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ORIGINAL ARTICLE

A STUDY ON MORPHOLOGICAL VARIATIONS OF MIDDLE EAR OSSICLES

Shubhpreet Sodhi[1], Zora Singh[2], Jai Lal Davessar[3]

[1]SR, Department of Anatomy, Dr. YS Parmar Govt. Medical College, Nahan, [2]Professor & Head, Department of Anatomy, Dasmesh Institute of Research and Dental Sciences, Faridkot, [3]Guru Gobind Singh Medical College, Faridkot

ABSTRACT:

Introduction: Various anomalies of these ossicles can lead to the hearing problems. Various congenital malformations of these ossicles have also been reported to cause hearing problems. To perform the microsurgical maneuvers and manipulations, so as to correct these abnormalities, surgeons need to fully conversant about the details of these tiny bones. So, the study was designed to report about the various variations of the ossicles which would help them while performing the reconstructive surgeries. **Materials and Methods:** 100 sets of middle ear ossicles (50 right and 50 left), each set consisting of malleus, incus and stapes were collected from 100 cadavers available among the various medical colleges of North India. The bones were carefully examined under the simple microscope. **Results:** Stapes is found to be most variable ossicle followed by malleus than incus. Various shapes of cruras, head, neck and obturator foramen of stapes were noted. Malleus too had number of variations among the head and manubrium shapes. Shapes of manubrium mallie were seen to be curved anteriorly or straight. Least variations were seen among incus. The most frequent being a notch in the inferior border of the short process.

Conclusion: The data in the present study depicts stapes with a large variety of variations anf incus to be the most stable on.

Key words: Ossicle, Ossiculoplasty, Otology, Stapes, Variation

Corresponding author: Dr. Shubhpreet Sodhi, SR, Department of Anatomy, Dr. YS Parmar Govt. Medical College, Nahan,

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INTRODUCTION

Ear subserves a special function of hearing, present in higher animals. In this, the three miniature bones, malleus, incus and stapes play a very important role in transmission of sound from tympanic membrane to inner ear (1). Malleus, being largest ossicle, is shaped like a mallet. It has head, neck, handle and anterior and lateral processes. Incus is shaped like anvil. It has body with short and long processes. At the tip of long process, it has lenticular process, which articulates with the head of stapes. The stapes is also known as stirrup which as head, neck, two limbs and a base (2).The development of these ossicles begin at 4th week of intrauterine life, ossify by 4th month of intrauterine life and attain their full size at the time of birth(3).

Various anomalies of these ossicles can lead to the hearing problems. Great degree of ossicular erosion is seen in cholesteatoma, resulting in poor hearing outcome(4). Bony erosion occurs in long process of incus, body of incus and head of malleus, which may extend to superstructure of stapes(5). Otosclerosis is a primary disease of bony labyrinthine but most often, otosclerotic focus involves stapes region leading to stapes fixation and conductive deafness(6).

Various congenital malformations of these ossicles have also been reported to cause hearing problems. Several cases of congenital absence of long process of incus and capitulum of stapes have been reported(7). Absence of long process of incus and abnormal position of stapes to malleus also cause hearing loss(8). In certain disease, e.g Marfan's syndrome, Down's syndrome, in microtia, various ontological deformities have been reported leading to fusion of these ossicles and thereby the hearing loss(9, 10, 11)

So, to perform the microsurgical maneuvers and manipulations, so as to correct these abnormalities, this study would be of great help to ontological surgeons who can keep in account about the various variations of these ossicles while performing the reconstructive surgeries.

MATERIALS AND METHODS:

The study was performed on 100 cadavers (50 males and 50 females), both from left and right sides, from various medical colleges of Punjab, Himachal, Haryana and Chandigarh. 100 sets of ossicles were exracted, each set consisting of malleus, incus and stapes.

The calvaria was removed with the help of hand saw and the brain was taken out. To extract the bones out, the tegmen tympani was removed with the help of hammer and chisel. Just below the bone, the malleus head was seen articulating with incus. Both these bones were removed with the help of foreceps with little manipulations. For removing the stapes, a diagonal section was taken through the arcuate eminence of temporal bone, which gave a wider space to act upon. Then, the stapes was also retrieved by gentle manipulations with the help of sharp foreceps, after breaking the tendon of stapedius muscle attached to the neck of stapes. The bones were washed and kept in plastic satchels after numbering and labeling them.

OBSERVATIONS

The three miniature bones were observed and carefully under the simple microscope and the following variations among the three bones were noted.

In case of Malleus:

1.The head of malleus showed bony projection.
2.The head of the malleus seen with a depression below the bony projection
3.Malleus seen with large globular head
4.Malleus seen with manubrium as curved process
5.Malleus seen with manubrium as straight process
6.Malleus seen with thick lateral process

Figure 1: Malleus head seen with bony projection

Figure 2: Depression seen below the bony projection

Figure 3: Large globular head

Figure 4: Manubrium seen as curved process


Figure 5: Manubrium seen as straight process


Figure 6: Thick lateral process

In case of Incus:

7.Incus seen with the notch on the inferior border of the short process

8.Incus seen with small straight short process

9.Incus seen with curved thin long process

10.Incus seen with depressed part at the body ,behind the articular surface

11.Incus seen with thick body due to more bony mass at the angle between two processes


Figure 7: Notch on inferior border


Figure 8: Straight short process


Figure 9: Curved and thin long process


Figure 10: Depression at the body behind the articulating surface


Figure 11: Thick body: more bony mass at the angle

Stapes

12. Stapes seen with equal cruras.
13. Stapes seen with unequal cruras.
14. Stapes seen with less curved cruras.
15. Stapes seen with large head.
16. Stapes seen with long neck.
17. Stapes seen with no neck.
18. Stapes seen with different shapes of footplate
19. Stapes seen with different shapes of obturator foramen
20. Stapes seen with obturator foramen covered by membrane.


Figure 12: Stapes with equal cruras


Figure 13: Stapes with unequal cruras


Figure 14: Stapes with less curved cruras

Figure 15: Stapes with large head

Figure 16: Stapes with long neck

Figure 17: Stapes with no neck

Figure 18: Different shapes of footplate

Figure 19: Different shapes of obturator foramen


Figure 20: Obturator foramen covered by membrane

DISCUSSION

Among the tiny bones, stapes is the most variable bone and incus is the most stable one (12,13,14,15,16). Since many studies are reveling out that ossicle homografts can be used to replace the eroded ones, available from the ossicular banks, it becomes very important to document various variations seen in these bones.

In the present study, malleus has large globular head with a bony projection, which is also reported in the earlier study (14). Malleus with different shapes of manubrium mallie have been reported earlier which is also seen in the present study. Sarrat et al (13) reported 53-70% of the curved manubrium. Unur et al (12) reported the same at the rate of 50%. They even reported the malleus with no neck (12,15) between head and manubrium. But no such specimen was seen in the present study. However, all mallie had prominent necks with impression of attachments of tensor tympani.

Various variations among the lengths of lateral and anterior processes have been reported earlier. One of the specimens showed a thick lateral process. Anterior process is the longest process of malleus in fetal life but it shortens after birth (17), wich is also supported by Unur et al in their study. But in the present study, minimal variations were seen in the length of anterior process.

In case of incus, it showed minimal morphological variations, the most frequent being a very prominent notch, on the inferior border of the short process, approximately 1 mm from the apex. This notch was also reported by Arensburg (18) in 41-42% cases, 45% by Mogra (19) and 38% by Singh(20). This notch can be of functional importance as short process of incus forms the part of axis of rotation for the transmission of vibrations to inner ear. This notch is lined with cartilage and posterior incudal ligament is attached to its depth (21). Those cases where the notch is not present can be explained by the ossification of a portion of the ligament(18).

Few bodies of incus showed a depression, just behind the articulating surface which is also reported earlier by Bellucci et al (22) where they reported it to be 68% frequent. He explained the probable reason to be a process of remodeling, the destruction of bone followed by reconstruction. Few studies claim the changes in the architecture of incus to be life long as compared to stapes, where major changes are completed in the fetal life.

The long process was seen as straight and curved too whereas in most of the studies, the long process is reported to be uniformly curved(11,12,23,24,25). Various degrees of the angle between the long and short process of this bone are also noted in the present study. These variations can be explained on the basis three data: amount of the bone tissue located in the angle between the processes, the extension of short process and the direction and changes of the long process (13).

The variations in Stapes could be in head, neck, cruras and obturator foramen as reported by various studies earlier (12,13,26). Stapes with large head and pointed head have been reported in the present study. A specimen without head has also been noted. Neck was seen to regular, irregular, long, short. Such variations are reported earlier by Padmini et al (29). Ossicle with no neck has also been reported in the previous studies (23,27,28). In that case, stapedius tendon was attached to posterior crus at its upper end. But no such occurrence was seen in our study.

However, some schools of anatomy do not acknowledge the stapes neck as a distinct arc. According to Awenger(30), in german textbooks, there is no recognition of the Neck, while English books of anatomy, refer it to be part of superstructure. Many authors (12,26,23) have described anterior crus to be straighter than the posterior one, which was also seen in the present study. But even equally curved cruras were also seen which is again reported by Anson and Bast(26). Dass et al(28) described frequency of posterior crus to be longer more than anterior crus; followed by equal length cruras, and least frequency of anterior crus to be longer than posterior crus. All the three cases were also observed in the present study. When compared the Indian population to the western one, centre of cruras is the thinnest portion in Indian population whereas distal third is the thinnest in western population which is highly significant in mobilization and stapedectomy procedures and also determines the site of fracture (26).

CONCLUSION

The data in the present study depicts stapes with a large variety of variations anf incus to be the most stable one. Documentation of all these variations may help the otological surgeons, in pre-surgical evaluation, who perform the microsurgeries and reconstructive ossiculoplasties.

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