

ORIGINAL RESEARCH

A Morphometric Study of foramen Magnum in Dry Adult Human Skull and its clinical significance

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ABSTRACT

Background: Foramen Magnum is a large oval shaped opening in the posterior cranial fossa. It is a very important feature in bipeds. The knowledge of the dimensions and the shape of the FM has important clinical implication in prognosis and treatment of various neurological pathologies like Arnold-Chiari Syndrome and posterior cranial lesions. Morphometric parameters of FM are of great importance to Orthopaedician, Neurosurgeon, Radiologist and Anthropologist to achieve the best exposure with appropriate surgical outcome.

Methods: a total of 30 dried human skulls were procured from the department of Anatomy, GMC Jammu from June 2021 to January 2022. The antero-posterior diameter and the transverse diameter were measured using Vernier calliper. A detailed morphometric analysis and the shape of FM is then noted and analysed.

Results: The mean Anteroposterior diameter of FM was found to be 35.11 ± 2.211 mm and the mean Transverse diameter of FM was found to be 25.19 ± 2.78 mm. The average FMI was found to be 1.39 ± 0.13 . Out of 30 skulls, the shape of FM which was most frequently observed was Oval, found in 12 skulls, 6 were Hexagonal in shape. The 2nd commonest shape was tetragonal, seen in 8 skulls and the least common was Round, seen in only 4 skulls.

Conclusion: Although the sample size was small and there was no gender discretion. Still the study can prove to be helpful to Anatomists, Radiologists and Surgeons. As the morphology of foramen magnum is variable, it is also important in evolution. It is also important for treatment of the Arnold Chiari's Syndrome, where the dimensions are needed prior to cut-off the Foramen magnum in posterior cranial fossa lesions.

INTRODUCTION

The Foramen Magnum, derived from Latin word, meaning Great hole, is a large oval shaped opening in the occipital bone of the skull.^[1] Foramen Magnum separates the Basilar and Squamous part of the Occipital bone.^[2-4]

The Foramen Magnum is a very important feature in bipedal mammals. One of the attributes of biped's Foramen magnum, is the forward shift of cerebellar tentorium-this is caused by the shortening of the cranial base. The discovery of this feature has given scientists another form of identifying bipedal mammals.^[5]

It is present in humans and in many other mammals which is bounded anteriorly by Basiocciput, posteriorly by Supraocciput and laterally by Occipital condyles.^[1] The Alar Ligament, which is attached on either side to the occipital condyles, divides Foramen Magnum in to anterior small and posterior large compartment.^[6]

The importance of foramen magnum can be understood by the fact that it transmits many important structures- The Apical Ligament of Dens, upper band of Cruciate ligament of Atlas and Membrana Tentoria. Structures passing from the posterior compartment are lower end of Medulla along with its meninges, 4th part of Vertebral artery, anterior and posterior Spinal arteries, spinal root of Accessory Nerve and Cerebellar Tonsils.^[6]

Furthermore, Intradural and Extradural tumours,^[7] congenital anomalies such as Foramen Magnum syndrome, caused by atlanto-occipital assimilation and basilar invagination^[7,8] and cerebellar tissue herniation which invaginated in to FM, may lead to neuronal complications and even death. These are the few pathologies which can be attributed to this anatomical region.^[9]

The knowledge of the dimensions and the shape of the FM has important clinical implication in prognosis and treatment of various neurological pathologies like Arnold-Chiari Syndrome and posterior cranial lesions. Its dimensions are also important during cranio-vertebral surgeries and to determine feasible trans condylar approaches to prevent complications like haemorrhage. Anomalies of FM size effects may vary from producing no symptoms to being associated with weakness of limbs and body, apnoeic spells, hyperreflexia, hydrocephalus and abnormal somatosensory potentials.^[10]

The longer A/P dimensions of FM permit greater condylar resection. Vital structures which pass through the FM, may suffer compression in cases of brain herniation and achondroplasia. Morphometric parameters of FM are of great importance to Orthopaedician, Neurosurgeon, Radiologist and Anthropologist to achieve the best exposure with appropriate surgical outcome.

MATERIALS AND METHODS

The Observational study was conducted on 30 adult dry human skulls of unknown sex, which were procured from the Department of Anatomy, GMC Jammu from June 2021 to January 2022. The morphology of FM was studied in detail. Only the Dry and complete skulls in good condition were used and the damaged and skulls of children were excluded. The Anteroposterior (APD) and the Transverse Diameter (TD). were measured using the Vernier calliper. The APD is the distance between Basion (midpoint of the anterior margin of foramen magnum) and Opisthion (midpoint of posterior margin of FM). The TD is the distance between the lateral margin of FM at the point of greatest lateral curvature. The FM index (FMI) was calculated based on the formula $FMI=APD/TD$.^[11] Statistical analysis was also carried out. Also the shape of the FM was noted and classified as Round, Oval, Tetragonal and Hexagonal. This was done by sketching the FM on a paper and observing its shape.

Fig: Figure showing the procedure of measuring anteroposterior and transverse diameter of Foramen Magnum, using Vernier calliper.

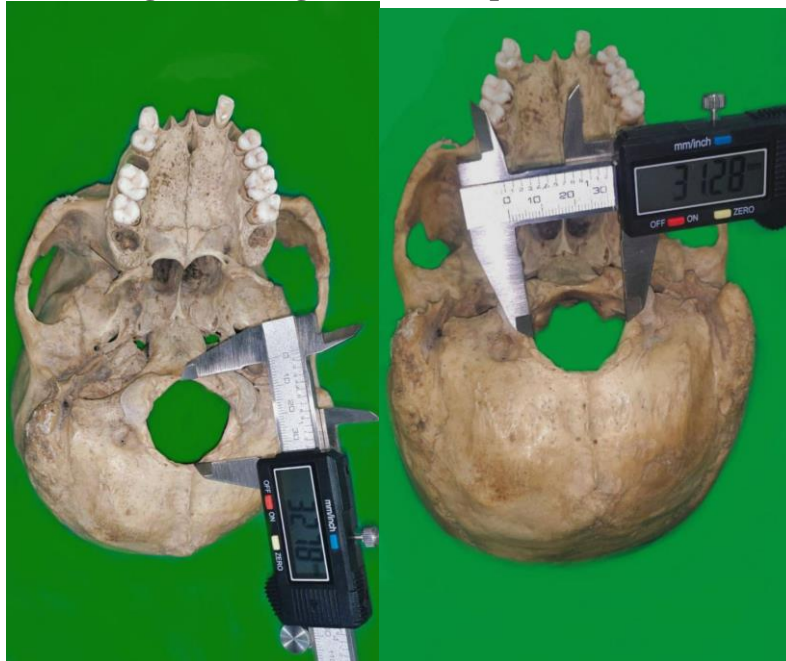
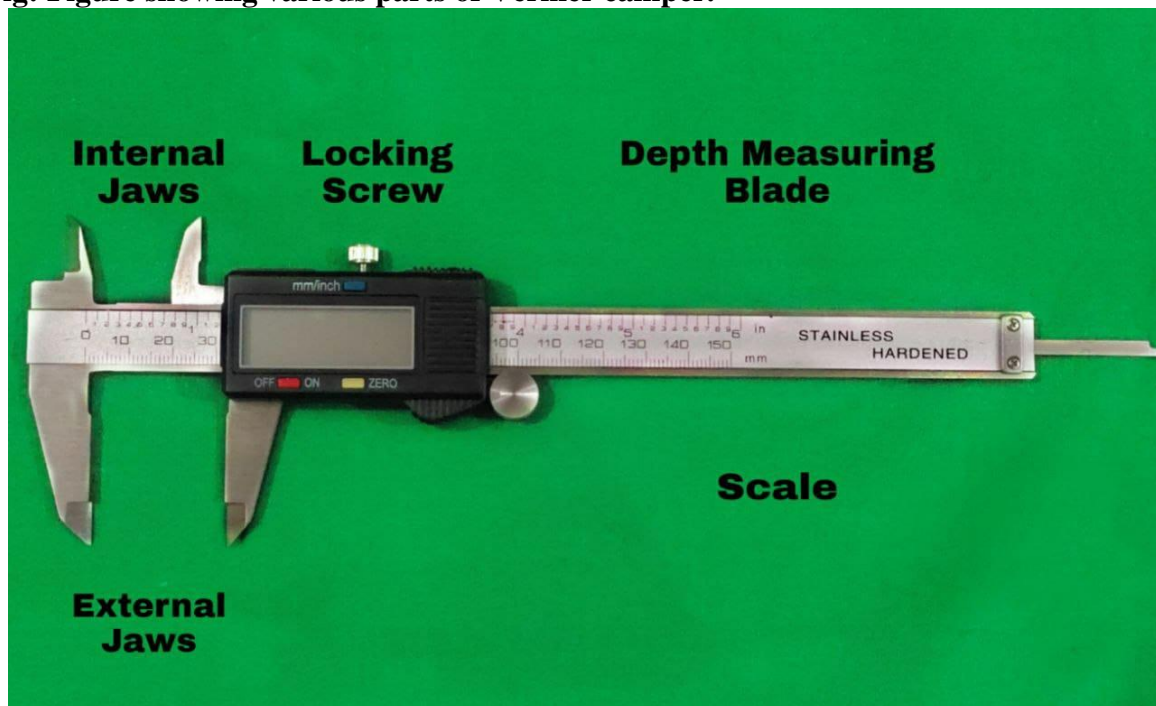


Fig: Figure showing various parts of Vernier calliper.



RESULTS

The mean Anteroposterior diameter of FM was found to be 35.11 ± 2.211 mm and the mean Transverse diameter of FM was found to be 25.19 ± 2.78 mm. The average FMI was found to be 1.39 ± 0.13 .

Out of 30 skulls, the shape of FM which was most frequently observed was Oval, found in 12 skulls, 6 were Hexagonal in shape. The 2nd commonest shape was tetragonal, seen in 8 skulls and the least common was Round, seen in only 4 skulls.

Table 1: Dimensions of Foramen Magnum

Parameters	N	Minimum	Maximum	Mean	Std. Deviation
APD	30	31.88	39.11	35.20	2.21
TD	30	21.11	30.12	25.19	2.78
FMI	30	1.51	1.29	1.39	0.13

Table 2: Variations in shape of Foramen Magnum

Shape	Number	Percentage
Oval	12	40%
Round	4	13.33%
Tetragonal	8	26.66%
Hexagonal	6	20%

DISCUSSION

FM includes many neuroanatomic structures. Lesions of these vital structures need special microsurgical intervention. So selecting the most suitable technique requires meticulous planning based on the foramen magnum size to refrain from any neurological impairment.^[12] Patel et al.^[13] found average anterior-posterior diameter to be 33.7 mm and average transverse diameter to be 28.3mm. Muthukumar et al.^[11] observed that the mean APD was 33.3 mm and mean TD Was 27.9mm. Kanodia et al.^[14] observed that the average APD was 34.1mm and the average TD was 27.5mm. Sendemir et al.^[15] observed the average APD was 36.4mm and the average RD was 30mm. In another study conducted by Lang et al.^[16], the results were mean APD to be 35.33mm and the mean TD to be 29.67mm. In a study performed by Fatma et al Tubbs et al.^[17] observed that the average APD was 31mm and the average TD was 27mm. Gruber et al.^[18] observed that the mean APD was 36.6mm and the mean Td was 31.1mm.

In the present study, the APD and the TD of foramen magnum both are comparable to various authors.

Regarding the shape of FM, oval shape was described as the most common in study conducted by various other authors. In this study also, oval came out to be the most common, in 12 dried skulls that is about 40%. Many other studies also revealed the Oval shape of Foramen Magnum.^[19-20]

The limitation of the present study was that the sample size of the study was small, study was done on dried skulls and no sexual difference was done.

CONCLUSION

Although the sample size was small and there was no gender discretion. Still the study can prove to be helpful to Anatomists, Radiologists and Surgeons. As the morphology of foramen magnum is variable, it is also important in evolution. It is also important for treatment of the Arnold Chiari's Syndrome, where the dimensions are needed prior to cut-off the Foramen magnum in posterior cranial fossa lesions.

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