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Morphometric Estimation of Cephalic Index in North Indian Population: Craniometrics Study

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Abstract: ***Craniometrics studies demonstrated that head shape varies in different races and population is related to the cephalic index. The purpose of this study was to establish specific standards data for sex determination from the cranium in north Indian population. The present study was carried out with 80 (45 male & 35 female) dry human skull procured from University College of Medical science, Delhi. Cranial measurements were taken, data tabulated and statistically analyzed. The mean cephalic index was 74.40±4.36. The mean cephalic index for male was 73.75±3.56 and for female was 75.22±5.15. The difference between male and female cephalic index was statistically significant (p< 0.001). The result of present study shows that majority of north Indian population are Dolicocephalic or Mesocephalic. This study will serve as basis of comparison for future studies on other geographical region population.***

Keywords: Cephalic index; Cranium length; Cranium breadth; Dolicocephalic; Head shape

1. Introduction

Cephalic index also called as cranial index or Index of breadth is one of the important parameter that helps to differentiate between different human races. The cephalic index was defined by Swedish professor of Anatomy Anders Retzius (1796–1860) and first used in physical anthropology to classify ancient human remains found in Europe [1]. The measures used by Retzius — when applied to living individuals — are known as cephalic index, and when referring to dry skulls, cranial index [2.3] . The most widely used anthropometric methods in the differentiation of race and ethnicity is cephalometry through which head (cranium) dimensions can be determined. The most important of cephalometric dimension are length and width of head (cranium) that they used in cephalic index determination (Vojdani et al., 2009) [4]. It has been reported that factors like race, ethnicity, genetic interaction, traditions, nutrition, environment and climate influences head types (Rexhepi and Vjollca. 2008) [5]. Craniometry is also employed in the measurement of cranial features in order to classify people according to race, criminal temperament, intelligence, and so forth. The underlying assumption of craniometry is that skull size and shape determine brain size which determines such things as intelligence and capacity for moral behavior [6,7].

Comparison of changes in cephalic index between parents, offspring and siblings can give a clue to genetic transmission of inherited characters [8]. On the basis of cephalic index head shapes grouped into four international categories, that including "Dolicocephalic" (from the ancient Greek Kephale, head and dolikhos, long and thin), "Brachicephalic" (short and broad), "Mesocephalic" (intermediate length and width) and "Hyperbrachicephalic" (very short and broad) [9]. Australian aborigines and native southern Africans are Dolicocephalic, Europeans and the Chinese skulls are Mesocephalic and Mongolians and the Andaman Islanders have Brachicephalic skulls [10]. The significance of age, gender and population specific cephalometric data is of multifold. Comparison between cephalic indices and the head shapes with race, age and sex is important, which are valuable for treatment monitoring and prediction of orthodontic treatment and the knowledge is valuable in plastic and reconstructive surgeries concerned with craniofacial deformities [9]. Today it is mainly used to describe individual's appearances and estimating age of fetuses for legal, obstetrical reasons [11-15]. Also, it provides the roots for diagnostic comparison as in cases of Dolicocephalic (less prone to Otosis media), and in the individuals with Apert's syndrome who are Hyperbrachicephalic [16, 17].

Though craniometry is often considered to be an important method dealing with sexual dimorphism in skeletal material, there is paucity of metrical data available for this bone for the north Indian population. This study was undertaken in adult dry human skulls to evaluate and report the association of sexual dimorphism and cephalic index pertaining to head shape from the north Indian population. Also compare this study with other similar studies.

2. Material and Methods

In the present study, dry human skull of known sex, were collected from the collection of human bones in the Department of Anatomy, University College of Medical Sciences, Shadara, Delhi. A total of 80 skulls were studied out of which 45 were of male and 35 of female. All the skulls were normal, fully mature, devoid of any fractures or damages. All parameters were measured independently by two different observers, with a predetermined methodology to prevent inter-observer and intra-observer error.

The cephalic measurements were obtained by cranial measurements using a spreading caliper using Hrdlika's (1956) method [18]. The measuring techniques followed internationally accepted standards in anthropometry and were taken to the nearest 0.01 cm.

The parameters measured in the present study were (Figure 1):

- Cranial length (AB) = Glabella to Opisthocranion (GOP)
- Cranial breadth (CD) = Euryon – Euryon (Eu-Eu)

The prongs of the vernier calipers were placed over the described landmarks, fixed manually with the screw provided and the length and breadth of cranium were recorded over the graduated metallic scale on the calipers itself. The anatomical landmarks taken were:

I. Glabella (G): A point above the nasal root between the eyebrows and intersected by mid-sagittal plane.
II. Opisthocranion (OP): It is the most posterior point on the posterior protuberance of the head in the mid sagittal plane.
III. Euryon (Eu): It is the most laterally placed point on the sides of the head. This point can be determined by measuring the maximum cranial breadth.

The cephalic indices were calculated by Hrdlika's method [18]:
Cephalic index (CI) = [Cranial breadth / Cranial length] X 100

Depending upon this index the types of head shapes were classified as given by Williams et al, 1995 [9].

S.No.	*Head Shape*	*Cephalic Index Range*
1	Dolicocephalic	<74.9
2	Mesocephalic	75.0 ---79.9
3	Brachicephalic	80.0 --- 84.9
4	Hyperbrachicephalic	85.0 --- 89.9

All the data were analyzed using Microsoft Excel and SPSS (Statistical Package for Social Sciences) version 22.0. Mean and Standard deviation were calculated. From the observations of the present study the parametric data were analyzed using independent sample t-test.

3. Results

Males' cranial length ranged from 16.2 cm to 19.7 cm with mean of 17.76±0.78 and cranial breadth from 12.1 cm to 13.9 cm with mean of 13.08±0.40. In female's cranial length ranged from 15.7cm to 18.3 cm with mean of 16.91±0.74 and cranial breadth ranged from 11.7 cm to 14.3 cm with a mean of 12.69 ±0.60 (Table 1).

The mean cephalic index was higher in females compared to males in the present study. Among the male skulls, the mean cephalic index recorded to be 73.75±3.56 whereas in females it was 75.22 ± 5.15. There was a statistically significant difference in the mean of the cranial indices in male and female skulls (Table 1). Head shape was classified by cephalic index in which dominant type was Dolicocephalic (53.33%) and Mesocephalic (42.22%), followed by 2.22% Brachicephalic and Hyperbrachicephalic in male skulls. The mean cephalic index in female was 75.22±5.15 which showed that majority were Mesocephalic (62.85%), 31.42% of Dolicocephalic, with 2.85% each Brachicephalic and Hyperbrachicephalic (Table 2).

4. Discussion

The present study provides valuable data pertaining to cranial indices and the cranial measurements on dry human skull belonging to north Indian population. The cranial length of the present study is 17.76 ± 0.78 in male and 16.91 ± 0.74 in female crania whereas the cranial breadth is 13.08 ± 0.40 and 12.69 ± 0.60 in male and female cranium respectively. The comparative analysis of the present cranial measurement with the other workers studies is shown in table 3. The result of this study showed that the cranial index was found to be higher for the female crania (75.22 ± 5.15) than for the male crania (73.75 ± 3.56), which indicate females have relatively shorter cranium in relation to the cranial breadth as compared to their male counterparts. Table 4 showed the comparison of prevalence of cephalic index in different ethnic groups, races and population. Since all these studies were done among subjects or dry human skulls of different races, this could explain the difference in the Cephalic index of male and females in various ethnic groups. Interaction of gene expression and cranial dimensions can make the gene expression differs in various racial, and ethnic groups in geographical zones [19].

Nigerian crania are considered as dolichocephalic while European crania as Mesocephalic. Heidari et al (2006) in his study on female population of South East of Iran reported 21.3% crania as Dolicocephalic, 41.3% crania as Mesocephalic and 31.5% crania as Brachycephalic [20]. Garba et al (2008) found in his study on Maiduguri Nigeria that the female crania were either Dolicocephalic (43.3%) or Mesocephalic (40.0%) whereas male crania were mostly Dolicocephalic (66.7%) followed by Mesocephalic (33.3%) [21]. Interestingly, Kasai et al (1993) reported that dietary habits have been also shown to influence the craniofacial form of a population [22]. In the present study dominant type was Dolicocephalic (53.33%) and Mesocephalic (42.22%), followed by 2.22% Brachicephalic and Hyperbrachicephalic in male skulls whereas in female crania majority were Mesocephalic (62.85%), 31.42% of Dolicocephalic, with 2.85% each Brachicephalic and Hyperbrachicephalic. Rathee et al (2014) reported in north Indian Haryanvi population that the most of the crania in both sexes were Mesocephalic (53.33% male and 62.85% female) followed by Brachycephalic (42.22% male and 31.42% female) [23]. Jay Singh et al (1979) in their study on 300 human skulls of Uttar Pradesh (India) reported 57.31% skulls as Dolicocephalic. Dolicocephalic crania seem to be the dominant head shape in male crania whereas Mesocephalic in female crania in the north Indian population, which can be used as a tool to identify crania of this region in medico legal cases.

In the present study least common type of head shape observed was Hyperbrachicephalic; 2.22% and 2.85% in male and female respectively. Hyperbrachicephalic was dominant type observed in on Fars males in North of Iran (52%), South Iran (34.3%) [25,26]. Brachycephalization is thought to be due to relative higher increase in the cranial breadth in comparison with the cranial length as a result of improvement in nutrition [27].

Although our study showed that the absolute sex differences seldom exist, there are some distinct differences observed in the cranial features of the male and female crania for given a population. Such dissimilarities are also known to occur between various geographical and ethnic groups. This is because the growth of the human skeleton is under the influence of several factors; among them are hormones, nutritional status, cultural differences and environmental factors [28].

5. Conclusion

In the present study (north Indian population), the mean cephalic index in males was 73.75 and in females 75.22. The dominant head shape was Mesocephalic in female (62.85%) and Dolicocephalic in male crania (53.33%). This data can be useful for forensic medicine experts, plastic surgeons, anatomist, anthropologist, oral surgeons and for clinical and research purpose. The observations and results of this study may provide platform for similar extended cephalometric studies based on various communities/ castes/ races of particular geographical zones.

Conflict of Interest

None of the authors has conflict of interest to declare. No source of support in form of grants.

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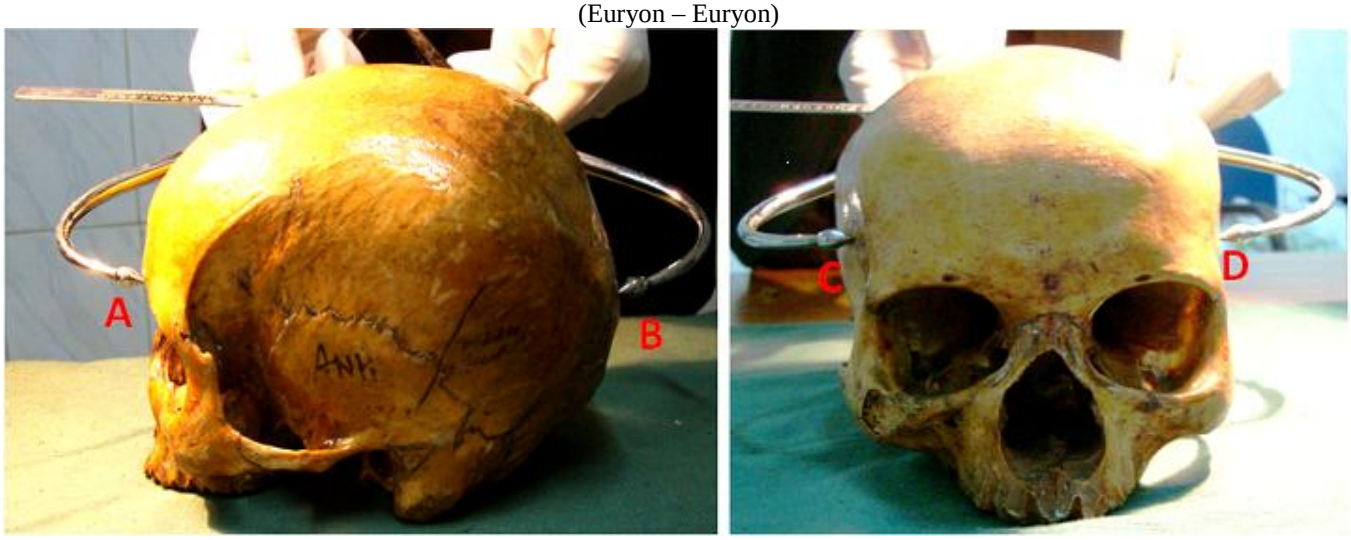
Figure Legend

Figure 1: Showing measurement of parameters of skull. AB-cranial length (Glabella to Opisthocranion), CD- cranial breadth (Euryon – Euryon)



Table's Legend

Table 1: Descriptive statistic showing various parameters of the present study
Table 2: Showing classification of head shape based on cephalic indices in the present study
Table 3: Comparison of Studies on Cephalic Index among various population groups
Table 4: showing comparison of cranial parameters of present study with other studies

Table 1: Descriptive statistic showing various parameters of the present study

Variables	*n*	*Range*	*Mean ± SD*	*P-value*
Cephalic index (Male)	45	65.00-80.25	73.75 ± 3.56	< 0.001*
Cephalic index (Female)	35	68.31-88.82	75.22 ± 5.15	
Cephalic index (Both)	80	65.26-83.44	74.27 ± 4.36	---
Cranial length (Male)	45	16.20-19.70	17.76 ± 0.78	< 0.001*
Cranial length (Female)	35	15.70-18.30	16.91 ± 0.74	
Cranial length (Both)	80	15.70-19.70	17.13 ± 0.87	---
Cranial breadth (Male)	45	12.10-13.90	13.08 ± 0.40	< 0.001*
Cranial breadth (Female)	35	11.70-14.30	12.69 ± 0.60	
Cranial breadth (Both)	80	11.70-14.30	12.69 ± 0.53	---

* means p-value is statistically significant

Table 2: Showing classification of head shape based on cephalic indices in the present study

Head shape	*Male (n= 45) n (%)*	*Female (n= 35) n (%)*
Dolicocephalic	24 (53.33%)	11 (31.42%)
Mesocephalic	19 (42.22%)	22 (62.85%)
Brachicephalic	01 (2.22%)	01 (2.85%)
Hyperbrachicephalic	01 (2.22%)	01 (2.85%)

Table 3: Comparison of Studies on Cephalic Index among various population groups

Authors and years	*Population studied*	*Cephalic index*
Turners (1906)[29]	Thug	72.90
	Pariahs	72.10
	Tamil sudra	81.00
	Bhil	72.90
Tildesley (1921)[30]	Marwari	74.60
	Hindu	75.80
Horrower (1926)[31]	Tamil	73.45
Singh (1955)[32]	South east Asian, Type I	75.00
	South east Asian, Type I	70.50
	South east Asian, Type I	72.40
Shukla (1960)[33]	Type I, Indian	72.20
	Type II, Indian	72.60
	Type III, Indian	72.00
	Type IV, Indian	71.40
Bhargav and Kher(1960)[34]	Bhills	76.98
Bhargav and Kher(1961)[35]	Barelas	79.80
Basu (1963)[36]	K.Vangaja	79.50
Chaturvedi & Harneja (1963)[37]	Indian	70.75
Jay Singh et al (1979)[38]	Uttar Pradesh	74.35
Adebisi (2003)[39]	Nigerian black male	76.70
	Nigerian black female	73.80
Shah and Jadhav (2004)[40]	Gujarati	80.42
Lobo SW et al (2005)[41]	Nepali Gurung males	83.10
	Nepali Gurung females	84.60
Oladipo and Olotu (2006)[42]	Ijaw males	80.98
	Ijaw females	78.24
	Igbo males	79.04
	Igbo females	76.83
	Ogonis males	11.18
	Ogonis females	75.09
Odokuma et al (2010)[43]	West African males	77.67
	West African females	78.14
Ilayperuma I (2011)[44]	Srilankan males	78.04
	Srilankan females	79.32
Anitha et al (2011)[1]	North Indian males	79.14
	North Indian females	80.74
Salve et al (2011)[45]	Andhra Pradesh males	75.68
	Andhra Pradesh females	78.2
Yogain V K et al (2012)[46]	Indian students males	77.92
	Indian students females	80.85
Mahesh Kumar et al (2012)[47]	Haryanvi males	66.72
	Haryanvi females	72.25
Ila Jitesh Gujaria et al (2012)[48]	Marathi males	77.08
	Marathi females	79.02
	Andhra males	76.28

	Andhra females	78.16
	Gujarati males	80.42
	Gujarati females	81.20
Jeremiah et al (2013)[49]	Kenyan males	71.04
	Kenyan females	72.37
Patro et al (2014)[50]	Odisha males	77.28
	Odisha females	78.38
Present study (2015)	North Indian males	73.75
	North Indian females	75.22

Table 4: Showing comparison of cranial parameters of present study with other studies

S.NO.	*Area of study*	*Authors and year of study*	*Cranial length (cm)*	*Cranial breadth (cm)*
1	Latvia	Nagle E et al (2005)[51]	18.33	14.58
2	Malaysian	Ngeow WC (2009)[52]	17.34	14.94
3	Nigeria (north eastern)	Raji JM (2010)[53]	18.39	13.57
4	Nigeria (Ibibio)	Oladipo GS (2010)[54]	18.80	14.70
5	Punjabi Students	Mahajan A (2010)[55]	17.90	14.72
6	Nigeria	Maina MB (2011)[56]	18.35	13.54
7	Japanese	Hossain MG (2011)[57]	18.01	14.78
8	Sri Lanka	Ilayperuma (2011)[44]	17.50	14.11
9	North India	Gupta et al (2013)[58]	17.77	13.61
10	Western UP	Agarwal et al (2014)[59]	17.53	14.32
11	Maharashtrian	Howale et al (2014)[60]	17.11	12.98
12	Indian	Gohiya et al (2010)[61]	17.87	12.54
13	Indian	Deshmukh and devrishi (2006)[62]	16.60	12.70
14	North Indian	Present study (2015)	17.13	12.69