Anatomic Variations of the Auditory Canal Pertaining to the Fit of Stethoscope Earpieces

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Leaks in the enclosed acoustical system of the stethoscope reduce its efficiency and can greatly impair the physician's ability to detect the faint murmurs of early valvular heart disease. The results of this study demonstrate a high degree of variability in size and configuration of the external auditory meatus among different individuals. It appears probable that both excessive leaks and also partial or complete occlusion of the acoustical pathways commonly result with the use of standard stethoscope earpieces.

In a recent study on auscultation differences of considerable magnitude were noted in the auscultatory thresholds of 40 physicians listening to a heart murmur. The intensity levels required for audibility of the murmur were 10 to 20 times higher for some subjects than for others. It was evident in this experiment that not all such differences in auscultatory proficiency were attributable to individual differences among the physicians in hearing acuity, professional training and experience, and psychologic reactions. Efficiency of the various stethoscopes employed—and particularly sound leaks around the earpieces—appeared to play a major role in some cases.

The undesirable effects of "leaks" in the enclosed acoustic system of the ordinary stethoscope have been discussed by Rappaport and Sprague, both as to the consequent decrease in efficiency of sound transmission and the increased interference by room noise. One source of leaks, certainly, is ill-fitting earpieces. The purpose of the study to be described was to measure the degree of anatomic variation in the size and configuration of normal external auditory meatuses, and to determine to what extent one can expect a stethoscope earpiece of standard size to function efficiently in a variety of ear canals.

Method

Ten male medical students served as subjects for this experiment. By means of a plastic impression material of the type used commercially in the fashioning of hearing-aid earpieces, 2 sets of casts were obtained from both ear canals of each subject: 1. A rigid "head halter" apparatus (fig. 1) was constructed which could be oriented on each subject in a uniform position, with use of bony landmarks of the skull as points of reference. Blunt pins projecting from this apparatus were incorporated into the first set of impressions while they were still soft, in order that the casts could be re-oriented subsequently for measurement of the directions taken by the axes of the meatuses. 2. Each subject was asked to put on the same stethoscope in his customary position of use. A second set of impressions was then made with this in place, incorporating the stethoscope earpiece directly into the casts.

Measurements of the direction and dimensions of the canals where the stethoscope earpieces rested were made on the first set of impressions and are set forth in table 1.

The second set was carefully inspected and analyzed to determine where leaks might occur around the earpieces and where there might exist total or partial occlusion of the earpiece apertures by misalignment in the canals.

Results and Discussion

In each case the stethoscope earpiece was found to rest not in the meatus proper but in the apex of the funnel formed by the concha, with its aperture adjacent to the orifice of the cartilaginous meatus (fig. 2).

The anatomy of the external ear has been described in detail by Bezold and Siebenmann. Axis of the concha, the funnel-shaped cartilaginous portion of the external ear bounded anteriorly by the tragus, is directed anteriorly and superiorly, its apex opening into the lateral cartilaginous portion of the meatus proper which is directed posteriorly, forming an angle with the concha. (A second bend, in the opposite direction, takes place between the cartilaginous lateral meatus and the medial osseus portion, but is not involved.
FIT OF STETHOSCOPE EARPIECES

Fig. 1. Apparatus for determining contour of the auditory canal, showing pins incorporated into plastic mold for orientation.

Fig. 2. Location of stethoscope earpiece in external ear.

in the fit of stethoscope earpieces.) This first bend is of interest because an earpiece that is too small may rest so deeply in the concha that its aperture is occluded by the anterior wall of the cartilaginous meatus. In 6 of our subjects it appeared from the second set of impressions that partial occlusion of this type was probable, 4 of them showing considerable occlusion bilaterally. Total occlusion in 1 ear or the other appeared to be imminent in 2 of the subjects.

Cross sections of molds of the concha at the point where the earpieces rested revealed its shape to be elliptical in all subjects. The average size was 11.8 by 8.0 mm. with the long dimension directed vertically. However, marked variation in size was observed, the largest being 14.2 by 10.1 mm., the smallest 8.2 by 6.2 mm. Comparison of measurements of the 2 ears in individual subjects showed discrepancies of up to 2.4 mm. in the long dimension, and 1.3 mm. in the smaller one. This irregularity of shape and variation in size might well be responsible for leaks, and indeed the second set of impressions showed that in 14 of the 20 ears measured the apposi-
tion of earpiece to canal wall was judged to be poor in at least 1 point.

It is evident in table 1 that the axis of the concha, though generally directed somewhat anteriorly and superiorly, showed considerable variation among the 10 subjects. This variation was as much as 43° in the vertical plane (angle "V" in fig. 2) and 33° in the horizontal plane (angle "H"). Direction of the canals in a given subject, however, was more uniform with no variation of greater than 10° in the vertical or 7° in the horizontal plane. Thus the angle of direction of earpieces, as well as their size and shape, would appear to be instrumental in determining stethoscope efficiency.

**Summary**

Plastic casts of the external auditory meatuses of 10 subjects were studied. Impressions were made both with and without "standard" stethoscope earpieces in place. Considerable variation was demonstrated among the subjects in size and conformation of the meatus.

Remarkably poor fits of earpieces, probably resulting in excessive leaks and partial or complete occlusion of earpiece apertures, were observed in more than half the impressions. The amount of "give" of the ear structures is uncertain, but it would appear that effective stethoscope efficiency might be appreciably improved by more allowance for individual anatomic variations of the auditory canal in the design of stethoscope earpieces.

**Summario in Interlingua**

Esseva modulate copias plastic del externe meatos acustic de 10 differente subjectos. Le copias esseva facite con a sin auriculares "standard" de stethoscopio in position. Considerabile variationes esseva demonstrate inter le varie subjectos con respecto al dimensiones e al conformation del meatos.

Esseva observate in plus que un mediate del casos un multo imperfecte ajustacion del auriculares, resultante—probablemente—in un considerabile escappamento de sono e in le complete o partial occlusion del aperturas del auriculares. Le grado del adaptabilitate del structuras del auro es incerte, sed il pare que le efficacia del uso de stethoscopi pote esser augmentate considerablemente si le construction de auriculares stethoscopic es guidate plus extensemente per le consideration de variationes anatomic individual del canal auditori.

**REFERENCES**

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