

Morphological and Morphometrical Variations of Incus in Human cadavers

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ABSTRACT

Introduction: Incus is one of the three ear ossicles present in middle ear. Through this study our aim was to determine variations in morphological and morphometrical parameters of incus. This study will help otologic surgeons to do reconstruction procedures in a better way to improve the sound conduction in conductive deafness by understanding the anatomical details of middle ear. **Methods:** The study was conducted for this purpose in 66 adult dry incus after its removal from temporal bones of adult human cadavers. Morphological variations were seen and a vernier caliper was used to measure different morphometrical parameters. **Results:** Incus had minimum morphological variations in the ossicles. There was a notch in the inferior border of the short process. The angle between the short and long process of the incus was variable. While the incus with a well-developed corpus had a wide angle, the incus with a less developed corpus had a narrow angle. The average of morphometric parameters showed that the incus was 7.26mm in total length, the total width was 5.95mm, and the maximal distance between tips of its two processes was 6.80mm. No significant difference was found when we compared morphological parameter (Notch) of right and left side incus. **Conclusion:** These parameters of incus will help in designing of implants and thereby it will help to reproduce the transmission of sound energy.

KEYWORDS: Incus, Morphological, Morphometrical, Sound conduction.

INTRODUCTION

Ear, the special sensory organ of the body associated with hearing and equilibrium in vertebrates, has three distinct subdivisions referred to as the external, the middle and the inner ear.¹ The middle ear is an air-containing cavity in the petrous part of the temporal bone and is lined with mucous membrane. It contains the auditory ossicles, malleus, incus and stapes whose function is to transmit the vibrations of the tympanic membrane (eardrum) to the perilymph of the internal ear. The incus is shaped less like an anvil, from which it is named, than a premolar tooth with its two diverging roots. It has a body and two processes. The body is somewhat cubical but laterally compressed. On its anterior surface it has a saddle-shaped facet for articulation with the head of the malleus. The long process, rather more than half the length of the handle of the malleus, descends almost vertically, behind and

parallel to the handle. Its lower end bends medially and ends in a rounded lenticular process, the medial surface of which is covered with cartilage and articulates with the head of the stapes. The short process, somewhat conical, projects backwards and is attached by ligamentoualveus fibres to the fossa incudis in the lower and posterior part of the epitympanic recess.²

There are various middle ear pathologies like acute and chronic otitis media, cholesteatoma etc. leading to conductive ear deafness. Chronic otitis media (inflammation of the middle ear) in almost any form can result in the disruption of the integrity of the ossicular chain. Chronic eustachian tube insufficiency and tympanic membrane retraction that results in prolonged contact of the tympanic membrane with the tip of the incus can cause this type of erosion, even without active infection. However, cholesteatoma (presence of

keratinizing squamous epithelium) is by far the most common cause and chronic otomastoiditis without cholesteatoma can also cause erosion of the ossicles. The pathology can be restricted to the incudostapedial joint with loss of the lenticular process, sometimes with preservation of a soft tissue connection, usually, however there is a complete loss of some portion of the distal incus. The entire long process of the incus can be eroded particularly in cases of cholesteatoma along with the stapes superstructure.

Surgical removal of the ossicles during cholesteatoma removal is another obvious and common cause of ossicular discontinuity. In most cases, this involves the entire incus and the head of the malleus. Trauma can also result in ossicular discontinuity, especially longitudinal temporal bone fractures. The force of the fracture tears the incus from its articulations with the malleus and stapes and the incus does not completely return to its normal position. The stapes superstructure may also be fractured. With complete ossicular discontinuity, the most common audiometric pattern is that of a near maximum (55-60 dB) conductive hearing loss across all frequencies³. The materials used in the reconstruction of ossicular chain are the autografts, homografts and allografts. To achieve good postoperative results in patients who require middle ear surgery, it is essential to know and consider the construction of the ossicular chain and the structure and position of its elements as well as the physiologic process of hearing⁴.

MATERIALS AND METHODS

This study was conducted in 66 adult dry incus after its removal from temporal bones of adult human cadavers in S.M.S Medical College, Jaipur, Rajasthan.

To observe the contents of the middle ear, we removed the tegmen tympani (bony roof of the middle ear). A mallet and chisel was used to break the tegmen tympani from the petrous portion of the temporal bone about-1.5cm from squamous part of the temporal bone and 2.5cm from the posterior ridge of the petrous part of the temporal bone.

RESULTS

In this study, the data were determined in two categories; the morphometric and the morphologic. Morphological data was based on observation while morphometrical data was determined by using vernier caliper. All the morphological and morphometrical variations were compared on the basis of side of origin- right side ossicles and left side ossicles.

In the morphological variations of incus it was found out that the incus had minimum morphological variations in the ossicles. There was a notch in the inferior border of the short process as shown in figure1. The angle between the short and long process of the incus was variable. While the incus with a well-developed corpus had a wide

angle, the incus with a less developed corpus had a narrow angle.

The average of morphometric parameters showed that the incus was 7.26mm in total length, the total width was 5.95mm, and the maximal distance between tips of its two processes was 6.80mm. No significant difference was found when we compared morphological parameter (Notch) of right and left side incus as shown in table 2 respectively.



A: Notch present on short process and angle between the 2 processes is wide.

B: Notch present on short process and angle between the 2 processes is narrow.

Table 1: Finding of Present Study.

MORPHOMETRICAL DATA	MEAN	SD
Total Length	7.26	0.70
Total Width	5.95	0.58
Distance b/w tip of its processes	6.80	0.53
Index(%) = Total width/total length	82.41	6.58

Table 2: Parameter (Notch) of right and left side incus

Side	Notch Present		Notch Absent		Total	
	n	%	n	%	n	%
Left	1	3.03	32	96.97	33	100.00
Right	2	6.06	31	93.94	33	100.00
Total	3	4.55	63	95.45	66	100.00

Chi-square = 0.000 with 1 degree of freedom; P = 1.000

DISCUSSION

Ossicles have a very important role in the process of hearing. A lot of work has been done previously on ear ossicles of adult and new born cadavers, guinea pig, hamster, various species of armadillos, and all these studies suggested different morphological and morphometrical variations. Study by Gajjar Yogesh and Aiyer Ranjan conclude that Ossiculoplasty using autologous incus graft material is an effective and safe

surgical method for reconstruction of the ossicular chain and for hearing restoration.

It can be concluded from our study that morphologically, incus is the most stable ossicle among the three ossicles which is in support to the work done by Unur, Ulger and Ekinci in 2002 on newborn human cadavers, with Aycan K. et al. and with Sarrat et al. in 1988 on human cadavers. A notch of about 41-42% was reported on the

crus breve (short process)⁸ and as 42%⁵ which is in support to our study ie 45%. While studying the morphometrical variations of incus we found total length to be 7.26mm, total width to be 5.95mm which was slightly less in other studies ie total length 6.47mm was found in the study of Unur, Ulger and Ekinci; 6.8mm was found in the study of Zenev et al; 4.27- 5.55mm in the study of Anson and Bast.

Values	Present study	Jyothi KC et al.	Unur et al.	Unur et al.	Arrensburg et al.	Harada	Arrensburg & Nathan	Masali	Bouchet & Giraut
	2015	2015	2012	1990	1981	1972	1972	1968	1968
Total length	7.26	6.3	6.5	6.7	6.4	6.8	6.8	6.4	6.5
Total width	5.95	4.4	4.9	5.1	5.1	4.8	5.1	4.8	5.1
Maxdist b/w tips of processes	6.80	-----	6.1	6.1	-----	4.2	-----	-----	-----
Angle	-----		100	99	88	-----	94	---	95
Index	82.41		-----	-----	-----	-----	-----	-----	-----

CONCLUSION

The advanced surgical procedures for treating conducting hearing loss and surgeries to recover the function of middle ear ossicles are through bone ossicular replacements or alignment. Autograft ossicles are removed from the patient and sculpted to serve as an interposition graft. The data on dimensions of incus may have a bearing in designing prosthesis more appropriately suited for Indian population. Successful ossicular repair remains a challenge and this success depends on the precise dimensions of implants.

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