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Recent Advances

Otorhinolaryngology

Anthony Hinton, Victoria Moore-Gillon

As in all other specialties, changes in the organisation of the NHS and the purchaser-provider split have had effects on the practice of otorhinolaryngology. The most extensive change in practice over the past 12 months has not been the widespread adoption of a radical new diagnostic technique or surgical procedure but the increasing introduction of day case surgery. Procedures such as grommet insertion and reduction of fractured noses have long been performed as day cases, but many departments are now carrying out adenoidectomy, tonsillectomy, all types of nasal surgery, and even major ear surgery on a day case basis.¹ This has necessitated changes in working practices and philosophy as well as an appraisal of the safety of such a move to day case surgery. The specialty is also being changed, however, not just by financial considerations and pressures from purchasers but by technical advances in fields as diverse as molecular biology, optical fibres, computers, microelectronics, and metal-lurgy.

Virtual reality programs and surgical training

The complex and variable anatomy of the middle and inner ear, and the disastrous consequences of operative errors, means that the otorhinolaryngologist in training must spend much time operating on cadaver temporal bones before even starting to deal with patients. Computers running virtual reality programs are becoming increasingly sophisticated and widespread,² and a virtual cadaver system is already available for training medical students and junior surgeons.

A virtual temporal bone model is currently under development and will allow the complex three dimensional anatomy of the temporal bone and the relation between the middle ear ossicles, cochlea, vestibular labyrinth, and the facial nerve to be better understood and appreciated. The advantages of such a system are that the anatomy can be viewed from any angle and not just from those possible by operation or temporal bone dissection. It is possible, for example, to view the contents of the middle ear from within the inner ear.

Advances in otorhinolaryngology

- Virtual reality programs for surgical training
- Otoacoustic emission testing for hearing impairment
- Advances in understanding the physiology of smell
- Better lasers for precision surgery
- New techniques for laryngeal reinnervation and palatal surgery
- Implanted aids to treat hearing loss

Diagnostic techniques—otoacoustic emissions

External sound waves move the basilar membrane in the cochlea. The cochlea itself then produces sounds, otoacoustic emissions, which can be detected and measured by a microphone in the external ear canal.³ Emissions are more easily recordable in younger subjects than in older people, making the technique particularly valuable in those in whom the more conventional tests of hearing function, which require a subjective response and the cooperation of the patient, are difficult. Testing the hearing of a 2 year old child may take two experienced technicians up to two hours with conventional behavioural hearing tests, but an otoacoustic emission may be completed in less than 10 minutes.⁴ The technique has obvious potential as a screening test in neonates and also in the relatively rare cases of feigned deafness or of hysterical deafness.⁵ Equipment is relatively large and expensive at present, but advances in microelectronics and computing power suggest that a hand held, cheap, portable unit cannot be more than two or three years away.

Basic science—understanding the sense of smell

The mechanisms underlying odour transduction—by which binding of odour molecules to the olfactory mucosa produces neuronal impulses—and those

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responsible for the complex matter of odour recognition are at last becoming clear.⁶ Odour molecules entering the olfactory region are absorbed into the nasal mucus and carried on a binding globulin to receptors on the olfactory neuronal cilia. Binding of odour molecules produces changes in receptor conformation which activate a stimulatory protein that binds guanosine triphosphate. In turn, adenyl cyclase is activated and cyclic AMP synthesised. This opens a cation channel in the ciliary plasma membrane, leading to depolarisation and the subsequent generation of an action potential. A separate second messenger system involving inositol triphosphate, which opens a calcium channel in the membrane, modulates the response by amplifying the generation of cyclic AMP.

The odour receptors themselves, in common with many protein receptor molecules, have a characteristic seven transmembrane domain structure. Large numbers—probably hundreds—of broadly similar but subtly different seven transmembrane domain receptor proteins are present in the olfactory mucosa. There may be 15-20 different members of this receptor family present on the surface of each olfactory neurone. Any one cell may thus react to many different odours, and different neurones react to different sets of odours. Odours are recognised by the combination of olfactory neurones in which they produce membrane depolarisation: for any given odour, a unique pattern of neuronal depolarisation is stimulated, and it is this which after central processing and analysis gives rise to the characteristic olfactory sensation associated with that odour. Furthermore, positron emission tomography suggests that the cortical representation of olfactory processing in humans may be functionally lateralised: while there is bilateral representation in the pyriform cortex, and further evidence indicates additional cortical activity in the right, but not the left, orbitofrontal cortex.

New surgical tools—advances in laser surgery

Carbon dioxide and argon lasers have long been used in otorhinolaryngology, particularly for laryngeal and intranasal surgery. The more recently introduced potassium-titanyl-phosphate (KTP) laser may have a number of advantages. The visible beam of this laser means that, unlike other lasers, no separate aiming laser is necessary; a 1 mm difference between an aiming beam and a working laser beam may not be critical in removing tonsils but could have devastating consequences in middle ear microsurgery. The KTP laser may offer greater precision than conventional drills when reshaping and rearticulating the component parts of the ossicular chain (which are only 3-4 mm long) and there is no risk of noise induced damage.⁷ The laser may also be suitable for welding of divided nerves and may give a superior result to traditional repairs using fine sutures.⁸

In future, the erbium-yttrium-aluminium-garnet laser may also have a role in middle ear and intralaryngeal work. Its effects are very circumscribed, with only 10% of the collateral tissue damage caused by a conventional carbon dioxide laser, but it is poor at sealing off blood vessels.⁹

New operative techniques in the pharynx and larynx

LARYNGEAL REINNERVATION

The traditional approach to a patient with a unilateral vocal cord palsy was to investigate the cause and treat it if possible, await any recovery, and then to inject Teflon lateral to the paralysed cord to improve cord apposition and thus the voice. This technique has since been superseded by implants of gel foam, Silastic, or cartilage, but these procedures still result in an

immobile vocal cord. Very recently the use of medialisation techniques has been combined with vocal fold reinnervation and is giving superior results.¹⁰ The technique can be carried out under local anaesthesia. A nerve muscle pedicle developed from the ansa hypoglossi to the anterior belly of the omohyoid muscle is inserted through a window cut in the thyroid cartilage and sutured to the intralaryngeal muscles. A Silastic block is then inserted through the window to medialise the vocal cord. Between two and six months after the operation the nerve-muscle pedicle implant restores both adduction of the vocal cord and the ability to tense the muscle and so control voice pitch. Experimental data confirm that physiological vocal cord movements can be achieved with this type of reinnervation technique.¹¹

PALATAL SURGERY FOR SNORING

Severe snoring is a laughing matter only for those who have never experienced it. It wrecks relationships, disrupts families, and causes problems with neighbours, on holiday, and in hotels. Many sufferers—and their partners—are desperate for help. Thorough investigation by a doctor with a special interest in disordered breathing in sleep is necessary before surgery is considered, in particular to check for obstructive sleep apnoea and to explore other remediable causes like obesity.

Recent studies have shown that the main contribution to the noise of snoring is palatal flutter, which in turn depends on palatal length and stiffness. In conventional uvulopalatopharyngoplasty the tonsils, together with the uvula and an area of soft palate, are removed (fig 1). This procedure is generally painful and if too radical can result in postnasal regurgitation of food and drink.¹² A new procedure, instead of trying to reduce the length of the palate, removes a central strip of palatal mucosa with a laser (fig 2). Fibrosis then occurs and stiffens the palate. Almost 90% of patients (or their partners) are said to benefit; the operation is less painful than uvulopalatopharyngoplasty, and the risk of postnasal regurgitation is much reduced.¹³ It must be emphasised, though, that the long term efficacy of the procedure is not yet known.

New operative techniques in the nose

Functional endoscopic sinus surgery techniques use rigid endoscopes and microinstruments to operate principally on the structures of the middle meatus, into which most of the nasal sinus ostia open and towards which the cilia lining the nasal sinuses beat. The surgery is "functional" in that it follows the natural physiological principles of paranasal sinus drainage wherever possible. In some centres these techniques have been practised for several years, but only very recently has such surgery become more widespread in Britain, with about a third of surgeons now using the approach. Prospective studies show excellent results in terms of sinus related symptoms and nasal mucociliary function in the best and most experienced hands.¹⁴ A thorough knowledge of the anatomy of the paranasal sinus and particularly the lateral nasal wall is vital: the surgeon, operating endoscopically, may at times be less than a millimetre from the orbital contents or the optic nerve.¹⁵ Careful training, even for surgeons with many years' experience of conventional sinus surgical techniques, is extremely important.

New technology and operative techniques in the ear

OSSICULAR IMPLANTS AND ELECTROMAGNETIC HEARING AIDS

Presbycusis is the most common cause of adult hearing loss and is due to a loss of both cochlear hair

FIG 1—A standard uvulopalatopharyngoplasty removes tonsils, uvula, and area of soft palate (shaded area) to reduce the length of the palate and hence the noise of snoring

FIG 2—Removing a central strip of palatal mucosa (shaded area) increases the stiffness of the palate, which reduces snoring

FIG 3—The magnet of an implanted hearing aid can be affixed to the malleus, as shown, or (suitably encased) can replace the incus; the amplifier can be worn behind the ear or housed in the ear canal with the coil

cells and neurones. This type of hearing loss is generally greater in the higher frequencies, causing particular problems with the perception of consonants, which are essential for the understanding of speech.¹⁶ Conventional analogue hearing aids can give good results but are surpassed by digital programmable aids which selectively boost the frequencies where hearing loss is greatest and also reduce the amplification of background noise. Even this sophistication still leaves problems with feedback, and the patients' own voices will sound louder to them with an aid blocking their external ear canal. The latest attempts to improve hearing aids further are based on moving the output stage of the hearing aid from a device vibrating air in the ear canal to a magnet implanted on the ossicular chain inside the middle ear. The movements of the magnet (and thus the ossicular chain) are driven by a coil generating a magnetic field in the ear canal. Previous problems with inefficient coupling between magnet and coil are being solved by the use of powerful magnets of neodymium-iron-boron and improved coil design.¹⁷ Until recently such hearing aids were still experimental; the patients under study, who had experienced problems with conventional aids, nearly all found excellent sound clarity by comparison when using the implantable aids (fig 3), which are now being made available commercially.

BONE ANCHORED HEARING AIDS AND OSSEOINTEGRATED PROSTHESES

Titanium osseointegrated implants were first used in dentistry as a system to replace missing teeth. Holes are drilled in bone by a special low speed drill with water cooling so that bone adjacent to the hole is left viable. A

screw thread is then tapped into the hole so that a titanium implant can be screwed in place. Within a few months the surface of the titanium integrates with the living bone and provides a nonreactive structure which can protrude through mucosal or skin surfaces without causing irritation.¹⁸ In otorhinolaryngology the use of these implants is becoming extensive. Bone conducting hearing aids can be attached to the titanium implants placed in the mastoid bone and in conjunction with silicone external ear prostheses also held in place by titanium implants are now the method of choice in the treatment of congenital external and middle ear abnormalities in children. Both the hearing and cosmetic results are far superior to traditional surgery involving multiple operations.¹⁹ Bone anchored hearing aids are also useful in patients with chronically discharging mastoid cavities and are even being proposed as an alternative treatment to a stapedectomy in patients with otosclerosis, as a way of avoiding the risk of total deafness in the operated ear after this operation.

COCHLEAR AND BRAIN STEM IMPLANTS

Treatment of profound and total deafness has been revolutionised in the past few years by a combination of the development of specialist multidisciplinary teams and by technical advances. In individuals with impaired or absent cochlear function, cochlear implants have had a dramatic impact. The most recent 22 electrode multichannel implants (fig 4) allow about half of patients to comprehend speech without the need for lip reading, and around a quarter can use a telephone.²⁰

Most implants have so far been in adults, but increasing numbers are being inserted into prelingually deaf children. This not only allows the child to hear but in consequence allows speech development in an individual who would otherwise be less likely to have recognisable speech.

A prerequisite for a cochlear implant, however, is a functioning cochlear nerve. For those without such function, the most recent development is the auditory brain stem implant,²¹ in which an electrode array is sited directly over the inferior ventral cochlear nucleus of the brain stem.²² Only a few have been inserted worldwide, the first British implant being carried out in Manchester in February 1994 in a patient with deafness due to bilateral acoustic neuromas. The "sounds" perceived are crude compared with those achieved by cochlear implants, but when such patients combine the input with lip reading the ability to communicate is improved.

What next?

Robotic surgery could well be next. Virtual reality systems are not only used for training purposes—similar programs can also be used to build up three dimensional data from computed tomography or magnetic resonance imaging scans of a living patient. Quite apart from aiding the conventional surgeon, the representation of any point within the potential operative field on an x,y,z coordinate system opens up the prospect of robotic surgery. Such surgery is most easily possible where there are fixed bony reference points and the operative area can be rigidly immobilised. Operations on the skull base, temporal bone, and paranasal sinuses would be particularly suitable. A robot, with suitable safety features,²³ could then use the coordinates to guide tools such as drills, biopsy forceps, or endoscopes to a target—for example to take a biopsy sample from a tumour.²⁴ Representations of the tool being used and its position may be generated and superimposed on three dimensional reconstructions from the preoperative scans.

FIG 4—Nucleus 22 channel cochlear implant system. Reproduced by permission of Cochlear (UK) Ltd

Even with robots now appearing, surgeons should not give free rein to their Luddite tendencies. Technological advances have always made easier what was once difficult. The same advances make the previously impossible merely the very difficult. The challenge of surgery, and the potential for progress, remains.

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Controversies in Management

Should obesity be treated?

Treatment is necessary

J S Garrow

This is the second in a series of articles examining some of the difficult decisions that arise in medicine

Most people will agree that mending machinery which has broken, teaching a child useful skills, and preserving an artistic masterpiece are, in principle, useful. Most will also acknowledge that it is possible to do these tasks so badly that the final state is worse than at the start. Similarly, it is possible to treat obesity so incompetently that the net effect is to make the obese patient worse. We should not argue from this that we should not treat obesity, any more than that we should not mend machinery, teach children, or preserve artistic masterpieces. I will assume, therefore, that by treating obesity we mean doing so with reasonable competence. Two further definitions need stating. By "obese" I mean having a Quetelet's index (body mass index) over 30. Also, I assume that the objective of all medical treatment is to make life more tolerable to patients by increasing the extent to which they can undertake activities or projects that they reasonably want to do.

Adverse effects of obesity

Disabilities associated with obesity are decreased longevity and increased risk of cardiovascular disease, hypertension, diabetes, osteoarthritis, and some forms of cancer sensitive to sex hormones. With weight loss longevity increases and the risk of these diseases falls.¹ Obese people are also discriminated against socially and tend to have a low self esteem. Psychologists may argue that by advocating weight loss we are condoning the discrimination against obese people and that when the treatment fails this will further damage the patient's self esteem.² I think this argument is nonsense: patients' morale may improve in the short term when they are assured that they have a right to be obese, but this does not reduce the long term physical penalties listed above. Certainly it is unethical to make a half hearted attempt to treat severe obesity, since in

this case the chance of achieving worthwhile weight loss is poor and the danger of damaging the patient's self esteem by failure is great.

There are two crucial questions in this debate. Firstly, is it physiologically possible for a severely obese patient to achieve normal weight and health? Secondly, if so, is the cure less distressing for the patient than the disease? Unless we can answer yes to both questions we should not treat obesity.

There is ample evidence to show that obese people can achieve normal weight. Under metabolic ward conditions any desired weight can be lost, at a rate of about 1 kg/week, by following a reduced energy diet.³ Statements that metabolic rate falls and blocks further weight loss² are incompatible with the evidence.⁴ Whether the cure is more distressing than the disease is more difficult to answer, since it depends on the patient's perception of the efficacy of dieting and of the probable consequences of remaining obese. This perception is affected by propaganda that obesity is not really a health hazard, that dieting is physiologically doomed to failure, or that weight can easily be lost without dieting by means of some magic pill or potion. The more persuasively arguments are advanced that obesity cannot be treated, or should not be treated, the more difficult it becomes to treat.

Who should treat obese patients, and how?

The prevalence of obesity is rapidly increasing in many countries, including the United Kingdom (figure).⁵ I have already noted the dangers of inadequate treatment, so with limited NHS resources how can adequate treatment be provided for the 13% of adults who are obese?

It is impractical to suggest that doctors in hospital or general practice should see patients individually and follow them up adequately. I believe that a combined

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