REVIEW
OF
LITERATURE
Chapter – 3

REVIEW OF LITERATURE

In the past, many researchers have evolved various metrical parameter and indices for foramina of posterior cranial fossa on dry human skulls and computed tomographic scan. The Gross examination of the foramen magnum includes -Shape, Anteroposterior diameters. Transverse diameters and same parameters are assessed radiologically (CT Scan), using dicom software. The Jugular foramen examined for Anteroposterior diameters, Mediolateral diameters and Hypoglossal canal present or absent, in order to determine if there is a correlation between the transverse and anteroposterior diameter, one must first understand the different structures surrounding the foramen magnum, Jugular Foramen, Hypoglossal canal, at the cranial base.

Gross skull morphology and variation in its foramina constitute in interesting field of research for better comprehension of development of craniofascial skeleton and related neurovascular anatomy. Various studies have been reported in literature regarding the anatomy and the radiological description of skull base foramina.

3.1 OSTEОLOGICAL STUDY

FORAMEN MAGNUM (FM)

Foramen Magnum (FM) is largest foramen of the base of the skull. It is situated in the squamous part of occipital bone. The foramen magnum is a wide communication between the posterior cranial fossa and the vertebral canal. Lower part of brain stem passes through the anterior part of the foramen magnum. Vertical band of cruciate ligament, dens of second cervical vertebra and vertebral artery passes through the posterior part of the foramen magnum.

Olivier (1975) conducted morphometric study of foramen magnum on one twenty-five dry skull in french population and reported that the mean anteroposterior and
transverse diameter of foramen magnum were found $35.70 \pm 2.72$ mm and $30.84 \pm 2.15$ mm.

**Berge & Bergmann et al (2001)***$^{18}$ studied the morphometry of foramen magnum on one hundred dry skulls in USA and found that the mean anteroposterior and transverse diameter of foramen magnum were found $33.8$ mm and $28.3$ mm.

Wanebo & Chinoine et al (2001)$^{146}$ performed a quantitative analysis of transcondylar approach of foramen magnum on thirty-two dry skull. The mean length, width and area of foramen magnum were found to be $36 \pm 3$ mm, $31 \pm 2$ mm and $780 \pm 110$ mm$^2$ respectively.

**Mutthukumar N et al (2005)$^{84}$** observed on 50 dry skulls the average anteroposterior and transverse of the foramen magnum was $33.3$ mm and the width was $27.9$ mm. $46\%$ cases of the skulls studied exhibited an ovoid foramen magnum.

**Naderi S et al (2005)$^{85}$** performed morphometric study of foramen magnum on two zero two dry skulls in turkey population and observed that the mean anteroposterior of foramen magnum was found $34.7 \pm 2.3$ mm.

**Emine Dondu Kizilkanat et al (2006)$^{65}$** observed morphometric study of foramen magnum on fifty-nine dry skull in Turkish population and reported that the mean anteroposterior and transverse diameter of foramen magnum were found $34.8 \pm 2.2$ mm and $29.6 \pm 2.4$ mm.

**Avci et al (2011)$^{13}$** conducted anatomic study of foramen magnum on thirty dry human skulls in Turkey. The mean anteroposterior and transverse diameter of foramen magnum were found $34.5$ mm and $29$ mm.

**Govsa et al (2011)$^{46}$** conducted anatomic study of foramen magnum on one hundred forty four Turkey dry human skulls reported that the mean anteroposterior, transverse diameter and area of foramen magnum were found to be $37.2 \pm 3.5$ mm, $30.8 \pm 2.9$ mm and $829 \pm 137.7$ mm$^2$ respectively.

**P. Chethan et al (2012)$^{29}$** conducted on total 53 dry skulls and observed that shape of the foramen magnum was round in $22.6\%$ cases, egg shaped in $18.9\%$ cases, tetragonal in $18.9\%$ cases, oval in $15.1\%$, irregular in $15.1\%$ cases, hexagonal in $5.6\%$
cases and pentagonal in 3.8% cases. The mean antero-posterior (AP) and transverse
diameters of the foramen magnum were determined as 31 ± 2.4 mm and 25.2 ± 2.4
mm respectively.

Osunwok EA et al (2012)91 conducted morphometric analysis of the foramen
magnum on one hundred twenty adult skulls in southern Nigerian population and
reported that the mean length and width were 36.11±2.6 mm and 29.56±2.6 mm.

Radhakrishna S.K. et al (2012)102 studied total 100 dry skulls for the foramen
magnum shape was found to be oval in 39%, round at 28%, tetragonal at 19%,
pentagonal in 14% of the case.

K. Natsis M. Piagkou et al (2013)87 noticed 43 dry skulls and saw that mean foramen
magnum width and length were 30.31±2.79 and 35.53±3.06 mm. The commonest
foramen magnum shape was two semicircles in 25.9 % cases, whereas the most
unusual was irregular in 0.7 % cases.

Arthi Ganapathy et al (2014)43 observation on 100 dry skulls that the mean APDand
TRD of FM as 3.39±0.23 cm and 2.87±0.2 cm. The FM shape was found to be oval in
52%, round in 9%, irregular in 22%, tetragonal in 17%, and hexagonal in 9. % cases.

Radhika P .M et al (2014)103 presented total 150 dry human skulls and measured
that mean values of APD and TRD of the FM were 35.30±2.709 mm and 29.49±2.57
mm. The FM shapes were oval in 40% cases, round in 20% cases, egg in 10% cases,
tetragonal in 6% cases, irregular in 16% cases, hexagonal in 6% cases and pentagonal
in 2% cases.

Bayat Parvindokht et al (2015)16 observed morphometric study of foramen magnum
on twenty-six dry skull in Iran population and found the mean values of APD and
TRD of FM as 31.65±0.854mm and 25.45±2.32 mm.

Faazila Fathima et al (2015)35 studied totally 53 dried human skulls and it was
noticed that mean values of antero-posterior(APD) and transverse diameters (TRD)
of the FM were 3.822cm and 3.515cm. The mean area of the foramen magnum was
recorded as11.025 cm². Egg shaped foramen was observed in 35.85%, oval shaped
foramen in 26.42%, hexagonal shaped in 20.75%, circular/round shaped foramen
in 13% and pentagonal shaped foramen in 3.77% cases. In 72% cases of the skull the occipital condyles were observed to protrude into the foramen magnum.

**Kopal Saini (2015)**\(^{118}\) presented in total 98 dry skulls (India), mean foramen length and width of (FM) foramen magnum to be 34.8±2.45 mm and 30±2.29 mm. The foramen magnum shape was found to be oval in 46%, round in 19%, tetragonal in 21%, asymmetrical in 14% cases.

**Mumal Nagwani et al (2015)**\(^{186}\) presented 120 dry skulls and found that the mean anteroposterior diameter (APD) and transverse diameter of the FM were 34.68±2.88 mm, and 27.24±2.4 mm. The foramen magnum area was 757.09±115.82 mm\(^2\).

**Sanjukta Sahoo et al (2015)**\(^{117}\) observed mean values of anteroposterior diameter (APD) and transverse diameter (TRD) of the FM in 150 skulls as 35.30±2.709 mm and 29.49±2.572 mm respectively.

**Shikha Sharma et al (2015)**\(^{118}\) conducted study on 50 dry skulls, the mean anteroposterior diameter (APD) of the foramen magnum to be 38.75 mm, and mean transverse diameter (TRD) of the foramen magnum was found to be 33.44 mm. The area of the foramen magnum was 970.57 mm\(^2\).

The foramen magnum was found to be round in 22%, tetragonal in 12%, oval in 16%, irregular in 18%, hexagonal in 8%, pentagonal 8%, egg in 16% cases.

**Shweta Solan (2015)**\(^{130}\) presented on 60 dry skulls and the mean APD of the foramen magnum was found to be 3.60±0.29 cm, and mean TRD of the foramen magnum was found to be 3.22±0.29 cm.

**Venkatesh Gokuldas Kamath (2015)**\(^{64}\) presented total 72 dry human skulls. The mean sagittal diameter (Length) of foramen magnum was 32.26±3.5 mm and the transverse diameter (TRD) was 26.29±2.5 mm.

**Riyaz Zuberi Hussain, Siddiqui Azhar Ahmed (2015)**\(^{112}\) conducted a study on 61 dry skulls. The mean APD and TRD were found 39±2.2 mm and 37.5±2.5 mm. The foramen magnum was found to be round 29.50%, tetragonal 18.03%, oval 31%, irregular 11.47%, hexagonal 8.19%, pentagonal 1.63% cases.
Lucas A.P. Pires et al. (2016)\textsuperscript{72} conducted morphometric aspects of the foramen magnum on seventy-seven in Brazilian dry skulls and reported that the mean anteroposterior and transverse diameter of foramen magnum were 34.23±2.54 mm and 28.62±2.83 mm.

Shifan Khanday, Pranu Chakarwarthy (2016)\textsuperscript{64} conducted study on 60 dry human skulls that the mean transverse and anteroposterior diameters were 36.8 mm and 30.9 mm.

Vishal Ramesh Jasuja (2016)\textsuperscript{58} presented 100 dry skulls that the mean foramen magnum anteroposterior and transverse diameters were 34.13 ± 2.73 and 27.82 ± 3.32 mm.

Sandeep Arora (2017)\textsuperscript{10} studied total 30 dry skulls and it was noticed that the mean transverse and anteroposterior diameters were 27.81 ± 2.58 mm and 5.42 ± 3.22 mm.

Berjina Farooq Naqshi et al (2017)\textsuperscript{19} studied in 15 dry skulls that mean foramen magnum anteroposterior and transverse diameters were 31.6±2.16 mm and 26.5±2.12 mm.

Lyrtzis Chi et al (2017)\textsuperscript{73} conducted anatomic study of foramen magnum on one hundred forty-one Greek dry human skulls. The mean values of anteroposterior, transverse diameter and area of FM were 35.05±2.57 mm, 30.19±2.69 mm and 778.15±125.11 mm$^2$.

K. C. Singh et al (2017)\textsuperscript{131} conducted a study on 50 dry skulls, the mean APD and TRD of the foramen magnum was found to be 33.76 ± 2.18 mm and 28.09 ± 2.15 mm and shape observed foramen magnum was oval 34%. The mean area of foramen magnum were 834.45±75.79 mm$^2$.

Pelin Ilhan et al (2017)\textsuperscript{96} studied morphological analysis of foramen magnum on one hundred Turkey dry human skulls and reported the mean APD and TRD of foramen magnum as 35.18±2.94 mm and 29.73±2.54 mm.

Sampada P.K. et al (2017)\textsuperscript{121} observed on 100 dry skulls that mean values of APD and TRD of the foramen magnum were in 34.84±2.32 mm and 29.39±1.073 mm. The mean area was 803.8±83.42 mm$^2$. The foramen magnum shapes were found as Round
in 9%, oval in 58%, Egg in 11%, Tetragonal in 8%. Pentagonal in 1%, Hexagonal in 3%, Irregular in 10% cases.

Shimaa Anter Farid et al (2018)\textsuperscript{37} conducted morphometric study of foramen magnum on seventy five human dry skulls in modern Egyptians and reported that the mean mediolateral diameter (length) and anteroposterior diameter (width) of foramen magnum were 35±2.8 mm and 29.4±2.9 mm.

**JUGULAR FORAMEN**

Jugular foramen (JF) lies in the posterior end of petro-occipital fissure as large irregular hiatus. Its long axis is directed antero-medially. Its upper margin is sharp and notched and its lower margin is smooth. Anterior wall contains a fossa called jugular fossa. Which lodges jugular bulb. In the posterior end of foramen there is marking for sigmoid sinus which continues in the foramen as internal jugular vein. Accessory, Vagus and glossopharyngeal nerve pass through the anterior part of foramina lies between inferior petrosal sinus and sigmoid sinus\textsuperscript{150}.

In Sturrock’s (1988)\textsuperscript{136} investigation on Nigerian skulls, the right foramen was larger in 69% and the left in 23%. In the remaining 8% they were almost the same size on both sides.

According to study done by Ekinei N et al\textsuperscript{34} et al (1997) in 70 Turks skulls, the sagittal diameters of the left and right jugular foramen were 15.5±2.6 mm and 16±2.5 mm, whereas right and left transverse diameters were 8.4±1.9 mm, and 7.6±1.7 mm.

O.E.Idowu et al (2004)\textsuperscript{57} studied that the mean values of the length of jugular foramen on the Rt. And Lt. Sides were found to be 13.90± 1.48 mm and 14.11± 3.13 mm and the mean width of the jugular foramen on the right and left were found 10.22± 2.67mm and 9.57± 1.87mm.

Hussain Saheb S et al (2010)\textsuperscript{56} calculated on 125 dry human skulls and recorded the mean length of the foramen jugular on the Rt. and Lt. sides as 23.62 mm and 22.86 mm and the width observed as 7.83mm and 6.83mm on the right and left sides.
Pereira, GAM et al (2010)\cite{97} studied total 111 skulls and it was observed that the mean anteroposterior diameter and sagittal diameter were 15.82 mm and 9.21 mm on the right side and 15.86 mm and 8.65 mm on the left side of the jugular foramina.

Namita A Sharma (2011)\cite{127} conducted studies on 50 dry skulls that the mean medio-lateral diameter (MLD) of the jugular foramen was 15.59±2.64 mm and 13.83±4.94 mm on the right and left sides respectively, while mean antero-posterior diameter was 9.02±1.79 mm on the right side and 7.73±1.79 mm on the left.

S.A. Adejuwon et al (2011)\cite{1} conducted study on 96 adult human skulls that the mean values of the left and right foramen were 0.742±0.247 cm and 1.049±0.258 cm respectively.

Osunwoke E.A et al (2012)\cite{91} presented on (240 foramina) 120 dry skull that the mean length (mediolateral) on the Rt. and Lt. side of JF was 15.76±0.22 mm and 13.39±0.23 mm, while the mean width (anteroposterior) on the Rt. and Lt. side of jugular foramen (JF) was 9.34±0.18 mm and 7.54±0.20 mm.

Anjali singla et al (2012)\cite{133} studied on 50 dry skulls, the mean anteroposterior diameters of the foramen jugular on the right and the Left were found 9.32±2.04 mm and 7.34±2.04 mm and mediolateral diameter was 15.67 & 14.85 mm.

Anitha M R et al (2013)\cite{6} recorded that the mean length of the foramen jugular in 100 dry skulls on the right and left as 15.21±2.21 mm and 13.39±2.27 mm. When the mean on the mean width of the jugular foramen on the right and left was found 10.13±1.94 mm and 8.81±1.91 mm.

Joshini Shanmugam (2013)\cite{60} conducted study on 51 dry skulls, the jugular foramen means length on the right was 9.96 mm and on the left. it was 9.27 mm while they mean breadth measured 12.29 mm on the right and 12.039 mm on the left side.

Vijisha P et al (2013)\cite{143} study on 60 foramina (30 dry skulls) shows the mean length of the foramen jugular on the right and the left were found 17.33±2.53 mm and 15.30±2.66 mm. When the width of the jugular on the right and left was found 12.13±1.63 mm and 9.27±1.79 mm.
Chandni Gupta et al (2014) studied on (100 foramina) 50 dried skulls that the mean values Rt. and Lt. side anteroposterior diameter and mediolatero diameter of the jugular foramina were 11.22 and 9.25 mm, 16.52 and 16.02.

Mr. K. M. Sakthivel et al (2014) studied total 23 dry skulls and it was noticed that the mean transverse diameter as 11.58±1.07 mm on the right side and 10.74±1.28mm on the left side; mean antero-posterior diameter as 10.06±1.13 mm on the right side and 8.83±1.60 mm on the left side.

Roma Patel & CD Mehta (2014) observe on 100 dry skulls (200 foramina) of jugular foramen that the mean values of mediolateral diameter (MLD) of JF on the Rt. and Lt. side were 12.17mm and 11 mm, while their anteroposterior diameter measured 7.9 mm and 6.2 mm on the right and left respectively.

N. Himabindu (2015) studied on (220 foramina) 110 dry human skull that the mean mediolateral diameter on the right and left were 14.60 and 12.69, while their anteroposterior diameter measured at right and left were 9.61 and 8.24 respectively.

Shruthi B.N et al (2015) studied total 250 adult dry skulls (Karnataka) the mean length(Medialateral) and the width (anteroposterior) of the jugular foramen on the Rt. and Lt. sides were 24.48±3.17 mm and 21.24±4.51 mm, 7.51±1.56 mm and 7.16±1.89 mm respectively.

Riyaz Zuberi Hussain, Siddiqui Azhar Ahmed (2015) studied on 80 jugular foramina shows the mean length of JF on the Rt. and Lt. side as 14.31mm and 13.64 mm, while the width was measured as 9.26mm and 7.96 mm on the right and left.

Maharshi Abhilasha (2016) observed on 100 foramina (50 dry skull) that the mean values of length of the jugular foramen on Rt. and Lt. sides were 17.19±3.66 mm and15.47±3.25 mm the width measured 6.68±1.99 mm and 5.78±2.07 mm on the right and left side.

Jasuja Vishal Ramesh et al (2016) Studied total 100 skulls and it was noticed that the mean transverse diameter was 17.28 ± 2.11 mm on the right side and 16.7 ± 2.01mm on the left side of jugular foramina whereas mean sagittal diameter was 11.80 ± 1.82 mm on the right side and 10.04 ± 1.90 mm on the left side.
Sandeep Arora (2016)\textsuperscript{10} studied total 30 skulls and it was noticed that the mean transverse diameter was 11.38 ± 1.85 mm on the Rt. side and 9.99 ± 1.76 mm on the left side; mean Antero-posterior diameter was 18.61 ± 2.43 mm on the right side and 17.76 ± 2.2 mm on the left side.

Hatiboglu and Anil\textsuperscript{50} studied 300 Anatolian skulls from the 17th and 18th centuries and observed that in 61.6% the foramen was larger on the right side and in 26% it was larger on the left side and in the remainder of equal size.

**HYPOGLOSSAL CANAL**

Hypoglossal Canal (HC) is directed laterally and forward, traverses the occipital condyle and opens anterior to the condyle. It is also called as anterior condylar canal. Hypoglossal nerve, emissary vein from basilar plexus and meningeal branch of ascending pharyngeal artery passes through it. Hypoglossal canal is situated infero-medial to the lower border of jugular foramen\textsuperscript{149}.

S.H.H. Zaidi et al (2011)\textsuperscript{152} out of 40 skulls studied the double hypoglossal canal was seen only in 5 skulls (in 2 bilaterally & in 3 unilaterally on left side). Thus, the incidence of this cranial variant was 12.5%. Out of these, it was bilaterally. Only in 5% cases. However, unilaterally it was present in 7.5% cases.

Jatin Goda et al (2013)\textsuperscript{59} total 64 the skulls condylar canal was found bilaterally in 45 skulls (70.31%); unilaterally in 13 skulls (20.31%) and was absent in 6 skulls (9.38%). Double condylar canals were found unilaterally in 5 skulls (7.81%), 2 skulls (3.12%) in the posterior condylar canal.

Roopali D. Nikumbh et al (2013)\textsuperscript{114} 100 adult dry human crania. The Unilateral double hypoglossal canal was noted in 25% dry skulls whereas bilateral double hypoglossal canal in 3% dry skulls.

Siva nageswara Rao, Sundara Setty et al (2013)\textsuperscript{105} observed only one bilateral doubled hypoglossal canal out of the 50 skulls. The incidence of present cranial variant in south India was 2%.

Meera Jacob et al (2014)\textsuperscript{78} out of 60 skulls studied, the double hypoglossal canal was seen only in 12 skulls (in 4 bilaterally and in 8 unilaterally. Thus, the incidence of
this cranial variant was 20%. Out of these, it was bilateral in 6.6% cases and unilateral in 13.3% cases. Bony spurs within the hypoglossal canal was seen unilaterally in 2 skulls. The incidence if this variant was 3.33%

**Manoj Kumar (2015)**\(^{36}\) of 60 skulls we have seen 11 skulls with the unilateral presence of the canal on the left side with an incidence of 18.33%, and right side in 9 skulls with an incidence of 15%. The bilateral presence of the posterior condylar canal is seen in 29 skulls with an incidence of 48.33%. The canal is absent in 10 skulls with an incidence of 16.66%

**Usha Kothandaraman et al (2015)**\(^{142}\) the incidence of posterior condylar foramina was 26%, bilateral 16%, and unilateral 10% of the 50 skulls observed in our study.

**Gajanand RP et al (2016)**\(^{42}\) Out of 84 skulls 29 (34.5%) skulls showed doubling of hypoglossal canal. Among them, 10 (11.9%) showed bilateral duplication and 19 (22.61%) unilateral of which 9 (10.7%) on the left side and 10 (11.9%) on the right side.

**Mian Azhar Ahmad et al (2016)**\(^{80}\) out of the 69 skulls studied, the posterior condylar foramina on either side of meline in 18%, and on one side posterior condylar foramina were found in 14% while the total incidence was 33% of observed skulls. In 17% posterior condylar foramina was present within the sinus while in 8% posterior condylar foramina.

**Vinay KV et al (2016)**\(^{144}\) studied on the mean length (anteroposterior) of the hypoglossal canal on the Rt and Lt. sides were found 9.32± 2.04mm and 7.34± 2.04mm.

**Manoj Borkute et al (2017)**\(^{23}\) study consists of 100 dry adult skulls obtained. Posterior condylar foramen was present on both sides (bilaterally) in 58 skulls. In 15 skulls it was present only on the right side, whereas in 10 skulls it was present only on the left side. Foramen was found to be absent on both sides in 17 skulls. When present unilaterally it was more common on the right side than left.

**Naees Fatima et al (2017)**\(^{38}\) they observed 15 cases (13.63%) of the double hypoglossal canal in which 8 (7.27%) specimens had unilateral while 7 (6.36%)
specimens had a bilateral double hypoglossal canal. The double hypoglossal canal was more common in right side. In 5 cases (4.54%) unilateral bony spicules were seen.

Nishigandha Sadamate et al (2017)\textsuperscript{116} study consists of 228 dry skulls of unknown sex and age obtained. Study shown posterior condylar canal was present in 83.33 % of skulls in which 48.68 % bilateral, 19.29 % Right Unilateral and 15.35 % Left Unilateral and 16.66% were bilateral absent.

3.2 COMPUTED TOMOGRAPHIC STUDY

FORAMEN MAGNUM

Khalil Awadh Mursheed et al (2003)\textsuperscript{83} presented total 110 CT scans of foramen magnum the shapes of the FM were found to be oval in 8.1% cases, egg-shaped in 6.3% cases, round in 21.8% cases, tetragonal in 12.7% cases, pentagonal in 13.6% cases, hexagonal in 17.2% cases, irregular (A) in 10.9% cases and irregular (B) in 9.09% cases.

Furtado SV (2010)\textsuperscript{41} studied on 21 CT Scans, the shapes of foramen magnum, he observed, were 4.6 % round, 9.6 % oval, 19.04 % Tetragonal, 19.04% asymmetrical, 9.6% pentagonal, 19.04% hexagonal, 9.5% as egg shaped.

Edwards K. et al (2013)\textsuperscript{33} calculated the total by Dicom software in 250 CT scans of foramen magnum, the mean that the mean TRD and APD of the foramen magnum (C T Scan) 31.87and 25.84 mm, (Dry skulls) 30.0 cm and 24.0

The various shapes of foramen magnum observed were 8 (3.2 %) egg shaped, 61 (24.4%) oval, 65 (26.0%) Round, 11 (4.4%) Tetragonal, 21 (8.4%) pentagonal, 41(16.4%) hexagonal, 31 (12.4%) Irregular, and 12 (4.8%) unclassified.

Arthi Ganapathy et al (2014)\textsuperscript{43} observation on CT Scans, mean APD and TRD of FM was 3.49±0.23 cm and 2.98±0.25cm. The FM shape was found to be oval in 66%, round in 9%, tetragonal in 9%, hexagonal in 10%, irregular 16% cases.
Alamin Musa Salih Omer (2015) studied a total of 241 CT scans; the foramen magnum shapes were found to be round in 55 (22.9%) of the cases, oval in 115 (47.8%), irregular in 36 (14.8%) and arrow head in 35 (14.5%) cases. The mean APD, TRD and area of the foramen magnum were found 34.0±2.98 mm, 29.3±2.44 mm and 770.0±111.09 mm².

Chandramani B. Moore et al (2015) presented CT scan images of head and neck (axial view) of total 250 healthy participants, the mean length of foramen magnum was 35.64±3.39 mm and mean width was 29.17±2.89 mm.

Aghakhani K et al (2016) observed total 100 CT scan, the mean sagittal diameter of the FM was 35.047±2.059 mm. Transverse diameter (width diameter) was 30.012±2.151 mm. The area calculated by Teixeira formula was 860.317±109 mm². The area calculated by Routal formula was 853.147±109.12 mm², and FM Index was 83.196±1.321. The shape of the foramen magnum in 35 subjects (35%) was oval and hexagonal in 23% cases. The difference was statistically significant (P<0.001).

Gautam Kanodia et al (2016) noted in total 100 normal computerized tomography (CT) scans of posterior fossa and 100 dry adult skulls that the mean APD and TRD of the foramen magnum were (CT Scan) 3.31±0.35 cm and (Dry skulls) 3.41±2.9 mm and 27.6±3.1 mm and 27.5±2.5 mm. The areas of foramen magnum were 729.15±124.87 (CT scan) and 747.67±108.60 mm² (dry skull).

The relevant review of literature concerned with the morphometric measurements of jugular foramen & hypoglossal canal seen in computed tomographic scans was not available.