MORPHOLOGICAL AND MORPHOMETRIC STUDY OF FORAMEN MAGNUM IN CADAVERIC SKULLS AND ITS CLINICAL IMPLICATIONS IN NORTHERN PAKISTANI POPULATION

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ABSTRACT

Aims and objectives: To study the different shapes of foramen magnum and to evaluate the anteroposterior, transverse diameters and foramen magnum index in adult male cadaveric skulls in northern Pakistani population.

Materials and Methods: A total of 47 human adult dry skulls from the bone banks of Anatomy Departments were examined and numbered. Different shapes of foramen magnum were classified. The anteroposterior and the transverse diameter were measured. From these dimensions the average foramen magnum index was calculated.

Results: In 25.5% the FM was noted to have egg shape, in 21.3% it was oval shape, in 17% was tetragonal, in 14.9% was pentagonal shape, in 10.6% it was hexagonal, in 6.4% it was round shape and in 4.3% of the total cases it was irregular shape. In 6 (12.8%) of the cases the occipital condyle was noted to protrude into the FM. The mean AP diameter was noted as 35.5 ± 3.4 and TD of the FM was noted as 31.9 ± 1.4 mm. The average FM index (AP divided by TD) was calculated as 1.12 + 0.11.

Conclusion: Normal ranges of various shapes and dimensions of Forman magnum were determined in this study. The data may be very helpful for the neurosurgeons and may also serve as a future reference for morphologists, anthropologists and clinical anatomists.

Key words: Foramen magnum, Anteroposterior diameter, Transverse diameter, Cadaveric skull Morphology, Morphometry, Foramen magnum index.

INTRODUCTION

Foramen magnum (FM) is the largest foramen in the posterior cranial fossa of the occipital bone. It has long antero-posterior diameter, it is wider behind than in front where it is intruded upon by the condyles. FM transmits the accessory nerves, the medulla oblongata and its membranes, the spinal arteries, the vertebral arteries, and the membrana tectoria and alar ligaments.[1]

The foramen magnum of the base of skull is a vital landmark in many fields of medicine. It is of particular interest due to its vital location because of its close relationship to important structures such as the brain above and the spinal cord below.[2] The size and shape of foramen magnum have significant differences amongst different populations.[3] It has also been reported that some correlation exists between the its shape and the origin of a person.

The dimensions of FM are clinically important as several important structures pass through it. These structures may become compressed as, in brain herniation[4,5], and FM achondroplasia[6]. In neurosurgery, the transcondylar method is frequently used in order to gain access to the structures that are located anteriorly to the cervico-medullary junction and the brainstem. It has been reported that anatomical knowledge of the condylar area is vital for this approach.[7]

Accordingly, calculation of the dimension of FM, in relation to hindbrain provides a sign for commencement and spread of Chiari I deformaty.[8]

Morphology of the FM plays a vital role in the pathophysiology of several ailments of the craniovertebral junction and the posterior cranial fossa. Narrowing of foramen magnum causes compression of brainstem resulting in respiratory problems, paresis of upper and lower extremity, hypo- or hypertonia, dysfunctions of lower cranial nerves, hyperreflexia, or clonus.[9-11]

Thus, to reach better diagnosis and treatment,

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a thorough anatomical knowledge of this region is imperative to the clinicians. The purpose of this study was to study different dimensions of FM in KPK population. The results could be helpful in better classification and management of diseases of this area and help as an anatomical reference in future.

MATERILAS AND METHODS

This study was conducted in Anatomy Department Khyber Girls Medical College (KGMC) Peshawar and Anatomy Department Khyber Medical College (KMC) Peshawar. Human adult dry skulls present in the bone banks were examined in this study. A total of 47 skulls of adult male were examined. Skulls without any gross bony abnormality were selected. Skulls were numbered and data was entered in the information sheet accordingly. The different shapes of FM were grouped as oval, round, egg, hexagonal, pentagonal, tetragonal, and irregular. In order to avoid observational bias, these shapes were determined by a three members team. The antero-posterior (AP) and transverse diameters (TD) of the FM were measured using digital Vernier calipers. The AP diameter was measured by measuring the distance between the ends of anterior and posterior border. The TD was measured by measuring the distance between the point of maximum on the right and left margins. The FM index was obtained by dividing AP by the TD. The data was analyzed and presented as mean + SD. Photographs were taken with Nikon D 3100.

RESULTS

The different shapes of foramen magnum observed in this study are given in figure 1. In 25.5% the FM was noted to have egg shape, in 21.3% it was oval shape, in 17% was tetragonal, in 14.9% was pentagonal shape, in 10.6% it was hexagonal, in 6.4% it was round shape and in 4.3% of the total cases it was irregular shape. The different shapes of foramen magnum and their percentages are shown in table 1. In 6 (12.8%) of the cases the occipital condyle was noted to protrude into the FM (Figure 2).

The mean AP diameter was noted as 35.5 ± 3.4 and TD of the FM was noted as 31.9 ± 1.4 mm (shown in figure 3). The average FM index (AP divided by TD) was calculated as 1.12 + 0.11. Different dimensions of foramen magnum are given in table 2.

DISCUSSION

Pathologies of the craniovertebral junctions and base of skull are fairly common. Anatomical and normal morphometric knowledge is vital for planning of the proper management. Differences in gender, races, physique, religions, geographical, and genetic factors have profound effect on normal variations. Although there are many studies in different countries on normal morphology and morphometry of foramen magnum, but very scarce data is available in Pakistan particular in Khyber Pakhtunkhwa.

Shape of FM

In present study 25.5% the FM was observed to have egg shape, in 21.3% it was oval shape, in 17% was

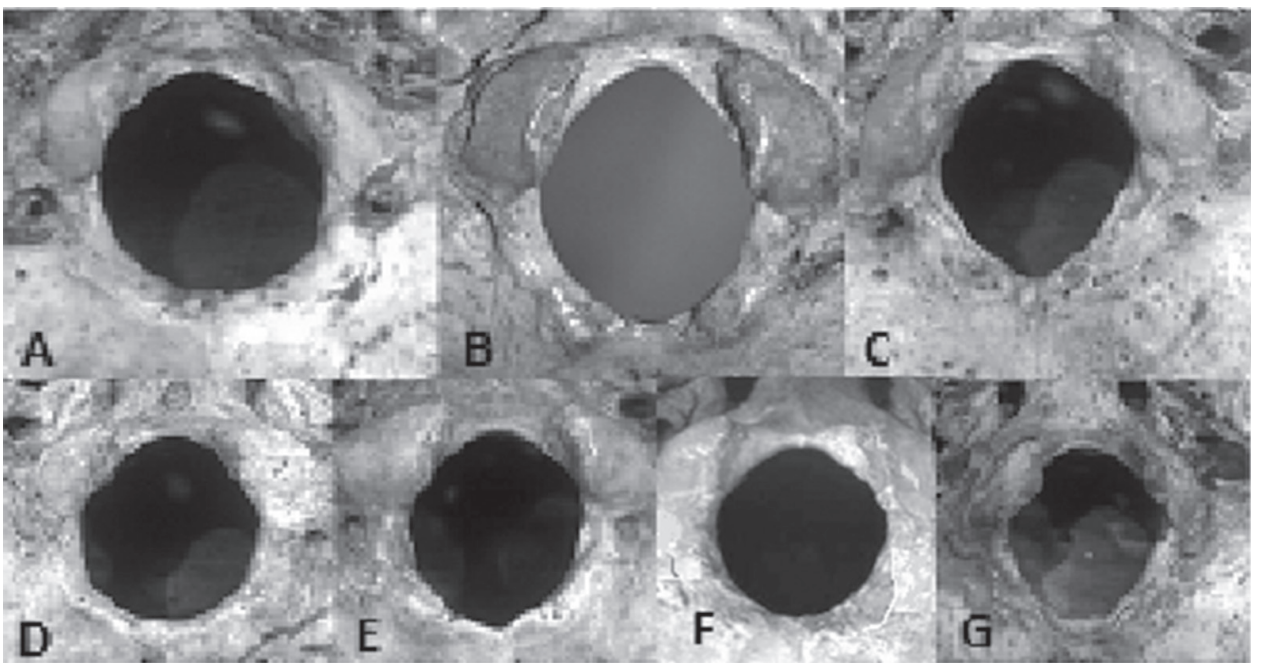

Figure 1: Showing different shapes of FM, A = Egg Shape B = oval, C = Tetragonal, D = Pentagonal, E =Hexagonal, F = Round, G = Irregular

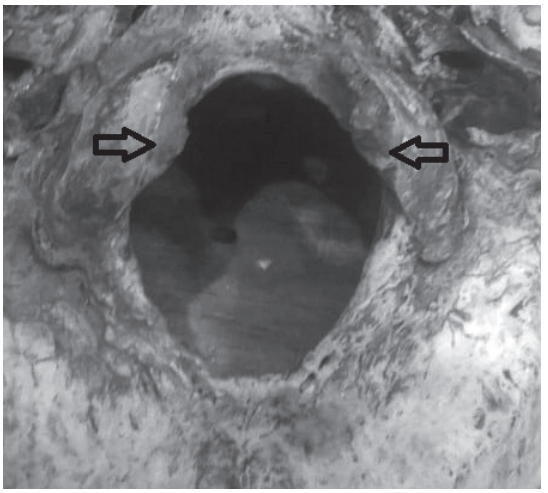

Figure 2: Arrows showing the occipital condyles protruding into FM

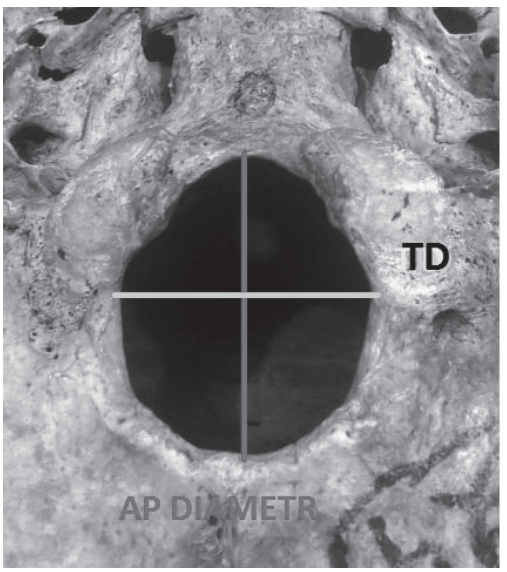

Figure 3: showing AP and TD of FM

Table 1: Various shapes of FM observed and their percentage (n = 47)

	Various shapes of FM	Number of cases	% Age
1	Egg shape	12	25.50
2	Oval shape	10	21.30
3	Tetragonal shape	08	17.00
4	Pentagonal shape	07	14.90
5	Hexagonal shape	05	10.60
6	Round shape	03	6.40
7	Irregular shape	02	4.30

Table 2: Dimensions of FM

	Mean	SD
AP Diameter	35.55	±3.44
Transverse diameter	31.96	±1.43
FM Index	1.12	±0.11

tetragonal, in 14.9% was pentagonal shape, in 10.6% it was hexagonal, in 6.4% it was round shape and in 4.3% of the total cases it was irregular shape. In a study performed by Zaidi and Dayal, the different shapes of FM observed were, oval shape in 64% hexagonal shape in 24.5%, pentagonal in 7.5%, irregular and round in 3.5% and 0.5% of the skulls respectively.[12]

In contrast Sindel et al. has reported oval foramen in only 18.9%, tetragonal in 49.4%, round in 15.8%, hexagonal in 5.3%, pentagonal in 4.2%, and irregular in 6.3% of the cases.[13] Murshed et al in their study on healthy individuals by examination of computer tomogram films has reported round shape in 21.8%, irregular in 20%, hexagonal in 17.2%, pentagonal in 13.6%, tetragonal in 12.7%, oval in 8.1%, and egg-shaped in 6.3% of the cases.[14] Chethan P. et al has reported round shape in 22.6%, oval in 15.1%, egg shape in 18.9%, tetragonal in 18.9%, irregular in 15.1%, hexagonal in 5.6% and pentagonal in 3.8% of the total cases.[15]

Dimensions of FM

In our study the mean AP diameter of the FM was noted as 35.5 ± 3.4 and TD was noted as 31.9 ± 1.4 mm. The mean FM index was noted as 1.12 + 0.11. The anatomic diameters reported by different studies were about 35 mm for the AP and 30 mm for the TD[16,17]. Zaragoza[18] has reported mean values of 38 mm and 28 mm, whereas the radiologic values obtained by Wackenheim[19] were 35 mm and 30 mm for the AP and the TD respectively. Another study by Tubbs et al. has reported 31 mm for the AP and 27 mm for the TD.[20] But our findings are comparable to that of Murshed et al[14] 35.9 ± 3.3 mm for AP and 30.4 ± 2.6 mm for the TD, Catalina-Herrera et al[21] (35.2 mm and 30.3 mm), and Schmeltzer et al[22] with 35 mm and 30 mm for the AP and TD respectively.

FM Index

The mean FM index in this study was recorded as 1.12 + 0.11 mm. protrusion of the occipital condyle into the FM was observed in 8 (17%) of the cases. A study by Chethan P. et al[15] has reported the mean FM index as 1.2 ± 0.1 mm. Testut and Latarjet argued that wide, sagittally disposed and medially bulging occipital condyles along with a FM index greater than 1.2 will require severe bone cutting during surgeries.[17] A study conducted on Nepalese population in order to find out the sexual dimorphism of the FM by using three-dimensional CT scan has reported increased mean AP, TD

and surface area in males as compared to females.[17] Gocmen Mas et al. in their study by using the Teixeria, Radinsky, and Cavalieri formulae have reported a significant difference in the mean surface area of FM.[24]

Clinical implications of shape and dimensions of FM

The AP and the TD have been observed to be independent risk factors in patients with carniocervical anomalies.[25-28] As compared to normal people, the FM of patients with Chiari I and II deformities has been observed to have greater configurations.[29] A study on children with confirmed Chiari I deformity, has shown markedly larger TD of the FM, as compared to the control group.[30] Patients with diseases which are associated with narrowing of FM such as Jeune's asphyxiating thoracic dystrophy, craniometaphyseal dysplasia and Marchesani's disorder,[31-33] and those with Beare-Stevenson syndrome which is characterized by hypertrophied bony margins, could develop more severe and early symptoms.[34]

CONCLUSION

The present study has presented the normal ranges of various dimensions and shapes of FM in adult male skulls for northern Pakistani population. The data may be valuable to the neurosurgeons in examining the morphological anatomy of craniovertebral junction. These findings may also serve as a future reference for morphologists, anthropologists and clinical anatomists.

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