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EVALUATION OF THE INDICATORS OF SEXUAL DIMORPHISM IN THE SKULL- AN ACCELERATED RESEARCH

Dr. Olive Singh

Associate Professor, Department of Anatomy, Malla Reddy Medical College for Women, Hyderabad, Telangana

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Corresponding author: Dr. Olive Singh
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Abstract

Introduction and Objective: Skull is the preferred bone for identification of sex of the deceased as it resists decomposition, mutilation and fire. Cranial Index (CI), Nasal Index (NI) and Orbital Index (OI) are commonly used for sexual dimorphism of skull and the objective of the study is to know the reliability of these indices for sexual dimorphism of the skull.

Materials and Method: The study material consisted of 100 adult skulls of known sex available in the Anatomy department of Mala Reddy Medical College for Women from August 2021 to January 2022 (6 months) which includes 60 males and 40 females. 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.

Results: The mean CI in the skulls of male and female subjects was respectively 74.32 and 76.56, while their NI was 49.66 and 56.44. The mean OI in male skulls was 86.44, whereas in female skulls it was 86.84. The nasal index could only identify 32.66% male and 5.14% female skulls using this method, whereas the cranial index could only identify 5% male and 20.98% female skulls. Both cranial index and nasal index were found to be statistically significant ($p<0.05$). The demarking point for the CI was 62.44 for men and 86.34 for women. Males' DP for NI was 36.78, while females' DP was 67.88. Due to a significant amount of skull overlap between male and female, DP for OI could not be determined.

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

Introduction

Anatomists, forensic specialists, and anthropologists place a high value on the morphology of the skeletal remains for sex identification. Due to its resistance to fire, explosions, mutilations, and decomposition, the skull is one of the most favoured bones for identification and sexual dimorphism. 90% of the time, a person's sex can be determined only by looking at their head.[1] There are several unavoidable and unintentional situations where anthropometry is required to determine a person's sex. These include intentional body mutilation, disfigurement, beating, or gauging as well as warfare, automobile and train accidents.[2] Various metrical variables and indices have been employed in the past to measure the sexual dimorphism of skulls. The sex of a large percentage of skulls is claimed to be determined by the cranial index (CI), nasal index (NI), and orbital index (OI), which are frequently employed for determining sexual dimorphism of the skull.[3,4,5,6] Due to racial and cultural variances, genetic and environmental influences, various assessment techniques, and sample sizes, previous research have shown significant variations in these indices. The proper application of these indexes depends heavily on prior knowledge about them. This study was conducted to evaluate the accuracy of these indices in detecting sex differences in skulls.

Material and Methods

The study material consisted of 100 adult skulls of known sex available in the Anatomy department of Mala Reddy Medical College for Women from August 2021 to January 2022 (6 months) which includes 60 males and 40 females. 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.

Methodology

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

Statistical Analysis

The measurements were tabulated and were expressed in millimeters. Each skull's three indices—CI, NI, and OI—were calculated, and their descriptive statistics—mean, standard deviation, and range—were computed for both sexes. The significance of the mean differences between the male and female indices was assessed using the Student t-test. The differences were deemed significant at $P< 0.05$ and a 95% confidence range was used. For each of the three indicators, the mean ± 3S.D. was used to calculate five demarking points and determined the percentage of the crania that were correctly classified as male or female.

Results

Table 1: Identification of various indices in male and female skulls using descriptive statistics

	Variables	Cranial Index (CI)	Nasal Index (NI)	Orbital Index (OI)
Males	Range	65.54-78.78	41.98-62.10	70.50-101.98
	Mean	74.32	49.66	86.44
	SD	4.20	5.10	8.20
	Identification Point	<67.44	<48.99	<71.66
	% identified	5.00	32.66	1.54
Females	Range	66.86-88.14	48.92-78.74	72.14-103.56
	Mean	76.56	56.44	86.84
	SD	4.12	6.34	5.24
	Identification Point	>78.78	>60.98	>102.58
	% identified	20.98	5.14	2.11
p-value		0.01*	0.02*	0.07

According to Table 1, in the current investigation, the mean CI in the skulls of male and female subjects was respectively 74.32 and 76.56, while their NI was 49.66 and 56.44. The mean OI in male skulls was 86.44, whereas in female skulls it was 86.84. The nasal index could only identify 32.66% male and 5.14% female skulls using this method, whereas the cranial index could only identify 5% male and 20.98% female skulls. Both cranial index and nasal index were found to be statistically significant. ($p<0.05$)

Table 2: Various Indices' calculated range and demarking points in male and female skulls

Sno.	Index	Gender	Mean ±3SD	Demarking points	% Identified
1	Cranial Index	Male	60.10-86.34	<62.44	0.00
		Female	60.30-88.48	>86.34	0.00
2	Nasal Index	Male	33.78-66.58	<36.78	0.00
		Female	36.90-75.80	>67.88	0.00
3	Orbital Index	Male	62.80-110.88	<71.10	5.14
		Female	70.24-104.14	-	0.00

According to table 2, the demarking point for the CI was 62.44 for men and 86.34 for women. Males' DP for NI was 36.78, while females' DP was 67.88. Due to a significant amount of skull overlap between male and female, DP for OI could not be determined. The percentage of skulls found by DP was then determined and it was 5.14 percent of male skulls which could be recognized using DP of OI. From DPs of other indices, it was impossible to determine the gender of the skull.

Discussion:

Next to pelvic bones, the human cranium is regarded as the best sex indicator.[4]Craniometry is the measuring of the skull that is done scientifically and is useful in anthropometry and forensics.[5] Numerous cephalic indices are frequently employed to measure racial and gender differences and offer a framework for metrical recording of cranial feature sizes and proportions.[6] The skull index is calculated as the cranial vault breadth divided by the glabellomaximal length, multiplied by 100.[6] The skull shape has an impact on the CI, a crucial characteristic which establishes how near or far apart the orbits seem to be as studied by different studies.[7,8] This indicator demonstrates racial and ethnic differences and is known to be greater in females than in males.[8,9]

The mean CI in the current study was 74.32 for male skulls and 76.56 for female skulls, with a statistically significant difference between the two. These findings confirm earlier findings that the CI was considerably higher in the female crania compared to the male crania.[4,9] According to Williams et al (2000) the skulls are divided into four types based on cranial index as follows, Dolicocephalic (CI<74.9), Mesocephalic (CI=75 to 79.9), Brachycephalic (CI=80 to 84.9), Hyperbrachycephalic (CI=85 to 89.9).[10]

However, several studies discovered that men had higher CI than women.[6,8] The largest nasal aperture width divided by the height of the nasal skeleton, multiplied by 100, is the nasal index. Due to its sexual dimorphism, it has proven a useful tool in forensic science.[11,12] 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.[13] 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).[13] 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.

Few similar studies done in comparison of means of cranial index of males and females skulls, Shanti et al[14] studied 100 skulls showed significant difference in means of Cranial index which is similar to results of our study. A study done by Vidya et al[3] among 80 skulls showed higher means of CI as compared to our study and it was not significant ($p>0.05$). As compared to the means of Nasal Index the results of the present study differ from the conclusion made by Vidya et[3] and Kotian et al[11]. In the study conducted by Biswas et al[15] and Mekala et al[16] the means of Orbital Index in both males and females were statistically non-significant this is similar to results of present study.

Conclusion:

In the present study the mean CI in male and female skulls was 74.32±4.20 and 76.56±4.12 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.[17]

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