



A STUDY OF MORPHOMETRIC MEASUREMENTS OF FORAMEN MAGNUM IN MALE ADULT DRY SKULLS.

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ABSTRACT **Background:** The Foramen Magnum is an important landmark of the skull base and is of particular interest for anthropology, anatomy, forensic medicine and other medical fields. The foramen magnum allows the passage of neurovascular structures so the Configuration and size of the Foramen Magnum play an important role in the pathophysiology of various disorders of the cranio vertebral junction. **Aim:** This original study helps in giving the standard information for anthropologists, surgeons, forensic experts, Denstirry and also for sex determination. **Materials And Method:** The present study was conducted in 58 human dry male skulls in different medical institutes of Hyderabad, Telangana. Foramen magnum shapes were documented visually, Vernier calipers was used to record the Transverse and Anteroposterior diameter of foramen magnum in male skulls. **Results:** The average APD of FM was found to be 34.79 mm in males. The average TD of FM was found to be 29 mm in males. The shape of foramen magnum is tetragonal in 27.5% of dry skulls and only 5.2 % was found to be round in shape. **Conclusion:** By taking the average dimensions of anterioposterior and transverse diameters of Foramen magnum it was found that these measurements play a crucial role in determining the sex of unknown human dry skull and also helps in giving the standard information for anthropologists, surgeons and forensic experts.

KEYWORDS : Foramen magnum, anteroposterior diameter, transverse diameter, shape of Foramen magnum, vernier calipers.

INTRODUCTION

Gender determination in unidentified skeletons is not always an easily and correctly performed procedure. In explosions, warfare and other mass disasters, identification may be extremely complicated because of skeletal fragmentation [1].

The FM is an important landmark of the skull base and is of particular interest for anthropology, anatomy, forensic medicine and other medical fields.

The clinical manifestations of FM stenosis include respiratory failure, vomiting, impotence, cranial nerves palsy, cerebellar symptoms/ ataxia, central cord syndrome, bulbar symptoms, headache, motor neurological deficits [6,9].

Some diseases involving this area such as meningiomas, neurofibromas, schwannomas, astrocytomas, chordomas (clivus), ependymoma, Arnold-Chiari type I and II malformations, hydatid cysts, Beare-Stevenson syndrome and Marchesani syndrome have been reported [10].

The determination of gender in human skulls is based on morphological differences, mainly on the size and strength of certain structures [12], which may be characteristics of each population that are influenced by genetic, environmental, and socioeconomic factors [13].

Recent studies states that morphometry is a fast and efficient method for the evaluation of morphological characteristics, such as ethnicity, gender, age, genetic factors, dietary habits, and regional variations which can alter the shape and size of bone structures.

The present study was conducted to give standard information of the parameters of foramen magnum which will be helpful to identify the sex from unknown skeletal remains and also in different fields of science which includes Anatomy, surgery, forensic, anthropology and Denstirry.

AIMS & OBJECTIVES

- To document and analyze the foramen magnum shapes.
- To determine the average dimensions of the Foramen Magnum in dry skulls.
- To record the following parameters in skulls.
 - Transverse diameter of foramen magnum.
 - Anteroposterior diameter of foramen magnum.

Material:

The present study was carried out on human dried sex determined male

skulls from the department of Anatomy in Kamineni Institute of Medical Sciences, Narketpally. Osmania Medical College, Hyderabad. Gandhi Medical College, Hyderabad. Army College of Dental Sciences, Hyderabad. Medicity Institute of Medical Sciences, Hyderabad. Nallamalla Reddy Institute of Medical Sciences, Hyderabad. Durghabhai Deshmukh college of physiotherapy, Hyderabad and the statistical Analysis was done in the department of Anatomy, Kamineni Institute of Medical Sciences, Narketpally.

Method:

The skull bone sex was determined by using standard morphological parameters and only male skulls were selected in this particular study.

By using vernier calliper, anterio posterior diameter of foramen magnum and transverse diameter of foramen magnum were taken.

Shape of foramen magnum was determined by taking the individual photograph.

Mean values of these parameters were recorded.

Anterio posterior Diameter (APD) of the foramen magnum:

It is the distance between opisthion to basion along the mid sagittal plane (Figure 2).

Transverse Diameter (TD) of foramen magnum:

It is the maximum distance along the transverse plane (Figure 3). Differences in length and width of foramen magnum were assessed by t-test.

Shape of foramen magnum:

Skull exhibits various shapes. The different shapes of FM were macroscopically noted and classified as oval, round, egg, tetragonal, pentagonal, hexagonal and irregular shapes (Figure 1).

Statistical Analysis: The data were submitted to statistical analysis (mean $\pm$ standard error), Student t test, with significance level of 5%. The Statistical analysis for the APD and TD of the foramen magnum by means of the SPSS statistics v19 (software) used.

Inclusion And Exclusion Criteria.

- Skulls with good conditions with gender identified were included for study.
- The skull samples which are damaged, incomplete or without identification were excluded from study.

The Various Shapes Of FM are:

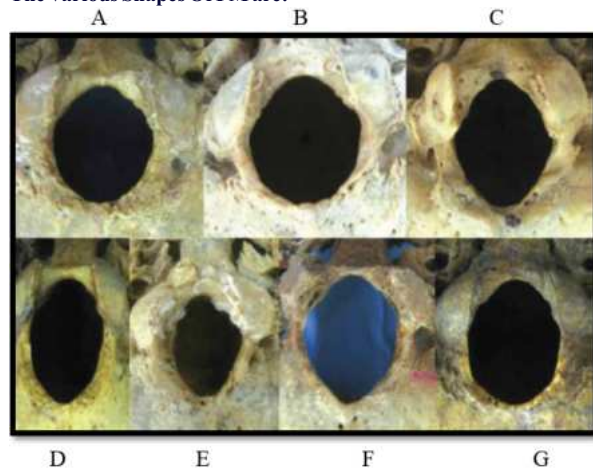


Figure 1: Showing the morphological variants of the shapes of foramen magnum (A- round shape; B- egg shape; C- tetragonal; D- oval; E- irregular; F- hexagonal and G- pentagonal shape).



Figure 2 : Method Used For Measuring Anterioposterior Diameter Of Foramen Magnum



Figure 3: Method Used For Measuring Transverse Diameter Of Foramen Magnum

OBSERVATIONSAND RESULTS.

The average APD of FM was found to be 34.79 mm in males. The average TD of FM was found to be 29 mm in males. 27.5% of shape of FM showed Tetragonal shape.

The following results were presented in the Table 1 and Table 2 below.

Table No.-:1 Morphological & Morphometric Data of FM In Male Skulls (in mm)

S. No	Shape of FM	Transverse diameter of FM	Anterioposterior diameter of FM
1	Tetragonal	28	34
2	Irregular	31	34
3	Oval	27	34
4	Hexagonal	30	36
5	Oval	30	37

6	Irregular	31	32
7	Oval	30	39
8	Oval	27	34
9	Oval	28	35
10	Tetragonal	29	34
11	Tetragonal	28	37
12	Oval	29	36
13	Irregular	28	35
14	Hexagonal	30	33
15	Hexagonal	29	34
16	Oval	27	35
17	Oval	30	37.5
18	Oval	28	34
19	Oval	30	31
20	Pentagonal	30	37.5
21	Tetragonal	27	33
22	Tetragonal	35	37.5
23	Tetragonal	31	35
24	Oval	28.5	37
25	Hexagonal	30	36
26	Tetragonal	29	35
27	Oval	27	37
28	Oval	30	36
29	Tetragonal	30	32.5
30	Oval	28	34.5
31	Egg	32	31
32	Tetragonal	30	34
33	Pentagonal	30	33
34	Irregular	30	36.5
35	Irregular	30	33
36	Egg	29.5	35
37	Egg	27.5	33.5
38	Egg	30	35
39	Egg	29	35
40	Round	26	34
41	Egg	27	36
42	Tetragonal	28.5	33
43	Tetragonal	31.5	34.5
44	Irregular	30	36.5
45	Pentagonal	25.5	34
46	Hexagonal	28	34
47	Irregular	28.5	34
48	Tetragonal	31	33.5
49	Tetragonal	31	32.5
50	Irregular	30	36
51	Pentagonal	28	35
52	Hexagonal	30	37
53	Irregular	28	34
54	Round	26.5	35
55	Round	25.5	37
56	Round	28	35
57	Tetragonal	29	34.5
58	Tetragonal	27.5	34

Table No: 2 Mean Values And Standard Deviation Of AP And TD Of Foramen Magnum And Shape Of Foramen Magnum In Males

Value	AP diameter of foramen magnum (in mm)	TD of foramen magnum (in mm)
Minimum Value	31	25.5
Maximum Value	39	31.5
MEAN Value	34.79	29
Standard deviation	1.67	1.7
Shape of foramen magnum in Males		
Shape of FM	Number (58)	Percentage (%)
Tetragonal	16	27.5 %
Oval	14	24 %
Irregular	9	15.5 %
Egg	6	10.4 %
Hexagonal	6	10.4 %
Pentagonal	4	7%
Round	3	5.2 %

DISCUSSION:

Identification of skeletal and decomposing human remains is one of the most difficult skills in forensic medicine. Sex determination is also an important problem in the identification. If almost all the bones composing the skeleton are present, sex estimation is not difficult. When the skeleton exists completely, sex can be determined with 100% accuracy. This estimation rate is 98% in the existence of the pelvis and cranium, 95% with only the pelvis or the pelvis and long bones and 80–90% with only the long bones.

According to Enlow and Has (2006), this difference is related to the fact that the main neurovascular bundle such as the cervical spinal cord, vertebral arteries, nerves and meninges pass through the skull base. Thus, the area of foramen magnum is larger in males due to larger structure of skeletal muscle in men.

Zaidi and Dayal [3], observed the oval shape FM in 64% of their specimens. However, Sindel et al. [32] observed the oval foramen in only 18.9% of the skulls and in 81.1% of the cases the shapes of the foramina were of different shapes.

According to Murshed et al. [29], the FM was found to be oval in 8.1%, egg-shaped in 6.3%, round in 21.8%, tetragonal in 12.7%, pentagonal in 13.6%, hexagonal in 17.2%, irregular in 10.9% of the cases. Their study involved the examination of computer tomogram films in the healthy individuals.

Chethan P. et al was observed to have round shape in 12 cases (22.6%), egg shape in 10 (18.9%), tetragonal in 10 (18.9%), oval in 8 (15.1%), irregular in 8 (15.1%), hexagonal in 3 (5.6%) and pentagonal in 2 (3.8%) of the cases.

In the present study, the FM was observed to have round shape in 5.2%, egg shape in 10.4%, tetragonal in 27.5%, oval in 24%, irregular in 15.5%, hexagonal in 10.4% and pentagonal in 7% of the cases.

The difference in shapes of the FM from various reports indicates racial variability among the morphology. The present study agrees with Murshed et al. [6] as in both these studies the round shape was the most common type.

In the skulls sample analyzed, a significant sexual dimorphism in the foramen magnum dimensions was observed. The accuracy in the classification is lower than those reported for majority of sexual dimorphism morphological indicators for the occipital bone. Hence, the indexes and tables of the expected range of foramen magnum dimensions in skulls of men and women should be used only as a first approximation to the diagnosis of sex.

The following Table no: 3 presents comparative analysis of foramen magnum with earlier studies.

Table No:3 Comparative Study Of Morphometric FM With Earlier Studies Of Male Dry Skulls

S. No	Author	Male			
		Mean-APD in mm	SD-APD	Mean-TD in mm	SD-TD
1	Routel et al (1984)	35.5	2.8	29.6	1.9
2	Murshed et al (2003)	37.2	3.2	31.6	2.99
3	Catalina (1987)	36.2	2.60	31.1	2.60
4	Gapert et al (2008)	35.91	2.41	30.51	2.60
5	Suazo et al (2009)	36.5	2.6	30.6	2.5
6	Ukoh U et al (2011)	36.26	2.3	30.09	2.5
7	Babu Raghavendra Y.P. et al (2011)	36.40	3.27	32.93	2.35
8	Singh & Talwar (2013)	33.54	2.80	27.77	2.10
9	Arjun kumar et al (2019)	34.8	2.25	28.17	2.85
10	Present study, (2024)	34.79	1.67	29	1.7

Study done by the Routel et al (1984) on dry human skulls showed the FM APD to be 35.5 ± 2.8 in males and the FM TD to be 29.6 ± 1.9 in males. These values are slightly higher than our findings.

Catalina (1987) found the FM APD to be 36.2 ± 2.60 while the FM TD values to be 31.1 ± 2.60 in males. All measurements are significantly higher than our findings.

Murshed et al (2003) measured the morphometric dimensions of FM. He found the FM APD to be 37.2 ± 3.2 and the FM TD to be 31.6 ± 2.99 in males. FM APD values and FM TD value in male is slightly higher than our findings.

Gapert et al (2008) who worked on FM found the FM APD to be 35.91 ± 2.41 and the FM TD to be 30.51 ± 2.60 in males. FM TD values and FM APD values are higher when compared with our findings.

Suazo et al in (2009) found the FM APD to be 36.5 ± 2.6 whereas the FM TD to be 30.6 ± 2.5 in males. FM APD and FM TD in males were significantly higher than our findings.

Ukoh U et al in (2011) studied the FM dimensions. He found the FM APD to be 36.26 ± 2.3 and the FM TD values to be 30.09 ± 2.5 in males respectively. All the values were higher than our findings.

According to Babu Raghavendra Y.P. et al (2011) the FM APD values to be 36.40 ± 3.27 while the FM TD values to be 32.93 ± 2.35 in males. FM TD values and the FM APD in males were higher than our study.

Arjun kumar et al in (2019) found FM APD values 34.8 ± 2.25 and FM TD values 28.17 ± 2.85 in males which is very much near to the present study.

CONCLUSION

The antero posterior diameter and transverse diameter of FM have been measured and the variability in shapes of FM have been studied in 58 male human dry skulls in the present study. The average APD of FM was found to be 34.79 mm in males. The average TD of FM was found to be 29 mm in males. 27.5% of shape of FM showed Tetragonal shape. This study has proven that FM AP > FM TD in adult male skulls. It is also concluded that variation in the FM shape should be taken into consideration during the clinical and radiological diagnostic procedures and the surgical approach.

Conflict Of Interests: None

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List Of Abbreviations: FM – Foramen magnum, FM APD- Foramen magnum anteroposterior diameter, FM TD – Foramen magnum transverse diameter.

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