The Mechanism of Bone Conduction

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It is generally assumed that the external auditory canal, the middle ear with the windows, the mandibula, the capsule and the fluid of the labyrinth, and possibly the contents of the skull, could be of importance regarding bone conduction. The hearing mechanism via bone conduction is therefore intricate. The various factors of this mechanism have been analysed separately by many investigators. The experiments, carried out on cats, were performed with the object of taking, as much as possible, into account the different facets, in which the bone conduction consists. Surgical alterations were performed, in that connection, on the external auditory canal, on the tympanic membrane, on the ossicu-lar chain, on both oval and round windows, and on the mandibula of the cat. The influence of these alterations has been tested thereafter on the sensitivity of the bone conduction, using microphonic potentials derived from the round window membrane.

The skull of 58 animals has been made to vibrate, first of all, with a vibrator, having a constant acceleration amplitude between 250 and 8000 cps. At the same time microphonic potentials have been continuously recorded in decibels. The curve, obtained by this means, is called the normal curve.

Surgical alterations were afterwards performed and the skull stimulated in the same way and a curve of the microphonic potentials was obtained.

The normal curve is then subtracted from this curve.

A third curve, called the difference curve, is thus obtained, showing how much the microphonic potentials have been altered by the surgical alterations; therefore, how much the sensitivity of the bone conduction has been altered.

Every surgical modification has been performed on numerous cats and many different curves were obtained. From those curves

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the median and the standard error of the median has been calculated for the octaves and half octaves. The results are plotted in graphs. The same procedure has been used in every surgical modification performed afterwards.

Studying the median difference curves of each surgical modification on their own, and making the comparison between them, we can draw the following conclusions for what concerns the hearing via bone conduction for the cat in the frequency range of 250 to 8000 cps:

The deformation of the labyrinth capsule is of no importance in the formation of the bone conduction for the cat.

The deformation of the middle ear walls is of no importance either.

The inertia of the ossicular chain and of the fluid of the labyrinth are both the most important components for the formation of the bone conduction. Both their parts are of equal importance for the whole of the analysed scale of frequencies.

This is not in agreement with the ascertainments of Kirikae (1959).

The inertia of the mandibula does not partake in the formation of the cat's bone conduction.

The aperture of the aquaductus cochleae and other foramina of the capsule of the labyrinth, other than the two windows, do not play any part in the bone conduction mechanism.

Nor does the resonance of the air in the middle ear play an important part.

Only few conclusions can be drawn from the experiments concerning the size of the different masses, stiffnesses and frictions.

It was possible to demonstrate that the stiffness of the eardrum and also the stiffness of the link between the ossicular chain on one side and the fluid of the labyrinth on the other side are small.

The system of mobile elements in the ear should be understood as being made up by two relatively loosely attached vibrating units. Of this a mechanical model is shown.

An alteration of the middle ear system always gives an alteration of the sensitivity of the bone conduction.