Post stapedotomy hyperacusis - A mechanical explanation

R. Raman, Associate Professor, Dept of ENT, Faculty of Medicine, University of Malaysia, 50603, Kuala Lumpur, Malaysia.

Abstract

A mechanical explanation for the hyperacusis that sometimes occurs after stapedectomy or stapedotomy is offered.

Hyperacusis and loudness intolerance is not an infrequent complaint of patients who have undergone stapedotomy for otosclerosis (Ramsay, Karkkainen and Palva, 1997). The standard explanation given is that there is loss of stapedius function (Ramsay, Karkkainen and Palva 1997). An alternative mechanical explanation is offered based on physical principles.

Sound pressure transformation, solving the problem of impedance matching is due to ossicular lever action and hydraulic action. Ossicular lever action is due to the ratio of 13:1 between the handle of malleus and the process of incus. Hydraulic action is due to the functional ratio of 14:1 between the functional vibratory part of the tympanic membrane and the mobile footplate. The combined advantage works out to be an amplification of 18 times (Ludman 1988).

However in a stapedotomy surgery for otosclerosis, if a prosthesis of 0.6 mm diameter is used for interposition, the functional area of the base of the prosthesis is 0.283 mm² (III2),

as compared to a normal stapes footplate which is 3.2 mm (Ludman 1988), (Anson and Donaldson 1967). Hence theoretically the hydraulic action advantage works out more than a hundred times, even if the ossicular lever action is nullified, due to the fact the loop of the prosthesis is never at the lenticular end of the incus. Thus the amplification at the base of the prosthesis is very much more than a normal intact mobile footplate of the stapes. This probably is the cause of the hyperacusis and increased sensitivity of the operated ear. The increased sensitivity of the operated ear usually cannot be picked up objectively as almost all the standard audiometers are calibrated at 0 dB

However the hyperacusis and the loudness intolerance is not a persistent symptom and disappears after sometime. This means the above mentioned factor is also taken care of at a later date. Hence, this explanation for impedance matching and amplification factor contributed by the ossicular chain and the tympanic membrane needs to be reconsidered.

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References.

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