

USEFULNESS OF VARIOUS MEASUREMENTS OF INCUS TO DETERMINE THE SEXUAL DIMORPHISM

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ABSTRACT

Background: The incus is the intermediately placed ear ossicle in the middle ear cavity between the malleus and the stapes.

Materials and Methods: In present study, various measurements of incus were taken for the purpose of sexual dimorphism. Out of total 60 incus used in the present study, 30 were retrieved from the male cadavers and 30 were retrieved from the female cadavers.

Results and Discussion: Mean of total length of incus, mean of total width of incus, mean of maximum distance between the tips of the processes of incus and mean of index of incus in male are more as compared to female in the present study.

Conclusion: Among all the measurements taken in the present study; total length of incus and total width of incus having statistically significant difference between the male and female incus and both can be used for the sexual dimorphism of incus for Kachchhi Gujarati population of present study.

KEY WORDS: Total length of incus, Total width of incus, Maximum distance between the tips of the processes of incus, Index of incus

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INTRODUCTION

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 ligamentous fibres to the fossa incudis in the lower and posterior part of the epitympanic recess. The incus has a cartilaginous precursor continuous with the dorsal extremity of Meckel's cartilage.

Ossification often spreads from a single centre in the upper part of its long process in the fourth fetal month; the lenticular process may have a separate centre. [1]

In present study, various measurements of incus were taken for the purpose of sexual dimorphism.

MATERIALS AND METHODS

In the present study, 60 dry adult incus bones were used. These bones were retrieved during the routine dissection of cadavers donated to the Department of Anatomy, Gujarat Adani Institute of Medical Sciences, Bhuj, Gujarat, India. Out of total 60 incus used, 30 were retrieved from the male cadavers and 30 were retrieved from the female cadavers. Pathological, fractured or incus of unknown sex were excluded from the study. Only fully ossified incus of known sex were included in the study. The study was done during the year 2017-18 after the prior approval of the institutional ethics committee of Gujarat Adani Institute of Medical Sciences, Bhuj, Gujarat, India. Following measurements of the incus were taken by using digital vernier caliper:

Total length of incus [Fig. 1]: Total length of incus was measured as the maximum straight distance between the superior edge of the body and the end of the long process of the incus.

Fig. 1: Showing the measurement of total length of incus.



Total width of incus [Fig. 2]: Total width of incus was measured as the maximum straight distance between the superior edge of the body and the end of the short process of the incus.

Fig. 2: Showing the measurement of total width of incus.



Maximum distance between the tips of the processes of incus [Fig. 3]: Maximum distance between the tips of the processes of incus was measured as the maximum straight distance between the end of the long process of the incus and the end of the short process of the incus.

Fig. 3: Showing the measurement of maximum distance between the tips of the processes of incus.



To avoid intra-observer variation, each measurement was taken at three different times and the mean of all three readings was taken as the final reading.

Above mentioned measurements were further used to calculate the following index:

Index of incus

Index of incus was calculated by using the following formula:

Index of incus = Total width of incus/ total length of incus x 100

For each of this measurement, mean value,

standard deviation, standard error of mean, range (minimum-maximum), mean \pm SD (Standard Deviation) were calculated. Independent sample t test was applied and p value was calculated at 95% confidence interval by using SPSS (Statistical Package for the Social Sciences) software for the comparison of various parameters and index of incus in male and female.

RESULTS AND DISCUSSION

As shown in the table 1, in the present study, mean of total length of incus in male is 6.7073 mm, SD is 0.4164 mm, range from 5.34 mm to 7.57 mm and mean \pm SD from 6.2909 mm to 7.1237 mm.

Mean of total length of incus in female is 6.6710 mm, SD is 0.3375 mm, range from 5.93 mm to 7.27 mm and mean \pm SD from 6.3335 mm to 7.0085 mm.

Mean of total width of incus in male is 5.2830 mm, SD is 0.2200 mm, range from 4.89 mm to 5.95 mm and mean \pm SD from 5.0630 mm to 5.5030 mm. Mean of total width of incus in

female is 5.1357 mm, SD is 0.2504 mm, range from 4.70 mm to 5.71 mm and mean \pm SD from 4.8853 mm to 5.3861 mm. Mean of maximum distance between the tips of the processes of incus in male is 5.5983 mm, SD is 0.3293 mm, range from 4.92 mm to 6.18 mm and mean \pm SD from 5.2690 mm to 5.9276 mm. Mean of maximum distance between the tips of the processes of incus in female is 5.3653 mm, SD is 0.3345 mm, range from 4.73 mm to 6.29 mm and mean \pm SD from 5.0308 mm to 5.6998 mm.

Mean of index of incus in male is 79.01, SD is 5.2234, range from 72.61 to 99.06 and mean \pm SD from 73.7866 to 84.2334. Mean of index of incus in female is 77.1433, SD is 4.8779, range from 68.07 to 86.68 and mean \pm SD from 72.2654 to 82.0212.

Mean of total length of incus, mean of total width of incus, mean of maximum distance between the tips of the processes of incus and mean of index of incus in male are more as compared to female in the present study.

Table 1: Showing the parameters, Sex-Male/Female, N-number of bones taken, Mean, SD-Standard deviation, Standard error of mean, Range (minimum-maximum), Mean \pm SD of various measurements and index of incus.

Parameters	SEX	N	Mean	SD	Std. Error Mean	Range (min-max)	Mean \pm SD
Total length of incus	male	30	6.7073 mm	0.4164 mm	0.0760 mm	5.34 mm - 7.57 mm	6.2909 mm - 7.1237 mm
	female	30	6.6710 mm	0.3375 mm	0.0616 mm	5.93 mm - 7.27 mm	6.3335 mm - 7.0085 mm
Total width of incus	male	30	5.2830 mm	0.2200 mm	0.0402 mm	4.89 mm - 5.95 mm	5.0630 mm - 5.5030 mm
	female	30	5.1357 mm	0.2504 mm	0.0457 mm	4.70 mm - 5.71 mm	4.8853 mm - 5.3861 mm
Maximum distance between the tips of the processes of incus	male	30	5.5983 mm	0.3293 mm	0.0601 mm	4.92 mm - 6.18 mm	5.2690 mm - 5.9276 mm
	female	30	5.3653 mm	0.3345 mm	0.0611 mm	4.73 mm - 6.29 mm	5.0308 mm - 5.6998 mm
Index of incus	male	30	79.01	5.2234	0.9537	72.61-99.06	73.7866 - 84.2334
	female	30	77.1433	4.8779	0.8906	68.07- 86.68	72.2654 - 82.0212

Table 2: Showing the statistical analysis and the results of independent samples test applied to various measurements and index of incus.

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Total length of incus	Equal variances assumed	1.951	0.168	1.094	58	0.027	0.129	0.11795	-0.1071	0.3651
	Equal variances not assumed			1.094	48.081	0.028	0.129	0.11795	-0.10814	0.36614
Total width of incus	Equal variances assumed	0.15	0.7	-0.495	58	0.023	-0.035667	0.0720659	-0.179922	0.1085889
	Equal variances not assumed			-0.495	55.873	0.023	-0.035667	0.0720659	-0.180039	0.1087059
Maximum distance between the tips of the processes of incus	Equal variances assumed	35.922	0	1.823	58	0.073	0.2013333	0.1104443	-0.019745	0.4224116
	Equal variances not assumed			1.823	50.399	0.074	0.2013333	0.1104443	-0.020457	0.4231237
Index of incus	Equal variances assumed	0.498	0.483	1.431	58	0.158	1.8673449	1.3049044	-0.744705	4.479395
	Equal variances not assumed			1.431	57.729	0.158	1.8673449	1.3049044	-0.744966	4.4796561

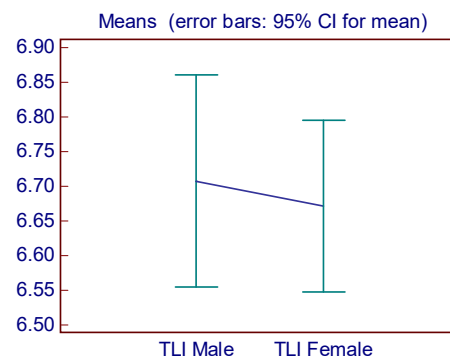
As shown in table 2, p value for the total length of incus for equal variances assumed is 0.027 and for equal variances not assumed is 0.028, which suggest statistically significant difference between the male and female incus for the total length of incus. P value for the total width of incus (for both- with equal variances assumed as well as equal variances not assumed) is 0.023, which suggest statistically significant difference between the male and female incus for the total width of incus. P values for other parameters are more than 0.05, which suggest that there is no statistically significant difference for these parameters of incus between male and female.

As shown in table 3, Arensburg et al [2] in 1981 measured the total length, total width and index of incus in Indian population. In that study, mean of total length of incus was 6.4 mm with SD 0.24 mm, mean of total width of incus was 5.1 mm and mean of index of incus was 80.1. Unur E et al [3] in 1993 measured the total length, total width and maximum distance between the processes of incus in Turkish population. In that study, mean of total length of incus was 6.7 mm, mean of total width of incus was 5.1 mm and mean of maximum distance between the processes of incus was 6.1 mm.

Siori et al [4] in 1995 measured the total length, total width and maximum distance between the processes of incus in Gebelein/Assiut and Antinoe population. In Gebelein/Assiut population, mean of total length of incus was 6.49 mm, mean of total width of incus was 4.89 mm and mean of maximum distance between the processes of incus was 6.02 mm. In Antinoe population, mean of total length of incus was 6.78 mm, mean of total width of incus was 5.14 mm and mean of maximum distance between the processes of incus was 6.15 mm.

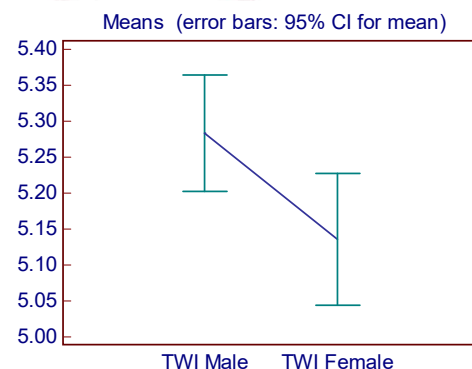
Unur E et al [5] in 2002 measured the total length, total width, maximum distance between the processes and index of incus in Turkish population. In that study, mean of total length of incus was 6.47 mm with SD 0.55 mm, mean of total width of incus was 4.88 mm with SD 0.47 mm, mean of maximum distance between the

Graph 1: Showing the distribution of observations of total length of incus in male and female (with 95% confidence interval for mean) as well as line joining the mean of total length of incus in male and mean of total length of incus in female.



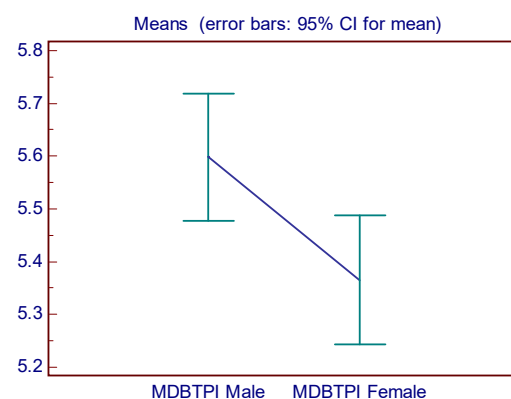
(TLI: Total Length of Incus)

Graph 2: Showing the distribution of observations of total width of incus in male and female (with 95% confidence interval for mean) as well as line joining the mean of total width of incus in male and mean of total width of incus in female.



(TWI: Total Width of Incus)

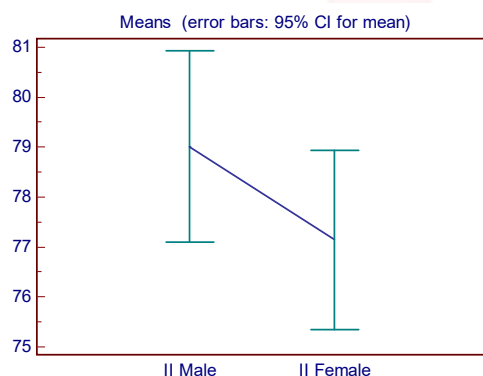
Graph 3: Showing the distribution of observations of maximum distance between the tips of the processes of incus in male and female (with 95% confidence interval for mean) as well as line joining the mean of maximum distance between the tips of the processes of incus in male and mean of maximum distance between the tips of the processes of incus in female.



(MDBTPI: Maximum Distance Between the Tips of the Processes of Incus)

Table 3: Showing the comparison of findings of various parameters and index of incus of male and female in the present study with the findings of other researchers.

Sr No	Researcher	Study population	Sex and side	Parameters			
				Total length of incus (mm) (mean±SD)	Total width of incus (mm) (mean±SD)	Maximum distance between the processes of incus (mm) (mean±SD)	Index of incus (mean±SD)
1	Arensburg et al [2] -1981	Indian	-	6.4±0.24	5.1	-	80.1
2	Unur E et al [3] (1993)	Turkey	-	6.7	5.1	6.1	-
3	Siori et al [4] (1995)	Gebelein/Assiut	-	6.49	4.89	6.02	-
		Antinoe	-	6.78	5.14	6.15	-
4	Unur E et al [5] (2002)	Turkey	-	6.47±0.55	4.88±0.47	6.12±0.43	79.84±6.75
5	Natekar & De Souza [6] (2006)	Indian	-	6.52	5.06	5.86	-
6	Nadeem G [7] (2012-13)	Uttar pradesh	-	6.38±0.036	4.6±0.031	-	-
7	Rathava J et al [8] (2015)	Gujarati	-	6.43±0.29	4.99±0.32	5.82±0.44	-
8	Singh K et al [9] (2016)	Haryana, India	Total	6.674	5.043	6.01	75.714
			Male right	6.691±0.419	5.104±0.394	6.039±0.459	76.429±5.828
			Female right	6.656±0.33	5.013±0.279	5.993±0.29	75.445±4.81
			Male left	6.682±0.498	5.112±0.396	5.985±0.447	76.714±6.176
			Female left	6.666±0.334	4.942±0.281	6.031±0.313	74.27±4.717
9	Sodhi S et al [10] (2017)	North India	Total	6.47		5.31	75.45
			Right	6.465±0.36	4.834±0.44	5.396±0.4	74.87
			Left	6.48±0.42	4.93±0.4	5.23±0.44	76.04
10	Present study (2017-18)	Kachchhi (Gujarati)	Male	6.7073±0.4164	5.283 ±0.22	5.5983±0.3293	79.01±5.2234
			Female	6.671±0.3375	5.1357±0.2504	5.3653±0.3345	77.1433±4.8779

Graph 4: Showing the distribution of observations of index of incus in male and female (with 95% confidence interval for mean) as well as line joining the mean of index of incus in male and mean of index of incus in female.**(II: Index of Incus)**

processes of incus was 6.12 mm with SD 0.43 mm and mean of index of incus was 79.84 with SD 6.75. Natekar and De Souza et al [6] in 2006 measured the total length, total width and maximum distance between the processes of incus in Indian population. In that study, mean of total length of incus was 6.52 mm, mean of total width of incus was 5.06 mm and mean of maximum distance between the processes of

incus was 5.86 mm.

Nadeem G [7] in 2012-13 measured the total length and total width of incus in population of Uttar Pradesh, India. In that study, mean of total length of incus was 6.38 mm with SD 0.036 mm and mean of total width of incus was 4.6 mm with SD 0.031 mm.

Rathava J et al [8] in 2015 measured the total length, total width and maximum distance between the processes of incus in Gujarati population. In that study, mean of total length of incus was 6.43 mm with SD 0.29 mm, mean of total width of incus was 4.99 mm with SD 0.32 mm and mean of maximum distance between the processes of incus was 5.82 mm with SD 0.44 mm.

Singh K et al [9] in 2016 measured the total length, total width, maximum distance between the processes and index of incus in population of Haryana, India. In that study, mean of total length of incus was 6.674 mm, of male right side was 6.691 mm with SD 0.419 mm, of female right side was 6.656 mm with SD 0.33 mm, of male

left side was 6.682 mm with SD 0.498 mm and of female left side was 6.666 mm with SD 0.334 mm. In that study, mean of total width of incus was 5.043 mm, of male right side was 5.104 mm with SD 0.394 mm, of female right side was 5.013 mm with SD 0.279 mm, of male left side was 5.112 mm with SD 0.396 mm and of female left side was 4.942 mm with SD 0.281 mm. In that study, mean of maximum distance between the processes of incus was 6.01 mm, of male right side was 6.039 mm with SD 0.459 mm, of female right side was 5.993 mm with SD 0.29 mm, of male left side was 5.985 mm with SD 0.447 mm and of female left side was 6.031 mm with SD 0.313 mm.

Sodhi S et al [10] in 2017 measured the total length, total width, maximum distance between the processes and index of incus in North Indian population. In that study mean of total length of incus was 6.47 mm, of right side was 6.465 mm with SD 0.36 mm and of left side was 6.48 mm with SD 0.42 mm. In that study, mean of total width of incus was 4.88 mm, of right side was 4.834 mm with SD 0.44 mm and of left side was 4.93 mm with SD 0.4 mm. In that study, mean of maximum distance between the processes of incus was 5.31 mm, of right side was 5.396 mm with SD 0.4 mm and of left side was 5.23 mm with SD 0.44 mm. In that study, mean of index of incus was 75.45, of right side was 74.87 and of left side was 76.04.

In the present study (2017-18), we measured the total length, total width, maximum distance between the processes and index of incus in population of Kachchh, Gujarat, India. In this study, mean of total length of incus in male is 6.7073 mm with SD 0.4164 and in female it is 6.671 mm with SD 0.3375 mm. Mean of total width of incus in male is 5.283 mm with SD 0.22 mm and in female it is 5.1357 mm with SD 0.2504 mm. Mean of maximum distance between the processes of incus in male is 5.5983 mm with SD 0.3293 mm and in female it is 5.3653 mm with SD 0.3345 mm. Mean of index of incus in male is 79.01 with SD 5.2234 and in female it is 77.1433 with SD 4.8779.

CONCLUSION

In the present study, we determined the normal range of the values of various measurements and index of incus in the Kachchhi Gujarati population. Among all the measurements taken in the present study; total length of incus and total width of incus having statistically significant difference between the male and female incus and both can be used for the sexual dimorphism of incus for Kachchhi Gujarati population of present study.

Conflicts of Interests: None

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