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"MORPHOMETRIC AND COMPUTED TOMOGRAPHIC STUDY OF FORAMEN MAGNUM"

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INTRODUCTION

The foramen magnum is the largest foramen in the base of the skull, located centrally in the deepest area of the posterior cerebral fossa. It is surrounded by squamous section of the occipital bone posteriorly, the lateral parts of the occipital bone on either side and the basilar part of the occipital bone anteriorly. The vertebral arteries, spinal roots of the accessory nerve[XI], lower end of medulla oblongata with meninges, anterior and posterior spinal arteries, apical ligament of dens & tectorial membrane.

From the foramen magnum, the clivus slopes upward. Between the basilar portion of the occipital bone and the petrous part of the petromastoid component of the temporal bone, lateral to the clivus, is a groove for the inferior petrosal sinus. An oval foramen is located laterally, spanning the top half of the posterior surface of the petrous portion of the temporal bone. It is traversed by the labyrinthine artery, the facial [VII], and vestibulocochlear [VIII] nerves. The large jugular foramen divides the temporal bone from the occipital bone posterior to the internal acoustic meatus. The sigmoid sinus groove and the inferior petrosal sinus groove lead to this foramen from the lateral and medial sides, respectively. The inferior petrosal sinus empties into the internal jugular vein in the vicinity of the jugular foramen, whereas the sigmoid sinus enters into the jugular foramen and is continuous with the internal jugular vein.

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FORAMEN MAGNUM

The morphometric analysis of foramen magnum and its variations is important not only for anatomists but also to the anesthetist, neurosurgeons, orthopedicians and radiologist .The applications of morphometric analyses of the foramen magnum are quite diverse. The length and breadth of the foramen magnum is clinically relevant in patients with achondroplasia; the cervicomedullary junction may be compressed as a result of marked foramen magnum stenosis, resulting in neurologic manifestations. Achondroplasia is a genetic disorder that results in dwarfism and abnormal endochondral bone formation at the cranial base, leads to a narrow cervical spinal canal and a stenotic foramen magnum.

The knowledge of size and shape of foramen magnum is helpful to neurosurgeons in cranio-vertebral surgical approaches as well as in posterior cranial fossa surgeries. Irregular shape of foramen magnum is accentuated by the developmental anomalies of the bone and soft tissues at the craniovertebral junction. Due to high chances of morbidity and mortality during various surgical procedures at the skull base, this area is having higher clinical importance. It has also has important clinical implications in the prognosis and treatment of various neurological pathologies like Arnold Chiari syndrome, and posterior cranial fossa lesions. Recent evidences supported by the computed tomography (CT) / Magnetic resonance Imaging (MRI) imaging of cranial structures suggested that the overcrowding of hindbrain due to underdevelopment of the posterior fossa is the main cause for the development of numbers of disorder in and around craniovertebral junction.Thus, a fundamental knowledge of normal anatomy about the region is important to the clinician for diagnosis and treatment.

The foramen magnum is a large opening in the occipital bone at the base of the skull. Its development is closely associated with the overall growth of the skull and vertebral column during embryogenesis and postnatal development.

MATERIAL AND METHODS

STUDY SETTING

This study was conducted in the Department of Anatomy, in association with the Department of Radio- diagnosis at Rama Medical College Hospital and Research Centre, Kanpur.

ETHICAL CLEARANCE

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The ethical committee clearance certificate was taken from starting of study institutional medical ethical committee.

INCLUSION CRITERIA

All the skulls used for the study were dried, complete, showed normal anatomical features

EXCLUSION CRITERIA

Skulls with broken and deformed foramen magnum were excluded from this study.

TYPES OF STUDY

Prospective study and Cross-sectional study

DURATION OF STUDY

This study was conducted from December 2023 to November 2024.

STUDY DESIGN-

Our study was conducted in Department of Anatomy in association with the Department of Radio- diagnosis, Rama Medical College Hospital and Research Centre, Mandhana, Kanpur.

Morphometric parameters were measured on 75 dry skulls in Department of Anatomy of unknown sex and age and 75 CT scans from Department of Radiology of known sex and age.

All individuals participating in the study had given their informed consent.
STUDY TOOL-

G Wipro Ct scan machine, Digital Vernier caliper, thread.

Radi Ant DICOM Viewer software is used for study scan images.

METHODS

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1. Length of the FM(Foramen Magnum):Distance in a straight line from the end of the anterior border(basion) through the center of the FM until the end of the posterior border (opisthion), toward the median sagittal plane.

2. Width of FM: Distance in a straight line from the end of the border right side, with the concavity stronger through the center of the FM to the opposite end of the lateral border of concavity more pronounced with transverse direction.

Figure number 1 showing the tranverse diameter of foramen magnum

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Figure number 2 showing anteroposterior of foramen magnum

RESULT
FORAMEN MAGNUM

Table number 1 showing the AP of Foramen magnum

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Minimum	Maximum	Mean		Std. Deviation	Skewness		Kurtosis	
Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error	Statistic	Std. Error
24.85	38.31	31.07	.43	3.09	.046	.337	-.299	.662

In the present osteological study the maximum anteroposterior diameter of foramen magnum is 38.31mm and the minimum diameter of foramen magnum is 24.85 and the mean value with standard deviation is 31.07±0.43mm as shown in table no 1.

Table number 2 showing the transverse diameter of foramen magnum

Minimum	Maximum	Mean		Std. Deviation	Skewness		Kurtosis	
Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error	Statistic	Std. Error
18.30	33.80	26.1652	.45532	3.94317	-.191	.277	-.859	.548

In the present osteological study the maximum transverse diameter of foramen magnum is 33.80mm and the minimum diameter of foramen magnum is 18.30mm and the mean value with standard deviation is 26.15±0.45 as shown in table no 2.

Table number 3 showing the shape of foramen Magnum

S. No	Shape	Number	Percentage
1	Circular	28	37
2	oval	39	52
3	irregular	8	11

In the present osteological study the most common shape of foramen magnum is oval as shown in pie chart and table no 3.

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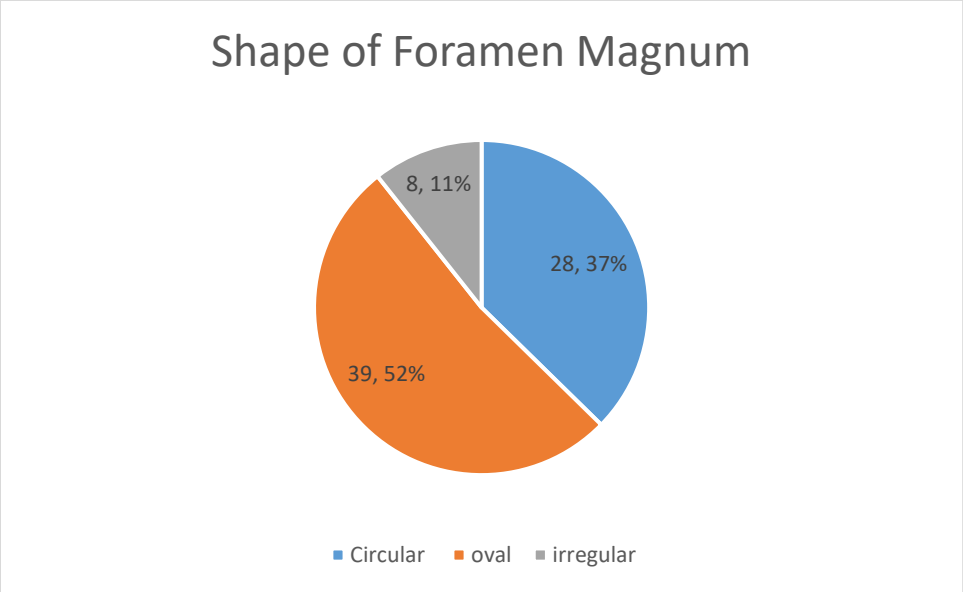

Pie chart showing shape of foramen magnum

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Table number 4 showing the anteroposterior diameter of foramen magnum

Minimum	Maximum	Mean		Std. Deviation	Skewness		Kurtosis	
Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error	Statistic	Std. Error
16.20	35.20	25.0967	.54169	4.69120	.031	.277	-1.027	.548

In the present radiological study the maximum anteroposterior diameter of foramen magnum is 35.20mm and the minimum diameter of foramen magnum is 16.20mm and the mean value with standard deviation is 25.09±0.54mm as shown in bar graph and table no 3.

Table number 5 showing the transverse diameter of foramen magnum

Minimum	Maximum	Mean		Std. Deviation	Skewness		Kurtosis	
Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error	Statistic	Std. Error
18.30	33.80	26.1652	.45532	3.94317	-.191	.277	-.859	.548

In the present radiological study the maximum transverse diameter of foramen magnum is 33.80mm and the minimum diameter of foramen magnum is 18.30mm and the mean value with standard deviation is 26.15±0.45 as shown in table no 4.

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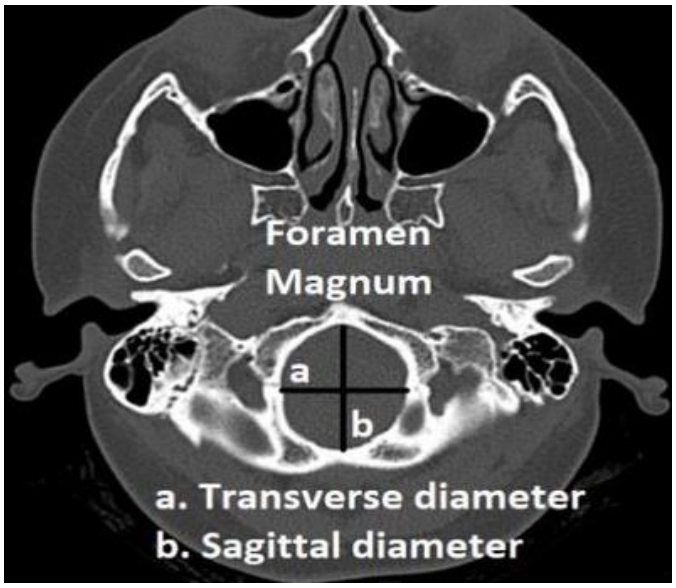

Figure number 3 measuring the anteroposterior and transverse diameter of foramen magnum

DISCUSSION

FORAMEN MAGNUM (Anteroposterior Diameter)

In our present study we found the mean anteroposterior of foramen magnum is 31.0746 .And in our radiological study mean value with standard deviation is 25.09±0.54mm while comparing with **Osama A. Samara et al**conducted a study on 247 individual and they found the anteroposterior value of foramen magnum were 35.1 ± 3.2 mm.Another study of **Vikrant Yadav et al.**conducted a study on 120 patients with known sex, age ranged from 18 to 70 years. They observed anteroposterior diameter30.99±2.23mm (range 27.6–35.8 mm).similar study of **Dan Zimelewicz Oberman et al** performed a study on 55 dry human skulls of unknown sex and found the anteroposterior diameter of foramen magnum 34.51mm.Another study like **Dalvinder Singh et al.** carried out a study on dried adult skulls and they found that the average anteroposterior diameter were 33.57±2.82 mm. One more study of **R. Shane Tubbs et al. [2010]** worked on 72 dry skulls and they found that the mean anterioposterior diameter of foramen magnum was 3.1 cm. Similar study like **Shrestha B et al** performed a study on 68 patients and they found that the age of the patients ranged between 6 and 16 years, the mean anteroposterior diameter of foramen magnum were 3.31 ± 0.12 mm. And similar study like **Ankur Saxena et al** conducted study on 59 dry human skull and the mean anteroposterior diameter of

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the foramen magnum was 32.25 ± 2.55 mm. Another study like **Anshu Sharma et al** conducted a study on 50 dry skulls the mean anteroposterior diameter of the foramen magnum was 34.44 mm. There finding is similar with our finding. No such study found in previous year which conflicted with our finding.

FORAMEN MAGNUM (Transverse Diameter)

In our present study we found the mean transverse of foramen magnum is29.20±0.27.And in our radiological study mean value with standard deviation is 26.15±0.45 while comparing with **Osama A. Samara et al** conducted a study on 247 individual and they found the transverse value of foramen magnum were 29.3 ± 2.5 mm.Another study of **Vikrant Yadav et al.**conducted a study on 120 patients with known sex, age ranged from 18 to 70 years. They observed transverse diameter observed transverse diameter, of foramen magnum was diameter 27.12 ± 1.42 mm (range 23.6–30.1 mm) similar study of **Dan Zimelewicz Oberman et al**
study like **Anshu Sharma et al** conducted a study on 50 dry skulls the mean transverse diameter of the foramen magnum was30.46 mm. There finding is similar with our finding .No such study found in previous year which conflicted with our finding.

FORAMEN MAGNUM [SHAPE]

In our present study we observed that the most common shape of foramen magnum is oval.

CONCLUSION

Osteological Findings

In the osteological examination, significant variations in dimensions were observed in foramen magnum The mean anteroposterior diameter of the foramen magnum measured 31.07±0.43 mm , while the transverse diameter measured 29.20±0.27 mm . These findings indicate that the foramen magnum is slightly larger on the anteroposterior dimension but exhibits a reduced transverse diameter.

Radiological Findings

Radiological measurements revealed smaller dimensions for all cranial foramina compared to osteological findings, likely due to the influence of soft tissues, imaging

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resolution, and technical limitations inherent in radiological methodologies. For the foramen magnum, the mean anteroposterior diameter were
measured 31.07, while the transverse diameter was 29.20 mm.

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