Clinical Otolaryngology

EDITED BY

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AND

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Preface

When we set out to edit this book we tried to picture the needs of a postgraduate student preparing for the final Fellowship examinations in the United Kingdom, Canada and Australia, or the Specialty Board examinations in the United States of America. During the training years the student will have read many excellent monographs in otolaryngology and its related sciences, and several of the atlases of surgery. He will also have acquired a grounding in the basic sciences and will have read basic texts in audiology. We felt, therefore, that towards the end of training there was a need for a comprehensive account in one volume of all aspects of the principles of otolaryngology which correlated previous reading.

A book on the principles *and* practice of otolaryngology must occupy several volumes due to the enormous expansion in the scope of the subject, from audiology and its applied physiological aspects at one end of the spectrum to the treatment of malignancy and reconstructive surgery at the other end. What then have we sacrificed to produce a one-volume text? The primary omission is operative technique. We felt that, due to the requirements of the various examining boards, candidates for final examination will have acquired sufficient knowledge of operative technique. Moreover, this is a skill which is not to be learned from the written word; instruction from teachers and reference to atlases of surgery are thus preferable to reading about it in a book of this type.

Basic sciences have also been pruned down to what might be considered an unacceptable brevity. Again we felt that by the time a candidate is in the final stages of preparation for an examination he should certainly know the relevant surgical anatomy and physiology at a satisfactory level. To have included more surgical anatomy and physiology would have increased the length of the book to unmanageable proportions.

If books that cover the entire principles and practice of otolaryngology are becoming more impossible to produce because of size, the days of one man writing a book on the principles of otolaryngology are certainly over. With the increasing subspecialization in otology, audiology, head and neck surgery and plastic and reconstructive surgery, there must be few general otolaryngologists with a sufficient expertise in all branches to create a book.

We thus had to recruit a team of authors, each of whom was chosen not only for his expertise but also for his international knowledge of the requirements demanded by the various examining boards. We were fortunate in obtaining help from forty-seven of the world's most prominent otolaryngologists. These contributions have inevitably been subject to editing, both to produce a uniformity of style and form and to avoid duplication: the editors are deeply grateful to the contributors for their tolerance of this editing process. Any faults in production of the chapters, therefore, are those of the editors and the authors should be absolved.

The book is subdivided into the four main subspecialties of otolaryngology: otology, rhinology, head and neck surgery, and paediatric otolaryngology. Some duplication was inevitable but we hope that it has been kept to a minimum.

Finally, we wish to record our gratitude to a number of people: to all the contributors; to the staff of Blackwell Scientific Publications, and Mr. Nigel Palmer in particular, for their patience and help; to Dr. John Hibbert for reading the proofs and preparing the index; to numerous registrars for their criticisms at the galley stage; to our secretaries for typing, organizing and portering with good grace; and finally, but by no means least, to our wives.

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A.G.D. Maran
P.M. Stell

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CHAPTER 1

Audiology

AUDITORY SYMPTOMS

The four basic auditory symptoms are *hypoacusis*, *dysacusis*, *dysstereoacusis* and *tinnitus*. There are also indirect symptoms, such as *delayed* or *defective speech development*, *auditory inattention* (or *unresponsiveness*) and *response inconsistency*, which are very important in respect of children. Auditory hallucinations, being psychotic symptoms, are the proper subject of psychiatry.

Hypoacusis

Hypoacusis is an elevation of the threshold of hearing (*anacusis*, if there is no hearing). Hypoacusis indicates either impairment of sound transmission through the external and middle ears to the internal ear or a lesion of the first and/or second cochlear neurone. The term 'deafness' should be reserved, as in its simple everyday use, to a total or severe impairment of hearing [1].

Dysacusis

Dysacusis is best restricted to cover difficulties in hearing other than those due to hypoacusis or dysstereoacusis. Thus, dysacusis comprises *distortion* of sound, *diplacusis binauralis* (difference in pitch of the same tone presented to each ear) *echoing* sensations and abnormal growths of loudness, including *phonophobia* (abnormal sensitivity to suprathreshold sounds). Distortion of sound and diplacusis binauralis indicate lesions of the spiral receptor organ. Phonophobia may occur not only in internal ear disorders but also in conditions where there is no lesion of the auditory system, for example, in paralysis of the nerve to stapedius and in anxiety and other psychological states. The term *paracusis Willisii* is applied to the symptom of hearing better in noisy environments than in quiet ones. Paracusis Willisii is characteristic not only of otosclerosis but of conductive hearing impairments in general. *Autophony* refers to the perception of one's own voice as though it were originating inside the skull.

Dysstereoacusis

Dysstereoacusis comprises both impaired sound directionalization and impaired distance perception; both of these are rare as presenting symptoms. The symptom may indicate a central lesion which is responsible for failure to integrate sound signals coming to the two ears. Subjects with a sudden incomplete unilateral hearing loss rapidly adapt to the disturbance in sound localization.

Tinnitus

If a patient complains of hearing sounds for which there is no evident external cause, this symptom is referred to as tinnitus. But this term does not include the hearing of organized sounds, which symptom is referred to as an auditory hallucination. On the one hand, tinnitus may be intermittent and the only symptom heralding a tumour of, or pressing on, the vestibulocochlear nerve, and such a tinnitus may be insufficiently annoying for the patient to seek medical help. On the other hand, a sustained tinnitus may be associated with benign aural disease or no evident disease at all and yet, because of its terrifying soul-destroying nature, drive the patient towards suicide.

Objective tinnitus is tinnitus which is also audible to observers other than the patient. It may arise from a foreign body in the external acoustic meatus, or from some physiological disturbance in the head [2]. Mandibular joint dysfunction may present as 'clicking' tinnitus. In Costen's syndrome, a mandibular joint derangement is associated with an internal ear dysfunction, which itself may be characterized by tinnitus. Myogenous tinnitus is experienced with palatal myoclonus (myorhythmia), in tensor tympani disorders, and after facial palsy. Respiratory tinnitus – hearing one's own breathing – occurs in patulous auditory tubal conditions. Vascular tinnitus may be pulsatile or due to a high frequency tone [3].

Subjective tinnitus is far more common than objective tinnitus, and can occur in almost any type of auditory disorder. Conventionally, subjective tinnitus is divided into 'peripheral' and 'central' according to whether or not it can be masked. It is unusual for 'peripheral' subjective tinnitus to be a pure tone, but patients prefer to match the sound that they hear to a pure tone rather than a narrow band of noise.

There are broad similarities between pathological pain states and tinnitus; in particular, both symptoms are very resistant to section of the corresponding sensory nerve, although they are frequently ameliorated by such procedures. Although tinnitus is usually brought to a tolerable level by section of the vestibulocochlear nerve, there has been at least one case where such a procedure accentuated the tinnitus.

AUDIOLOGICAL UNITS

The pitch of a pure tone is a function of its *frequency* (symbol, f). The frequency of a tone is defined as the number of sound waves passing any point of the sound field each second. Thus, according to the International System of Units, a tone with 2000 waves passing a given point in 1 second is said to have a frequency of 2000 hertz. The symbol for 'hertz' is 'Hz'. Since this unit is the reciprocal of the second, which is an SI base unit, it is said to be a derived unit. Thus a frequency that was formerly referred to as 2000 c.p.s., or 2000 c/s, is now referred to as 2000 Hz.

The *intensity* (symbol, J) of a sound is expressed in watts per square metre ($W{\cdot}m^{-2}$) which is also a SI derived unit. The smallest audible intensity is about 10^{-12} $W{\cdot}m^{-2}$. Sound intensities more than one thousand million times greater than this occur in factories where noise hazards exist. A reduced scale is thus required for practical purposes. This is the *decibel* scale. The decibel (dB) is one-tenth of a *bel*, which is the logarithm of the ratio of two particular sound intensities. Since the scientist measures sound pressure and not sound intensity, and pressure is proportional to the square root of intensity, the decibel scale is also derived from the ratio of two sound pressures:

i.e. $$L = 10 \log_{10} I_2/I_1 \qquad (1.1)$$

where L = sound level in decibels
I_1 = reference intensity ($W{\cdot}m^{-2}$)
and I_2 = intensity of sound in question ($W{\cdot}m^{-2}$).

$$L = 10 \log_{10} (p_2/p_1)^2 \qquad (1.2)$$

$$L = 20 \log_{10} p_2/p_1 \qquad (1.3)$$

where L = sound level in decibels
p_1 = reference pressure in pascals
and p_2 = pressure of sound in question in pascals.

Equation (1.3) indicates that 1 dB corresponds to a 12% change in sound pressure. Depending on the reference pressure, there are three decibel scales. First, unless stated otherwise, the reference pressure (p_1) is taken to be 20 μPa (micropascals). This latter value was formerly expressed as 0·00002 newtons per square metre (and before that as 0·0002 dynes per square centimetre). The pascal is a derived SI unit. If the reference pressure is 20 μPa, a sound level of, for example, 95 dB should be expressed as 95 dB *SPL* (*sound pressure level*). The use of this particular decibel scale is usual when measurements are made of industrial sound levels. In audiometry (see later), the reference pressure depends upon the frequency, since it is the pressure of the faintest sound heard by otologically normal young adults at that frequency. These pressures have now been defined by the International Organization for Standardization. To avoid specifying the reference pressure at each frequency, audiometric sound levels are referred to, for example, as 45 dB *HL* (*hearing level*). A third decibel scale is that which refers sound levels to a particular individual's threshold of hearing at a given frequency, i.e. the scale of *sensation level* (*SL*). Thus, if a patient has an impaired threshold of hearing of 45 dB HL, a tone which is 25 dB above his threshold, i.e. at 70 dB HL, is said to have a level of 25 dB SL.

AUDITORY DIAGNOSTIC TESTS

It is convenient to discuss auditory diagnostic tests under three headings:

(1) Psychoacoustical, i.e. tests of auditory sensation and perception;

(2) Acoustical, i.e. measurement of the acoustical properties of the ear, and changes incurred in these by various stimuli, and

(3) Electrophysiological, i.e. measurement of the electrical changes (evoked potentials) induced by acoustic stimuli.

Psychoacoustical tests are frequently termed *subjective*, since the results depend upon the patient's volunteered responses to acoustic stimuli. *Acoustical* and *electrophysiological* tests are frequently termed *objective*, since they do not require the patient to volunteer a response. Although the second and third groups of tests are objective in respect of the patient, the interpretation of some of these tests requires a decision that is sufficiently subjective that the term 'quasi-objective' would be more appropriate.

Psychoacoustical tests comprise both clinical tests of hearing and tests of hearing using electroacoustic equipment, i.e. conventional audiometry.

Clinical tests

Clinical tests of hearing comprise both speech tests and tuning fork tests.

Clinical speech tests

Clinical speech tests comprise both *forced whisper* and *conversational voice tests*. A forced whisper test uses a whispered voice after a forced expiration by the examiner. When either forced whisper or conversational voice tests are employed, the examiner stands facing the side of the patient. Two precautions to avoid false results must be taken: the patient's eyes must be shielded by the palm of the examiner's hand to prevent lip-reading; the tragus of the ear not being tested should be massaged by the middle finger of the examiner's other hand; this produces a masking noise in the non-tested ear.

When the examiner's hands are so occupied, the maximum distance between the examiner's mouth and the patient's ear is about 50 cm. However, if a patient can hear a forced whisper at this distance under the ambient noise conditions that commonly obtain in clinical examination rooms, the patient is unlikely to have any appreciable impairment of hearing.

Tuning fork tests

The principal tuning fork tests of value to the otological surgeon are three tests (bone-conducted cross-hearing, Teal, and Stenger) to ascertain whether a unilateral hearing loss is non-organic or organic and two tests (Schmalz and Rinne) to determine the nature of organic loss.

The first test for a unilateral suspected non-organic hearing loss is to ascertain whether the patient denies hearing a tuning fork placed on the ipsilateral mastoid process; irrespective of the degree of hearing loss the patient should hear the fork because the interaural attentuation of bone-conducted sound is negligible.

The Teal test. If a patient with a unilateral loss to air conducted sound admits to hearing by bone conduction, the examiner should then retest the patient, who should have his eyes closed, by applying a non-vibrating tuning fork to the ipsilateral mastoid process and simultaneously bringing the prongs of a vibrating fork near to the patient's ear. Usually the patient does not suspect that two tuning forks are being used; he feels the fork applied to the mastoid process and at the same time hears a sound if his hearing is normal; in this case he does not dissociate these two sensations and acknowledges hearing a sound.

The Stenger test. If the two ears of a person with the same threshold of hearing in each ear are stimulated by a sound of the same frequency but of a different intensity a single sound is heard in the ear that receives the greater sound intensity. Thus, if, in a patient exhibiting a unilateral deafness to air conducted sound, a pair (unknown to the patient) of vibrating tuning forks are so disposed that one is much nearer the deaf ear, the patient will deny hearing anything if the hearing on that side is normal; if the hearing is truly impaired in that ear, the patient will acknowledge hearing a sound but refer it to the opposite ear.

The Schmalz test* ascertains whether a unilateral organic hearing loss is conductive (due to impairment of sound transmission through the external and middle ears), or sensorineural (due to a lesion of the internal ear or the auditory nervous pathway). If, with a unilateral hearing impairment, a vibrating fork is applied to the vertex, a sound will be heard in the impaired ear if the loss is conductive; if the loss is sensorineural, the sound will be heard in the normal ear.

The Rinne test ascertains whether a unilateral or bilateral hearing loss is conductive or sensorineural. An ear is said to exhibit a *Rinne positive response* if a vibrating tuning fork is heard better by air conduction than by bone conduction (with the footpiece of the fork applied to the mastoid process). This response occurs in normal ears and in those with a sensorineural hearing loss. If the vibrating fork is heard better by bone conduction than by air conduction (*Rinne negative response*) the test must be repeated with a Bárány noise box applied to the opposite ear; if the same response occurs, then it is said to be a true Rinne negative; if the fork is no longer heard better by bone conduction, then it is said to be a false Rinne negative response. The effect of the noise in the opposite ear is to exclude the possibility of cross-hearing that occurs with severe sensorineural hearing loss. True Rinne negative responses occur with conductive hearing losses.

AUDIOMETRY

An audiometer is an electroacoustic instrument specifically designed to measure one or more aspect of auditory sensation or perception for clinical purposes [4]; this definition excludes instruments for measuring the acoustical properties of the ear or for measuring acoustically evoked potentials.

Audiometry [5] may:

(1) be performed by either air-conducted or bone-conducted acoustic stimuli;

(2) if using an air-conduction route, use stimuli delivered by either a loudspeaker or by an earphone;

(3) use tonal or verbal stimuli;

(4) be concerned with threshold or suprathreshold stimuli;

(5) be monaural or binaural;

(6) have the presentation of the stimulus controlled by the tester or by the patient; and

(7) if the presentation of the stimulus is under the control of the patient, use tonal stimuli that may be sustained or interrupted.

By choosing various combinations, a large number of audiometric procedures are possible. In practice, a limited number of tests are in use. Thus, we have:

(1) measurement of the air-conduction threshold of hearing for tones by earphone listening;

(2) the same as (1) but for bone-conducted stimuli;

(3) measurement of auditory adaptation at threshold for fixed frequency tonal stimuli;

(4) measurement of auditory adaptation at threshold for sweep frequency tonal stimuli;

(5) measurement of suprathreshold auditory adaptation for fixed frequency tonal stimuli;

(6) measurement of suprathreshold auditory adaptation for sweep frequency tonal stimuli;

(7) measurement of the recruitment of loudness sensation by

(a) recording the most comfortable loudness level,

(b) recording the threshold of uncomfortable loudness (sometimes referred to as the uncomfortable loudness level or the loudness discomfort level, but, of course, there are many such levels),

(c) alternate binaural loudness matching;

(8) measurement of fused binaural tonal threshold, i.e. audiometric Stenger test [6];

* Usually, but erroneously, referred to as the Weber test.