Clinical review

Recent advances

Otorhinolaryngology

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Otorhinolaryngology has developed over the past few decades into a wide diversity of subspecialties, each with its own changes, developments, and trends. One important area where much development is still needed is head and neck oncology. Nearly 5% of human cancers originate in the upper aerodigestive tract, and mortality has hardly changed in recent years. The incidence of head and neck cancer has increased slightly, and it is still accompanied by a high rate of morbidity due to impairment of breathing, swallowing, chewing, and speaking despite considerable effort being put into developing alternative treatments and methods to restore form and function.

Computer technology has made remarkable advances possible for some groups of patients. Cochlear implants have allowed deaf patients to regain their hearing ability, and the miniaturisation of hearing aids has greatly helped people with impaired hearing. Use of computer guided surgery also seems likely to improve outcomes, especially in patients whose anatomy has been affected by previous surgery or malignancy.

Digital hearing aids

The recent development of digital hearing aids has been a big step forward in overcoming hearing impairment.^{1,2} The hearing aids work by converting an incoming analogue signal into a digital one, which is then processed by a microprocessor and then changed back into an analogue signal before output (fig 1).³

The main advantages of the digital technique are that the signal can be processed to suppress noise or to amplify specific frequencies or sounds.⁴ The latest generation of digital hearing aids can recognise speech, which allows them to suppress other noise and make hearing clearer. The multiprogram devices can adapt to specific situations in the patients' everyday lives, especially with noise suppression, which further improves the ability to hear. The enhanced sound quality of the digital amplifying system also make voice and sound more similar to reality, increasing the acceptability to patients. Other advantages include greatly reduced feedback and easier handling. The development of "real" binaural interactive signal processing may provide even better hearing in noisy environments.⁵

Summary points

Digital hearing aids with multichannel and programming systems can reduce noise and greatly improve the hearing ability of the hearing impaired

Auditory brainstem implants give patients with bilateral nerve deafness the chance to partly regain their hearing ability or to support their lip reading capability

Injections of botulinum toxin type A are a fast and safe treatment in patients with adductor spasmodic dysphonia

Aesthetic surgery has been improved by using endoscopic facial plastic surgery and laser skin resurfacing to remove altered or photodamaged skin without bleeding

Laser induced fluorescence spectroscopy may be useful for non-invasive early diagnosis of cancer of the upper aerodigestive tract

Lasers are also being used in photodynamic therapy of cancer and for removal of hypopharyngeal and laryngeal cancers

Reconstruction of the head and neck region after radical surgery or trauma with free flap transfer is a fast and reliable way to diminish physical, psychological, and social problems due to soft tissue defects in the head and neck region

Auditory brainstem implant

The past 15 years has seen much progress in restoring hearing to deaf patients. Cochlear implants were successfully introduced for patients with inner ear deafness. However, in rare cases when both auditory nerves are destroyed, such as in neurofibromatosis type 2 or after traumatic lesions, a cochlear implant cannot be used. Auditory brainstem prostheses have been developed for these patients that work by electrical stimulation of the second auditory neurone in the brainstem. The implant has been developed from

single channel electrodes positioned in the brainstem,⁶ to the 21 channel model currently used in Europe. Like patients with cochlear implants, patients with auditory brainstem implants wear a body level speech processor and a transmission coil on the scalp. The electrodes are placed in the lateral recess of the fourth ventricle, adjacent to the cochlear nuclei.

Hearing results are not as good as with cochlear implants.⁷ Only a few patients with auditory brainstem implants can understand closed set speech without lip reading, but many patients report that the device improves their conversational ability significantly because it helps lip reading.^{8,9} Experience with multichannel auditory brainstem implants is limited because of the low incidence of patients with neurofibromatosis, but the implants are a promising way of improving hearing in these patients. Continuing research and refinement of hardware and software will help to improve the hearing of patients with neurofibromatosis further.

Treatment of focal dystonias with botulinum toxin

Spasmodic dysphonia is a rare focal dystonia of the larynx that affects the vocal muscles. The disorder results in abnormal speech production with a hoarse or strained voice and often leads to aphonia. Difficulties with communication in these patients often leads to anxiety and depression. In adductor spasmodic dysphonia, paralysis of the thyroarytenoid muscle helps prevent the development of the high subglottic pressure that is associated with vocal spasms. Recently impressive relief of symptoms has been reported with injection of botulinum toxin type A into the thyroarytenoid muscles.¹⁰ The neurotoxin, which is produced by the anaerobic Gram positive bacterium *Clostridium botulinum*, acts at the neuromuscular junction, causing chemical denervation of the muscle. The success rate is reported to be up to 92%, and side effects are rare, usually being limited to swallowing problems.¹¹ The treatment needs to be repeated every two or three months since the effect fades over time. Speech production after injection can be classified as normal, and patients are able to work without any impairment. Botulinum toxin has also been used to treat of vocal fold granulomas,¹² glabellar frown lines, and hyperfunctional lines of the face in facial plastic surgery.

Computer assisted surgery

Computer assisted surgery gives the surgeon continuous orientation within the skull. The computer provides a three dimensional picture based on computed tomography or magnetic resonance imaging scans taken before surgery and superimposes the position of the endoscope or microscope.^{13,14} A high resolution scan is taken before surgery with the patient wearing a headset or other device to provide anatomical reference points for intraoperative calibration. The accuracy depends not only on the reference points but also on the immobilisation of the head, calibration, and sequencing.¹⁵

Computer assisted surgery has recently been used for operations on the paranasal sinuses, the maxillo-facial region, and the middle and lateral skull base. The

Fig 1 Schematic illustration of a digital hearing aid (modified according to Steffens^{3,4})

technology helps surgeons to avoid harming any sensitive structure and is especially useful when the patient has had previous surgery or malignancy that has altered the normal anatomical structure. The next logical step is to link robotics to the computer to aid and direct surgery. An intraoperative guidance system with a proprioceptive robotic-like print arm has already been used successfully for operations on the skull base.¹⁶

Aesthetic surgery

The increasing desire for facial rejuvenation by more and also younger patients has led surgeons to seek better approaches. Two recently developed techniques have improved results in aesthetic surgery. The first is the application of endoscopic techniques in facial plastic surgery and the second is laser skin resurfacing, which is used mainly to treat facial wrinkles.

Most patients having cosmetic brow lifts are now treated by endoscopy using the subperiosteal approach rather than incisional brow plasty.¹⁷ The endoscopic malar pad lift has many advantages, and the results are encouraging.¹⁸ A full facelift through an endoscopic approach has been indicated for younger people without significant skin excess but with mild laxity of the midface.¹⁹

Laser skin resurfacing is a promising new treatment for photodamaged skin, wrinkles, and fine scars. A high energy, short pulse, carbon dioxide laser is used that can complete high power pulses in less than the thermal relaxation time of skin, which is estimated to be less than 1 millisecond.²⁰ The technique allows removal of layers of skin only 100 µm thick without bleeding.²¹ A computerised pattern generator provides more rapid resurfacing with more uniform, accurate, and precise distribution of the laser impact than is possible freehand.²² Although treatment is usually successful, in a few cases a transient erythema and hypopigmentation can occur.²³

Lasers

Lasers have been used in medicine for over 20 years, and they now have several established applications in otorhinolaryngology. Three possibilities for extending their use have become available in recent years.

Early detection of upper aerodigestive tract cancer

Research into the use of laser induced fluorescence spectroscopy as a potential non-invasive diagnostic tool for differentiating normal and neoplastic human tissues has been underway for over 10 years. The tech-

nique involves illuminating tissues with a monochromatic light from a helium-cadmium²⁴ or nitrogen laser²⁵ and measuring the intensity of the resulting fluorescence. The fluorescence characteristics depend on the biochemical composition and histomorphological architecture of the tissues, both of which are altered during malignant transformation. Malignant changes are therefore detectable as an alteration in the fluorescence profile of the tissue.²⁶ First results suggest that the technique may be useful for early diagnosis of cancer of the upper aerodigestive tract.^{25 27}

Another possibility for early detection of neoplastic lesions is the fluorescence labelling of mucosal lesions by the local application of 5-aminolevulinic acid. This technique seems to be a promising diagnostic procedure for neoplastic lesions that are difficult to detect during white light examination.²⁸

Photodynamic therapy

Photodynamic therapy is a method of specifically destroying cancer cells. Light of a specific wavelength is absorbed by a photosensitising dye which accumulates in tumour tissue. It is unclear exactly how the drug works after exposure to light, but it seems to be based on excitation of dye molecules to a higher energy level. In the subsequent decay free radicals are released, which destroy vital cell structures and cause cell death. The treatment initially used a haematoporphyrin derivative as the photosensitiser and laser light with a wavelength of 630 nm.²⁹ New photosensitisers have been developed that have reduced systemic toxicity and are more effective than the initial compounds. Promising results in the treatment of head and neck tumours

have been obtained with second generation photosensitisers like meta-tetrahydroxyphenylchlorin.²⁹

The advantage of photodynamic therapy is that it destroys only malignant cells and therefore causes less morbidity than standard treatments like surgery and radiotherapy. However, it can produce a general photosensitivity and is limited to small tumours because of the photophysical properties of the sensitising dye and use of a wavelength with a low penetration depth.

Excision of laryngeal and hypopharyngeal cancer

Use of laser surgery to treat limited carcinomas of the vocal cord has increased considerably since its introduction in the 1970s, and it has been shown to be as successful as radiation therapy. In contrast endoscopic treatment of advanced laryngeal carcinomas with carbon dioxide lasers is still controversial, partly because these tumours are often not removed in one piece with laser surgery.^{30 31} Nevertheless, long term studies of laser surgery of advanced laryngeal carcinomas and hypopharyngeal carcinomas show that it produces results comparable with those of radiation and conventional surgery.³² These results need to be confirmed by other studies.

The most important aim of laser surgery is preservation of the larynx, which is especially important for carcinomas of the hypopharynx. The prognosis of most patients with hypopharyngeal cancer is poor (five year survival 20-30%) because of the high rate of lymphogenic metastases and, less often, local recurrences. In patients with a hopelessly advanced metastasis laser surgical resection can help to preserve the larynx for the remaining life time (fig 2) and increase the quality of life.

Reconstruction with free flap transfer

Resection of tumours from the head and neck is often associated with serious destruction of anatomical features. This is followed by physical, psychological, and social problems because of difficulties in swallowing, breathing, speaking, and chewing. These difficulties can be reduced through the reconstruction of affected areas in the head and neck region by using musculocutaneous free flaps. Rapid developments in microsurgical techniques mean that head and neck surgeons can now radically resect the primary tumour and reconstruct the operated site in a single procedure. Free flaps generally require large vessels to allow easy anastomosis and a sensory cutaneous nerve for reinnervation of the flap. The donor site should provide an adequate amount of easily harvested tissue, and the removal should result in minimal morbidity.³³ Different free flaps have been developed and evaluated, and each has advantages and disadvantages.^{34 35} Jejunal flaps are usually used in reconstructive surgery of the oral cavity as they are highly flexible and produce mucous, which cleans the surface of the transplant. Other sources include the lateral arm, the lateral thigh, the latissimus dorsi, and the scapular. Free flaps are reliable and may make it unnecessary to sacrifice trunk muscles to close the wound. They are therefore now the main method for reconstruction of head and neck defects.

Fig 2 Carcinoma in right hypopharynx (►) of 53 year old man before (top) and 30 months after (bottom) laser surgical excision. Right vocal cord is indicated with → and endotracheal tube with *

Laser activated cancer treatment: a low power red argon laser passes through from optical fibre waveguides to treat a cancer in a woman's throat

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Osseointegrated implants for head and neck reconstruction

Reconstruction and rehabilitation of patients with head and neck cancer is a challenging task. Musculocutaneous flaps or bone flaps are usually used to reconstruct mandibular or midface defects after resection of malignant tumours, severe trauma, or congenital effects. In certain cases osseointegrated implants can be used to provide stability and support for facial and intraoral prostheses to restore head and neck defects.³⁶ The patient may then have dental and facial rehabilitation later. Osseointegrated implants are placed into either a bone flap or the native bone.³⁷ The most common form is osseointegrated dental implants, which are used after resection of oral or oropharyngeal tumours and reconstruction of the mandible with a fibular graft. But nasal, aural, and ocular prostheses can also be integrated into the head and neck region for reconstruction of affected areas. High success rates have been reported for osseointegrated implants in mandibular, auricular, and nasal reconstruction. Success rates have been lower when they are placed in frontal bone for retention of orbital prostheses and in irradiated bone sites. Most implants placed in irradiated bone are beginning to show signs of impending failure.³⁶ Currently facial prostheses are normally used in patients with defects caused by removal of tumours or congenital defects, and although there is also some experience with extraorally bone anchored implants, patients and medical and dental staff are still reluctant to use them.

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