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Descripitive Morphometeric Study of The Orbit in Human Dry Skulls - in South Indian Population

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ABSTRACT:

AIM: To assess the quantitative morphometry of orbital cavity for south Indian population in dry Skulls
Objectives: To assess the morphometric measurements of right and left orbital cavity in adult dry skulls and to see the statistical significance in it.
Materials & Methods: 50 dry skulls of known sex (male = 25, female =25) from the department of Anatomy, Meenakshni Medical college Hospitals and Research Insitute where used for the study. Only the skulls with no apparent deformity were measured. Juvenile skulls were also excluded from the study.
The following Paramaters were measured in right and left orbit of the skulls. The parameters like orbital height and width, Length of Medial wall, lateral wall , superior wall and inferior wall , orbital perimeter, orbital index, biorbital distance, interorbital distance and orbital opening area were done . Kolmogorov Smirnov test has been used to test the normality **of** the data. Mann Whitney U test was used to find the statistically significant difference in orbital parameters between males and females Discriminant analysis was performed to predict whether the skull belongs to male or female.
Results: P values of 0.017, <0.001, 0.009, 0.009 and <0.001 indicate that there is significant difference between males and females in Length Of Superior Wall Right, Length Of Superior Wall Left, Length Of Medial Wall Left, Length Of Lateral Wall Right and Length Of Lateral Wall Left respectively.
P value of 0.029, <0.001 and 0.034 indicate that there is significant difference between males and females in Orbital Rim Perimeter (CM) Right, Orbital Rim Perimeter (CM) Left, Orbit opening area Right respectively.
The discriminate function revealed a significant association between groups and all predictors, accounting for 64.9% of between group variability, although closer analysis of the structure matrix revealed two significant predictors, namely Length Of Superior Wall Left(-0.445) and Orbital Rim Perimeter (CM) Left (–.357) with remaining parameters as poor predictors. The cross validated classification showed that overall 78.0% were correctly classified
Conclusion: Comparing the results from the present study with other similar studies we found that the highest accuracy for sex determination is length of superior wall left side and orbital rim perimeter on the left side

Keywords: Morphometry, discriminant analysis, south Indian population
Abbreviations: MF- Maxillo Frontal Suture, EC- Ectoconchion , SO- Supra Orbital Margin , IO- Infra Orbital Margin

1. Introduction

The orbit is a structure which attracted much interest from researchers, both because of its complexity and the variability of diameters from one individual to another. Specialists have tried to quantify these measurements and make correlations between groups, related to ethnicity, gender and race.(Badiu et al 2015) In forensic anthropology, the identification of sex from skeletal remains can be a very important task. While the pelvis is the most reliable indicator of sex, previous studies indicate that it is followed by the skull (France DL.1998). The personal identification of an individual can be determinate with age, sex, stature and ethnicity which form the feature of tentative identification. Sex can be like wise determined by various bones and among individual bones skull is known to provide 92% accuracy (Tanuj Kanchan, Kewal Krishan 2016)..Natural disasters, mass transportation accidents, and terrorism, usually require a large number of individuals to be identified. The process is easy if the complete body are well preserved or documentation enables forensic identification. However, when the victims are carbonized, or have an advanced degree of tissue destruction, the process of establishing identity is difficult or impossible. Several studies have used orbital aperture morphometry to estimate the sex of dry skulls. The orbit is a structure that is superficially accessible and easy to measure. Orbits show significant sexual dimorphism among parts of the skull, with male orbits being characteristically squarer and relatively. smaller, while female orbits are rounder and comparatively larger. However, age, sex, ancestry, and evolutionary periods cause variation in the orbital characteristics.(Sangvichien S 2007) . The aim of the study is to estimate the degree of sexual differentiation using direct measurements of orbit diameters on dry adult skulls, being representative for the contemporary south Indian population.

2. Materials & Methods

The quantitative morphometry of orbital cavity has been studied in 50 adult dry Skulls (of known sex 25 male and 25 female) of Known sex at Department of Anatomy, Meenakshni Medical College Hospital & Research Institute.

Inclusion and Exclusion Criteria

Only normal skulls were selected for the study. Skulls with craniofacial malformations or fractures were excluded from the study.

The ethical clearance committee clearance has been got from the Institutional ethical clearance board IAEC 81A/ANAT/FACULTY/IEC/2021

METHODOLOGY FOR DRY BONE STUDY

In adult dry skulls, measurements were taken by using digital vernier caliper.

The following points were marked over the orbital margins of skulls, between which the measurements were taken.

1. A point MF was marked on the medial orbital margin over maxillofrontal suture.
2. A point EC was marked on the lateral orbital margin over ectoconchion. The point ectoconchion was defined as the anterior most point on the lateral orbital margin intersected by the horizontal bisecting line of orbital cavity.
3. A point SO was marked on the supraorbital margin, over the point of intersection of supraorbital margin and perpendicular bisector of the line joining MF and EC.
4. A point IO was marked on the infra orbital margin, over the point of intersection of infra orbital margin and perpendicular bisector of the line joining MF and EC.

Parameters Measured:

1. Orbital height; The orbital height was measured as the distance between the marked points on supraorbital margin and infraorbital margin. (figure .No.1)
2. Orbital Breadth: The orbital breadth was measured as the distance between the marked points on the medial orbit margin and the lateral orbital margin .(figure.no.1)
3. Orbital index was calculated as Orbital height X 100 / Orbital breadth
4. Length of superior wall : The length of superior wall was measured as the distance from the marked point on the supraorbital margin to the superior most point on the superior border of optic foramen .
5. The length of inferior wall was measured as the distance from the marked point on the infraorbital margin to the inferior most point on the inferior border of optic foramen .
6. The length of medial wall was measured as the distance from the marked point on the medial orbital margin to the medial most point on the medial border of optic foramen .
7. The length of lateral wall was measured as the distance from the marked point on the lateral orbital margin to the lateral most point on the lateral border of optic foramen The length of four walls of the orbital cavity was measured by placing thread along the walls of the orbital cavity. The points were marked on the thread and the distance between the marked points on the thread was measured with vernier caliper after placing the thread on the flat surface.
8. Orbital rim perimeter : It is measured by placing the thread continuously along the orbital margins without any overlapping. The thread was taken out and its length was measured by vernier caliper after placing it over flat surface (figure.No.2)
9. Orbital opening area = 22/7 × AB where A and B are the halves of orbital height and breadthrespectively.
10. Inter orbital distance was measured as the distance between the marked points on the medial orbital margin of right and left orbital cavities. (figure.No.3)
11. Biorbital distance was measured as the distance between the marked points on the lateral orbital margin of right and left orbital cavities (figure.No.4)

Statistical analysis is done by using SPSS software to detect the Mean, standard deviation, range (in right and left and total in both right and left). The Quantitative morphometry of right and left orbital cavities is compared by independent sample T test Sex differences in the total means (in each individual and for each variable, the mean between right and left side was calculated) between the males and females for all the parameters. Kolmogorov Smirnov test has been done for the normality of the data on univariant analysis . Mann Whitney U test was used to find the statistically significant difference in orbital parameters between males and females. Discriminant analysis was performed to predict whether the skull belongs to male or female.

3. Results:

Normality of the data
Kolmogorov Smirnov test has been used to test the normality of the data. Alpha value of 5% is considered to be statistically significant

Table.No.1. Showing Univariant analysis of the orbital parameters- T –test and p-value

	Test Statistic	P Value
Orbital Length Right	0.124	0.053

Orbital Length Left	0.130	0.035
Orbital Breadth Right	0.138	0.018
Orbital Breadth Left	0.160	0.003
Orbital Index Right	0.183	0.000
Orbital Index Left	0.142	0.013
Length Of Superior Wall Right	0.190	0.000
Length Of Superior Wall Left	0.177	0.000
Length Of Inferior Wall Right	0.228	0.000
Length Of Inferior Wall Left	0.225	0.000
Length Of Medial Wall Right	0.100	0.200*
Length Of Medial Wall Left	0.147	0.009
Length Of Lateral Wall Right	0.155	0.004
Length Of Lateral Wall Left	0.135	0.024
Inter Orbital Distance (cm)	0.195	0.000
Bi Orbital Distance (cm)	0.133	0.026
Orbital Rim Perimeter (CM) Right	0.167	0.001
Orbital Rim Perimeter (CM) Left	0.361	0.000
Orbit opening area Right	0.228	0.000
Orbit opening area Left	0.095	0.200*

P values less than 0.005 indicate that the data doesn't follow normal distribution. Hence, Non parametric analysis was used to test the difference between males and females

Table.No.2.showing the difference between male and female in orbital length,breadth & orbital Index

		Mean	Standard Deviation	Minimum	Maximum	Mann Whitney Test Statistic	P value
Orbital Length Right	Male	34.7	1.9	31.1	37.5	219.5	0.07
	Female	33.8	1.6	31.1	36.6		
Orbital Length Left	Male	33.4	1.8	29.7	35.6	236.0	0.14
	Female	33.1	1.0	31.7	34.8		
Orbital Breadth Right	Male	35.7	1.3	33.0	37.3	276.0	0.48
	Female	35.2	1.5	33.0	37.3		
Orbital Breadth Left	Male	35.5	1.2	33.6	37.2	280.5	0.53
	Female	35.1	2.4	31.4	38.7		
Orbital Index Right	Male	97.4	5.6	90.3	108.2	264.5	0.35
	Fem	95.	3.2	92.6	103.1		

	ale	9					
Orbital Index Left	Male	94.1	3.6	88.2	100.4	280.5	0.53
	Female	94.8	8.0	84.0	106.3		

P values indicate there is no difference in orbital Length, Breadth and Index between males and Females

Table.No.3. showing the difference between male and female in superior, inferior, Medial & Lateral wall

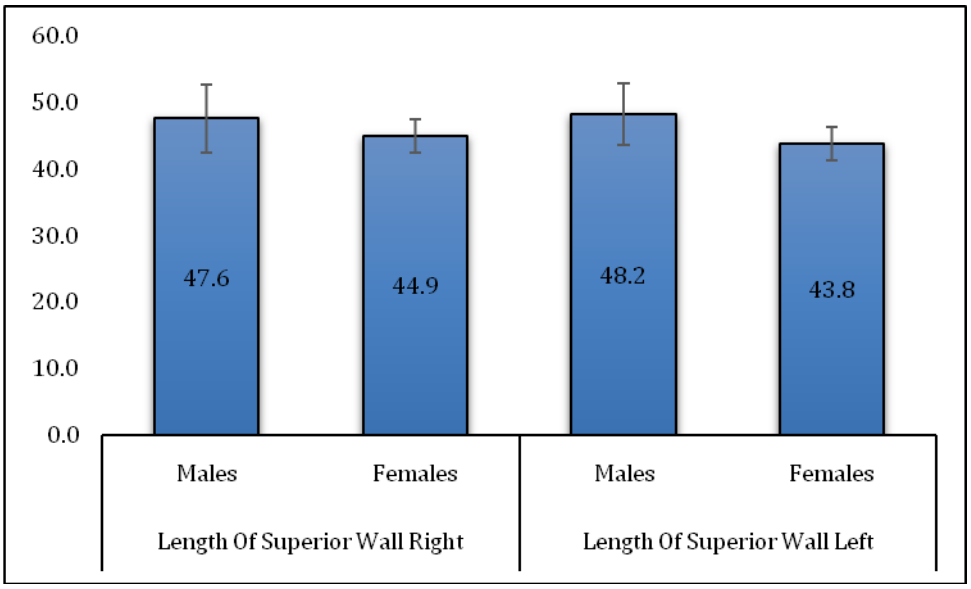
		Mean	**Standard Deviation**	**Minimum**	**Maximum**	**Mann Whitney Test Statistic**	**P value**
Length Of Superior Wall Right	Male	47.6	5.1	38.7	55.0	190.0	0.017*
	Female	44.9	2.6	38.7	54.0		
Length Of Superior Wall Left	Male	48.2	4.7	39.7	55.4	131.5	<0.001*
	Female	43.8	2.5	39.7	50.7		
Length Of Inferior Wall Right	Male	49.8	3.9	45.0	55.5	305.5	0.89
	Female	49.2	2.2	47.2	55.0		
Length Of Inferior Wall Left	Male	47.6	3.8	42.0	54.4	303.0	0.85
	Female	47.9	2.9	43.0	53.4		
Length Of Medial Wall Right	Male	45.3	2.8	40.8	49.4	296.5	0.76
	Female	44.6	2.2	40.8	46.9		
Length Of Medial Wall Left	Male	45.5	2.2	41.3	48.1	177.0	0.009*
	Female	44.0	2.6	41.3	54.5		
Length Of Latera	Male	46.8	2.4	41.9	50.7	177.0	0.009*
	Fem	43.8	3.9	39.4	50.7		

l Wall Right	ale						
Length Of Lateral Wall Left	Male	48.8	2.1	44.3	51.3	43.0	<0.001*
	Female	43.4	2.7	40.4	50.6		

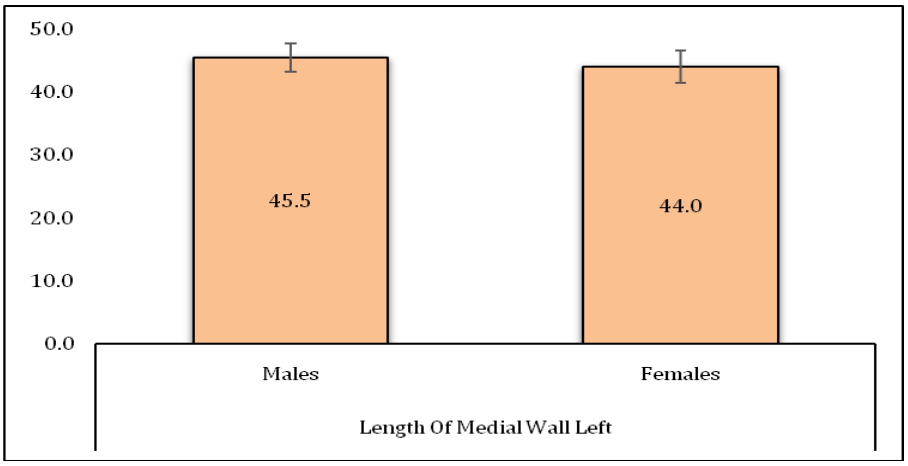
*Statistically significant

P values of 0.017, <0.001, 0.009, 0.009 and <0.001 indicate that there is significant difference between males and females in Length Of Superior Wall Right, Length Of Superior Wall Left, Length Of Medial Wall Left, Length Of Lateral Wall Right and Length Of Lateral Wall Leftrespectively.

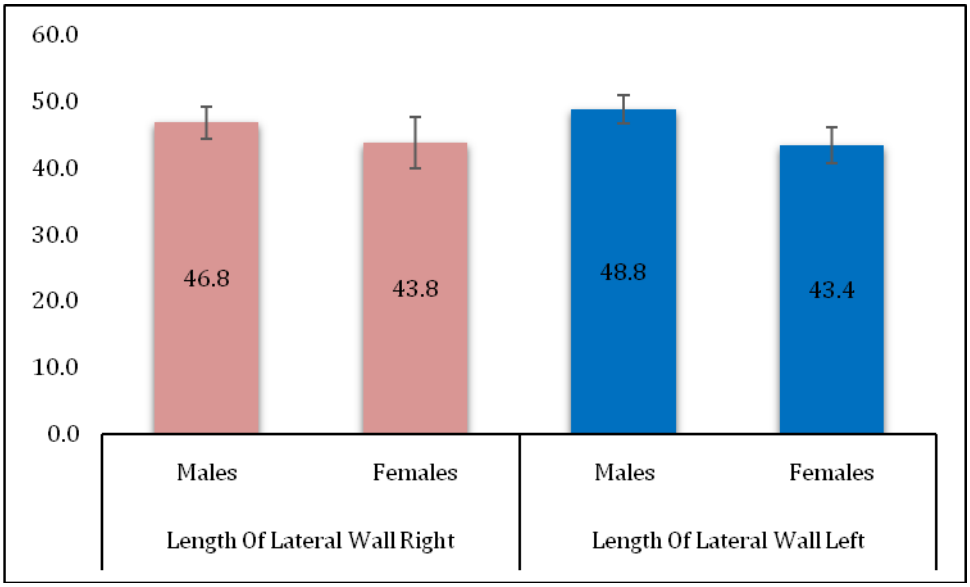
P values of 0.89, 0.85, 0.76indicate that there is no significant difference between males and females in Length Of Inferior Wall Right, Length Of Inferior Wall Left, Length Of Medial Wall Rightrespectively.



Graph.No.1 Showing the difference in superior wall in right and left orbit



Graph.No.2 Showing the difference in Medial wall in right and left orbit



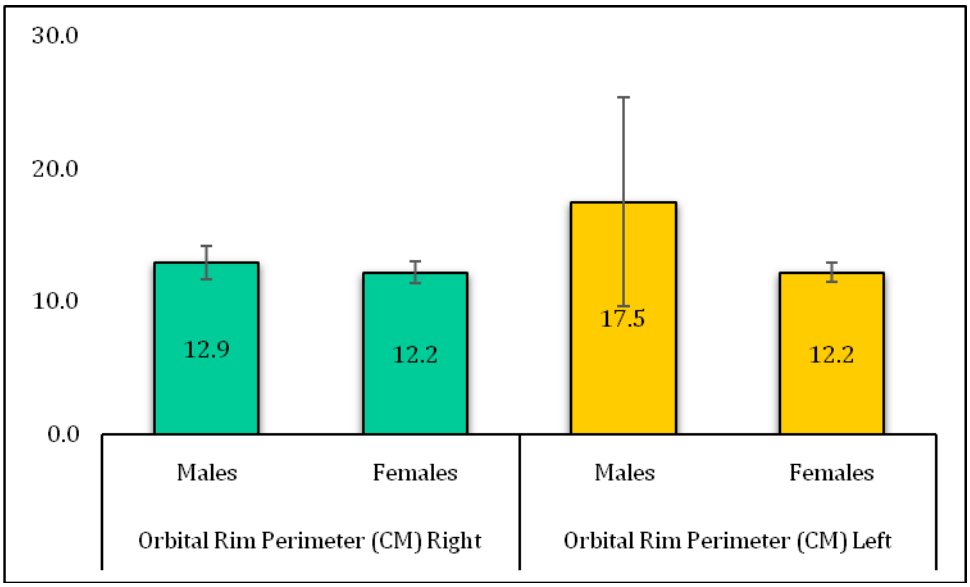
Graph.No.3 Showing the difference in Lateral wall in right and left orbit

Table.No.4.showing the difference between male and female in Inter orbital distance, biorbital distance & orbital opening area

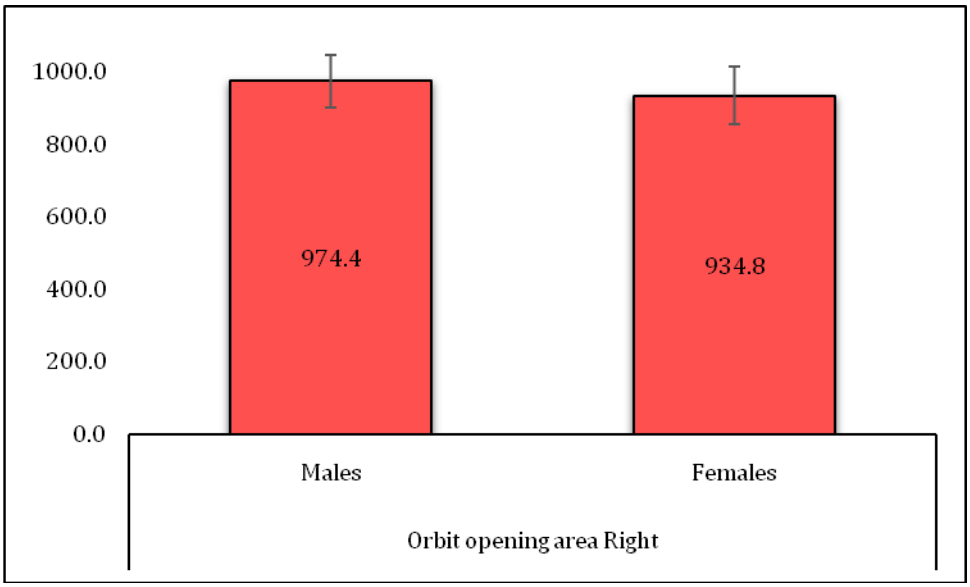
		Mean	Standard Deviation	Minimum	Maximum	Mann Whitney Test Statistic	P value
Inter Orbital Distance (cm)	Male	2.1	0.4	1.0	2.8	237.5	0.14
	Female	2.2	0.4	1.0	2.7		
Bi Orbital Distance (cm)	Male	10.4	0.7	8.9	11.4	294.0	0.72
	Female	10.3	0.5	8.9	11.0		
Orbital Rim Perimeter (CM) Right	Male	12.9	1.3	10.5	14.9	200.0	0.029*
	Female	12.2	0.8	10.6	14.3		
Orbital Rim Perimeter (CM) Left	Male	17.5	7.9	11.2	31.2	131.5	<0.001 *
	Female	12.2	0.7	11.3	13.5		
Orbit opening area Right	Male	974.4	71.6	806.9	1052.5	203.5	0.034*
	Female	934.8	79.2	806.9	1021.2		
Orbit opening area Left	Male	935.2	75.1	783.5	1038.5	235.5	0.14
	Female	910.2	57.3	822.5	998.1		

P value of 0.029, <0.001 and 0.034 indicate that there is significant difference between males and females in Orbital Rim Perimeter (CM) Right, Orbital Rim Perimeter (CM) Left, Orbit opening area Right respectively.

P values of 0.14, 0.72, 0.14indicate that there is no significant difference between males and females in Inter Orbital Distance (cm), Bi Orbital Distance (cm), Orbit opening area Left respectively.



Graph.No.4 Showing the difference in orbital rim perimeter in right and left orbit



Graph.No.5. Showing the difference in male and female in orbital opening

Discriminant analysis :

Discriminant analysis was performed to predict whether the skull belongs to male or female. Predictor variables were Orbital Length Right, Orbital Length Left, Orbital Breadth Right, Orbital Breadth Left, Orbital Index Right, Orbital Index Left, Length Of Superior Wall Right, Length Of Superior Wall Left, Length Of Inferior Wall Right, Length Of Inferior Wall Left, Length Of Medial Wall Right, Length Of Medial Wall Left, Length Of Lateral Wall Right, Length Of Lateral Wall Left, Inter Orbital Distance (cm), Bi Orbital Distance (cm), Orbital Rim Perimeter (CM) Right, Orbital Rim Perimeter (CM) Left, Orbit opening area Right, Orbit opening area Left.

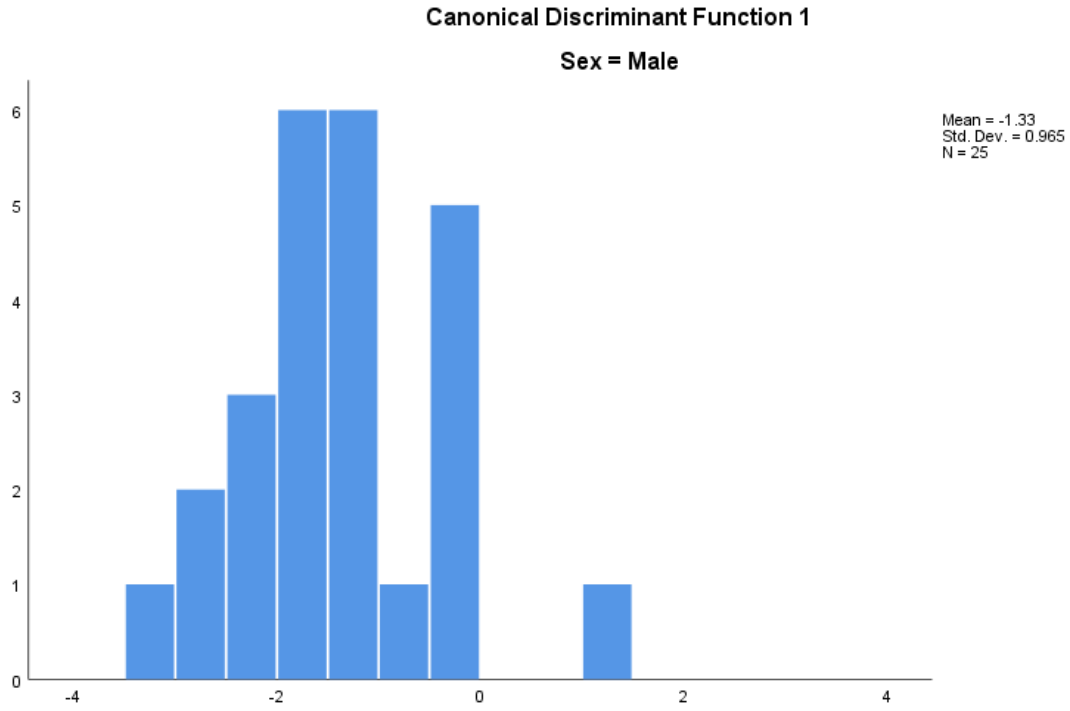
Statistically significant difference in mean were observed for the predictors namely Orbital Length Right, Orbital Length Left, Orbital Breadth Right, Orbital Breadth Left, Orbital Index

Left, Length Of Superior Wall Right, Length Of Superior Wall Left, Length Of Inferior Wall Right, Length Of Inferior Wall Left, Length Of Medial Wall Right, Length Of Medial Wall Left, Orbital Rim Perimeter (CM) Right, Orbital Rim Perimeter (CM) Lefton the dependent variable.

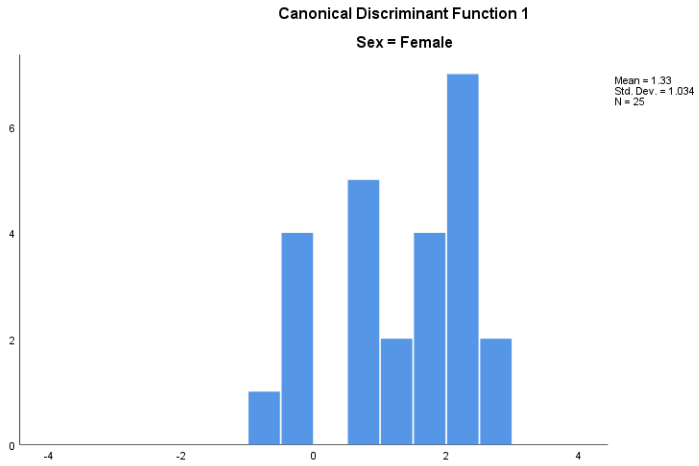
Table.No.5-Discriminant analysis function for the orbital parameters

Variables	Coefficients	Centroid	P value	Chisquare value	Wilks Lambda	Accuracy	Cross validated accuracy
Orbital Length Right	-0.743	Male = -1.332 Female = 1.322	<0.001	43.456	0.351	88%	78%
Orbital Length Left	-4.811						
Orbital Breadth Right	0.122						
Orbital Breadth Left	3.907						
Orbital Index Left	1.530						
Length Of Superior Wall Right	0.792						
Length Of Superior Wall Left	-0.748						
Length Of Inferior Wall Right	-0.146						
Length Of Inferior Wall Left	0.157						
Length Of Medial Wall Right	0.227						
Length Of Medial Wall Left	0.237						
Orbital Rim Perimeter (CM) Right	0.916						
Orbital Rim Perimeter (CM) Left	-0.147						
(Constant)	-133.918						

The discriminate function revealed a significant association between groups and all predictors, accounting for 64.9% of between group variability, although closer analysis of the structure matrix revealed two significant predictors, namely Length Of Superior Wall Left(-0.445) and Orbital Rim Perimeter (CM) Left (–.357) with remaining parameters as poor predictors. The cross validated classification showed that overall 78.0% were correctly classified.



Graph.No.6. Showing canonical discriminat function in male



Graph.No.7. Showing canonical discriminat function in Female

4. Discussion:

Orbit is one of the most complex structures of the skull. Its diameters and volume are different from one person to another. From this variability emerged the increasing interest in the morphometric study of the orbit in the last century. Despite this, there is still no standardized method at the global level. The measurement of orbital diameters has an important role both in the medical practice due to multiple pathology at this level (Sârbu AE et al,2016), but also in anthropology and in forensic medicine.

The Craniometric parameters are employed to determine the sex of a person in forensic medicine. The prior knowledge of these measures is paramount to their successful application since they are different from one population to another.

Sexual dimorphism could also be based on bone development, ossification centers appear earlier in female sex, but bone development occurs sooner in men. Also, different hormonal

secretions may have a role in sexual differentiation. Over time, several authors have been interested in researching various parameters to determine the sex using human skulls. The results of these studies are comparable to our study, these studies analyzing similar segments of the skull. Jain et Jasuja [2015] studied 200 adult skulls, 100 female and 100 male obtaining original accuracy of 79% and cross-validated accuracy of 77%.. In the present study the cross validated accuracy was 78 %.

Sarkar et al [2018] studied 92 skulls (61 male and 31 female) from a contemporary population of Bengal, India. They measured only the width and height of the orbits, using the same anatomical reference points as in our study (dacryon and ectoconchion). He studied a single discriminant function which uses the parameters of the 4 measurements from both orbits. For this function, the accuracy is 68.5% . In the study of Sarkar et al [2018] the mean height of the orbit in female skulls is higher than in male skulls. In the present study, the height of the orbit in females is lower than the height of the orbit in males; this can be caused by the difference between the population groups.

Mihai Marinescu et al [20], studied the sexual dimorphism of the skulls in the Romanian population. With regard to orbit, they used as parameter the length of the orbit and achieves results very similar to those shown in our work. For male skulls they obtained a mean of 39.9 mm, and in our study the same mean is 34.7 mm. For female skulls, the mean of the same parameter is 38.1 mm, and in our study the mean is 33.8 mm. In Dayal et al [2008] the mean of the orbital width is 42.62 mm in male and 41.10 mm in female, and in this work the mean width of the orbit is 35.7 mm in male and 35.2 in female.

Rossi et al [2012] studied the relationship of orbital dimensions with the sex of skulls in Brazilian population. They measured the width and the height of the orbit and the interorbital distance. Rossi et al [2012] reported that there is a significant difference between the sexes for the width of the orbit and the interorbital distance,but not for the height of the orbit. The maximum accuracy obtained by Rossi et al. [22] is 76% for the univariate analysis of the biorbital distance and 79% for the multivariate analysis. In our study, the maximum accuracy for the multivariate accuracy is 78%.

Statistically significant difference in mean were observed for the predictors namely Orbital Length Right, Orbital Length Left, Orbital Breadth Right, Orbital Breadth Left, Orbital Index Left, Length Of Superior Wall Right, Length Of Superior Wall Left, Length Of Inferior Wall Right, Length Of Inferior Wall Left, Length Of Medial Wall Right, Length Of Medial Wall Left, Orbital Rim Perimeter (CM) Right, Orbital Rim Perimeter (CM) Left on **the DV.**
When the parameters of the left and right orbits were used separately, the discriminating power of the model was significantly [Ghosh, et al.:2019] reduced, as seen from the value of Wilks' lambda and the cross-validation tables. Therefore, despite the left and right side measurements showing no significant differences, we used both to achieve better discriminating power in the predictive model.

On present study shows The discriminate function revealed a significant association between groups and all predictors, accounting for 64.9% of between group variability, although closer analysis of the structure matrix revealed two significant predictors, namely Length Of Superior Wall Left (-0.445) and Orbital Rim Perimeter (CM) Left (–.357) with remaining parameters as poor predictors. The cross validated classification showed that overall 78.0% were correctly classified.

5. Conclusion:

The present results revealed that out of 8 orbital measurements and 2 multivariate functions, accuracy of correct sex classification was achieved up to 78.0%. The discriminate function revealed a significant association between groups and all predictors, accounting for 64.9% of between group variability, although closer analysis of the structure matrix revealed two significant predictors, namely Length Of Superior Wall Left(-0.445) and Orbital Rim Perimeter (CM) Left (–.357) with remaining parameters as poor predictors .However, it was seen that these orbital measurements could be used for the sex determination of skull. This study can be very useful for specialists in forensic medicine and anthropology, especially when the human remains examined belonged to individuals from south indian population.

6. References:

1. 1.Badiu G.A.. et al., (2015)Sex determination using the dimensions of the orbit, Revista Română de Anatomie funcţională şi clinică, macro- şi microscopică şi de Antropologie, Vol. XVIII – Nr. 3 – 2019.

2. 2.Dayal MR, Spocter MA, Bidmos MA,(2008) An assessment of sex using the skull of black South Africans by discriminant function analysis, Homo, 59(3):209-221..

3. 3.France DL. (1998) Observation and metric analysis of sex in the skeleton. In: Reichs KJ, editor. Forensic Osteology: Advances in the Identification of Human Remains. Springfield, Ill, USA: Charles C. Thomas; p. 163-86.

4. 4.Ghosh, et al.:(2019(Sex estimation from orbital fossa of skulls, Journal of Forensic Science and Medicine ,volume 5, issue 4 , October-December 2019, 173-176.

5. 5.Jain D, Jasuja OP, Nath S, (2015) Determination Of Sex Using Orbital Measurements, Ind J Phys.Anthrop. and Zumzet. Genet, 34(1):.97-108.
6. Marinescu M, Panaitescu V, Rusu M, Maru N, Punga A,(2014) Sexual dimorphism of crania in a Romanian population: Discriminant function analysis approach for sex estimation. Rom J Leg Med, 22(1):21-26..
7. Rossi AC, de Souza Azevedo FH, Freire AR, et al.,(2012) Orbital aperture morphometry in Brazilian population by postero-anterior Caldwell radiographs, Journal of Forensic and Legal Medicine, 19(8): 470-473..
8. Sârbu AE et al,(2016) Anthropometric measurements of the orbit. A study on 332 orbital cavities using dry skulls, Medicine in evolution, 3:202,
9. Sangvichien S, Boonkaew K, Chuncharunee A, Komoltri PH, Piyawinitwong S, Wongsawut A.(2007) Sex determination in Thai skulls by using craniometry: Multiple logistic regression analysis. Siriraj Med p;59:21621.
10. Sarkar N, Mukhopadhyay PP,(2018). Determination of sex from the morphometry of orbits in adult skull of contemporary eastern Indian population, Egyptian Journal of Forensic Sciences, 8(1):61
11. Tanuj Kanchan, Kewal Krishan (2016). Personal Identification in Forensic Examinations Anthropol ;2:114.

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FIGURE.No.1.Showing measurement of orbital height and breadth

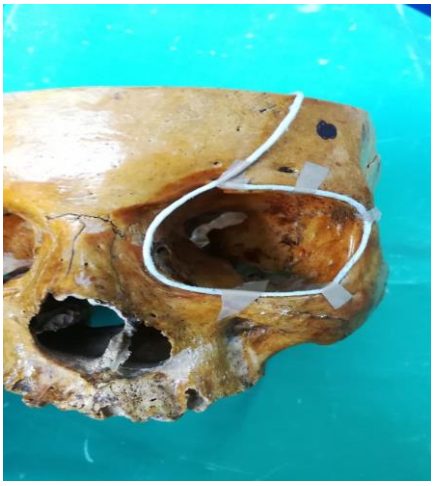

Figure.No.2. Showing the measurement of orbital rim perimeter

Figure.No.3-showing the measurement of Inter orbital distance

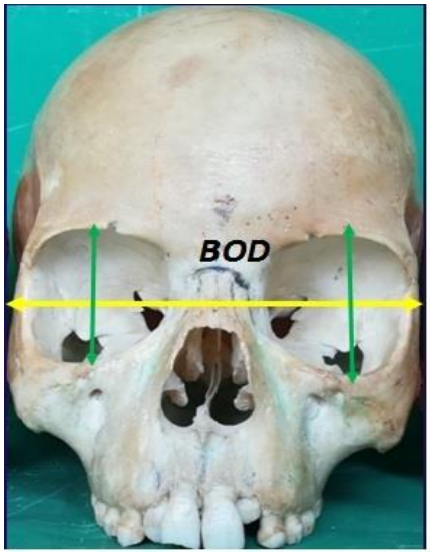

Figure.No.4-showing the measurement of bi –orbital distance