

What You Need To Know – Hearing Loss and Inner Ear Diseases – Can They Be Cured?

R S Ruan, K B K Soh, K H Yeoh

INTRODUCTION

The inner ear consists of two delicate systems responsible for hearing and balance. Because of their anatomic contiguity, disease processes tend to affect both systems simultaneously. For this reason, patients with disorders of the inner ear have both hearing as well as balance symptoms – hearing loss, tinnitus and giddiness. Inner ear symptoms tend to be permanent because most diseases cause irreversible damage to the inner ear structures. The delicate cells of the cochlear and vestibular systems, once destroyed, show little potential for repair and regeneration. Presbycusis and noise induced hearing loss, which are associated with age related degeneration and noise induced damage respectively, cause permanent hearing loss for which there is little scope for recovery.

Traditional treatment of inner ear problems include oral and intravenous vasodilators, corticosteroids and antihistamines. However, systemic medications have to be administered in high doses before they can reach the inner ear to exert a therapeutic effect. This is because a blood-labyrinth barrier between the inner ear and blood circulation makes it difficult for drugs to enter the inner ear. Unfortunately, these high doses are associated with unwanted systemic side effects. Another major disadvantage of systemic administration is that both ears are treated even though only one ear is involved.

Topical transtympanic administration

There is a trend towards administration of inner ear medications through a topical method so that the drug bypasses the circulation to go straight to the inner ear. How is this done?

1. Medications are injected through the tympanic membrane directly into the middle ear. The patient then lies on his side with the affected ear facing upwards. This allows the medication to settle on the medial wall of the middle ear, so that it can slowly work its way into the inner ear.
2. In order to avoid the pain of repeated injections through the eardrum, a middle ear ventilation tube may be inserted onto the postero-inferior quadrant of the tympanic membrane. The medication can be applied as an eardrop into the external ear canal while the patient is lying on the side. A pneumatic otoscope is used to flush the medication through the ventilation

tube, forcing it into the middle ear so that it can come into contact with the inner ear.

The above methods suffer from one problem – unreliable drug delivery into the inner ear. This is because effective entry into the inner ear depends on the integrity of the round window membrane. The round window membrane is the route to the inner ear. Any anatomic problem such as adhesions, scar tissue, or bony overhang may interfere with the passage of medication from the middle ear onto the round window niche.

3. A reliable method of inner ear drug delivery depends on the placement of an inner ear microcatheter system onto the round window under local anaesthetic. Once in place, medications can be delivered directly onto the round window so that they can diffuse across the membrane to enter the inner ear. The delivery port of the catheter system may be secured behind the ear for several weeks for drug infusion.

Practical applications

Three situations exist where this new catheter placement method can be applied.

1. Patients with certain types of subjective tinnitus are ideal candidates. Recent developments in hearing research have demonstrated that some types of tinnitus are generated at the synapses between the inner hair cell of the cochlea and their afferents⁽¹⁾. This type of tinnitus, referred to as cochlea-synaptic tinnitus, is mediated by the amino acid glutamate. Caroverine^(2,3) is an exciting new drug that acts as a glutamate receptor antagonist. It has been shown that systemic administration of caroverine alleviates the cochlea-synaptic type of tinnitus. Trials are now being planned for the administration of caroverine via a microcatheter system to deliver it directly into the inner ear, so that higher concentrations of the drug can be achieved.
2. Patients with Meniere's disease suffer from recurrent episodic vertigo, hearing loss and tinnitus. When symptoms persist in spite of maximal medical therapy, surgery such as vestibular neurectomy and labyrinthectomy may be performed. Although surgery is highly effective in alleviating the symptoms of Meniere's disease, they are also associated with a significant risk of morbidity. An intermediate measure

Department of
Otolaryngology
National University Hospital
5 Lower Kent Ridge Road
Singapore 119074

R S Ruan, MB, MD
Research Scientist

K B K Soh, FRCSE,
FRCSG, FAMS
Consultant

K H Yeoh, FRCSE, FRACS,
FAMS
Clinical Professor and Chief

Correspondence to:
Dr R S Ruan

would be to administer a drug such as gentamicin or streptomycin into the inner ear by one of the three methods described above^(4,5). The intention is to ablate and stabilise vestibular function in order to relieve the disabling effects of recurrent vertigo and nausea. Topical administration of gentamicin has a success rate of 70% in alleviating vertigo, while ablative surgery has a 90% success rate. However, the lower risks, avoidance of general anaesthesia, and the ability to avert complete ablation of vestibular function in order to obtain symptom relief may compensate this lower success rate.

3. Autoimmune hearing loss is a syndrome that gives rise to episodic or long term hearing loss. Oral steroid treatment has been effective in dealing with this condition. However, the administration of long courses of high dose oral steroids has its list of complications. This is where topical treatment has an important role to play. The direct application of corticosteroids into the inner ear through a microcatheter system has exciting potential in the management of autoimmune ear disease.

In conclusion, topical administration of drugs into the inner ear provides an exciting alternative to oral or intravenous medications. It enhances safety by limiting treatment to the ear only. It is also more efficacious by allowing higher doses to be delivered to the inner ear, without the side effects of systemic therapy.

REFERENCES

1. Ehrenberger K, Brix R. Glutamic acid and glutamic acid diethyl ester in tinnitus treatment. *Acta Otolaryngol* (Stockh) 1983; 95:599-605.
2. Ehrenberger K, Felix D. Caroverine depresses the activity of cochlear glutamate synapses in guinea pigs: in vivo model for drug-induced neuroprotector? *Neuropharmacol* 1992; 31:1259-63.
3. Denk DM, Heinzl H, Franz P, Ehrenberger K. Caroverine in tinnitus treatment: a placebo-controlled double-blind study. *Acta Otolaryngol* (Stockh) 1997; 117:825-30.
4. Hirsch BE, Kamerer DB. Intratympanic gentamicin therapy for Meniere's disease. *Am J Otol* 1997; 18:44-51.
5. Murofushi T, Halmagyi GM, Yavor R. Intratympanic gentamicin in Meniere's disease. *Am J Otol* 1997; 18:52-7.