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Original Research Paper

Anatomy

SEX DETERMINATION AND CLINICAL IMPORTANCE OF FORAMEN MAGNUM ON BASIS OF ITS MORPHOMETRICAL ANALYSIS IN ADULT HUMAN DRY SKULL IN TRIBAL REGION OF CENTRAL INDIA.

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ABSTRACT

Background: The Foramen Magnum lies in an anteromedian position and leads into the posterior cranial fossa. Its dimensions can be used in the field of forensic identification and anthropology for determination of the gender of the human skulls. There are certain diseases like Arnold chiari malformation (tonsillar herniation), Achondroplasia, its stenosis, meningioma and Atlanto-occipital fusion associated with it. So, we are proposing the present study on basis of its morphometry for sex determination and its clinical importance. The present study is planned To evaluate its morphometry by following parameters: a. Anteroposterior diameter(APD)/Length(L) b.Transverse Diameter(TD)/Width(W) c. Area of FM by Radinsky Formula($1/4 \times APD \times TD \times \pi$) d.FM index($TD \times 100/APD$) e. Shape of FM. To find correlation between male and female FM by using above parameters. **Materials and Method:** 50 dry adult human skulls of unknown sex and vernier calliper. After classification, Male (29) and Female (21) skulls were taken with All the above stated parameters and unpaired t-test is applied statistically. **Result:** Antero-posterior diameter 34.90 ± 2.366 is larger in male as compared to females 32.43 ± 2.481, mean transverse diameter is slightly larger in male than females i.e. 29.76 ± 1.864 and 29.24 ± 3.375 respectively, Area of Foramen magnum is 816.79 ± 85.145 in males and 748.95 ± 128.391 in females, where males show the higher value. The Foramen Magnum index is larger in Females 90.14 ± 8.344 than in males 85.55 ± 6.738.The results were found to be Statistically Significant except for Transverse diameter. **Conclusion:** The dimensions of Foramen Magnum - Anteroposterior diameter, Transverse diameter and its Area are larger in male skull as compared to female skulls. The Foramen Magnum index is larger in Females than in Males. Its shape shows sexual dimorphism, Oval shape being more common in Males. These parameters are helpful for posterior and lateral approach to Cranio-verterbral junction by neurosurgeons and orthopedicians. Radiological evaluation is also important for surgical approach to prevent complications like Haemorrhage, Atlanto-occipital instability.

KEYWORDS : Skull, Foramen Magnum, Foramen Magnum Index and shape

I. INTRODUCTION:

The Foramen Magnum lies in an anteromedian position and leads into the posterior cranial fossa [1]. Its dimensions can be used in the field of forensic identification and anthropology for determination of the gender of the human skulls. This knowledge can be applied in its morphometric analysis when there is involvement of other parts of the craniofacial skeleton, as in severe injuries, accidents, fire or explosion. The cranial base has been noted for its ability to remain intact in cases where the rest of the cranium has been compromised and researchers have made use of that fact by analyzing sexually significant dimorphic trait for this anatomic region [2]. There are certain diseases associated with compression of structures present in it like Arnold chiari malformation (tonsillar herniation), Achondroplasia, stenosis of Foramen Magnum, meningioma and Atlanto-occipital fusion [3]. During the early fetal growth, development of skull base begins as a cartilaginous mass with multiple centers of ossification and the FM alone is one such center. Its irregular shape is accentuated by the developmental anomalies of the bone and soft tissues at the cranio-vertebra junction. Variation in its shape should be taken into consideration during the clinical and radiological diagnostic procedures and the surgical approach[4].Its shape and morphological variations are important in neurological interpretation[2].Gender determination in human skulls is based on morphological features especially the size, shape, and strength of certain structures which may also show ethnic variation in each population group which are influenced by certain factors like genes, environment and socioeconomic status[5]. Anthropologists are often faced with the task of assigning sex to the remains that are incomplete, fragmented or damaged as may result from incidents such as mass disasters, airplane crashes, fire accident, explosions or physical violence. Compromised remains will affect the accuracy of sex estimation and thus necessitate the development of reliable sexing criteria based on isolated bony elements, so it has attracted considerable interest as it shows sexual dimorphism. The robusticity of the occipital bone and the relatively protected anatomical position of the Foramen Magnum beneath a mantle of soft tissue may make it less vulnerable to fragmentation, or to the effects of inhumation and taphonomic process in comparison to other cranial and facial bones. Its size does not change after puberty, not related to the age then after owing to the forensic values the morphology and carries more significance [6]. Because the studies on this topic are less in the tribal region, so our study will add a contribution to the literature.

II. MATERIALS AND METHODS:

50 dry adult human skulls were taken from Department of Anatomy, GMC, Gondia and vernier calliper. The skulls taken were categorized as male and female by observing its external features. The skulls were accepted as adults according to tooth eruption [3].

The prongs of vernier calipers were placed over the described landmarks, fixed manually with the screw provided and its length and width was recorded over the graduated metallic scale on the calipers itself[2]. (Photograph No. 1)

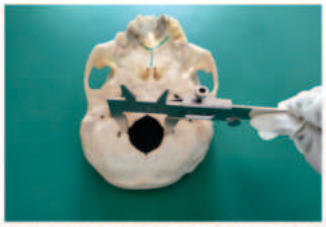
Photograph no 1. showing study materials

Its morphometry was studied as follows:

a. Anteroposterior Diameter(APD)/Length(L): Maximum straight anteroposterior diameter from basion (median point on the anterior margin of FM) to opisthion (median point on the posterior margin of the FM) was measured (Photograph No. 2.)

Photograph no. 2. showing measurement of Antero-posterior diameter of FM

b. Transverse Diameter (TD)/Width(W): Maximum straight transverse diameter between two points of the FM on most laterally placed margins was measured(Photograph No. 3).



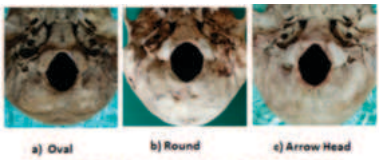
Photograph no. 3. showing measurement of Transverse diameter of FM

Readings were taken in mm.

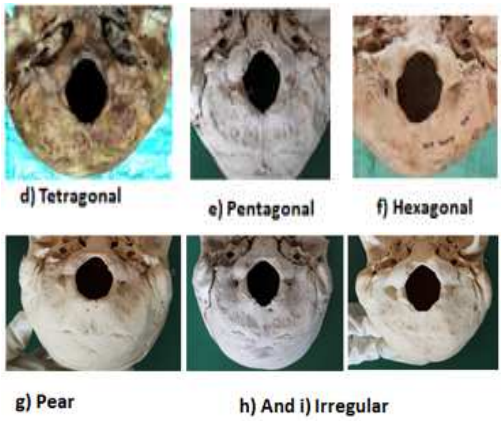
c. Area of FM: The area of FM was calculated by using Radinsky's Formula = $1/4 \times \pi \times APD \times TD$ ($\pi = 22/7$).

d. Foramen Magnum index (FMI): FMI was calculated as: $TD \times 100/APD$.

e. Shape of FM: The different shapes of FM were macroscopically noted [2]. (Photograph No. 4,5,6)



Photograph no.4. showing Different shapes of FM a) Oval b) Round c) Arrow Head



Photograph no.6. showing Different shapes of FM g)Pear h)and i)Irregular

Exclusion:

Any skulls that showed signs of prior cranial surgery, malformation, damaged, incomplete, with any pathological condition and juvenile skulls were excluded [3].

Statistical Analysis:

The data was collected, tabulated and statistically analyzed. Data was analyzed using EPI INFO 2007. Descriptive statistics including range, mean and standard deviation was calculated for each parameter. Unpaired 't' test was used as the test of significance to test the difference in means between males and females[2].

RESULTS AND DISCUSSION:

In present study antero-posterior diameter 34.90±2.366 is larger in male as compared to females 32.43±2.481. Also mean transverse diameter is slightly larger in male than females i.e. 29.76±1.864 and 29.24±3.375 respectively. Area of Foramen m agnum is 816.79±85.145 in males and 748.95±128.391 in females, where males show the higher value. The Foramen Magnum index is larger in Females 90.14±8.344 than in males 85.55±6.738.The results were found to be Statistically Significant except for Transverse diameter.

Table 1 showing comparison of APD, TD, Surface Area and Index of FM Separately in Male and Female

Author	Population	Sam-ple Size (n)	APD		TD		Mean area		FM index	
			Male	Female	Male	Female	Male	Female	Male	Female
Present study	Tribal region of central India	50	34.90±2.366	32.43±2.481	29.76±1.864	29.24±3.375	816.79±85.145	748.95±128.391	85.55±6.738	90.14±8.344
Mrunal Muley (2017) [7]	Aurangabad Maharashtra	55	34.99±2.19	33.75±2.55	28.53±1.58	27.41±1.93	765±98.81	728.96±96.6	81.79±6.04	81.39±5.00
Chandekar KS (2017)[8]	Chandrapur, Maharashtra	80	36.23±1.76	31.5±1.88	29.06±2.54	27.41±1.42	—-	—-	80.19 ±7.51	87.01±3.66
Bharati AS (2021)[9]	Karnataka	40	30±2.357	29.43±2.699	26.1±2.13	25.033±1.847	616.392±82.20	580.485±80.234	87.33±8.205	85.54±7.88

In the present Study the results are similar to results obtained by Mrunal Muley [7] and nearly similar to results obtained by Chandekar KS [8] and Bharati AS [9]. Shapes as demonstrated in Table 2, Oval was the Shape most commonly found in 21 samples, followed by Round in 7, Irregular in 4, Tetragonal in 4, Hexagonal in 5, Arrowhead in 5, Pentagonal in 1 and Pear shaped in 5 samples.

The findings corresponding to Radhakrishna S.K. [10], Zuberi Hussain Riyaz [11], Chandekar KS [8], P Devadas [5], Deshpande SH [6], Sarvaiya BJ [3], S.P. Vinutha [12], Archana Singh [13] and Amit Singh Bharati [9].

In our study, Oval shape was most commonly found in Male. This finding is similar to Radhakrishna S.K. [10].

Table 2 Showing comparison of percentage of different shapes of foramen magnum

Shape of FM	Sample	Oval	Round	Tetra-gonal	Penta gonal	Hexa Gonal	Arrow Head	Pear Shaped	Irregular
Present Study	50	21	7	2	1	5	1	3	4

Radhakrishna S.K.(2012) [10]	100	39	28	19	14	-	-	-	-
Zuberi Hussain Riyaz (2015)[11]	61	31.14	29.50	18.03	1.63	8.19	-	-	11.47
Chandekar KS(2017)[8]	80	38.75	32.5	-	-	-	-	-	28.75
P Devadas(2017) [5]	100	45	29	14	12	-	-	-	-
Deshpande SH(2017)[6]	136	61.76	10.29	-	-	-	16.17	-	11.76
Sarvaiya BJ(2018)[3]	326	42.33	32.82	8.59	4.6	7.67	-	-	3.99
S.P. Vinutha (2018)[12] (CT Scan finding)	200	36.5	8.5	7	4.5	15	-	-	A-10.5 B-9
Archana Singh(2019)[13]	120	33.3	13.3	16.6	13.3	16.6	-	6.6	-
Bharati A. S.(2021)[9]	40	35	32.5	25	-	7.5	-	-	-

The authors concluded that when shape is considered, it is dependent on the observer experience and also replicability is not high. Hence, variations between different studies may exist.[12]

CONCLUSION:

The dimensions of Foramen Magnum- Anteroposterior diameter, Transverse diameter and its Area are larger in male skull as compared to female skulls.

The Foramen Magnum index is larger in Females than in Males. Its shape shows sexual dimorphism, Oval shape being more common in Males.

These parameters are helpful for posterior and lateral approach to Cranio-verterbral junction by neurosurgeons and orthopedicians. Radiological evaluation is also important for surgical approach to prevent complications like Haemorrhage, Atlanto-occipital instability.

Conflict of interest: nil

Abbreviations:

FM: Foramen Magnum
APD: Anteroposterior Diameter
TD: Transverse Diameter
L: length
W: width
Mm: Millimeter

REFERENCES:

[1]. Susan Standring, Gray's Anatomy: The anatomical basis of clinical practice. 2016, 41st edition:422-426.
[2]. Anil Kumar, Mitesh Dave, Sanam Anwar. Morphometric evaluation of Foramen Magnum in dry human skulls, International Journal of Anatomy and Research, 2015;Vol 3(2):1015-23.
[3]. Sarvaiya BJ , Hathila SB, Chaudhari JS, Fichadiya N. Morphometric analysis of Foramen Magnum in adult human dry skull of Gujarat region, International journal of Anatomy and Research,2018;Vol 6(4.1):5787-02.
[4]. Chethan P, Prakash KG, Murlimanju BV, Prashanth KU, Prabhu LV, Saralaya W. et al. Morphological analysis and morphometry of the foramen magnum: an anatomical investigation, Turkish Neurosurgery,2012; Vol 22(4):416-419.
[5]. P Devadas, et al. Study On The Morphometric Analysis Of The Foramen Magnum As An Indicator For Sex Determination, International Journal of Anatomy and Research,2017;Vol 5(3.1):4163-67.
[6]. Deshpande SH, et al. Morphometric study of Foramen Magnum in human dry skulls, National Journal of Clinical Anatomy, 2017;Vol 6(3):188-192.
[7]. Mrunal Muley et al. Morphometric study of Foramen Magnum in Adult Indian skulls, Indian Journal of Anatomy; Vol 6(4):491-494.
[8]. Chandekar KS et al. Morphometric Study of Foramen Magnum of Human Skull in Vidarbha Region, International Journal of Research and Review,2017;Vol 4(5):157-160.
[9]. Bharati AS et al. Morphometric study of Foramen magnum in East Godavari region of Andhra Pradesh, International Journal of Health and Clinical Research,2021;Vol 4(5):294-297.
[10]. Radhakrishna SK, Shivarama CH, Ramakrishna A, Bhagya B. Morphometric analysis of Foramen Magnum for sex determination in South Indian population, university journal of health science, 2012:20-22.
[11]. Zuberi Hussain Riyaz et al. Morphometric study of foramen magnum in human skulls, International Journal of Recent Trends in Science And Technology,2015; Vol 17, Issue 1: 28-31. [12].Vinutha SP et al. Discriminant Function Analysis of Foramen Magnum Variables in South Indian Population: A Study of Computerized Tomographic Images, Hindawi Anatomy Research International Volume 2018, Article ID 2056291, 8 pages
[13]. Archana Singh et al., Morphological and Morphometric Study of Foramen Magnum in dry human skull and clinical Significance, International Journal of Anatomy, Radiology and Surgery,2019;Vol-8(3): AO10-AO12.