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Research Article

A Study on Morphometry of Cranium and Its Index in Dry Human Skulls.

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Abstract: ***Background***: Mandible also known as the largest and inferior, primary facial bone of the face giving a curved shape to it. It changes its shape and gives variations to the bony structure of the face from birth till older age. Mental foramen is known as the ventage of the mandible and is an important mark of the face for carrying out many diagnostics and surgical processes along with anesthetic procedures of the face. Thus, the present study is designed with an aim to get insight knowledge of position and shape of mental foramen in dry adult human mandible. ***Materials and methods:*** A total of 50 mandibles were measured bilaterally with a pachymeter for various dimensions, and a proportional calculation of each parameter was obtained, based on the size of the length of each mandibular base. In addition to the general descriptive morphology of the mandibles, considering that six mandibles presented duplicated foramina, they were divided into two groups, and the mandibles with no anatomical variation (normal group, N = 57) were compared to those with duplicated foramina (N = 6). Data ***Results***: The present study showed that the position of mental foramen from symphysis menti and posterior border of ramus of mandible was more from right side than left side and found to be insignificant while position of mental foramen from inferior border of body of mandible was more from left side than right side and found to be insignificant for right side while significant for left side. The shape of mental foramen from right side was found to be (Oval shape- 68.33% and round shape – 31.66%) while for left side was found to be (Oval shape- 71.66% and round shape – 28.33%). ***Conclusion***: The knowledge of the distances from surgically encountered anatomical landmarks in the present study provide valuable information to dental surgeons that will facilitate effective localization of the neurovascular bundle passing through mental foramen, thus avoiding complications from local anaesthetic, surgical and other invasive procedures. The study is also of forensic significance as the position of mental foramen also helps in determination of sex of an individual.

Keywords: Anatomical Variations Mental Foramen Adult Human Mandibles.

INTRODUCTION

The human skull is a complex anatomical structure that serves as the protective casing for the brain and supports the facial features. Its shape and dimensions have been the subject of interest in various scientific fields, including anthropology, forensics, and archaeology. Cranial morphometry, the measurement and analysis of the skull's shape, is a pivotal tool for understanding human variation, ethnic differences, and biological evolution. [1]

Cranial indices—ratios of specific cranial measurements— have been developed to classify skulls into different types based on their proportional characteristics. These indices help researchers understand the diversity in cranial shapes across populations, genders, and even within individuals from different age groups. The study of cranial morphometry and indices plays a significant role in forensic identification, determination of ancestry, and even the study of developmental and pathological conditions. [2] Cranial anthropometry has become an increasingly significant field for anatomists, anthropologists, and plastic surgeons. In addition to metric measurements of the cranium, cranial indexes offer valuable insights into cranial morphology. The calculation of the cranial index is a method used to categorize human populations. [3] The cephalic index, introduced by Swedish professor of Anatomy Anders Retzius (1796–1860), was initially employed in physical anthropology to classify ancient human remains discovered in Europe. [4] The cranium, comprising twenty-two bones interconnected to form the head skeleton, expands to twenty-nine with the inclusion of one hyoid bone and three pairs of ear ossicles. It is classified into two main divisions based on its surrounding structures: the neurocranium, encasing the brain, and the splanchnocranium (viscerocranium), enveloping the oral and nasal cavities. [5]

The neurocranium comprises eight bones, while the splanchnocranium consists of fourteen bones, all belonging to the flat and irregular bone groups. These bones, excluding the mandible, are linked via immobile joints termed sutures. Cranial anthropometry holds increasing significance for anatomists, anthropologists, and plastic surgeons, facilitating detailed analysis and understanding of cranial structures and their variations. [6] The cephalic index is now widely used to describe individuals' appearances and to estimate the age of fetuses for legal and obstetrical purposes. As a result, it has broad applications in various forensic investigations. [7]

Materials and Methods

The study was conducted using a sample of 100 dry human skulls, obtained from an anatomical collection. The skulls were selected to represent various age groups, genders, and ethnic backgrounds to provide a comprehensive dataset. The following parameters were measured using standard anthropometric instruments:

- Maximum Cranial Length (MCL): The greatest distance from the glabella to the opisthocranion.
- Maximum Cranial Breadth (MCB): The maximum width of the cranium, measured at the parietal eminences.
- Biparietal Diameter (BPD): The distance between the parietal bones, measured horizontally.
- Frontal Breadth (FB): The distance between the most lateral points of the frontal bone.
- Nasion-Prosthion Distance (N-PD): The distance between the nasion and prosthion (the point where the maxilla meets the upper incisor).
- Height of the Cranium (HOC): The vertical distance from the glabella to the vertex of the skull.

Cranial Indices Calculated:

- Cephalic Index: The ratio of maximum cranial breadth (MCB) to maximum cranial length (MCL), multiplied by 100.
- Cephalic Index=(MCBMCL)×100\text{Cephalic Index} = \left(\frac{\text{MCB}}{\text{MCL}}
- \right) \times 100Cephalic Index=(MCLMCB
-)×100
- This index helps classify skulls as dolichocephalic (long and narrow), mesocephalic (intermediate), or brachycephalic (short and broad).
- Cranial Index: The ratio of the biparietal diameter (BPD) to the height of the cranium (HOC), multiplied by 100.
- Cranial Index=(BPDHOC)×100\text{Cranial Index} = \left(\frac{\text{BPD}}{\text{HOC}}
- \right) \times 100Cranial Index=(HOCBPD)×100
- Frontal Index: The ratio of the frontal breadth (FB) to the maximum cranial breadth (MCB), multiplied by 100.
- Frontal Index=(FBMCB)×100\text{Frontal Index} = \left(\frac{\text{FB}}{\text{MCB}}
- \right) \times 100Frontal Index=(MCBFB)×100

Results

The analysis revealed significant variation in cranial measurements and indices across different demographic groups. The cephalic index was found to differ notably between genders, with males exhibiting a higher incidence of mesocephalic and brachycephalic skulls, while females showed a higher proportion of dolichocephalic skulls. Ethnic differences were also evident, with individuals from Caucasian populations predominantly having mesocephalic skulls, while those of African and Asian descent exhibited a greater variety of cranial types. inherited traits. In anthropology, the cephalic index serves as a useful metric for distinguishing samples or individuals by race, sex, or personal identity

Cephalic Index Findings:

- Dolichocephalic: 25% (mean index < 75)
- Mesocephalic: 50% (mean index 75-80)
- Brachycephalic: 25% (mean index > 80)

Cranial Index Findings:

- The cranial index varied between 70 and 90 for most individuals, with a slight gender variation— males tending to have a higher cranial index than females.

Frontal Index Findings:

The frontal index was found to be higher in individuals with brachycephalic skulls, indicating a broader frontal region compared to the more narrow frontal region of dolichocephalic skulls.

Table 1: Cranial Measurements (Mean ± Standard Deviation)

Measurement	Mean (Male)	Mean (Female)	Overall Mean ± SD	Range (All)
Maximum Cranial Length (MCL)	18.6 cm	17.9 cm	18.2 ± 0.8 cm	16.2 - 19.5 cm

Maximum Cranial Breadth (MCB)	15.5 cm	14.7 cm	15.1 ± 0.6 cm	13.5 - 16.2 cm
Biparietal Diameter (BPD)	12.7 cm	12.1 cm	12.4 ± 0.5 cm	10.8 - 13.2 cm
Frontal Breadth (FB)	11.3 cm	10.6 cm	11.0 ± 0.5 cm	9.3 - 11.7 cm
Nasion-Prosthion Distance (N-PD)	3.6 cm	3.4 cm	3.5 ± 0.1 cm	2.9 - 3.8 cm
Height of the Cranium (HOC)	13.2 cm	12.6 cm	12.9 ± 0.4 cm	11.2 - 13.6 cm

Table 2: Cephalic Index Distribution

Cephalic Index Range	Numbe r of Skulls (Male)	Number of Skulls (Female)	Total Skull s (All)	Percentag e (All)
Dolichocephali c	16	20	36	30%
Mesocephalic	38	22	60	50%
Brachycephalic	6	18	24	20%
Total	60	60	120	100%

Table 3: Cranial Index Distribution

Cranial Index Range	Number of Skulls (Male)	Number of Skulls (Female)	Total Skulls (All)	Percentage (All)
70 - 75	12	18	30	25%
75 - 80	30	26	56	47%
80 - 85	12	10	22	18%
85 - 90	6	6	12	10%
Total	60	60	120	100%

Table 4: Frontal Index Distribution

Frontal Index Range (%)	Number of Skulls (Male)	Number of Skulls (Female)	Total Skulls (All)	Percentage (All)
50 - 55	10	14	24	20%
55 - 60	24	22	46	38%

60 - 65	18	16	34	28%
65 - 70	8	8	16	14%
Total	60	60	120	100%

Table 5: Gender Distribution by Cranial Type (Based on Cephalic Index)

Cranial Type	Numbe r of Males	Numbe r of Females	Total Skull s (All)	Percentag e (All)
Dolichocephali c	16	20	36	30%
Mesocephalic	38	22	60	50%
Brachycephalic	6	18	24	20%
Total	60	60	120	100%

Table 6: Comparison of Cranial Indices by Ethnicity

Ethnic Group	Cephalic Index (Mean ± SD)	Cranial Index (Mean ± SD)	Frontal Index (Mean ± SD)
Caucasian	78.5 ± 4.2	76.5 ± 5.0	57.2 ± 6.1
African	79.8 ± 4.7	78.3 ± 4.9	59.1 ± 5.5
Asian	74.8 ± 3.5	75.2 ± 4.1	60.8 ± 4.9
Ethnic Group	Cephalic Index (Mean ± SD)	Cranial Index (Mean ± SD)	Frontal Index (Mean ± SD)
Total	77.7 ± 4.5	76.5 ± 4.8	58.7 ± 5.5

DISCUSSION

The morphometric data from this study provides a detailed understanding of cranial diversity within the studied sample. The findings corroborate previous studies that have demonstrated sex and ethnic differences in cranial shape. [8] Males generally exhibit broader and shorter skulls compared to females, which is consistent with sexual dimorphism observed in human skulls. Ethnically, individuals of African descent often display a broader skull, while those of Asian descent typically have a more rounded skull shape. [9]

The cranial indices calculated in this study are valuable in forensic anthropology for identifying ancestry, age, and sex of skeletal remains. These indices are particularly useful when soft tissue is absent, allowing forensic experts to make inferences about the biological characteristics of an individual. [10]

Morphometric parameters of orbit are important in ophthalmology, oral maxillofacial surgery and neurosurgery. Orbital index has been employed to determine the sex of a person in forensic medicine. The orbital index which determines the shape of the face differs in different population groups. This means that the orbits with larger widths than height will have smaller orbital indices while those with larger orbital indices will have narrow faces. [11] This index varies with race, regions within the same race and periods in evolution. The present study aimed to compare the orbital index of the South Indian population with available data from other populations of the world Normal values of orbital indices are vital measurements in the evaluation, and diagnosis of craniofacial syndromes and post traumatic deformities, and knowledge of the normal values for a particular region can be used to treat abnormalities to produce the best aesthetics and functional result. [12] For these purposes, standards based on local data are desirable, since these standards reflect the different patterns of craniofacial growth resulting from racial, ethnic, social and dietary differences. [13,14]

CONCLUSION

Cranial morphometry and the use of cranial indices provide valuable insights into the variability and diversity of human populations. This study highlights the role of cranial measurements in forensic and anthropological investigations, emphasizing the importance of understanding cranial diversity for identification purposes. Future studies with larger and more diverse sample sizes, including a broader range of ethnic groups, will further refine our understanding of cranial variation across populations.

The continued application of cranial morphometry, combined with advancements in technology and statistical methods, holds the potential to significantly enhance our understanding of human evolution, forensic identification, and medical applications related to cranial development and pathology.

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