Osteometric Evaluation of Human Skull for Sex Determination: A Comparative Study

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Abstract

Background: Sex determination from analysis of bony remains is one of the most important arduous job for medicolegal experts, especially in cases where identity of the deceased person is in question. Aims & objectives: Our study focuses on evaluation of different osteometric parameters of skull which will be helpful for sex determination.Material and Method: Current study was conducted on 60 human skull bones & they were studied by using calipers for various osteometric measurements. Results: In our study we observed that, skull length, interorbital breadth, biorbital breadth, maxillo-alveolar breadth, maxillo-alveolar length, bizygomatic breadth & nasion-prosthion length are the statistically significant variables & are good determinants for sex than rest of the parameters. As compared to them, cranial breadth & orbital height are poor parameters for sex determination. Conclusion: Human Skull bone as a whole & it's different measurements taken from anatomical landmarks & their osteometric analysis is a good determinant for sex of an individual.

Keywords: *Human skull, cranial osteometry, human identification, bony remains.*

Introduction

There are many challenges, a medicolegal expert faces during his work & sex determination from bony remains is one of such a crucial task to establish an identity of the individual. Such condition arises in many cases like homicidal investigation, archeological interest, mass disaster (both natural & manmade), cases where there is violation of human rights etc. Current global sex ratio is 1.018, which implies that if we are well versed with the aspects of sexual dimorphism then we can reduce our search result to nearly half of the population[1,2]. If whole skeleton is available for analysis then, sex determination is extremely authentic. But in most of the cases, part of the skeletal remains or some bones or even in extreme cases parts of the bony fragments are available for examination. Now in such cases, there arises a need of studies of various skeletal elements of individual bone for determination of sex of that individual. From the past studies it has been well established that sex determination from examination of skull bone & its components has precision rate of almost 85-95%[3]. There is a long list of factors that determine & influence the characteristics of bony prominences which are useful for sex determination, especially during the adolescence. Generally boys have exceptionally vigorous growth surge as compared to girls in their adolescent age group[4]. Roughly there are two techniques for determination of gender from bones & their characteristics. They are: visual evaluation & osteometric method. Visual method is comparatively very easy to asses, does not require any instrument to asses but is highly individual specific & depends on the skill of the forensic expert (which is variable). While the osteometric method is more objective, reliable, depends on indices & is less dependent of investigator's

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subjective evaluation. It in turn reduces the bias between two individual experts which means the results obtained from this method are highly reproducible. Our investigation is done to evaluate the dimorphic features of male and female crania of Central Indian origin based on osteometric analysis.

Material and Method

Current study was performed on dry skull bones at Datta Meghe Medical College, Nagpur which is a part of Datta Meghe Institute of Medical Sciences University. Institutional Ethics committee gave approval for the same. Intact skull bones which are showing well defined sexually dimorphic characteristics on visual examination were involved in our research. Skull bones were taken from departments of Anatomy & Forensic Medicine of Datta Meghe Medical College, Nagpur & Jawaharlal Nehru Medical College, Sawangi. Skull bones which are showing inconclusive dimorphic characteristics on direct visual examination/incomplete skull bones or skulls having any bony deformity were excluded from our study. On the basis of our inclusion & exclusion criteria, we finalized a total of 60adult skull bones out of which 35 were of males & 25 were of females.After reviewing the past researches regarding skull osteometry, we took ten measurements into our consideration. All the measurements were taken using Vernier calipers & sliding calipers. Following anatomical landmarks were included: ecto-conchion, dacryon, nasion, eurion, zygion, prosthion, opisthocranion, glabella, basion, alveolon, opisthion, ectomolare.

Table 1: Following measurements were taken into consideration for our study:

Variable	Abbreviation	Distance between
Maximum Cranial Length	MCL	Opisthocranion & glabella
Maximum Cranial Breadth	MCB	both the eurions
Inter-Orbital Breadth	IOB	both the dacryons
BiorbitalBreadth	BOB	outer & lateral margins of orbital rims
Orbital Breadth	OB	lateral & medial border of the orbit
Orbital Height	OH	superior & inferior border of the orbit
NasionProsthionLength	NPL	Nasion & prosthion
BizygomaticBreadth	BZB	two zygions
Maxillo Alveolar Breadth	MAB	two ectomolares
Maxillo Alveolar Length	MAL	Alveolon & prosthion

Our obtained data was analyzed using statistical package for social sciences (SPSS) software. Student's t- test was applied to study the mean differences in various cranial parameters. P- value< 0.05 was considered as significant.

$$\text{Index of sexual dimorphism} = \frac{\text{Meanvalueinmales}}{\text{Meanvalueinfemales}} \times 100$$

Results

Table 2: Descriptive statistics for cranial parameters

Variable	Male (N=35)		Female (N=25)		p – value
	Mean	SD	Mean	SD	
BZB	10.08	0.49	9.44	0.51	<0.0001
BOB	9.86	0.57	8.88	0.5	<0.0001
OB	3.87	0.25	3.55	0.33	0.0001
IOB	2.31	0.24	2.52	0.31	0.0477
OH	3.21	0.28	3.2	0.31	0.2174
NPL	4.81	0.42	4.19	0.57	<0.0001
MCL	13.46	0.6	12.41	0.65	<0.0001
MCB	10.39	0.63	10.21	0.28	0.3257
MAL	6.46	0.36	6.06	0.45	<0.0001
MAB	5.28	0.39	4.96	0.31	0.0012

In present study mean Bizygomatic Breadth was found to be significantly higher in males. Both Biorbital breadth and Orbital breadth were higher in males but no significant difference was observed between males and females in Orbital breadth whereas Biorbital breadth in males was significantly higher compared to females. Similarly inter-orbital breadth in males was observed to be significantly higher in this study. Orbital height was found have insignificant difference and was much similar in males and females. Nasion-Prosthion length and Maximum Cranial length were noted to be significantly higher in males while maximum cranial breadth was insignificant although it was higher in males compared to females. Both MaxillOo-Alveolar Length and Maxillo-Alveolar Breadth were found to be larger in males significantly.

Calculation of sexual dimorphism indices revealed that Nasion-Prosthion Length was strongest determinant of sex followed by Biorbital breadth, Orbital breadth, Maximum Cranial length. Inter-orbital breadth, Bizygomatic breadth, Maximum alveolar length and maximum alveolar breadth also showed good degree of sexual dimorphism. Maximum crania breadth and orbital height are observed to be poor determinants of sex in our study.

Table 3: Sexual dimorphism indices.

Variable	Index of sexual dimorphism
BZB	106.78%
BOB	111.04%
OB	109.01%
IOB	91.67%
OH	100.31%
NPL	114.80%
MCL	108.46%
MCB	101.76%
MAL	106.60%
MAB	106.45%

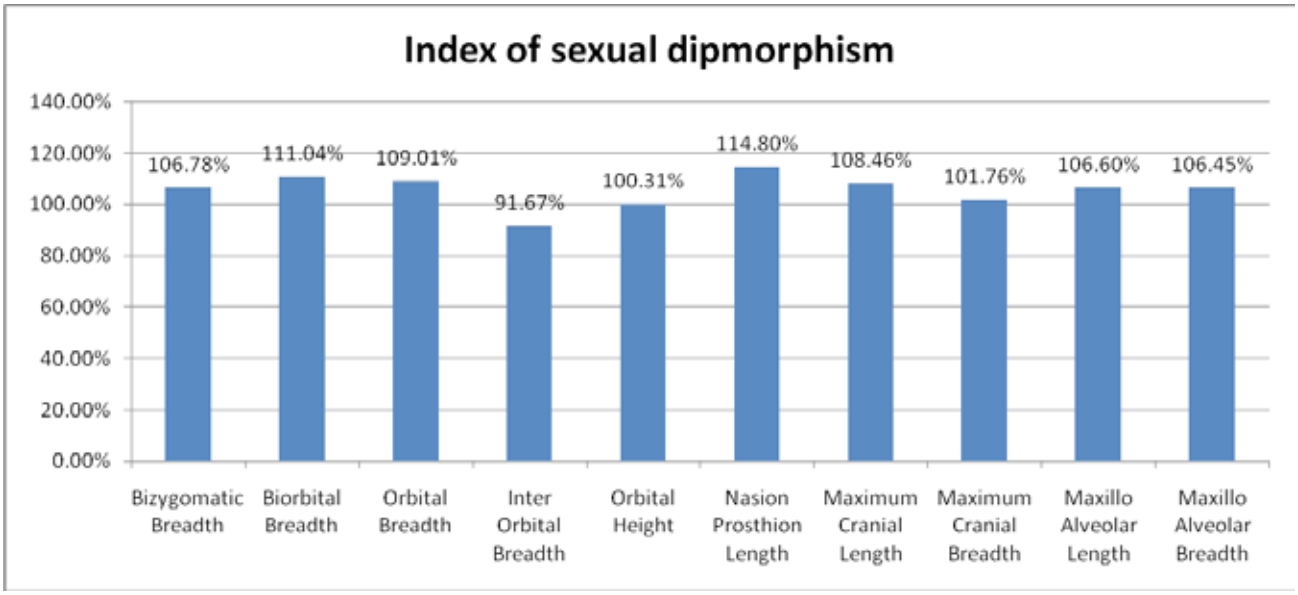

Figure 1: Graphical depiction of Sexual dimorphism indices

Discussion

In this study BB, BOB, IOB, OB, NPL, MCL, MAB and MAL were significantly higher in males compared to females. OB and MCB were found to be insignificant although they were comparative higher in males. The findings in our study are in agreement with study done by Gupta A et al.[5] The sexual dimorphism indices indicate that NPL is the strongest index followed by BOB, OB, IOB, and MCL. Also MAL, MAB, BZB are good at determination of sex while OH and MCB are poor determinants of sex from crania. These findings are similar reported to indices calculated by Gupta

A et al. When BZB, MCL, NPL were compared with study conducted bySteyn M et al[6] findings reported were similar and the parameters differed significantly among males and females. Steyn M et al. also reported that accuracy of prediction of sex from human skull was found to be 85.7%, which was highest among rest of the bony parameters which were analyzed in the same study. Thuangthong T et al[7] conducted a study on sex determination using computer aided software and compared those results with the findings obtained by conventional caliper method. In that study it was reported that OH and BZB differed significantly among both sexes. Also use of computer aided technique determined sex with greater accuracy as compared with use of conventional caliper method. A study done by Saini V et al[8]assessed various parameters for determination of sex among which BZB and BOB differed significantly similar to our study but in contradiction IOB was insignificant between both sexes. OH was insignificant in agreement to present study. Indices such as BZB(105.5), OB(103.295), BOB(103.251) in that study were not in agreement with indices found in our study BZB(106.78), OB(109.01) and BOB(113.04). Ramamoorthy B et al[9] conducted a similar study by using CT head scans of adult live subjects using various craniometric parameters (few of them are included in our study). They found out that accuracy for sex determination approximately ranged from 91.4% to 97.1% in multivariate analysis. Accuracy was highest when all variables were taken into consideration. The parameters which were similar in our study are in agreement with results obtained by Ramamoorthy B et al. Dayal M.R. et al[10] in their study reported that MCL, BZB, OB are significant while OH is not significant which matches to the results of present study. In the same study Dayal M. R. et al. reported that the accuracy of determination for sex is greater with mandible(85%) compared to that with cranium(80.8%). The findings in present study are in agreement with those in a study done by IscanM et al[11]in modern Japanese crania.

Conclusion: India is a diversified country with respect to climatic conditions, food habits, occupations, etc. With such a wide geographical variations, skeletal assortment to represent whole country is difficult. This study indicates the index for sexual dimorphism for various cranial parameters. In this study Nasion-Prosthion Length is observed to be strongest index for sexual dimorphism followed by Biorbital breadth, Orbital breadth, Interorbital Breadth and Maximum cranial length. These indices are useful for the population with similar groups. It is necessary to conduct more & more studies in geographically diversified population especially in different regions of our country on a larger scale so as to represent whole population as the results may not fully reveal true nature of sexual variation in parameters in a small sample size.

Ethical Clearance: Taken from institutional ethics committee.

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Conflict of Interest: Nil.

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