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Original Research Article

MORPHOLOGICAL AND MORPHOMETRIC STUDY OF FORAMEN MAGNUM IN DRIED HUMAN SKULL BONES OF NORTH-WEST INDIAN REGION

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ABSTRACT

Background: The Foramen Magnum is communication between vertebral canal and posterior cranial fossa and important landmark to key structures such as brain, spinal cord, vertebral arteries. Anatomical knowledge of the foramen magnum is significant for understanding the pathophysiology of various disorders of the craniovertebral junction as well as for planning surgical procedures.

Materials and Methods: The study was conducted on 62 dry skulls of unknown gender obtained from the Department of Anatomy. The shape of foramen magnum was classified as oval, round, tetragonal, pentagonal, hexagonal and irregular in shape and measurements like anterio-posterior diameter and transverse diameter of foramen magnum were taken using the Digital Vernier sliding caliper.

Results: In the present study most common shape was oval in 22 (35.48%) skulls, followed by Egg shape in 12 (19.35%) skulls and least common pentagonal shape in 1(1.61%) skulls. In our study the mean anteroposterior diameter was 34.17 mm. and mean transverse diameter was observed to be 28.86 mm.

Conclusion: Results of our present study may help in neurosurgeons, orthopedicians, radiologist and anesthetist in North West indian population.

KEY WORDS: foramen magnum, skull, transverse diameter, oval.

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INTRODUCTION

Foramen Magnum is regular well preserved structure due to its anatomical position as it is positioned at the base of the skull. The Foramen Magnum creates communication between vertebral canal and posterior cranial fossa [1] and this foramen plays a significant role as a landmark because of its close relationship to key structures such as brain, spinal cord, vertebral arteries and accessory spinal nerves [2]. The foramen magnum is protected by soft tissue mass inferiorly and

margins of the foramen are anteriorly encroached by the occipital condyles which articulate with the superior articular facets of the atlas [3,4].

Measurements of foramen magnum have proven to be important in forensics anthropology and other medical fields [5].

In the foramen magnum the vital structures traverse so its morphometrical study acts as an important guide to diagnose and treat various complications like foramen magnum stenosis, meningiomas, achondroplasia and cerebral herniation [6,7].

Anatomical and morphometric knowledge of the foramen magnum is important for understanding the pathophysiology of various disorders of the craniovertebral junction as well as for planning surgical procedures [8-10]. Besides anatomists, the morphometric study of foramen magnum is essential for neurosurgeons, orthopedicians, radiologist and anesthetist also. Hence, the present study was done to determine and analyse the morphological types and diameters of the Foramen magnum in adult skull of Indian population so that the data can help in improving the efficacy and minimize the failure rates in surgical procedures in posterior cranial fossa particularly those involving the approaches through foramen magnum.

MATERIALS AND METHODS

The study was conducted on 62 dry human adult skulls of unknown gender, obtained from the Department of Anatomy, National Institute of Medical Sciences & Research and Jaipur Dental College Jaipur (Rajasthan), India. All the skulls used for the study were dry, complete & showed normal anatomical features. Skulls with broken and deformed foramen magnum were excluded from the present study.

The shape of foramen magnum was noted and classified as oval, round, tetragonal, pentagonal, hexagonal and irregular in shape. The number and incidence of each type in the studied skull was registered and tabulated. Various morphometric measurements like anterio-posterior diameter and transverse diameter of foramen magnum were taken using the Digital Vernier sliding caliper which is accurate to 0.01 millimeter. The various parameters measured using vernier caliper are as follows: -

Anteroposterior diameter of Foramen magnum: Anteroposterior diameter of the foramen magnum was measured from basion (median point on the anterior margin of the foramen magnum) to opisthion (median point on the posterior margin of the foramen magnum) in sagittal plane.

Transverse diameter of Foramen magnum: Transverse diameter of Foramen magnum was measured perpendicular to anteroposterior diameter in the coronal plane at a point where it was maximum.

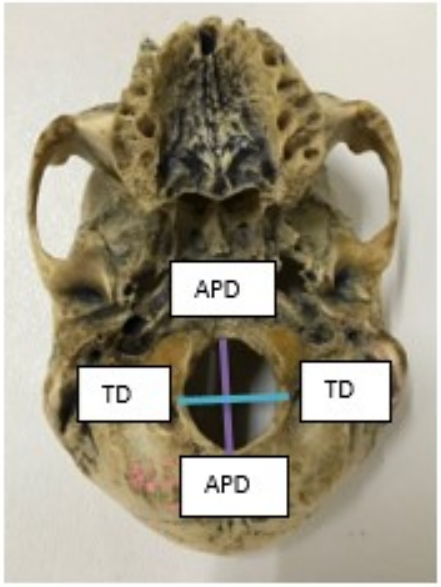

Fig. 1: Showing the anterioposterior diameter and transverse diameter of foramen magnum.

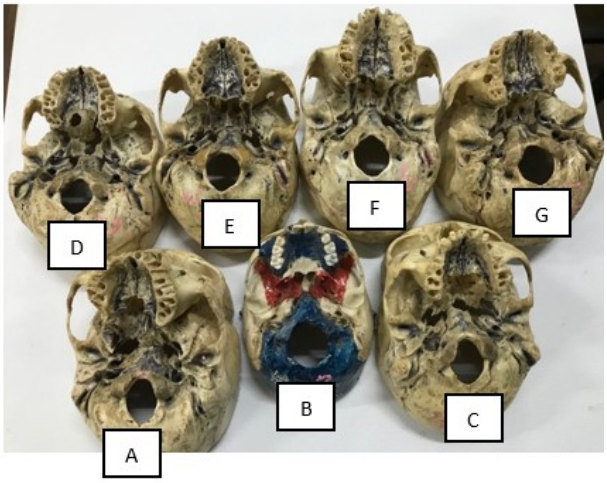

Fig. 2: Showing the morphological variants of the shapes of foramen magnum (A: oval, B: round, C: egg, D: tetragonal, E: pentagonal, F: hexagonal, G: irregular).

RESULTS

In the present study various morphological shapes were observed. The most common shape was oval in 22 (35.48%) skulls, followed by Egg shape in 12 (19.35%) skulls, Round shape in 11 (17.74%) skulls, Tetragonal shape in 7 (11.29%) skulls, Hexagonal shape in 6 (9.68%) skulls, Irregular shape in 3 (4.84%) skulls and pentagonal shape in 1(1.61%) skulls. In our study the mean anteroposterior diameter was 34.17 mm. and mean transverse diameter was observed to be 28.86 mm.

Table 1: Showing different shapes and dimensions of foramen magnum.

Shape	Number (%)	Anteroposterior diameter (mm)	Transverse diameter (mm)
Oval	22 (35.48%)	-	-
Round	11 (17.74%)	-	-
Egg	12 (19.35%)	-	-
Tetragonal	7 (11.29%)	-	-
Pentagonal	1 (1.61%)	-	-
Hexagonal	6 (9.68%)	-	-
Irregular	3 (4.84%)	-	-
Total	62	34.17	28.86

DISCUSSION

Table 2: Showing Comparison of shape of foramen magnum with different studies.

		Shape of foramen magnum						
Author	Population	Oval (%)	Round (%)	Egg (%)	Tetragonal (%)	Pentagonal (%)	Hexagonal (%)	Irregular (%)
Mursheed KA et al 2003 [11]	Turkish	8.1	21.8	6.3	12.7	13.6	17.2	19.18
Chethan et al 2012 [12]	Mangaluru	15.1	22.6	18.9	18.9	3.8	5.6	15.1
Sharma S et al 2015 [6]	Tundla	16	22	16	12	8	8	18
Zuberi et al 2015 [13]	Badnapur	31.14	29.5	-	18.03	1.63	8.19	11.47
Rohinidevi M et al 2016 [14]	Tamil Nadu	18	26	14	11	6	6	22
Sampada PK et al 2017 [15]	Karnataka	58	9	11	8	1	3	10
Singh KC et al 2017 [16]	Varanasi	34	20	-	16	4	18	8
Mishra AK et al 2018 [17]	Lucknow	37.8	30.9	-	7.04	7.04	11.2	9.85
Mondal et al 2018 [18]	North Bengal	34.28	22.85	-	17.14	5.71	20	-
Veeramani et al 2018 [19]	Puducherry	6	15	12	11	3	21	32
Singh A et al 2019 [20]	Uttar Pradesh,	33.3	13.3	6.6	16.6	13.3	16.6	-
Singh D et al 2019 [21]	Delhi-Haryana	29.76	26.19	10.71	16.67	4.76	5.95	5.95
Present study 2020	Rajasthan	**35.48**	**17.74**	**19.35**	**11.29**	**1.61**	**9.68**	**4.84**

Table 3: Showing comparison of anteroposterior(AP) and transverse (T) diameters of foramen magnum.

Author	Population	Anteroposterior diameter (mm)	Transverse diameter (mm)
Mursed et al 2003 [11]	Turkish	35.9	30.4
Gruber et al 2009 [22]	Europe	36.6	31.1
Mahajan et al 2011 [23]	Chandigarh	32.83	27.47
Patel et al 2014 [24]	Surat	42.2	28.29
Zuberi et al 2015 [13]	Badnapur	33.4	28.5
Sampada PK et al 2016 [15]	Karnataka	34.84	29.39
Rajkumar et al 2017 [25]	Rajasthan	33.98	28.16
Singh KC et al 2017 [16]	Varanasi	33.76	28.09
Feridoz et al 2018 [26]	Chennai	35	29.4
Mishra AK et al 2018 [17]	Lucknow	34.09	28.22
Singh A et al 2019 [20]	Uttar Pradesh,	33.79	28.25
Kumar A et al 2019 [27]	Uttar Pradesh,	34.08	28.17
Singh D et al 2019 [22]	Delhi-Haryana	33.57	27.49
Present study 2020	Rajasthan	34.17	28.86

In the present study, mean anteroposterior diameter of foramen magnum was 34.17 mm and the mean transverse diameter was 28.86 mm. Kumar A et al observed that the average anteroposterior length of the foramen magnum was 34.08 mm and the transverse diameter was 28.17mm. Mishra et al reported an average anteroposterior diameter of foramen magnum was 34.09 mm and an average transverse diameter of 28.22 mm. However Gruber et al in his study on skulls from Europe found the average anteroposterior diameter of foramen magnum was 36.6 mm and the average

transverse diameter was 31.1 mm. Mursed et al observed that the mean diameters were 35.9 mm for the length and 30.4 mm for the width of the foramen magnum. Mahajan et al observed that the mean anteroposterior diameter of foramen magnum was 32.83 mm and mean transverse diameter was 27.47 mm.

In our study, oval shape of foramen magnum was commonly seen (35.48%). This was followed by egg (19.35%), round (17.74%), tetragonal shaped (11.29%), hexagonal (9.68%), irregular (4.84%) and pentagonal (1.61%). The findings of previous studies are presented in Table 2. According to Sampada PK et al, Singh KC et al, Mishra AK et al, Zuberi et al, Archna Singh et al. Singh D et al, Mondal et al, the oval shape is the main type, while it is the round shape according to Rohinidevi M et al, Mursheed KA et al, Chethan et al and Sharma S et al. According to Veeramani et al, the irregular shape type is the main type. The variations in the shape of the foramen magnum might have been attributed by the factors such as diverse ethnical group, sample size, sexual dimorphism and types of population.

CONCLUSION

Result of present study is important not only for neurosurgeons but also to the anaesthetist, orthopedist, radiologists, forensic experts, anatomists and anthropologists. The knowledge of the variations in foramen magnum shapes and dimensions important during radiological diagnostic procedures and surgical approaches to the region and important for deciding that how much bone must be removed.

Conflicts of Interests: None

REFERENCES

[1]. Grey's Anatomy the anatomic basis of clinical practice. 39th edition. Elsevier Churchill Living stone: 455, 463- 4465.

[2]. Nevell L and Wood B. Cranial base evolution within the hominin clade. J Anat. 2008; 212: 455-468. https://doi.org/10.1111/j.1469-7580.2008.00875.x PMid:18380865 PMCid:PMC2409105

[3]. Manoel C, Prado FB, Caria PHF, Groppo FC. Morphometric analysis of the foramen magnum in human skulls of brazilian individuals: its relation to gender. Braz J Morphol Sci 2009;26(2):104-8.

[4]. Muralidhar P Shepur, Magi M, Nanjundappa B, Pavan P Havaldar, Premalatha Gogi, Shaik Hussain Saheb. Morphometric analysis of foramen magnum. Int J Anat Res 2014;2(1):249-55.

[5]. Kanchan T, Gupta A, Krishan K. Craniometric analysis of foramen magnum for estimation of sex. International journal of medical, Health, biomedical and pharmaceutical engineering, 2013; 7(7): 111-3.

[6]. Sharma S, Sharma AK, Modi BS, Arshad M. Morphometric evaluation of the foramen magnum and variation in its shape and size: a study on human dried skull. Int J Anat Res., 2015; 3(3):1399-03. https://doi.org/10.16965/ijar.2015.246

[7]. Kumar A, Dave M, Anwar S. Morphometric evaluation of foramen magnum in dry human skulls. Int J Anat Res., 2015; 3(2):1015-23. https://doi.org/10.16965/ijar.2015.154

[8]. Furtado SV, Thakre DJ, Venkatesh PK, Reddy K and HegdeAS. Morphometric analysis of foramen magnum dimensions and intracranial volume in pediatricchiari I malformation. ActaNeurochir (Wien).2010; 152: 221-227. https://doi.org/10.1007/s00701-009-0480-5 PMid:19672553

[9]. Wanebo JE, Chicoine MR. Quantitative analysis of the transcondylar approach to the foramen magnum. Neurosurgery, 2001;49(4):934-943. https://doi.org/10.1227/00006123-200110000-00027 PMid:11564256

[10]. Kizilkanat ED, Boyan N, Soames R, et al. Morphometry of the hypoglossal canal, occipital condyle, and foramen magnum. Neurosurg Q. 2006;16(3):121-125.https://doi.org/10.1097/01.wnq . 0000214018.49915.49

[11]. Murshed KA, Cicekeibasi AE, Tuncer I. Morphometric evaluation of the foramen magnum and variations in its shape. A study of computerized tomographic images of normal adults. Tur J Med Sci. 2003;33:301-306.

[12]. Chethan P, K.G. Prakash, B.V. Murlýmanju, K.U. Prashanth, Latha V. Prabhu, Vasudha V. Saralaya, Ashwin Krýshnamurthy, M.S. Somesh, C. Ganesh Kumar. Morphological Analysis and Morphometry of the Foramen Magnum: An Anatomical Investigation. Turkish Neurosurgery 2012;22(4):416-419. https://doi.org/10.5137/1019-5149.JTN.4297-11.1 PMid:22843456

[13]. Zuberi Hussain Riyaz, Azhar Ahmed Siddiqui. Morphometric study of foramen magnum in human skulls. International Journal of Recent Trends in Science and Technology November 2015; 17(1): 28-31

[14]. Rohinidevi M and Vimala V. Morphometric analysis of foramen magnum and variations in its shape in dried human adult skulls: . Int J Anat Res. 2016;4(3):2670 -73. https://doi.org/10.16965/ijar.2016.298

[15]. Sampada P K, Poornima B, Mallikarjun M, Santosh B Sakri. Morphometric and morphological study of foramen magnum in dried human skull bones. Int J Anat Res 2017;5(2.1):3682-3686. https://doi.org/10.16965/ijar.2017.139

[16]. Singh KC, Gunjan Rai, Rahul Rai. Morphological Variations of the Foramen Magnum in Adult Human Dry Skull in Eastern UP (India) Population. Int J Med Res Prof. 2017; 3(2):205-08.

[17]. Mishra AK, Pandey SB, Yadav CK, Haque M, Chandra N. Morphometric study of foramen magnum of skulls in population of Uttar Pradesh. Int J Anat Res. 2018;6(2.2):4287:5186-90. https://doi.org/10.16965/ijar.2018.150

[18]. Mondal M, Sanga A, Mukherjee A. Morphometric and morphological analysis for sex determination of dry human skull. Indian Journal of Basic and Applied Medical Research; September 2018;7(4):511-518.

[19]. Veeramani R, Manjunath KY, et al. Morphological and Morphometric study of variations in the shape and size of the foramen magnum of human skulls. Int J Anat Radiol Surgery 2018;7(2):1-8.

[20]. Singh A, Agarwal P, Singh A. Morphological and Morphometric Study of Foramen Magnum in Dry Human Skull and Its Clinical Significance. International Journal of Anatomy, Radiology and Surgery. 2019;8(3):AO10-AO12.

[21]. Singh D, Patnaik P, Gupta N. Morphology and morphometric analysis of the foramen magnum in dried adult skulls in North Indian region. Int J Health Sci Res. 2019; 9(4):36-42.

[22]. Gruber P, Henneberg M, et al. Variability of human foramen magnum size. The Anatomical Recrd 2009;292:1713-1719. https://doi.org/10.1002/ar.21005 PMid:19777568

[23]. Mahajan D, Agnihotri G, et al. An anatomical perspective of human occipital condyles and foramen magnum with neurosurgical correlates. Int J of Exp Clin Anatomy 2011;6(7):29-33. https://doi.org/10.2399/ana.11.141

[24]. Patel R, Mehta CD. Morphometric study of foramen magnum at the base of human skull in South Gujarat. IOSR J of Dental and Med Sci 2014;13(6):23-25. https://doi.org/10.9790/0853-13642325

[25]. Rajkumar, Kattimuthu P, et al. Morphometric analysis of foramen magnum of dry human skulls in North Indian population. Int J Anat Res 2017;5(1):3480-3484. https://doi.org/10.16965/ijar.2016.495

[26]. Feridoz J, Babu Y. Morphometric analysis of foramen magnum. Int J Sci Dev Res 2018;3(4):302-305.

[27]. Kumar A, Potdar P, Singh K, Dhakar JS. A study of foramen magnum and its clinical relevance. Santosh University Journal of Health Sciences, July - December, 2019;5(2): 72 - 77. https://doi.org/10.18231/j.sujhs.2019.015

[28]. Morphometry of the hypoglossal canal, occipital condyle, and foramen magnum. Neurosurg Q. 2006;16(3):121-125. https://doi.org/10.1097/01.wnq.0000214018.49915.49

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