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RESEARCH ARTICLE

OSTEOMETRIC ANALYSIS OF EAR OSSICLES IN POPULATION OF RAJASTHAN.

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Key words:-

Abstract

Background: It has been long known fact that mammalian ear ossicles have evolved from transformation of hyomandibular cartilage, quadrate and articular bone which transmits sound waves to inner ear.

Aims and objectives: This study was an attempt to analyse morphometry of three ear ossicles and to deduce a correlation between their dimensions.

Material and methods: 30 human cadavers were dissected to extract the temporal bones of both the sides and the ear ossicles were procured and all the ear ossicles were analysed for their osteometric dimensions using medcalc software.

Observation and conclusion: The distance between the tympanic part of facial nerve and the ossicles were also noted approximately 3.02 mm as it is an important structure to be preserved in ossiculoplasty. A positive correlation was found between the dimensions and the respective weights of the ossicles which is useful for designing the ossicular implants.

Key words: Ear ossicles, facial nerve, Osteometric analysis, middle ear, digital vernier calliper

Introduction: Middle ear bones have evolved from hyomandibular cartilage of amphibians, reptiles and birds which suspends upper jaw from skull. These transmits sound wave into inner ear. In mammals two ear ossicles malleus and incus have been derived from quadrate and articular bone which in lower land vertebrates intervene between lower jaw and skull bone [1]. Thus any deformity or damage to the ossicles may lead to conductive hearing loss which may be corrected by using middle ear prosthesis. Thus this study was an attempt to analyse morphometry of the three ear ossicles and also to deduce any correlation between their dimensions so as to aid the prosthesis design and its manufacture.

Material and method:- 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 anatomy. The tegmen tympani was chipped off by using micro motor, chisel and hammer and the three ear ossicles were

removed and 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 course of facial nerve was also observed and its distance with the ossicles was also measured with digital vernier calliper. All the results which were obtained were analysed using medcalc software. The angle of incus was measured using sketch up pro 2014 software.

Result and observation: Mean distance was calculated from head of malleus to the tympanic part of facial nerve as 3.02 mm(fig 1).

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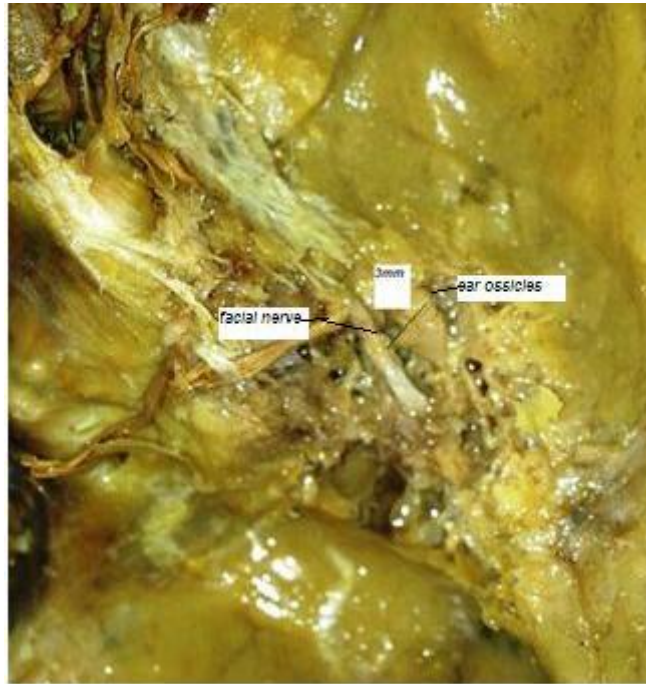


Fig 1:- (Prosection of Temporal Bone showing facial nerve and ear ossicles)

The following dimensions were measured in malleus (fig 2), incus (fig 3) and stapes (fig4,5) and recorded as per table 1 ,2, 3, 4, 5 and 6

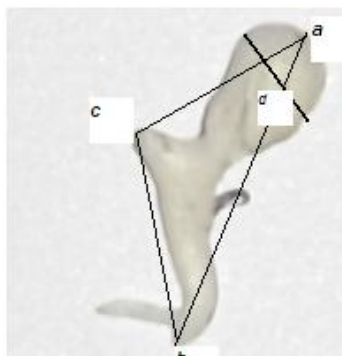


fig 2:- (malleus)

1. Malleus

Total length: a-b

Length of manubrium or handle: b-c

Length of head and neck :(a-c)

Results were recorded as per in table no. 1 and 2 for malleus, table no. 3 and 4 for incus and table no. 5 and 6 for stapes.

Table no.1:- (Dimensions of malleus)

Malleus Parameters(mm)	RT		Lt	
	mean	±Sd	mean	±Sd
Total length(a-b)	7.56	0.39	7.97	0.34
Length of handle(b-c)	4.63	0.31	4.48	0.6
Head and Neck(a-c)	4.54	0.4	4.51	0.22
Diameter of Head(d)	2.54	0.41	2.34	0.20
Weight(mg)	23.49	0.92	23.5	0.2

(Rt –right, Lt- left)

Graph no.1:-(comparison between rt and Lt sided malleus)

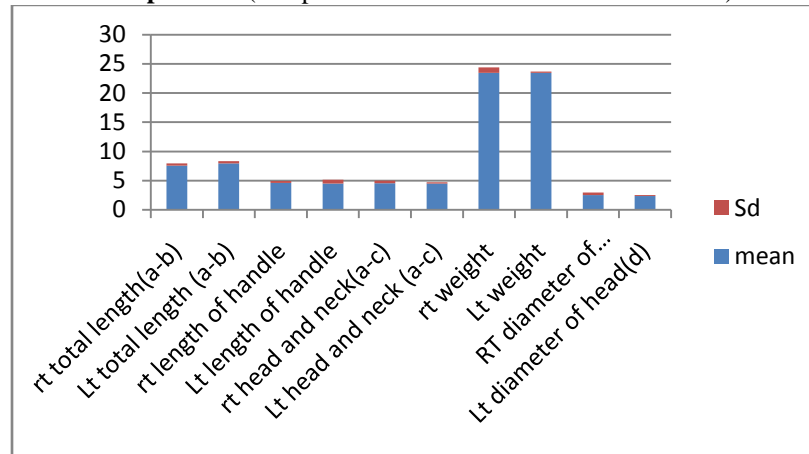


Table no. 2:- (Regression equation between various dimension of malleus and their respective weight)

Variable		Coeff 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

(Rt –right ,Lt left)

2.Incus:- (fig 3):

Length of long process mm (d-e)
 Length of short process(mm)= (d-f)
 distance between two process=(e-f)

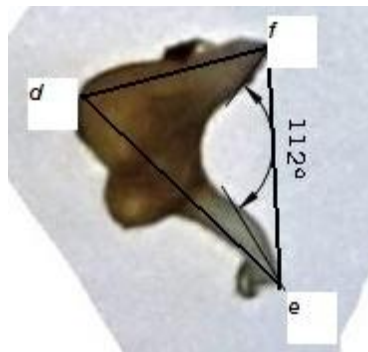
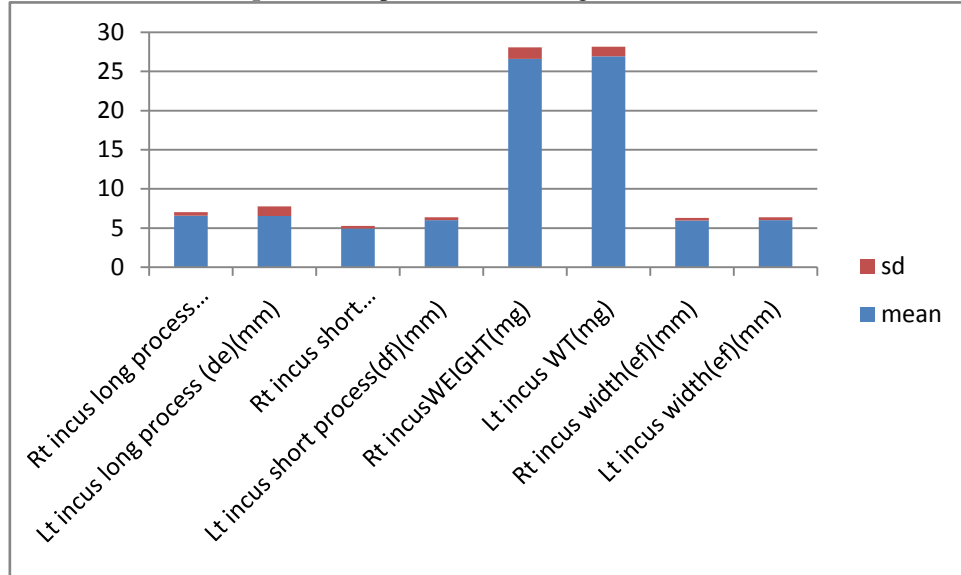


fig 3(Incus)

Table 3:- (Dimensions of Incus)

Incus Parameters(mm)	RT		Lt	
	mean	±Sd	mean	±Sd
Long process (de)	6.57	0.45	6.52	0.44
Short process(df)	4.94	0.34	5.99	0.4
Distance b/w two (ef)	4.54	0.4	4.51	0.22
Angle °	106.00°	3.73	106.67°	3.79
Weight(mg)	26.62	1.56	26.94	1.22

(Rt- right ,Lt- left , Wt -weight)

Graph 2:- (Comparison between right and left incus)

Regression coefficient with weight was also calculated as per table no.4 and Pearson correlation coefficient between width and angle of right and left incus was **0.66 and 0.86** respectively.

Table no. 4:- (Regression equation between various dimension of incus and their respective weights)

Variable		Coeff. Of Determination (R ²)	P value	Regression equation
Dependent(y)	Independent(x)			
Rt incus Weight	Rt incus long process	0.6314	<0.0001	$y = 9.8531 + 2.5523 x$
Lt incus Weight	Lt incus long process	0.7757	<0.001	$y = 11.0353 + 2.4370 x$
Rt incus Weight	Rt incus short process	0.1032	<0.0001	$y = 19.8064 + 1.3844 x$
Lt incus Weight	Lt incus short process	0.01	<0.0001	$y = 25.0598 + 0.3832 x$

(Rt- right ,Lt- left)

Stapes:

Height= (g-h)

Length of Footplate=(i-j)

Breadth of Footplate = (k-l)

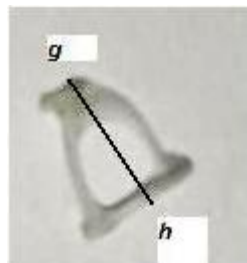


fig 4(stapes)

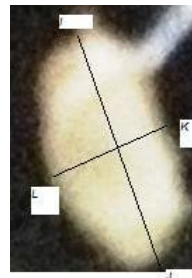
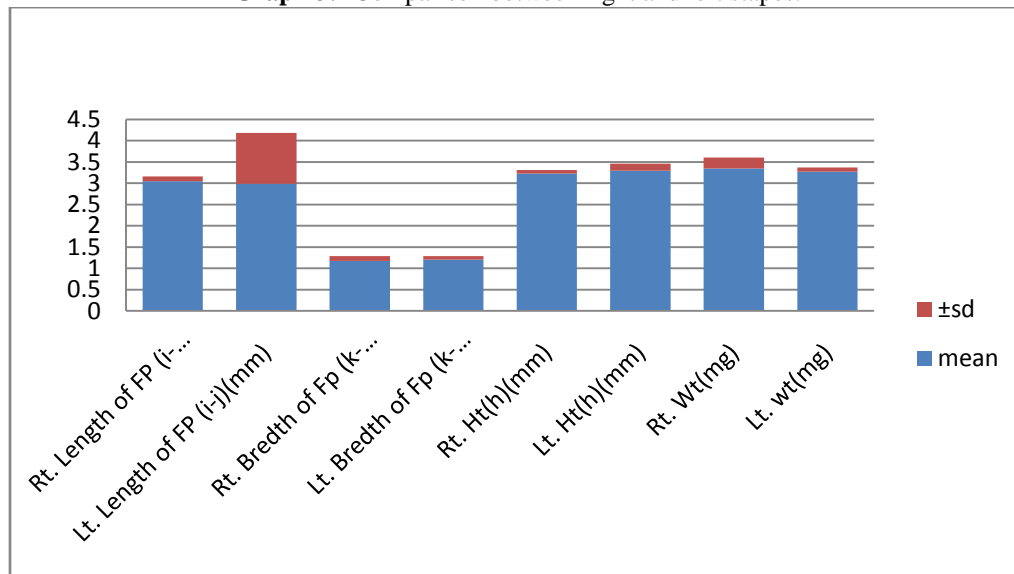


fig 5(stapes footplate)

Table 5:- (Dimension of stapes)

Stapes parameters	Rt		Lt	
	mean	±sd	mean	±sd
Lt OF fp(mm)(i-j)	3.05	0.11	2.98	0.21
Breath Of fp(mm)(k-l)	1.18	0.11	1.2	0.08
Weight(mg)	3.35	0.26	3.2	0.1
Ht(g-h)(mm)	3.23	0.08	3.29	0.17

(Rt- right ,Lt- left, fp- foot plate, Ht -height)

Graph 3:- Comparison between right and left stapes.

(Rt- right ,Lt- left, fp- foot plate, Ht -height)

Table 6:-(Regression equation between various dimension of incus and their respective weight)

(Rt –right,Lt -left , Coeff-coefficient)

Variable		Coeff. Of Determination (R^2)	P value	Regression equation
Dependent(y)	Independent(x)			
Rt stapes Weight	Rt Height	0.29	0.26	$y = 1.7641 + 1.5866 x$
Lt Stapes Weight	Lt Height	0.20	<0.0001	$y = 2.4625 + 0.2467 x$
Rt Stapes Weight	Rt Length of foot plate	0.89	0.61	$y = 0.1089 + 1.0662 x$
Lt Stapes Weight	Lt Length of foot plate	0.09	<0.0001	$y = 2.8722 + 0.1351 x$
Rt stapes Weight	Rt Breath of foot plate	0.06	0.07	$y = 1.0767 + 2.2458 x$
Lt Stapes Weight	Lt Breath of foot plate	0.89	0.20	$y = 0.2501 + 2.5014 x$

Discussion:-

Current study has evaluated various dimensions of ossicles and were compared with previous results in table no. 7 (2,3,4,5,6,7,8,9,10), 8 (3,11,12,4,3,5,6,14,7,8,9,10) and 9 (3,15,4,9). Apart from these dimensions the present study has also evaluated a positive correlation between the dimensions and weight of the ossicles which may be useful in the designing of the prosthesis. The distance between the facial nerve and ossicles was also evaluated which is an important structure to be preserved in ossiculoplasty and also its branch chorda tympani course was seen which in 80% of the observed cases traversed medial to the manubrium. Also weight of incus is more than malleus in our finding and minimum that of stapes. Incus was stouter than malleus.

Table no 7:- Comparative morphometric data of middle ear ossicles of present study with previous studies.

Parameters	Previous studies									Present study
	Vinay Chand er et al 2014	Padmi ni et al 2014	Erdog na n et al. 2002	Ayca n et al. 1990	Arensbe rg Et al, 1981	Harada(19 72	Arensberg &nathan,19 71	Bouch et & Giraut 1969	Masa li 1968	
Total length(a-b)	7.45	5.54	7.7	8.1	7.8	8	7.3	7.9	7.6	7.95
Length of manubrium(b-c)	-	3.03	4.7	4.9	4.4	4.2	3.5	4.7	4.6	4.65
Length of head and neck(a-c)	-	2.79	4.9	5.1	-	5	-	-	-	2.55
Weight (mg)	18.25	-	-	-	-	-	-	-	-	23.5
Diameter of head(d)	-	- -	-	-	-	-	-	-	-	2.44

Metric values of malleus given in mm and mg

Table no 8:- Comparative morphometric data of middle ear ossicles of present study with previous studies.

Parame ters	Pad mini et al 2014	Ka mal et al 201 0	Nate kar & De Souza 2006	Erdog nan et al. 2002	Unu r, Ulg er, Eki nci (20 02	Ayc an et al. 199 0	Arens berg Et al, 1981	Harnej a & Chatur vedi 1973	Harada(1972	Arensber g &nathan, 1971	Bouc het & Gira ut 1969	Mas ali 196 8	prese nt stud y
Total length of long process (d-e)	5.13	6.67 4	6.52	6.5	6.5	6.7	6.8		6.4	6.4	6.5	6.4	6.54 5
Distanc e betwee n the pocesse s(ef)	4.5	6.01	5.86	6.1	6.1	6.1	-	-	4.2	-	-	-	5.97
Total length of short process (d-f)	3.47	5.04 3	5.06	4.9	4.9	5.1	5.1	-	4.8	5.1	5.1	4.8	5.46 5
Weight (mg)	-	26.3 03	20.7 4	-	-	-	-	25.06	-	-	-	-	26.7 8
Angle	-	74.3 42	-	-	-	-	-	-	-	-	-	-	106. 335

Metric values of incus given in mm and mg.

Table no 9:- Comparative morphometric data of middle ear ossicles of present study with previous studies.

Parameters	Previous study				present study
	Padmini et al 2014	Wadhwa et al 2005	Erdognan et al. 2002	Bouchet & Giraut 1969	
Total height (gh)(mm)	2.71	3.4	3.2	3.5	3.26
length of footplate(ij)(mm)	2.36	2.97	2.6		3.02
breadth of foot plate (kl)(mm)	1.91		1.3		1.19
weight (mg)					3.275

Metric values of stapes given in mm and mg.

Conclusion:-

Osteometric dimensions are useful in prosthesis designing which can be used in ossicular reconstruction. Also the ear ossicles may be used to create a bank for allograft in ossiculoplasty.

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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