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A Morphologic And Morphometric Study of Foramen Magnum in Dry Adult Human Skull of North Indian Population

SumitaShukla[1],Dr.Pawan Kumar Mahato[2], Dr.Azmi Mohsin[3],SagunShukla[4]

[1]Ph.D Scholar MalwanchalUniversity,Indore(M.P)
[2]Associate Professor, Dept Of Anatomy Index Medical College MalwanchalUniversity,Indore (M.P)
[3]Professor DeptOf Anatomy Naraina Medical College & Research Centre, (Kanpur)
[4]Assistant Professor DeptOf Anatomy VarunArjun Medical CollegeBanthra(Shahjahanpur)

First Author: Sumita Shukla
Corresponding Author: Dr.Pawan Kumar Mahato

1. INTRODUCTION

Structure of foramen magnum:

The foramen magnum (FM) is an essential feature of the base of skull and is of great significance to several departments of medicine (1) Variations of the shape of FM have got diagnostic, clinical and radiological implications. Also there exists some association between the shape of FM and ancestry of an individual.

Clinical importance:

Because critical structures that pass through FM may be compressed, as in FM achondroplasia and FM brain herniation, the dimensions of FM have clinical significance (2). The transcondylar method is commonly used in neurosurgery to treat lesions that are ventral to the brainstem and corticomedullary junction. According to some accounts, understanding the bone architecture of the condylar area is crucial to this method. As a result, comparing FM dimensions to hindbrain tissue can reveal information about the development and progress of Chiari I symptomatology. Despite the fact that it is of great clinical importance, there are only a few anatomical accounts in the literature. The goal of this study was to document and investigate the morphologies of the foramen magnum (FM) in dry cadaver skulls, as well as to compute the average FM measurements.

In forensic anthropology, a person's gender is determined through their skeleton. Even though a complete skeleton is essential for accurate results, finding one that is both complete and in good condition is extremely unusual. If the right methods are utilised, gender can be determined from skeletal remains. In determining a person's gender, the pelvis, femur, tibia, humerus, radius, mandible, and cranium are all useful. (3) However, the skull is second only to the pelvis in terms of gender identification in archaeological contexts, where it has the ability to identify an individual's sex with great precision, due to its superior preservation. (4) The skull's dimorphic features are more stable than those of other skeletal relics due to the skull's resistance to environmental alteration.

Sex determination techniques are divided into two categories: molecular and morphological approaches. (5) Robustness and size discrepancies are the primary causes of skull dimorphism. The adult skull is favored in sex determination over the sub-adult skull due to

hormonal control over bone growth and development (6). Because of the differences in bone production and the pressures that act on it, female skulls differ from male skulls. Females develop their bones earlier than boys, and during puberty, the female skull undergoes significant modifications. The morphological distinctions between male and female skeletons are more obvious in adult skeletons. (7)

2. MATERIAL AND METHODS

The Study Is Cross Sectional. Material For The Study Consisted Of 150 Dry Adult Fully Ossified Skulls Of North Indian Population. The Sample Skull Were Collected From Department Of Anatomy at Index Medical College Hospital And Research Centre, Madhya Pradesh, Indore And Department Of Anatomy VarunArjun Medical College BanthraShajahpur. One More Medical College Rajshree Medical Research Institute &Hospital Bareilly India. All The Bones Will Be Fully Ossified And Free From Any Congenital Or Pathological Defects. Deformed And Malformed Bones Will Also Be Excluded From The Study

Foramen of Magnum:

1. Antero-posterior diameter: max straight ant-post diameter from basion (midpoint on anterior margin of foramen magnum) to opisthion (medial point posterior margin of foramen magnum).
2. Transverse diameter: max straight transverse diameter between two points of foramen magnum on most laterally placed margin.
3. Foramen magnum index: calculated by foramen magnum width × 100/foramen magnum length.
4. Shape of foramen magnum: different shape of foramen magnum were macroscopically noted and classified as oval, round and irregular.

Fig 01: showing the frequency of different shapes of foramen magnum

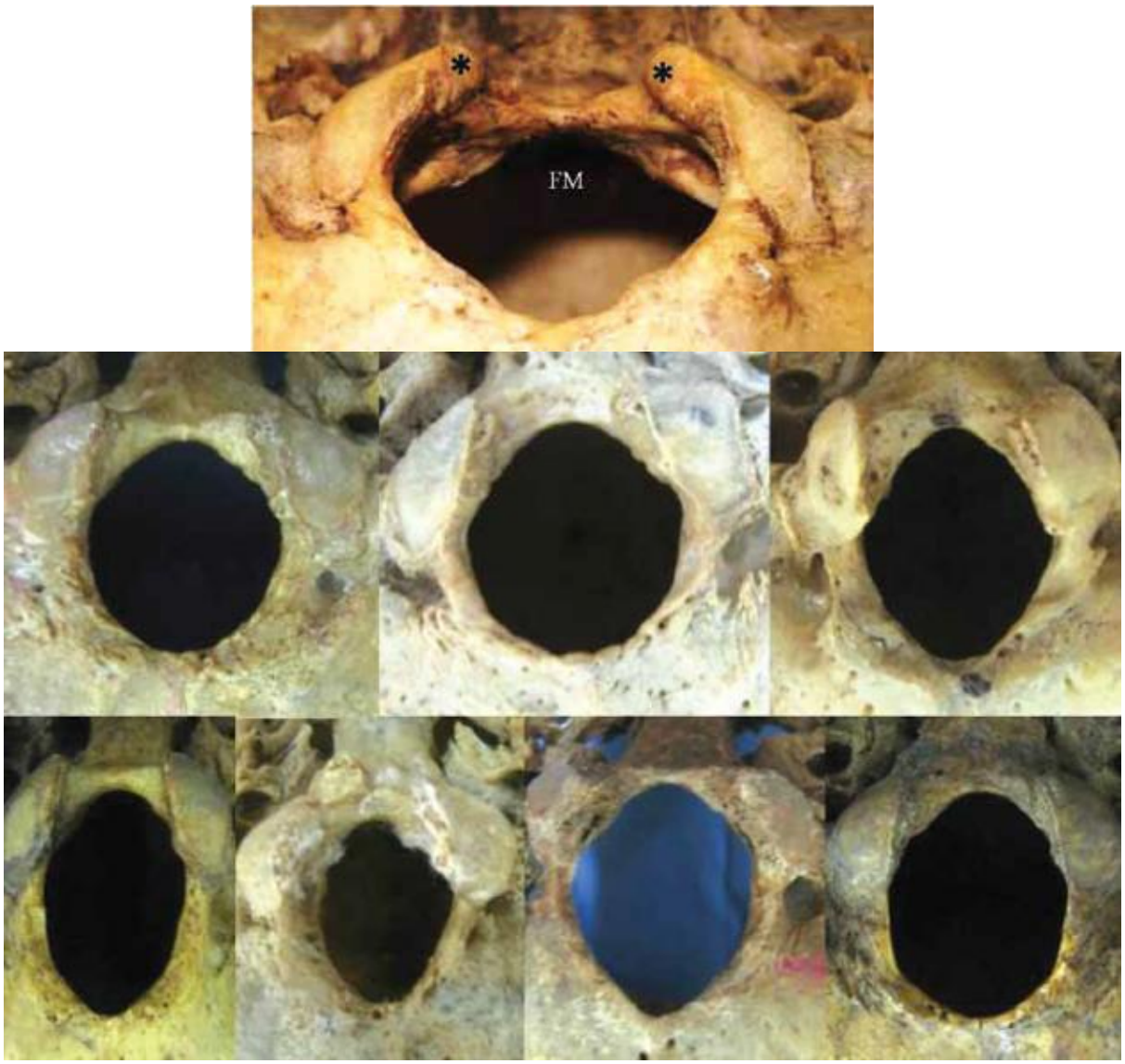

Figure 02: Showing the morphological variants of the shapes of foramen magnum (**A**- round shape; **B**- egg shape; **C**- tetragonal; **D**- oval;**E**- irregular; **F**- hexagonal and **G**- pentagonal shape).

3. RESULTS

Foramen magnum:

Table 01: Showing the Frequency of Different Shapes of Foramen Magnum (n=150)

Morphological variants of FM	Frequency and number
round shape	22.6% (28)
egg shape	18.9% (25)
tetragonal shape	18.9% (25)
oval shape	15.1% (20)
irregular shape	15.1% (22)
hexagonal shape	5.6% (17)

pentagonal shape	3.8% (13)

Table 02: Showing the Comparison of Morphometric Data of FM with the Previous Reports

Authors	Sagittal diameter	Transverse diameter
Schmeltzer et al. (123), 1971	35 mm	30 mm
Catalina-Herrera (124), 1987	35.2 mm	30.3 mm
Wanebo and Chicoine (125), 2001	36 ± 2 mm	32 ± 2 mm
Murshed et al (126), 2003	35.9 ± 3.3 mm	30.4 ± 2.6 mm
Tubbs et al (127), 2010	31 mm	27 mm
Present study, 2021	31 ± 2.4 mm	25.2 ± 2.4 mm

TABLE 03: Descriptive Results of the Examined Foramen Magnums

	Mean	**Minimum**	**Maximum**	**SD**
AP diameter (mm)	34.38	29.00	.60	
TD (mm)	28.95	24.20	35.00	2.19
Area (R) (mm2)	783.66	569.13	1122.61	4
Area (T) (mm2)	790.47	572.27	1145.50	36
FM index	650.25	215.41	235.23	1

AP, antero-posterior; mm, millimeter; R and T, area estimated by using Radinsky and Teixeira formulas, respectively; SD, standard deviation; TD, transverse diameter.P<0.05.
The results of descriptive statistics and areas of the FMs are presented in Table 12. The mean AP and TD of FMs were found as 34.38 2.38 and 28.95 2.19, respectively. The mean area of the FMs estimated by Teixeria formula16 was determined significantly larger than the mean area of the FMs estimated by Radinsky formula15 (P<0.001). According to estimated FM index of the 150 adult dry skulls, 87 (58%) of skulls were described as being round in shape and 63 (42%) of skulls were described as being oval in shape.

4. DISCUSSION

The FM, which has caused medical concerns in several disciplines, serves as a signpost for the skull's base. Diagnostic, clinical, and radiological implications of variations in FM form are significant. Forensic medicine uses FM and occipital condyle morphometry for identification of unknown individuals in addition to its surgical significance.As far as gender identification is concerned, some evidence suggests that the FM width is the most reliable method of doing so (8). According to Uthman et al. (9,10), circumference and area of the FM were the best discriminating parameters for determining sex with an overall accuracy rate of 67 percent and 69.3 percent, respectively, in their study using helical computed tomography scanning. Using discriminant function analysis, Ukoha et al. (11) studied 100 skulls from a Nigerian ethnic group and concluded that FM dimensions showed sexual dimorphism. According to most studies (12,13), the FM's mean size is greater for male than for females; nevertheless, Gruber et al (14) investigated the diameters of FM in Central European dry specimens dating from Pleistocene to current periods and found no gender dimorphism. With respect to Turkish population, Gunay and Altinko k (15) discovered that males had a considerably bigger FM mean area than women, while Uysal and colleagues (16) also found significant gender differences in FM width using three-dimensional computed tomography.Lesions located ventral to the FM, lower clivus, or ventral aspect of the upper

cervical spine have inadmissibly exposed patients to grave dangers, including increased mortality and incomplete tumor removal (17).

As a result, many surgical procedures have been developed to ensure more effective and safer surgery. As a result of its large dimensions and wide viewing field (18), FM reduces the amount of bone extraction required during surgery, making it the most suited surgical technique for the patient.In spite of similar-sized lesions anterior to the brain stem, oval-shaped FM requires more bone extraction than round-shaped FM. itDivide the anteroposterior diameter by the transverse diameter to get the FM index. If the FM index is more than 1.2, the FM is described as oval-shaped; otherwise, it is described as round-shaped. (19) It was revealed that in Eastern Europeans, 36.62 percent of men had oval-shaped fibromyalgia and 39.18 percent of women had round-shaped fibromyalgia, according to Burdan et al (20). There was an oval-shaped FM in 46 percent and 58 percent of Indian and Turkish skulls, respectively.

These were higher than the 14.7% which was observed in Greek population by Natsis et al. (21).On the other side, Murshed et al (22) found that 8.1 percent of Turkish patients had oval-shaped FM, while 21.8 percent of Greek patients had round-shaped FM, while Natsis et al found that 14.7 percent of Greek patients had oval-shaped FM, while 1.4 percent of Greek patients had round-shaped FM. On the other hand, we found that oval-shaped FM was found in 42 percent of dry skulls and 58 percent of cadaveric skulls, respectively; Avci et al (23) reported 58 percent and 42 percent of dry skulls with oval-shaped and round-shaped FM.

5. CONCLUSION

The morphometric knowledge regarding foramen magnum is very important for various neurological &surgical procedures of posterior cranial fossa. The study of foramen magnum provide supportive findings for forensic experts in estimation of sex of fragmented, incomplete or damaged dry human skulls. This type of morphometric study also gives us significant parameters which should be applied during cranio-vertebral surgery& to determine feasible transcondylar approaches to prevent complications like hemorrhage and injury to vital structures going through it. Therefore, at last we conclude that the comparative evaluations on data of foramen magnum showed significant difference between various parameters, so further studies are required on it due to its great clinical significance.

6. REFERENCES

[1] Gruber P, Henneberg M, Boni T, Ruhli FJ: Variability of human foramen magnum size. Anat Rec 292:1713-1719, 2009

[2] Reich JB, Sierra J, Camp W, Zanzonico P, Deck MD, Plum F: Magnetic resonance imaging measurements and clinical changes accompanying transtentorial and foramen magnum brain herniation. Ann Neurol 33:159-170, 1993

[3] . Sangvichien S, Boonkaew K, Chuncharunee A, Komoltri C, Piyawinitwong S, Wongsawut A, et al. Sex determination in Thai skulls by using Craniometry: multiple logistic regression analysis. Siriraj Med J 2007;59:216e21

[4] Gonzalez PN, Bernal V, Perez SI. Analysis of sexual dimorphism of craniofacial traits using geometric morphometric techniques. Int J Osteoarchaeol 2009;21: 82e91.

[5] Suazo GIC, Zavando MDA, Smith RL. Performance evaluation as a diagnostic test for traditional methods for forensic identification of sex. Int J Morphol 2009;27: 381e6.

[6] Nagaoka T, Shizushima A, Sawada J, Tomo S, Hoshino K, Sato H, et al. Sex determination using mastoid process measurements: standards for Japanese human skeletons of the medieval and early modern periods. AnthropolSci 2008;116:105e13.
[7] Suazo GIC, Zavando MDA, Smith RL. Evaluating accuracy and precision in morphologic traits for sexual dimorphism in malnutrition human skull: a comparative study. Int J Morphol 2008;26:877e81
[8] Landl MK, Walter Grand: Trigeminal Neuralgia: Fluoroscopically –Assisted Laser Targeting of the Foramen Ovale: Technical Note. Minrad International, 2005
[9] Chimmalgi M, Kulkarni Y, Sant SM: Sexing of skull by new metrical parameters in west India. J AnatSoc India 56(1): 28-32, 2007
[10] James TM, Presley R, Steel FL: The foramen ovale and sphenoidal angle in man. AnatEmbryol 160: 93-104, 1980
[11] Murshed KA, Cicekcibasi AE, Tuncer I. Morphometric evaluation of the foramen magnum and variations in its shape: a study on computerized tomographic images of normal adults. Turk J Med Sci 2003;33:301–306
[12] Chethan P, Prakash KG, Murlimanju BV, et al. Morphological analysis and morphometry of the foramen magnum: an anatomical investigation. Turk Neurosurg 2012;22:416–419.
[13] Gapert R, Black S, Last J. Sex determination from the foramen magnum: discriminant function analysis in an eighteenth and nineteenth century British sample. Int J Leg Med 2009;123:25–33
[14] Uthman AT, Al-Rawi NH, Al-Timimi JF. Evaluation of foramen magnum in gender determination using helical CT scanning. DMFR 2012;41:197–202
[15] Ukoha U, Egwu OA, Okafor IJ, et al. Sexual dimorphism in the foramen magnum of Nigerian adult. IJBMR 2011;2:878–881
[16] Olivier G. Biometry of the human occipital bone. J Anat 1975;120:507– 518
[17] Routal RR, Pal GP, Bhagawat SS, et al. Metrical studies with sexual dimorphism in foramen magnum of human crania. J AnatSoc India 1984;33:85–89
[18] Sayee R, Janakiram S, Thomas IM. Foramen magnum measurements of Crania from Karnataka. J AnatSoc India 1987;36:87–89
[19] Babu YR, Kanchan T, Attiku Y, et al. Sex estimation from foramen magnum dimensions in an Indian population. J Forensic Leg Med 2012;19:162–167
[20] Gruber P, Henneberg M, Boni T, et al. Variability of human foramen magnum size. Anat Rec 2009;292:1713–1719
[21] Gu¨nay Y, Altinko¨k M. The value of the size of foramen magnum in sex determination. J Clin Forensic Med 2000;7:147–149
[22] Uysal S, Gokharman D, Kacar M, et al. Estimation of sex by 3D CT measurements of the foramen magnum. J Forensic Sci 2005;50:1310– 1314.
[23] Babu RP, Sekhar LN, Wright DC. Extreme lateral transcondylar approach: technical improvements and lessons learned. J Neurosurg 1994;81:49–59