



**COMPARATIVE STUDY OF AREA AND INDEX OF FORAMEN MAGNUM OF SKULL IN POPULATION OF UTTAR PRADESH**

**Abhinav Kumar Mishra<sup>1\*</sup>, Pawan Kumar Dubey<sup>2</sup>, Gyan Prakash Mishra<sup>3</sup> and Navneet Kumar<sup>4</sup>**

<sup>1,3,4</sup>Department of Anatomy, Maharshi Vashishtha Autonomous State Medical College, Basti (U.P.), India

<sup>2</sup>Department of Community Medicine, Maharshi Vashishtha Autonomous State Medical College, Basti (U.P.), India

**ARTICLE INFO**

**Article History:**

Received 06<sup>th</sup> May, 2020

Received in revised form 14<sup>th</sup>

June, 2020

Accepted 23<sup>rd</sup> July, 2020

Published online 28<sup>th</sup> August, 2020

**Key words:**

Foramen Magnum Area, Foramen Magnum Index, Achondroplasia, Radinsky's Formula

**ABSTRACT**

**Background :** Measurements of area and index of the Foramen Magnum in U.P. Population measured which are anatomically and clinically important. The area and index provides us valuable data. Geographically it varies.

**Objectives :** To determine the morphometric parameters of Foramen Magnum

**Materials and Methods :** The study was conducted on 71 dry human skulls of unknown sex and measured its Antero-Posterior, Transverse, Right Oblique and Left Oblique diameters with the help of digital caliper.

**Result :** The obtained mean  $\pm$  SD value of FMA and FMI are  $756.78 \pm 88.05$  and  $82.99 \pm 6.90$  respectively. There is no significant correlation between FMA and FMI.

**Conclusion:** The present study will help as guide for neuroanatomists and forensic experts

Copyright©2020. *Abhinav Kumar Mishra et al.* This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

**INTRODUCTION**

The embryonic development of the skull is a complex process involving the notochord as an inducer of neuroectodermal differentiation and the paraxial mesoderm [1]. The dimensions like Antero-Posterior Diameter (APD) and Transverse Diameter (TD) are useful in sex determination [2]. The dimensions and Area of FM (FMA) are greater in males than in females [3] but the Foramen Index (FI) was found greater in females than males [4]. The dimensions and Area of FM (FMA) are greater in males than in females [3] but the Foramen Index (FI) was found greater in females than males [4]. Widening of FM is very important because the dimensions of FM is small in all individuals with achondroplasia [5] in which the calvarium of the skull is large but the base is short [6]. The patients suffer with obstructive sleep apnoea [7] and larger dimensions of FM in Arnold Chiari's Syndrome [8] in which the cerebellar tonsils displace via the FM into the vertebral channel and patient suffers with hydromyelia [9].

**MATERIAL AND METHODS**

The study was carried out on 71 completely ossified dry human skulls obtained from Department of Anatomy, Integral Institute of Medical Sciences & Research and King George's Medical University, Lucknow, U.P., India. Partially or Un-ossified skulls and damaged or deformed skulls were excluded from the study.

The parameters were observed twice in this study. All the measurements of Foramen Magnum were taken by Digital caliper.

Foramen Magnum Area (FMA) was calculated by using **Radinsky's Formula [10]**.

$FMA = \frac{1}{4} \times \pi \times \text{Foramen Magnum Length} / \text{Foramen Magnum Width}$

Foramen Magnum Index (FMI) was calculated by using **Martin's Formula [11]**.

$FMI = \text{Transverse diameter} \times 100 / \text{Antero-posterior Diameter}$

**Table 1** Descriptive analysis of FMA and FMI with different shapes

Total No. of Skull=71	Shape of FM	Area of Foramen Magnum (mm <sup>2</sup> ) (FMA)		Foramen Magnum Index (FMI)	
		Range (Min-Max)	Mean $\pm$ SD	Range (Min-Max)	Mean $\pm$ SD
24 (37.08)	Oval	563.41-971.08	754.60 $\pm$ 111.37	64.65-92.76	80.31 $\pm$ 6.58
22 (30.9)	Round	650.99-879.97	768.81 $\pm$ 61.42	72.26-96.93	85.13 $\pm$ 6.60
5 (7.04)	Tetragonal	607.95-847.31	751.45 $\pm$ 77.47	69.99-96.01	79.54 $\pm$ 10.22
5 (7.04)	Pentagonal	713.22-851.92	742.46 $\pm$ 57.14	81.44-92.56	86.88 $\pm$ 4.41
8 (11.02)	Hexagonal	802.39-975.22	802.39 $\pm$ 66.56	74.43-87.98	81.55 $\pm$ 5.03
7 (9.85)	Irregular	634.89-739.52	692.16 $\pm$ 39.35	77.66-96.15	86.78 $\pm$ 6.09

**Table 2** Comparison of Foramen Magnum Area and Foramen Magnum Index

No. of Samples	Variables	Min-Max	Mean $\pm$ SD	p- Value
71	FMA	20.84 - 35.52	756.78 $\pm$ 88.05	<0.001
	FMI	28.88 - 35.47	82.99 $\pm$ 6.90	

\*Corresponding author: **Abhinav Kumar Mishra**

Department of Anatomy, Maharshi Vashishtha Autonomous State Medical College, Basti (U.P.), India

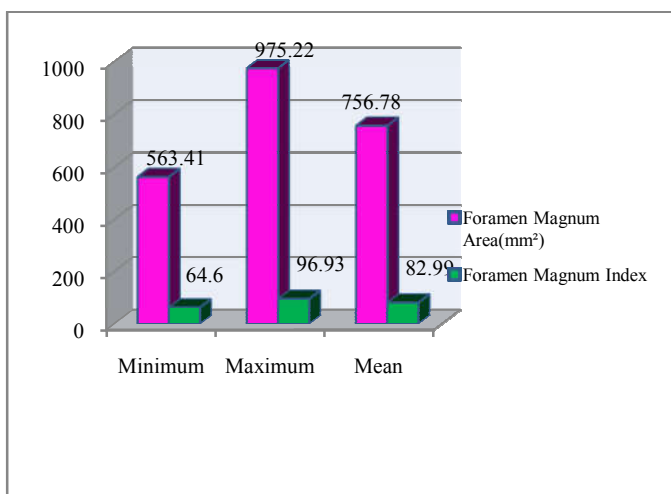


Fig 1 Comparison of Foramen Magnum Area and Foramen Magnum Index

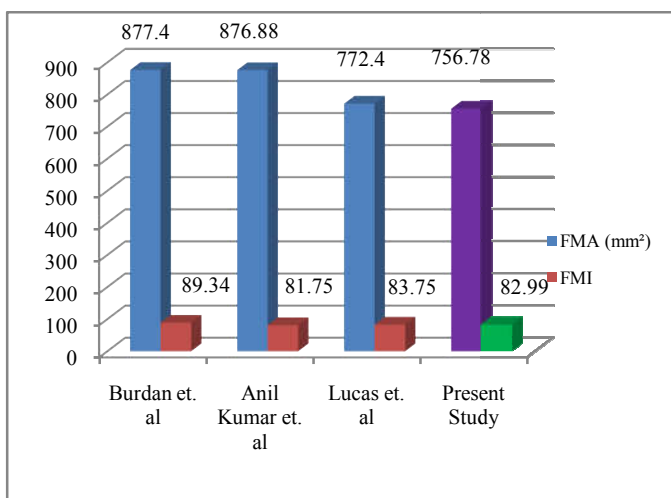


Fig 2 Comparison between Foramen Magnum Area and Foramen Magnum Index with previous studies

**RESULTS**

**Table 3** Correlation result between Area of Foramen Magnum and Foramen Magnum Index

Area of Foramen Magnum Vs. Foramen Magnum Index	Pearson Correlation	0.199
	Significant value	0.096

The Parametric distribution of FMA and FMI in which the Mean ± SD of FMA is 756 ± 88.05 and the Mean ± SD of FMI is 82.99 ± 6.9 whereas it lies the range between min-max is 563.41 - 975.22 in FMA and 64.6-96.93 in FMI respectively. The result showing positive correlation coefficient between FMA and FMI though the result is not statistically significant at p<0.05 level of significance.

**DISCUSSION**

The obtained data of this study is given which provides the necessary knowledge about the FMA and FMI. The present study showing that the Area of FM was 756.78 mm² which was similar as study done by Lucas *et al.* 772.4 mm² whereas the study done by Anil Kumar *et al.* and Burdan *et al.* was 876.88 mm² and 877.4 mm² respectively. The Index of FM

was 82.99 which was similar from Anil Kumar *et al.* and Lucas *et al.* was 81.75 and 83.75 respectively whereas Burdan *et al.* calculated 89.34.

**CONCLUSION**

The obtained data of FMA and FMI helps forensic experts where only the availability of norma basalis for sex determination and also to the neuroanatomists for various surgical approaches.

**References**

1. Tubbs R.S., Griessennauer C.J., Louka S.M., Shoja M.M. and Cohen-Gadol A.A. Morphometric Analysis of the Foramen Magnum: An Anatomic Study. *Neurosurgery.* 2012; 66: 385-388.
2. Gunay Y., Altinkök M. The value of the size of foramen magnum in sex determination. *J. Clin. Forensic Med.* 2000; 7: 147-149.
3. Sgouros S., Goldin H.J., Hockley A.D., Wake M.J., *et al.* Intracranial volume change in childhood. *J. Neurosurg.* 1999; 91 : 610-616.
4. Erdil Hayat Fatma, Sabanciogullari Vedat, Cimen Mehmet, Isik Oktay. Morphometric Analysis of the Foramen Magnum by Computed Tomography. *Erci. Med. J.* 2010; 32(3) : 167-170.
5. Hetch T.J., Horton W.A., Reid C.S., Pyeritz R.E., Chakraborty R. Growth of the foramen magnum in acondroplasia. *American J. Med. Gen.* 1989; 32 : 528-535.
6. Hamblen H. David, Hamish A., Simpson R.W. General Affectionsof the skeleton, bone dysplasias, Achondroplasia. *Adam’s Outline of Orthopedics.* 2010; 6 : 61-62.
7. Kleingman Robert M. ed. *Nelson’s Text book of Pediatrics.* 1<sup>st</sup> edition. Elsevier, 2016; 2: 2145-2146.
8. Gardner W.J., Goodall R.J. The surgical management of Arnold-Chiari malformation in adults. An explanation of its mechanism and importance of encephalography in diagnosis. *J. Neurosurg.* 1950; 7:199 206.
9. Karnienko Valery N., Pronin Igor N. *Diagnostic Neuroradiology.* 2009; 2 : 29-31.
10. Martin R., Saller K; *Lehrbuch der Anthropologie. Band I.* Stuttgart: Gustov Fisher Verlag, 1957; 455-509.
11. Radinsky L. Relative brain size: a new measure. *Science.* 1967; 155: 836-838.
12. Burdan F. *et al.* Morphology of the Foramen magnum in young Eastern European adults. *Folia. Morphol.* 2010; 71(4) : 205-216.
13. Kumar Anil, Dave Mitesh, Anwar Sanam. Morphometric Evaluation of Foramen Magnum In Dry Human Skull. *Int. J. Anat. Res.* 2015; 3(2) : 1015-23.
14. Pires Lucas A. S., Teixeira Álvaro R., Leite Tulio F. O., Babinski Marcio A. Chagas Carlos A. A. Morphometric aspects of the foramen magnum and the orbit in Brazilian dry skulls. *Int. J. Med. Res.* 2016; 5(4) : 34-42.