

Malleus and its anatomical variations

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Abstract

The dimensions of ossicular chain are important for surgical purpose and also to design the implants. Thus the present study has included all possible anatomical variations of malleus. 30 human cadavers' temporal bones were dissected and the malleus was extracted of both the sides. Total length, length of handle, Length of head and neck, and diameter of head, index and weight were calculated and t-test was applied to compare dimensions of right and left side. Chi square was applied for non parametric data. Medcalc software was used for statistical analysis. Regression equation was also calculated between various parameters and weight and a positive correlation was deduced. All the findings may augment the knowledge of prosthesis designers for ossiculoplasty.

Keywords: Malleus, anatomical variations, ossiculoplasty, prosthesis

Introduction

Structural and functional anatomy of ear ossicles has been studied in humans but their amplifying dynamics is still a litigious topic. Various mathematical models using elements have been used to study the mechanics of the ear ossicles which are useful for reconstructing particular forms of small bones.

Exact measurement of ossicular chain in human middle ear (tympanic cavity) is thus important for surgical purpose and also constructing the motif of electromagnetic implants which are capable of transmitting sound energy.

Thus present study is an attempt to include all possible parameters of malleus which provide a vivid description about its all probable anatomical variations.

Materials and methods

The Present study was performed in 30 human cadavers. The skull bone was confiscated and brain was removed carefully according to Cunningham's manual of practical human anatomy. The tegmen tympani was chipped off by using micro motor, chisel and hammer and the malleus was removed carefully. Total 60 malleus were procured 30 of each side. The dimensions were taken by digital vernier calliper with resolution of 0.01mm. Weight was taken by digital analytical balance with the sensitivity of 0.01mg.

The descriptive data involved Shape of handle, presence or absence of anterior process and the shape of head of malleus. The parametrical data (fig. 1) included its weight, length of the manubrium (bc), length of Head and neck (ac), diameter of head (d)

and the total length(ab). Index was also calculated by using the formula:
 Index=length of manubrium (bc)/total length (ab) X100

The qualitative data were analyzed by chi square test and parametrical data were compared using t test in medcalc software.

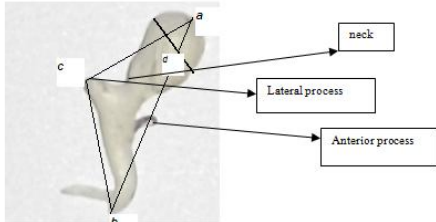


Figure 1: The parametrical data.



Figure 2: Fig 2.Straight long process, globular head.



Figure 3: Curved long process and elongated head.

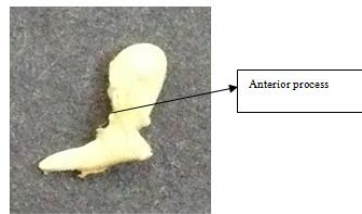


Figure 4: Anterior process present.



Figure 5: Anterior process is absent with prominent neck.



Figure 6: Neck absent.

Table 1: Showing descriptive parameters of Malleus.

Parameters	Rt malleus		Lt malleus		Chi square	p-value	Contingency coefficient
	Present	Absent	Present	Absent			
Neck	80%	20%	86.70%	13.30%	0.07	0.79	0.05
Anterior process	93.30%	6.70%	90%	10%	18.64	<0.0001	0.62
Shape of handle	Curved	Straight	Curved	Straight	14.6	0.0001	0.57
	36.70%	63.30%	30%	70%			
Shape of head	Elongated	Globular	Elongated	Globular	0.64	0.42	0.15
	83.30%	16.70%	90%	10%			

Table 2: Showing t-test between right and left Malleus.

Variables	right malleus		left malleus		t-test	p-value
	mean	±sd	mean	±sd		
Weight (mg)	23.4057	0.6046	23.5067	0.7287	-0.584	0.32
head and neck a_c (mm)	4.702	0.2185	4.5743	0.1155	2.829	0.001
length of handle b_c (mm)	4.6427	0.3096	4.4907	0.3247	1.855	0.8
total length a_b (mm)	7.5973	0.3697	7.624	0.1468	-0.367	< 0.001
diameter of head d (mm)	2.343	0.1971	2.541	0.2054	-3.81	0.827
Index	61.44	4.335	58.88	2.865	2.694	0.029

Table 3: Regression equation between various dimension of Malleus and their respective weight.

Variable		Co-eff of determination (R ²)	p-value	Regression equation
Dependent (y)	Independent(x)			
Rt malleus Weight	Rt total length(a-b)	0.7451	<0.0001	y = 12.6817 + 1.4115 x
Lt malleus Weight	Lt total length(a-b)	0.8045	0.0027	y = -10.4265 + 4.4508 x
Rt malleus Weight	Rt length_of_handle(b-c)	0.2629	<0.0001	y = 18.7581 + 1.0011 x
Lt malleus Weight	Lt length_of_handle(b-c)	0.3566	<0.0001	y = 17.4893 + 1.3400 x
Rt malleus Weight	Rt head and neck(a-c)	0.5397	<0.0001	y = 13.8492 + 2.0324 x
Lt malleus Weight	Lt head and neck(a-c)	0.9404	0.0022	y = -4.4774 + 6.1176 x
Rt malleus Weight	Rt diameter of head(d)	0.7516	<0.0001	y = 15.2542 + 3.3979 x
Lt malleus Weight	Lt diameter of head(d)	0.7940	<0.0001	y = 11.3523 + 4.9806 x

Table 4: Comparative morphometric data of middle ear ossicles of present study with previous studies.

Parameters	(a-b) (mm)	(b-c) (mm)	(a-c) (mm)	Wt (mg)	Index (%)	d (mm)
Present study	7.95	4.65	4.702	23.5	60.165	2.44
Radha 2016	7.4	4.2	3.4	-	-	-
Vinay Chander et al 2014	7.45	-	-	18.25	-	-
Padmini et al 2014	5.54	3.03	2.79	-	54.73	-
Mogra et al(2013)	8.5	5.2	4.72	-	61.01	-
Ramirez et al (2013)	8.18	-	-	-	-	-
Unur et al, 2012	-	-	-	-	61	-
Erdognan et al. 2002	7.7	4.7	4.9	-	56.61	-
Aycan et al. 1990	8.1	4.9	5.1	-	-	-
Arensberg Et al, 1981	7.8	4.4	-	-	-	-
Harneja et al 1973	7.15	4.22	-	-	-	-
Harada(1972)	8	4.2	5	-	-	-
Arensberg & Nathan,1971	7.3	3.5	-	-	-	-
Bouchet & Giraut 1969	7.9	4.7	-	-	-	-
Masali 1968	7.6	4.6	-	-	-	-

Table 5: Comparison of Descriptive parameters of Malleus.

	Neck		Head		Anterior process		Handle curve	
	present	absent	globular	elongated	present	absent	present	absent
Present study	83.50%	16.65%	13.35%	86.65%	91.65%	8.35%	33.35%	66.65%
Mogra et al 2014	89.39%	10.61%	-	-	-	-	42.20%	57.58%
Padmini 2014	97%	3%	-	-	-	-	-	-
Unur 2002	noticed absence in some		-	-	noticed variable length		-	-
Sarrat et al 1988	-	-	-	-	-	-	noticed forward handle curve	

Conclusion

Osteometric dimensions of malleus are useful in prosthesis designing which can be used in ossicular reconstruction. Also the ear ossicles may be used to create a bank for homografts in ossiculoplasty. The variable shape of malleus gives a better view to the designers of prosthesis.

Consent: Not applicable

Ethical approval: Not applicable as study is on cadavers in department of anatomy

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Interest of conflict: None

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