

Morphometric Study of Malleus by Computerised Tomography

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Abstract: ***Introduction:** The tympanic cavity contains three small immovable bones, the malleus, incus and stapes which have a fundamental role in transmission of sound. The malleus is the largest of the ossicles, and its shape seems like a mallet. The study was conducted to determine the various morphometrical parameters of malleus which can be helpful during reconstructive procedures to the otologic surgeon for the improvement of sound conduction. **Material and Method:** The prospective study was performed on 114 subjects (61 males and 53 females) in Dr. D.Y. Patil, Hospital navi, Mumbai, CT scan images of 114 subjects are studied for ossicular chain on either side, and the malleus are obtain to investigate the morphometric parameters. **Result:** The average of Morphometric parameters shows that the mean length of right malleus is 6.974mm in male and 7.017mm in female, where the mean length of left side malleus is 6.919mm in male and 7.015mm in female. the mean length of right manubrium of malleus is 4.288mm in male and 4.25mm in female, where the mean length of left side manubrium of malleus is 4.227mm in male and 4.217mm in female. The mean maximum width of head of right malleus is 1.858mm in male and 1.927mm in female, where the mean maximum width of head of left malleus is 1.911mm in male and 1.94mm in female. No significance difference was found when we compared these parameters of right and left side in both sexes. **Conclusion:** The knowledge of the morphometry of malleus will helpful in designing of implants during operations to improve hearing.*

Keywords: Ear ossicles, incus, malleus, stapes.

1. Introduction

The high burden of deafness worldwide and in India is largely preventable and avoidable. According to the 2005 estimate of W.H.O. (World health's organization) 278 million people have disabling hearing impairment. In India, 63 million people (6.3%) suffer from significant auditory loss. Nationwide disability surveys have estimated hearing loss to be the second most common cause of disability.

In rural India incidence of deafness is 25000 million and in urban area it is 7000 million. Failure of transmission of sound from the ossicular chain to the inner ear causes an air-bone gap of 40 db – 60db. Various middle ear pathologies may fix or disassociate the chain leading to conductive deafness.

The three ear ossicles lodged in the middle ear are the malleus, incus and stapes. The ear ossicles form an articulated chain, connecting the lateral and medial walls of the tympanic cavity. The ear ossicles amplify and transmit the sound vibrations to the cochlear receptors in the inner ear.

The malleus is largest ossicle, shape like a mallet. It has a head, neck, handle (manubrium) and anterior and lateral processes. The head is the large upper part of the bone and it is situated in the epitympanic recess. The neck is the narrowed part below the head, and inferior to this is an enlargement from which the anterior and lateral processes project. The handle or manubrium of the malleus is connected by its lateral margin to the tympanic membrane. It decreases in size towards its free end.

Significant conductive hearing loss is usually a result of the fixation of ossicles in the middle ear. Malleus fixation is very common it usually occurs at some location on anterior surface of head of the malleus.

In 21st century with the help of microsurgical operative techniques, it is possible to rectify these problems, reconstructive surgeries in early stages will help to restore the hearing and speech at the earliest, thereby help to overcome hearing disability and psychic trauma.

So precise measurements of ear ossicles are essential in the design of the ear ossicles grafting and electromagnetic implants. The knowledge of variations of these ossicles and its morphometric data will help the otologist during reconstructive surgery and provide necessary information for the prosthesis designer. Successful ossicular repair remains a challenge, this success depends on precise dimensions of implants. Hence in present radiological (CT images) study an attempt is made to study morphometrical analysis of malleus.

Aims and Objectives

- To study morphometric details of malleus with computed tomography.
- To determine morphometrical parameters for otologist to the ossicular grafting and implants during reconstructive surgery.

2. Materials and Methods

Prospective study was conducted in Department of Anatomy and Radiology, D.Y. Patil hospital and school of medicine, Nerul, Navi Mumbai.

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CT images of 114 (61 males and 53 females) are studied for ossicular chain bilaterally, and the malleus are obtain to investigate the morphometric parameters.

Inclusion criteria

Normal adults from 20 yrs to 50 yrs of age.

Exclusion criteria

- No deafness.
- No past or present history of ear disease.
- No complains of ear discharge.
- The morphometric measurements of the malleus, are measured with GE Optima CT600 CT Scanner.
- The total length of malleus from the top of the head to lower end of handle.
- Length of the manubrium from the end of the lateral process to the end of handle.
- Maximum width of the head of the malleus is the maximum distance between the two lateral margins of the head.

Statistical Analysis

Mean and Standard Deviation are worked out to assess the average dimensions of the Malleus. P-value is the probability rate at 0.05 level of significance for the corresponding degree of freedom.

P < 0.05 is significant

P > 0.05 is not significant.

All the statistical calculations were performed using the software SPSS.

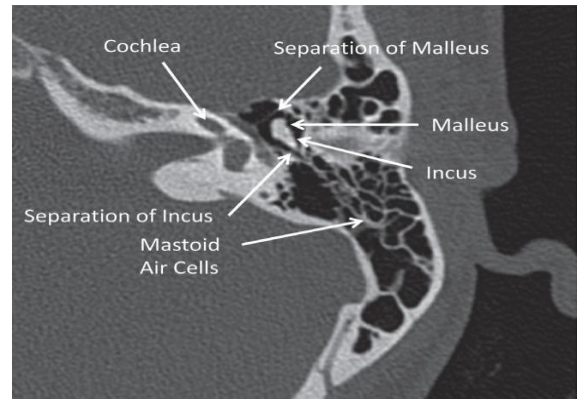


Figure 3: CT Image of Three Ear Ossicles



Figure 4: CT Image of Length of Manubrium



Figure 5: CT Image of Width of Head

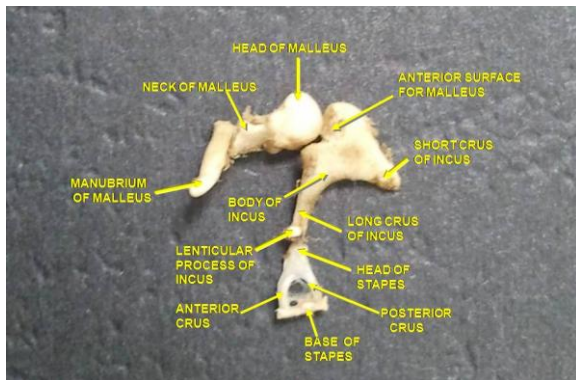


Figure 1: Ear ossicles



Figure 2: GE Optima CT600 CT Scanner

3. Results

In this study, the morphometric data of Right and Left side ear ossicles are recorded gender wise, it included the Total Length of Malleus, Length of manubrium, and maximum width of Head of malleus. The recorded data for Total length of malleus is shown in Table.

Table 1: Total Length of malleus

	Male		Female	
	Right (mm)	Left (mm)	Right (mm)	Left (mm)
N	61	61	53	53
Minimum	5.8	5.9	5.9	5.5
Maximum	7.8	7.9	8.1	8.4
Mean	6.972	6.916	7.017	7.018
Standard Deviation	0.47	0.45	0.68	0.74

In male mean total length of malleus is 6.972 and 6.916 of Rt. and Lt. side respectively.

In female mean total length of malleus is 7.017 and 7.018 of Rt. and Lt. side respectively.

Table 2: Mean and standard deviation of Length of Manubrium

	Male		Female	
	Right (mm)	Left (mm)	Right (mm)	Left (mm)
N	61	61	53	53
Minimum	3.4	3.1	3.4	3.2
Maximum	4.9	5.3	4.8	5
Mean	4.288	4.227	4.258	4.211
Standard Deviation	4.9	5.3	4.8	5

The mean length of manubrium in male is 4.288 and 4.227 of Rt. and Lt. side respectively.

The mean length of manubrium in female is 4.258 and 4.211 of Rt. and Lt. side respectively.

Table 3: Mean and standard deviation of Maximum width of head of malleus

	Male		Female	
	Right (mm)	Left (mm)	Right (mm)	Left (mm)
N	61	61	53	53
Minimum	1.4	1.2	1.5	1.2
Maximum	2.3	2.4	2.2	2.3
Mean	1.85	1.911	1.918	1.945
Standard Deviation	0.2	0.24	0.19	0.25

The mean Width of Head in male is 1.850 and 1.911 of Rt. and Lt. side respectively.

The mean Width of Head in female is 1.918 and 1.945 of Rt. and Lt. side respectively.

4. Discussion

Ossicles, a tiny small ear bones plays an important role in the process of hearing. The presence of malleus provides 1.3 times mechanical advantage due to lever mechanism. A lot of work has been done previously on ear ossicles of adult and new born cadavers, and all these studies shows different morphometrical variations.

Table 4: Comparison with previous studies

Authors	Masali 1968	Giraut 1968	Nathan et al 1972	Unnur, Ulger, Ekink 2002	Jyoti K.C. 2011	Present study Male	Present study Female
Total length of malleus	7.6 mm	7.9 mm	7.3 mm	7.7 mm	7.6 mm	6.9 mm	7.0 mm
Length of Manubrium	4.6 mm	4.7 mm	3.5 mm	4.7 mm	3.5 mm	4.2 mm	4.2 mm

In the present study, Total length of malleus ranged from 5.8 to 7.9 mm with an average 6.9 mm for male and 5.9 to 8.4 mm with an average 7.0 mm for female, which is slightly low compare to previous studies. In 1949 Bast TH and Anson BJ reported as 7.69-9.11 mm. and Schafer EA et al 1909 observed that the malleus was 8-9 mm, Unnur E. in 2002 found is slightly less as 7.69 mm.

Length of Manubrium ranged from 3.1 to 5.3 mm with an average 5 mm for male and 3.2 to 5 mm with an average 4.9 mm for female. It is again supported by Unnur E et al as 4.7 mm, the Masali et al (1968) 4.6 mm and Giraut (1968) 4.7

mm, but it is higher than the Jyoti K.C. (2011) 3.5 mm and comparatively less than The bast T.H. And Anson BJ (1949)

Maximum width of head of malleus ranged from 1.2 to 2.4 mm with an average 1.9 mm for male and 1.2 to 2.5 mm with an average 1.9 mm for female., which is slightly low compare to previous studies. In 2011 Jyoti K.C. reported it as 2.37 mm and The bast T.H. And Anson BJ (1949) reported as 2.13 mm.

5. Conclusion

- The advanced surgical procedures for treating conducting hearing loss and surgeries to recover the function of middle ear ossicles are complete with bone ossicular replacement.
- Morphometric data of malleus will help the prosthesis maker in the formation of various implants and grafts required to treat various diseases.
- In the present scenario, with the advent of microsurgical operative techniques, it is possible to rectify many middle ear problems, such as to restore speech and hearing at the earliest, thereby help to overcome disability and psychic trauma.

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