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Morphometric Analysis of Sexual Dimorphism of Foramen Magnum in a Bangladeshi Population

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Abstract

At the base of skull in occipital bone, there is a large oval opening called the foramen magnum through which the cranial cavity communites with the vertebral canal. The squamous part of the occipital bone makes up the posterior portion of foramen magnum, while the basilar part makes up the anterior portion. A cross-sectional, analytical study was conducted in the Department of Anatomy, Dhaka Medical College, Dhaka, Bangladesh, from January to December of 2022, to observe sexual dimorphism of foramen magnum in a Bangladeshi population. One hundred and twenty dry adult human occipital bone was collected for the measurement of the foramen magnum. We adopted convenient purposive sampling technique. However, occipital bone having fractured or if a part of occipital bone was missing or incomplete occipital bone was excluded to construct standard measurement. Measurements were done by using digital Vernier slide calipers. The length of the foramen magnum in male was greater than that of female; the difference was statistically significant (34.47±0.84mm vs. 32.83±0.96mm; p<0.001). The width of the foramen magnum was greater in male than that of female; the difference was statistically significant (29.01±1.23mm vs. 27.43±0.82mm; p<0.001).

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Introduction

The word ‘occipital’ comes from the Latin word ‘occiput’ which means the back of the head. The occipital bone is a flat bone and the main bone of the occiput. It is trapezoid in shape and curved on itself like a shallow dish. The occipital bone overlies the occipital lobes of the cerebrum). At the base of skull in the occipital bone, there is a large oval opening called the foramen magnum through which the cranial cavity communicates with the vertebral canal. It is composed of four parts: squamous part, basilar part and two lateral parts.[1] It is composed of four parts: squamous part, basilar part and two lateral parts. This is a wide communication between posterior cranial fossa and vertebral canal.[1,2] The foramen is divided by alar ligaments into anterior small and posterior large compartments. Structures passing through anteriorly from before backward are: apical ligament of dens and membrane tectoria, both attached to the upper surface of basiocciput. Hence, the anterior compartment may be called osseo-ligamentous compartment.[1,3] Structures passing through posterior compartment are: lower end of medulla oblongata

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and meninges, fourth part of vertebral arteries, spinal roots of accessory nerves, anterior and posterior spinal arteries.[1,3] The anterior atlanto-occipital membrane is attached to its anterior margin and posterior atlanto-occipital membrane is its posterior margin. The midpoint of the anterior margin of foramen is known as 'basion' and midpoint of posterior margin is 'opisthion'.[1,3] Configuration and size of the foramen magnum and posterior fossa plays an important role in the pathophysiology of various disorders of the posterior fossa and craniovertebral junction.[1] Besides, estimating sex from skeletal remains involves the identification and evaluation of characteristics that tend to show differences between male and female skeletons. Such characteristics are variably expressed throughout the skeleton including base of the skull (also foramen magnum).[4] The present study aims to observe sexual dimorphism of foramen magnum in a Bangladeshi population.

Methods

This cross-sectional, analytical study was conducted in the Department of Anatomy, Dhaka Medical College, Dhaka, Bangladesh, from January to December of 2022. One hundred and twenty dry adult human occipital bone was collected for the measurement of the foramen magnum. We adopted convenient purposive sampling technique. However, occipital bone having fracture or if a part of occipital bone was missing or incomplete occipital bone was excluded to construct standard measurement. Then the sex of the collected human adult occipital bones were determined by morphological criteria and discriminant function analysis equation.[5] Measurements were done by using digital Vernier slide calipers. To measure the length of the foramen magnum, one dot was given at the basion which was marked by A and another dot was given at the opisthion which was marked by B. Then the distance between A and B was measured with the help of digital slide calliper in mm (Fig. 1).[4] To measure the width of foramen magnum, one dot was given at the left lateral margin of the foramen magnum at the point of greatest lateral curvature which was marked by A. Another dot was given at the right lateral margin of foramen magnum at the point of its greatest lateral curvature which was marked by B. Then the distance between A and B was measured as width of the foramen magnum with the help of digital slide calliper in mm (Fig. 2).[4]

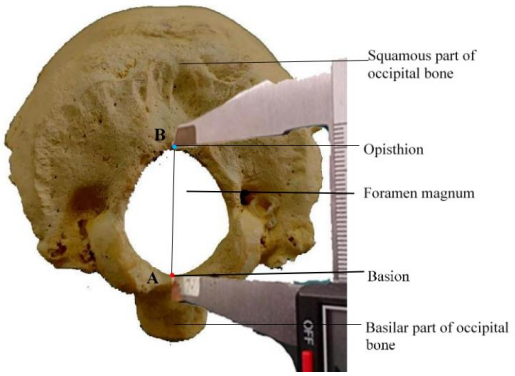

Fig. 1: Measurement of length of foramen magnum of occipital bone (posterior inferior view); A=Basion; B=Opisthion; AB=length of the foramen magnum).

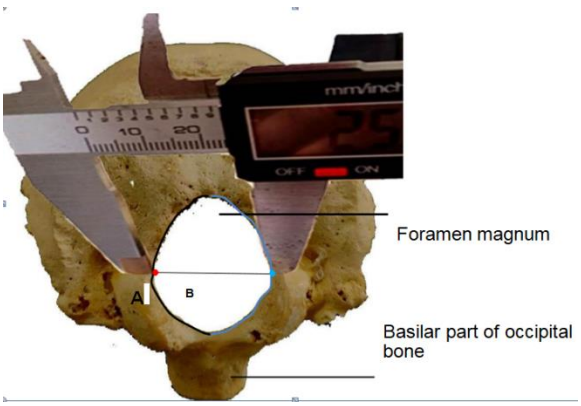

Fig. 2: Measurement of width of the foramen magnum of occipital bone (posterior inferior view); A=greatest lateral curvature of left lateral margin; B=greatest lateral curvature of right lateral margin; AB=width of the foramen magnum.

After the collection of data, statistical analysis was done by using Statistical Package for Social Sciences (SPSS) version 25.0 for Windows. Comparison between male and female were done by using unpaired Student's t-test. A p-value <0.05 was considered statistically significant. Observations and results of this study were described in tables.

The study was approved by the Ethical Committee of Dhaka Medical College, Dhaka, Bangladesh.

Results

The mean length of foramen magnum was recorded 34.47±0.84mm in male and 32.83±0.96mm in female. The range of length of foramen magnum was from 31.90 to 35.91mm in male and from 30.61 to 34.88mm in female. The length of the foramen magnum in male was greater than that of female; the difference was statistically significant (p<0.001). The mean width of foramen magnum was 29.01±1.23mm in male, 27.43±0.82mm in female. The range of width of foramen magnum was from 23.53 to 31.24mm and from 26.07 to 28.79mm in male and female respectively. The width of the foramen magnum in male was greater than that of female; the difference was statistically significant (p<0.001) (Table-I).

Table-I: Maximum length and width of foramen magnum in male and female (N=120)

Variables	Male (n=72) Mean±SD (Range)	Female (n=48) Mean±SD (Range)	p-value
Maximum length (in mm)	37.47±0.84 (31.90–35.91)	32.83±0.96 (30.61–34.88)	<0.001[S]
Width (in mm)	29.01±1.23 (23.53–31.24)	27.43±0.82 (26.07–28.79)	<0.001[S]

Comparison between sex was done by unpaired Student's t-test; S=significant.

Discussion

The occipital bone forms the base of the cranium. It articulates with the 1st cervical vertebrae that forms an atlanto-occipital joint.[1,2] Dimorphism in the foramen magnum (in occipital bone) was examined in this study. Bangladeshis are mixed race of Negroid, Caucasoid and Mongoloid. The findings of this study was statistically analyzed and revealed important information about morphometric variations in male and female. A comparative discussion of the results with that of different researchers is mentioned below:

The mean length of foramen magnum was recorded 34.47±0.84 mm in male and 32.83±0.96 mm in female in our study. The length of the foramen magnum was greater in male than female (p<0.001). Berge & Bergmann found the mean length of foramen magnum 33.4 mm and 33.1 mm in male and female.[6] Deshpande *et al*. also found 33 mm in both males and females in Karnataka region of India.[7] Those findings were almost similar to that of the present study. Manoel *et al*. found that mean antero-posterior diameter of foramen magnum was 35.7 mm and 35.1 mm in male and female respectively in skulls of Brazilian individuals.[8] El-Barrany *et al.* reported that the lengths of foramen magnum were 38.54±3.22 mm and 37.05±2.99 in male and female respectively in Sudanese population.[9] However, those values are slightly higher than that of our study. Erdil *et al.* reported the mean antero-posterior diameter 30.75 mm and 29.98 mm in male and female respectively in Turkish population.[10] Those values are slightly lower than that of our results.

The mean width of the foramen magnum was 29.01±1.23 mm in male and 27.43±0.82 mm in female. The width of the foramen magnum was greater in male than that of female (p<0.001). Berge

& Bergmann found the mean width of foramen magnum 28.5 mm and 27.3 mm in male and female respectively.[6] Deshpande *et al.* found 27 mm in males and 26 mm in females.[7] Those results are nearly similar to the findings of the present study. El-Barrany *et al.* reported that the widths of foramen magnum were 31.57±2.62 mm and 30.33±2.46 mm in male and female respectively.[9] Erdil *et al.* found the mean transverse diameter in male and female 36.95 mm and 34.41 mm respectively.[10] However, the values of the present study are slightly lower than that of those findings. The dissimilarities found in comparison among different study findings are attributable to racial difference and difference in methodical approach (e.g., adopting CT scan or other imaging studies). Several factors may influence sexual dimorphism, e.g., genetic factors, nutrition, health status.[11]

Conclusion

The occipital dimension shows significant sexual dimorphism in the studied adult population. Statistically significant difference was found in the variables of length and width of foramen magnum. The value of length and width of foramen magnum were higher in male than female in a Bangladeshi population we studied. The results of the present study will be useful to neurosurgeons, orthopedicians and clinical anatomists. However, further studies into different geographical regions and ethnic origins are recommended to have population specific data for our country estimating sexual dimorphism in large scale.

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