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A Morphometric Study of Foramen Magnum and Posterior Condylar Foramen

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Abstract

Foramen magnum is a large opening through which vital structures pass. The foramen magnum is an important landmark of the skull base. Posterior condylar canal, Posterior condylar vein and Occipital emissary vein are of utmost importance for postero-lateral surgical approaches to foramen magnum. *Aim*: To provide a database of dimensions of foramen magnum and posterior condylar foramen to help in various surgical procedures. *Methods and Materials*: Seventy five dry human skull of unspecified gender and age obtained from Department of Anatomy of Medical colleges. Various parameters of foramen magnum and presence or absence of posterior condylar foramina were noted. *Results and Conclusions*: The mean antero-posterior distance through the centre of foramen magnum was 33.56mm, mean transverse distance was 28.38mm, Foramen magnum index was 84.89 and Foramen magnum surface area was 751.46 mm^2. The posterior condylar foramina were present bilaterally in 66.66% of skulls, absent bilaterally in 14.66% and were unilateral in 18.66%. This study will be helpful to clinicians and surgeons dealing with the region of posterior cranial fossa before planning a surgery in the occipital condylar region.

Keyword: Foramen Magnum; Posterior Condylar Foramen; Foramen Magnum Index; Foramen Magnum Surface Area.

Introduction

The skull base at bottom of the cranium supports and protects the brain. Major vascular and neural structures enter and exit through various foramina's. Foramen magnum is a large opening in occipital bone of cranium. It lies in posterior cranial fossa. It contains the lower end of the medulla oblongata, meninges, vertebral arteries and spinal accessory nerve. These vital structures can undergo compression in cases of foramen magnum herniation and foramen magnum meningiomas.

The knowledge of foramen magnum diameters is needed to determine some malformations such as Arnold Chiari syndrome, which shows expansion of transverse diameter [1]. Configuration and size of the foramen magnum play an important role in the pathophysiology of various disorders of the craniovertebral junction [2]. The foramen magnum is an important landmark of the skull base and is of particular interest for anthropology, anatomy, and forensic medicine. Emissary veins connect the extracranial venous system with intracranial venous sinuses. The posterior condylar emissary vein connects the lower end of the sigmoid, marginal or occipital sinuses with the internal vertebral venous plexus [3].

Emissary valveless veins are an important component in selective brain cooling by allowing blood to flow bidirectionally thereby allowing cooler blood from the evaporating surfaces of the head to cool the brain. In upright position they also provide as primary outflow route [3]. Posterior condylar canal, Posterior Condylar vein and Occipital emissary vein are of utmost importance for posterolateral surgical approaches to foramen magnum [4].

Any variations in these veins can lead to change in surgical approach in posterior fossa. Our study will provide a database of dimensions of foramen

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magnum and posterior condylar foramen.

Methods

The present study was carried out on Seventy five dry human skulls obtained from Department of Anatomy of Medical colleges. The skulls were of unspecified gender and age. Fractured, deformed skulls were excluded from study. Serial numbers were assigned to the skull. Measurements were taken using a vernier caliper (0-300mm with a precision of 0.01 mm). Two authors made all measurements at separate sittings, one measurement serving as a check to the other. Mean of the two readings was taken for final statistics. The mean value and standard deviation was then calculated for that foramen magnum. Presence or absence of posterior condylar foramen was also noted. Observations were made by passing a probe into the posterior condylar foramina to confirm whether they were opening into the posterior cranial fossae in their entire course. Photographs were taken of skull base with a digital camera.

The following parameters were recorded:

Mean Antero-posterior diameter (APD) of foramen magnum was recorded from anterior border (basion) through centre of foramen magnum until the end of posterior border (opistion).

Mean transverse diameter (TD) was measured from end of right border with maximum concavity through the foramen magnum to end of left border with maximum concavity.

Surface area of Foramen magnum [FMA] was calculated using Radinsky's formula [5].

Radinsky's formula (Foramen magnum area)

$$= ¼ * \pi(pi) * APD * TD$$

Foramen magnum index [FMI] was calculated using formula

FMI= TD*100/ APD

The mean values, Standard deviation for above parameters were computed.

Results

- The antero-posterior distance through the centre of foramen magnum ranged from 25.8-41.9mm with a mean of 33.56mm± 2.86.
- The transverse diameter through the centre of foramen magnum ranged from 21.3 – 35.07mm with a mean of 28.38mm ±2.64
- The foramen magnum surface area ranged from 500.39- 1049.36 mm^2 with a mean of 751.46 ±115.61 mm^2
- The foramen magnum index ranged from 71.23 – 117.82 with a mean of 84.89±8.28.
- Posterior condylar foramina were present bilaterally in 66.66% of skulls i.e., 50 skulls.
- Posterior condylar foramina were absent bilaterally in 14.66% of skulls i.e., 11 skulls.
- Posterior condylar foramina were present unilaterally in 18.66% of skulls. i.e., 14 skulls.
- Posterior condylar foramen only on right side was present in 12% while only on left side was present in 6.66% of skulls.

Table 1: Mean Antero-posterior and Transverse diameter of Foramen magnum.

	Mean AP Diameter (mm)	Mean Transverse Diameter (mm)
Tubbs et al [2]	31	27
Gruber et al.,[6]	36.6	31.1
Muthukumar et al. [8]	33.3	27.9
Natis et al.[9]	35.53	30.31
Nagwani [10]	34.68	27.24
Deepa G.[11]	34.1	28.68
Present study	33.56	28.38

Table 2: Surface area of Foramen magnum

	Foramen magnum surface area (mm^2)
Tubbs et al.[2]	558
Nagwani [10]	757.09
Deepa G.[11]	774.17
Acer et al [12]	760
Present study	751.46

Table 3: Foramen magnum index

	Foramen magnum index
Nagwani [10]	78.71
Deepa G.[11]	84.18
Chaturvedi and Harneja [13]	83.81
Howale et al [14]	84.85
Present study	84.89

The results of present study are in compliance with other studies.

Table 4: Posterior condylar foramen

	Bilateral (%)	Right unilateral (%)	Left unilateral (%)	Bilateral absence (%)
Sadamate [16]	48.68	19.29	15.35	16.66
Manoj K. [17]	48.33	15	18.33	16.66
Manoj B. [18]	58	15	10	17
Present study	66.66	12	6.66	14.66

Ginsberg observed the posterior condylar canal to be bilateral in 55.9% and unilateral in 17.6% [15].

Fig. 1: Measuring anteroposterior diameter

Fig. 3: Bilateral absence of posterior condylar canal

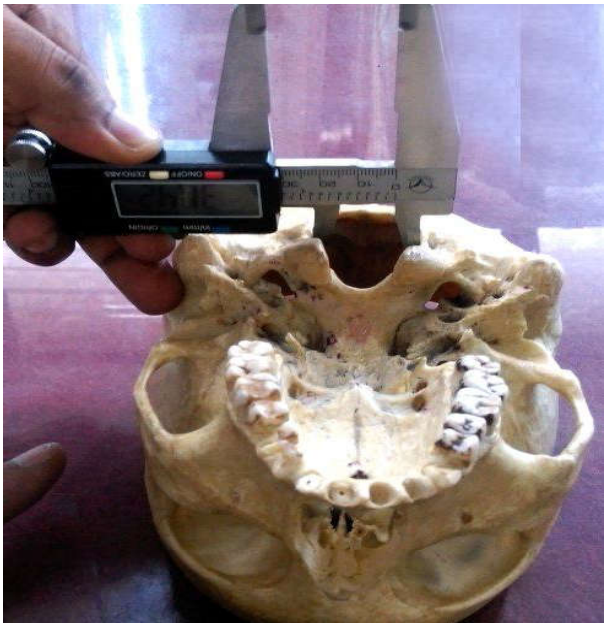

Fig. 2: Measuring transverse diameter

Fig. 4: Left unilateral posterior condylar canal

Discussion

The Foramen Magnum has raised interest in many fields of medicine as an important landmark of the base of the skull [6].

In addition to its significance for the surgery, the morphometry of FM medicolegally plays an important role in identification of unknown individuals in Forensic medicine [7].

Conclusion

Passage of vital structures and increasing use of skull base microsurgical approaches like far lateral and transcondylar approaches has made knowledge of foramen magnum very important. Morphometric analysis of foramen magnum plays an important role in transcondylar approach. This anatomic study describes geometric characteristics of foramen magnum and may serve as a standard reference for future. This study provide a baseline useful data that enable surgeons to perform effective and reliable surgery in FM region with maximum safety. The emissary veins are important agents to equalize intracranial pressure, acting as safety valves. The posterior condylar foramen serves as a communication between the intracranial and extracranial venous drainage. Posterior condylar foramen and posterior condylar emissary vein are important structure for posterolateral surgical approach to foramen magnum region. This study will be helpful to clinicians and surgeons dealing with the region of posterior cranial fossa before planning a surgery in the occipital condylar region.

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