



A NORTH INDIAN SKULL BASED STUDY OF A MORPHOLOGICAL AND MORPHOMETRICAL MEASUREMENTS OF FORAMEN MAGNUM.

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ABSTRACT Foramen magnum is a Latin word meaning largest aperture in skull. It is formed by the fusion of the four individual parts of the occipital bone (pars squama, left and right pars lateralis, and pars basilaris). The major structures passing through this foramen are the lower end of the medulla oblongata, meninges, vertebral arteries and the spinal accessory nerve. Present study conducted in the Department of Anatomy, Saraswati medical college. Study conducted on completely ossified adults 92 dry skulls. Deformed and fractured skulls were excluded from the study. Anteroposterior diameters (Anteroposterior diameter of foramen magnum is the distance measured between Basion and opisthion.). Transverse diameters (Transverse diameter of foramen magnum is the distance measured at right angles to anteroposterior diameter of foramen magnum). Area of the foramen magnum-anteroposterior diameters / transverse diameter. In our study the mean anteroposterior diameter was 34.46 ± 2.42 . The mean measurement of transverse diameter was 29.23 ± 2.1 . The mean surface area of foramen magnum was 789 ± 91.01 . When the index of foramen magnum was > 1.2 , the foramen was considered to be ovoid. In the present study we found 63.05% skulls exhibited ovoid shape foramen magnum. The incidence of the morphological types of foramen magnum had the following frequency of distribution: Oval 56(60.87%), Round 4(4.35%), Egg 13(14.13%), Tetragonal 15(16.30%), Pentagonal 4(4.35%). The morphometry of foramen magnum is necessary for surgeon during the surgeries of foramen magnum meningiomas or posterior cranial fossa lesions and also in determining Arnold Chiari Syndrome.

KEYWORDS : foramen magnum, cervical cranial surgery, morphological, morphometrical measurements.

Introduction:

Foramen magnum is a Latin word meaning largest aperture in skull. It is formed by the fusion of the four individual parts of the occipital bone (pars squama, left and right pars lateralis, and pars basilaris) (Avcı E et al., 2011). The major structures passing through this foramen are the lower end of the medulla oblongata, meninges, vertebral arteries and the spinal accessory nerve (Mc Graw Hill et al., 2002). It is of particular interest for anthropology, anatomy, forensic medicine and other medical fields. Various studies have reported that significant differences exist in the morphometry of foramen magnum between the two sexes within a restricted geographical region and historical period. (NUJHS., 2012, Sauza GIC et al., 2009 and Manoel C et al., 2009). The knowledge of foramen magnum diameters is needed to determine some malformations such as Arnold Chiari syndrome, which shows expansion of transverse diameter (Sgouros S et al., 1999). The dimensions of the foramen magnum are important prior to the cutting off of the foramen magnum lesions or posterior cranial fossa lesions, because more the antero-posterior diameter, greater is the contralateral exposure (Murshed K A et al., 2003).

Aims and Objectives:

The aim of the study to analysis of morphometric and morphology parameters of foramen magnum.

Materials and Methods:

Present study conducted in the Department of Anatomy, Saraswati medical college. Study conducted on completely ossified adults 92 dry skulls. Deformed and fractured skulls were excluded from the study. Measurements were done using following bony landmarks on the skull. Basion middle point of the anterior margin of foramen magnum) and Opisthion (Opisthion is middle point of posterior margin of foramen magnum). Following parameters were taken in this study.

1. Anteroposterior diameters (Anteroposterior diameter of foramen magnum is the distance measured between Basion and opisthion.)
2. Transverse diameters (Transverse diameter of foramen magnum is the distance measured at right angles to anteroposterior diameter of foramen magnum)
3. Area of the foramen magnum-anteroposterior diameters / transverse diameter

AREA (A) = $\frac{1}{4} \times \pi \times w \times h$.

W = Transverse diameter

H = Anteroposterior diameters

$\pi = 22/7 = 3.14$

4. Shapes of the foramen magnum (Ovoid, Oval, Round, Egg, Tetragonal, Pentagonal, Hexagonal and Irregular). All measurements parameter of the foramen magnum was taken by digital Vernier calipers graded upto 0.01mm. Discrete data regarding shape of the foramen magnum in number (percentage) and continuous data regarding the morphometrical parameters of the foramen magnum tabulated in table and shown in the diagram. Institutional ethical committee approval has been taken before the commencement of the study.

RESULTS:

In our study the mean anteroposterior diameter was 34.46 ± 2.42 . The maximum anteroposterior diameter was 41.36 mm and minimum anteroposterior diameter was 29.9mm. and mean measurement of transverse diameter was 29.23 ± 2.1 . The maximum transverse diameter was 33.51mm and minimum transverse diameter was 24.85mm. (Table 1 and diagram 1).

The mean surface area of foramen magnum was 789 ± 91.01 (Table 1). When the index of foramen magnum was > 1.2 , the foramen was considered to be ovoid (Table 2). In the present study we found 63.05% skulls exhibited ovoid shape foramen magnum. The incidence of the morphological types of foramen magnum had the following frequency of distribution: Oval 56(60.87%), Round 4(4.35%), Egg 13(14.13%), Tetragonal 15(16.30%), Pentagonal 4(4.35%) (Table 3) and Diagram (2).

In the present study mean foramen magnum index was found to be 1.18mm, with range being minimum 1.03 to maximum being 1.50 with standard deviation of 0.10 out of 92 specimens. Out of 93 skulls 63.5% exhibited ovoid foramen magnum.

Table 1: The antero-posterior diameter, transverse diameter and area of foramen magnum in present study.

FORAMEN MAGNUM	ANTEROPOSTERIOR DIAMETER (mm)	TRANSVERSE DIAMETER(mm)	AREA	Index
MEAN	34.46	29.23	792.61	1.18
MEDIAN	33.99	29.42	789.70	1.15
MODE	36.79	28.35	623.68	1.28
STANDARD DEVIATION	2.42	2.10	91.01	0.10
MINIMUM	29.9	24.85	603.52	1.03
MAXIMUM	41.36	33.51	988.38	1.50

Diagram (1): Anthropometric measurements of the foramen magnum.

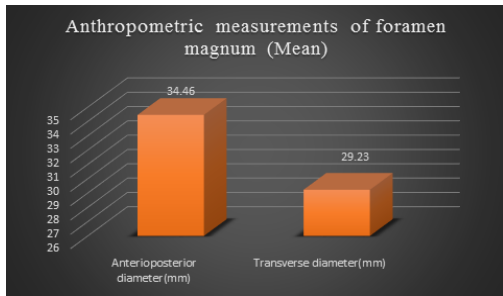


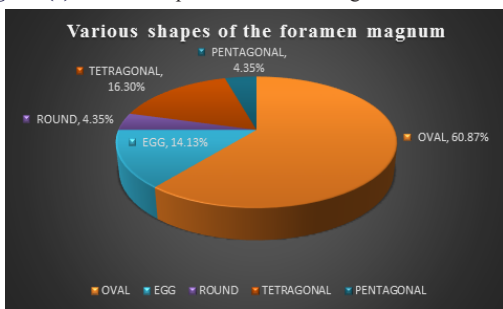
Table 2: Frequency and percentage of foramen magnum index.

Foramen magnum index	Frequency	Percentage (%)
<1.20	58	63.05
≥1.20	34	36.95
Total	92	100.00

Table 3: Various types of foramen magnum based on their shape

TYPES OF FORAMEN MAGNUM	PERCENTAGE (%)
OVAL	56(60.87%)
EGG	13(14.13%)
ROUND	4(4.35%)
TETRAGONAL	15(16.30%)
PENTAGONAL	4(4.35%)

Diagram (2): various shape of the foramen magnum.



DISCUSSION:

The shape and size (AP and TD) of the foramen magnum is vital parameter for the manifestation of clinical signs and symptoms, also these have been found to be independent risk factors in patients with craniovertebral anomalies (Kanodia G et al., 2013). In a study done by (Patel and Mehta 2014) they have mentioned the mean anterior posterior diameter was 33.7mm and transverse diameter was 28.29mm respectively. (Howale et al., 2014) study reports also suggest the anteroposterior and transverse diameters was 31.2mm and 26.9mm respectively. (Muralidhar D et al., 2014) study in south Indian population observed the mean anteroposterior and transverse diameter

Table 5: Comparison of foramen shapes with previous studies.

Shapes of foramen magnum	Murshed et AL., 2003	Radhakrishna et AL., 2012	Chethan P et al., 2012	Radhika PM et AL., 2012	Anil kumar et al., 2015	Sampada et al., (2017)	Present study
Oval	9(8.1%)	39(39%)	8(15.1%)	60(40%)	18(50%)	58(58%)	56(60.87%)
Round	7(6.3%)	----	10(18.9%)	15(10%)	7(20%)	9(9%)	4(4.35%)
Egg	24(21.8%)	28(28%)	12(22.6%)	30(20%)	----	11(11%)	13(14.13%)
Tetragonal	14(12.7%)	19(19%)	10(18.9%)	9(6%)	2(6%)	8(8%)	15(16.30%)
Pentagonal	15(13.6%)	14(14%)	2(3.8%)	3(2%)	----	1(1%)	4(4.35%)
Hexagonal	19(17.2%)	-----	3(5.6%)	9(6%)	3(8%)	3(3%)	-----
Irregular	22(19.9%)	-----	8(15.1%)	24(16%)	6(16%)	10(10%)	-----

CONCLUSION:

The effort of our study to study the morphological and morphometrical parameters of the foramen magnum in north Indian skulls. The morphometry of foramen magnum is necessary for surgeon during the surgeries of foramen magnum meningiomas or posterior cranial fossa lesions and also in determining Arnold Chiari Syndrome. The variations of shape of foramen magnum are important in neurological interpretation. Diameter of foramen magnum and its variations is important not only anatomists but also to the anesthetist, neurosurgeons, orthopedic, radiologists.

was 33.4mm and 28.5mm respectively. In our present study we found the mean Anteroposterior diameter was 34.46mm and transverse diameter was 29.23mm respectively. some other author findings were mentioned and compared with findings of the present study was shown in table no 4.

The result of in this morphometric study of foramen magnum comparison with other studies has been shown in (table 4). In this study, the mean area of foramen magnum was 792.61±91.01mm². In the study done by (Shika et al 2015) on 50 dried skulls, mentioned the mean area of foramen magnum was 970.57mm². (Rohini Devi M et al., 2016) study on 35 dried skulls of unknown sex, they found that the mean area of foramen magnum was 820.53mm². In a study of (Sampada et al.,2017) on 100 dry skulls, the mean area of foramen magnum was 803.8±83.42mm². The variations obtained in the mean values of area of foramen magnum in the above-mentioned studies may be due to sexual dimorphism.

In the present study mean foramen magnum index was found to be 1.18mm, with range being minimum 1.03 to maximum being 1.50 with standard deviation of 0.10 out of 92 specimens. Out of 93 skulls 63.5% exhibited ovoid foramen magnum. (Muthukumar et al.,2005) determined the shape of foramen magnum using foramen magnum index and found in 46% of specimen foramen magnum index was equal or more than 1.20 and was considered as oval. (Kizilanat et al.,2006 and Tubbs RS et al., 2010) found that foramen magnum index as 1.2. [13,14] In a study done by (Avic et al., 2011), 58 % of specimens were showing ovoid foramen magnum.

According to the shape of the foramen magnum shown in the table 5, (Murshed et al., 2003) mentioned majority of the foramens in their study was egg shaped (21.8%). In a study done by (Anil Kumar et al.,2015) observed majority of the foramen magnum was oval shaped (50%). (Radhika et al.,2012 and Sampada et al., 2017) study results also stated maximum no foramen magnum in their study was oval shaped.in our study we found maximum no foramen magnum was oval shaped 56(60.87%). Our study results correlate with the study results of the (Radhika et al., (2012) and Sampada et al., (2017) study.

Table 4: The anteroposterior and transverse diameter of foramen magnum of present study were compared with other studies.

Authors and years	Anteroposterior diameter (mm)	Transverse diameter (mm)
Patel and Mehta et al., (2014)	33.7	28.29
Howale et al., (2014)	31.2	26.9
Osunwoke E.A., (2012)	36.1	29.5
Muralidhar et al., (2014)	33.4	28.5
Mahajhan D et al., (2013)	32.83	27.47
Santhosh et al., (2013)	34.37	28.98
Anil kumar et al., (2015)	36.78	30.05
Ganapathy et al., (2014)	33.9	28.7
Radhakrishna et al., (2012)	34.04	28.63
Sampada et al., (2017)	34.84	29.39
Present study	34.46	29.23

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References

- Anil Kumar, Mitesh Dave, Sanam Anwar. Morphometric evaluation of foramen magnum in dry human skulls. Int J Anat Res 2015;3(2):1015-1023.
- Arthi Ganapathy, Sadeesh T, Sudha Rao. Morphometric analysis of foramen magnum in adult human skulls and ct images. Int J Cur Res Rev. 2014;6(20):11-15.
- Avci E, Kara E, Ozturk N C, Uluc K: Anatomical variation of the foramen magnum, occipital condyle and jugular tubercle. Turkish Neurosurgery, 2011;2(2): 181-90.
- B. Morphometric analysis of foramen magnum for sex determination in South Indian

- population. NUJHS, March 2012;2(1): 20-22.
5. Chethan P, Prakash KG, Murlimanju BV, Prashant KU, Prabhu LV, Saralaya VV et al Morphological Analysis and Morphometry of the Foramen Magnum: An Anatomical Investigation. Turkish Neurosurgery 2012;22(4):416-419.
 6. Deepak S. Howale, Anil Bathija, Sudarshan Gupta, D P Pandit. Correlation between cranial index and foramen magnum index in human dried skulls. GJRA. 2014;3(1):3-6.
 7. Divya Mahajan, Gaurav Agnihotri, Abha Sheth, Rahat Brar. An anatomical perspective of human occipital condyles and foramen magnum with neurosurgical correlates. International journal of clinical and experimental anatomy. 2013;6(7):29-33.
 8. Kanodia G, Parihar V, Yadav YR, Bhatele PR, Sharma D. Morphometric analysis of posterior fossa and foramen magnum. J Neurosci Rural Pract [serial online] 2012 [cited 2013 Jan 11]; 3: 261-6.
 9. Kizilkat Emine Dondu, Boyan Neslihan, et al. Morphometry of hypoglossal canal, occipital condyle and foramen magnum: abstract, Neurosurgery quarterly 2006; 16(3): 121-125.
 10. 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): 104-108.
 11. Mc Graw Hill Concise Dictionary of Modern Medicine (2002): Mc Graw Hill Companies Inc.
 12. Muralidhar P Shepur, Magi M, Nanjundappa B, Pavan P Havaladar, Premalatha Gogi, Shaik Hussain Saheb. Morphometric analysis of foramen magnum. Int J Anat res., 2014;2(1):249-55.
 13. Murshed K A, Cicekeibasi A E, 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
 14. Murshed KA, Cicekeibasi AE, and Tuncer I. Morphometric Evaluation of the Foramen Magnum Variations in its Shape: A Study on Computerized Tomographic Images of Normal Adults. Turkish Journal of Medical Sciences. 2003;33(1):301-306.
 15. Muthukumar N, Swaminathan R, Venkatesh G, Bhamumathi SP. A morphometric analysis of the foramen magnum region as it relates to transcondylar approach. Acta neurochir (Wien), 2005; 147(8): 889-895.
 16. Osunwoke EA, Oladipo GS, Gwunireama IU, Ngaokere JO. Morphometric analysis of the foramen magnum and jugular foramen in adult skulls in southern Nigerian population. Am. J. Sci. Ind. Res., 2012;3(6):446-448.
 17. P K Sampada, B Poornima, M Mallikarjun, Santosh B Sakri. Morphometric and morphological study of foramen magnum in dried human skull bones: an original article. int j anat res 2017;5(2.1):3282-86.
 18. Radhakrishna S, Shivarama C, Ramakrishna A, Bhagya B. Morphometric analysis of foramen magnum for sex determination in south Indian population. Nite university journal of health science. 2012;2(1):20-22.
 19. Rohinidevi M, Vimala V. Morphometric analysis of foramen magnum and variations in its shape in dried human adult skulls: an original article. Int J Anat Res 2016;4(3):2670-2673.
 20. Roma Patel, C. D. Mehta. Morph metric study of Foramen Magnum at the base of human skull in South Gujarat. Journal of Dental and Medical Sciences. 2014;13(6):23-25.
 21. Santhosh CS, Vishwanathan KG, Ashok Gupta, Siddesh RC, and Tejas J. Morphometry of the Foramen Magnum: An Important Tool in Sex Determination. Research and Reviews: Journal of Medical and Health Sciences. 2013;4(2):88-91.
 22. Sgourous S, Goldin HJ, Hockely AD, Wake MJ, et al. Intracranial volume change in childhood. J Neurosurg 1999; 91:610-616.
 23. Shika S, Anil Kumar S, Bhawani S M, Arshad M. Morphometric Evaluation of the Foramen Magnum and Variation in its Shape and Size: A Study on Human Dried Skull. International Journal of Anatomy and Research. 2015;3(3):1399-03.
 24. Suazo GIC, Russo PP, Zavando MDA, Smith RL. Sexual dimorphism in foramen magnum dimensions. International Journal of Morphology; 2009; 27(1): 21-23.
 25. Tubbs RS, Griessenauer CJ, Loukas M, Shoja MM, Cohen-Gadol AA. Morphometrics analysis of foramen magnum: an anatomic study. Neurosurgery 2010; 66(2): 385-88.
 26. Radhika. P.M, Shailaja shetty, Pratap K.J , C. Sheshgiri, Jyoti K.C, Asian J Med Clin Sci, Ma- Aug 2014, Vol-3, Issue -2, 68-72.