ASSESSMENT OF INDICES USED FOR SEXUAL DIMORPHISM OF SKULL

Anatomy

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ABSTRACT

Introduction: Skull is the preferred bone for identification of sex of the deceased as it resists decomposition, mutilation and fire. Cranial Index, Nasal Index and Orbital Index are commonly used for sexual dimorphism of skull.
Objective: To know the reliability of these indices for sexual dimorphism of the skull.
Materials and Method: The study was performed on 98 adult Indian skulls consisting of 60 male and 38 female skulls of known age and sex. Parameters measured were Cranial Index (CI), Nasal Index (NI) and Orbital Index (OI) which were expressed in descriptive statistics i.e. mean, range and standard deviation. For all the three indices, 'identification points' and 'demarking points' were calculated and then percentage of skulls identified by these points were recorded.
Results- In the present study, mean CI in male and female skulls was 74.68±4.21 and 77.12±4.92 respectively while their NI was 50.76±5.61 and 56.86±6.65 respectively. In male skulls the mean OI was 87.47±8.09, while it was 87.88±5.55 in female skulls. The identification points and demarking points were calculated for all these three indices.
Conclusion: None of the three indices namely CI, NI or OI were promising individually in identifying sex as a very low percentage of skulls could be identified. The study concludes that the reliability of these three cranial indices is doubtful in sexual dimorphism of the skull.

KEYWORDS

Cranial Index; Nasal Index; Orbital Index; Sexual dimorphism; Demarking points; Skull

INTRODUCTION-

Morphometry of the skeletal remains for identification of sex is of great importance to anatomists, forensic experts and anthropologists. Skull is one of the most preferred bones for identification and sexual dimorphism because it resists fire, explosions, mutilations and decomposition. Sex of an individual can be identified accurately in 90% of cases using skull alone.[1] Various natural and accidental circumstances may necessitate the use of anthropometry to identify the sex of a person. These include wars, road and train accidents and deliberate mutilation, disfigurement, pounding, or gauging of the body.[2]Several metrical parameters and indices have been used previously for sexual dimorphism of skull. Cranial Index (CI), Nasal Index (NI) and Orbital Index (OI) are commonly used for sexual dimorphism of skull and are reliable and are stated to determine the sex in a high percentage of skulls.[3,4,5,6] Previous studies present large variations in these indices due to genetic and environmental factors, racial and ethnic differences, different measurement methods and sample size. The prior knowledge of these indices is paramount to their successful application. Therefore, this study was done to assess the reliability of these indices to identify sex differences in skulls.

MATERIAL AND METHODS-

The study material consisted of 98 adult skulls of known sex available in the Anatomy department of which 60 were male and 38 were female. Measurements were taken after putting the skull in Frankfurt's horizontal plane. Instruments used for the measurement were Vernier caliper, spreading caliper, scale and marker. Measurements were taken twice at different sittings and their average was taken.

Following parameters were measured in all the skulls-
1. Maximum cranial length- from glabella to the most posterior point in the mid-sagittal plane on occipital bone (opisthocranium).
2. Maximum cranial breadth- the greatest horizontal diameter of the cranium taken at the point above supramastoid crest perpendicular to median sagittal plane.
3. Cranial Index[4,5] - Calculated as Maximum cranial breadth X 100/Maximum cranial length
4. Nasal height- from nasion to the lowest tip of the nasal spine on the lower border of nasal aperture.
5. Nasal breadth- maximum breadth of nasal aperture.
6. Nasal Index[6] - Calculated as Nasal breadth X100/Nasal height
7. Orbital Breadth (OB)-from the dacryon (d) to the ectoconchionec (ec)
8. Orbital Height (OH)- the maximum vertical distance between the superior and inferior orbital margins
9. Orbital Index (OI)[7] - Calculated as Orbital Height X 100/Orbital Breadth

All the measurements were recorded in millimetres and were tabulated. The three indices CI, NI, and OI were calculated for each skull and their descriptive statistics i.e. mean, SD and Range were calculated in both the sexes. The differences of means between the male and female indices were compared for significance using the Student t-test. Confidence interval of 95% was assumed and the differences were considered significant at P≤0.05. Three indices were then subjected to "demarking points" (DPs) analysis as evolved by Jit and Singh (1966).[5] Demarketing points were calculated from mean ± 3 S.D. for each of the three indices. Percentage of the crania identified correctly as male or female by D.P. was then calculated.

RESULTS-

Table 1- Descriptive Statistics and Identification point of Various Indices in Male and Female Skulls

		Cranial Index	Nasal Index	Orbital Index
Male	Range	66.11 – 79.81	42.03 – 62.15	71.51 – 102.99
	Mean	74.68	50.76	87.47
	SD	4.21	5.61	8.09
	Identification point	<67.87	<49.06	<72.88
	% Identified	*5.00*	*33.34*	*1.67*
Female	Range	67.87 – 87.12	49.06 – 79.86	72.88 – 104.65
	Mean	77.12	56.86	87.88
	SD	4.92	6.65	5.55
	Identification point	>79.81	>62.15	>102.99
	% Identified	*21.05*	*5.26*	*2.63*
	P value (Difference of Mean)	P<0.05	P<0.001	P>0.05

As per table 1 In the present study, mean CI in male and female skulls was 74.68±4.21 and 77.12±4.92 respectively while their NI was 50.76±5.61 and 56.86±6.65 respectively. In male skulls the mean OI was 87.47±8.09, while it was 87.88±5.55 in female skulls. With the help of this method the cranial index could identify only 5% male and 21% female skulls while nasal index could identify only 33.34% male and 5.26% female skulls.

Table 2- Calculated range and Demarking points for Various Indices in Male and Female Skulls

Sr. No.	Index	Sex	Calculated Range (Mean±3SD)	Demarking points	% Identified
1	Cranial Index	M	62.05- 87.31	<62.36	0.00
		F	62.36 – 91.88	>87.31	0.00
2	Nasal Index	M	33.93 - 67.59	<36.91	0.00
		F	36.91 – 76.81	>67.59	5.26
3	Orbital Index	M	63.2 – 111.74	<71.23	0.00
		F	71.23 – 104.53	-	-

As per table 2 Demarking point for CI was 62.36 in males and 87.31 in females. DP for NI was 36.91 in males and 67.59 in females. DP could not be calculated for OI due to high degree of overlap between male and female skulls. Percentage of the skulls identified by DP was then calculated. Using DP of NI, 5.26% of female skulls could be identified. Sex identification of skull was not possible from DPs of other indices.

DISCUSSION-

Human cranium is regarded as the best indicator of sex (next to pelvic bones).[4]Craniometry is the scientific measurement of the skull useful for anthropometry and forensic practice.[5] Many cephalic indices are widely used for racial and sex differences and they provide a system for metrical recording of sizes and proportions of cranial features.[4] The ratio of the cranial vault breadth to the glabellomaximal length multiplied by 100 gives the cranial index.[2] The CI is an important feature that is influenced by the shape of the head. It determines how close or apart the orbits appear to be.[1] This index has been known to be higher in females than in males and shows racial and ethnic variations.[8,9] In the present study, mean CI in male skulls was 74.68±4.21 and in female skulls was 77.12±4.92 with statistically significant difference. These results support prior findings in which the CI was found to be significantly higher for the female crania than for the male crania.[4,9] A few researchers, however, found higher CI in males than females.[6,8] Nasal index is a ratio of the greatest width of the nasal aperture to the height of the nasal skeleton multiplied by 100.[9] It has been a useful tool in Forensic Science as it exhibits sexual dimorphism.[10,11]Various studies have been conducted in the past on nasal aperture measurements and nasal index to determine sex and in distinguishing racial and ethnic differences.[12] Based on the index, the nose has been classified into leptorrrhine or fine nosed (≤69.9), mesorrhine or medium nosed (70.0-84.9) and platyrrhine or broad nosed (≥85.0). (40). The orbital index (OI), the proportion of the orbit height to its breadth multiplied by 100, is determined by the shape of the face and varies with race, regions within the same race and periods in evolution.[13]

CONCLUSION-

In the present study the mean CI in male and female skulls was 74.68±4.21 and 77.12±4.92 respectively placing the Indian study population in Mesocephalic group. Though the OI was less in male skulls than the female skulls, the differences were statistically insignificant excluding their role in the sexual dimorphism of the skull. Thus, though the sex differences of CI and NI are significant by 't' test, none of the three cranial indices i.e. CI, NI and OI are reliable for sexual dimorphism of skull in general population as proven by demarking point analysis.

REFERENCES-

1. Krogman WM, Iscan YM. The Human Skeleton in Forensic Medicine (2 Edition) (1986) Springfield, Illinois, U.S.A. Charles C. Thomas Pub Ltd.
2. Marinescu M, Panaitescu V, Rosu M, Maru N, Punga A. Sexual dimorphism of crania in a Romanian population: Discriminant function analysis approach for sex estimation. Romanian Journal of Legal Medicine.2014;XXII(1):21-26.
3. Vidya CS, Prashantha B, Gangadhar MR. Anthropometric Predictors for Sexual Dimorphism of Skulls of South Indian Origin. International Journal of Scientific and Research Publications, 2012;2(10):1-4.
4. Kumar A, Nagar M. Morphometric Estimation of Cephalic Index in north Indian population: Craniometric Study. International Journal of Science and Research. 2015;4(4):1976-82.
5. Pires LAS, Teixeira AR, Leite TFO, Babinski MA, Chagas CAA. Morphometric aspects of the foramen magnum and the orbit in Brazilian dry skulls. International Journal of Medical Research &Health Sciences, 2016; 5(4):34-42.
6. Mahajan SA, Gandhi D. Cephalometric study of adult human skulls of north Indian origin. International Journal of Basic and Applied Medical Sciences. 2011;1(1):81-83.
7. Jeremiah M, Pamela M and Fawzia B. Sex differences in the cranial and orbital indices for a black Kenyan population. International Journal of Medicine and Medical Sciences.2013;5(2):81-84.
8. Adejuwon SA, Salawu OT, Eke CC, Akinlosotu WF, Odaibo AB. A Craniometric Study of Adult Humans Skulls from Southwestern Nigeria. Asian Journal of Medical Sciences.2011; 3(1): 23-25.
9. Sangvichien S, Boonkaew K, Chuncharunee A, Komoltri C, Piyawinitwong S, Wongsawut A, Namwongsa S. Sex determination in Thai skulls by using craniometry: Multiple logistic regression analysis. Siriraj Med J 2007;59:216-221.
10. Kotian R, Bakkannavar SM, Shekhar H, Pradhan P, Nayak VC. Sex Determination Based on Nasal Index and Nasal Parameters using (Big Bore 16 Slice) Multidetector Computed Tomography 2D Scans. Indian Journal of Forensic and Community Medicine. 2015;2(3):167-171.
11. Orish CN, Ibeachu PC. Craniometric Indices of Nigeria Skulls. Int J Anat Appl Physiol.2016;2(1):6-13.
12. Mahakkanukrauh P, Sinthubua A, Prasitwattanaseree S, Ruengdit S, Singsuwan P, Praneatpolgrang S, Duangto P. Craniometric study for sex determination in a Thai population. Anat Cell Biol 2015;48:275-283.
13. Biswas S, Chowdhuri S, Das A, Mukhopadhyay PP. Observations on Symmetry and Sexual Dimorphism from Morphometrics of Foramen Magnum and Orbits In Adult Bengali Population. J Indian Acad Forensic Med.2015;37(4):346-51.