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# Age Related Changes in Lateral Ventricles of Brain in Normal Individuals by CT Method

**Mallika B[1], Sharada B Menasinkai[2], Brahmendra M[3]**

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**Abstract**

*Context:* As human brain ages, characteristic structural changes occur that are considered to be normal. Knowledge of age related changes is important before analysing the abnormal findings. As age advances there is regression of brain tissue and thus ventricles size enlarges.

*Aims:* To analyse the morphometric measurements of lateral ventricles of the brain in different age group in both genders.

*Material and Methods:* The study was done from Feb 2009 to July 2010. Data was collected from the CT scans Dept of Radiology Mysore Medical College & Research Institute. 200 normal CT scans (100 male, 100 female) in the age group of 10–80 yrs were collected.

*Results:* Right frontal horn measures 28.8 ± 2.5 in youngest and 30.3 ± 2.5 in oldest group. Right body part measures 47.9 ± 2.9 in youngest and 49.0 ± 1.9 in oldest group. Posterior horn measures 26.2 ± 1.9 in youngest age group and 26.0 ± 1.4 in oldest age group. Inferior horns could not be visible in few scans and were taken wherever possible as transverse diameter (TD) and vertical diameter (VD). All the measurements were found to be more in age group > 60 yrs compared to younger age group.

*Statistical methods:* Data was analysed by using SPSS 2004 version, Standard Deviation and Independent 't' test, analysis of variant and P – value.

*Conclusion:* Advances in CT imaging helps us to understand the normal structure and function of brain. The present study has shown increase in ventricular measurements as age advances.



**Keywords:** CT brain; Lateral Ventricles of brain; brain atrophy.

## Introduction

The cerebral ventricular system comprises of interconnecting cavities filled with cerebrospinal fluid and are derived from central lumen of the embryonic neural tube. The ventricular system of brain consists of two lateral ventricles, midline third and fourth ventricles which communicate via inter-ventricular foramen and aqueduct of Sylvius respectively. Detailed analysis of normal and abnormal morphology of cerebral ventricular system is essential for neurosurgeons and radiologists in routine clinical practice. Computed Tomography (CT) and Magnetic Resonance imaging (MRI) produce cross sectional images that allow real time assessment of ventricular dimensions. Though MRI is far superior to CT, CT scores in view of its easy availability, reduced cost and faster imaging. Assessment of ventricular morphology and dimensions play a critical role in a wide range of clinical conditions.[1]

Lateral ventricle size is an index of brain atrophy that can be measured noninvasively by computed tomography (CT). In cross sectional studies of healthy aging, lateral ventricle size increases, whereas memory and visuo-spatial performance decreases. Variance of lateral ventricle size

also increases with age suggesting substantial differences in age related atrophy.[2]

Thorough knowledge of the age related normal changes that occur in brain is required before any abnormal findings are analysed. Both imaging and autopsy studies revealed that there is correlation with increase in cerebrospinal fluid spaces and reduction in cerebral volume in normal human aging. There is regression of thalamic nuclei after 50 years of age which explains demonstration of early third ventricular enlargement. There is more shrinkage with age in the frontal cortex, brainstem and components of diencephalon. Ventricular enlargement is more sensitive indicator of cortical atrophy due to increasing age and dementias. To understand the changes, knowledge of normal ventricular system of brain is important.[3]

It is also important for knowing the normal upper and lower limits of brain ventricular size in different age groups and in both sexes so as to diagnose various brain pathologies.[4]

Ventricles of brain constitute about 2% of total brain volume. Lateral ventricles contribute about 82% of total ventricular system. A well defined reference system to represent and classify age related, gender related or developmental changes in anatomy of brain ventricles should facilitate.[5]

Expansion of CSF volume with age provides a good index of brain shrinkage although changes and growth of head with age tend to confound.[6]

*Aim and Objective*

To analyse the morphometric measurements of lateral ventricles of the brain in different age group in both genders CT method.

## Material and Methods

The study was done for a period of 18 months from Feb 2009 to July 2010. Data was collected from the CT scans done in the Dept of Radiology K R Hospital attached to Mysore Medical College & Research Institute. CT scans were randomly selected which were reported by radiologists as normal. 200 CT scans in the age group of 10–80 yrs were collected. The study group includes 100 male and 100 female. Normal CT scans of both male and female subjects aged between 10– 80 yrs were included in the study. CT scans with head injuries, cerebral infarctions local mass lesions, previous intracranial surgeries were excluded from the study.

Ct scan machine used for the study was GE High Speed Dual Slice Version 2.0 having a fan beam scanner with a scan time of 1 to 10 seconds. The density of CSF was 10 Hounsfield Units (HU) that of white matter was 22–32 HU and grey a matter was 36–46 HU. The matrix was 256 × 256 with a slice thickness of 10 mm in supratentorial region and 4 mm in infratentorial region.

Measurements were taken in mm on both right and left sides of frontal horn, body, posterior horn & inferior horns of lateral ventricles.

1. At the level of interventricular foramen of Monro: Length of frontal horns
2. Above the level of interventricular foramen: Length of body and posterior horns.
3. Below the level of interventricular foramen: Transverse diameter and height of inferior horns.


**Fig. 1:** CT image showing the anterior horn, body and posterior horns of lateral ventricles.

## Results

Data was analysed by using SPSS 2004 version, Standard Deviation and Independent 't' test, analysis of variant and P – value.

Analysis of data was done by making 7 groups according to age.

Table 1: Showing the number of subjects according to age groups in male and female subjects.

Table 2: Showing the length (mm) of frontal horn, body and posterior horn on right and left side.

Table 3: Showing the transverse (TD) and vertical diameters (VD) of inferior horn of lateral ventricles on right and left side.

**Table 1:** Showing the distribution of number of CT scans of male and female subjects and age group.

| Age (yrs) | Male | female | Total |
|---|---|---|---|
| 10-19 | 20 | 12 | 32 |
| 20-29 | 21 | 26 | 47 |
| 30-39 | 13 | 17 | 30 |
| 40-49 | 15 | 15 | 30 |
| 50-59 | :20 | 15 | 35 |
| 60-69 | 08 | 09 | 17 |
| 70-79 | 03 | 06 | 09 |
| **Total** | 100 | 100 | 200 |

## Discussions

The two most important conditions that produce ventricular enlargement are hydrocephalus and atrophy. Atrophy can either be due to aging, or due to neuro-degenerative disease. Hydrocephalus on the other hand results from impaired circulation of CSF or in certain rare circumstances, due to the increased production of CSF, such as what occurs in choroidplexus tumors. The other features which suggest a ventricular enlargement due to increased CSF pressure include effacement of the cortical sulci, elevation and thinning of the corpus callosum, dilatation of the optic and infundibular recess of the third ventricle and pineal recess

**Table 2:** showing the measurements of frontal horn, body and posterior horn on right and left side.

| Age (yrs) | Frontal horn | | | | Body | | | | Post horn | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Right P > 0.05 | | Left P > 0.05 | | Right P > 0.05 | | Left P > 0.05 | | Right P > 0.05 | | LEFT P> 0.05 | |
| | mean | SD | mean | SD | mean | SD | Mean | SD | mean | SD | mean | SD |
| 10-19 | 28.8 | 2.5 | 30.1 | 2.4 | 47.9 | 2.9 | 49.3 | 3.0 | 26.2 | 1.9 | 27.8 | 2.4 |
| 20-29 | 29.0 | 2.6 | 30.1 | 2.9 | 48.2 | 2.9 | 49.8 | 3.0 | 26.3 | 2.1 | 27.7 | 2.5 |
| 30-39 | 29.1 | 2.1 | 30.3 | 2.0 | 48.6 | 2.8 | 49.8 | 3.0 | 26.3 | 1.9 | 27.3 | 2.1 |
| 40-49 | 29.2 | 2.7 | 30.6 | 2.5 | 48.9 | 2.7 | 49.9 | 2.6 | 26.5 | 2.1 | 27.9 | 2.7 |
| 50-59 | 29.9 | 2.7 | 30.7 | 2.5 | 48.6 | 3.0 | 49.9 | 3.1 | 26.8 | 2.8 | 28.2 | 2.9 |
| 60-69 | 30.6 | 1.5 | 31.6 | 1.7 | 47.6 | 2.1 | 48.9 | 2.3 | 27.1 | 2.7 | 28.5 | 2.9 |
| 70-79 | 30.3 | 2.5 | 31.4 | 2.4 | 49.0 | 1.9 | 50.3 | 2.1 | 26.0 | 1.4 | 27.0 | 1.6 |
| Total 200 | 29.34 | 2.5 | 30.5 | 2.5 | 48.4 | 2.8 | 49.7 | 2.9 | 26.5 | 2.1 | 27.8 | 2.6 |

**Table 3:** Shows transverse (TD) and vertical diameters (VD) of inferior horn on right and left side and number of subjects in the age group.

| Age (yrs) | Right side | | | | | Left side | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No | TD P>0.05 | | VD P>0.05 | | No | TD P>0.05 | | VD P>0.05 | |
| | | mean | SD | mean | SD | | mean | SD | mean | SD |
| 10-19 | 28 | 7.7 | 2.4 | 3.1 | 0.9 | 27 | 7.9 | 2.8 | 3.0 | 0.9 |
| 20-29 | 44 | 9.5 | 3.1 | 3.2 | 1.4 | 42 | 8.9 | 3.4 | 3.0 | 1.1 |
| 30-39 | 29 | 7.3 | 2.4 | 2.9 | 1.1 | 28 | 7.1 | 2.4 | 2.9 | 1.1 |
| 40-49 | 24 | 8.4 | 2.2 | 3.4 | 1.3 | 22 | 8.7 | 2.1 | 3.0 | 1.2 |
| 50-59 | 33 | 7.6 | 2.4 | 3.3 | 1.0 | 33 | 7.4 | 2.0 | 3.0 | 1.0 |
| 60-69 | 16 | 7.1 | 2.8 | 3.1 | 1.1 | 16 | 7.5 | 2.9 | 3.2 | 1.0 |
| 70-79 | 08 | 8.6 | 2.6 | 3.4 | 0.7 | 08 | 8.8 | 2.1 | 3.1 | 0.6 |
| | 182 | 8.1 | 2.7 | 3.3 | 1.9 | 176 | 8.0 | 2.7 | 3.0 | 1.0 |

**Table 4:** Following table shows comparing the measurements of frontal horn on both sides with study reported by Shaikh Shamama et al[7].

| Age (yrs) | Present study | | Shaikh Shamama et al[7] | |
|---|---|---|---|---|
| | Right | Left | Right | Left |
| 10-19 | 28.8 ± 2.5 | 30.1 ±2.4 | – | – |
| 20-29 | 29.0 ± 2.6 | 30.1±2.9 | 27.2 ±1.92 | 29.7 ±30.1 |
| 30-39 | 29.1 ±2.1 | 30.3±2.0 | 27.3 ±1.79 | 30.1 ±1.27 |
| 40-49 | 29.2 ±2.7 | 30.6±2.5 | 27.3 ±1.79 | 30.2 ±1.52 |
| 50-59 | 29.9 ± 2.7 | 30.7±2.5 | 27.4 ±1,89 | 29.7 ±1.34 |
| 60-69 | 30.6 ±1.5 | **31.6±1.7** | 27.6 ±1.36 | 29.9 ±1.03 |
| 70-79 | 30.3 ± 1.5 | **31.4±2.4** | 28.1 ±1.56 | 30.3 ±1.74 |

posteriorly.[4]Table Shaikh Shamama et al[7] reported a study of 500 CT scans between age group of 20–79 in 250 male and 250 female cases. There is gradual increase in length of frontal horn with increase in age, more so between 70– 79 yrs and on left side. In the present study there is gradual increase in length of frontal horn more so in age group between 60–79 yrs and on left side.

Table 4 Following shows comparing the measurements of frontal horn on both sides with study reported by Shaikh Shamama et al[7].

Mitsunori Matsumaf et al[6] reported a MRI study of age related changes in Brain from 49 volunteers between 24–80 yrs. There was no change in ventricular volume of men and women. There was no ventricular enlargement between youngest and middle age, but between middle and oldest age group there was significant enlargement in ventricular volume. Expansion of CSF volume with age provides a good index of brain shrinkage. In the present study also enlargement of ventricular size is significant among age group of > 60 yrs in length of frontal horn and body more so on left side.

Bijayalakhmi Parija et al[8] reported a study of 150 randomly selected CT scans between age group of 15–70 yrs. The data is divided in to 3 groups. Group one between 15–30 yrs where brain fully developed and no degeneration, group two 31–50 yrs degeneration process may get initiated, as with aging brain start degeneration. Group three 51–70 yrs, degeneration would be evident in majority of people. P value of length of frontal horn on right and left side was not significant in group one and $P \leq 0.0001$ in group two. In group three $P \leq 0.002$ on right side and $P \leq 0.001$ on left side. There was no remarkable difference with respect to gender in younger age group however in subsequent higher age group males had higher ventricular size than females. Ventricular size was more evident in lateral ventricles in group three. The findings are comparable with our study. In the present study ventricular enlargement is evident in age group > 60 yrs in males on left side.

Dr Arun Kumar S et al[1] reported a study of 100 CT scans of male and female subjects between age group of 5–90 yrs. Frontal Horn Ratio (FHR) was calculated there was steady rise in mean FHR in all age groups in males as well as females which was statistically significant. The mean FHR was in the range of 0.3 to 0.32 across the age group from 21 to > 60 yrs. The mean FHR was slightly lower at 0.23 ± 0.03 in ≤ 20 yrs age group among females. The highest mean FHR was seen in the ≥ 60 yrs in both genders. Although we have not calculated FHR in our study, length of frontal horn shows increasing values after 60 yrs age.

Brij Raj Singh et al[3] reported a study of 358 CT scans of both male and female between age group of 20–60 yrs, 270 were between 20–60 yrs and 88 were more than 60 yrs. The length of the left frontal horn was more than the right. The mean length of right frontal horn with body between 20–40 yrs age group was 52.23 ± 4.80, between 41–60 yrs, 55.80 ± 6.18 and > 60 yrs age was 57.73 ±6.92. The measurements show increasing ventricular size as age increases. In the present study mean length of frontal horn was 29.34 ± 2.5 on right side and 30.5 ± 2.5 on left side.

## Conclusion

As the human brain ages the normal structural changes are better understood by studying morphometric measurements of CT images of different age groups. The present study has made an attempt to analyse the changes in relation to age, gender, and side of lateral ventricles.

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# Morphometry of Menisci of Human Knee Joint, A Cadaveric Study

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**Abstract**

*Context:* The menisci are cartilaginous tissue which provide structural integrity to the knee during tension and torsion. Variations of form, thickness and width determine possibility and kind of injury. Now a days, Menisci are considered having integral role in normal knee joint mechanics. The detail knowledge of meniscal morphometry is important to understand its pathology and treatment.

*Aims:* To measure width, thickness, outer and inner circumference, distance between anterior and posterior horn of medial and lateral menisci.

*Methods and Material:* Study was done on 80 menisci of both sides. Distance between anterior and posterior end, outer and inner circumference, width and thickness of menisci measured by using Vernier caliper.

*Statistical analysis used:* P value calculated by t test to assess statistical significance.

*Results:* Width of posterior 1/3rd shows statistically significant variation, along with thickness of posterior 1/3rd.

*Conclusions:* The difference between anterior and posterior horn of the medial meniscus was quite higher than that of lateral meniscus. In the medial meniscus, the posterior third was widest and thickest part which was statistically significant, whereas there was no statistically significant difference in anterior and middle third thickness and width of both menisci. These findings are in accordance with certain injuries being common in medial menisci. However more sophisticated instruments needed for better measurement.



**Keywords:** Knee; Meniscus; Morphometry; Injury; Horn.

**Keymessages:** Detailed morphometry of menisci helps to understand meniscal injuries and their management.

## Introduction

The menisci are cartilaginous tissue which provide structural integrity to the knee during tension and torsion.[5] Variations of form, thickness and width determine possibility and kind of injury.[2,6] There are many differences in anatomical features and insertion between lateral and medial meniscus. The contour of meniscus changes from semicircular to circular. So detailed morphometric study is needed to measure its width, thickness, distance between anterior and posterior horn. Meniscal injury is very common clinical condition. Now a days, Menisci are not optional or expandable s tructures,[1] they have integral role in normal knee joint mechanics. The detail knowledge of meniscal morphometry is important to understand its pathology and treatment.[5]

## Subjects and Methods

The study was done on 40 cadavers. Total no of sample were 80 menisci including both right and left (Fig. 1,2). After removing skin over knee joint, Ligamentum patellae and patella turned superiorly. Knee was flexed to see menisci. Menisci showing structural changes due to injury, degenerative changes were excluded.

The measurements include outer and inner circumference of menisci, width and thickness by using Vernier caliper. Distance between anterior and posterior end is also measured (Fig. 3,4,5,6,7).

## Results

In present study, mean distance between two ends of medial meniscus found is 22.6±6.1mm for medial meniscus (Table 3) and 11.7±5.6mm for lateral meniscus (Table 4) (Graph 3). There being no statistical difference among them (Table 1).

Mean width of medial meniscus in anterior 1/3rd 8.60±2.3mm, middle 1/3rd 8.70±2.4mm, posterior 1/3rd 11.70±3.5mm (Table 3). So it is observed that posterior most part is the thickest (p=0.00) (Table 1), while width for lateral meniscus is anterior 1/3rd 9.30±1.7mm, middle 1/3rd.

9.10±1.9mm, posterior 1/3rd 10.00±2.0mm (Table 4) (Graph 2). There is no statistical difference observed among the parameters (Table 1).

Mean thickness of medial meniscus meniscus in anterior 1/3rd 4.40±1.1mm, middle 1/3rd 4.80±1.5mm, posterior 1/3rd 4.70±1.3mm (Table3), the posterior most part is the thickest (p=0.00) (Table 1), while width for lateral meniscus is anterior 1/3rd 4.10±1.4mm, middle 1/3rd 4.90±1.7mm, posterior 1/3rd 5.10±1.7mm (Table 4) (Graph 1).

Mean outer circumference for medial meniscus is 84.50±11.1mm, inner circumference is 49.30±7.2mm (Table 3), while lateral meniscus has mean outer circumference of 77.70±13.3 mm, inner circumference of 41.90±10.6mm (Table 4) (Graph 4).

Width of posterior 1/3rd shows statistically significant variation, along with thickness of posterior 1/3rd as well (Table 1).

For distance between two ends of meniscus, mean difference between right and left knee of medial meniscus is 3.25 and for lateral meniscus it is –3.4 mm. Mean difference in width from anterior, middle, posterior third it is 0.55, 3, 0.4 mm respectively for medial meniscus. For lateral meniscus these parameters are – 0.3, 0.1, – 0.05 mm. Mean difference in thickness from anterior, middle, posterior third it is 0.2, 0.2, – 0.75 mm respectively for medial meniscus, for lateral meniscus these parameters are – 0.8, 0.6, 0.25 mm. Mean difference in circumference is 6.4 (outer), 1.4 (inner) mm for medial meniscus and 2.05 (outer), – 2.4 (inner)mm for lateral meniscus (Table 2).

**Table 1:** Comparison of different parameters between medial and lateral meniscus (T- Test).

| Independent Samples Test | | | | | |
|---|---|---|---|---|---|
| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | |
| | | F | Sig. | t | df |
| Distance between two ends of meniscus | Equal variances assumed | .195 | .660 | 8.276 | 78 |
| | Equal variances not assumed | | | 8.276 | 77.532 |
| width anterior third | Equal variances assumed | 3.190 | .078 | – 1.464 | 78 |
| | Equal variances not assumed | | | – 1.464 | 71.146 |
| width middle third | Equal variances assumed | .783 | .379 | – .814 | 78 |
| | Equal variances not assumed | | | – .814 | 75.070 |
| width posterior third | Equal variances assumed | 12.388 | .001 | 12.617 | 78 |
| | Equal variances not assumed | | | 12.617 | 52.123 |
| Thickness anterior third | Equal variances assumed | .329 | .568 | – 1.489 | 78 |
| | Equal variances not assumed | | | – 1.489 | 68.872 |
| thickness middle third | Equal variances assumed | .007 | .936 | – .872 | 78 |
| | Equal variances not assumed | | | – .872 | 77.057 |
| thickness posterior third | Equal variances assumed | 48.149 | .000 | – 34.418 | 78 |
| | Equal variances not assumed | | | – 34.418 | 39.740 |
| circumference outer | Equal variances assumed | .881 | .351 | 17.493 | 78 |
| | Equal variances not assumed | | | 17.493 | 77.884 |
| circumference inner | Equal variances assumed | .941 | .335 | 3.655 | 78 |
| | Equal variances not assumed | | | 3.655 | 68.373 |

p value <0.05* statistically significant – marked in yellow.

**Table 2:** Mean difference of the parameters between right knee and left knee of medial meniscus and lateral meniscus.

| Parame ters / Side of the Knee | Distance between two ends of meniscus (in mm) | Width (in mm) | | | Thickness (in mm) | | | Circumference (in mm) | |
|---|---|---|---|---|---|---|---|---|---|
| | | Anterior third | Middle Third | Posterior Third | Anterior Third | Middle Third | Posterior Third | Outer | Inner |
| Medial Right- knee vs Left knee | 3.25 | 0.55 | 3 | 0.4 | 0..2 | 0.2 | –0.75 | 6.4 | 1.4 |
| Lateral Right- knee vs Left knee | –3.4 | –0.3 | 0.1 | –0.05 | –0.8 | 0.6 | 0.25 | 2.05 | –2.4 |

**Table 3:** Descriptive statistics of different parameters of medial meniscus.

| Parameters | | Minimum | Maximum | Mean | Std. Deviation | Median |
|---|---|---|---|---|---|---|
| **Distance between two ends of meniscus (in mm)** | | 10.0 | 38.0 | 22.6 | 6.1 | 23.0 |
| **Width (in mm)** | Anterior third | 5.0 | 15.0 | 8.6 | 2.3 | 8.0 |
| | Middle third | 4.0 | 15.0 | 8.7 | 2.4 | 9.0 |
| | Posterior third | 4.0 | 20.0 | 11.7 | 3.5 | 11.5 |
| **Thickness (in mm)** | Anterior third | 2.0 | 7.0 | 4.4 | 1.1 | 4.0 |
| | Middle third | 3.0 | 10.0 | 4.8 | 1.5 | 4.0 |
| | Posterior third | 2.0 | 10.0 | 4.7 | 1.3 | 5.0 |
| **Circumference (in mm)** | Outer | 65.0 | 117.0 | 84.5 | 11.1 | 83.0 |
| | Inner | 30.0 | 65.0 | 49.3 | 7.2 | 50.0 |

**Table 4:** Descriptive statistics of different parameters of lateral meniscus.

| Parameters | | Minimm | Maximum | Mean | Std. Deviation | Median |
|---|---|---|---|---|---|---|
| **Distance between two ends of meniscus (in mm)** | | 4.0 | 26.0 | 11.7 | 5.6 | 10.0 |
| **Width (in mm)** | Anterior third | 06.0 | 12.0 | 9.3 | 1.7 | 9.0 |
| | Middle third | 6.0 | 14.0 | 9.1 | 1.9 | 9.0 |
| | Posterior third | 7.0 | 15.0 | 10.0 | 2.0 | 10.0 |
| **Thickness (in mm)** | Anterior third | 2.0 | 10.0 | 4.1 | 1.4 | 4.0 |
| | Middle third | 3.0 | 11.0 | 4.9 | 1.7 | 5.0 |
| | Posterior third | 3.0 | 12.0 | 5.1 | 1.7 | 5.0 |
| **Circumference (in mm)** | Outer | 50.0 | 104.0 | 77.7 | 13.3 | 78.0 |
| | Inner | 5.0 | 59.0 | 41.9 | 10.6 | 44.0 |
| | Inner | 5.0 | 59.0 | 41.9 | 10.6 | 44.0 |

**Table 5:** Comparison of thickness of medial meniscus with previous studies.

| Medial menisci Thickness in mm | Almeida et al (2004) | Braz and Silva (2010) | Ashwini C et al(2013) | Present study |
|---|---|---|---|---|
| Anterior 1/3rd | 5.92±1.37 | 6.17 | 1.54±0.78 | 4.40±1.1 |
| Middle 1/3rd | 5.31±1.06 | 6.31 | 1.77±0.56 | 4.80±1.5 |
| Posterior 1/3rd | 5.91±1.13 | 5.18 | 1.8±0.78 | 4.7±1.3 |

**Table 6:** Comparison of thickness of lateral meniscus previous studies.

| Lateral menisci Thickness in mm | Almeidaetal (2004) | BrazandSilva (2010) | AshwiniCetal (2013) | Presentstudy |
|---|---|---|---|---|
| Anterior 1/3rd | 3.71±1.15 | 4.40 | 1.41±0.57 | 4.10±1.4 |
| Middle 1/3rd | 6.10±1.04 | 6.52 | 1.76±01 | 4.9±1.7 |
| Posterior 1/3rd | 5.91±0.78 | 5.46 | 2.06±0.93 | 5.10±1.7 |

**Table 7:** Comparison of width of medial meniscus previous studies.

| Medial menisci Thickness in mm | Almeida et al (2004) | Ashwini C et al (2013) | Muralimanju et al (2008) | Present study |
|---|---|---|---|---|
| Anterior 1/3rd | 9.02±1.59 | 6.52±1.29 | 8.38±1.64 | 8.60±2.3 |
| Middle 1/3rd | 12.16±2.58 | 6.66±1.11 | 7.68±1.92 | 8.70±2.4 |
| Posterior 1/3rd | 17.37±2.22 | 11.28±2.09 | 13.93±2.69 | 11.70±3.5 |

**Table 8:** Comparison of width lateral meniscus previous studies.

| Medial menisci Thickness in mm | Almeida et al (2004) | Ashwini C et al (2013) | Muralimanju et al (2008) | Present study |
|---|---|---|---|---|
| Anterior 1/3rd | 11.86±1.81 | 8.08±1.14 | 9.84±1.78 | 9.30±1.7 |
| Middle 1/3rd | 11.97±2.56 | 8.52±212 | 8.82±2.01 | 9.10±1.9 |
| Posterior 1/3rd | 11.44±1.07 | 9.36±1.19 | 9.70±1.69 | 10.00±2.0 |

**Table 9:** Comparison of outer and inner circumference of medial meniscus previous studies.

| Medial menisci | Braz and Silva | Ashwini C et al (2010) | Muralimanju et al (2008) | Present study |
|---|---|---|---|---|
| outer circumference | 91.85±5.66 | 90.12±8.00 | 99.06±11.21 | 84.50±11.1 |
| inner circumference | | 59.96±85.51 | 55.44±8.37 | 49.30±7.2 |

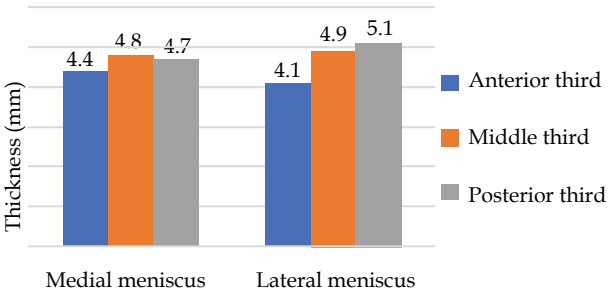
**Table 10:** Comparison of outer and inner circumference lateral meniscus previous studies.

| Lateral menisci | Braz and Silva (2010) | Ashwini C et al (2013) | Muralimanju et al (2008) | Present study |
|---|---|---|---|---|
| outer circumference | 92.80±7.52 | 83.28±7.46 | 90.25±9.36 | 77.70±13.3 |
| inner circumference | | 49±5.49 | 50.63±5.33 | 41.90±10.6 |

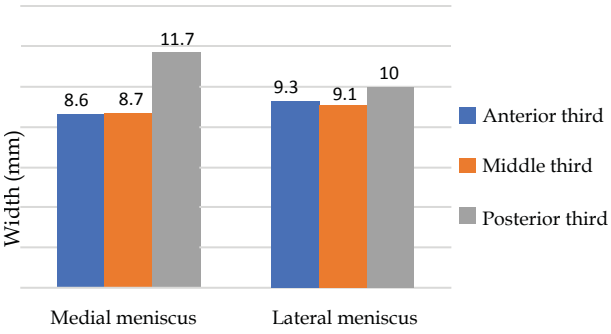
**Table 11:** Comparison of distance between anterior and posterior horn of medial and lateral meniscus with previous studies.

| menisci | Braz and Silva (2010) | Ashwini C et al (2013) | Muralimanju et al (2008) | Almeida et al | Present study |
|---|---|---|---|---|---|
| distance between horns of medial meniscus | 25.80±3.7 | 21.32±7.46 | 24.13±4.19 | 29.70±4.12 | 22.6±6.10 |
| distance between horns of lateral meniscus | 6.8±1.99 | 49±5.49 | 11.31±3.86 | 12.71±1.84 | 11.7±5.60 |

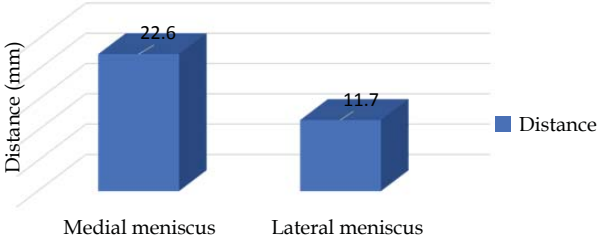
**Graph 1:** Mean thickness (mm) at different sites of medial and lateral meniscus.




**Graph 2:** Mean width (mm) at different sites of medial and lateral meniscus.




**Graph 3:** Mean distance (mm) between two ends of meniscus.




**Graph 4:** Mean circumference (mm) at different sites of medial and lateral meniscus.

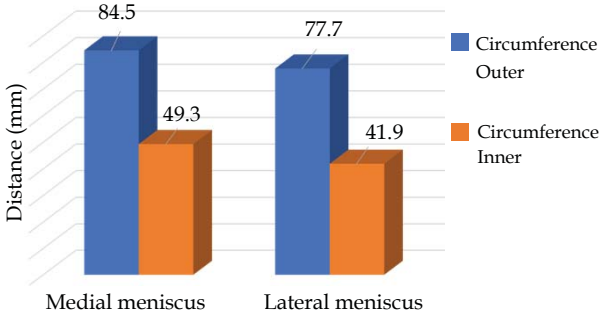



**Fig. 1:** Medial and lalteral menisci.

**Fig. 2:** Dissected out menisci

**Fig. 3:** Measurement of width.

**Fig. 4:** measurement of thickness.

**Fig. 5:** Measurement of distance between anterior and posterior horn.

**Fig. 6, :** Measurement of outer circumference.

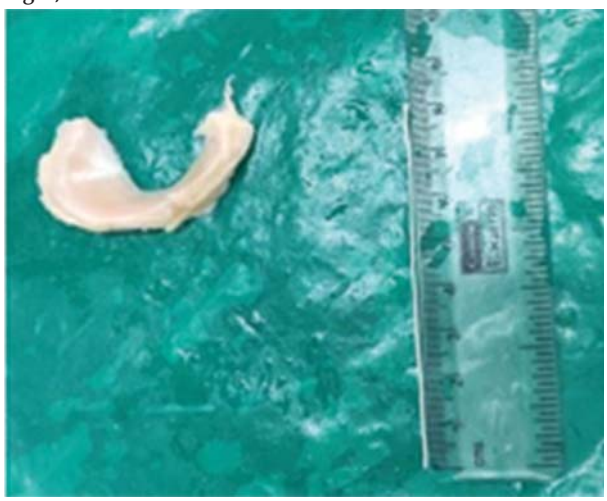


**Fig. 7:** Measurement of outer circumference.

## Discussion

Braz and Silva (2010)[3] mentioned the average thickness of outer circumference of medial and lateral menisci as 5.88 mm and 5.46. Ashwini C.[1] et al found posterior third of medial meniscus as thickest ( 1.8+ – 0.78), then middle third (1.77+ – 0.56), anterior third (1.54 = – 0.78mm). The difference in thickness of anterior, middle and posterior thirds of medial meniscus was of no statistical significance.($p>0.05$). They also found that posterior third (2.06+-9.3mm) of lateral meniscus was thickest ($p<0.05$), then middle third (0.81mm) and anterior third (1.41+-0.51) was the least. They also observed that thickness of middle third of medial meniscus was more than middle third of lateral meniscus (Table 5, 6). This explains higher incidence of injuries in medial meniscus. There was no statistically significant difference in thickness of anterior and posterior third of both the menisci. Regarding width of posterior third of both menisci, it was widest part similar to findings of Muralimanju et al[6] and Almeida et al.[2] While

anterior third of medial meniscus was having the smallest width compared with other two points (Table 7,8).

This explains lower incidence of injury in anterior third i.e. wider the meniscus, it is more exposed for injury.

There was no statistically significant difference between peripheral length of medial and lateral meniscus which was found by Braz ans Silva.[3]

Inner length of medial meniscus was significantly higher than of lateral meniscus.($p<0.05$) which was not seen by Muralimanju et al (Table 9,10).

The distance between two horns was less in lateral menisci, this finding was similar in most of the studies (Table 11).

Almeida et al[2] observed that medial meniscus was thinnest at posterior third followed by anterior and middle third.

M. Panigrahi et al[4], in a cadaveric study of Morphometric analysis of adult menisci found that length of medial menisci of both right and left was more than of lateral menisci. Width of medial meniscus was less on right side.

## Conclusion

Menisci are considered as having important role in knee joint biomechanics. Meniscal injuries are commonly seen, though now a days the emphasis is in preserving the meniscus. In such cases meniscal replacement and regenerative techniques are followed, for which accurate knowledge of anatomy in terms of morphometry of menisci plays a vital role. We have observed that there was no statistically significant difference between the outer length or circumference of medial and lateral menisus. The difference between anterior and posterior horn of the medial meniscus was quite higher than that of lateral meniscus. In the medial meniscus, the posterior third was widest and thickest part which was statistically significant, whereas there was no statistically significant difference in anterior and middle third thickness and width of both menisci. These findings are in accordance with certain injuries being common in medial menisci. However more sophisticated instruments needed for better measurement and study can be correlated with radiological study done to measure the parameters in living.

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# Sexual Dimorphism with the Shape of Hyoid Bone

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**Abstract**

*Background:* Hyoid bone is of considerable forensic interest owing to its susceptibility to fracture during manual strangulation, hanging and other forms of neck compression. In road traffic accidents it may get injured leading to significant airway concerns. A hyoid bone's shape may influence its susceptibility to fracture and hyoid fractures are frequently confused with normal variations in both clinical and forensic medico-legal cases. Aim our study was to establish a method of sex differentiation by the shape of hyoid bone there by helping the forensic expert to come to a conclusion.

*Materials and Methods:* The study was conducted in the department of anatomy on 60 hyoid bones obtained from medico legal postmortems conducted in the department of forensic medicine, Government medical college Mysore.

*Results:* It is observed that the most common shape of hyoid is 'U' in male's and deviated type in female's. Least common types are 'V' shape in male's and boat shape in females.

*Conclusion:* The present study was conducted to know the relationship of the sex with the shape of the hyoid bone . The presence of a fractured hyoid bone is of great importance in cases involving badly decomposed bodies and skeletal remains lacking soft tissue evidence of neck injury. The present study was conducted to help forensic experts while diagnosing hyoid fractures and determination of sex from the skeletal remains.

**Keywords:** hyoid bone; shape; Fracture; sex determination; Forensic expert.

## Introduction

Hyoid bone is a 'U' shaped bone suspended from the tips of the styloid process by stylohyoid ligaments.[1] It lies at the level of the 2nd to 3rd cervical vertebrae and approximately at the level of lower margin of the lower jaw when the head is held in natural position.[2]

It has a body, 2 greater and 2 lesser horns or cornuae. Body is irregular, elongated and quadrilateral having anterior surface which is convex, faces antero – superiorly and posterior surface which is smooth, concave faces postero – inferiorly. Greater cornuae project backwards from the body and each cornua laterally ends in a tubercle. Lesser cornuae are 2 small conical projections at the junction of the body and greater cornuae.[2]

*Ossification:* All elements originate in the cartilaginous tissue of the pharyngeal (also known as branchial) arches. By a generally accepted concept of origin, the lesser horn's and superior part of the body above the horizontal ridge are derived from the 2nd, so called hyoid arch. While the rest of the body and greater horns differentiates from 3rd pharyngeal arch.[3]

Determination of the sex of the skeletal remains of an individual from an examination of a single bone, except hip bone is considered to be a most impossible task.[4]

Studies have been done on establishing sex from femur, sternum, clavicle, radius, ulna, scapula and other bones.[5,6,7]

The hyoid bone is a rather neglected structure of the human skeleton which has not been given sufficient attention.[8]

After going through the literature regarding the shapes of human hyoid bone, it is noticed that the work is limited to western population till 1988. The present study was conducted to know the relationship of the sex with the shape of the hyoid bone.

## Materials and Methods

The material for the present study include 60 specimens (male: female, 30:30) of hyoid bones collected from the cadavers during autopsies (2013 to 2016) at Government medical college, Mysore. All specimens were aged between 19 to 80. The damaged hyoid bones mainly of hanging and strangulation cases were excluded from the study. The specimens were stored in 10% formaldehyde solution.

In these specimens laryngeal cartilages, thyroid gland, infrahyoid muscles and thyro hyoid membranes were dissected. First infrahyoid muscles and thyrohyoid membrane were cut following from the down to 1 cm of hyoid bone, then muscular and ligamentous structures of bone were removed. During dissection care was taken to preserve the lesser cornua of hyoid bone and then each bone was completely dried in air. Later each hyoid bone was numbered, shape of each bone was recognized and tabulated.

Hyoid bones were classified according to their shape in to following 5 types as shown in figure 1, as done by Harjeet and Jit I 1996[9] as follows.

1. Hyperbolic ('U' shaped) – figure 2
2. Parabolic ('V' shaped) – figure 3
3. Boat shape – figure 4
4. Horse shoe type – figure 5
5. Deviated type – figure 6

## Results

Modern text books of anatomy do not provide adequate information about various shapes of hyoid bone which are important in identifying sex of the hyoid bone.

The present study shows that 'U' shaped hyoid bone is more common (33.33%) in adult males followed by Horse shoe shaped type (30%) and

| U Type | V Type | Boat Type | Horse Shoe Type | Deviated Type |
|---|---|---|---|---|
| It is a half circle Anteriorly; the greater cornua are almost straight | It is triangular in shape and resembles 'V', body is bent upon itself with convexity forward | It resembles a boat, the two greater cornua deviate from each other as if opened out | It is half circle anteriorly the greater cornua faces each other | One greater cornua deviates more than the other making the Cornua asymmetrical |

**Table 1:** Various shapes of Hyoid bone in males and females with their percentage.

| Shape of hyoid bone | Male | Female | Total |
|---|---|---|---|
| 'U' shape | 10 (33.33%) | 5(16.66%) | 15(25%) |
| 'V' shape | 2(6.66%) | 6(20%) | 8(13.33%) |
| 'B' shape | 5(16.66%) | 4(13.33%) | 9(15%) |
| 'H' shape | 9(30%) | 6(20%) | 15(25%) |
| 'D' shape | 4(13.33%) | 9(30%) | 13(21.66%) |
| **Total** | 30 | 30 | 60 |

**Table 2:** Comparision of Shape of Hyoid bone of present study with previous studies. (in %).

| Name of authors | 'V' shape | | | 'U' shape | | | 'B' shape | | | 'H' shape | | | 'D' type | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | F | T | M | F | T | M | F | T | M | F | T | M | F | T |
| Papadopoulos et al (1989)[10] | 5.3 | 5.3 | 5.4 | 1.54 | 21.1 | 18.3 | 2.11 | 3.16 | 26.4 | 10.5 | 31.6 | 21.1 | 17.1 | 10.5 | 13.8 |
| Harjeeth and Jit et al (1996)[9] | 33.5 | 18 | 25.8 | 20.5 | 33 | 26.8 | 14 | 19 | 11.5 | 10.1 | 12 | 11.1 | 22 | 18 | 20 |
| Mahima Srivastava (2016)[5] | 36 | 20 | 28 | 14 | 34 | 24 | 10 | 8 | 9 | 14 | 16 | 15 | 26 | 22 | 24 |
| Sayeda Sadia Sameera (2016)[4] | 36.36 | 20.58 | 31 | 13.6 | 35.29 | 21 | 10.6 | 8.8 | 10 | 13.63 | 14.70 | 14 | 25.75 | 20.58 | 24 |
| Present study 2019 | 6.66 | 20 | 13.33 | 33.33 | 16.66 | 25 | 16.66 | 13.33 | 15 | 30 | 20 | 25 | 13.33 | 30 | 21.66 |


**Fig. 1:** Different shapes of hyoid bone.


**Fig. 2:** 'U' Hyperbolic shape.


**Fig. 3:** 'V' Parabolic shape.


**Fig. 4:** 'B'- Boat shape.


**Fig. 5:** 'H' – Horse shoe shape.


**Fig. 6:** 'D'- Deviated type.

least common is 'V' shaped type (6.66%) as shown in table 1.

In females, deviated type of hyoid bone is more common followed by 'V' shape (20%), Horse shoe shape (20%) and least common type is boat shape (13.33%) as shown in (Table 1).

## Discussion

Modern sex determination techniques originated in traditional physical anthropology, even today initial assessment of sex is based on visual gauze of the width of the pubic bone and the subpubic angle or greater sciatic notch. However, since the pelvis is not always available, intact or 100% diagnostic, more options were needed.[11]

The standards from classical studies like those of Pearson and Bell 1919[12] on the femur, Borovansky [1936] on the skull and washburns 1948[13] ischio-pubic index are still being used with success. Accuracy rate in identification of sex from an entire skeleton is highest when compared to the accuracy rate from individual bone. Even with human pelvis alone and skull alone sex can be determined with 95% and 92% accuracy only.[14]

The incidence of 'U' shape in males it is more than all other studies.[4,5,9,10] In females it is least in the present study compared to all other studies.[4, 5,9, 10]

The incidence of 'B' shape is more in both sexes when compared with all other studies[4,5,9,10] except in females it is less than incidence given by Harjeet and Jit I (1996).[9]

The incidence of 'H' shape is more in both the sexes when compared with other studies.[4,5,9,10] except in females it is less than incidence noted by Papadopoulos (1989).[10]

The incidence of deviated type is less when compared with other studies.[4,5,9,10] (Table 2).

in males and it is more when compared with other studies[4,5,9,10] among females.

The incidence of 'V' shape in males, it is almost same as that of Papadopoulos (1989)[10] and it is less than other studies[4,5,9] where as in females it is almost same as that of other studies[4,5,9] and it is more than that of Papadopoulos (1989).[10]

Newer investigative modalities have brought in to light the role of spatial inter – relationships of the hyoid to its neibouring structures. Thus highlighting the anatomic basis of various clinical procedures. Hyoid suspension is a procedure designed to stabilize the airway behind the back of the tongue to correct obstructive sleep apnea. The hyoid bone is pulled forward in front of voice box either in conjunction with genioglossus for tongue advancement or isolated procedures.[15]

## Conclusion

After studying different shapes of hyoid bone it is concluded that in males 'U' shape and in females 'D' shape of hyoid bone were the leading types. However the study of hyoid bone alone will be inadequate in sex determination and needs to be considered along with the measurements of other bones of the same individual for more accuracy.

A hyoid bone's shape may influence its susceptibility to fracture and hyoid fracture is frequently confused with normal variation in both clinical and forensic applications. The present study was conducted to help forensic experts while diagnosing hyoid fractures and determination of sex from the skeletal remains.

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*Original Article*

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# The Supratrochlear Foramen of Adult Humerus and its Clinical Considerations

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**Abstract**

*Background:* Supratrochlear foramen (STF) is located on the bony septum that separates the olecranon fossa from the coronoid fossa, at the lower end of the humerus. The knowledge of the presence of STF in a humerus may be important for preoperative planning for treatment of supracondylar fracture. The presence of STF may also result in erroneous interpretation of radiographs.

*Materials and methods:* The STF was studied in detail in 300 (175 right side and 125 left side) human dried humeri of unknown sex and age. The topographical anatomy of the STF was studied in detail, morphometric measurements were taken, and the specimens were photographed.

*Results:* Out of the 300 bones studied, 140 cases (46.6%) showed the presence of STF. The STF was oval, round, and triangular in shape in 128, 7, and 5 cases, respectively. The mean length of the transverse diameter for supratrochlear foramen was 6.60 mm and 5.9 mm on the left and right sides, respectively. The mean length of the vertical diameter for STF was 4.80 mm and 3.80 mm on the left and right sides, respectively. Most of the bones that had no STF showed a translucency of septum, in 54.4% of the bones.

*Conclusions:* The results of our study show that STF is more common on the right side, with the oval shape being more common. The respective sides did not exhibit any statistical significant differences. Presence of STF may be important for anthropological, clinical, and academic purpose.



**Keywords:** Humerus; intramedullary humeral nailing; supratrochlear foramen; Translucent septum.

## Introduction

Olecranon and the coronoid fossa of humerus are separated by a thin plate of bone, which may become perforated in some cases to give rise to a foramen known as supratrochlear foramen.[1] Supratrochlear foramen was first described by Meckel (1825).[2] Since then, it has been described in various animals like dogs, hyenas, cattle, and other primates.[3,4] Morphologically in humans thin plate of bone present until the age of seven years, after which the bony septum occasionally becomes absorbed to form the STF.[5] Individuals with this anatomic variation may be able to overextend the elbow joint.[6] In intramedullary fixation of the humerus is commonly used in traumatic injuries and pathological fractures.[7] The Proper anatomical knowledge of the humerus is important in preoperative planning in the presence of variations in the distal end of the humerus.[8] The presence of supratrochlear foramen is also important for radiologists and orthopaedicians for proper interpretation of x-rays as they appear radiolucent and may be mistaken for cystic or osteolytic lesions.[8] Our study aims to highlight STF incidence, different shapes and clinical importance, which

may be beneficial for anthropologists, orthopaedic surgeons, and radiologists in day-to-day clinical practice.

## Materials and Methods

A total of 300 (125 right side and 175 left side) human dried humeri free of any pathological changes and of unknown sex of Indian origin, were studied in Department of Anatomy, Kannur Medical College, Anajarakandy, India for various parameters such as; presence or absence of a STF; Shape (oval, round, and triangular); transverse and vertical diameters of the STF and its distance from the tip of the medial epicondyle were measured using a vernier caliper.

Statistical analysis: Data were expressed in Mean±Standard deviation (SD). The Side differences of transverse and vertical diameter of the STF were compared using the unpaired Student's t test; the level of significance was set at $P<0.05$ (Table 3). All statistical tests were performed using GraphPad Prism version 5.0 for Windows (GraphPad Software, San Diego, CA).

## Results

Out of the 300 bones studied, 140 cases (46.6%) showed the presence of STF. In 69 (49.2%) cases on the left side and in 71 (50.7%) cases on the right side, a STF was present. The STF was oval (128), round (7), and triangular (5) in shape (Fig. 1, Table 2). The mean length of the transverse diameter for supratrochlear foramen was 6.60 mm and 5.9 mm on the left and right sides, respectively. The mean length of the vertical diameter for STF was 4.80 mm and 3.80 mm on the left and right sides, respectively (Table 3). The differences between the sides were not significant (Table I). The incidence of STF was slight higher on the right side (50.7%) as compared to the left side (49.2). Most of the bones that had no STF showed a translucency of septum, in 54.4% of the bones (Table 1).


**Fig. 1:** Photograph showing various shapes of supratrochlear foramen (STF). A: triangular STF; B: round STF; C: Transparent STF: D: Oval STF.

**Table 1:** Frequency of Supratrochlear foramen and Translucent septum.

| Sl. No. | Types | Total | Percentage (%) |
|---|---|---|---|
| 1 | Translucent septum | 160 | 54.4 |
| 2 | STF | 140 | 46.6 |

**Table 2:** Different shapes of foraminae and their prevalence.

| Sl no | Shapes | Total | Percentage (%) |
|---|---|---|---|
| 1 | Oval | 128 | 91.4 |
| 2 | Round | 7 | 5 |
| 3 | Triangular | 5 | 3.5 |

**Table 3:** Different measurements in supratrochlear foramen. Data are shown as mean ±standard deviation & range).

| | Right side | | Left side | |
|---|---|---|---|---|
| | Mean±SD | Range | Mean±SD | Range |
| Transverse diameter for supratrochlear foramen (mm) | 5.9 ±2.1 | 3.2–8.5 | 6.6 ±1.47 | 2.2–10.1 |
| Vertical diameter for supratrochlear foramen (mm) | 4.80±2.3 | 2–7.5 | 3.8±0.99 | 2.2–5.6 |

Differences between the sides were not significant ($P>0.05$, unpaired Student's t test).

**Table 4:** Incidence of supratrochlear foramen in various human races.

| Serial no. | Author | Population studied | Incidence (%) |
|---|---|---|---|
| 1. | Trotter M 1935 | White Americans | 4.3 |
| 2. | Ndou R et al 2013 | African Negroes | 21.7 |
| 3. | Akabori, 1934 | Ainus | 8.8 |
| 4. | Akabori, 1934 | Japanese | 18.1 |
| 5. | Nayak SR 2009 | Indians | 34.4 |
| 6. | Hirsh, 1927 (quoted by Morton and Crysler) | Arkansas Indians | 58 |
| 7. | Present study | South Indians | 46.6 |

## Discussion

The supratrochlear foramen (STF) was first described by Meckel in 1825.[2] The STF is of great interest to anthropologists, who claim it as important in establishing relationships between humans

and lower animals,[2] According to Hrdlicka, the perforation is very frequent in primates other than man.[9] Apart from its evolutionary significance STF has much clinical and surgical importance in the recent times.[10] There is a wide variation in the rate of the STF occurrence in various human populations. Studies on STF in different populations showed an incidence of 58% in Arkansas Indians[9], African Negroes (21.7%), South Africans (32.5%) [11], in White Americans (4.3%)[12], in American Negroes (18.4%)[12], 18.1% in Japanese [13], 17.5% in Chinese.[14] 6.1% in Netherlands[15] (Table 4). The incidence of STF in the Indian population ranges from 28% to 34.4%.[16] In the present study, majority of STF were oval (91.4%) followed by it was round shape (5%). Veerappan et al.[16] observed oval shape in 42.85%, round shape in 37.71%, triangular shape in 14.28% and sieve like in 7.14% in their study. A study had defined the STF to be ovoid in shape with the long axis transversal (6.3/3.7 mm).[17] Another study reported that STF, Transverse diameter were left side (6.55 mm) and right side (5.99 mm) and vertical diameter left (4.85 mm) and right (3.81 mm) side respectively.[8] In our study transverse diameter for supratrochlear foramen was 6.60 mm and 5.9 mm and mean length of the vertical diameter for STF was 4.80 mm and 3.80 mm on the left and right sides.

*Limitations*

Dry humeri of unknown gender and age were considered in the study. The effect of the ulnar morphometry and its bearing on the formation of STF could not be ascertained.

## Conclusion

The results of our study showed 46.6% STF incidence in the south Indian population, with the left side predominant. By its high incidence it is important to the orthopaedician in the preoperative planning at distal humerus and to the radiologist for differentiating it from other pathological or morphometric variations.

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# A Study on the Morphometric Measurements of Pterion and Its Importance in Surgical Approach

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**Abstract**

Aneurysms, tumours, meningiomas and extradural haemorrhage are the most common alarming neurological problems in the present era. These may have pathological cause and sudden stroke or fractures either by fall from a height accidentally, road traffic accidents proper or suicidal attempts leading to any of these above mentioned conditions primarily or secondarily.

*Aim and Objectives*

*Aim of The Study:* This study is therefore aimed at determining the position of Pterion at various palpable points with relation, types of Pterion with relation to middle meningeal artery and brain.

*Objectives of The Study:* To achieve the above aim, the work is planned by the following objectives –

1. To analyze type of Pterion based on Murphy classification.

Murphy's classification includes 4 types Pterion namely,

A) *Spheno-parietal type:* Greater wing of sphenoid articulates with the parietal bone to form the letter 'H'.

B) *Frontotemporal type:* Squamous part of the temporal bone articulates with the frontal bone.

C) *Stellate type:* Here all bones (frontal, temporal, greater wing of sphenoid and parietal) articulates at a point in the form of letter 'k'.

D) *Epipteric type:* A sutural bone is lodged between the four bones forming the Pterion.

2. To analyze comparision of Pterion on both sides of a same skull. To measure length of Pterionic suture. To measure the distance from centre of Pterion to centre of zygomatic arch. To measure the distance from centre of Pterion to posterolateral margin of frontozygomatic suture. To measure distance from centre of Pterion's inner aspect to lateral end of crest of ridge on the lesser wing of sphenoid bone. To measure distance from centre of Pterion's inner aspect to lateral margin of optic canal.To measure distance from centre of Pterion to lower end of mastoid process.

*Material And Methods:* 100 adult human dry skulls of known sex, collected from the department of anatomy, Narayana medical college, Nellore and S.V medical college, Tirupathi.This was an observational study.

*Observation and Results:* In the present study various types of pterions were observed as shown in pie diagram. 100 adult dry skulls were examined. Sphenoparietal (92%), Frontotemporal (3%), Stellate (2%) and Epipteric (3%). The results of remaining parameters are tabulated and photographed.

*Conclusion:* Knowledge of the location and relations of Pterion is important in relation to surgical intervention, particularly with respect to course of the branches of middle meningeal artery and Broca's motor speech area on the left side. The distances between the Pterion, lesser wing of sphenoid ridge and optic canal are of practical importance in surgical approaches to these regions via Pterion.

**Keywords:** Pterion; Middle meningeal artery; Lesser wing of sphenoid; Optic canal.

## Introduction

The anatomical location of aneurysms, stroke, cerebral hemorrhage tumors and meningioma conditions are important for surgical interventions. In neurosurgery, it is important to have the most suitable bony aperture in order to be minimally invasive (Ersoy et al., 2003).[4] To achieve optimum craniotomy where neuro navigation devices are not available, the surgeon then relies on external landmarks called as Craniometric points (Oguz et al., 2004).[11] These craniometric points are related to the structures in the cranial cavity one such craniometric point which forms a structural confluence of skull bones in the temporal fossa is called as "PTERION" (Williams et al., 1988).[17] The position of Pterion however cannot be discerned easily because it is usually covered by scalp (Williams et al.,).[17]

The Temporal fossa is a significant area of the skull where elements of the facial skeleton, the skull base and the calvaria converge (Urzi et al., 2003; Williams Et al.,1998).[16,17] The zygomatic arch, the temporal line, the fronto zygomatic process and the supramastoid process delineate the temporal fossa, and temporal muscle is attached to its floor. Temporal fossae are characterized by the four distinct bony elements: the frontal and parietal bones, the greater wing of sphenoid bone, and the squamous part of temporal bone. All of these bones are in close proximity in a region described by a small circular area termed Pterion located in norma lateralis approximately 4.0 cms above zygomatic arch and 3.5 cms behind the frontozygomatic suture (Williams et al.,).[17] This point is known as Sylvian point. It occurs as an irregular H-shaped meeting point of sutures, forming a horizontal limit between the anterioinferior parietal angle and the apical border of greater wing of sphenoid (Moore, 1992).[9]

The Pterion is also commonly used as an important guide for age by cranial suture closure methodology. During foetal period and at birth the region of pterion form a large membranous area called ("Soft Spot") anterolateral fontanelle or sphenoidal fontenelle.[14,17] It provides space to the skull bone to overlap while passing through pelvis at birth.[17] The fontenelles permit skull to accommodate the rapid growth of brain during infancy.[14] Complete ossification of anterolateral fontenelle normally occurs immediately after birth.

A study reveals that there are four types of Pterions: Sphenoparietal, Frontotemporal, Stellate, Epipteric. ( Murphy).[10] The Pterion is an important anatomical and anthropological land mark as it overlies both anterior ramus of middle meningeal artery and the lateral fissure of cerebral hemisphere. Thus, the knowledge of sutural joints between frontal, parietal, temporal, and greater wing of sphenoid at Pterion is clinically, radiologically, and surgically important during surgical interventions involving bur hole surgeries. The anatomical location of pterion is important in surgical approaches to the anterior and middle cranial fosse, following extra dural haemorrhage as well as tumours involving inferior aspects of frontal lobe, such as olfactory meningiomas, used in operationson the Boca's motor speech area, anterior pole of insula and in repairing aneurysms of middle cerebral artery and those of upper basilar complex (Bage E, 2002).[3]

The pterional approach is commonly employed in surgery of anterior circulation and upper basilar complex artery aneurysms as well as tumours of orbital, retro orbital, retro orbital, sellar, chiasmatic, sub frontal and prepontine areas and lesions around the sella especially for lesions behind the clivus. Also tumours arising from the medial sphenoid ridge, the superior orbital fissure, the anteromedial temporal surface, or the cavernous sinus region are approached through a Pterional exposure. The surgical technique is based on the experience, training and observation of the neurosurgeon. One technique is not necessarily better than the other regardless of the surgical technique, the end results depend on a rigorous, methodical, systematic and step by step approach to target, securing it with minimal injury to surrounding structures.

Also the anatomical varieties of the Pterion, is of interest mainly to the anthropologists and forensic pathologists, deserve further investigation in other geographical areas and different populations. Such findings could also be useful for assessing the location of the Pterion in incomplete archaeological remains or forensic materials (Ari Ilknur et al., 2009).[1] Thus the anatomical variations of Pterion had so much cared by the anthropologist, neurosurgeons and forensic pathologists. It was found necessary to study the occurrence of Pterion in the human skull, and also its relation to middle meningeal artery to fulfil the criteria.

### *Aim and Objectives*

*Aim of The Study:* This study is therefore aimed at determining the position of Pterion at various palpable points with relation, types of Pterion with relation to middle meningeal artery and brain.

*Objectives of the study:*

To achieve the above aim, the work is planned by the following objectives –

1. To analyze type of Pterion based on Murphy classification.

   Murphy's classification includes 4 types Pterion namely,

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   C) *Stellate type:* Here all bones (frontal, temporal, greater wing of sphenoid and parietal) articulates at a point in the form of letter 'k'.

   D) *Epipteric type:* A sutural bone is lodged between the four bones forming the Pterion.
2. To analyze comparision of Pterion on both sides of a same skull.
3. To measure length of Pterionic suture.
4. To measure the distance from centre of Pterion to centre of zygomatic arch.
5. To measure the distance from centre of Pterion to posterolateral margin of frontozygomatic suture.
6. To measure distance from centre of Pterion's inneraspect to lateral end of crest of ridge on the lesser wing of sphenoid bone.
7. To measure distance from centre of Pterion's inneraspect to lateral margin of optic canal.
8. To measure distance from centre of Pterion to lower end of mastoid process.

## Material and Methods

*Source of Data:* 100 adult human dry skulls of known sex, collected from the department of anatomy, Narayana medical college, Nellore and S.V medical college, Tirupathi.

*Study Design:* This was an observational study. 100 Adult dry skulls were included based on following criteria.

*Inclusion Criteria:*

1. Adult human skull of known sex.
2. Both calvaria intact and cut skulls.
3. Third molar tooth erupted.
4. Sutures Well-defined.

*Exclusion Criteria*:

1. Damaged skulls.
2. New born, infant's children skulls.
3. Very old skulls with obliterated sutures.

*Materials Used*:

1. 100 Adult human dry skulls.
2. Sliding callipers.

*Method Of Collection Of Data:* Study had been conducted on 100 human adult dry skulls of known sex. Dry skulls are taken up for the study as there is paucity of cadavers. Those that had third molar teeth erupted will be considered as adults and hence studied.

Pterion is classified based on Murphy's classification.

Measurements taken on both sides of the skull from centre of Pterion to the midpoint of zygomaticarch, distance from centre of Pterion to poster lateral margin of frontozygomatic suture, distance from centre of Pterion to lower end of mastoid process, from centre of pterion's inner aspect to lateral end of the crest of ridge on the lesser wing of sphenoid, distance from centre of pterion's inner aspect to lateral margin of optic canal and length of pterionic suture in sphenoparietal and frontotemporal type of pterion, using sliding callipers. Each of the Measurements will be taken twice then averaged so as to minimize bias errors.

Relevant findings regarding various types of Pterion and position of pterion will be noted. Values will be recorded separately on right and left sides and compared. Values will also be compared with previous studies for their statistical significance. It is an observational study; the data collected in this study will be analysed statistically using descriptive statistics like percentages, mean, and standard deviation. To compare between right and left sides paired't' test will be used.

**The standard anatomical landmarks used in this study were:**

*Pterion (Pt):* Confluence of frontal, parietal, temporal and greater wing of sphenoid bones.

*Pterionic Suture (PT):* Present only in frontotemporal type and sphenoparietal. In frontotemporal type of Pterion, Pterionic suture is present between frontal bone and squamous part of temporal bone. In sphenoparietal type of Pterion, Pterionic suture is present between greater wing of sphenoid bone and parietal bone.

*Frontozygomatic suture (FZ):* Suture Present between zygomatic process of frontal bone and frontal process of zygomatic bone.

*Zygomatic arch (ZA):* It is formed by the temporal process of zygomatic bone and zygomatic process of temporal bone. It is felt through the skin, where the cheek and temporal region meet each other.

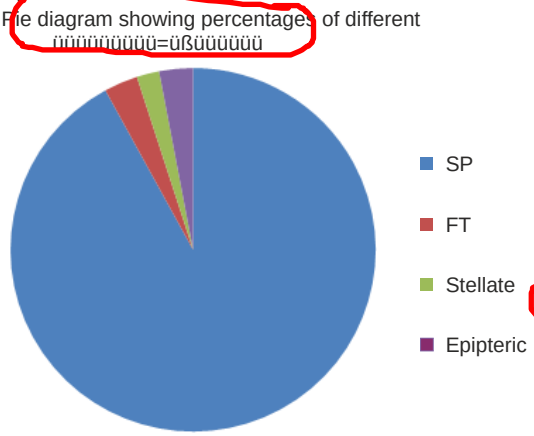
*Mastoid process (MP):* A nipple shaped process on the temporal bone that extends downward and forward behind external acoustic meatus.

*Optic canal (OC):* Optic canal is bounded by roots of lesser wing of sphenoid bone. Optic canal leads to orbit which transmit optic nerve and ophthalmic artery.

*Crest of lesser wing of sphenoid (LWS):* Lateral end of lesser wing of sphenoid.

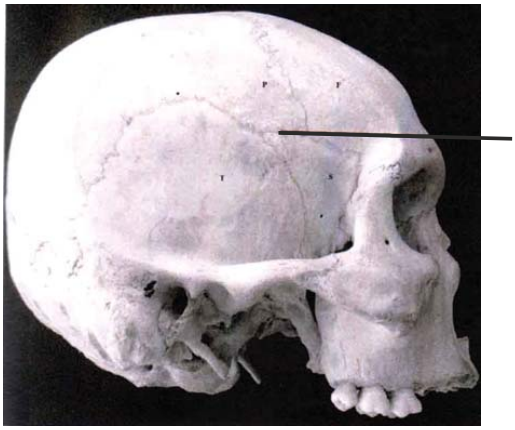
## Discussion

In the present study various types of pterions were observed as shown in pie diagram. 100 adult dry skulls were examined. Sphenoparietal type of Pterion Picture 1 is seen in (92%), Frontotemporal type of Pterion is seen in (3%) Picture 2, Stellate Picture 3 (2%) and Epipteric Picture 4 (3%), which are shown in graph 1 and table 1 and also their percentages on right and left side, the same in graph 2. Table 2 shows different types of terion and percentage towards right and left side in females. In the present study sphenoparietal, frontotemporal, stellate, epipteric types of pterion were observed. Sphenoparietal type of Pterion is most common seen in Asiatic Indians (95.1%),[14] Northern Indians (87.72%),[12] South Indians (93.55%)[8] and Nigerians (87.79% and 82.1%)[7,12] and in this study (92%); While it was significantly lower in Korean (76.5%)[6] and Kenyan (66%)[7] Populations as compared to this study Table 3 and Graph 3.




SP – Sphenoparietal, FT-Frontotemporal

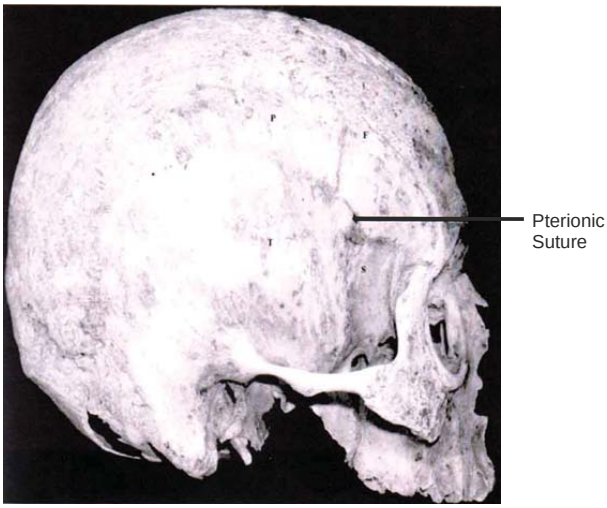
SP – 92%, FT-3%, Stellate-2%, Epipteric-3%




Sphenoparietal type of Pterion : Pterionic Suture between parietal and sphenoid bone.

F-Frontal, P-Parietal, T-Temporal, S-Sphenoid

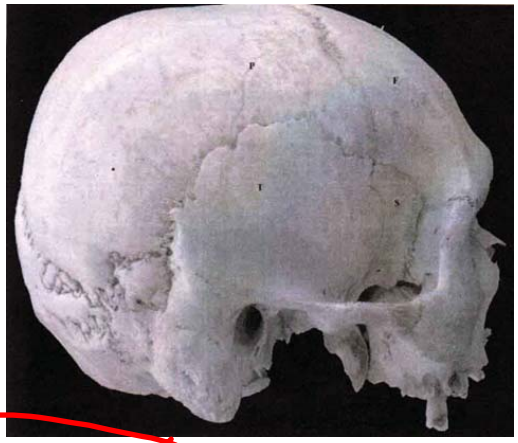
**Picture 1:** Sphenoparietal type of Pterion




Frontotemporal type: Pterionic Suture between frontal and temporal bone.

F-Frontal, P-Parietal, T-Temporal, S-Sphenoid

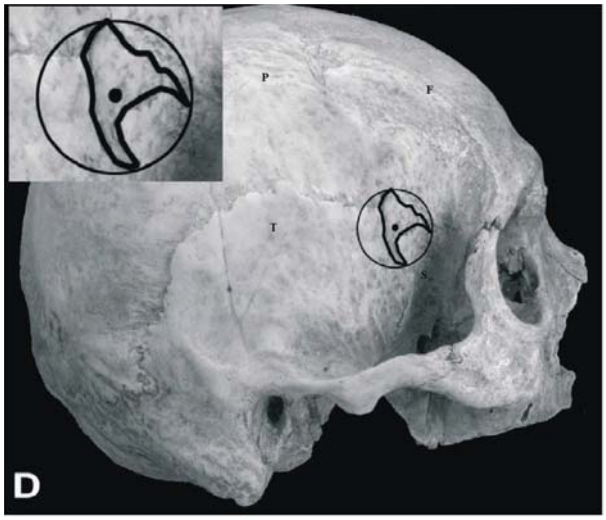
**Picture 2:** Frontotemporal type of Pterion.



üüüü type of pterion

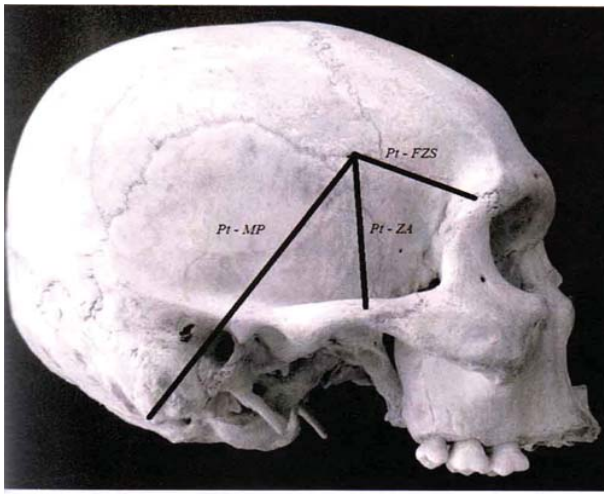
F-Frontal, P-Parietal, T-Temporal, S-Sphenoid

**Picture 3:** Stellate type of Pterion.



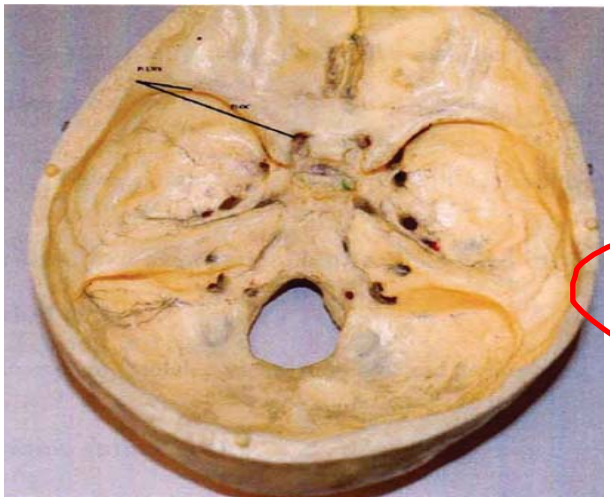

Epipteric Type of Pterion

Picture 4 : Epipteric Type of Pterion



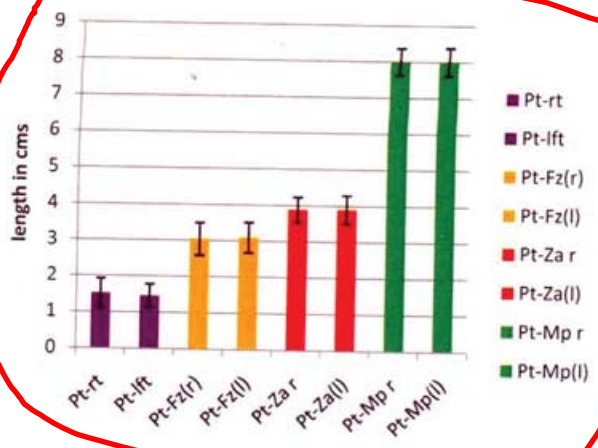

Pt-Pterion, FZS-Frontozygomatic suture, ZA-Zygotamic arch, MP-Mastoid process

**Picture 5:** Showing measurement taken from variable landmarks.



Pt-Pterion, LWS-crest of lesser wing of sphenoid, LOC-Lateral margin of optic canal

**Picture 6:** Showing measurement taken from inner aspects of Pterion to variable land marks.




**Graph 1:** Showing mean and Standard deviation of various landmarks around Pterion in 100 adult skulls.

**Table 1:** Percentages of different types of Pterion in 100 adult skulls.

| Type of Pterion | Right side | Left side | Both sides |
|---|---|---|---|
| Sphenoparietal | 94% | 90% | 92% |
| Frontotemporal | 03% | 03% | 03% |
| Stellate | 00% | 04% | 02% |
| Epipteric | 04% | 02% | 03% |

**Graph 2:** Showing percentages of different types of Pterion in 70 male skulls and 30 female skulls of both right and left sides.


**Table 2:** Showing percentages of different types of Pterion in 70 male and 30 female skulls.

| Sex | Side | SP Type | FT Type | Stellate | Epipteric |
|---|---|---|---|---|---|
| | Right | 92.8% | 2.1% | 0.7% | 0.7% |
| Male | Left | 92.8% | 0.7% | 0.7% | 2.1% |
| | Total | 92.8% | 2.8% | 1.4% | 2.8% |
| | Right | 90% | 1.6% | 1.6% | 1.6% |
| Female | Left | 90% | 1.6% | 1.6% | 1.6% |
| | Total | 90% | 3.3% | 3.3% | 3.3% |

**Graph 3:** Comparison of percentages of different types of Pterion from present study with other previous studies.

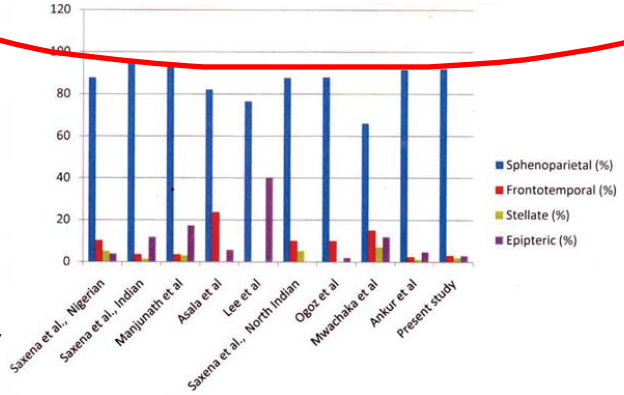


**Table 3:** Comparison of percentages of Pterion types in different populations.

| Study/Population n (Skull), sex | Type of Pterion | | | |
|---|---|---|---|---|
| | Sphenoparietal (%) | Frontotemporal (%) | Stellate (%) | Epipteric (%) |
| Saxena et al[45]., 1988, Nigerian, n = 40, unknown sex | 87.79 | 10.11 | 5.06 | 3.79 |
| Saxena et al., 1988, Indian, n = 72, unknown sex | 95.3 | 3.46 | 1.38 | 11.79 |
| Manjunath et al[30]., 1993, South Indian, n = 172, unknown sex | 93.55 | 3.52 | 2.93 | 17.3 |
| Asala et al[7]., 1996, Nigerian, n = 212, unknown sex | 82.1 | 23.6 | – | 5.7 |
| Lee et al[16]., 2001, Korean, n = 149, unknown sex | 76.5 | – | – | 40.3 |
| Saxena et al[46]., 2003, North Indian, n = 203, both sex | 87.72 | 10.01 | 5.17 | 0 |
| Ogoz et al[39]., 2004, Turkish, n = 26, Male | 88 | 10 | 0 | 2 |
| Mwachaka et al[29]., Kenyan, n = 50, both sex | 66 | 15 | 7 | 12 |
| Anker et al., 2009, West Indian, n = 42, both sex | 91.7 | 2.4 | 1.2 | 4.8 |
| Present study | 92 | 03 | 02 | 03 |

**Table 4:** Distance between Pteion and zygomatic arch in male skulls.

| | Side | N | Mean (cm) | STD. Deviation (cm) | p Value |
|---|---|---|---|---|---|
| **Male** | Right | 70 | 3.90 | 0.39 | 0.70 |
| | Left | 70 | 3.88 | 0.35 | 0.70 |

**Table 5:** Distance between Pterion and zygomatic arch in female skulls.

| | N | Side | Mean (cm) | STD. Deviation(cm) | p Value |
|---|---|---|---|---|---|
| **Female** | Right | 30 | 3.86 | 0.34 | 0.73 |
| | Left | 30 | 3.86 | 0.34 | 0.73 |

**Table 6:** Distance between Pterion and frontozygomatic suture in male skulls.

| | N | Side | Mean (cm) | STD. Deviation (cm) | p Value |
|---|---|---|---|---|---|
| **Male** | 70 | Right | 3.09 | 0.42 | 0.43 |
| | 70 | Left | 3.04 | 0.45 | 0.43 |

**Table 7:** Distance between Pterion and frontozygomatic suture in female skulls.

| | N | Side | Mean (cm) | STD. Deviation (cm) | p Value |
|---|---|---|---|---|---|
| Female | 30 | Right | 3.05 | 0.44 | 0.52 |
| | 30 | Left | 3.03 | 0.46 | 0.52 |

**Table 8:** Distance between Pterion and mastoid process in male skulls.

| | N | Side | Mean (cm) | STD. Deviation (cm) | p Value |
|---|---|---|---|---|---|
| Male | 70 | Right | 8.00 | 0.37 | 1.000 |
| | 70 | Left | 8.00 | 0.39 | 1.000 |

**Table 9:** Distance between Pterion and mastoid process in female skulls.

| | N | Side | Mean (cm) | STD. Deviation (cm) | p Value |
|---|---|---|---|---|---|
| **Female** | 30 | Right | 7.8 | 0.4 | 0.75 |
| | 30 | Left | 7.7 | 0.5 | 0.75 |

**Table 10:** Distance between internal aspect of Pterion and lesser wing sphenoid ridge in male skls.

| | N | Side | Mean (cm) | STD. Deviation (cm) | p Value |
|---|---|---|---|---|---|
| **Males** | 30 | Right | 2.49 | 0.50 | 0.68 |
| | 30 | Left | 2.45 | 0.49 | 0.68 |

**Table 11:** Distance between internal aspect of Pterion and lesser wing sphenoid ridge in female skls.

| | N | Side | Mean (cm) | STD. Deviation (cm) | p Value |
|---|---|---|---|---|---|
| **Females** | 20 | Right | 2.45 | 0.52 | 0.69 |
| | 20 | Left | 2.42 | 0.54 | 0.69 |

**Table 12:** Distance between internal aspect of Pterion and lateral margin of optic canal in male skulls.

| | N | Side | Mean (cm) | STD. Deviation (cm) | p Value |
|---|---|---|---|---|---|
| **Males** | 30 | Right | 4.34 | 0.33 | 0.32 |
| | 30 | Left | 4.40 | 0.28 | 0.32 |

**Table 13:** Distance between internal aspect of Pterion and lateral margin of optic canal in female skulls.

| | N | Side | Mean (cm) | STD. Deviation (cm) | p Value |
|---|---|---|---|---|---|
| **Females** | 20 | Right | 4.30 | 0.32 | 0.35 |
| | 20 | Left | 4.33 | 0.29 | 0.35 |

**Table 14:** Length of the Pterionic suture in male skulls.

| | N | Side | Mean (cm) | STD. Deviation (cm) | p Value |
|---|---|---|---|---|---|
| **Male** | 70 | Right | 1.52 | 0.40 | 0.46 |
| | 70 | Left | 1.46 | 0.32 | 0.46 |

**Table 15:** Length of the Pterionic suture in female skulls.

| | N | Side | Mean (cm) | STD. Deviation (cm) | p Value |
|---|---|---|---|---|---|
| **Female** | 30 | Right | 1.48 | 0.43 | 0.49 |
| | 30 | Left | 1.43 | 0.45 | 0.49 |

The incidence of frontotemporal type of Pterion has also been observed to vary in different groups, being reported of (10.11–23.6%) in Nigerians,[7,12] (15%) of Kenyans[7] (41.1%) of Papuan skulls[15]; which are significantly higher than present study. In the present; which are significantly higher than present study. In the present study the frequency of frontotemporal type of Pterion was (3%) being closest to that reported in other populations of India (Table 3).[13,8] An Epipteric type of Pterion was observed in a small number of skull (3%) in the present study, being significantly less than that reported in Nigerians (23.6%) (Asala S A et al., 1996),[2] Australian Aborigines (18.5%) (Murphy T 1998) and (10.01%) of Northern Indians (Saxena RC et al., 2003)[13] but similar to that in (3.52%) of South Indians (Manjunath KY et al., 1993).[8] Stellate type of Pterion was observed in (02%) of the observations alone in the present study where as it was observed to be (5.06%) in Nigerians (Saxena et al., 1988)[13] and also in Indians (1.38%) it was also found to be (2.93%) in South Indians (Manjunath et al., 1993).[8] Much of study was not highlighted in this type of Pterion by various authors and we found paucity of the literature in this type of Pterion for our present study.

The present study was conducted to note sutural Table 14 and 15, morphology of the Pterion among 100 skulls taken separately apart from the above mentioned skulls of Known gender (30 females and 70 males) and examined on both sides. Sphenoparietal type was observed 92%, in males (92.8%) and in females (90%); frontotemporal 3% in total, (2.85%) in males and (3.33%) in females; stellate type 2% in total, (1.42%) in males and (3.33%) in females; epipteric type 3% in total (2.85%) in males and (3.33%) in females. Sphenoparietal type was more in males (92%) compared to females (90%); frontotemporal type 2.85% in males and 3.33% in females and epipteric 2.85% in males and 3.33% in females.

The sphenoparietal was (92%) in males and (90%) in females in the present study. This was found to be (72.3%) in males and (66.2%) in females in South Indians (Ikedo et al., 1999)5 it was (87%) in male and (82%) in females in Indians (Saxena – 2003).[13]

Stellate type of Pterion was found to be (1.42%) in males and (3.33%) in females in our present study. It was (9.2%) in males and (10.2%) in females by (Ikedo et al., 1999)5 in South Indians.

In present study, as shown in Table 4 and 5 in both sexes, the Pterion was located 3.90 ± 0.38 cm superior to the midpoint of zygomatic arch on right side and 3.88 ± 0.35 cm superior to midpoint of zygomatic arch on the left side of male skull (Picture 5). On the right side the Pterion is situated slightly higher compared to left side of the male skull. But, it is not statistically significant. In female skull, the Pterion was located 3.86 ± 0.34 cm superior to zygomztic arch on right and left sides. Our study coincides with the study done by Ogouz o et al., (2004)[11] where the distances on the right and left sides of the Turkish male skulls were compared from the centre of the Pterion to the midpoint zygomatic arch was 4.05 ± 0.39 cm and 3.85 ± 0.25 cm respectively. The distance between Pterion to midpoint of zygomatic arch on right side of male and female skulls were compared. The distance of male skulls on right side 3.90 ± 0.39 cm is higher than the female skulls 3.86 ± 0.34 cm. The distance between Pterion to midpoint of zygomatic arch on left side of male and female skulls were compared. The distance of male skulls on left side 3.88 ± 0.35 cm is higher than the female skulls 3.86 ± 0.34 cm. The distance between Pterion and midpoint of zygomatic arch in the present study varied significantly (p = 0.43) among males and females. Males had higher Pterion than females. Our study coincides with Mwachaka p et al., (2008)[7] where the distance between the Pterion to the midpoint of zygomatic arch varied significantly among males and females.

The present study shown that the distance between Pterion to frontozygomatic as shown in table-6 and 7, suture among male skulls showed statistical significant side differences among male skulls (p = 0.43). The right side 3.09 ± 0.42 cm is posterior than the left side 3.04 ± 0.45 cm. The distance between Pterion to frontozygomatic suture among female skulls right and left side compared. The right side Pterion 3.05 ± 0.44 cm is posterior than the left side 3.03 ± 0.46 cm. It showed no statistically significant between side differences among female skulls (p = 0.52).The Pterion was 30.35 ± 3.61 mm posterior to frontozygomatic suture on right side. While the left Pterion was 30.34 ± 4.30 mm behind in Kenyans (Mwachaka P et al., 2008).[7] Conversely, the Pterion among the male turks lie 33 ± 4.0 mm and

34.4 ± 3.9 mm behind the frontozygomatic suture on the right and left respectively. The basis for differences among these populations could be genetic or evolutionary (Ikedo T et al., 1999).[5] The Pterion lies 30 to 35 mm away from the frontozygomatic suture (Urzi F et al., 2003).[16] The Pterion in Koreans 26.8 ± 4.5 mm away from the frontozygomatic suture.The distance between Pterion to frontozygomatic suture on right side of male and female skulls were compared. The distance of male skulls on right side 3.09 ± 0.42 cm is more posterior than the female skulls 3.05 ± 0.44 cm. It is showed statistically significant side differences among male and female skulls on the right side (p = 0.43). The distance of male skulls on left side 3.04 ± 0.45 cm is posterior than the female skulls 3.03 ± 0.46 cm. It showed statistically significant sides (p = 0.43). The present study shown that the distance between Pterion and mastoid process shows statistically side difference among male skulls (p = 1.000), as shown in Table 8 and 9, with right side 8.0 ± 0.37 cm and left side 8.0 ± 0.39 cm and in females 7.8 ± 0.4 cm right side and 7.7 ± 0.5 cm on left side. The distance between the internal aspect of the Pterion to the lesser wing sphenoid ridge Table 10 and 11, in 50 calvaria sectioned skulls is 2.49 ± 0.50 cm in right side and 2.45 ± 0.49 cm in left side in male skulls (30). In female skulls (20) 2.45 ± 0.52 cm right side and 2.42 ± 0.54 cm left side with statistical significance p = 0.68 (Nanda A et al., 2001).The distance between internal aspect of the Pterion and lateral margin of optic canal in present study, Table 12 and 13, Picture 6 is 4.34 ± 0.33 cm of right side and 4.40 ± 0.28 cm of left side in male skulls and 4.30 ± 0.32 cm of right side and 4.33 ± 0.29 cm of left side with p = 0.32. The present study shown that the length of Pterionic suture shows the statistical side difference among male skulls (p = 0.46) in sphenoparietal type 1.52 ± 0.40 cm on right side and 1.46 ± 0.32 cm and in frontotemporal type 1.48 ± 0.43 cm on right side and 1.43 ± 0.45 cm. Pterionic suture is not present in epipteric type and stellate type of Pterion. Gender differences in location of this craniometric point were significant; the male Pterion is more posteriorly located on the right and left side compared to the female skulls. This could be because of the larger size of skull in males (Moore KL et al., 1992, William LP et al., 1988).[9,17] Population based differences suggest that various genetic variations in humans underlie the different sutural patterns of the Pterion (Wang Q et al., 2006).[18] Murphy reported that variations of Pterion are likely a result of combination of environmental and genetic factors (Ari Ilknur et al., 2009).[1] Asala concluded that these variations are "epigenetic" (Asala SA et al., 1996).[2] In the present study the Pterion is located more superiorly (its distance from the midpoint of zygoma) and more posteriorly (its distance from the frontozygomatic suture) in males compared to that of females on both sides. Since there was minimal side differences among the right side measurements of male skull to that of left side measurements of male skull and also in comparision to female right side measurement to female left side used to locate the Pterion, this landmark can reliably be located using the frontozygomatic suture and midpoint of zygoma according to the sexual differences.

## Conclusion

Knowledge of the location and relations of Pterion is important in relation to surgical intervention, particularly with respect to course of the branches of middle meningeal artery and Broca's motor speech area on the left side. The distances between the Pterion, lesser wing of sphenoid ridge and optic canal are of practical importance in surgical approaches to these regions via Pterion. Gender differences in the location of this craniometric point were significant. This could be because of large size of skulls in males (Williams). In the present study Pterion is located more superiorly (the distance from the midpoint of zygomatic arch) and more posteriorly (its distance from frontozygomatic suture) in males compared to that of the female on both sides. There was a minimal side differences among the right side to left side measurements and also comparision to female skulls right and left sides used to locate Pterion. This landmark can reliably be located using frontozygomatic suture and midpoint of zygomatic arch according to sexual differences. This information may be useful in planning prior to surgery and recognition of this anatomy may render Pterional craniotomy safer. The present study has shown separate incidence of Pterion in known male and female skulls. Sphenoparietal variety was predominant type of Pterion. There is a considerable variation between types of Pterion and Point of division of middle meningeal artery. This difference of incidence was found to be statistically insignificant and may be due to population differences or racial differences. Relationship between the middle meningeal artery and the Pterion is of great importance in the field of surgery, anthropogy and forensic medicine. Hence, the present study has been compared and correlated with earlier studies done by Pterion workers.Types

and the position of Pterion in normal skulls vary among individuals and different racial groups. Sex has influence on the occurrence of the Pterion type, while sex, side and age affect the location of Pterion. Therefore, accurate and up-to-date data are required when performing intracranial surgery guided by recognizable bony landmarks preoperative radiographic assessment (CT, MRI) of Pterion should be confirmed to be anatomic guide line for surgeons in determining a safe location for performing surgical microsurgical procedures.

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# Morphological Variations in the Insertion of Coracobrachialis with Neurovascular Entrapment in the Arm

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**Abstract**

The coracobrachialis muscle is a muscle of arm that shows several variations in its attachments. It is inserted into the middle 5 cm of the medial border of the humerus. The median nerve crosses the brachial artery from lateral to medial near the insertion of coracobrachialis and enters the cubital fossa. The nerve and the artery may vary in their course This study was conducted in 36 embalmed adult upper limbs of both sexes of age group between 50–80 years from the Department of Anatomy, KMC, Chennai were studied. In this study, a musculoaponeurotic tunnel formed by coracobrachialis muscle was observed in 2.8% of the specimen in which entrapment of brachial artery and median nerve was present. The abnormality reported in the present study may lead to neurovascular compression syndrome in the upper limb. Knowledge of anatomical variations in the muscular structure and its related neurovascular entrapment is important surgically for orthopaedic surgeons, plastic surgeons and also physiotherapists clinically.

**Keywords:** Coracobrachialis tunnel; Variations; Median nerve; Entrapment syndrome.

## Introduction

The coracobrachialis muscle shows several interesting morphological and anatomical characteristics. It is the counterpart in the arm of the adductor longus/brevis/magnus of the thigh. It arises from the apex of the coracoid process, along with the short head of biceps. It is inserted into the middle 5 cm of the medial border of the humerus. The muscle is pierced by musculocutaneous nerve and supplied by it. It is a weak flexor of the arm.[1,2]

The brachial artery is a continuation of the axillary artery and it is superficial throughout its course in the arm along with the median nerve. The median nerve is formed by its medial and lateral root coming from medial and lateral cords of brachial plexus respectively. It descends laterally till middle of the arm. Then it crosses the brachial artery from lateral to medial near the insertion of coracobrachialis and enters the cubital fossa.

Knowledge of anatomical variations in the muscular structure and its related neurovascular entrapment is important surgically for orthopaedic surgeons, plastic surgeons and also physiotherapists clinically, hence the present study was done to observe the insertion of coracobrachialis and course of the median nerve and brachial artery.

## Materials and Method

The study was conducted on 36 upper limbs from embalmed cadavers from the Department of Anatomy, KMC, Chennai. A longitudinal incision was made in the anterior surface of brachial fascia from the level of pectoralis major to the elbow. The limbs were routinely dissected for observing

the insertion of coracobrachialis. The course of the median nerve and brachial artery were observed. The photograph of the variations is taken for proper documentation and ready reference.

## Results

In 35 specimens (97.2%), the insertion of coracobrachialis was to the middle 5 cm of the medial border of the humerus; and the course of brachial artery and the median nerve was normal, that is, the median nerve crossed the brachial artery from lateral to medial near the insertion of coracobrachialis and entered the cubital fossa.

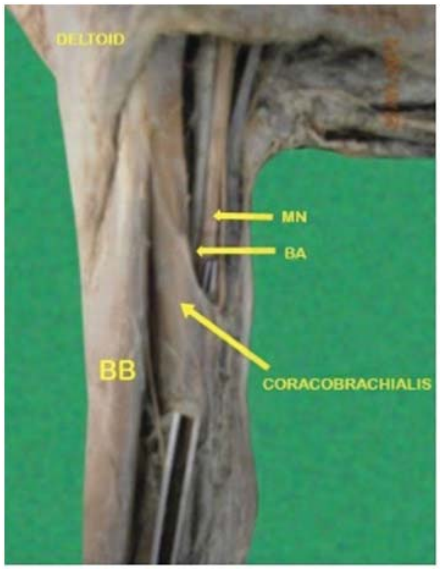


**Fig. 1:** Showing the Musculo aponeurotico fibres of the Coraco brachialis muscle formed a tunnel overlapping the Brachial artery and the Median nerve.

In one specimen (2.8%), a tunnel was formed by coracobrachialis muscle in the middle 1/3 of right upper limb and it was merging with the medial intermuscular septum. The length of the tunnel was measured about 3cm. It was unilateral, whereas in the left arm of the same cadaver, it was normal. An entrapment of the brachial artery and the median nerve was observed in this case in the tunnel formed by the coracobrachialis.

## Discussion

Many authors (Standring S (2005), Mcminn RMH (1990), Morris (1953), Ray B et al (2004)[1,2,3,4] have quoted that the coracobrachialis muscle fibre /slips have been seen superficial to the neurovascular bundle in the arm. A recent study quoted that the coracobrachialis muscle is formed a 3 cm length tunnel for the passage of neurovascular bundle in the arm which is very unusual.

There are three well defined entrapment syndromes involving the median nerve and its branches namely carpal tunnel syndrome, pronator teres syndrome and anterior interosseous syndrome. A few case reports (Dharap AS (1994), El- Nagger M et al (2001) were found in the literature revealed that the possible median nerve entrapment due to third head of biceps brachii.[5,6] Even though anatomy literature hardly mentions the median nerve compression due to bicipital aponeurosis, a few researches (El- Nagger M et al 2004) say that it could be a case of high median nerve compression along with the brachial artery.[7]

The clinical implication of the slip of the Coracobrachialis is that it has the potential to cause the median nerve entrapment and the brachial artery compression. Vollala VR et al 2008 have described about the compression of the median nerve and the brachial artery with anomalous muscle/slip from the muscles such as coracobrachialis, brachialis, pronator teres, accessory head of flexor pollicis longus.[8]

In the present study, the tunnel was formed by the coracobrachialis muscle which arose from the superficial fibre with its aponeurosis 3 cm in length, extending downward and overlapping the median nerve and brachial artery to get inserted into the medial intermuscular septum.

The coracobrachialis muscle reported in this case may be explained on the basis of the embryogenesis of the muscles of the arm. Lewis WH (1910), stated that during development of the limb bud, mesenchyme of the lateral plate mesoderm develops into the intrinsic muscles of the upper limb. At certain stage of development, a single muscle-mass primordium differentiates into separate layers of muscle. Thereafter, some muscle primordia will disappear through cell death called apoptosis. The variation in the present study may be due to failure of muscle primordia to disappear during embryological development.[9]

The insertion of coracobrachialis in the form of Musculo-aponeurotic tunnel into the intermuscular septum has not been noted previously. Since the median nerve and the brachial artery passed deep to this lengthy musculoaponeurotic tunnel, percentage of compression is very high. The possibility of coracobrachialis muscle anomaly should therefore be considered as an effective clinical point of neurocompressive syndrome. Clinically these kinds of tunnels will produce symptoms in the forearm and hand also.

## Conclusion

The abnormality reported in the present study may lead to neurovascular compression syndrome in the upper limb. Knowledge of anatomical variations in the muscular structure and its related neurovascular entrapment is important surgically for orthopaedic surgeons, plastic surgeons and also physiotherapists clinically. Therefore, the knowledge about this kind of rare variations are important for surgeons to avoid mislead diagnosis and treatment.

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*Legend:*

MN-Median nerve

BA- Brachial artery

BB- Biceps brachii

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*Original Article*

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# A Comparative Study to Evaluate The Morphometry of Placenta and Foetus in Different Grades of Toxemia of Pregnacy and Normotensive Pregnant Women

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**Abstract**

The placenta is a unique organ, short lived by design. Its existence is vital for the persistence of human embryo/foetus in the intra uterine environment. Structural and functional derangement of placenta arouses a considerable interest, as this may be the only index to measure adequacy of the foetal environment. Hypertensive disorders generating complications during pregnancy (Toxaemia of pregnancy) which are common and forming deadly characters along with haemorrhage and infection. Maternal hypertension (toxaemia of pregnancy) is diagnosed in 6–10% of all deliveries which is related with 22% of perinatal foetal deaths and 30% of maternal death. The present study has done in 240 pregnant mothers, divided into four groups 40 cases of mild preeclampsia, 40 cases of severe preeclampsia, 40 cases of Eclampsia, 120 cases of control (Normotensive) pregnant women admitted in Department of Obs and gynaecology, Rama medical college, Hospital and research centre, Mandana, Kanpur (Up) and Shadan institute of medical sciences, Peeranchuruvu, Hyderabad, Telangana (India). The placentae were weighed with a standard weighing machine. The fetal weight was noted from the case records provided. In this present study the mean placental, birth weights were low in different grades of toxemia of pregnancy when compared with control group. The fetoplacental weight ratio was higher in cases of eclampsia, severeand mild preeclampsia when compared with control group.

**Keywords:** Preeclampsia; Eclampsia; Placenta weight; Foetal weight; fetoplacental weight ratio.

## Introduction

The placenta is a unique organ, short lived by design. Its presence is vital for the survival of human embryo/foetus in the intra uterine environment. The placenta performs variety of functions, extending from anchoring the fertilized ovum, preventing its rejection by the maternal immune system to permit the transport of nutrients and wastes between the mother and the embryo/foetus. (Emin m et al.,2010). Structural and functional instability of placenta arouses a considerable interest, as this may be the only yardsticks to measure adequacy of the foetal environment (Benrischke k and Kauffmann p 1990). As the placenta is the direct connection between mother and foetus, the investigation of placenta gives a clear idea of what had happened with it, when it was in the mother's womb and what is going to happen with the foetus in future (Burke CJ and Tannenberg AE 1995).

Hypertensive disorders (Toxaemia of pregnancy) are generating complicationsduring pregnancy which are common and forming fatalcharactersalong with haemorrhage and infection (ACOG 2002). Pre-eclampsia (PE) is a disease occurs during the

pregnancy which is specified by the commencement of hypertension and the presence of protein in the urine in large amount (Eiland, Elosha, Nzerue, et al.,2012). Pre-eclampsiais considered if one or more of the following criteria are present:Blood pressure 140 mm Hg or higher systolic or 90 mm Hg or higher diastolic after 20 weeks of gestation in a woman with previously normal blood pressure. Proteinuria: 0.3g or more of protein in a 24-hours urine collection (usually correspond with 1+ or greater on a urine dipstick test) known as mild preeclampsia (ACOG 2002). When systolic blood pressure of 160 mm of Hg or higher or 110 mm of Hg or higher diastolic on two occasions at least six hours apart in a woman on bed rest,itis associated with proteinuria and oliguria, cerebral or visual disturbances, pulmonary oedema of cyanosis, epigastric pain or right upper quadrant pain, impaired liver function, thrombocytopenia, foetal growth restriction condition is known as severe preeclampsia. Eclampsia considered by presence of seizures during the pregnancy along with the signs and symptoms of severe preeclampsia (ACOG 2002).

Toxaemia of pregnancy is animportantreasonfor large number of maternal deaths and thereof foetal deaths. Maternal hypertension (toxaemia of pregnancy) is diagnosed in 6–10% of all deliverieswhichis associated with 22% of perinatal foetal deaths and 30% of maternal death (Fernando arias 2000).

Perinatal outcome powerfully influenced by gestational age and the severity of hypertension as expressed by the need for antihypertensive treatment, irrespective if the underlying syndrome preeclampsia and eclampsia is associated with degree of fetal injury. The main impact on the fetus is under nutrition as a result of utero-placental vascular insufficiency, which leads to growth retardation and low birth weight. Long term follow-up studies have demonstrated that babies who suffered intra uterine growth retardation are more likely to develop diabetes mellitus, hypertension, coronary artery disease in adult life due to catecholamine released from the mother at the time gestational period (Alicia M and Lapidus MD 2011, Perloff D 1998).

## Materials and Methodology

The present study has done in 240 pregnant mothers, divided into four groups 40 cases of mild preeclampsia, 40 cases of severe preeclampsia, 40 cases of Eclampsia, 120 cases of control (Normotensive) pregnant women admitted in Department of Obs and Gynae, Rama Medical College Hospital and research Centre, Mandhana, Kanpur, U.P (India) and Shadan institute of medical sciences, Peeranchuruvu, Hyderabad, Telangana (India). All the cases and controls pregnant women have filled written consent form for willing to give their samples for this study. Inclusion criteria: Antenatal mothers diagnosed with toxemia of pregnancy with their blood pressure of 140/90 mm of Hg or more in to case group. Standard questionnaire was prepared to get the past and present medical/surgical history of cases and controls. In questionnaires, several parameters were taken such as history of renal, liver failure, seizures, mother who has the hypertensive disorder before the pregnancy and other medical problems. The permission has taken from the institution ethical committee prior to conduction of this study. The placentae with cord and membranes were collected and examined immediately after the delivery for abnormality of the umbilical cord and membranes. The amnion and chorion were trimmed from all placenta. The umbilical cord was cut at a distance of 10 centimeters from the site of insertion. Placentae were washed in slow running tap water, dried with the help of blotting paper. The placentae along with the umbilical cord were given code numbers and were preserved in 10% formalin solution. The placentae were weighed with a standard weighing machine. The fetal weight was noted from the case records provided by the department of obstetrics and gynecology.

### *Statistical Analysis*

The data were statistically analyzed. The student t-test was used to compare the mean values of placental and fetal weight and fetoplacental weight ratio among case and controls.

## Results

The study sample was 240, Distributed in to 40 samples of mild preeclampsia, 40 samples of severe preeclampsia, 40 samples of eclampsia and 120 cases of normotensives mothers. For comparing the placentae, fetal weight and fetoplacental weight ratio to determine its increasing or decreasing trends, the mean value for each group was determined.

**Table 1:** Comparison of placentae, fetal weight and fetoplacental weight ratio in between control and case with sub groups.

| Groups | No of samples | Placental weight Mean±S.dev (Grams) | Foetal weight Mean±S. dev (Grams) | Fetoplacental weight ratio Mean±S.dev |
|---|---|---|---|---|
| I. Control | 120 | 444.16±100.77 | 2804.62±405.4 | 6.54±1.27 |
| II. Mild PET | 40 | 386.02±98.75 | 2548.75±582.66 | 6.84±1.45 |
| II. Severe PET | 40 | 295.62±68.25 | 2057.50±567.88 | 7.34±2.21 |
| IV. Eclampsia | 40 | 231.98±45.20 | 1855.00±744.8 | 7.90±2.27 |

**Table 2:** Comparison of placentae weight in between control and case with sub groups.

| Groups | No of samples | Mean±S.dev (Grams) | P value compared with control group |
|---|---|---|---|
| I. Control | 120 | 444.16±100.77 | – |
| II. Mild PET | 40 | 386.02±98.75 | <0.002 |
| II. Severe PET | 40 | 295.62±68.25 | <0.0001 |
| IV. Eclampsia | 40 | 231.98±45.20 | <0.0001 |

**Table 3:** Comparison of fetal weight in between control and case with sub groups.

| Groups | No of samples | Mean±S.dev (Grams) | P value compared with control group |
|---|---|---|---|
| I. Control | 120 | 2804.62±405.4 | – |
| II. Mild PET | 40 | 2548.75±582.66 | = 0.045 |
| II. Severe PET | 40 | 2057.50±567.88 | <0.0001 |
| IV. Eclampsia | 40 | 1855.00±744.8 | <0.0001 |

**Table 4:** Comparison of fetoplacental weight ratio in between control and case with sub groups.

| Groups | No of samples | Mean± S. Dev | P value compared with control group |
|---|---|---|---|
| I. Control | 120 | 6.54±1.27 | – |
| II. Mild PET | 40 | 6.84±1.45 | =0.760 |
| II. Severe PET | 40 | 7.34±2.21 | =0.047 |
| IV. Eclampsia | 40 | 7.90±2.27 | <0.0001 |

## Discussion

Mohan et al (1989) reported in that mean placental and foetal weight were less in preeclampsia and eclampsia groups when compared with control group and also noticed placental and fetal weight reduced significantly as the severity of the disease increases (Table 5) .

Das et al (1996) reports also suggested that placental and fetal weight reduces significantly as the severity of the diseaseincreases (Table 5). In their study mentioned majority of birth weights in severe PET and eclampsia groups were <2.5kg due to the very low placental weight leads to intra uterine growth retardation (IUGR).

Summit Gupta et al (2013) study also revealed that placental, birth weights were significantly reducing in mild, severe preeclampsia groups when compared with control group.

Raghavendra et al (2014) also in their study noticed mean placental and birth weights were reduced significantly with different grades of PIH. They have also noticed significant correlation between

**Table 5:** Comparison of the mean placental, fetal weight and fetoplacental weight ratio between present and previous studies.

| Study | Groups | No of cases | Plcaenta Weight in grams | Foetal weight Mean±S.dev (Grams) | Feto-placental weight ratio |
|---|---|---|---|---|---|
| **Mohan et al** | Control | 20 | 476 | 2.8 | 6.08:1 |
| | Mild PET | 10 | 477 | 2.86 | 6.00:1 |
| | Severe PET | 20 | 440 | 2.3 | 5.28:1 |
| | Eclampsia | 4 | 381.70 | 1.6 | 5.18:1 |
| **Das et al** | I | 20 | 442 | 2.9 | 6.56:1 |
| | II | 20 | 422 | 2.6 | 6.15:1 |
| | III | 20 | 377 | 2.05 | 5.43:1 |

| Study | Groups | No of cases | Plcaenta Weight in grams | Foetal weight Mean±S.dev (Grams) | Feto-placental weight ratio |
|---|---|---|---|---|---|
| | IV | 20 | 355 | 1.84 | 5.21:1 |
| **Raghavendra et al** | Control | 50 | 488.42 | 3.01 | 6.17:1 |
| | Mild PET | 29 | 406.69 | 2.54 | 6.26:1 |
| | Severe PET | 16 | 374.68 | 2.67 | 7.13:1 |
| | Eclampsia | 05 | 390.00 | 2.1 | 5.38:1 |
| **Present study** | I | 120 | 444.16±100.77 | 2804.62±405.4 | 6.54±1.27 |
| | II | 40 | 386.02±98.75 | 2548.75±582.66 | 6.84±1.45 |
| | III | 40 | 295.62±68.25 | 2057.50±567.88 | 7.34±2.21 |
| | IV | 40 | 231.98±45.20 | 1855.00±744.8 | 7.90±2.27 |

fetoplacental weight ratio and severity of the disease.

Conflicting results were found about foetaplacental weight ratio and severity of the disease in Mohan et al (1989) and Das et al (1996) studies. They mentioned foetaplacental weight ratio was reduced as the severity of the disease increases. Their study results show foetus weight reduced significantly when compared with placental weight as the severity of the disease increases.

In this present study the mean placental, birth weights were low in different grades of toxemia of pregnancy when compared with control group. The fetoplacental weight ratio was higher in cases of mild, severe preeclampsia and eclampsia when compared with control group. Present study results correlated with study results of Raghavendra et al (2014). It shows placental weight reduced significantly when compared with foetus weight as the severity of the disease increases. Severity of the toxaemia of pregnancy significantly influences the morphometry of the placenta then foetus.

## Conclusion

According to the results generated by the present study, the mean weight of placenta in sub groups of Toxaemia of pregnancy group was low compared to control group. In present study, the birth weight was low with increasing grades of hypertension compared to control groups. The fetoplacental weight ratio was higher in case eclampsia, severe and mild preeclampsiawhen compared with control group. From the present study, it can be concluded that, the toxemia of pregnancy adversely influences the weight of the placenta and foetal outcome. Thus, placenta acts as an effective index by examination of which we can predict the status of foetus in neonatal life as it can act as an indicator to the overall development of the foetus.

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**Results**

Present your results in logical sequence in the text, tables, and illustrations, giving the main or most important findings first. Do not repeat in the text all the data in the tables or illustrations; emphasize or summarize only important observations. Extra or supplementary materials and technical details can be placed in an appendix where it will be accessible but will not interrupt the flow of the text; alternatively, it can be published only in the electronic version of the journal.

**Discussion**

Include summary of key findings (primary outcome measures, secondary outcome measures, results as they relate to a prior hypothesis); Strengths and limitations of the study (study question, study design, data collection, analysis and interpretation); Interpretation and implications in the context of the totality of evidence (is there a systematic review to refer to, if not, could one be reasonably done here and now?, What this study adds to the available evidence, effects on patient care and health policy, possible mechanisms)? Controversies raised by this study; and Future research directions (for this particular research collaboration, underlying mechanisms, clinical research). Do not repeat in detail data or other material given in the Introduction or the Results section.

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List references in alphabetical order. Each listed reference should be cited in text (not in alphabetic order), and each text citation should be listed in the References section. Identify references in text, tables, and legends by Arabic numerals in square bracket (e.g. [10]). Please refer to ICMJE Guidelines (http://www.nlm.nih.gov/bsd/uniform_ requirements.html) for more examples.

**Standard journal article**

[1] Flink H, Tegelberg Å, Thörn M, Lagerlöf F. Effect of oral iron supplementation on unstimulated salivary flow rate: A randomized, double-blind, placebo-controlled trial. J Oral Pathol Med 2006; 35: 540-7.

[2] Twetman S, Axelsson S, Dahlgren H, Holm AK, Källestål C, Lagerlöf F, *et al.* Caries-preventive effect of fluoride toothpaste: A systematic review. Acta Odontol Scand 2003; 61: 347-55.

**Article in supplement or special issue**

[3] Fleischer W, Reimer K. Povidone iodine antisepsis. State of the art. Dermatology 1997; 195 Suppl 2: 3-9.

**Corporate (collective) author**

[4] American Academy of Periodontology. Sonic and ultrasonic scalers in periodontics. J Periodontol 2000; 71: 1792-801.

**Unpublished article**

[5] Garoushi S, Lassila LV, Tezvergil A, Vallittu PK. Static and fatigue compression test for particulate filler composite resin with fiber-reinforced composite substructure. Dent Mater 2006.

**Personal author(s)**

[6] Hosmer D, Lemeshow S. Applied logistic regression, 2nd edn. New York: Wiley-Interscience; 2000.

**Chapter in book**

[7] Nauntofte B, Tenovuo J, Lagerlöf F. Secretion and composition of saliva. In: Fejerskov O,

Kidd EAM, editors. Dental caries: The disease and its clinical management. Oxford: Blackwell Munksgaard; 2003. p. 7-27.

**No author given**

[8] World Health Organization. Oral health surveys - basic methods, 4th edn. Geneva: World Health Organization; 1997.

**Reference from electronic media**

[9] National Statistics Online—Trends in suicide by method in England and Wales, 1979-2001. www.statistics.gov.uk/downloads/theme_health/HSQ20.pdf (accessed Jan 24, 2005): 7-18. Only verified references against the original documents should be cited. Authors are responsible for the accuracy and completeness of their references and for correct text citation. The number of reference should be kept limited to 20 in case of major communications and 10 for short communications.

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