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Morphological And Morphometric Study Of Foramen Magnum In Dry Human Skulls

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Abstract:
Background: *The Foramen magnum is an important landmark present at the base of the skull. The vital structures passing through it are medulla oblongata, meninges, anterior and posterior spinal arteries, vertebral arteries, and spinal accessory nerves. The foramen magnum dimensions are important because there may be compression of the structures during meningiomas, achondroplasia, and herniation. Hence thorough knowledge of foramen magnum is required. The development of a particular shape of the foramen magnum is explained based on embryology data. It may be caused by the ossification of primordial cranial residues which join the enchondral ossification points in different locations, resulting in different shapes. The irregular shape is intensified by developmental anomalies of bone and soft tissues. Due to the high chance of morbidity and mortality during various surgical procedures at the base of the skull, this area has higher clinical importance.*
Materials and Methods*: 35 Dried adult human skull base obtained from the Department of Anatomy of R.N.T Medical College, Udaipur, Rajasthan. All adult skulls were observed from the outer side at their base by the naked eye.*
Results: *The shape of the foramen magnum in dry skulls was oval- 42.85%, round- 22.85%, tetragonal-11.43%, hexagonal -8.57%, irregular-5.71%, egg shape-5.71% and pentagonal-2.85%. The mean A-P and transverse diameter of the foramen magnum were determined 33.71mm, and 29.74mm respectively. The mean foramen index ~~and~~was 88.22 and the mean foramen magnum area was 751.81mm ^{2}.*
Conclusion:*Inferences of the present study in the form of variation in shapes and morphometry of foramen magnum will be helpful to neurosurgeons, radiologists, orthopedics, anthropologists, otorhinolaryngologists, forensic experts, and anatomists.*
Key Word*:Human skull, shape, foramen magnum, meningioma, achondroplasia.*

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I. Introduction

The foramen magnum represents the largest opening of the skull. The Foramen magnum is a clinically important landmark due to its close association with the brain stem and spinal cord. Besides meningiomas, herniation, and achondroplasia, it is also required to determine some malformations such as Arnold Chiari syndrome, in which there is an expansion of transverse diameter. The spinal cord and its membranes exit from this opening present in the occipital bone of the skull. The other structures passing through it are the vertebral artery, anterior and posterior spinal arteries, spinal accessory nerve, tectorial membrane, and alar ligaments which connect the dens of the axis with the occipital bone. [1] Foramen magnum is a fundamental component of studies on a skull in particular interest for anthropology, anatomy, orthopedists, forensic medicine, and other medical sciences. Achondroplasia is a genetic disorder resulting in dwarfism and abnormal endochondral bone formation at the base of the skull, that leads to a narrow cervical spinal canal and foramen magnum stenosis. Clinical presentation of a patient with constant brainstem compression due to stenosed foramen magnum and related structures are respiratory problems, lower cranial nerve disorders, upper and lower extremity lameness, increased or decreased muscle tone, and general motor development delay. [2] Other malformations related to the foramen magnum are abnormal coaxial angle, hypoplasia of the posterior cranial fossa, and platybasia i.e. abnormal flattening of the skull base. These abnormalities predisposed to herniation of the cerebellar tonsils into the foramen magnum can block blood and CSF flow between the cranial cavity and spinal canal leading to hydrocephalus. [2] The transcondylar approach is a skull-base technique that enables neurosurgeons to access the brainstem and craniovertebral region with minimum retraction. Knowledge of the bony anatomy of this region is essential for this approach.

II. Material And Methods

35 dried human skull bases were obtained from the Department of Anatomy, RNT Medical College, Udaipur, Rajasthan. All adult skulls were observed from the outer side at their base by the naked eye. The age and sex of the skulls were unknown. Original human skull bases were included in the study. The Specimens in which the foramen magnum was broken were excluded from the study. Morphology and morphometry of foramen magnum was studied. . The various parameters measured were as follows:

1. Anteroposterior diameter from basion to opisthion
2. Transverse diameter (TD) maximum diameter in the transverse plane.
3. Area of foramen magnum - $1/4 \times \pi \times Td \times APd$
4. Foramen magnum index - $(Td/AP\ d) \times 100$
5. Shape of foramen magnum – oval, round, and egg-shaped pentagonal, tetragonal, hexagonal, and irregular

III. Results

The foramen magnum in which both upper and lower ends were curved with anteroposterior diameter greater than transverse diameter were classified as oval.The FM with one end tapered and the other end curved along with a.p diameter greater than transverse were termed as Egg shape.The FM with almost equal transverse and anteroposterior diameters were termed as round. FM with four-sided shapes was called Tetragonal. The FM with five or six-sided shapes were termed Tetragonal and Hexagonal respectively. The leftover skulls were classified as Irregular shapes

Table no1: Showing the frequency and percentage (%) of various shapes of FM in present study

S.N	Shapes of foramen magnum	No. of specimens (out of total 35)	Percentage
1	Oval	15	42.85%
2	Round	8	22.85%
3	Egg-shape	2	5.71%
4	Tetragonal	4	11.43%
5	Pentagonal	1	2.85%
6	Hexagonal	3	8.57%
7	Irregular	2	5.71%

Table 2: Showing comparision of morphometric data of FM with previous reports.

PARAMETER	**Present study**	**Anshu et al**	**Dalvinder et al**	**Sharma et al**	**Rajkumar et al**	**Singh et al**
ANTEROPOSTERIOR DIAMETER(mm)	**33.71**	**34.44**	**33.57 +_2.82**	**38.76**	**33.98 +2.75**	**33.76+2.18**
TRANSVERSE DIAMETER (mm)	**29.74**	**30.46**	**27.49 +_2.61**	**33.44**	**28.16+2.16**	**28.09+1.92**
FORAMEN MAGNUM INDEX	**88.22**	**88.44**	**82.09 +_7.04**	**87.68**	**83.14+6.33**	**84.65+6.32**
FORAMEN MAGNUM AREA(mm^2)	**751.81**	**745.72**	**728 .12 + _ 112.98**	**970.57**	**754.38+105.16**	**834.45+75.79**

IV.Discussion

Table no 3: Showing comparision of percentage (%) of different shapes of FM with previous reports.

AUTHOR	YEAR	POPULATION(N)	ROUND	OVAL	EGG-SHAPE	TETRA GONAL	PENTA GONAL	HEXAG ONAL	IRREGULAR
Anshu et al	2019	Chandigarh (50)	2	8	3	9	2	23	3
Dalvinder et al	2019	North India (84)	26.19	29.76	10.71	16.67	4.76	5.95	5.95
Sharma et al	2015	Tundla (50)	22	16	16	12	8	8	18
Fathima et al	2016	Chennai (53)	13	26	36	-	4	21	-
Rajkumar et al	2017	Rajasthan (298)	24.83	66	-	3.35	2.68	4.02	-
Veeramani et al	2018	Puducherry (100)	15	6	12	11	3	21	32
Arora et al	2017	Bareily (40)	40	60	-	-	-	-	-
Singh et al	2017	Varanasi (100)	20	34	-	16	4	18	8
Mishra et al	2018	Lucknow (71)	30.9	37.8	-	7.04	7.04	11.2	9.85
Devesh et al	2019	Rajasthan (75)	14.67	22.67	12	14.67	9.33	16	10.67
Present study	**2023**	**Rajasthan (35)**	**22.85**	**42.85**	**5.71**	**11.53**	**2.85**	**8.57**	**5.71**

In the present study oval -shaped foramen magnum was the commonest shape which is comparable to the findings of Dalvinder et al i.e 29.76 %, Devesh et al 22.67 %, Anshu et al i.e 8 %, Mishra et al i.e 37.28%, Arora et al i.e 60 %.In this study oval shaped foramen magnum was 42.87 % contrast to Arora et al being the highest i.e 60%, and the least was in Veeramani et al i.e. 6%.The mean anteroposterior diameter was 33.71 mm, comparable to Dalvinder et al i.e 33.57mm. The mean transverse diameter in the present study was 29.74mm which was similar to Anshu et al i.e 30.46mmThe foramen magnum index was 88.22 which is similar to Anshu et al and Sharma et al being 88.44, 87.68 respectively. The foramen magnum index was lower in the Dalvinder et al study i.e. 82.09. The highest area of foramen magnum reported was by Sharma et al i.e. 970.57 mm^2 and the least by Dalvinder et al i.e. 728.12 mm^2.The area obtained in the present study was 751.81mm^2 comparable to Anshu et al area i.e. 745.72mm^2. The study of the shape and size of the foramen magnum is crucial to determine pathological changes caused by diseases such as achondroplasia, occipital vertebra, basilar invagination, condylar hypoplasia, atlas assimilation, thoracic dystrophy, marchesani syndrome, meningioma, plagiocephaly, and Jeune asphyxiating. The difficulty of bony resection during surgery is directly proportionate to the size of the foramen magnum.[3]

V.Conclusion

The analysis of various shapes of foramen magnum is of utmost importance, as the various surgical and diagnostic procedures have their limitation. this data obtained may serve as a useful guide to neurosurgeons, radiologists, orthopedists, anthropologists, anatomists, and forensic experts. When different studies on various ethnic groups are compared it helps in identifying different races. The variation in shapes and sizes has become significant because of newer imaging techniques such as computed tomography and magnetic resonance imaging in the field of diagnostic medicine.

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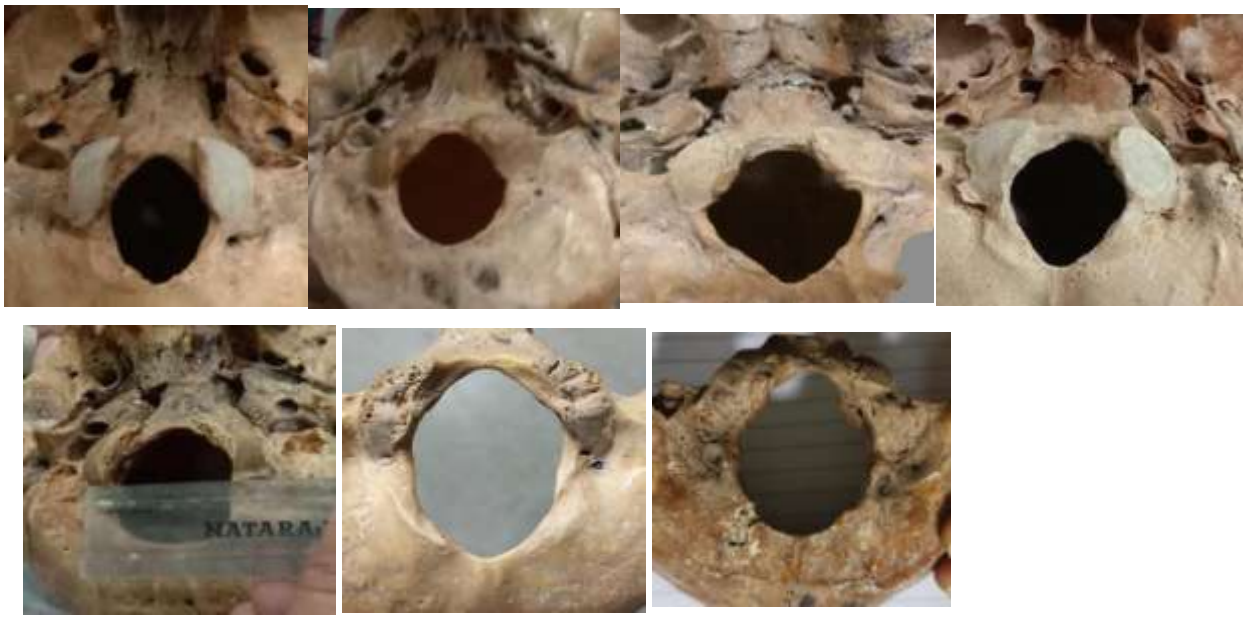

1.OVAL2.ROUND3.EGG-SHAPE4.TETRAGONAL5.PENTAGONAL6.HEXAGONAL7.IRREGULAR