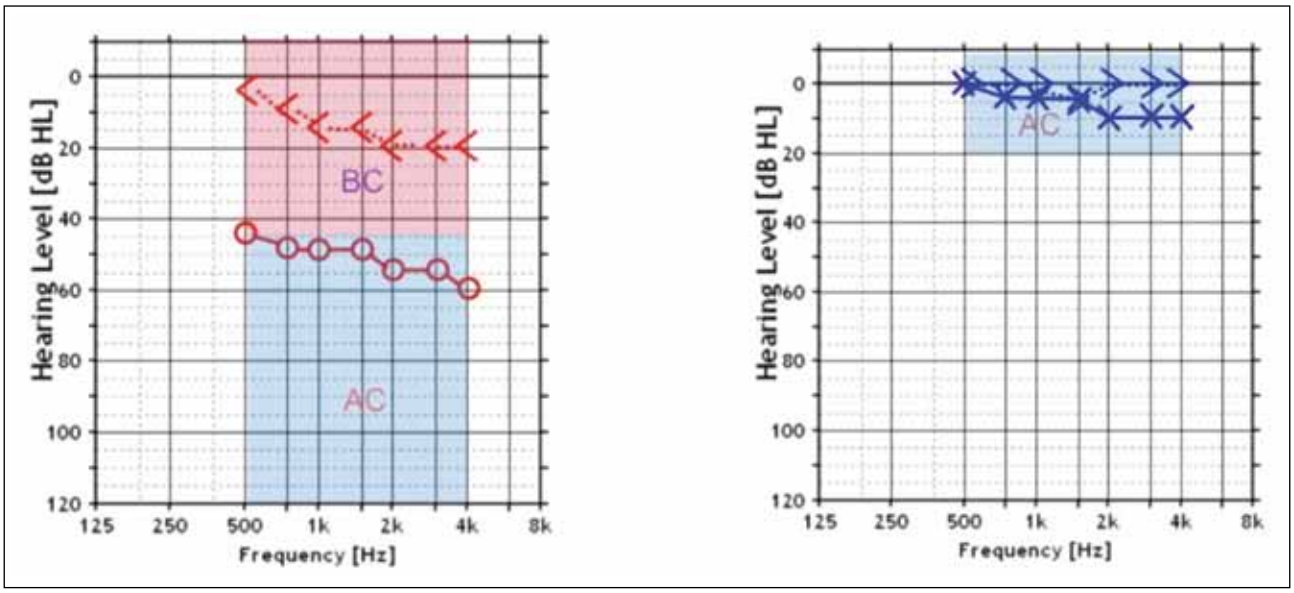

Figure 7: *The MEDEL Bonebridge™. Audiological fitting range. The fitting range for conductive loss and for a unilateral hearing loss. Images reproduced with the kind permission of MEDEL.*

this time[29].

2012 saw the launch of the Medel BONEBRIDGE™. This is an 'active' bone conducting implant. One surgical procedure is required to position the implant within the temporal bone. The active component of the implant (BC-FMT) is placed within the mastoid antrum and secured with two titanium screws. A 'well for the internal magnet is fashioned as for a cochlear implant. The external sound processor is attached with magnets in a similar fashion to a cochlear implant. This active bone conduction implant is not available for use in children.

Outcomes and quality of life.

Outcomes from the 'abutment –free' implants systems are still in their infancy however initial potential patient reactions to the transcutaneous systems are very positive[30].

The subjective and audiological benefits and also patient perspectives of the percutaneous implant systems have been studied by many of the implant centres worldwide and the percuatneous bone anchored hearing aid system has been show to be very effective and beneficial with minimal morbidity, in both adults8 and children[12] with both unilateral and bilateral hearing loss[31-33].

Conclusions:

The advances in Implantation Otology have brought benefit to many patients who otherwise would have struggled with their hearing loss. The management of these patients can be very complex not least deciding which of the increasing number of implants would be of most benefit to them. A Multidisciplinary team approach to these cases is essential to ensure the patient receives the best care. Advances in the technology of both the implant system and sound processor, makes the field of implantation otology an exciting expanding subspecialty for the otolaryngologist.

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Non-melanoma skin cancer: a review of current management guidelines

Nadia Ashraf BMedSci(Hon) DA(SA) DOHNS MRCS
Ullas Raghavan FRCS(ORL-HNS)
Department of Otolaryngology Head and Neck Surgery
Doncaster Royal Infirmary
Armthorpe Road, Doncaster
DN2 5LT

Correspondence to:
Nadia Ashraf
Department of Otolaryngology Head and Neck Surgery
Doncaster Royal Infirmary, Armthorpe Road
Doncaster DN2 5LT

Email: nashraf@doctors.org.uk

Abstract
Non-melanoma skin cancer (NMSC) is associated with significant morbidity and the incidence is rising. Basal cell carcinoma (BCC), which is locally-invasive, is the commonest subtype. Squamous cell carcinoma (SCC) has the potential to metastasise and therefore is associated with greater morbidity and mortality. The gold standard management of NMSC is surgical excision with histological assessment of the surgical margins. The recommended margins are 4-5mm for BCC and 4-6mm for SCC in order to achieve clear margins in 95% of cases. Non-surgical treatments, particularly radiotherapy, also have an important role in management; particularly in cases where surgical margins remain positive or in recurrent disease.

Key words
Non-melanoma skin cancer, basal cell carcinoma, squamous cell carcinoma

Introduction
Skin cancer is the commonest cancer in the UK, Europe and the USA. The incidence has been rising over the last decade and this looks set to continue with the aging population[1]. Approximately 60,000 new cases are registered in England and Wales each year, although the actual figure is likely to be higher due to non-standardised methods of reporting[2]. Ultra-violet light (UV) exposure through natural and artificial sources remains the main risk factor in addition to genetic factors and hence prevention remains one of the key strategies in tackling this disease.

Basal cell carcinoma (BCC), squamous cell carcinoma (SCC) and malignant melanoma (MM) comprise more than 95% of all skin cancers[3]. This article will discuss current UK guidelines on the management of non-melanoma skin cancers (NMSC).

Basal Cell Carcinoma
BCC [Figure 1] is the commonest type of cancer in England and Wales[3]. It is a slow-growing malignant skin tumour arising from the basal cells of the epidermis, which is locally invasive, but rarely metastasises. BCC typically occurs in Caucasians in their 7th decade and most commonly presents on exposed areas; the head and neck region and upper limbs. It is commoner in men, but incidence in both sexes has been increasing equally[4]. Mortality remains low, but given the cosmetically sensitive areas affected, particularly in the head and neck, BCC leads to significant morbidity.

Multiple BCCs are found in basal cell naevus syndrome, more commonly known as Gorlin's syndrome, with a prevalence of approximately 1 in 100,000. It is also associated with odontogenic tumours, medulloblastoma, ovarian fibromas, plantar and palmar pits, calcification of falx cerebri and rib anomalies.

Nodular, superficial and pigmented forms of BCC are the less aggressive forms. Aggressive subtypes are the morphoeic, micronodular, infiltrative and baso-squamous types. Lesions close to the eye, nose and ears are considered to be at high risk of recurrence.

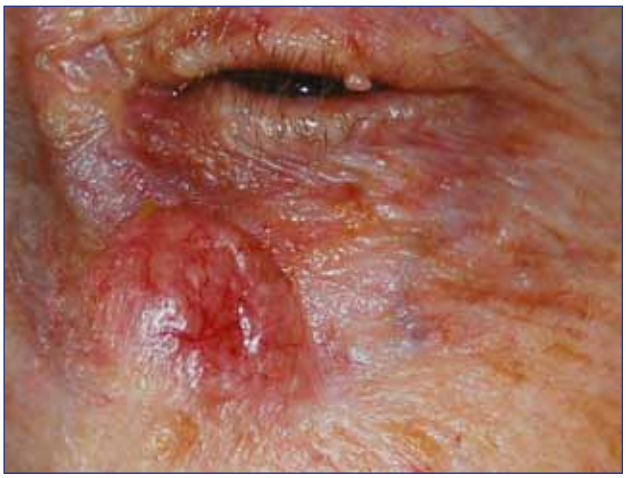

Figure 1: *Basal carcinoma*

Most BCCs can be diagnosed clinically, although biopsy may sometimes be required if there is clinical doubt. Complete clinical examination to assess for lymphadenopathy is essential, but further investigation for staging is not routinely required, unless invasion of bone or nearby important structures, such as the orbit, parotid gland, or major nerves, is suspected.

The aim of treatment is to eradicate the tumour achieving a cosmetically acceptable result. The "gold standard" to achieve this is performing surgical excision with histological assessment of the margins, with evidence that such treatment is associated with recurrence rates <2% at five years[5,6].

Studies show that 85% of BCCs will be cleared by excising with a 3mm margin of normal tissue and 95% with a 4-5mm margin[7-9]. Given the higher risk of further recurrence in previously recurrent BCC, the margin of excision should be increased to between 5 and 10mm10. The required surgical margin for primary high-risk morphoeic BCCs is considerably higher, with a 13-15mm margin required to achieve at least 95% clearance[7]. There is less evidence available for the depth of excision required, but it is generally advisable for the excision to include subcutaneous fat[11].

There is evidence to suggest that complete excision with clear margins is more completely achieved by Hospital Specialists than General Practitioners[12]. This has led to the National Institute of Clinical Excellence (NICE) guidance that only pre-malignant lesions and low-risk BCCs should be treated in primary care3. These low-risk lesions would include nodular type BCCs (the most common subtype) and BCCs less than 1cm in size. Furthermore, NICE have specifically highlighted the need to ensure that all lesions excised in primary care are sent for histological assessment, since up to 50% have previously been found not to have been[13].

Studies suggest that risk of recurrence is highest where lateral and deep margins are involved and more so with the latter14. Although not all cases where margins are positive will recur (30-41%) in some studies[15,16], re-treatment should be undertaken, particularly where the margin involved is the deep one, the histology confirms an aggressive subtype or the lesion is in the midface[17]. Conventional re-excision or Mohs micrographic surgery (MMS) are the treatments of choice. Radiotherapy[14] may also have a role in selected cases.

MMS involves resection in a precise staged approach identifying all traces of tumour with comprehensive histological examination of the surgical margins, ensuring preservation of normal tissues. Systematic histological examination in stages is key to achieving high cure rates and this can be performed using frozen tissue sections over the course of hours or employing formalin-fixed paraffin-embedded tissues over the course of days. Conventional histological examination involves taking cross-sections and therefore only a small sample of the tissue is examined microscopically. However, in MMS, the specimen is sectioned horizontally, so that lateral and deep margins are examined in one piece of tissue. This leads to more accurate assessment of tumour clearance and reduces false negatives.

Published 5-year cure rates for MMS are high, 99% for primary tumours18 and 94% for recurrent tumours[19]. Indications for MMS include tumours on the central face in the 'H' region, tumours >1cm or growing rapidly, high-risk histological subtypes or features, clinically indistinct tumour edges and incompletely excised or recurrent lesions.

The availability of MMS is limited by the length of procedures, due to the staged approach involved, the high training and equipment requirements and consequently,

Table 1 – Clinical differences between basal cell carcinoma (BCC) and squamous cell carcinoma (SCC)

BCC	SCC
Nodular with well-defined margins	Nodular with scab/crust
Pearly white nodule	Friable tissue which bleeds easily
Ulcerated with rolled edges	Ulcerated with everted margins
Pigmented	

the higher costs involved compared to conventional surgical excision. Current NICE guidelines aim to improve patient outcomes by ensuring that a Mohs surgeon is available in each cancer network[3].

Destructive surgical techniques, such as cryosurgery and curettage and non-surgical techniques, such as photodynamic therapy, may have a role in low-risk BCCs[11], but they do not provide any histological confirmation of margins.

Radiotherapy has a role in the adjuvant treatment of BCCs where surgical margins remain positive[20], recurrent BCC following surgical excision and in high-risk primary BCCs where patients cannot tolerate surgery[21]. When radiotherapy is considered as the primary treatment, tissue diagnosis is essential before the treatment. The main group in whom radiotherapy is contraindicated is those with Gorlin's syndrome, as radiation exposure can predispose to new tumours.

Five-year cure rates for radiotherapy are quoted at over 90% for primary lesions[22], but cosmesis outcomes are generally not as favourable as that achieved with surgical excision[23]. Cosmetic results can be improved by using fractionated radiation treatments11, although single-fraction treatment may be used in frail patients who cannot manage multiple hospital visits. The head and neck generally has a good tolerance to radiotherapy, but certain areas, such as the bridge of the nose, have a higher risk of radionecrosis[11]. Additional post-treatment problems can include altered skin pigmentation, telangiectasia and radio-dystrophy. Furthermore, radiotherapy cannot be used to treat the same area more than once and surgery on irradiated tissues for recurrent disease is clearly more difficult.

The incidence of metachronous BCC has been reported as up to 50% at five years, with the majority of these occurring within three years of the primary tumour[3]. These tend to be in high-risk patients, who have had multiple BCCs or with recurrent disease. These groups should be followed up, since they have a higher risk of new BCCs and further recurrence respectively[24]. Post-treatment follow-up beyond one or two visits is, however, not necessary for a single primary BCC[25]. Patients should be educated regarding protection against sun exposure and self-monitoring for new lesions both at the surgical scar site and other sun-exposed areas.

Squamous Cell Carcinoma

SCC is the second commonest skin cancer[26] [Figure 2]. It is a malignant skin tumour arising from the keratinising cells of the epidermis or its appendages. It is locally invasive and also has the potential to metastasise, particularly via lymphatics to local and regional lymph nodes. These tumours, unlike BCCs, should therefore all be managed by the local skin cancer multidisciplinary team.

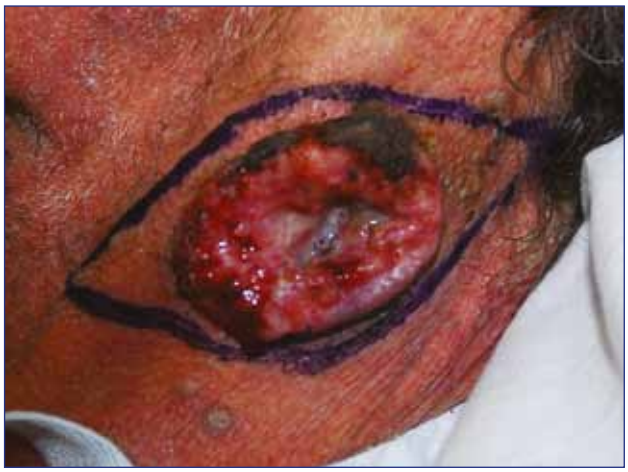

Figure 2: *Squamous cell carcinoma*

There are various factors affecting potential for metastasis. Tumours over 2cm are deemed high-risk, but more importantly tumour depth greater than 4mm is a poor prognostic factor. These tumours are more prone to nodal metastasis and local recurrence[28]. Horizontally small but thick SCCs are more likely to metastasise than horizontally large but thin tumours.

SCC of the lip and external ear, as well as tumours in areas of previous insult, such as burns, chronic cutaneous sinuses or ulcers, are more likely to metastasise than tumours at other sites[28].

Histological differentiation is also important, with worsening differentiation being associated with higher local recurrence and metastasis rates[29]. Broders classification comprises Grade 1; well-differentiated, Grade 2; moderately-differentiated, Grade 3; poorly differentiated and Grade 4; un-differentiated, with Grades 3 and 4 being high risk. Certain subtypes; acantholytic, spindle and desmoplastic are associated with poorer prognosis compared to verrucous subtypes.

Furthermore patients who have evidence of poor cellular immune response, such as those on immunosupression therapy following organ transplantation, are associated with a poorer prognosis and with a greater propensity for nodal metastasis[30].

Surgical excision is the "gold standard" treatment. A surgical margin of 4mm is recommended for low-risk

primary lesions. This would lead to tumour clearance in 95% of cases. High-risk tumours (>2cm, Broders grades 2-4, tumours extending into subcutaneous tissue or those in central areas of the face, scalp or ears) should be given a surgical margin of 6mm into healthy tissue to achieve similar clearance rates[31]. Preoperative knowledge of the differentiation of the tumour, by means of a biopsy, is helpful in correctly deciding the excision margin. This can be achieved with conventional surgical excision or with MMS. Some surgeons will additionally take a further margin once the MMS margin is confirmed to be histologically clear, in order to excise microscopic metastases that may be present around the primary lesion. Similarly to BCC, indications for MMS include recurrent SCCs, aggressive tumours (either clinically by growth or histological subtype) and where the tumour boundary in indistinct.

Radiotherapy has a role in the treatment of SCC, with either curative or palliative intent. It is indicated where tumours are deemed non-resectable, would cause unreasonably high surgical morbidity or where the patient is unfit or unwilling to undergo surgery. This treatment modality can, however, lead to skin changes, such as pigmentation alteration and telangiectasia, which may be less acceptable than a well-healed surgical scar, particularly in younger patients. Additionally, lesions invading bone or cartilage may progress to radionecrosis following treatment with radiotherapy. In contrast, some areas of the eye (lower lid and inner canthus), lip, tip of the nose and some parts of the ear may have superior results with radiotherapy compared to removing large areas of tissue surgically. Furthermore, there is a role for radiotherapy in the adjuvant treatment of nodal metastases; following neck dissection where there is histological evidence of extracapsular spread.

Regional lymph node dissection is appropriate for tumour with positive lymph nodes that have been confirmed by fine needle aspiration cytology. However, elective lymph node dissection based upon the risk of the primary lesion, such as has been suggested for tumours greater than 8mm in depth, has a poor evidence base[32]. Sentinel lymph node biopsy is used in some centres to target treatment to likely affected lymph nodes, but further evidence is needed to support this form of management and to define its usefulness[33].

Early detection of new SCC lesions can reduce the morbidity associated with the disease and the treatment. This includes detecting recurrent disease or new primaries in patients who have already been treated. Follow-up of up to five years post-treatment has been proposed for high-risk SCCs, given that 95% of recurrences, metastases and new lesions present within this timeframe[29].

Other non-melanoma skin cancers

Less common non-melanoma skin cancers include Merkel cell, cutaneous lymphoma, primary mucoepidermoid carcinoma, primary mucinoid carcinoma, angiosarcoma and cutaneous neurofibrosarcoma. These tumours require input from the local specialist skin multidisciplinary team (MDT) and some, such as lymphomas and sarcomas, will indeed need to be discussed at more than one MDT.

Summary

The principles of management of NMSC include surgical excision as the gold standard with adequate margins appropriate to the pathology. The employment of a surgical management results in patient high cure rates. MMS has an important role to play in high-risk lesions and achieves high clearance rates through staged, precise and thorough histological assessment. Non-surgical techniques also have a role in selected cases, particularly radiotherapy in recurrent tumours following surgical excision or as adjuvant treatment where surgical margins remain positive. Management should be multidisciplinary and involve a team of surgeons (ENT, maxillofacial, plastic), dermatologists, oncologists, pathologists, radiologists and clinical nurse practitioners. This ensures that the patient is offered all potential treatment options and is key to achieving good outcomes.

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Indications for the use of the osteoplastic flap, with or without obliteration, in the management of frontal sinus disease in the endoscopic era

Anshul Sama, B Med Sci, BM, BSc, FRCS (Gen Surg), FRCS (OTOL)
Department of Oto-rhino-laryngology-Head & Neck Surgery
Nottingham University Hospitals NHS Trust
Queens Medical Centre Campus,
Nottingham NG7 2UH

Abstract

Osteoplastic flap, with or without obliteration, has been the "gold standard" of treatment for frontal sinus diseases until the introduction of the endoscopes. Over the last 30 years, with the growth and evolution of endoscopic sinus techniques many newer surgical procedures have been developed enabling the rhinologist to treat an expanding variety of frontal sinus diseases. Using the endoscopic sinus technique has challenged the role of the osteoplastic flap approach within the current surgical armoury. This article reviews the current literature and examples from the author's personal experience elucidate the possible indications for the use of the osteoplastic flap technique in the endoscopic era.

Key words

Frontal sinus disease, Osteoplastic flap, Frontal sinus obliteration, Endoscopic Modified Lothrop's procedure, Draf type III surgery.

Introduction

Conventionally various open approaches to frontal sinus disease have been used and are described in the literature. These approaches can be categorised as "trans-facial approaches" such as the external fronto-ethmoidectomy (Lynch procedure) and "maxi-trephine" or the osteoplastic flap (OPF) approach. The Lynch procedure offers limited visualisation of the frontal sinus and surgery can be complicated by stenosis of frontal recess, due to loss of the antero-lateral buttress of the frontal recess[1]. The loss of this antero-lateral support is counterintuitive considering the procedure was designed to augment the frontal drainage pathway. The limitations of trans-nasal and trans-facial approache to the frontal sinus made the OPF approach combined with frontal sinus obliteration (FSO) the definitive procedure for complex and recalcitrant frontal sinus disease.

The OPF approach was first described by Hoffman (1904), and popularised by Goodale and Montgomery (1958) when they described their technique of frontal sinus obliteration (FSO) using fat[2]. This approach allowed surgeons to access the frontal sinus via a brow, mid-brow, or coronal incision in a unilateral or bilateral fashion and offers excellent visualization, use of bimanual instrumentation and resulting in excellent access to deal with large tumours and/or extensive disease in any location within the frontal sinus, including the supraorbital cells. Despite reported initial success rates (85-90%), long-term studies have shown that the OPF approach with FSO are associated with significant morbidity with include; cosmetic deformity (frontal bossing), postoperative frontal pain, cerebrospinal fluid (CSF) leak, forehead numbness, and post-operative headaches[3]. Weber et al[4] reported a 10% incidence of mucocele formation after FSO in a 5 years follow up study using MRI as surveillance. Given these concerns, the introduction of endoscopic sinus surgery in the mid-1980's, the endoscopic approaches have become the primary surgical option for the majority of patients with frontal sinus disease. However, the management of complex and recalcitrant frontal sinus disease remained a challenge, until the evidence published using the expanded approaches such as the Endoscopic Modified Lothrop Procedure (EMLP) or Draf III surgical procedure. The Lothrop procedure first described in 1914[5] as an external technique, and was subsequently adapted in the early 1990's, and then modified by using the operating microscope with the endoscopes in the mid 1990's as a transnasal approach[6,7]. This procedure involves resection of the frontal sinus floor bilaterally, the superior part of adjacent nasal septum and inferior area of interfrontal sinus septum, creating a large frontal sinus antrostomy. With additional surgical experience, better visualisation and improved technology (powered instrumentation), EMLP has become the "gold standard" for complex and

difficult frontal sinus disease. However there remain certain situations in which the OPF approach provides unparalleled views and access to the frontal sinus, which are not possible using the current endoscopes. Some of these specific indications are considered below.

Neo-osteo-genesis:

Neo-osteo-genesis due to chronic infection remains one of the greatest challenges to the rhinologist treating and establishing drainage of the frontal sinus. In a retrospective review of all frontal sinus procedures performed over a period of 3 years, Hahn et al[8] noted that 6% of patients required a surgical revision using an external approach due to failure of an endoscopic technique. Their review of 683 patients, 32 underwent a total of 38 external procedures (5.3%). The most common indication for using an external approach was neo-osteo-genesis of the frontal recess (63.2%). Approximately 80% of these cases of neo-osteo-genesis had on average 2.5 previous endoscopic sinus surgery procedures. Other indications listed for employing an external approach included distortion of the critical anatomic landmarks and laterally located diseased mucosa.

With neo-osteo-genesis, the extent of bone drilling required to open the outflow tract results in a circumferential area of denuded bone that is prone or at risk of contracture, stenosis and resulting in treatment failure. Furthermore a case illustrated in Figure 1, the neo-osteo-genesis and scarring can prevents safe identification of the frontal sinus, as well as the development of significant new bone between the nasal cavity and the frontal sinus pathology. In these cases, the use of an OPF may provide an alternative surgical approach to the management of chronic frontal sinusitis. By employing the OPF approach the frontal sinus ostium can be identified safely from "above", resulting that a wide endoscopic frontal sinusotomy can be completed from "below"[8].

Lateral and Supra-Orbital Mucocele:

Inflammatory disease or previous trauma with resultant outflow tract obstruction may lead to the formation of a frontal sinus mucocele. While the majority can be drained endoscopically, some may be better addressed using an OPF approach. Such a case is illustrated, Figure 2; a patients with nasal polyposis, having previously undergone x16 endoscopic surgical interventions. The mucocele illustrated is lateral to orbital contents, with extension into the orbital apex and with fragmentation of the bony wall, should suggest suspicious of a possible neoplastic process. Such a laterally based frontal sinus mucocele, associated with a potential uncertain pathology is unlikely to be

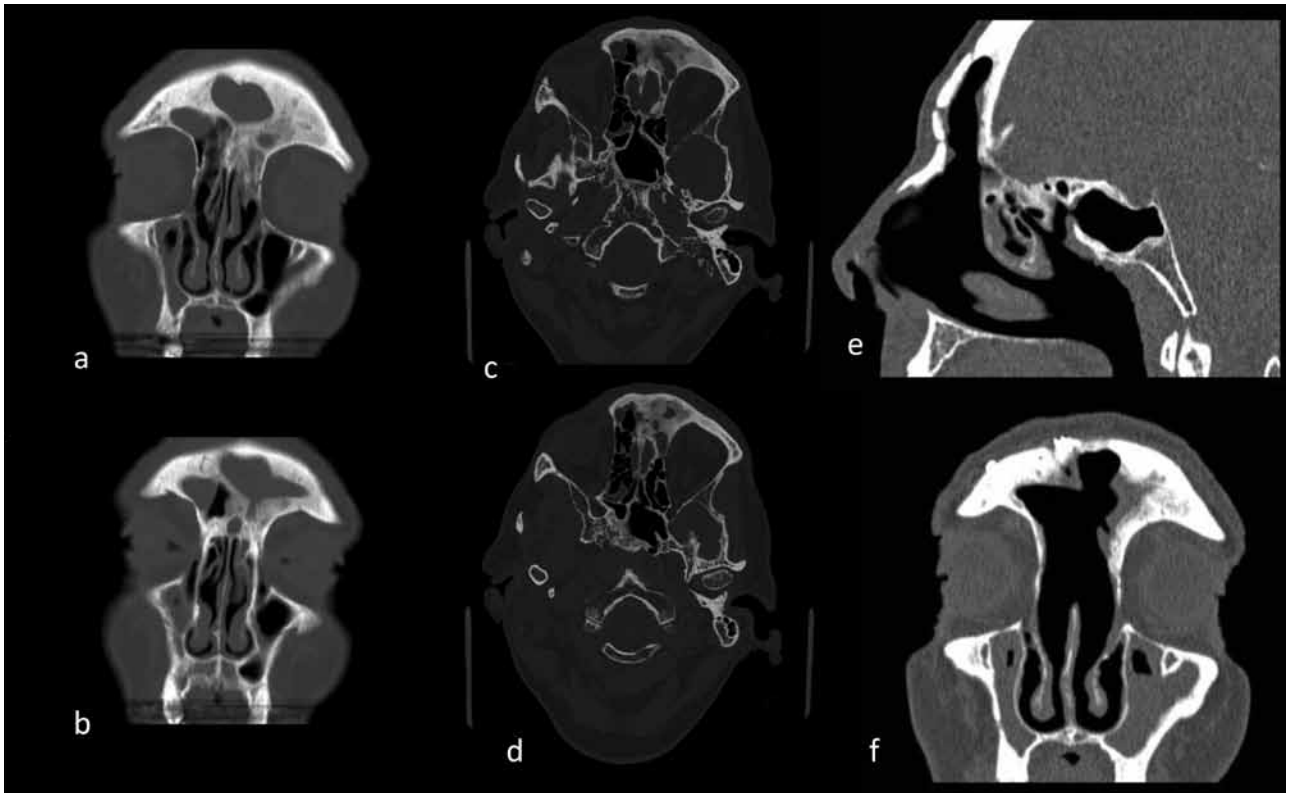

Figure 1: *Neo-osteo-genesis of frontal sinus and recess with secondary frontal mucocele.* **a- d** *Axial and Coronal pre-op CT scans,* **e-f** *12 months post-op OPF and endoscopic Draf III.*

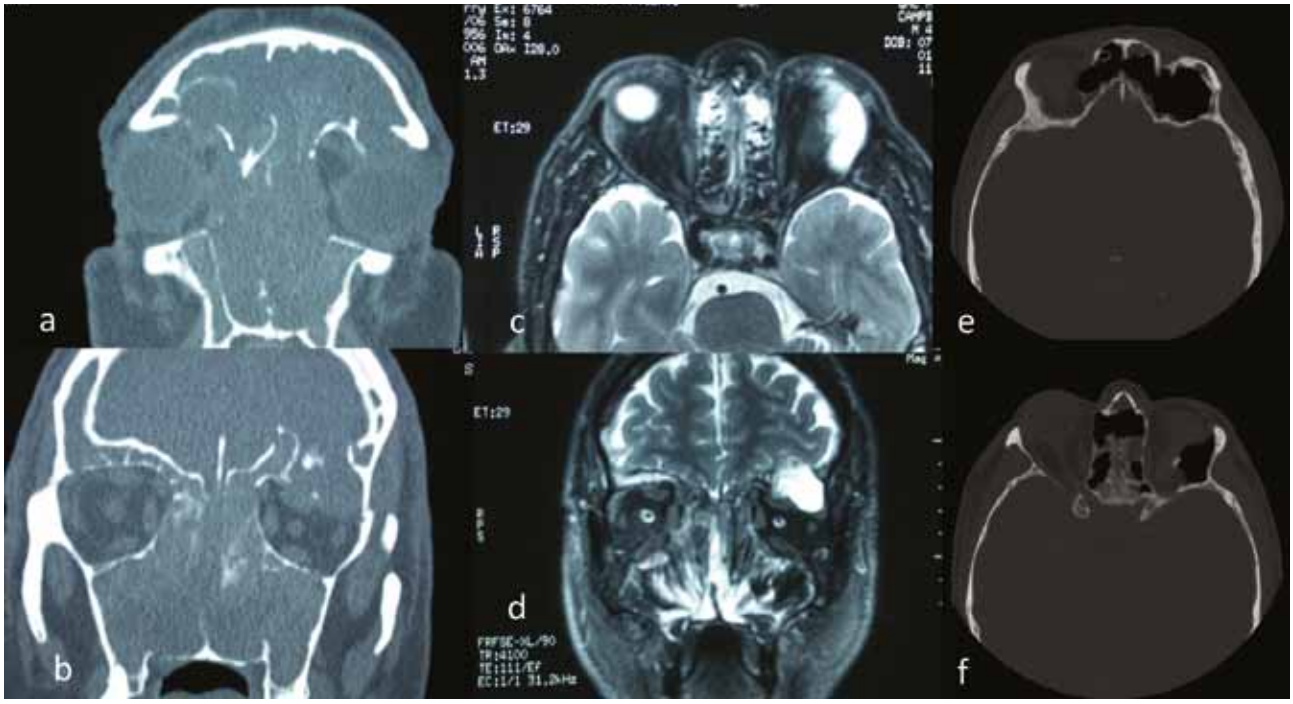

Figure 2: *Nasal polyposis with left lateral orbital mucocele.* **a-b** *pre-op Coronal CT scans,* **b-c** *pre-op MRI scan,* **e-f** *24 months post-op CT scans*

adequately accessible and managed with current available endoscopic techniques. In such circumstances and in the illustrated mucocele case, the OPF approach would allow better visualisation, bimanual access to the mucocele contents and ability to establish a lateral drainage pathway that is more likely to remain patent long-term.

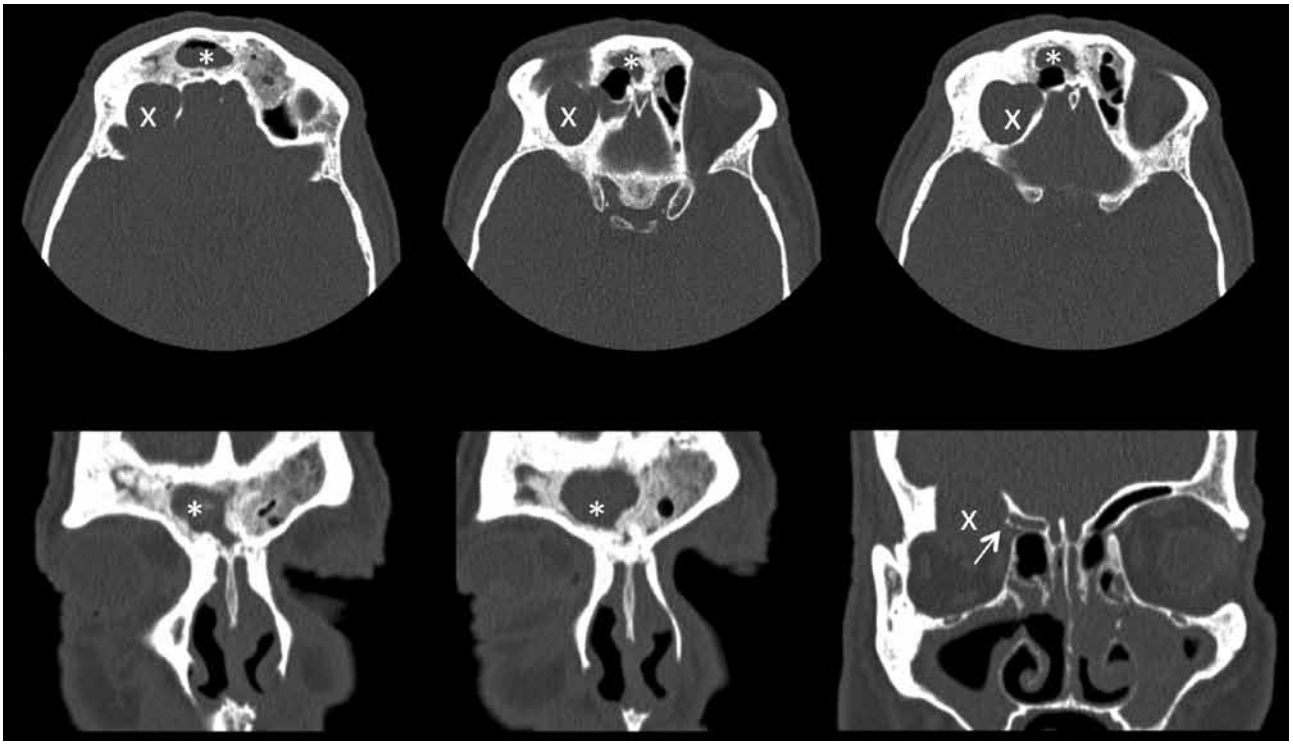

Figure 3: *Right Supraorbital Mucocele. x = Supraorbital mucocele, * = Frontal sinus, arrow = anterior ethmoidal artery. Also note the significant neo-osteo-genesis of the opposite frontal sinus.*

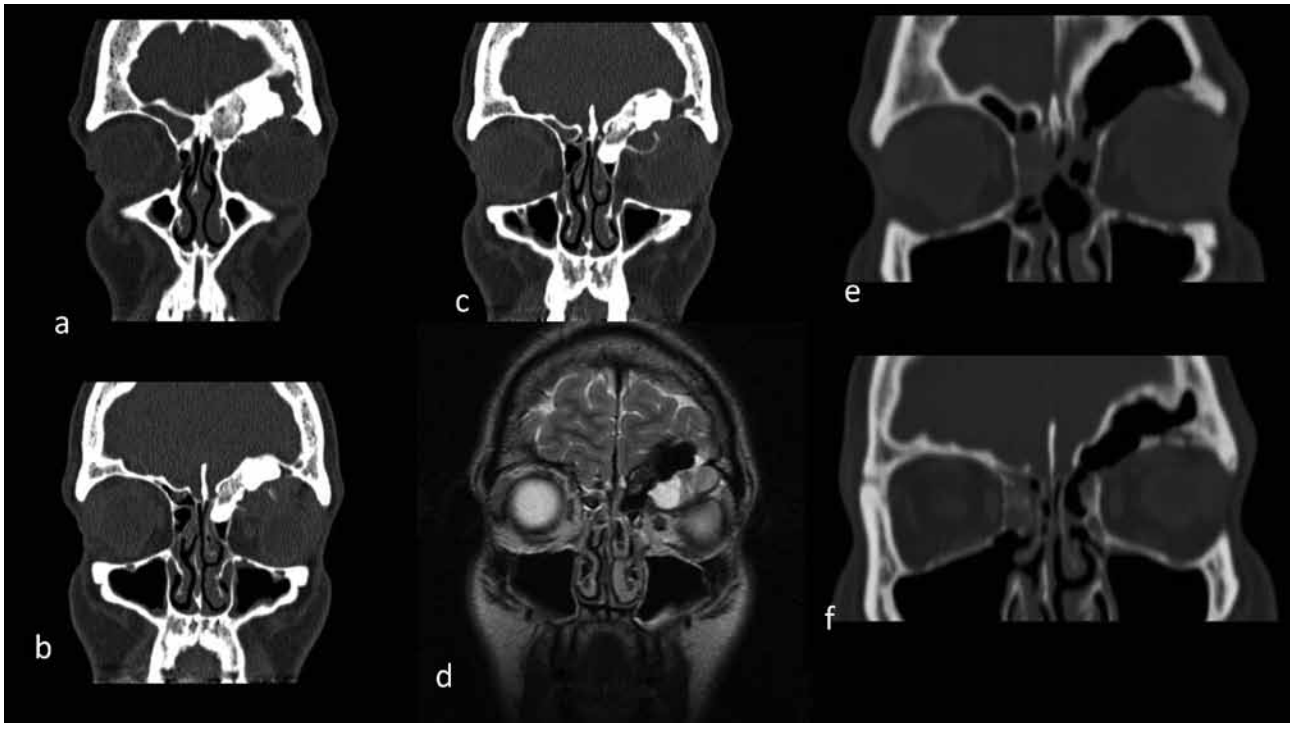

Figure 4: a-d *Left fronto-ethmoidal osteoma with two secondary supro-orbital mucoceles. Arrows show the bony walls of the mucoceles.* **e-f-** *post-operative outcome 24 months after surgery demonstrating the elevated bony walls of the mucocele.*

Amongst the fronto-ethmoidal mucoceles, the supra-orbital mucoceles present the greatest challenge. These mucoceles often have very narrow drainage pathways, sandwiched between the thin lateral lamella and lamina papyracea. Not uncommonly, the anterior ethmoidal artery is exposed within the ethmoidal cavity. When these mucoceles communicate with the frontal recess anteriorly, endoscopic drainage is feasible. Occasionally, they may become isolated in the superior plate of the orbit without any adequate midline communications as illustrated [Figure 3]. In these situations, it is the authors' preference to gain access and establish drainage into the posterior wall of the frontal sinus, which requires the greater access provided by the OPF approach and not achievable through an extended endoscopic techniques.

An external approach may also be appropriate in cases where a tumour is an underlying cause of the mucocele formation. Most of these mucoceles would resolve with adequate management of the obstructing tumour, but occasionally lateral or supra-orbital mucoceles become isolated and cannot be accessed by current endoscopic approaches. In these cases removal of the obstructing tumour will not be sufficient to restoring drainage [Figure 4]. This case shows two small supra-orbital mucoceles secondary to an obstructing osteoma. Although, it may be feasible to address the osteoma endoscopically, these mucoceles are likely to fail to drain due to their bony superior wall. Not only would it be extremely difficult to endoscopically drill the superior walls of these mucoceles, the proptosis resultant from the mucoceles would not resolve without elevating the expanded floor of these mucocels to decompress the orbit. This would become apparent when these Mucocoeles are addressed using an OPF approach, as the proptosis failed to settle with simple drainage, and required elevation of the bony fragments to achieve decompression as seen in the post-operative scans of the patient.

Narrow Frontal drainage pathway-

In some individuals, the frontal drainage pathway is developmentally too narrow to be adequately accessed endoscopically. Traditionally a narrow antro-posterior dimension between the frontal beak and skull base is considered a contraindication for EMLP. In others, trauma and previous surgery can significantly distort the frontal recess anatomy, precluding any primary endoscopic approach. This most often occurs in the setting of previous mid-facial trauma involving the nasal-orbital-ethmoid complex or in situations where previous surgery has altered the drainage or allowed excessive collapse of facial or orbital soft tissue[8,9]. In these situations, the pathology can be best managed by combination of OPF and an endoscopic approach. This technique can be extremely useful to avoid inadvertent injury to the skull base or orbit given the altered anatomy [Figure 5]. This case is illustrated:

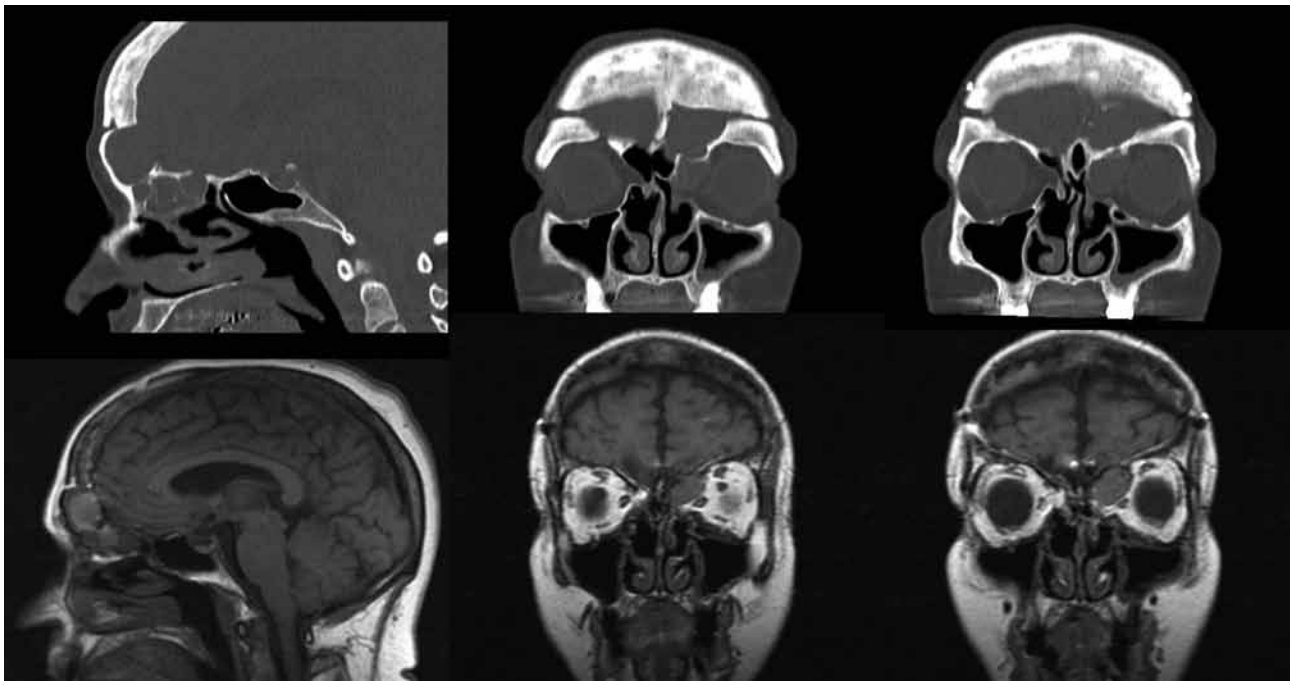

Figure 5: *Series of CT scans with accompanying MRI scans demonstrating a frontal and intra-orbital mucocele secondary to previous skull base resection for memingioma.*

a patient who had a previous craniotomy for skull base meningioma, subsequently developed two separate fronto-ethmoidal mucoceles. Endoscopic access to these mucoceles was precluded by the medial collapse of orbital contents, resultant from the previous skull base surgery. The referring surgeon had attempted an endoscopic approach only to aspirate CSF due to inadequate localisation of the mucocele. The case was managed with an "above and below" approach (OPF and endoscopic approach) with the anterior frontal mucocele drainage established into the frontal recess and the posterior supraorbital mucocele drainage into the posterior ethmoid cells.

Frontal Sinus Tumours:

Osteomas:

Since the 1990's using the endoscopic approaches has gained increasing popularity as an alternative to the external approaches for the management of frontal sinus osteomas. Chui et al[10] recommendation was to adopt OPF approach in managing grade III and IV tumours; osteomas with anterior and superior attachment within the frontal sinus (grade III), tumours which extend lateral to sagittal plane through the lamina papyracea (grade III), and tumors that filled the entire frontal sinus (grade IV). Ledderose et al[11] undertook a retrospective review of all procedures performed for frontal osteomas at Munich University during a fourteen-year period and reported that of 24 patients, 33% (8/24) were successfully approached entirely endoscopically, 17% (4/24) were approached entirely externally, whilst 50% (12/24) required a combined endoscopic and external approach. In their experience, approx. 90% of Grade III (9/10) and Grade IV (5/6) osteoma's required some external incision (Brow or Coronal). Sliberling et al[12] reported on their experience of 25 patients of frontal sinus osteomas treated at the University Hospitals of Adelaide in the preceding decade. In this series, endoscopic unilateral approach or EMLP alone was successfully adopted in managing all patients with grade I-III osteoma's. In the 10 patients with Grade IV osteomas, EMLP alone was used in 60% patients, whilst two (20%) required adjunctive external transfacial incision and further two (20%) required Osteoplastic flap approach. However, in four out of eight patients approached through an EMPL+/- transfacial approach, the resection was incomplete leaving 5-10% of the osteoma attached to the skull base. Even in the hands of a very experienced endoscopic surgical team, complete resection of Grade IV osteomas remain a challenge. An illustrative case, Figure 6, with a Grade IV osteoma previously failed EMLP and surgery was successful when managed by an OPF approach.

Inverted papilloma (IP):

Traditionally, frontal sinus IP was managed via the OPF approach because of the high risk of recurrence and the associated possibility of malignant transformation[13,14].

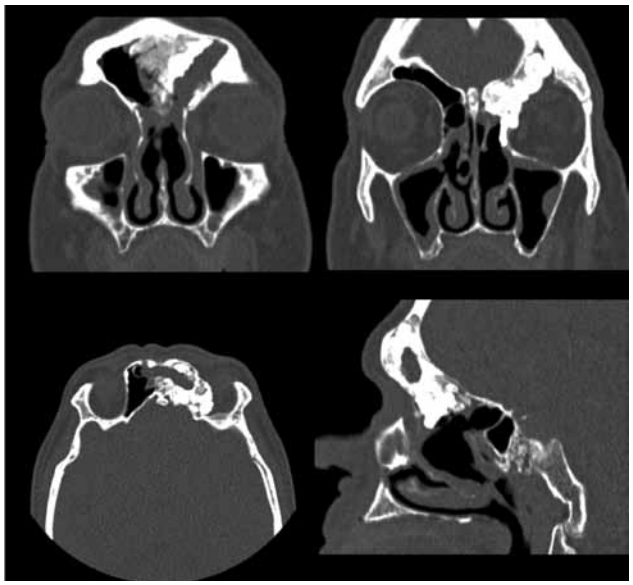

Figure 6: *Grade IV Left Frontoethmoidal osteoma with previous attempted endoscopic resection with EMLP*

However, endoscopic techniques such as the EMLP have provided surgeons greater access to the frontal sinus, such that many of these cases can be successfully treated endoscopically. Yoon et al[13] reviewed eighteen patients who were treated for frontal sinus IP over a ten year period. Seven patients (39%) required an adjunct open procedure. They concluded that while endoscopic techniques may be useful for uni-focal disease, as well as for medial or posterior wall attachments, multi-focal disease with attachments either to the anterior or lateral wall may be best managed with an OPF approach given the limits of current frontal sinus instrumentation.

Ultimately, the goals of frontal sinus IP management should remain clear; to ensure complete tumour removal and enable long-term surveillance to identify early recurrent disease. This is especially true in the presence of concomitant dysplasia or overt malignancy.

Conclusion

The history of sinus surgery has undoubtedly progressed from the external approaches in the pre-1980's to the extended endoscopic approaches. However, despite the considerable advancement in endoscopic techniques, the literature still supports a role for external procedures in certain specific situations. It is paramount for the budding endoscopic sinus surgeon to realise and appreciate the limitations of the endoscopic technique, and hence needs to be able to choose the most appropriate surgical treatment for each individual patient. Extensive neo-osteogenesis of frontal recess and sinus, lateral or isolated supraorbital mucoceles, Grade III and IV osteomas, uncertain pathology, notable altered or a narrow frontal drainage pathway and in multifocal recurrent frontal sinus inverted papilloma are situations where consideration must be given to the role of an OPF approach. It is important to appreciate that the OPF approach and the use of an endoscope are essentially means of gaining access to the pathology. The degree and nature of surgical exposure required is determined by the pathology that one is dealing with and the specific anatomy of the patient. Although currently "we ride the tide of the endoscopic era, we need to be cautious that our zeal is not misguided by the philosophy that one size fits all".

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Extracorporeal septoplasty- indications, technique and evidence

Mr N Ahmad FRCSEd(ORL-HNS), MSc, DOHNS, BSc (Hons)
Otology & Skull Base Fellow
Sir Charles Gairdner Hospital, Perth, Australia

Mr M R El Badawey MSc, FRCS (Ed), MD, FRCS (ORL HNS)
Consultant Otolaryngologist
Honorary Senior Lecturer
Freeman Hospital, Newcastle-upon- Tyne
NE7 7DN

Corresponding author:
email mohamed.reda@nuth.nhs.uk

Abstract
The severely deviated septum is often associated with external deformities of the nose. Significant anterior septal deviations can be difficult (if not impossible) to correct with a standard endonasal septoplasty. In extracorporeal septoplasty (ECS) the entire deformed septum is removed, corrected and re-implanted. The research evidence demonstrates the technique to be safe, with a low complication rates even in large series (of over 2300 cases). Good outcomes are reported with significant improvements in 22-Item Sinonasal Outcome Test (SNOT-22), Nasal Obstruction Score and Nasal Obstruction Symptom Evaluation [NOSE] scale.

Key words
Septopalsty. Septal deformities, extracorporeal septoplasty, septal grafts.

Introduction
The famous facial plastic surgeon, Dr Irving B. Goldman said, 'As the septum goes, so goes the nose.' This is an often forgotten principle - that the nasal septum has decisive effect on the cosmesis and function of the nose. This dual aspect is often neglected in the evaluation and surgical correction of the deviated septum – with septoplasty being usually considered (sometimes incorrectly) as a routine straightforward procedure.

The severely deformed septum is often associated with external deviation of nose. The effects of nasal septal deviation are also frequently underestimated during the correction of the externally deformed nose. Severe septal deviations usually arise as a result of nasal trauma, previous surgery, or congenital malformation. Classic septoplasty and septorhinoplasty techniques are not usually capable of reliably correcting severe anterior nasal septal deformities.

The concept of removing the entire deformed septum, correcting and re-implanting it, was first postulated by King and Asley in 1952[1]. However, the procedure itself was first performed by Gubisch in 1981 through a closed technique[2]. Due to some patients having dorsal irregularities, the technique was modified to an external approach with improved results[3].

Indications (table 1)
1. Certain types of severe anterior septal (and/or caudal edge) deformities are particularly difficult, if not impossible, to treat adequately through conventional septoplasty techniques e.g. where the septum comes off the nasal spine at an angle of greater than 30° in the

Table 1: Indications for extracorporeal septoplasty
1- Severe anterior septal deviations.
2- Dorsal septal deviations.
3- Saddle nasal deformities.
4- Septal perforations.
5- Cleft palate nasal deformities.
6- Revision septorhinoplasties.

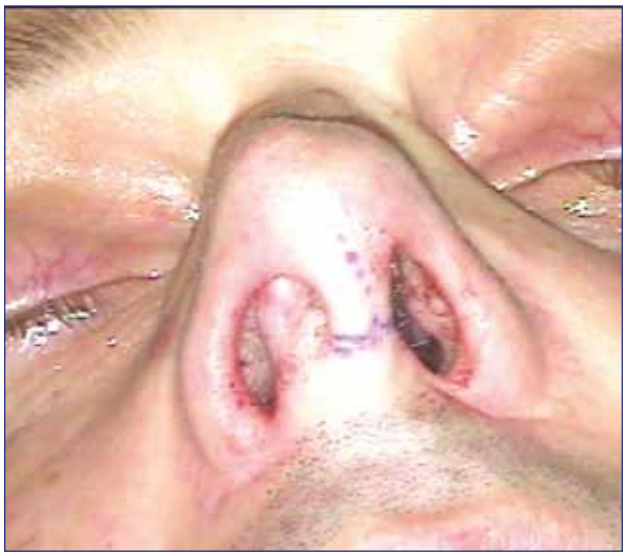

Figure 1: *Severe anterior septal deviation, with a deformity of the columella and asymmetry of the tip because of the deviation.*

axial plane. The septum may be flat or cup shaped and in these more extreme septal deformities, it can be difficult to address the septum by conventional means and therefore an extracorporeal approach is useful (Figure 1).

In some patients the cause of nasal airway obstruction includes a narrow valve angle and high septal deflection, which are generally not treated with standard septoplasty techniques. Although placement of spreader grafts has been well described, this technique alone does not address significant deviations of the anterocaudal nasal septum[4-6].

2. Crookedness of the dorsal edge of the septum can cause cosmetic deformities of the middle third of the nose and using a traditional septoplasty approach is limited by possible loss of tip support should overresection/weaking occur. The ability to take out the entire anterior septum, reshape it and reimplant it (as in the extracorporeal approach) is very useful in these cases (with the ability to address any asymmetry of the upper lateral cartilages).

3. Saddle nasal deformities are usually associated with a significant septal deformity, which could be difficult to address with the standard septoplasty techniques.

4. Septal perforations can be addressed with the extracorporeal technique as the reimplanted septum can be designed to provide cartilaginous or bony support between the repaired flaps. It also addresses the associated septal deviation in the remnant part of the septum which could be difficult to address with routine septoplasty techniques (Figure 2).

5. Cleft palate nasal deformities are usually associated with septal deviations in all the planes of space (axial, sagitttal and coronal). Gubisch et al have documented the use of this technique in gaining satisfactory results in the particularly challenging cases of patients with cleft lip and palate[7].

6. Finally, in cases of revision septorhinoplasties in which the main cause of the deformity is related to the deviation of the septum.

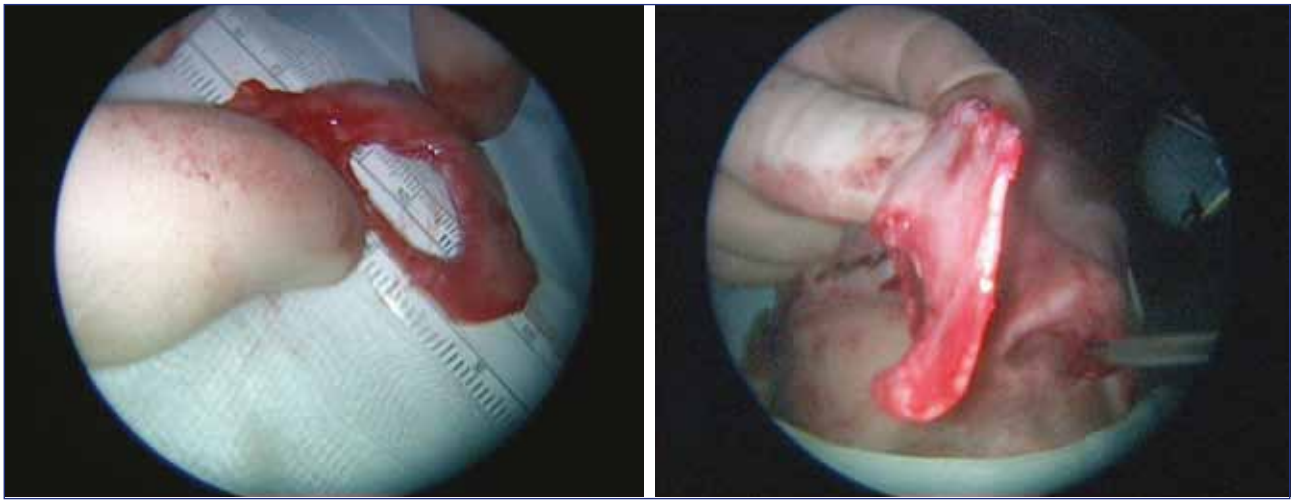

Figure 2: *Left - The harvested cartilage remnant with a 2 cm sepal perforation. Right - shows the associated deviation of the posterior and inferior parts of the remnant.*

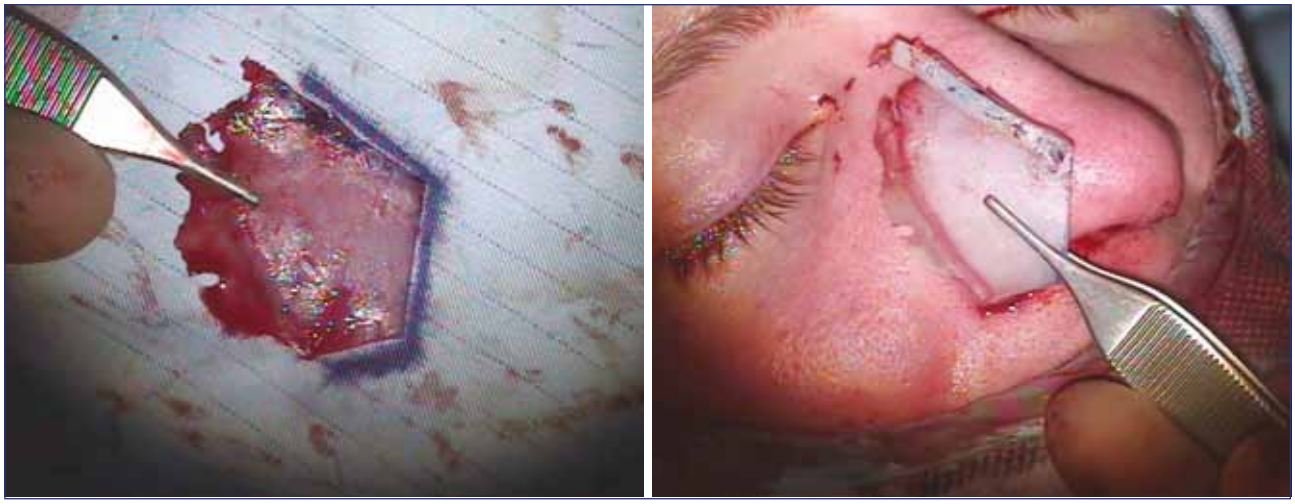

Figure 3: *Left - The reconstructed cartilaginous graft in an open rhomboid fashioned to replace the caudal, dorsal and inferior parts of the nasal septum. Right - The dorsal edge of the graft is fixed with spreader graft before reimplantation.*

Surgical Technique

Total intravenous anaesthesia (TIVA) is ideal for reducing bleeding. The nose is prepared with a chlorhexidine solution and also injected with Lignospan local anaesthetic (2% lidocaine with 1:80000 epinephrine) after which vibrissae can be plucked to aid visualisation.

A standard external approach, starting with an "inverted v" mid-columellar incision with marginal incisions are followed by dissection to expose the anterior cartilaginous septum. Submucoperichondral dissection is done initially on the concave side of the nasal septum to minimise the risk of tearing the mucosa during the approach. This step is followed by bilateral dissection of the mucosa at the junction of the border between the dorsal septum and upper lateral cartilages. The upper lateral cartilages are separated bilaterally from the dorsal septum by sharp dissection just parallel to the septum. This step makes the nasal septum more mobile and makes mucosal dissection easier and more accurate. Inferior tunnels are then dissected to complete the raising of mucosal flaps and to mobilise the septum inferiorly.

The bony septum is then fractured posteriorly in a vertical direction with a 5-mm chisel. The complete cartilaginous and bony septum is then removed in one piece facilitating a number of options to create the ideal sized, stable reconstructed septum. After assessing preoperative photography and the necessary changes needed, the ideal size and shape are drawn onto the reorientated septum. Any redundant cartilage and fracture lines can then be excised and/or sutured together to provide a stable reconstructed nasal septum. The ideal sized septum needs to be large enough to correct (or prevent) any cosmetic deformities and have stable dorsal and caudal borders. In many cases there is not a paucity of cartilage to reshape but it is just a matter of rotating the excised septum to allow an open rhomboid to be fashioned (Figure 3).

Once the suitable size has been determined, there are a number of methods for creating a straight septum. Smoothing the cartilage and bone with a sharp drill may be necessary to reduce asymmetric thickening and spurs. If the cartilage is soft and unstable, providing poor support, then two options exist to strengthen it. The perpendicular plate of the the ethmoid or vomer can be thinned (if necessary) and multiple holes drilled to allow

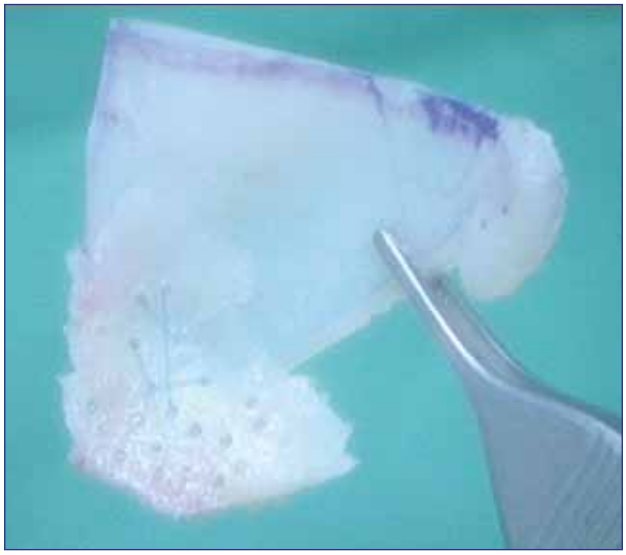

Figure 4: *A straight part of the vomer was perforated and used to support the weak cartilage at the future caudal edge of the septum.*

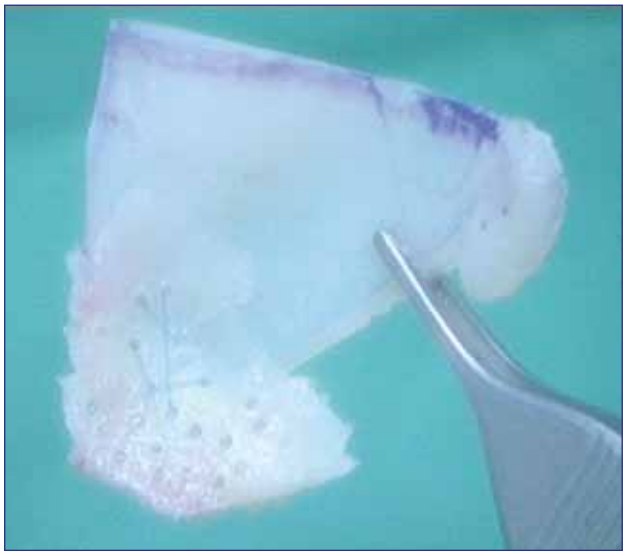

Figure 4: *A straight part of the vomer was perforated and used to support the weak cartilage at the future caudal edge of the septum.*

suture splinting, thereby simultaneously straightening and strengthening the weak cartilaginous septum (figure 4). Spreader grafts can also be sutured to the upper border of the septum to stabilise it and reinforce the internal nasal valve. In posttraumatic cases with multiple fractures sites and cartilaginous fragments which have healed in suboptimal positions, it is possible to dissect and preserve many pieces of cartilage. These can then be used to construct a straight neoseptum.

Reorientation of the septum to provide maximal stability of the caudal and dorsal aspect is sometimes necessary. The neoseptum is then reimplanted between the mucoperichondrial/ostial flaps. Stable fixation of the implanted neoseptum is essential in achieving a good longterm functional and cosmetic result. The neoseptum is positioned at the height of the upper lateral cartilage (ULC), temporarily fixed with needles and then sutured to the ULCs (Figure 5). A dorsal groove is made in the anterior nasal spine and maxillary crest (Figure 6). Then a hole is drilled in the nasal spine for anterior fixation of the neoseptum. A non-absorbable suture is placed through the hole in the nasal spine and the lower septum border to anchor it.

To prevent irregularities of the nasal dorsum, a cadaveric Tutoplast fascia lata graft is placed over the dorsal neoseptum. A quilting absorbable suture is placed and the incision closed with prolene and PDS. An internal and external nasal splint is used to stabilise the nose.

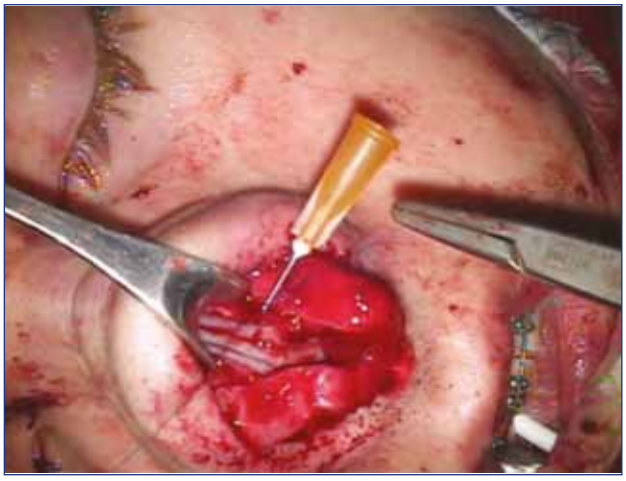

Figure 5: *The dorsal part of the neoseptum is placed at the level of the edge of the upper lateral cartilage and fixed with 5/0 prolene.*

Evidence

It is important to establish outcome reporting evidence of benefit for the procedure as it is longer in duration and draws on more resources than endonasal septoplasty (even though it is indicated where standard septoplasty would be inadequate).

In a prospective study of 30 patients with a mean follow-up of 12.2 ± 9.5 months, pre- and postoperative nasal peak inspiratory flow (NPIF) improved significantly from 93.3 ± 34.7 to 143.0 ± 44.3 ($p < 0.001$). Nasal obstruction score improved significantly from 3.6 ± 1.3 to 0.69 ± 1.2 ($p < 0.001$). SNOT-22 improved significantly from 34.1 ± 17.2 to 12.7 ± 14.9 ($p < 0.001$). Ninety-six percent had subjective improvement in nasal function, and 96% had no change or improvement in cosmesis[8].

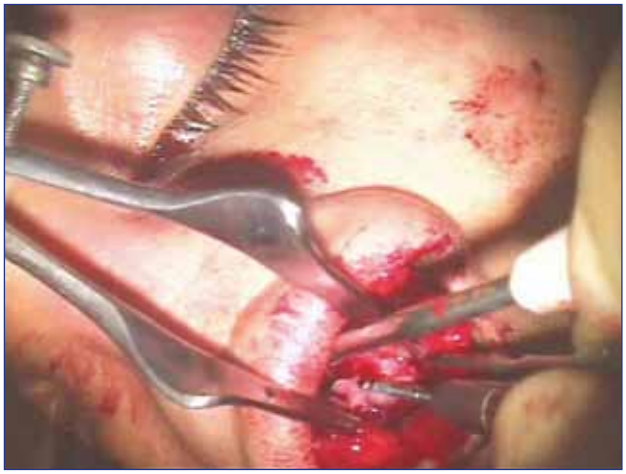

Figure 6 "Original": *A groove is created in the maxillary crest and anterior nasal spine using a fisher burr.*

A larger study of 153 patients, though retrospective in nature, showed significant objective (Active Anterior Rhinomanometry) and subjective (Nasal Obstruction Symptom Evaluation [NOSE] scale) improvements at 3 and 6 months postoperatively with no postoperative complications[9]. In another smaller but prospective study of 12 patients, no complications occurred and all patients noted improved airway function postoperatively. There was a significant improvement in mean Nasal Obstruction Symptoms Evaluation score postoperatively (76.6 vs 12.9; P<.01). Examination of postoperative photographs revealed improved midvault and tip anatomy[10].

The biggest case series (2301 extracorporeal septoplasties!) is that of Gubisch who, with an experience spanning over 25 years, had a revision rate of 5% (and 7% if done by a junior surgeon) in even the most severely deviated septums[11].

Conclusions

Extracorporeal septoplasty is a useful technique in cases of severely deviated anterior nasal septum where the normal endonasal septoplasty would not suffice.

The technique is safe (with a low complication rate) and has good (subjective and objective) outcomes demonstrated in the world literature.

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Endoscopic management of benign sinonasal tumours

Joanna C Stephens MBChB, DOHNS, FRCS
Hesham A Saleh MBBCh, FRCS, FRCS (ORL-HNS)
Department of Otolaryngology
Charing Cross Hospital
Fulham Palace Road
Hammersmith
London
W6 8RF

Corresponding author:
Joanna Stephens
Department of Otolaryngology
Charing Cross Hospital
Fulham Palace Road
Hammersmith
London
W6 8RF

Email: jstephens@doctors.org.uk

Abstract
Benign sinonasal tumours are uncommon, and have a varied pathophysiology. Traditionally, excision of larger tumours necessitated invasive open approaches but advances in both endoscopic surgical skills and equipment have broadened the scope of lesions which can be successfully removed endoscopically. We present a review of the more common benign sinonasal tumours, and their endoscopic management.

Key words
Sinonasal tumours, benign, endoscopic

Introduction
Tumours of the sinonasal tract are extremely varied, and can be classified into benign or malignant. An extensive range of benign tumours are classified in Table 1, but the commonest benign neoplasms are inverted papilloma, fibro-osseous lesions, pleomorphic adenomas and vascular lesions[1]. Advances in anatomical understanding, endoscopic surgical skills and equipment have allowed the majority of these lesions to be managed endoscopically with excellent results, with a significant reduction in morbidity, and reduced costs.

Diagnosis

History and examination
Patients will typically present with unilateral nasal obstruction as the main feature. A proportion will also have symptoms of epistaxis or rhinorrhea, or possibly unilateral features of acute or chronic rhinosinusitis. With tumour expansion, facial swelling or pressure symptoms may also manifest.

On examination, the finding of a unilateral nasal lesion alerts the clinician to the possibility of a malignancy, or one of the pathologies discussed below, however it should be noted that 1% of polyps have a different histological diagnosis to that which was suspected by the clinician[2], so a high index of suspicion for any unusual appearances should be maintained.

Imaging
To aid both accurate diagnosis and successful excision, appropriate imaging is essential. CT is a mandatory examination, and if there is any clinical suspicion of extension intracranially or into the orbit, an MRI scan will provide invaluable additional information[3]. Examination

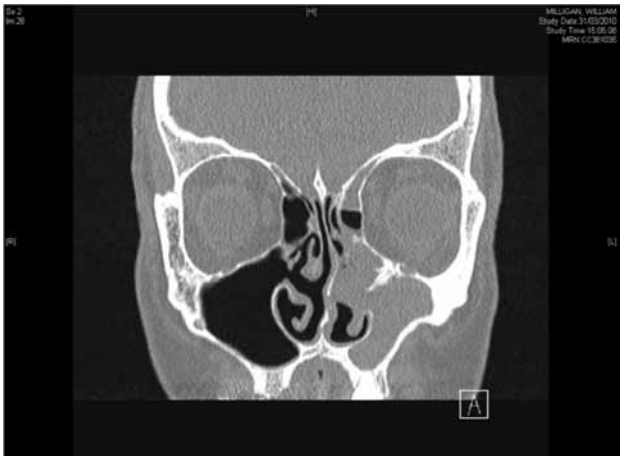

Figure 1: *Inverted papilloma of the left nasal cavity. Note the characteristic feature of calcification with the lesion.*

under anaesthetic, representive biopsies of the lesion, and specialist histopathological analysis are crucial if there is any doubt as to the diagnosis, or any concern that malignancy may be present. However in some lesions, as the radiological findings are pathognomic, or if there is suspicion of a vascular lesion, then biopsy is clearly ill advised.

Management

Traditionally, tumours of the sinonasal tract, both benign and malignant, were dealt with via external approaches such as the lateral rhinotomy or midfacial degloving. The advent of angled endoscopes, curved and innovative instruments which allow both visualization and resection around corners, and ever increasingly high definition hardware have dramatically increased the scope of the endoscopic resection. It is however essential that endoscopic management is a sound oncological clearance, rather than a tumour debulking exercise.

Epithelial tumours

Inverted papilloma

Inverted papillomas are benign epithelial tumours, which typically arise from the lateral nasal wall or within or the maxillary or ethmoid sinuses, with a characteristic inverted appearance of the epithelium into the underlying stroma, but an intact basement membrane[4]. They can also rarely originate in the sphenoid and frontal sinuses, or on the nasal septum[5]. The characteristic findings on CT are of a lobulated mass arising from the lateral nasal wall, with calcification and bony remodelling often demonstrated[6]. (Figure 1 & 2) These exophytic lesions have a tendency to recur, particularly if inadequately excised, and also have a risk of malignant transformation in the region of 2%, although rates between 2-53% have previously been reported[7]. A recent review of the literature found that the

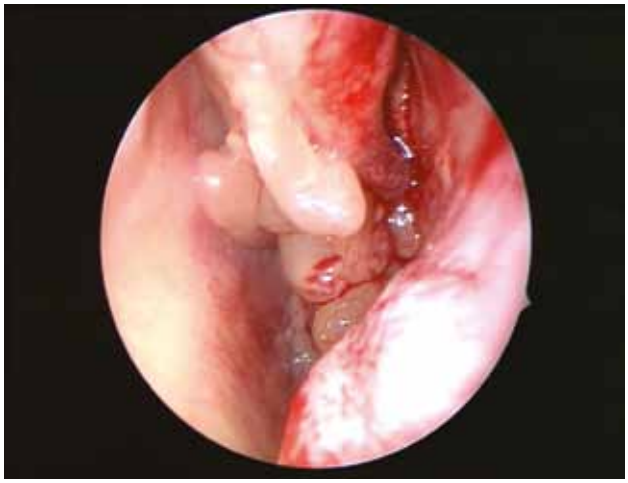

Figure 2: *a typical inverted papilloma arising from the left lateral nasal wall.*

rates of synchronous and metachronous carcinomatous transformation of inverted papilloma are 7.1 and 3.6 per cent, respectively and 11 per cent malignant transformation in recurrent inverted papillomas[8].

Endoscopic management is possible in the vast majority, with the exceptions being tumour in those areas which are inaccessible endoscopically – for example the lateral half of the frontal sinus, or the anterior wall of the maxillary sinus. The key to successful excision with minimal risk of recurrence is removal of all diseased mucosa, and a subperiosteal dissection to include removal of all sclerotic bone, with or without a medial maxillectomy[19]. Patients should be followed up for a minimum of 3 years[1].

Less common papillomas include everted papilloma and cylindromas, true papillomas lined by stratified squamous and microcyst-laden, columnar, oncocytic epithelium, respectively[10]. Cylindrical papillomas, like inverted papillomas, typically arise on the lateral nasal wall and have a tendency towards both recurrence and malignant transformation. In both cases, complete surgical excision is advised.

Vasiform tumours

Juvenile Nasopharyngeal Angiofibroma

Juvenile Nasopharyngeal Angiofibroma (JNA) is a rare, benign, locally invasive tumour, which exclusively affects adolescent males. It is a highly vascular tumour which arises at the sphenopalatine foramen, and should not be biopsied under any circumstances. CT and MRI allow both diagnosis and staging, showing two pathognomic features: a mass in the posterior nasal cavity and pterygopalatine fossa; and erosion of bone behind the sphenopalatine foramen with extension to, and blunting

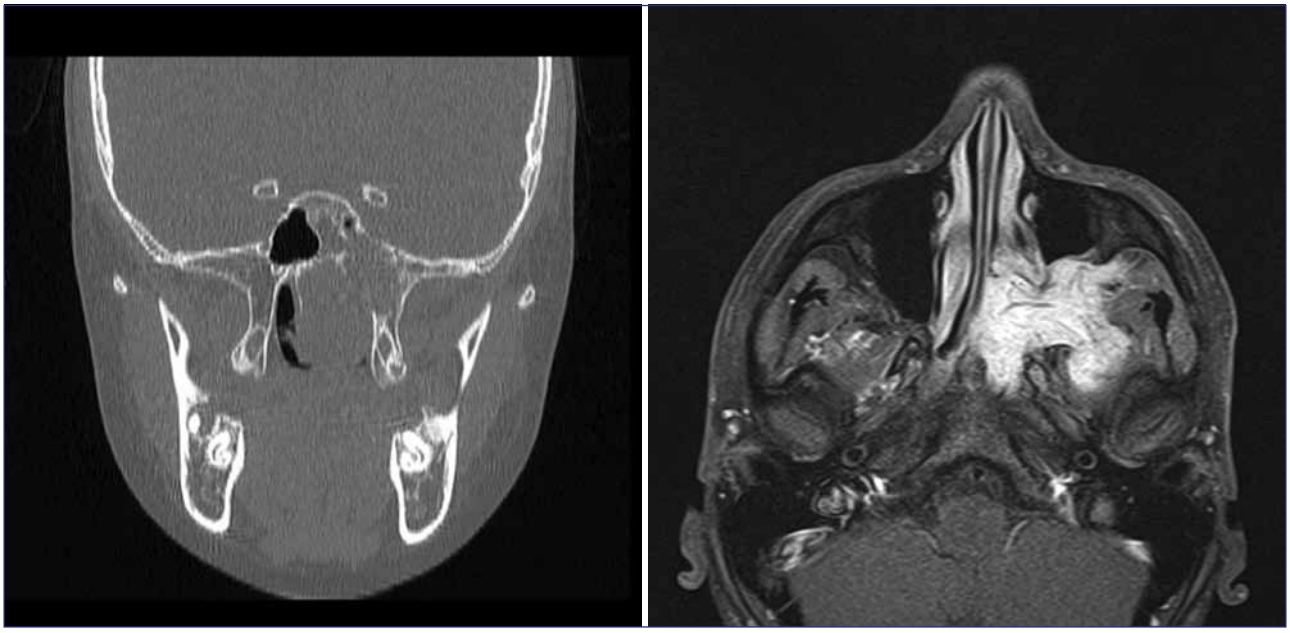

Figure 3: *Left – CT showing a mass filling the nasopharynx, typical of JNA. Right – MRI shows widening of the sphenopalatine foramen and large tumour mass.*

of, the upper medial pterygoid plate[11]. (Figures 3) The Holman Miller sign of anterior bowing of the posterior wall of the maxillary sinus may also be seen, however this is not specific to JNA and may be caused by other rare conditions[12].

Several staging systems exist, for example Radkowski - which is presented in Table 2[13], and Fisch[14]. For stage 1 and 2 tumours, and even for stage 3 in experienced hands, successful excision of tumour can be achieved endoscopically with a similar recurrence rate when compared to external approaches[1]. To achieve these low recurrence rates, it is essential to carry out a subperiosteal dissection at the attachment of the tumour to the basisphenoid, with drilling of the denuded bone in this area. Pre-operative embolization has been shown to decrease intra-operative bleeding[15], therefore better allowing complete resection of tumour. In cases of recurrent disease, or incomplete surgical excision, radiotherapy can be contemplated, but the potential

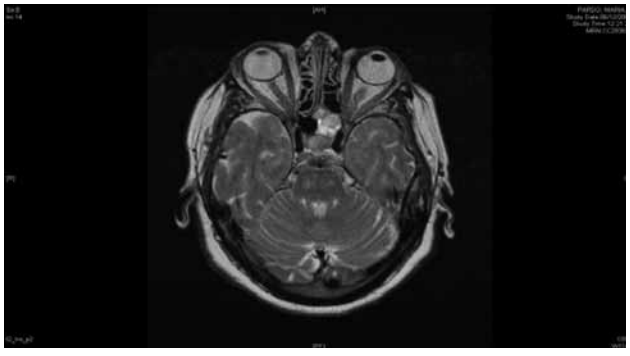

Figure 4: *MRI shows a highly vascular tumour in the left ethmoid cavity.*

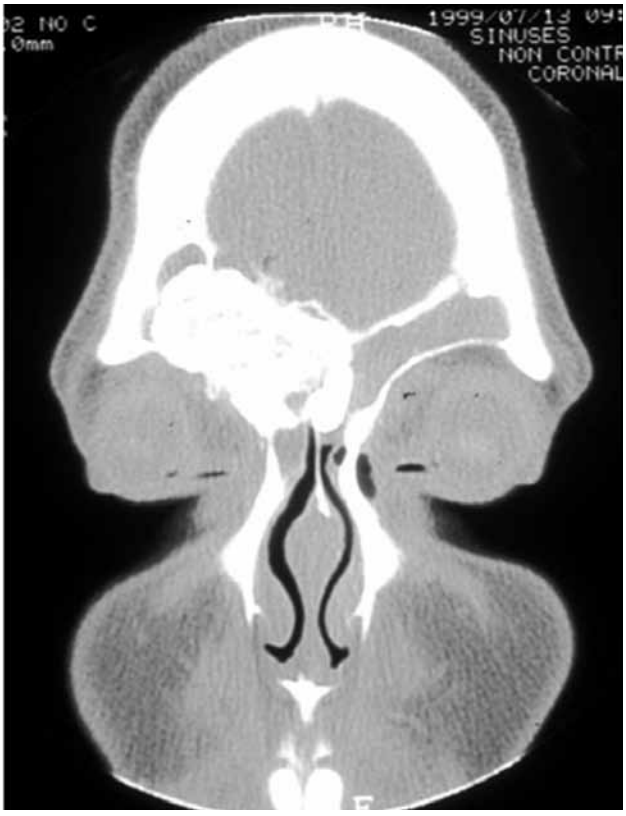

Figure 5: *A large osteoma of the right frontal sinus with associated frontal sinusitis – this lesion necessitated surgery*

sequelae associated cannot be overlooked, particularly in such a young cohort of patients.

Haemangioma

Both cavernous and capillary intra nasal haemangiomas have been reported in the literature, and represent 20% of benign nonepithelial tumours of the nose and paranasal sinuses[16]. Management is endoscopic surgical excision, with possible pre-operative embolization for bigger lesions[17].

Haemangiopericytoma

Haemangiopericytomas are rare tumours in the head and neck, featuring pericytes (extracapillary cells) distributed around normal vascular channels. They have a variable malignant potential[18,19]. Clinical examination usually demonstrates a red submucosal nasal mass (Figure 4) whilst the patient complains of epistaxis and nasal obstruction. It is essential for detailed histopathology and immunological staining to differentiate this tumour from other sarcomatous lesions[17]. Wide local excision is mandatory, as late recurrences have been reported, with systemic metastases seen in up to 10%9. Follow up should be long term[9].

Fibro osseous lesions

Osteoma

Osteomas are benign bony growths, most commonly originating in the frontal sinus, but also seen in the ethmoids, maxillary, and rarely sphenoid sinuses. There is an association with Gardner syndrome, which is an autosomal dominant condition characterized by intestinal polyposis and pigmented skin lesions in addition to the osteomas. They are most commonly an incidental finding in up to 3% of sinus CT scans, and are frequently asymptomatic . (Figure 5) If so, these lesions can be managed conservatively, however if causing symptoms such as sinusitis or orbital problems secondary to mass effect, endoscopic removal is advocated[21].

Fibrous dysplasia

There are 3 sub types of fibrous dysplasia: monostotic, polyostotic, and McCune-Albright syndrome – a combination of polyostotic fibrous dysplasia, endocrine dysfunction leading to precocious puberty, and skin pigmentation[20]. The commonest form is monostotic, and in the head and neck predominantly affects the mandible and maxilla[22]. These are slowly expanding lesions where normal bone is replaced with abnormal fibrous tissue[23]. The diagnosis is made radiologically, with the typical ground glass appearance on CT scanning[24]. (Figure 6) The lesions are often asymptomatic, and the disease process tends to burn itself out beyond puberty, and

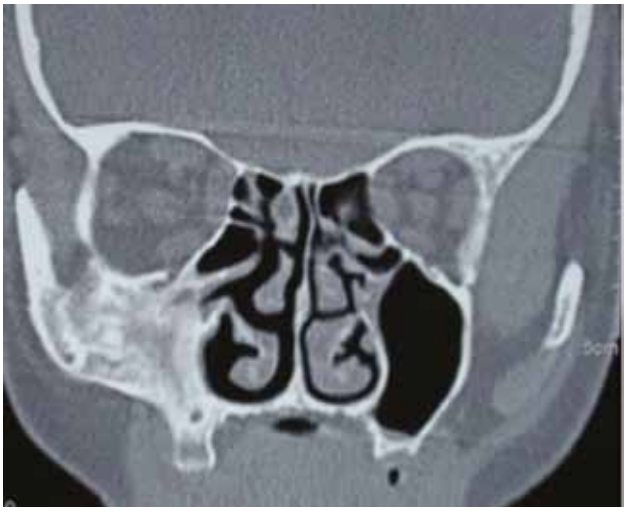

Figure 6: *Fibrous dysplasia of the right maxillary sinus. Note the characteristic ground glass appearance.*

so treatment is reserved for those cases where the lesion is causing facial asymmetry, or compression on surrounding structures such as the orbital apex. In these cases, endoscopic debulking is effective, but may need to be repeated if necessary. Complete tumour excision is invariably impossible and also ill-advised, due to unacceptable morbidity from potential damage to surrounding structures.

Ossifying Fibroma

Ossifying fibroma (OF) is a benign tumour comprised of bone, fibrous tissue, calcification and cementum1. Radiologically, the lesion is sharply circumscribed with an

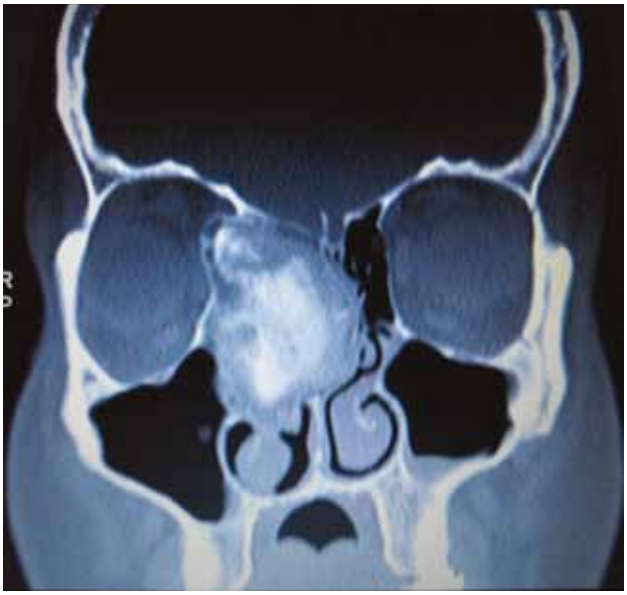

Figure 7: *Large ossifying fibroma in the right ethmoids, displacing the orbit. Note the core calcification with surrounding less dense fibrous tissue. The lesion is well delineated when compared to fibrous dysplasia.*

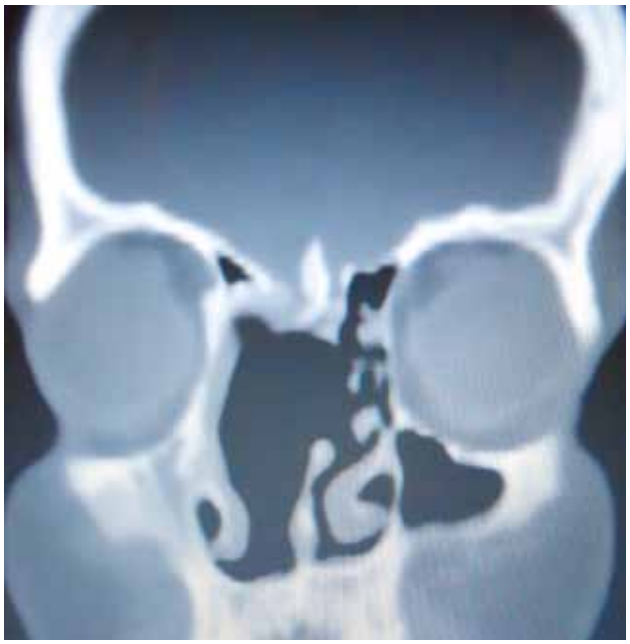

Figure 8: *6/12 post endoscopic excision of lesion.*

eggshell rim and central radiolucency. (Figure 7 & 8) OFs are locally aggressive, and continue to expand over time, so treatment is entirely surgical, and must comprise complete excision of the lesion to prevent further re-growth or recurrence[25].

Salivary Gland tumours

Pleomorphic adenomas

Pleomorphic adenoma (PA) is a benign tumour of salivary gland tissue, and is most frequently found in the parotid gland. However these tumours can occur at any site which is populated with salivary gland tissue, and so can extremely rarely be found within the sinonasal cavity. In this area, they typically arise on the nasal septum, and usually behave in a benign fashion[26]. PA's have also been described in the maxillary sinus, in which case they may present with facial or palatal swelling. There are a small number of cases in the literature of sinonasal carcinoma-ex-pleomorphic adenoma[27], therefore early and complete excision is recommended, which can usually be achieved endoscopically, depending on the tumour site and size.

Oncocytomas are tumours composed of epithelial or myoepithelial cells with abundant granular eosinophilic cytoplasm[28]. Malignant transformation has been described, so excision is recommended[28].

Mesenchymal tumours

Intraosseous lipomas of the sinonasal cavity have been reported, and are rare slow-growing benign tumours[29]. The presentation is of facial swelling and nasal obstruction, and treatment is excision[9].

Fibromas result from progressive inflammation or fibroblastic proliferation of the nasal mucosa , and present as grey-white, indolent masses in the nose[9].

Myxomas are benign mesenchymal tumors of uncertain etiology. They can arise from odontogenic tissue, as well as from the sinonasal tract and from the facial and temporal bones They typically present in childhood, and are locally aggressive with a high recurrence rate when locally excised[9].

Tumours of muscle origin

Both leiomyomas and rhabdomyomas are rarely seen in the nose and paranasal sinuses, as they originate in smooth and skeletal muscle respectively, of which there is little in this area. Both tend to be slow growing, and act in a non aggressive fashion, so simple excision is appropriate[32,33].

Conclusion

Benign sinonasal tumours are rare, but when encountered endoscopic techniques are suitable for the majority. The exceptions are tumours in the lateral portion of the frontal sinus, on the anterior wall of the maxillary sinus, and those tumours with extension through the anterior skull base or into the orbit.

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Abstracts for Registrars' Gold Medal presentations, 8th Annual National ENT Masterclass, 25-27th Jan 2012, Royal College of Surgeons, London.

The Management of Thyroglossal Duct Cyst Carcinoma – What is the Optimum Strategy?

Ausama Alaani, Iain Nixon, Jean-Pierre Jeannon, Rose Ngu, Ashish Chandra, Eddy Odell, Hosahalli Mohan, Ricard Simo

Presenting Author: Ausama Alaani, ENT and head and neck department, Guy's Hospital, Great Pond, London SE1 9RT

E mail : alaani2@yahoo.com

Background

Thyroglossal duct cysts are the commonest congenital abnormality associated with the thyroid gland. While most of these cysts are benign, a small percentage can be malignant. The aim of this paper is to describe the clinical presentation, diagnostic difficulties, management and outcome of this uncommon presentation.

Patients and methods

Retrospective review of 6 patients presented with thyroglossal duct cysts carcinoma (TDCC) presenting to the Head and Neck Unit at Guy's and St Thomas' Hospital NHS Foundation Trust between 2000 to 2009. Patients were investigated with TFT, Ultrasound-FNAC and MRI when indicated. All patients were discussed at the Thyroid Multidisciplinary Team Meeting where the management strategy was agreed.

Results

6 consecutive patients with TDCC were included. Age ranged between 31 and 66 years with a mean age mean of 41. All patients treated surgically either in single stage procedure (total thyroidectomy and excision of the thyroglossal cyst in 2 patients) or in staged procedures (excision of the cyst followed by total thyroidectomy in 4). All patients received post-operative radioactive iodine and TSH suppression. All the patients are alive and well with no evidence of recurrence with a minimum follow-up of 2 years and a maximum of 11 years.

Conclusion

The management of TDCC is still controversial. A systematic approach to the treatment including total thyroidectomy, excision of the thyroglossal cyst and track and level VI selective neck dissection followed with radioactive iodine and TSH suppression appears to be the best management strategy and the prognosis of these patients is excellent.

Comparison of Voice Handicap Index with Voice Handicap

E Hoskison, J A McGlashan

Presenting Author: Miss E Hoskison, Department of Otorhinolaryngology, Head and Neck Surgery.
Nottingham University Hospitals NHS Trust, Nottingham NG7 2UH

Email: emmahoskison@hotmail.com

Background

The Voice Handicap Index1 is a recognised patient based self assessment questionnaire of 30 items. It is widely used in the assessment of voice disorders. An abbreviated version called the VHI-10 has been developed which assesses only 10 of these items2. This study assesses the validity of using the VHI-10 instead of the VHI.

Methods

Retrospective review and analysis of VHI and VHI-10 scores for patients attending the voice clinic at Nottingham University Hospitals. The patient scores were taken in both pre and post treatment consultations.

Results

Two thousand eight hundred and sixty patient scores were identified. Patients had a wide range of pathologies including structural, neuromuscular, muscle tension imbalance and inflammatory. Some patients were assessed

on more than one occasion and had more than one underlying pathology; reflecting the broad spectrum of voice disorders included in this study. Statistical analysis using Pearson rank showed an overall correlation of 0.97 (p=0.01).

Conclusion

This study shows that the VHI-10 is an equally valid assessment tool in comparison with the VHI. The VHI-10 is shorter and quicker to complete in the voice clinic setting.

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Minimally Invasive Parathyroidectomy (MIP)

Mr. C W P Kelly, Mr. C Y Eng, Mr. M S Quraishi
Presenting Author: Mr C Kelly. **Email:** ciaran.kelly@nhs.net

Introduction

Parathyroid surgery is becoming more popular and gradually establishing itself as the acceptable definitive treatment for primary hyperparathyroidism (pHPT) due to parathyroid adenoma. Patients may undergo Minimally Invasive Parathyroidectomy (MIP) with excellent cure rate and minimal morbidity.

Aim

1. To demonstrate the safety, efficacy and subjective patient satisfaction of Minimally Invasive Parathyroidectomy (MIP).

2. To investigate the accuracy of pre-operative radiological localisation in relation to operative findings.

Methods

A retrospective case notes review of 120 patients who underwent MIP at Doncaster Royal Infirmary was performed. Data collected included patient demographics, referral route and presentation, results of pre-operative biochemical and radiological investigations, operative findings, post-operative calcium levels and subjective patient satisfaction with MIP.

Results

Ninety one percent of patients were referred via an Endocrinologist. Sixty-two percent of patients were asymptomatic and were picked up at primary care clinics. Twenty one percent of patients presented with renal calculi, 17% with musculoskeletal symptoms such as osteoporosis/myalgia/bone pain, and 8% with psychological symptoms or abdominal pain.

Pre-operative Ultrasound scans and MIBI scans were concordant in 69% of cases. The findings were discordant in 25% and not applicable in 5% of cases since only ultrasound scan was performed. When the scans were concordant, there was 95.5% identification of parathyroid tissue confirmed by intra-operative frozen section.

The average age of patients who underwent MIP was 62.4 years. 75.6% of the adenomas were found to be in the lower pole positions. Ultrasound scans localised 92.9% parathyroid adenomas accurately whereas MIBI localisation was only 72.8% accurate. In combined modality (Ultrasound and MIBI), localisation was 95.5% accurate.

Ninety percent of patients who underwent MIP went home within 24 hours. Forty percent of patients went home in less than 12 hours. Ten percent of patients had their operation under local anaesthesia and the remaining were performed under general anaesthetic. None of the local anaesthetic cases required intra-operative conversion to general anaesthesia. The mean operative time was 66 minutes including frozen section time (Range: 32 – 140 minutes, Std. deviation 27.3 minutes).

The mean pre-operative calcium level was 2.97 mmol/l and the immediate mean post-operative calcium level was 2.68 mmol/l (Paired t-test, p = 0.000) and the short-to-medium term mean calcium level was 2.49 (Paired t-test, p=0.000).

Ninety five percent of patients were subjectively satisfied with the outcome of MIP. In this series, 1 patient developed post-operative hypocalcaemia and needed calcium replacement. There was no other significant complication.

Conclusion

MIP is a safe, effective and well-tolerated procedure in the treatment of pHPT. It confers significant advantages over the traditional gold standard treatment of bilateral neck exploration. Accurate localisation is the key to successful MIP.

Pathological involvement of the submandibular gland in oral cancer; a rare entity.

J-P Jeannon, M S Elliott, E Ofo, E Odell, P Morgan, R Simo & M McGurk.
Presenting Author: Mr E Ofo, Department of ENT-Head & Neck Surgery
Guy's & St Thomas' NHS Foundation Trust, London, SE1 9RT. UK.
Tel. 0207 188 2213 Email: enyinnaya.ofo@gstt.nhs.uk

Introduction

Oral cavity squamous cell carcinoma (OCSCC) with lymph node metastasis confers a significantly worse prognosis, hence surgical management usually involves a neck dissection. In current practice the submandibular gland (SMG) is usually removed during excision of level I neck nodes, despite not having intraparenchymal lymphatic tissue. SMG excision is not without morbidity, as a significant proportion of patients experience xerostomia. The aim of our study was to determine the incidence of pathological SMG involvement in OCSCC patients undergoing a neck dissection.

Methods

Retrospective analysis identified 120 patients with newly diagnosed OCSCC who underwent either a selective or modified radical neck dissection at our single academic institution over a 9-year period (1999 to 2008). Median follow up was 65 months. Pathological reports were examined to determine the incidence of SMG involvement in level I of the neck. Statistical analysis was performed using PASW Statistics 18.

Results

Mean age was 60 years (range 21 to 100). Most patients had T2-T4 disease. Pathological SMG involvement was found in only 2 cases (1.7% of patients), both of which had advanced disease (T4) at presentation. Two year and five-year disease free survival for the whole group was 65% and 55% respectively. The two patients with SMG involvement had a 50% and 0% survival at two and five years respectively.

Conclusions

SMG invasion in OCSSC appears to be a very rare event. SMG preservation during neck dissection should be considered, and may be oncologically safe if there is no pre-operative indication of gross glandular invasion on clinical or radiological assessment.

Outcome of bone anchored hearing aids for single-sided deafness: a prospective study

Pai I, Kelleher C, Nunn T, Pathak N, Jindal M, Fitzgerald O'Connor A, Jiang D
Presenting Author: Miss Irumee Pai, Auditory Implant Department, St. Thomas' Hospital, Westminster Bridge Road, London SE1 7EH. Email: irumeepai@nhs.net

Objective

To evaluate the efficacy of the Bone Anchored Hearing Aid (BAHA) system for single-sided deafness (SSD) in adults by comparing pre- and post-operative Speech, Spatial and Qualities of hearing scale (SSQ) scores.

Study design

A prospective case series conducted within the Auditory Implant Team at St. Thomas' Hospital, London.

Methods

The inclusion criteria were unilateral profound hearing loss with normal or mild high frequency hearing loss in the hearing ear (pure tone average better than or equal to 25 dBHL measured at 0.5, 1, 2 and 3kHz) and subjective benefits reported by patients following a trial with BAHA worn on a Softband. Patients who met these criteria and wished to proceed with surgery were asked to complete the SSQ questionnaire pre-operatively. The post-operative SSQ response was collected after at least one month of consistent BAHA usage following the switch-on appointment.

Results

This study included 26 adult patients and the mean age at implantation was 57.5 years. There was a statistically significant improvement in the average SSQ score in all three sections of the questionnaire with the use of BAHA. Our patients experienced most marked benefits in speech hearing in challenging listening situations. All patients remain consistent users and there has been no explantation to date.

Conclusion

The BAHA system can offer significant benefits to patients with SSD, primarily by lifting the head shadow effect. It is likely that careful patient selection and on-going support play a vital role in successful rehabilitation.

Sodium Tetradecyl Sulfate Sclerotherapy For Treating Venous Malformations Of The Oropharynx In Children

Paul Stimpson, Richard Hewitt, Alex Barnacle, Derek J. Roebuck, Ben Hartley
Presenting Author: Mr Paul Stimpson, ENT StR. Great Ormond Street Hospital for Children, London UK.
Email: paulstimpson@doctors.org.uk

Objective

Venous vascular malformations in the head and neck region present a difficult management challenge. We describe our experience of using sodium tetradecyl sulfate injection sclerotherapy to treat children presenting with venous malformations of the oropharyngeal region.

Methods

We performed a retrospective case note review of consecutive children treated at our institution between 2004 and 2011. Patient notes were analysed for demographic details, site and size of lesion, number and duration of treatments, treatment response and complications.

Results

Twelve patients were included (7 boys and 5 girls, mean age 7 years). Sites of lesions included tongue, floor of mouth, pharynx, tonsillar fossae, parapharyngeal space and soft palate. All patients were treated with 3% sodium tetradecyl sulfate (STS) foam injected trans-orally or percutaneously under ultrasound or fluoroscopic guidance. The mean lesion volume was 4mls (2-14mls). An average of 3 treatments was required (range 1-9). In 4 patients a single treatment was sufficient. For those patients requiring multiple treatments, a mean of 4 treatments were required over an average period of 28 months. The overall response rate was 83% (10/12). Complete resolution was achieved in 4 cases (33%) with a significant reduction in size in a further 6 cases (50%). Larger lesions generally require more treatments than low volume lesions. Two cases recurred despite treatment. One patient suffered minor bleeding following transcutaneous injection.

Conclusions

Injection sclerotherapy using STS foam offers an effective treatment option when managing children presenting with oropharyngeal venous malformations. A single treatment may be adequate for small lesions but the procedure may be safely repeated until a satisfactory result is obtained.

What factors influence choice of cochlear implant model in paediatric patients?

Philip J Clamp, Terri Rotchell, Jennefer Maddocks, Philip J Robinson.
Presenting Author: Philip J Clamp, Registrar in ENT Surgery, Southmead Hospital, Westbury-on-Trym, Bristol BS10 5NB
Email: pjclamp@doctors.net.uk

Introduction

The West of England Cochlear Implant Programme purchases two makes of cochlear implant (CI) for paediatric use (MED-EL and Cochlear). If the CI team has no preference, the decision regarding which implant to use is made by the patient and family. Families are provided with information about the devices and allowed time to handle dummy implants and ask questions.

The aim of this study is to establish how patients make this choice and which factors are considered most important in the decision-making process.

Method

Patients who received a CI within the past 4 years were sent a postal survey, with reminders issued when patients attended for checkups. Patient were asked to rate certain factors from 0 to 10 depending on their importance in the decision making process.

Results

Sixty-four patients replied (response rate 74%). In most cases (83%), the parents and/or children were involved in the decision regarding the choice of implant. Eighty-nine percent of patients received information about the choices of CI from the CI team. Patients also accessed information directly from the manufacturer, from other CI users and from websites.

The most important factor in choosing cochlear implant model was robustness and reliability (mean score 9.6), followed by comfort (9.4), size/shape (9.2) and control system/ease of use (8.9). All patients were happy with the choices they made.

Conclusion

In this study, most patients undergoing CI were offered a choice of model. Robustness, reliability, comfort and size/shape of CI are considered the most important factors in this decision.

Patterns of Disease in Patients Presenting With Cervical Squamous Cell Carcinoma of Unknown Origin

Dr AD Dragan[1], Mr IJ Nixon1, Professor Eddy Odell[2], Dr T Guerrero-Urbano[3], Mr R Oakley1, Mr JP Jeannon1, Mr R Simo[1]

[1]Head and Neck Surgery Department, [2]Oral Histopathology Department, [3]Head and Neck Oncology Department
Guy's and St Thomas' NHS Foundation Trust, London
Presenting Author: Dr D Dragan. Email: dragan_denisa@yahoo.com

Objective

Diagnosis and management of patients presenting with carcinoma of unknown primary (CUP) has evolved over the last decade. Current guidelines recommend treating all levels of the neck. For the majority of cases this requires comprehensive neck dissection (ND), which may result in significant morbidity particularly in relation to the spinal accessory nerve (SAN).

Our aim is to define the pattern of lymph node metastasis, in a contemporary group of CUP patients, focusing on the anatomical distribution of levels involved.

Materials and Methods:

Retrospective review of patients presenting between 2000-2011 with CUP.

Results:

25 patients were identified with CUP. Median age 60 years and M:F ratio 3:1. 2 patients (8%) were pN1, 18 (72%) pN2 and 5 (20%) were pN3. 19 (76%) underwent comprehensive and 6 (24%) selective ND.
95 nodal basins were analyzed from comprehensive NDs. 65 (68%) were considered clinically N0. Of these, 5 levels (8%) harboured metastatic disease on pathological examination. The occult disease rate was 0% for level I, 40% level II, 10% level III and 6% for levels IV and V. The level V micrometastasis was below the accessory nerve (Vb).

Conclusion:

The rate of occult metastasis in neck levels is low in patients with CUP (8%). In carefully selected patients those without evidence of disease in level I or V may be considered for selective ND, with the potential benefit of sparing both submandibular gland and SAN function without compromise of oncological outcomes.

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