

**“Sexual Dimorphism and Morphometric
Analysis of Foramen Magnum, Mastoid
Process, Styloid Process and Foramen Ovale”**

A THESIS SUBMITTED TO



D. Y. PATIL EDUCATION SOCIETY, KOLHAPUR

(Deemed to be University, Declared u/s 3 of the UGC Act 1956)

Accredited by NAAC with A⁺⁺ Grade

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DOCTOR OF PHILOSOPHY IN ANATOMY (MEDICAL)

UNDER THE FACULTY OF MEDICINE

BY

DR. PARASHURAM SHIVAPPA KOLI

M. Sc. (Medical Anatomy)

UNDER THE GUIDANCE OF

DR. VASUDHA RAVINDRA NIKAM

M.S. (Human Anatomy)

Associate Dean, Professor and Head, Department of Anatomy

D. Y. Patil Medical College, Kolhapur

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Dr. Parashuram Shivappa Koli
Research scholar,
Faculty of medicine,
Kolhapur


Mr. Suraj Vankundre
Mr. Suraj Vankundre
System Analyst
D.Y. Patil Education Society, Kolhapur
(Deemed to be University)

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And to the best of my knowledge and belief the work embodied in this thesis has not formed earlier the basis for the award of any degree or similar title of this or any other university or examining body.

Place: Kolhapur

Date:

Head of Department

Dr. Mrs. Vasudha R. Nikam

Associate Dean, Professor and Head

Department of Anatomy

D. Y. Patil Medical College, Kolhapur.

Research Guide

Dr. Mrs. Vasudha R. Nikam

Associate Dean, Professor and Head

Department of Anatomy

D. Y. Patil Medical College, Kolhapur

Research Director and Dean CIR

Prof. (Dr.) C. D. Lokhande

Center for Interdisciplinary Research,

D.Y. Patil Education Society,

(Deemed to be University), Kolhapur

Dean,

Prof. and Dean (Dr.) R. J, Khyalappa

D. Y. Patil Medical College,

D.Y. Patil Education Society,

(Deemed to be University), Kolhapur

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Place: Kolhapur

Date:

Dr. Parashuram Shivappa Koli

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ABBREVIATIONS

AST-MS	Asterion to mastoidale
AST-PO	Asterion to Porion
APD	Antero-posterior Diameter
APL	Antero-Posterior length
CT	Computed tomography
CI	Confidence Interval
CF	Center of foramen
D1-CF	Distance from root of zygoma to center of foramen
D2-CF	Distance from midline of skull to center of foramen
EAM	External acoustic meatus
FMA	Foramen Magnum Area
FMI	Foramen Magnum Index
FML	Foramen Magnum length
FMW	Foramen Magnum width (Transverse diameter)
FNAC	Fine needle aspiration cytology
LSP	Length of Styloid Process
MI	Mastoid Index
ML	Mastoid length
MLD	Medio-lateral Diameter
MRI	Magnetic resonance imaging
PEIM	Posterior border of incisura mastoidea
PO-MS	Porion to Mastoidale
S	Shape
SEM	Standard Error of the Mean
TW	Transverse Width

ABSTRACT

Background: Foramen magnum was derived from Latin word, the meaning of which was a big opening present antero-medially in the occipital bone. The basic idea of the normal anatomy of the skull base in which mostly foramen magnum and structures related to foramen magnum are helpful for clinicians to correlate correct diagnosis and treatment of various diseases.

The mastoid, a conspicuous projection from the temporal bone that resembles a breast like projection, is situated postero-inferiorly to the external auditory meatus. The most dimorphic bone in the skull and a key component of sexual dimorphism is the mastoid process.

The word styloid process derived from the word “stylos” which means the pillar, in Greek language. This process was present in temporal bone of skull and lies anterior to the Stylomastoid foramen. It was cylindrical in shape it gradually tapers towards apex like pinnacle.

There are many foramina present in greater wing of sphenoid bone; the foramen ovale is one of them. The structure's passing through this foramen is mandibular nerve, accessory meningeal artery, lesser petrosal nerve, and emissary vein.

OBJECTIVES

- > To derive multivariate analysis that will help us in establishing the sex.
- > To evaluate the use of foramen magnum, mastoid process, styloid process, foramen ovale, measurement as a tool for sex determination in unknown age and sex of the skulls.

MATERIAL AND METHOD: The random sample size was 100 dry human skulls collected from the Department of Anatomy, D.Y. Patil Medical College, Kolhapur. The skulls were free from any fracture or deformities. Morphometric measurements of the foramen magnum, mastoid process, styloid process, and foramen ovale, were taken with Digital Vernier Caliper graduated to the last 0.01 mm

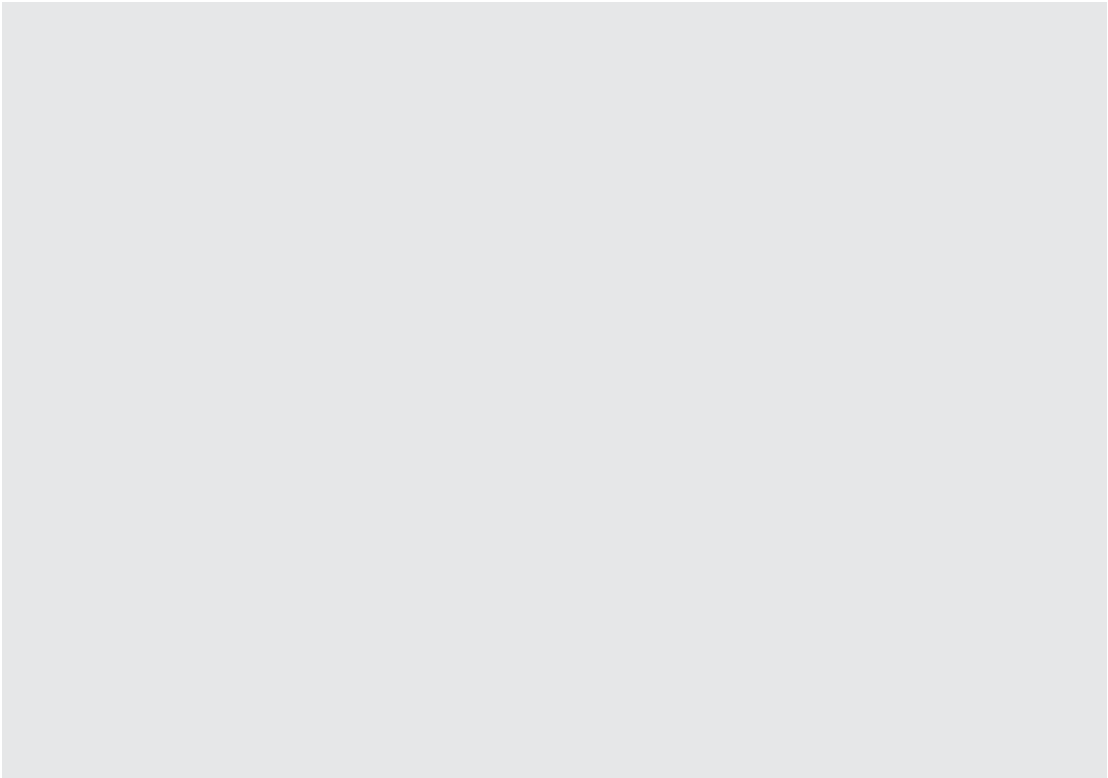
Keywords

Digital Vernier Caliper, Standard Flexible Steel Tape, Thread, Chalk, Marker and Scale.

RESULTS

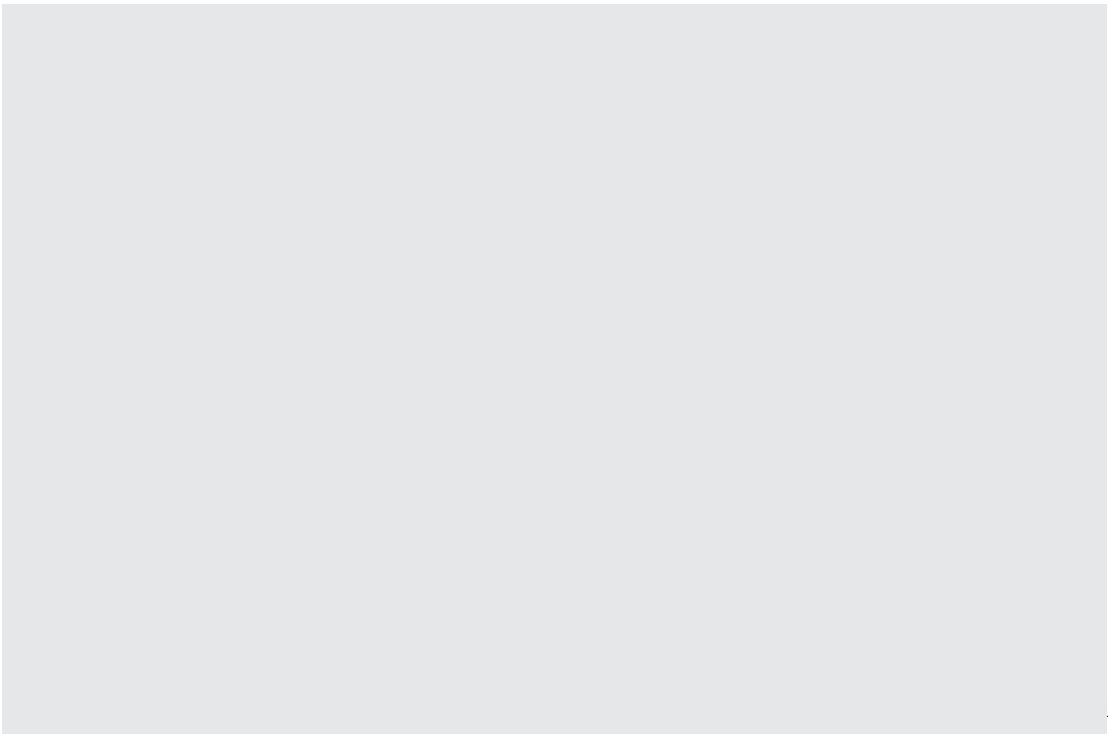
Parameter	Results in Males	Results in Females
Diameter of Styloid Process Normal range (25-30 mm)	• 46 mm in 8 skulls on Right side • 35 mm in 3 skulls on left side • 36 mm Bilateral only in One skull	
Antero-posterior diameter of Foramen Ovale NR (up to 8 mm)	• > 8mm on right side= 14 skulls, • > 8mm on Left side= 2 skulls. • > 8mm on Bilaterally= 17 skulls	• > 8mm on right side = 5 skulls • > 8mm on Left side = 2 skulls No bilateral data found
Transverse width of foramen Ovale NR (up to 2 mm)	• > 2 mm on right side = 14 skulls • > 2 mm on left side = 11 skulls	• > 2mm on Bilaterally 1 skull
Foramen magnum shape	Round shape = 37 Ovale shape = 13	Round shape = 30 Ovale shape = 20

- Diameter of Mastoid triangle was more in males than in females. (Statistical significant)
- Diameter of Mastoid index was more in females than in males. (Statistical significant)
- Diameter of foramen magnum area was more in males compare to females.



CHAPTER - I

INTRODUCTION



CHAPTER - I**SEXUAL DIMORPHISM AND MORPHOMETRIC ANALYSIS OF FORAMEN
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CHAPTER - I

INTRODUCTION

1.1.1 The foramen magnum

The term “foramen magnum” comes from Latin word it refers to a large orifice that is located in the antero-median region of the occipital bone. Clinicians can more accurately diagnose and treat a variety of illnesses if they have a basic understanding of magnum and structures associated to it. ^[1]

The foramen magnum had an oval form and was wider at the back. Its antero-posterior diameter is lengthy. The medulla oblongata lower end, meninges, spinal accessory nerve, vertebral arteries, dens’ apical ligament, and tectorial membrane are all located within it.^[1] The condyles of the occipital bone overlapped the anterior edge of the foramen magnum, where it joins the atlas bone’s superior articular facet.

The foramen magnum’s measurements, which are useful in anthropology and forensic research, determine the gender of a human skull. ^[2-3] When additional areas of the craniofacial bone are involved, such as in serious injury, accidents, fire, or explosion instances, information from morphometric analysis can be helpful for Orthopedicians, radiologists, anesthetists, and neurosurgeons, in addition to anatomists, place greater importance on the morphometric analysis and changes in the foramen magnum’s size. ^[4]

Now days the newer imaging techniques are MRI (magnetic resonance imaging and CT (Computed tomography) these tools used in the department of diagnostic medicine and they consider these parameters are in relation of foramen magnum with its variations.

Our current study’s objective was to quantify the foramen magnum’s length, width, index, and area in dry human skull. In relation to gender along with variations in shapes of foramen magnum.

1.1.2 The mastoid process

The mastoid process of the skull have very important role play in determination of the sex because of its anatomical position at its baso- lateral part of temporal bone , this part is most resistant to damage and most protected , so it is very dimorphic bone of its size and robustness. The many studies analyze that the morphometric and morphology of cranium also plays an important role in the sexual dimorphism.

The mastoid process is a conspicuous, slender projection that resembles a breast like projection that is located postero-inferiorly to the external auditory meatus on the inferior face of the temporal bone. ^[6] It may analyze the baseline data for sex determination of skull.

Determination of sex can be taken by three variables, mastoid length, mastoid breadth (medio-lateral diameter) and antero-posterior diameter, mastoid area, and mastoid size. The temporal bone was paired bone and it has four parts: squamous part, styloid part, tympanic part and petro-mastoid part. The petro-mastoid part was again divided in two parts mastoid and petrous part. ⁽⁷⁾

Outer surface of mastoid process is roughened by muscular attachment of auricular posterior, and occipito-frontalis. And lateral surface was by splenius capitis, longissimus capitis and sternocleidomastoid muscles.

Due to the anatomical advantageous placement of the skull, the individual parts of the skull like the mastoid process are being analyzed for determination of sex.

Purpose of the current study was to assess how well the mastoid process parameters were used to determine sex in the remains of mutilated and decomposing human skulls. The goal of the current study is to determine the sexual dimorphic reliability of the mastoid process morphometric analysis utilizing discriminant function analysis.

There are greater differences in males than females in the mean mastoid length [25.32 mm], the asterion-mastoidale [48.33 mm], the asterion-prion [44.96 mm], the medio-lateral diameter [10.71 mm], the antero-posterior diameter [21.60 mm], and the porion-mastoidale [29.86 mm]. Its “p” value indicates that it is extremely significant for determining sex. ^[8–12]

Anthropological knowledge of human skeleton was important parameter in identification of this biological profile. The first indicator for sex determination was pelvic bone and pelvis; it is more accurate than skull. ^[13]

Cranium was also a highly reliable sign of sexual dimorphism, with up to 92% of studies demonstrating this. ^[14]

1.1.3 The styloid process

A slender, pointed like projection present on inferior aspect of temporal bone called as styloid process. The length varies few millimeters to average 2.5 cm. mostly it is straight and it can show the curvature antero-medially.

The proximal part (tympanohyal) is covered by the tympanic plate and distal part (stylohyal) is attached by the muscles and ligaments. The Greek word “stylos,” which meaning “the pillar” is the source of the name “styloid process”, [15-17]

This process is located in front of the Stylomastoid foramen and was found in the temporal bone of the skull. It has a cylindrical shape that progressively tapers to a pinnacle-like summit. Its apex is situated between the internal and external carotid arteries in the tonsillar region of the pharynx's lateral wall.

The glossopharyngeal nerve is closely related to the tonsillar fossa [18]. The stylomandibular ligament arises, the styloglossus muscle originates, and it is inserted on the mandibular angle. Its tip offers attachment to the stylohyoid ligament up to the lesser cornu of the hyoid bone. Nerves and vessels are two other components that are connected to the styloid process. The muscles that attach to the base, middle section and tip of the process are the stylopharyngeus, stylohyoid, and styloglossus, respectively.

The 7th, 9th, and 12th cranial nerves innervate these muscles. The facial nerve runs antero-medial to the process before piercing the parotid gland, and the spinal accessory nerve and vagus nerve, as well as the start of the internal jugular vein, run medial to the styloid process.

Laterally it is related to parotid gland and facial nerve at its base of process. Styloid process was considered normal when it is shorter than 2.5 cm and elongated when it is longer than 4 cm. An elongated styloid process was not a pathognomonic evidence to rule out the Eagles syndrome. Many previous workers studied that abnormal angulation mostly on inward angulation rather than elongation is more responsible for irritating the structures related to the styloid process and it can lead to Eagles syndrome and it occurs in about 4% of general population.^[19]

As the age advances the elongation of styloid process was increased in some amount because of calcification of stylohyoid ligament cause the foreign body sensation or intermittent throat pain, facial pain, dysphasia. It is especially noticed in the postmenopausal women.^[20]

The morphology and variations of the craniofacial bones have been studied since the beginning of century.^[21]

The current study's objectives were to determine the length of the styloid process's incidence and to exclude both its mean and its variability.

1.1.4 The foramen ovale

Which connects the middle cranial fossa to the infra-temporal fossa, is one of the numerous foramina found in the larger wing of the sphenoid bone. It is located between the foramen lacerum and the medial to foramen spinosum. The mandibular nerve, accessory meningeal artery, lesser petrosal nerve, and emissary vein are the structures that passed through this foramen.

The foramen ovale is situated in middle cranial fossa in the infra-temporal surface of greater wing of sphenoid bone, postero-lateral to foramen rotundum (interior of skull in middle cranial fossa) and antero-medial to Foramen spinosum (exterior at base of skull).

The Otic ganglia were present under this foramen and closely related to upper end of posterior margin of lateral pterygoid plate. This foramen connects the extra-cranial and intracranial structures hence this foramen is used in various diagnostic and surgical procedures.

The sphenoid bone developed from both intramembranous and endochondral ossification centers. The sphenoid bone consists of a body (basisphenoid), a pair of lesser wing (orbitosphenoid) and pair on greater wing (alisphenoid).

The first ossification center appears in alisphenoid and it forms greater wing of sphenoid by membranous ossification in which the mandibular nerve is surrounded by cartilage to form foramen Ovale.

The foramen ovale is seen in 7th month of intrauterine life and predominantly visible at 3 years after birth. The pterygoid venous Plexus connects to cavernous sinus through emissary vein. ^[22]

Variations in the measurement and shape of foramen Ovale are explained on the basis of development. In some cases accessory foramen may be present on the side of foramen Ovale. In clinical manifestation the narrow size of foramen Ovale is commonly present in Paget's disease or Osteoporosis.

Fine needle aspiration cytology (FNAC) through foramen ovale was done to diagnose squamous cell carcinoma of brain, meningioma and also deep lesion biopsy of brain. ^[23]

To avoid complications during surgical procedures which are related to the brain for that morphological analysis of length and width of foramen Ovale and also variation in shape of foramen Ovale was the aim of study.

CHAPTER - I

1.2. REVIEW OF LITERATURE**1.2.1 Why measure skulls?**

For several generations the physical anthropologists measured skulls in the belief that there by they were likely to obtain results which will enable them to trace the relationship between the races of mankind.

It was believed that the form of the skull in a particular remained constant in each race, and that different races typically showed different cranial indices. Hence, all one had to do was to measure skulls, calculate the indices, and draw the more or less “obvious” conclusions.

Unfortunately for this rather naive belief there are several crucial objections to it. In the first place the form of the head is now known to be subject to change through environmental influences.

In the second place there are great differences in intragroup variability in all measurements and indices among the ethnic groups of mankind. In third place closely related groups and individuals frequently exhibit considerable differences in cranial measurements and indices, while more distantly related groups and individuals exhibit striking likenesses.

Finally, the cephalic index of all whole groups was change in the course of time as the trend towards brachycephalization in man abundantly shows. Why then, it may well be asked, measure skulls.

The answer is: specifically to get this kind of information and to be able to describe skulls as accurately as possible. Additionally, study of craniometrical data for nearby populations or subsets of the same population may produce useful results in studies of the micro-evolutionary process ^[24].

In order to describe and analyses the fossilized remains of man and other primates, as well as to study the morphology of the skull and dental apparatus and the relationships between individuals and extinct populations whose cranial remains are the primary source of information, craniometry was an essential tool.

In forensic medicine, in the identification of persons from their crania, and finally when the genetics of the skull comes to be thoroughly studied, as it must, craniometric techniques were become increasingly indispensable.

1.2.2 Definitions

Head, in actual use, this word can refer to either (1) the skeleton of the face, lower jaw, and braincase, or (2) the skeleton of the face and braincase without the lower jaw. Although most anthropologists and anatomists define the term strictly in the first sense, there is no issue with this twofold usage.

Cranium: Used to refer to the same thing as a skull.

Calvarium: The lower jaw removed from the skull

Calvaria: The brain case without the lower jaw and facial bones

Calotte, or Calva, the skull cap

1.2.3 The sex of the skull

Before puberty, it is impossible to identify the sex of a skull with any degree of confidence. The female skull is often lighter and smaller than the male skull. The appearance is more childlike, with smoother, more graceful, and delicately fashioned bones.

The occipital muscle marks are weakly developed, the mastoid process is short, the supra-mastoid crests are scarcely developed, and the supraorbital and temporal ridges are little to non-existent.

In females, the orbital borders are sharper and the facial skeleton, teeth, mandible, zygomatic arcs, and cheek bones are smaller and more delicate ⁽²⁵⁾.

1.2.4 Foramen magnum

- **Gautam Kanodia et al (2012)⁽¹⁾ and Standardings s. (2008) Gray's Anatomy⁽¹⁵⁾:** All the dimensions of foramen magnum were larger in males as compared to females. Normal values of foramen magnum serve as a future reference to new researchers. We need to do large number of data collections as there could be variations in parameters in different region in India.
- **Tanuj Kanchan et al 2013⁽²⁾, K. Edward et al (2013)⁽³⁾, Muralidhar P Shepur et al (2014)⁽⁴⁾, Standardings s. (2008) Gray's Anatomy⁽¹⁵⁾:** The length, width (transverse diameter), and area of foramen magnum were larger in male than female. Area of foramen magnum was observed to have better accuracy in calculating the sex of the cranium when compared to length and width of foramen magnum.
- **K. Edward et al (2013)⁽³⁾:** Discriminant function analysis should the best univariate variables for prediction of sex were the length and width of foramen magnum. The area of foramen magnum was the least reliable singular prediction for analysis of sex.
- **Muralidhar P Shepur et al (2014)⁽⁴⁾:** Mean antero-posterior diameter, transverse diameter and area of foramen magnum were more in males than females.

In order to ascertain or supplement existing knowledge regarding the size of the foramen magnum, one must assess abnormalities such as Arnold Chiari syndrome, which manifests as transverse diameter expansions.

1.2.5 Mastoid process

- **Sumati Patnaik et al (2010)⁽⁶⁾:** All fore mastoid variables showed significant sexual dimorphism, P value > 0.001.
- **Gupta AD et al (2012)⁽⁸⁾, Vineeta S et al (2011)⁽⁹⁾, Nidgula H et al (2013)⁽¹⁰⁾, Verma Shobha et al (2015)⁽¹¹⁾:** The mastoid process is correctly classified the sex in 90% of the subject and in that the mastoid length was found to be the best to determine the sex which analyzed by discriminant function analysis. All parameters showed significant sexual dimorphism.
- **Ghule SB et al (2014)⁽¹²⁾:** In comparison to men, females have a much higher mastoid process index. The Mastoid Process Index provides more accurate results when determining sex.
- **Saini V et al (2012)⁽¹³⁾:** in the mastoid triangle the asterion-mastoidale and mastoid breadth has provided an accuracy of 87% in male skull.

- **Spradley MK et al (2011)** ⁽¹⁴⁾: Postcranial elements outperform the skull in estimating the sex.
- **Standring S. 40th ed. Et al (2008)** ⁽¹⁵⁾: The variations in Inca bones or interparietal bones (supernumerary) bones are normal variants in occipito- parietal area and it is mistaken for a skull fracture. It also be very useful in forensic identification of an unknown individuals.

1.2.6 Styloid process

- **De Paz FJ et al (2012)** ⁽¹⁶⁾, **Patil S. et al (2014)** ⁽¹⁷⁾, **Kar JB et al (2013)** ⁽¹⁸⁾ : Anterior elongation and distance between base and tip decreased in elongated styloid process, while medial angulation does not show any significance associated with symptoms of stylalgia.
- **Rooparshi G. at al (2012)** ⁽¹⁹⁾: As the age advances the length of styloid process is increased and which is more predominance in females.
- **Magi Murugan et al (2014)** ⁽²¹⁾: It is observed that the mastoid emissary foramen are present on both side or one side, eighter single, double, triple respectively in mastoid process. The mastoid emissary vein and accessory mastoid emissary vein during the otology surgery is critical to avoid the significant bleeding. The variability in number of mastoidal emissary veins with its connection to the venous sinuses. Such type of knowledge is very helpful for neurosurgical practice.

1.2.7 Foramen ovale

- **Magi Murugan et al (2014)** ⁽²¹⁾ : both functions and neurosurgical cranial neuroanatomy and it provide transcutaneous surgery for skull base, especially in trigeminal neuralgia, as the Gasserion ganglion can be approached through it.
- **Desai SD et al (2012)** ⁽²²⁾ : The knowledge of foramen ovale is useful for neurosurgeons for skull base surgery.

CHAPTER - I**1.3 JUSTIFICATION****1.3.1 Introduction**

- Finally the conclusion of our study, the observations of the study will surely serve as baseline values for further studies.
- Considering the morphometric parameters and morphology of foramen magnum, mastoid process, styloid process and foramen ovale as tool for research.
- The evaluated values of the study will help to clinicians, neurosurgeons for skull base surgeries to diagnose and treat the various deformities of the skull.

1.3.2 What is already known on this topic?

- The all metric variables of previous workers.
- Correlate the data between Anthropometric and Morphometric analysis in all Variables.

1.3.3 What this study adds?

- The morphometric analysis of the foramen magnum, mastoid process, styloid process and foramen ovale is tool for determination of the sex.
- It will give primary data for analysis.
- The estimated values of foramen magnum, mastoid process, styloid process and foramen ovale may be useful for future research studies to analysis the data.
- These parameters will give good knowledge to neurosurgeons for skull base surgery.

1.3.4 Limitations of study:

- The selected data present in small sample size.
- The morphometric values are not compared with modern investigation like radiograph, MRI (Magnetic Resonance Imaging), CT (Computed Tomography).

1.3.5 Recommendation:

- Increase in the study sample size for more data analysis.
- More significant facts or values regarding the mastoid process, styloid process, and foramen ovale are included in this study, which benefit to future researchers as well as doctors, anatomists, and forensic experts.
- The study of metric measurement of all parameters could be useful to compare with other population, and may be help to add more information.
- The different values of all parameters which **were** help for primary diagnosis or gives base line data for new researchers.

1.3.6 Focus of the study:

- The study of metric analysis of foramen magnum, mastoid process, styloid process, and foramen ovale has a great importance to give primary data for investigation in day to day practice.
- The focus of the study is to predict the data for various researchers.
- It estimate to gives correct metric analysis..
- This study gives more advantage to forensic experts, neurosurgeons for and anthropologists.

CHAPTER - I**1.4 RESEARCH AIM AND OBJECTIVES****1.4.1 Aim**

To investigate and study of sexual dimorphism and morphometric dimensions of Foramen magnum, Mastoid process, Styloid process and Foramen ovale.

1.4.2 Objectives

- 1) To derive multivariate analysis that will help us in establishing the sex.
- 2) To evaluate the use of Foramen Magnum, Mastoid Process, Styloid Process, Foramen Ovale Measurement as a tool for sex determination in unknown age and sex of the skulls.

CHAPTER - II

**MATERIALS AND
METHODS**

SEXUAL DIMORPHISM AND MORPHOMETRIC ANALYSIS OF FORAMEN MAGNUM, MASTOID PROCESS, STYLOID PROCESS AND FORAMEN OVALE

Materials and Methods

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MATERIALS AND METHODS

2.1 Source of data:

The study was conducted at Department of Anatomy, D. Y. Patil Medical College, Kolhapur.

2.2 Study design

A prospective cross-sectional study was conducted in the Department of Anatomy, D. Y. Patil Medical College, Kolhapur, Maharashtra.

2.3 Study population

100 adult unknown human dry skulls were collected from the Department of Anatomy, D.Y.Patil Medical College, Kolhapur.

2.4 Sample size

The following formula was used to determine the sample size

Standard deviation (S.D.) of D2-CF is calculated from the pilot study (S.D. = 16.55)

Margin of error = 3.3

The sample size is calculated by using the following formula

$$n = \frac{(S.D. \times Z_{1-\alpha/2})^2}{d}$$

Where $Z_{1-\alpha/2}$ is the critical value of the normal distribution at α (e.g. for a confidence level of 95%, α is 0.05 and the critical value is 1.96, is the standard deviation and d is the margin error. Taking S.D.= 16.55, and d = 3.3

$$n = \frac{(16.55 \times 1.96)^2}{3.3}$$

$$n = 97$$

The minimum sample size is 97

2.5 Inclusion criteria

Adult dried unknown human skulls without destruction of mastoid process and styloid process were chosen for study.

2.6 Exclusion criteria

Skull that shows evidence of fracture or deformity, congenital anomalies, and skulls of children were excluded from the study.

2.7 Administrative and ethical consideration:

Institution Research Committee prior consent (ref. no. DMCK/255/2019/IEC) was obtained for further research.

2.8 Tools and techniques for data collection

- . Permission was taken from the Head of Department of Anatomy for data collection.
- . The collection of samples was started on September 2019 and continued until reached the sample size i.e. 100, which was completed on February 2024.

2.9 Material required for data collection:

- 1) Digital Vernier Caliper 2) Standard flexible steel tape,
- 1) Thread 4) Chalk 5) Marker 6) Scale.

2.10 Method of obtaining the data

- To determine the sample size, one hundred human dried skulls were obtained from the Department of Anatomy, at D.Y. Patil Medical College, Kolhapur.
- The skulls were free from any fracture or deformities. Morphometric measurement of the foramen magnum, mastoid process, styloid process, and foramen ovale, were taken with Digital Vernier Caliper graduated to the 0.01 mm.

2.11 Following parameters were used to identify the sex of the skull.

Table of the male and female differences⁽²⁶⁾

Features	Male	Female
General		
Size	Larger, longer	Small
Architecture	Ragged	Smooth
Anterior surface		
Forehead	Steep and less rounded	Vertical, rounded
Glabella	Prominent	Less prominent
Supra-orbital ridge	Prominent	Less prominent
Supra-orbital margin	Rounded	Sharp
Orbit	Placed lower on face, Rectangular	Higher on face, Rounded
Zygoma	Prominent	Less prominent
Superior surface		
Frontal eminence	Less prominent	More prominent
Parietal eminence	Less prominent	More prominent
Inferior surface		
Palate	U-shaped	Parabola
Foramen magnum	Larger and longer	Small and rounded
Dental arc	Larger	Smaller
Lateral surface		
Mastoid	More prominent, large, rounded and Blunt	less pointed and smooth
External auditory meatus (suprameatal crest)	Bony ridge along upper border prominent	often absent
Digastric groove	More deep	Shallow
Posterior surface		
Occipital protuberance	More prominent	Smooth
Nuchal lines	More prominent	Not prominent
Foramen magnum	Surface area is 963 sq.mm or larger	Surface area is 805 sq. mm or less

2.12 Landmarks for Measurement

2.12.1 Foramen magnum: all parameters were measured independently by two- three observation, with a predetermined methodology to prevent inter-observer and intra-observer error.

- 1) **Antero-posterior diameter:** It is the distance between basion (the midpoint of the anterior margin of the foramen magnum) and opisthion (the midpoint of the posterior margin of the foramen magnum).
- 2) **Transverse diameter:** It is the distance between the lateral margins of the Foramen magnum at the point of greatest lateral curvature.

All measurements were recorded to an accuracy of 0.01 mm.

- 3) **Foramen magnum index :** $\text{foramen magnum breadth} / \text{foramen magnum Length} \times 100$

The foramen magnum's measurements, which are useful in anthropology and forensic research, determine the gender of a human skull ^[2-3]. When additional areas of the craniofacial bone are involved, such as in serious injury, accidents, fire, or explosion instances, information from morphometric analysis can be helpful ^[4] for Orthopedicians, radiologists, anesthetists, and neurosurgeons, in addition to anatomists, place greater importance on the morphometric analysis and changes in the foramen magnum's size.

Now days the newer imaging techniques are MRI (magnetic resonance imaging and CT (Computed tomography) these tools used in the department of diagnostic medicine and they consider these parameters are in relation of foramen magnum with its variations.

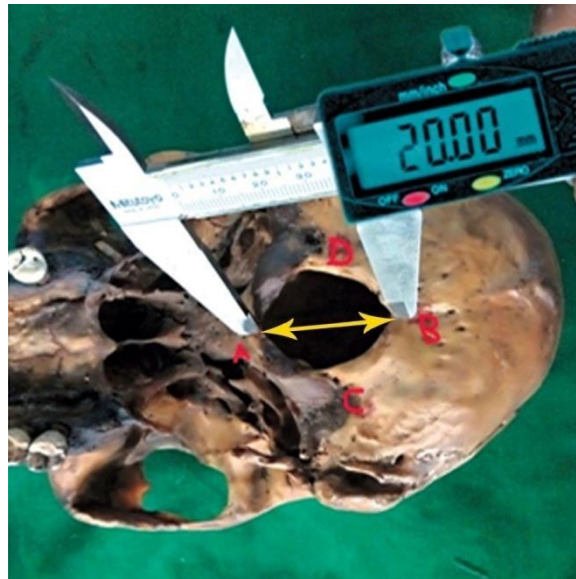


Figure 2.1 antero-posterior length of foramen magnum (mm)

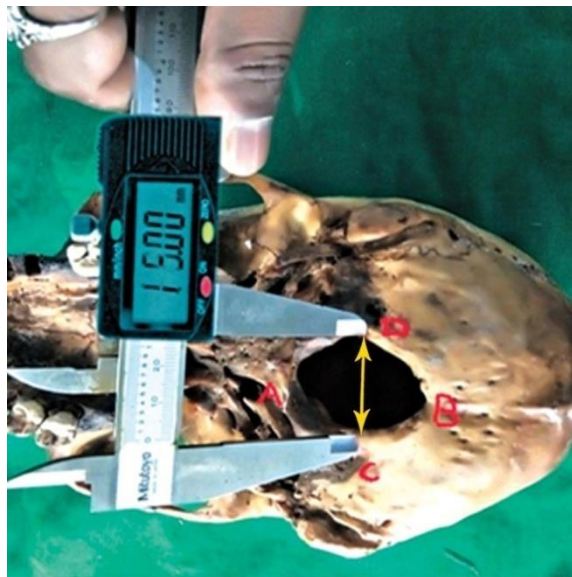


Figure 2.2 Transverse width of foramen magnum (mm)

2.12.2 Mastoid process

- 1 **Mastoid Length:** vertical projection of the mastoid process below and perpendicular to the eye-ear (Frankfort) plane. The Vernier Caliper's fixed arm was placed on the upper edge of the auditory meatus, with the skull facing the observer.
- 2 **Medio-lateral diameter:** The measurement was made from the most lateral point of the mastoid process to the uppermost portion of the medial surface inside the digastric fossa.
- 3 **Antero-posterior diameter:** (mastoid breadth): measured as a straight line from the closest point of the posterior border of the external acoustic meatus to the rear end of the incisura mastoidea (PEIM). The groove medial to the mastoid process of the temporal bone, which gives rise to the digastric muscle, is known as the incisura mastoidea. [Digastric or Mastoid notch]
- 4 The Mastoid process index is $(\text{Maximum Mastoid breadth} / \text{Maximum Mastoid length} \times 100)$.

2.12.3 The following details were taken into account for further mastoid measurements.

- a) The **asterion** (AST) is where the parieto-mastoid, occipito-mastoid, and lambdoid sutures converge.
- b) **Porion (Po):** the external acoustic meatus's superior point.

Porion - Is simple anatomical landmark that can be used in simple Anthropometric and cephalometric analysis, and was frequently represented by external acoustic meatus [EAM]. If the position of EAM [external acoustic meatus] was not parallel with Po [Porion], it can make the inaccurate baseline to construct the reference plane, and it can lead to the deep errors for analysis of facial asymmetry.

- c) The tip of the mastoid process is called the **mastoidale (Ms)**.

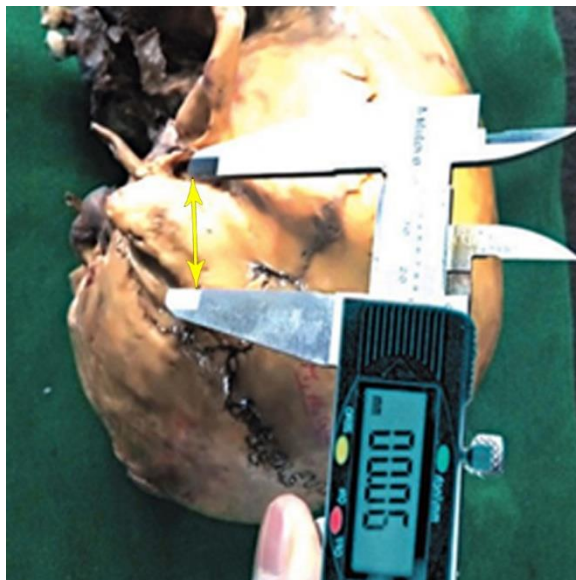
The locations of the points were noted.

The Digital Vernier caliper was used to measure the following readings. Mastoidale to Asterion (Ms.-AST).

Asterion to Porion (AST-Po.). Mastoidale to Porion (Po- Ms)



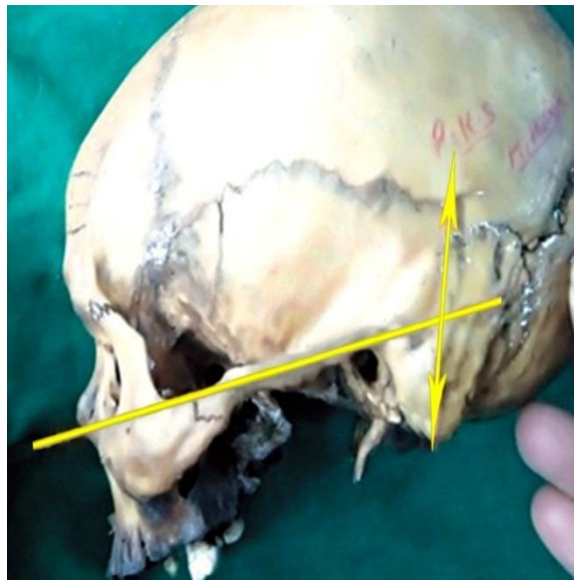
2.3 Length of mastoid process (mm)



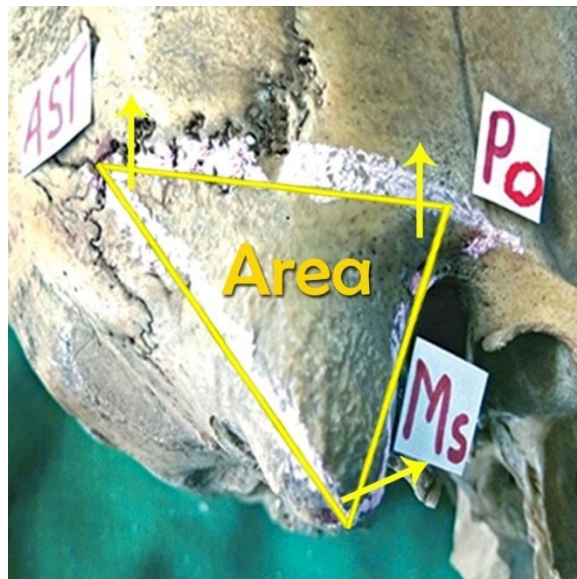
2.4 Antero-posterior diameter of mastoid process (mm)



2.5 Medio-lateral diameter of mastoid process (mm)

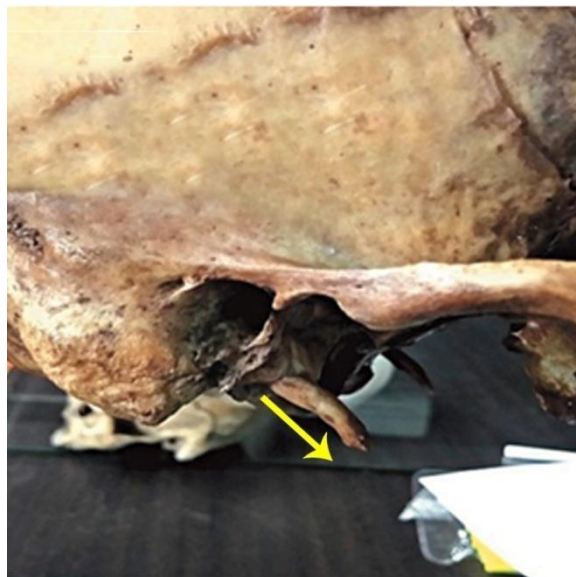


2.6 Frankfurt's plane of mastoid process (mm)

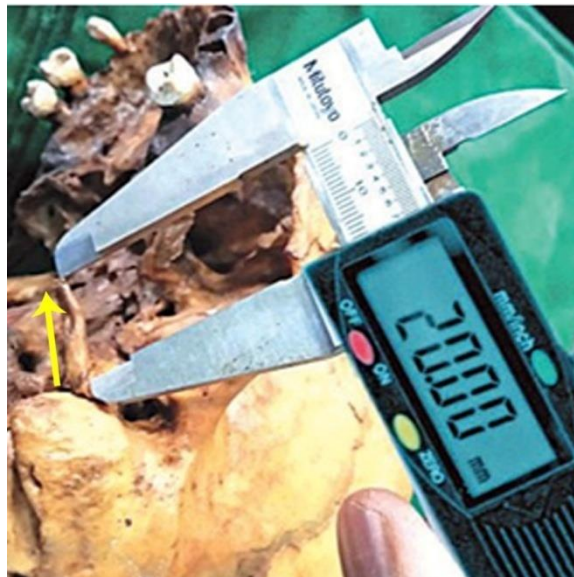


2.7 Asterion, Porion and Mastoidale and mastoid triangle (mm)

2.12.4 Styloid process



2.8 Direction of the styloid process (mm)



2.9 Length of the styloid process (mm)



2.10 Distance between two styloid processes at the tip (mm)



2.11 Distance between two styloid processes at the base (mm)



2.12 Thickness at the base of styloid process.(mm)

2.12.1 Foramen ovale



2.13 Antero-posterior length of the foramen ovale (mm)



2.14 Transverse width of the foramen ovale (mm)

2.12.1. Foramen ovale

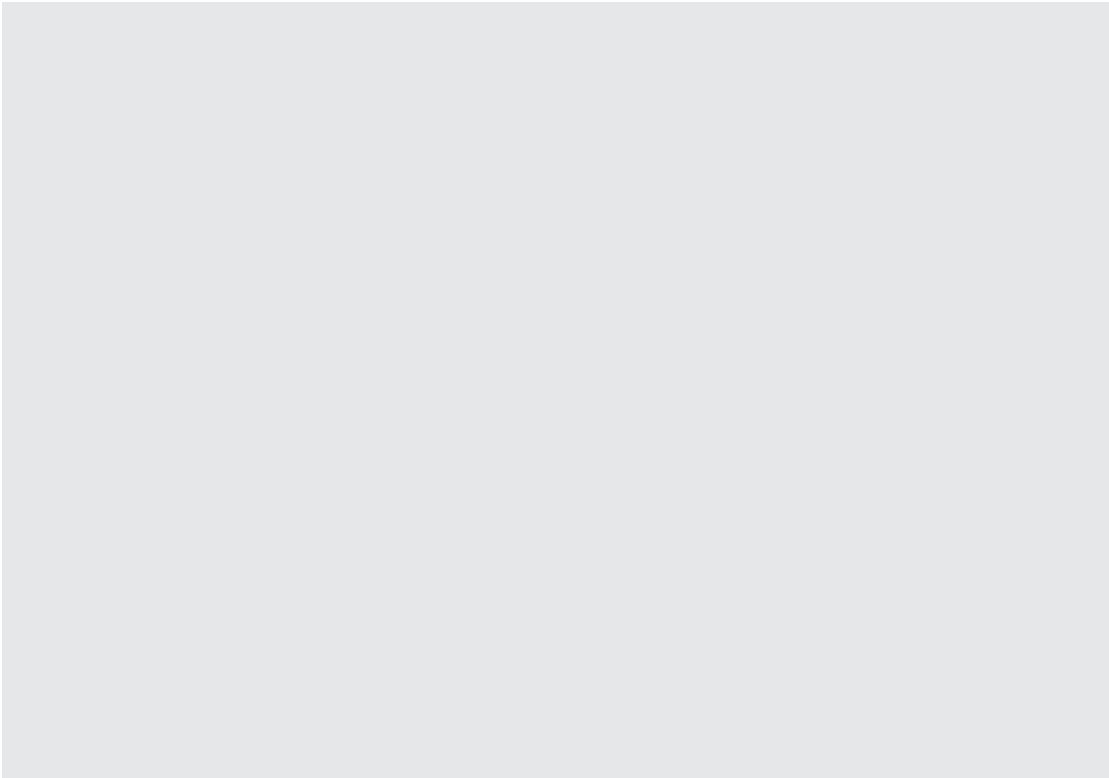


2.15 Distance from midline of the skull to zygoma of the foramen ovale (mm)

Photograph of base of the skull and measurement of distance from midline of base of skull to root of zygoma in relation with foramen ovale.

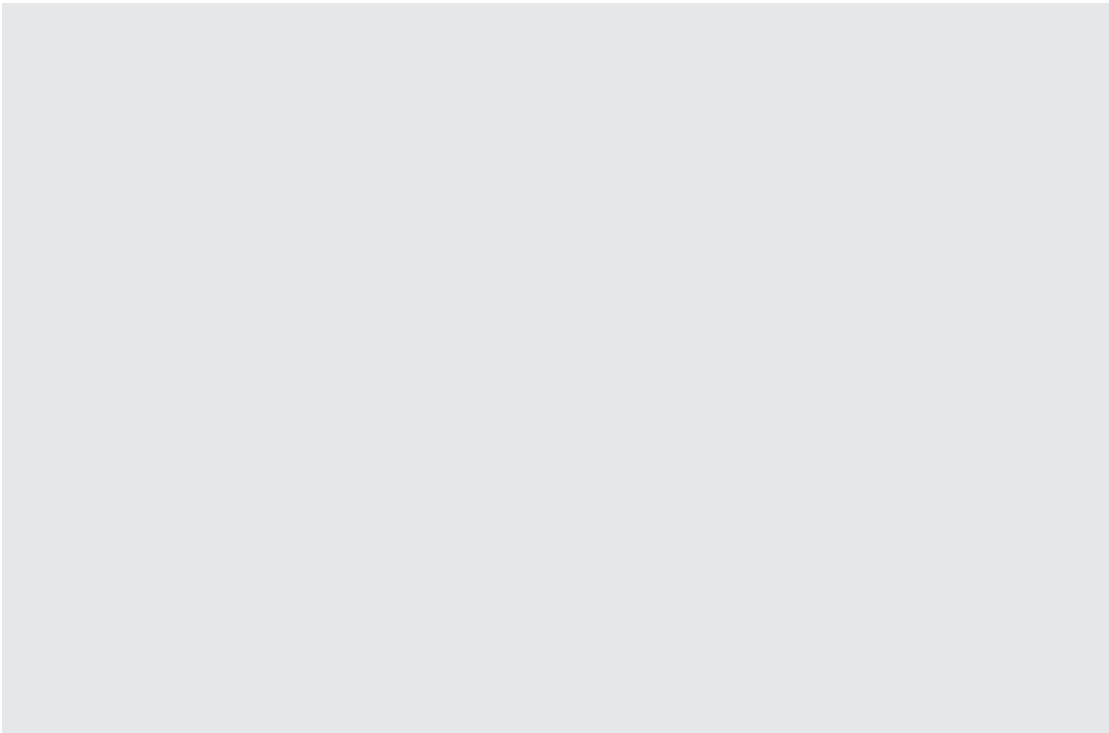
Distance (d1): from tubercle to root of zygoma to the center of foramen (CF).

Distance (d2): from midline of base of skull to center of foramen (CF).



CHAPTER - III

DATA ANALYSIS PLAN



Chapter III
SEXUAL DIMORPHISM AND MORPHOMETRIC ANALYSIS OF FORAMEN
MAGNUM, MASTOID PROCESS, STYLOID PROCESS AND FORAMEN OVALE

Data Analysis plan

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CHAPTER - III

DATA ANALYSIS PLAN

3.1 Introduction

The prongs of the Digital Vernier caliper were placed over the described landmarks, fixed manually and record the length and width of foramen magnum. The data was collected, tabulated and statistically analyzed. The data was analyzed by using SPSS 28.0.0 program. Descriptive statistics including range mean and standard deviation was calculated for each parameter to test the significance of the difference in means between males and females.

Statistical analysis

3.2 Foramen Magnum

Table 3.2.1: Statistical analysis of all variables of foramen magnum

Parameters	Male		Female		P value
	Mean	SD±	Mean	SD±	
FML	33.40	3.73	31.89	3.25	0.0169**
FMW	28.99	2.99	27.08	3.35	0.0017**
FMA	762.08	129.28	680.85	123.94	0.0008**
FML	87.77	12.51	85.56	12.33	0.1880

Table 3.2.2: Tests of normality

Parameters	Kolmogorov-Smirnov			Shapiro-wilk		
	Statistic	df	Sig	Statistic	df	Sig
FML	0.060	100	0.200*	0.983	100	0.224
FMW	0.101	100	0.013	0.971	100	0.026
FMA	0.056	100	0.200*	0.981	100	0.165

*This is the lower bound of true significance

a. Lilliefors significance correlation

Table 3.2.3: Analysis of single parameter of Foramen Magnum Length

Wilks lambda	Eigenvalue	Canonical Correlation	Centroid Value	Structure Matrix	Accuracy
0.955	0.047	0.213	F= -0.215, M = +0.125	1	63%

$$\text{Model= Gender} = (-9.331) + 0.286 \times \text{FM}$$

Table 3.2.4: Analysis of single parameter of Foramen Magnum Area

Wilks lambda	Eigenvalue	Canonical Correlation	Centroid Value	Structure Matrix	Accuracy
0.904	0.107	0.31	F= - 0.323 M= + 0.323	1	67%

$$\text{Model= Gender} = (-5.695) + 0.008 \times \text{FMA}$$

Table 3.2.5: Analysis of all parameter of Foramen Magnum Length and Foramen Magnum Area

Wilks lambda	Eigenvalue	Canonical Correlation	Centroid Value	Structure Matrix	Accuracy
0.902	0.109	0.314	F= - 0.327 M = + 0.327	FML = 0.659 FMA = 0.988	69%

$$\text{Model= Gender} = (- 4.441) - 0.068 \times \text{FML} + 0.009 \times \text{FMA}$$

FML

Table: 3.2.6 Gender wise classification results in foramen magnum length**Classification of Results**

Gender			Predicted Group Membership		Total
			0	1	
Original	Count	0	32	18	50
		1	19	31	50
	%	0	64.0	36.0	100.0
		1	38.0	62.0	100.0
Cross-validated ^b	Count	0	32	18	50
		1	19	31	50
	%	0	64.0	36.0	100.0
		1	38.0	62.0	100.0

- a. 63.0% of original grouped cases correctly classified.
- b. Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.
- c. 63.0% of cross-validated grouped cases correctly classified.

FML + FMA

Table: 3.2.7 Classification of results of foramen magnum length and foramen magnum area**Classification of Results**

Gender			Predicted Group Membership		Total
			0	1	
Original	Count	0	34	16	50
		1	15	35	50
	%	0	68.0	32.0	100.0
		1	30.0	70.0	100.0
Cross-validated ^b	Count	0	34	16	50
		1	16	34	50
	%	0	68.0	32.0	100.0
		1	32.0	68.0	100.0

- a. 69.0% of original grouped cases correctly classified.
- b. Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.
- c. 68.0% of cross-validated grouped cases correctly classified.

Table: 3.2.8 Comparison of dimensions of foramen magnum with various studies with current study (male).

Authors	Antero-posterior diameter (mm)	Transverse diameter (mm)
Raghvendra et al 2012 (31)	35.68	28.91
Radhakrishna et al 2012 (32)	34.04	28.63
Burdan et al 2012 (33)	37.06	32.98
Shanti and Lokandham 2013 (34)	37.1	32
Sukumar et al 2012 (35)	35.18	29.53
Singh and talwar 2013 (36)	33.54	27.77
Kanchan et al 2013 (37)	34.51	27.36
Mahajhan D et al 2013 (38)	32.83	27.47
Santosh et al 2013 (39)	34.37	28.98
Loyal p et al 2013 (40)	40	38
S.K. jain et al 2013 (41)	36.9	31.5
Patel and Mehta 2014 (42)	33.7	28.29
Radhika P. M. et al 2014 (43)	35.3	29.4
Ganpathy et al 2014 (44)	33.9	28.7
Jain D et al 2014 (45)	36.2	31.3
Muralidhar et al (46)	33.4	28.5
Howel et al 2014 (47)	31.2	26.9
Current study 2025	33.39	28.99

Table: 3.2.9 Comparison of the dimensions of current study of area of foramen magnum and foramen magnum index with previous workers (male)

Author	Area of Foramen Magnum (mm ²)	Foramen Magnum Index
Raghvendra et al 2012 (31)	811.67	-
Buridan et al 2012 (33)	877.4	89.34
Singh and talwar 2013 (36)	733	-
Patel and Mehta 2014 (42)	755.37	-
Howel et al 2014 (47)	-	84.85
Muralidhar et al 2014 (46)	748.6	-
Jain D et al 2014 (45)	-	86.69
Current Study 2025	762.08	87.77

Table: 3.2.10 Comparison of morphological type of foramen magnum with earlier researchers

Types of foramen magnum	Murshed et al (48)	Radhakrishna et al (32)	P.chethan et al (49)	Radhika P.M. (43)	Current study
Oval	9 (8.1%)	39 (39%)	8 (15.1%)	60 (40%)	M= 14 (28%) F= 20 (40%)
Round	24 (21.8%)	28 (28%)	12 (22.6%)	30 (20%)	M= 37 (74%) F= 30 (60%)
Tetragonal	14 (12.7%)	19 (19%)	10 (18.9%)	9 (6%)	-
Hexagonal	19 (17.2%)	-	3 (5.6%)	9 (6%)	-
Irregular	22 (19.9%)	-	8 (15.1%)	24 (16%)	-

3.3 Mastoid Process

Table: 3.3.1 Statistical analysis for mastoid process measurements right side

Sr. no	Mastoid variable	Male (n=50) Right		Female (n=50) Right		SEM (Male)	SEM (Female)	95% CI	t value	P value
		Mean	SD±	Mean	SD±					
1	ML	37.21	8.72	34.68	7.00	1.23	0.99	5.07	1.6	0.11
2	APD	23.19	4.89	21.00	4.33	0.92	0.92	0.36-4.03	2.37	0.019**
3	MLD	6.36	1.84	4.77	2.06	0.26	0.26	0.81-2.36	4.07	P<0.001**
4	MI	64.81	15.84	62.11	14.82	2.24	2.09	3.39-8.78	0.87	0.38
5	MS	56.22	27.48	37.94	28.04	3.88	3.96	7.25-29.29	3.29	P<0.001**
6	MA	537.07	77.12	494.06	106.49	11.01	15.06	517.49-561.84	2.43	0.016**

All measurements were in millimeters (mm); * significant; ** highly significant

Table: 3.3.2 Statistical analysis for mastoid measurements left side

Sr. no	Mastoid variable	Male (n=50) Left		Female (n=50) Left		SEM (Male)	SEM (Female)	95% CI	t value	P value
		Mean	SD±	Mean	SD±					
1	ML	37.47	9.10	32.87	7.25	1.28	1.05	11.77-5.38	2.78	0.003**
2	APD	24.24	4.11	22.23	5.54	0.58	0.78	.07-3.94	2.05	0.04*
3	MLD	6.06	1.44	5.22	2.35	0.2	0.33	0.068-1.62	2.16	0.033*
4	MI	67.78	17.53	70.92	25.06	2.47	3.54	11.77-5.38	0.73	0.46(NS)
5	MS	55.30	20.49	39.80	25.37	2.89	3.58	6.34-24.64	3.35	P<0.001**
6	MA	510.08	135.69	465.77	112.16	19.38	15.86	474.05-552.07	1.88	0.06(NS)

All measurements were in millimeters (mm); * significant; ** highly significant

Table 3.3.3: All Variables on Right Side

Variable	Wilks lambda	Canonical correlation	Structure Matrix	Centroid Value	Mean precision
ML	0.974	0.160	1.00	F= -0.160 M= + 0.160	Over all 55% F= 56% M= 54%
APD	0.945	0.233	1.00	F= - 0.238 M= + 0.238	Over all = 56% F= 62% M= 50%
MLD	0.855	0.381	1.00	F= - 0.407 M = + 0.407	Over all = 68% F= 72% M= 62%
MS	0.9	0.316	1.00	F= - 0.329 M = + 0.329	Over all =65% F= 80% M=50%
All Variable	0.809	0.437	ML= 0.333 APD= 0.494 MLD= 0.847 MS = 0.684	F= - 0.481 M= +0.481	Over all= 68% F= 64% M= 72%

Model $Y = -4.544 + (0.126) \times ML$

$Y = -4.473 + (0.216) \times APD$

$Y = -2.85 + (0.511) \times MLD$

$Y = -1.696 + (0.036) \times MS$

All variable = $Y = -10.138 + (0.103) \times ML + (0.202) \times APD + (0.855) \times MLD - (0.063) \times MS$

Table: 3.3.4 All Variables on Left Side

Variable	Wilks lambda	Canonical correlation	Structure Matrix	Centroid Value	Mean precision
ML	0.926	0.271	1.00	F= -0.279 M= +0.279	Overall= 60% F= 70% M= 50%
MS	0.897	0.321	1.00	F= -0.336 M= + 0.336	Overall= 69% F= 74% M= 65%
MI	0.994	0.074	1.00	F= + 0.074 M= - 0.074	Overall= 53% F= 44% M= 62%
All variable	0.886	0.338	ML= 0.784 MS= 0.946 MI= 0.208	F= - 0.335 M= + 0.335	Overall= 66% F= 70% M= 62%

Models ML = $Y = -4.273 + (0.121) \times ML$ MS = $Y = -2.062 + (0.043) \times MS$
 MI = $Y = -3.208 + (0.046) \times MI$ All = $Y = -3.429 + (0.052) \times MI + (0.031) \times MS + (0.002) \times MI$

Table: 3.3.5 Discriminant Analysis only for MA on Right Side

Variable	Wilks lambda	Canonical correlation	Structure matrix	Centroid value	Accuracy
MA	0.949	0.226	1	F= - 0.230 M= + 0.230	61%

Discriminant function $D = MA \times (0.011) - 5.511$

Table: 3.3.6 Discriminant Analysis only for MA on Left side

Variable	Wilks lamda	Canonical correlation	Structure matrix	Centroid value	Accuracy
MA	0.969	0.177	1	F= - 0.178 M= + 0.178	56%

Discriminant function $D = MA \times (0.008) - 3.915$

3.4 Styloid Process

Table: 3.4.1 Statistical analysis of styloid process (mm)

Parameters	Male		Female		P value
	Mean	SD±	Mean	SD±	
R_LSP	21.54	9.67	19.82	5.09	0.1339
R_THICKNESS	5.31	1.62	4.29	1.51	0.0008
L_LSP	20.24	7.31	16.26	4.27	0.0006
L_THICKNESS	4.63	1.51	4.89	1.52	0.1986
Interstyloid Distance at TIP	64.73	9.60	69.01	6.60	0.0054
Interstyloid Distance at BASE	81.38	6.32	79.00	6.83	0.0366

Table: 3.4.2 Gender wise classification of styloid process

Classification of Results

Gender			Predicted Group Membership		Total
			0.00	1.00	
Original	Count	0.00	39	11	50
		1.00	18	32	50
	%	0.00	78.0	22.0	100.0
		1.00	36.0	64.0	100.0
Cross-validated	Count	0.00	37	13	50
		1.00	19	31	50
	%	0.00	74.0	26.0	100.0
		1.00	38.0	62.0	100.0

- 71.0% of original grouped cases correctly classified.
- Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.
- 68.0% of cross-validated grouped cases correctly classified.

Table: 3.4.3 The accuracy of styloid process

Wilks lambda	Eigenvalue	Canonical correlation	Structure matrix	Centroid value	Accuracy
0.741	0.35	0.509	Left LSP= 0.567, Rt. Thickness= 0.553, distance at tip= -0.443, Distance at base= 0.309	F= -0.586, M= +0.586	71%

Model = Gender = (-4.824) + 0.324 X Rt.thickness+0.089 X Lt. LSP – 0.07 X Distance at tip + 0.079 X Distance at base

3.5 Foramen Ovale

Table: 3.5.1 Statistical Analysis of Foramen Ovale

Parameter	Male		Female		P Value
	Mean	SD±	Mean	SD±	
R_APL	8.33	3.32	6.58	1.91	0.0009
R_TW	4.43	1.17	3.98	1.17	0.0286
R_D1_CF	27.52	4.83	24.45	2.98	0.0001
R_D2_CF	23.05	3.24	25.44	23.23	0.2365
L_APL	7.89	1.75	6.87	1.38	0.0008
L_TW	4.46	1.20	4.03	0.89	0.0220
L_D1_CF	26.07	4.00	23.47	2.97	0.0002
L_D2_CF	23.19	3.91	21.98	2.84	0.0402

Table: 3.5.2 The tests of Normality

Parameter	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	Df	Sig.
R_APL	0.157	100	0.000	0.669	100	0.000
R_TW	0.121	100	0.001	0.963	100	0.006
R_D1_CF	0.106	100	0.007	0.941	100	0.000
R_D2_CF	0.353	100	0.000	0.193	100	0.000
L_APL	0.058	100	.200 [*]	0.985	100	0.345
L_TW	0.115	100	0.002	0.949	100	0.001
L_D1_CF	0.090	100	0.043	0.969	100	0.019
L_D2_CF	0.139	100	0.000	0.847	100	0.000

*. This is a lower bound of the true significance.

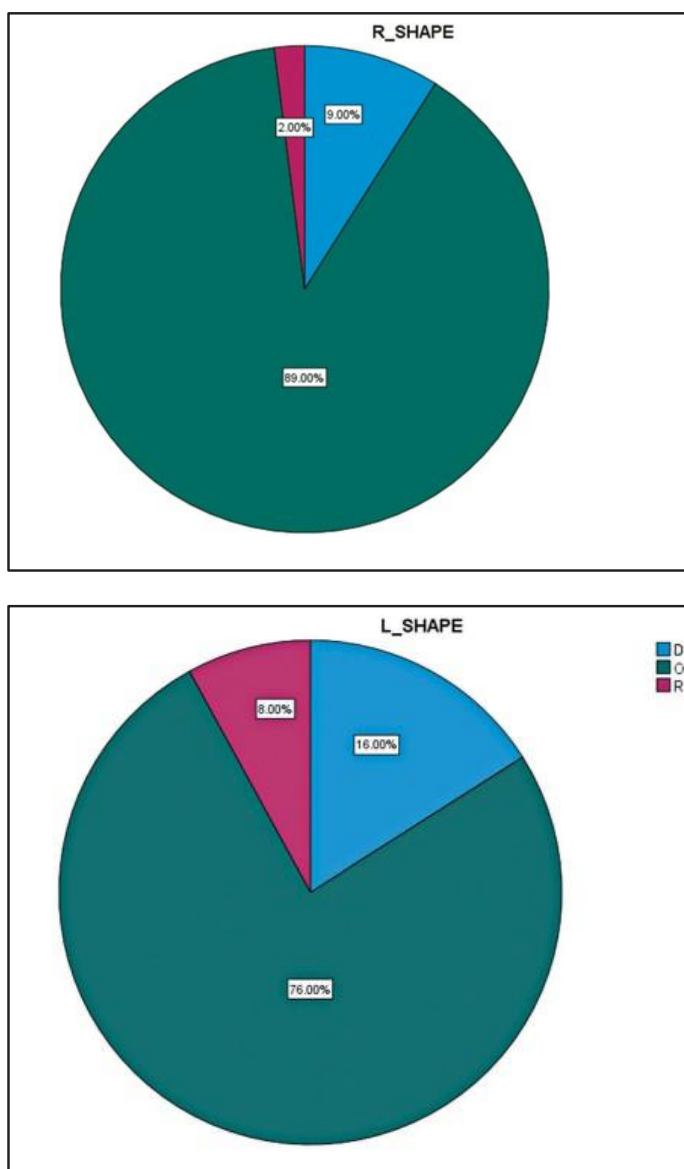
Lilliefors Significance Correction

Table: 3.5.3 The Right side Shape of foramen Ovale

Shape	Frequency	Percentage	Valid Percentage of	Cumulative Percentage
D Shape	9	9.0	9.0	9.0
Ovale	89	89.0	89.0	98.0
Round	2	2.0	2.0	100.0
Total	100	100.0	100.0	

Table: 3.5.4 The left side Shape of foramen ovale

Shape	Frequency	Percentage	Valid Percentage	Cumulative Percentage
D Shape	16	16.0	16.0	16.0
Ovale	76	76.0	76.0	92.0
Round	8	8.0	8.0	100.0
Total	100	100.0	100.0	

Graph: 3.5.5 Percentage of different shapes of foramen ovale**Table 3.5.6 Antero-posterior length of foramen ovale on left side**

Wilks lambda	Eigenvalue	Canonical correlation	Structure Matrix	Centroid value	Accuracy
0.904	0.106	0.31	1	F= - 0.323 M= + 0.323	64%

$$\text{Model} = \text{Gender} = (-4.684) + 0.635 \times \text{Lt. APL}$$

Table: 3.5.7 Statistical analysis of all parameters

Wilks lambda	Eigenvalue	Canonical correlation	Structure matrix	Centroid value	Accuracy
0.71	0.408	0.538	Rt. APL = 0.51, Rt. TW= 0.305, Rt. D1-CF= 0.605, Rt. D2-CF = -0.114, Lt. APL= 0.511, Lt. TW= 0.323, Lt. D1-CF= 0.584, Lt. D2-CF= 0.279	F= - 0.632, M = + 0.632	69%

Model = Gender = (- 10.498) + 0.16 X Rt. APL + 0.19 X Rt. TW + 0.09 X Rt. D1-CF - 0.009 X Rt.D2-Cf + 0.076 X Lt. APL + .194 X Lt. TW + 0.135 X Lt. D1-CF + 0.074 X Lt. D2-CF

L_APL

Table: 3.5.8 Gender wise classification of results on left side antero-posterior length

Classification of Results

Gender			Predicted Group Membership		Total
			0.00	1.00	
Original	Count	0.00	33	17	50
		1.00	19	31	50
	%	0.00	66.0	34.0	100.0
		1.00	38.0	62.0	100.0
Cross-validated ^b	Count	0.00	33	17	50
		1.00	19	31	50
	%	0.00	66.0	34.0	100.0
		1.00	38.0	62.0	100.0

- 64.0% of original grouped cases correctly classified.
- Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.
- 64.0% of cross-validated grouped cases correctly classified.

Table: 3.5.9 Gender wise classification results of all variables**Classification of Results**

Gender			Predicted Group Membership		Total
			0.00	1.00	
Original	Count	0.00	36	14	50
		1.00	17	33	50
	%	0.00	72.0	28.0	100.0
		1.00	34.0	66.0	100.0
Cross-validated ^b	Count	0.00	34	16	50
		1.00	17	33	50
	%	0.00	68.0	32.0	100.0
		1.00	34.0	66.0	100.0

- a. 69.0% of original grouped cases correctly classified.
- b. Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.
- c. 67.0% of cross-validated grouped cases correctly classified.

CHAPTER - IV

**OBSERVATIONS AND
RESULTS**

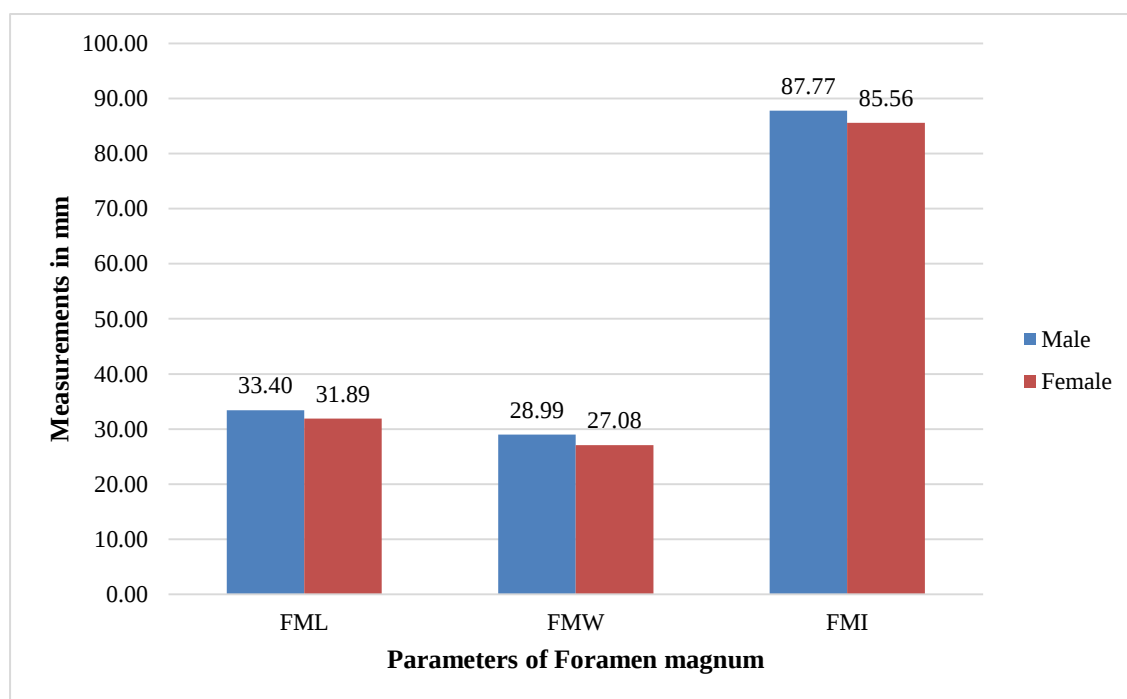
Chapter IV**SEXUAL DIMORPHISM AND MORPHOMETRIC ANALYSIS OF FORAMEN MAGNUM, MASTOID PROCESS, STYLOID PROCESS AND FORAMEN OVALE****OBSERVATIONS AND RESULTS**

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CHAPTER - IV

OBSERVATIONS AND RESULTS

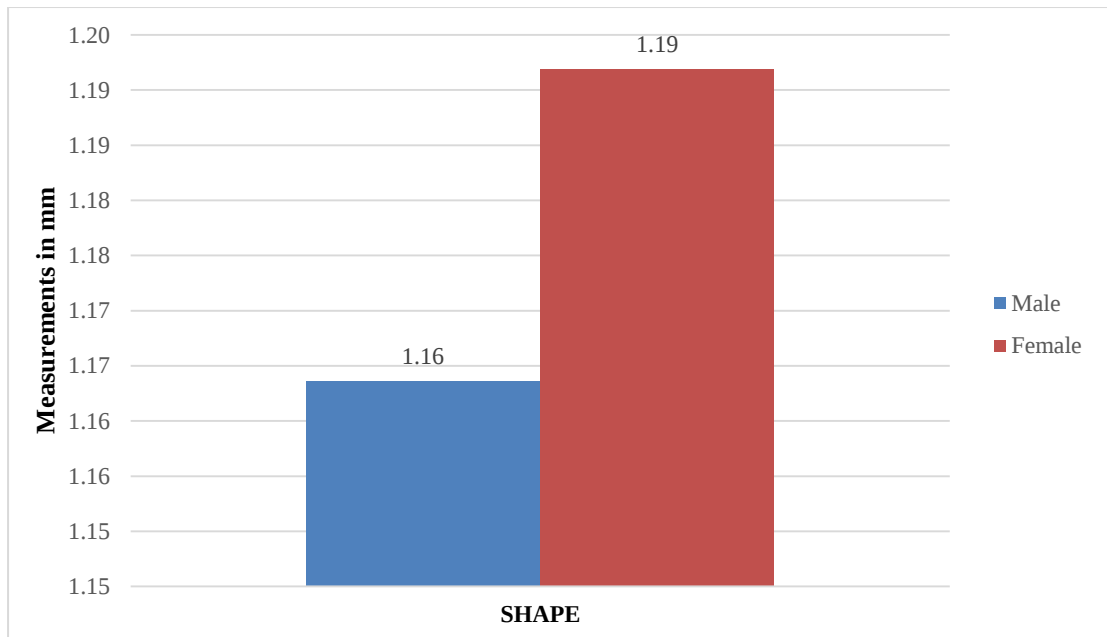
4.1 Foramen Magnum



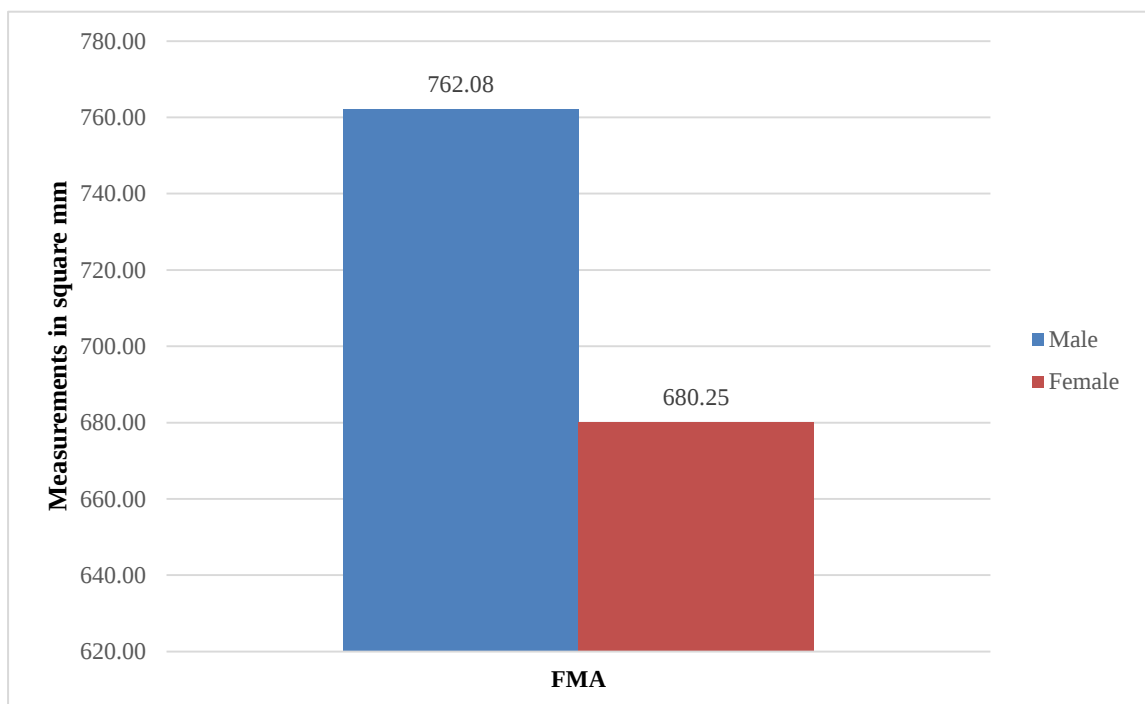
Graph 4.1.1 Gender wise mean of parameters of Foramen magnum

Graph 4.1.1 the mean length of foramen magnum was 33.40 ± 3.73 mm in males and in females is 31.89 ± 3.25 mm and the mean transverse diameter in males 28.99 ± 2.99 mm and in females' 27.08 ± 3.35 mm. The mean length and width of foramen magnum was greater in males than in females.

- The FML, FMW, and FMA these findings are **highly significant**.



Graph 4.1.2 Gender wise mean of Shape of Foramen magnum



Graph 4.1.3 Gender wise mean of Area of Foramen magnum

The mean area of foramen magnum in males 762.08 ± 129.28 mm, and in females 680.25 ± 123.94 mm. The mean area of foramen magnum is more in males than that of females.

Table: 4.1.4 Examining the foramen magnum's morphological type in Correlation to earlier research

Types of foramen magnum	Murshed et al (48)	Radhakrishna et al (32)	P.chethan et al (49)	Radhika P.M. (43)	Current study
Oval	9 (8.1%)	39 (39%)	8 (15.1%)	60 (40%)	M= 14 (28%) F= 20 (40%)
Round	24 (21.8%)	28 (28%)	12 (22.6%)	30 (20%)	M= 37 (74%) F= 30 (60%)
Tetragonal	14 (12.7%)	19 (19%)	10 (18.9%)	9 (6%)	-
Hexagonal	19 (17.2%)	-	3 (5.6%)	9 (6%)	-
Irregular	22 (19.9%)	-	8 (15.1%)	24 (16%)	-

Table (4.1.4) in the 100 foramen magnum (50males, 50females), 37 foramen magnum were observed that round (74%) and Oval are 14 (28%) in case of males, 30 (60%) foramen magnum were observed that round and oval 20 (40%) in the females.

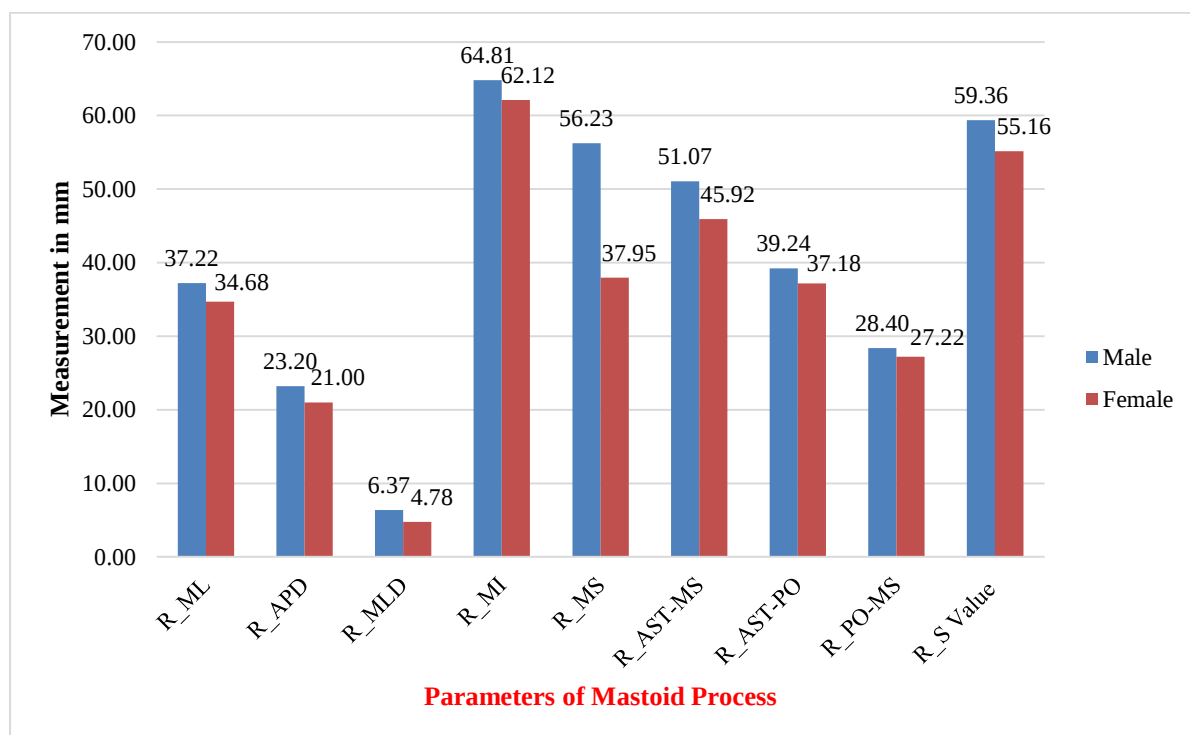
4.2 Mastoid Process

Table: 4.2.1 the mean of males and females in mastoid process on right side

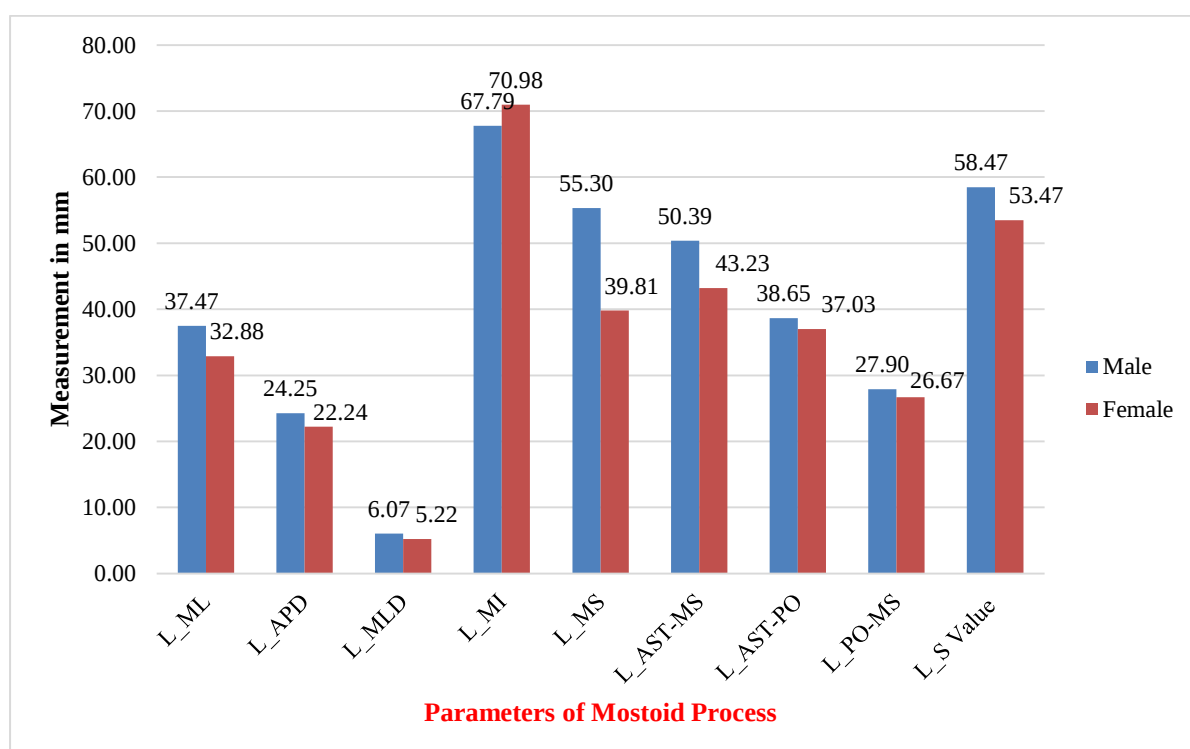
Parameters	Male		Female	
	Mean	SD ($\pm$)	Mean	SD ($\pm$)
R_ML	37.22	8.72	34.68	7.01
R_APD	23.20	4.89	21.00	4.33
R_MLD	6.37	1.84	4.78	2.06
R_MI	64.81	15.85	62.12	14.83
R_MS	56.23	27.48	37.95	28.04
R_AST-MS	51.07	4.77	45.92	4.91
R_AST-PO	39.24	3.61	37.18	4.62
R_PO-MS	28.40	3.26	27.22	4.24
R_S Value	59.36	3.59	55.16	4.95
R_MA	537.07	78.50	494.06	106.49

Table: 4.2.2 the mean of males and females in mastoid process on left side

Parameters	Male		Female	
	Mean	SD ($\pm$)	Mean	SD ($\pm$)
L_ML	37.47	9.11	32.88	7.25
L_APD	24.25	4.12	22.24	5.55
L_MLD	6.07	1.44	5.22	2.36
L_MI	67.79	17.53	70.98	25.06
L_MS	55.30	20.49	39.81	25.38
L_AST-MS	50.39	6.03	43.23	8.62
L_AST-PO	38.65	5.23	37.03	4.05
L_PO-MS	27.90	3.90	26.67	3.87
L_S Value	58.47	5.67	53.47	5.81
L_MA	510.08	135.94	465.78	112.16



Graph 4.2.3 Gender wise Mean of parameters of Mastoid Process on Right side



Graph 4.2.4 Gender wise Mean of parameters of Mastoid Process on Left side

Graphical analysis shows various parameters of mastoid process by various workers in different areas. The mastoid length was more in males as compare to females and this is true in our study.

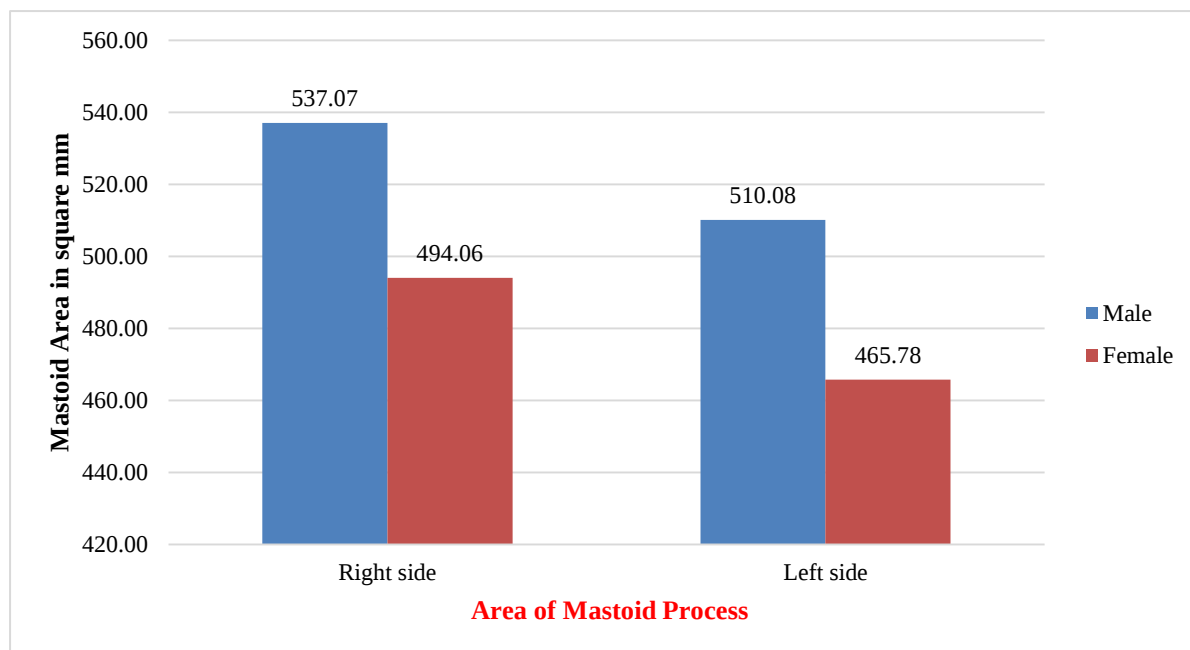
If the skull remains flat, it is the male skull; if it rests on the mastoid process, it is the female skull. It was female if it was lying on the occipital condyles. This claim subtly supports the idea that male skulls are longer than female skulls.

The mastoid process antero-posterior and medial diameter values were calculated by previous workers observed that these factors were more in males as of females. The current study correlates with previous workers.⁽⁹⁻¹⁶⁾

The mastoid process index on the right and left sides were examined independently, and the results showed that females had a considerably higher mastoid process index than males.

In the current study, females had a higher mastoid process index (66.55mm) than males (66.30mm), however the difference is statistically not significant.

The mastoid index proved useful in determining the sex of the skull because there has been very little research on the mastoid process index.



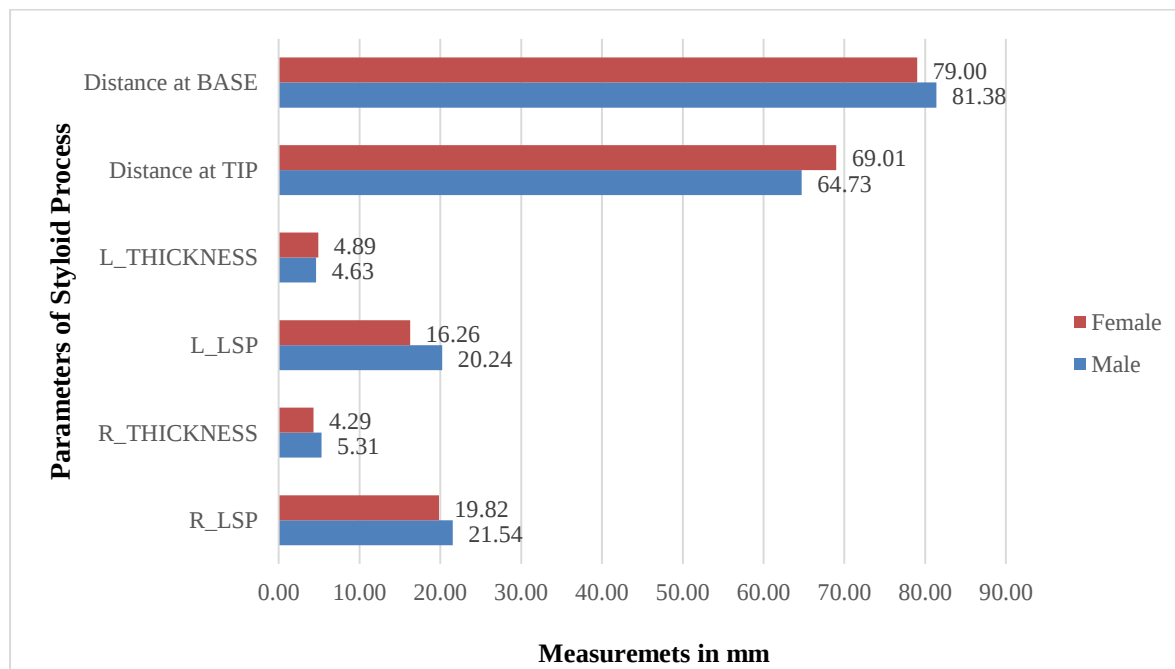
Graph 4.2.5 Gender wise Mean of Mastoid Area

In the current study the new finding is mastoid size (55.76 mm) which was more in males as in females (38.87mm). The area of mastoid process in males on right side (537.07 ± 77.12 mm), on left side was (510.08 ± 135.69 mm), and for females on right side was (494.06 ± 106.49 mm), on left side (465.74 ± 112.16 mm). The area of mastoid process is more in males as compared to females. By this parameter we confirm the **skull is of male or female**.

4.3 Styloid Process

Table: 4.3.1 the mean of males and females in styloid process

Parameters	Male		Female	
	Mean	SD ($\pm$)	Mean	SD ($\pm$)
R_LSP	21.54	9.67	19.82	5.09
R_THICKNESS	5.31	1.62	4.29	1.51
L_LSP	20.24	7.31	16.26	4.27
L_THICKNESS	4.63	1.51	4.89	1.52
Interstyloid Distance at TIP	64.73	9.60	69.01	6.60
Interstyloid Distance at BASE	81.38	6.32	79.00	6.83

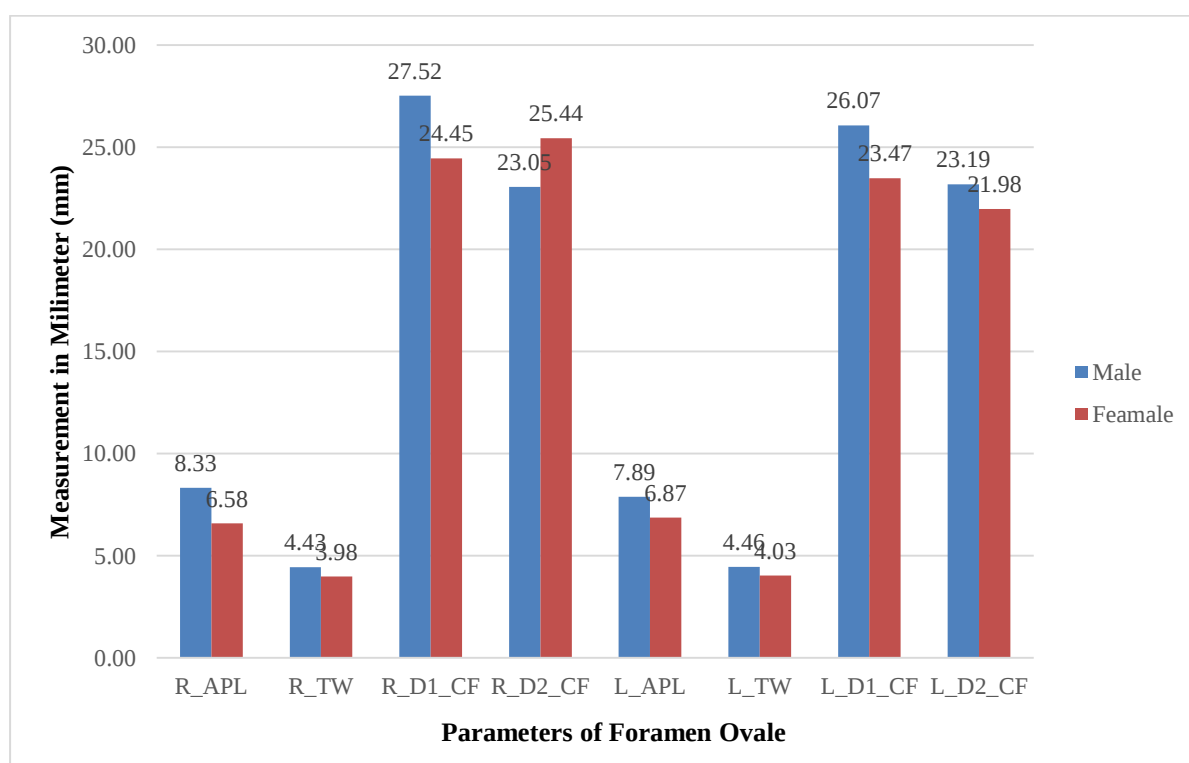


Graph 4.3.2 Gender wise Mean of parameters of styloid Process

4.4 Foramen Ovale

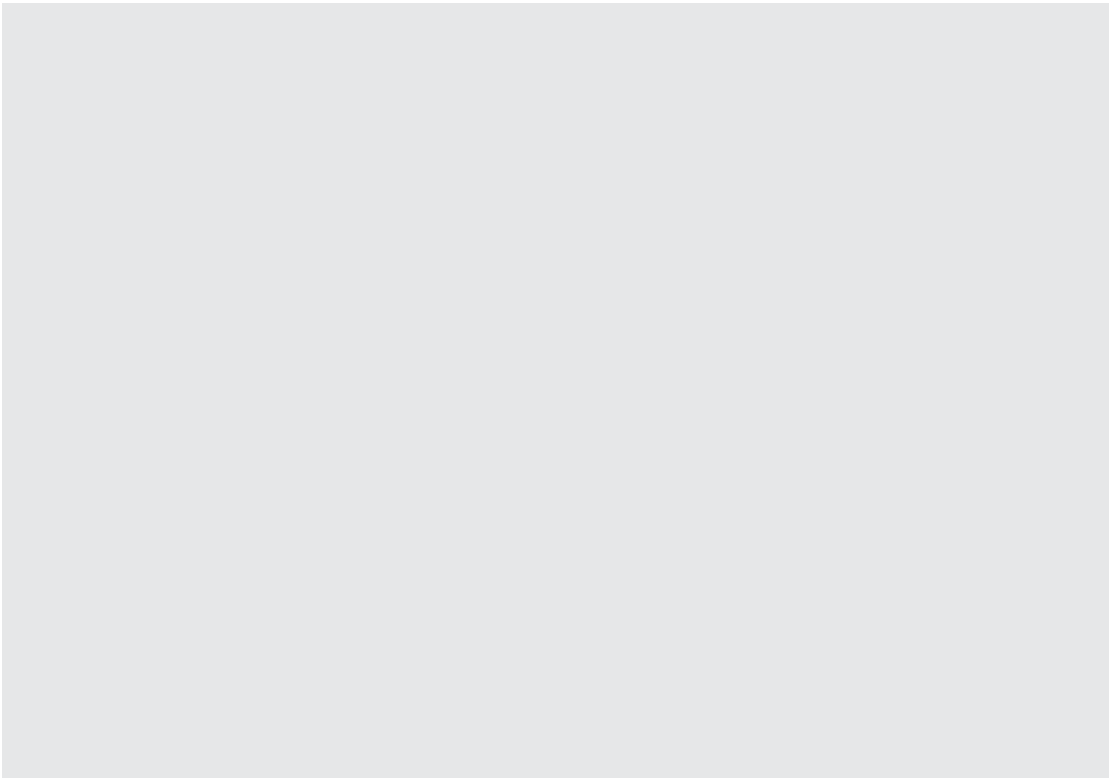
Table: 4.4.1 The mean of males and females in foramen ovale

Parameter	Male		Female	
	Mean	SD ($\pm$)	Mean	SD ($\pm$)
R_APL	8.33	3.32	6.58	1.91
R_TW	4.43	1.17	3.98	1.17
R_D1_CF	27.52	4.83	24.45	2.98
R_D2_CF	23.05	3.24	25.44	23.23
L_APL	7.89	1.75	6.87	1.38
L_TW	4.46	1.20	4.03	0.89
L_D1_CF	26.07	4.00	23.47	2.97
L_D2_CF	23.19	3.91	21.98	2.84



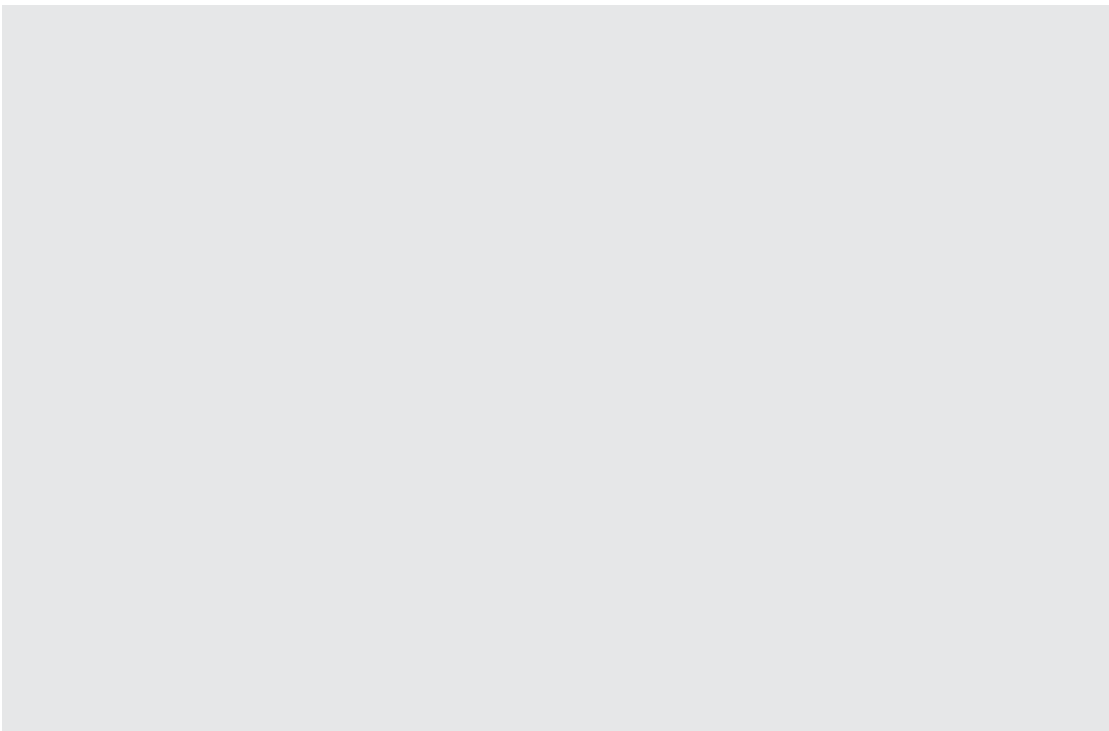
Graph 4.4.2 Gender wise mean of parameters of Foramen Ovale

- The current study was conducted on 100 unknown dry skulls. The mean length of foramen ovale in males on right side is 8.33 ± 3.32 mm, in females on right side 6.58 ± 1.17 mm. On Left side in males was 7.89 ± 1.75 mm, and on left side in females was 6.87 ± 1.38 mm.
- Width of foramen ovale on Right side in males 4.43 ± 1.17 mm, females 3.98 ± 1.17 mm width of foramen ovale on left side in males 4.46 ± 1.20 mm, in females 4.03 ± 0.89 mm/
- Right side of foramen ovale D1-CF= Males = 27.52 ± 4.83 mm, Females = 24.45 ± 2.98 mm (**D1-CF = Distance from root of zygoma to center of foramen**) Left side of foramen ovale in Males = D1-CF = 26.07 ± 4.00 mm, Females = 23.4 ± 2.97 mm.
- Right side of foramen ovale D2- CF = Males = 23.05 ± 3.24 mm, Females = 25.44 ± 23.23 mm Left side of foramen ovale D2- CF= Males = 23.19 ± 3.91 mm, Females = 21.90 ± 2.84 mm (**D2-CF = Distance from midline of skull to center of foramen**)
- The length and width were greater in males on right side as compared with left side. The difference between the length of right side and left side was statistically significant, and also the difference between width of right side and left side was also statistically significant.
- Left side D2 – CF is longer in male as compare to female and it is significant.
- Right side D2 _ CF is not statistically significant.



CHAPTER - V

DISCUSSION



Chapter V

SEXUAL DIMORPHISM AND MORPHOMETRIC ANALYSIS OF FORAMEN MAGNUM, MASTOID PROCESS, STYLOID PROCESS AND FORAMEN OVALE

DISCUSSION

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CHAPTER - V

DISCUSSION

5.1 Foramen Magnum

- By using the formula for calculating the shape of foramen magnum

$$\text{FMI} = \frac{\text{Transverse diameter (width)}}{\text{AP diameter (length)}} \times 100.$$
- If the foramen magnum index is equal or greater than 1.2cm then it were consider as Oval shape foramen magnum, and if it is less than 1.2cm then it is of round shape foramen magnum.
- Morphologically the foramen magnum has the great variation. The several variations in the shapes of the foramen magnum were calculated in the current study as follows: for males, Oval (28%), Round (74%) and in females Oval (40%), Round (60%).
- In the current study the frequency of Oval shape and Round shape foramen magnum is comparatively more as of previous workers.

Area of foramen magnum (FMA):

- The Radinsky Formula (FMA) is as follows: $\frac{1}{4} \times \pi \times \text{FML} \times \text{FMW}$; π (the mathematical constant) = 22/7.

FML= foramen magnum length and FMW= foramen magnum width

Foramen magnum index (FMI): Calculated by $\text{FMW}/\text{FML} \times 100$

5.2 Mastoid Process

5.2.1 Introduction

- The analysis of mastoid process is important in the discrimination of sex for forensic and anthropological purpose. Many researchers agree that qualitative aspect, such as their size, ruggedness for muscular attachment inclination or mastoid process inclination are very good indicators of sexual dimorphism;
- However from the quantitative point of view their utility is discussed because on the one hand, there does not exist consent about the parameters to determine the height, width, and antero-posterior diameter of the mastoid process. Even in fragmented skull the mastoid process is well preserved and protected.
- The current investigation provides baseline data to determine the sex of the skull. Males had higher mean values for mastoid length, medio-lateral diameter, and antero-posterior diameter than females did. Additionally, it has statistical significance in determining sex. By contrasting them with the results of earlier researchers, the single mastoid parameter was examined.

Table 5.2.2. A comparison of the mastoid length, medio-lateral, antero-posterior diameter between the current study and earlier researchers

Author	Population studied	No. of skulls	Mastoid length (mm)	Medio-lateral diameter (mm)	Antero-posterior diameter (mm)
Sumati and others (2010) (6)	North India	M= 30 F= 30	M= 28.3± 4.0 F= 23.18± 4.2	M= 11.46± 2.7 F= 8.68± 2.6	M= 17.52± 4.69 F= 13.69± 3.67
Gupta AD et al. (2012) (8)	South India	M= 35 F= 35	M= 29.23± 2.42 F= 22.44± 3.77	M= 11.24± 2.0 F= 8.59± 1.5	M= 16.55± 3.82 F= 15.78±2.47
Vineetasaini et al. (2012) (9-13)	North India	M= 104 F= 34	M= 35.82±3.55 F= 31.86± 3.32	-	M= 25.58± 1.89 F= 22.77± 2.37
Nidugala H (2013)	South India	M= 40 F= 40	M= 35.63± 3.91 F= 30.55± 4.09		M= 21.97± 2.60 F= 20.03± 2.74
Shobhaverma et al. (2015) (11)	UP Population	M= 50 F= 50	M= 28.62± 0.63 F= 23.92± 1.54	M= 12.33± 0.86 F= 12.38± 1.56	M= 17.36±1.03 F= 15.39± 1.81
Author	Population studied	No. of skulls	Mastoid length (mm)	Medio-lateral diameter (mm)	Antero-posterior diameter (mm)
Present Study (2025)	Western Maharashtra	(Rt)= 37.21±8.72	(Rt)=6.36±1.84,	(Rt)=23.19±4.89,	(Rt)= 37.21±8.72
		M=50	(Rt)= 37.21±8.72	(Rt)=6.36±1.84,	(Rt)=23.19±4.89,
			(Lt)= 37.47±9.10	(Lt)=6.06±1.44.	(Lt)= 24.24±4.11.
		F=50	(Rt)= 36.68±7.00,	(Rt)= 4.77±2.06,	(Rt)= 21.00±4.33,
			(Lt)= 32.87±7.25	(Lt)=5.22±2.35	(Lt)= 22.23±5.54

Table 5.2.2 various parameters of mastoid process by various workers in different areas. The mastoid length is more in males as compare to females and this is true in our study.

- If the skull remains flat, it is the male skull; if it rests on the mastoid process, it is the female skull. It is feminine if it rests on the occipital condyles. This claim subtly supports the idea that male skulls are longer than female skulls.
- The parameters of Medio-lateral diameter and Antero-posterior diameter of mastoid process was calculated by previous workers noted that these parameters were more in males as of females. The current study correlates with previous workers.⁽⁹⁻¹⁶⁾
- After examining the mastoid process index on the right and left sides independently, researchers found that women had a considerably higher index than men.
- The mastoid process index was somewhat higher in females (66.55 mm) than in males (66.30 mm) in the current study.
- The mastoid index proved useful in determining the sex of the skull because there has been very little research on the mastoid process index
- In the current study the new finding is mastoid size (55.76 mm) which was more in males as in females (38.87 mm).
- The area of mastoid process in male on right side (539.66 ± 77.12 mm), on left side was (513.06 ± 135.69 mm), and female on right side was (494.06 ± 106.49 mm), on left side (465.74 ± 112.16 mm).
- The area of mastoid process is more in males as compared to females. By this parameter we confirm the skull is of male or female.

5.3 Styloid Process

5.3.1 Introduction

- In Greek words the meaning of styloid process “Standing pillar”. From the base of skull a slender projection directed downward, forward and medially. Embryo- logically lesser cornu of hyoid bone,
- Stylohyoid ligament and styloid process are developed from second pharyngeal arch called as Richards’s cartilage, because the **four segments are** —the tympanohyal, stylohyal, ceratohyal, and hypohyal—develop from cartilage. These four portions are divided into two halves.
- The tympanohyal and stylohyal segments, which typically united at puberty, give rise to the styloid process. The hypohyal segment gives rise to the smaller cornu of the hyoid bone, while the ceratohyal segment is the source of the stylohyoid ligament.
- For the same person, the styloid process’ duration on the left and right sides may differ. Excessive or improper stylohyoid complex ossification during development can lead to angulated or unusually long styloid processes.
- Any traumatic damage to the styloid process will excite it, which may cause metaplastic changes in the styloid ligament’s cells. These changes may end in partial or complete ossification of the styloid ligament, which would cause Eagles syndrome ⁽⁷⁾
- The length of the styloid process has been studied in relation to Eagles syndrome by numerous prior researchers. But in the styloid complex component, there was often no association discovered.
- The aberrant angulation, not the length of the styloid is what causes the symptoms ⁽²⁷⁾.

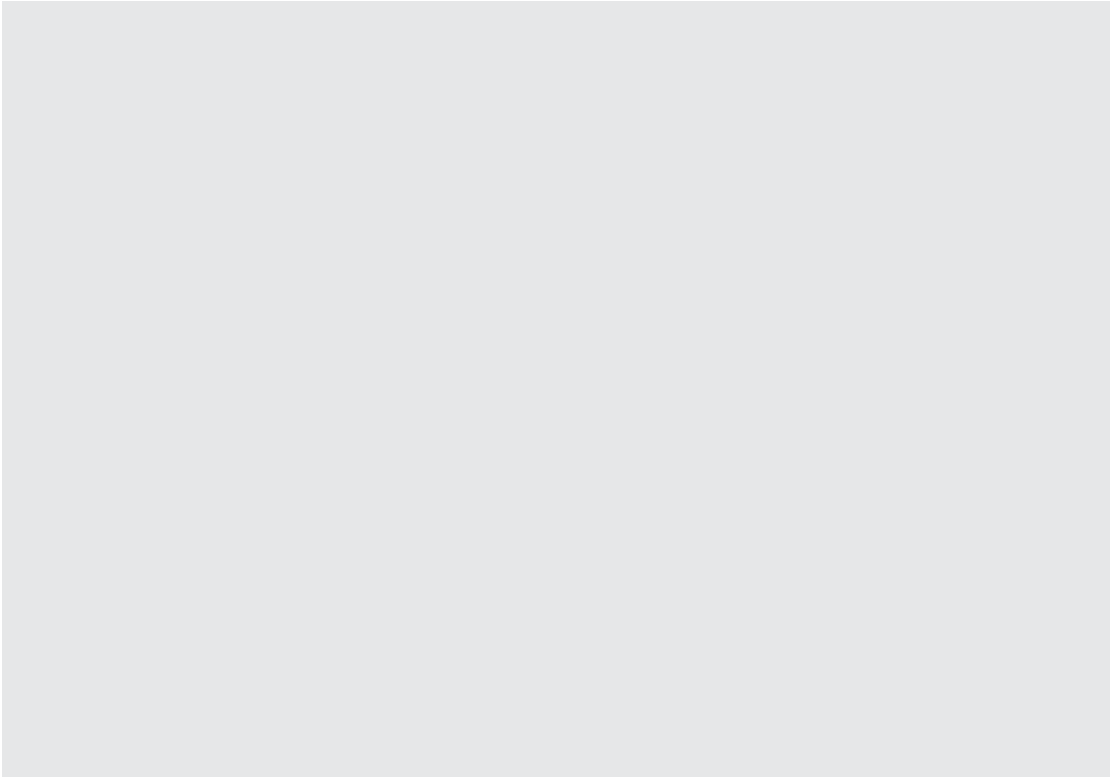
- After studying 100 skulls, Chauhan et al. found that the styloid process measured more than 30 mm in 16 of the skulls ⁽¹⁴⁾.
- This study was comparable to that of Chauhan et al. (2014) in that statistical analysis reveals that, of 100 skulls, 50 of them are male and had a styloid process length of more than 30 mm ⁽²⁸⁾.
- The styloid process and stylohyoid ligament complex structural diversity in length and angulation is very significant from an anatomical, anthropological, and clinical standpoint.

5.4 Foramen Ovale

5.4.1 Different shapes of foramen Ovale with percentage

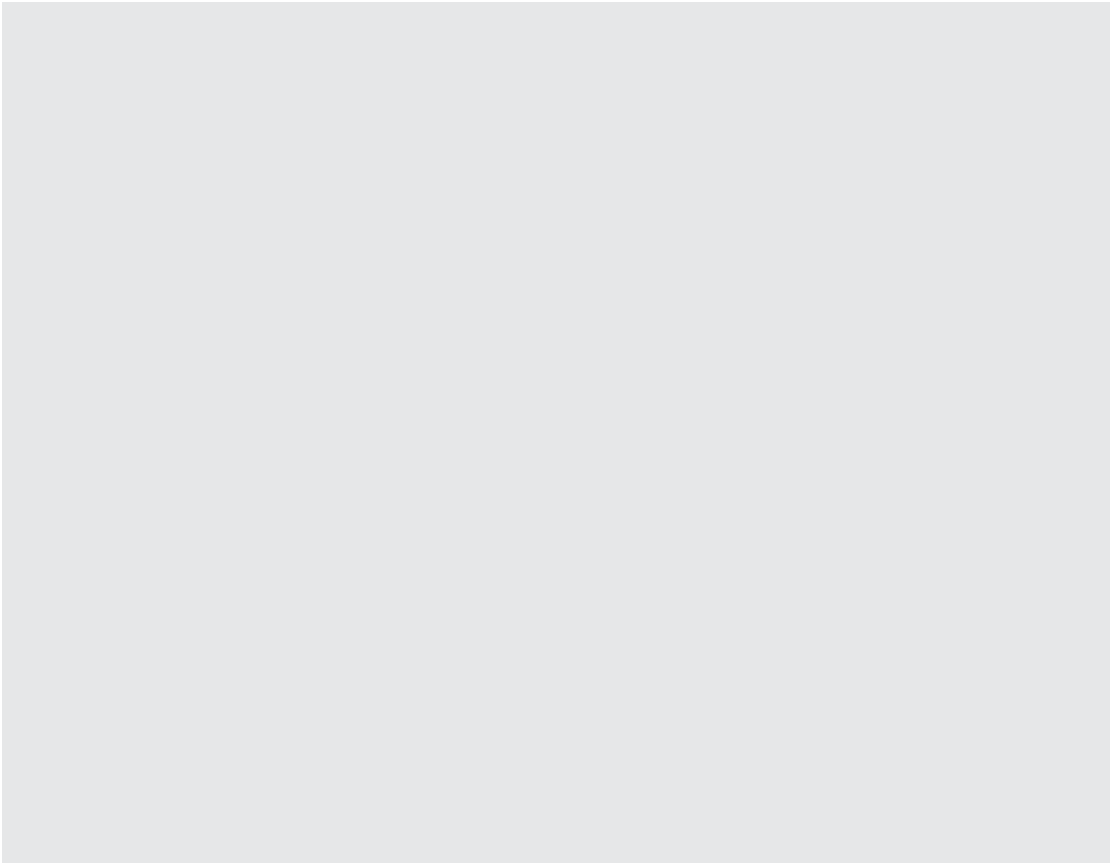
Author	Oval shape	Round shape	D shape	Almond Shape
Chandra Philips 2013(28)	76%	2%	2%	14%
Patel et al 2014 (29)	59.8%	27.5%	-	12%
Daimi SR 2011(30)	29.87%	12.52%	46.16%	-
Present study 2025	89%	10%	25%	-

- A study by Chandra Philips et al ⁽²⁸⁾ conducted on 50 dry human skulls shows that the mean length of foramen ovale was 7.27 ± 1.41 mm on right side and 7.46 ± 1.41 mm on left side.
- A study by Patel et al ⁽²⁹⁾ conducted on 100 dry human skulls showed that the mean length of foramen ovale was 6.6mm on right side and 6.5 mm on left side. Width was 3.6 mm on right side and 3.5 mm on left side .The right side length and width of foramen ovale was more than the left side.
- The foramen ovale on the right side of the study was longer and wider than the foramen ovale on the left. Our research aligned with the investigations carried out by Daimi et al. and Patel et al ⁽³⁰⁾.



CHAPTER - VI

CONCLUSIONS



CHAPTER VI

SEXUAL DIMORPHISM AND MORPHOMETRIC ANALYSIS OF FORAMEN MAGNUM, MASTOID PROCESS, STYLOID PROCESS AND FORAMEN OVALE

CONCLUSIONS

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CHAPTER VI

CONCLUSIONS

6.1 Foramen Magnum

- The foramen magnum length, width, and area are statistically significant factors; in the present investigation.
- They can serve as baseline data for anthropometric studies, radiologists, neurosurgeons doing skull base surgery, and forensic experts.
- The best parameter for sex determination of the skull is area of foramen magnum.

6.2 Mastoid Process

- From the present study conducted on 100 dry skulls unknown sex and statistical analysis of P-value, which shared to be very significant.
- It is concluded that mastoid length is a reliable indication for sexual dimorphism in mastoid process skulls.
- Moreover, by comparing our data with known sex of skulls studies conducted earlier, it can be concluded that, Mastoid length, Mastoid area, Mastoid size, is higher in males than females ^(7-8and11).
- Therefore the current study validates the use of mastoid length, mastoid area, mastoid size, as a reliable metric parameter for the role of mastoid process as tool for sex determination.
- Out of all parameters the most reliable parameter for determine the gender of the skull is mastoid length.
- As the new findings in current research the mastoid area, and mastoid size plays an important role in sex determination of the skull.

6.3 Styloid Process

- In the statistical analysis reveals that, of 100 skulls, 50 of them are male and had a styloid process length of more than 30 mm ⁽²⁸⁾.
- The styloid process and stylohyoid ligament complex structural diversity in length and angulation is very significant from an anatomical, anthropological, and clinical standpoint.
- The key feature to identify the sex of the skull is length of styloid process.

6.4 Foramen Ovale

- Out of 50 male and 50 female skulls, the antero-posterior diameter of foramen ovale is larger in 35 skulls of males, and 7 skulls in females.
- The transverse diameter is also greater in males of 25 skulls and 1 skull in females.
- The variations of dimensions of foramen ovale present in the current study which may be useful for treating the Gasserian neuralgia.

CHAPTER - VII

**SUMMARY AND
CONCLUSIONS**

Chapter VII

SEXUAL DIMORPHISM AND MORPHOMETRIC ANALYSIS OF FORAMEN MAGNUM, MASTOID PROCESS, STYLOID PROCESS AND FORAMEN OVALE

SUMMARY AND CONCLUSIONS

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CHAPTER - VII

SUMMARY AND CONCLUSIONS

In the present study titled “SEXUAL DIMORPHISM AND MORPHOMETRIC ANALYSIS OF FORAMEN MAGNUM, MASTOID PROCESS, STYLOID PROCESS, AND FORAMEN OVALE” we studied 4 parameters on 100 adult human skulls of unknown sex.

7.1 Summary

7.1.1 Foramen Magnum

- The mean length of foramen magnum was 33.40 ± 3.73 mm in males and in females are 31.89 ± 3.25 mm and the mean transverse diameter in males 28.99 ± 2.99 mm and in females' 27.08 ± 3.35 mm.
- The mean length and width of foramen magnum was greater in males than in females.
 - The mean area of foramen magnum in males 762.08 ± 129.28 mm, and in females 680.25 ± 123.94 mm.
 - The Area of foramen magnum was calculating by the Heron's formula. By using this formula the area of foramen magnum was larger in males as of females.
 - The mean area of foramen magnum **is more in males than that of females.**
- In the 100 foramen magnum (50males, 50females), 37 foramen magnum were observed that round (74%) and Oval are 14 (28%) in case of males, 30 (60%) foramen magnum were observed that round and oval 20 (40%) in the females.
 - The FML, FMW, and FMA these findings are **highly significant**

- If the foramen magnum index is equal or greater than 1.2cm then it was consider the Oval shape, and if it is less than 1.2cm then it is of round shape.
- In the current study the frequency of oval shape and round shape foramen magnum is comparatively more as of previous workers.
- In the current study indicates that significantly sexual dimorphism exists in FMA, FML, and FMW.
- But out of above all parameters the foramen magnum area plays an important role in sexual dimorphism then followed by length and width of foramen magnum and it is statistically significant.

7.1.2 Mastoid Process

Table 7.1.2.1 The mean of mastoid process on right side

Parameters of mastoid process	Males	Females
Length	37.22±8.72 mm	34.68±7.01 mm
Mastoid size	56.23±27.48 mm	37.95±28.04
Mastoid area	537.07±178.50 mm	494.06±106.49 mm

Table 7.1.2.2 The mean of mastoid process on left side

Parameters of mastoid process	Males	Females
Length	37.47±9.11 mm	32.88±7.25 mm
Mastoid size	55.30±20.49 mm	39.81±25.38
Mastoid area	510.08±135.94 mm	465.78±112.16 mm

- The mastoid length was more in males as compare to females and this is true for the study. Mastoid process index on right and left side ¹³ studied separately and conclude to indicating females had a higher mastoid process index (66.55 mm) than males did (66.30 mm), however not statistically significantly.
- The sex of the skull can be inferred from the mastoid process index because it has been the focus of comparatively little investigation.
- In the current study the new finding the mastoid size (55.76 mm) which was more in males as in females (38.87 mm).
- And also the area of mastoid process was more in males as compare to females.
- The mastoid process is a sexually dimorphic bone by using the all mastoid variables. The mastoid length is the best discriminant analysis for sex determination 73% on right side ($P > 0.001$) and 76% on left side ($P > 0.003$) and it is highly significant.
- The right side mastoid area in male was highly significant and for left side is border line significant. With the help of all these parameters we also come to conclude that the skull is of male or

female.

7.1.3 Styloid Process

Table 7.1.3.1 the mean of all parameters of Styloid Process

Parameters	Male		Female	
	Mean	SD ($\pm$)	Mean	SD ($\pm$)
R_LSP	21.54	9.67	19.82	5.09
R_THICKNESS	5.31	1.62	4.29	1.51
L_LSP	20.24	7.31	16.26	4.27
L_THICKNESS	4.63	1.51	4.89	1.52
Interstyloid Distance at TIP	64.73	9.60	69.01	6.60
Interstyloid distance at BASE	81.38	6.32	79.00	6.83

- In the males the mean of right side length and thickness of styloid process, and on left side length and thickness along with Inter-styloid distance at the base was found larger as compare to females.
- The styloid process and stylohyoid ligament complex structural diversity in length and angulation is very significant from an anatomical, anthropological, and clinical stand point
- The difference between the length of right side and left side was statistically significant, and also the difference between width of right side and left side was also statistically significant.

7.1.4 Foramen Ovale

- The current study was conducted on 100 unknown dry skulls. The mean length of foramen ovale in males on right side is 8.33 ± 3.32 mm, in females on right side 6.58 ± 1.17 mm. On Left side in males was 7.89 ± 1.75 mm, and on left side in females was 6.87 ± 1.38 mm.
- Width of foramen ovale on Right side in males 4.43 ± 1.17 mm, females 3.98 ± 1.17 mm width of foramen ovale on left side in males 4.46 ± 1.20 mm, in females 4.03 ± 0.89 mm/
- Right side of foramen ovale D1-CF= Males = 27.52 ± 4.83 mm, Females = 24.45 ± 2.98 mm (D1-CF = Distance from root of zygoma to center of foramen) Left side of foramen ovale in Males = D1-CF = 26.07 ± 4.00 mm, Females = 23.4 ± 2.97 mm.
- Right side of foramen ovale D2- CF = Males = 23.05 ± 3.24 mm, Females = 25.44 ± 23.23 mm Left side of foramen ovale D2- CF= Males = 23.19 ± 3.91 mm, Females = 21.90 ± 2.84 mm..
- The length and width were greater in males on right side as compared with left side. The difference between the length of right side and left side was statistically significant, and also the difference between width of right side and left side was also statistically significant.
- Left side D2 – CF is longer in male as compare to female and it is significant.
- Right side D2 _ CF is not statistically significant.
- The variations of dimensions of foramen ovale present in the current study which may useful for treating the trigeminal neuralgia.

7.2 CONCLUSIONS

7.2.1 What is already known to his topic?

- The mean values of all metric parameters in Indian population.
- Correlation the data between anthropometric and morphometric analysis in all Variables.
- Morphology and morphometric values are a guide line to clinicians, anatomist, anthropologist, and forensic science.

7.2.2 What this study adds?

- The progress in the neuro-imaging techniques to diagnose cranio-vertebral abnormalities accurately has increased interest for craniovertebral surgery. Such as vascular and neural structures to foramen magnum.
- Advances in skull base surgeries such as “far lateral trans-condylar approach” have improved the better and wider access of surgical exposure leading to successful surgeries. To perform such surgeries, prior to the analysis of the morphometric dimensions of foramen magnum is essential.
- The morphometric analysis of the foramen magnum, mastoid process, styloid process and foramen ovale is tool for determination of the sex.
- It will give primary data for analysis.
- The estimated values of foramen magnum, mastoid process, styloid process and foramen ovale may be useful for future research studies to analysis the data.

7.2.3 Limitations of study:

- The selected data present in small sample size
- The morphometric values are not compared with modern investigation like radiograph, MRI, CT.
 - Increase in the study sample size for more data analysis.
 - The metric analysis of the foramen ovale, mastoid process, styloid process, and foramen magnum in this study has more significant data or values, which can benefit future studies as well as doctors, anatomists, and forensic specialists.
 - The study of metric measurement of all parameters could be useful to compare with other population, and may be help to add more information.
 - The variation in values of different parameters of foramen magnum, mastoid process, styloid process, and foramen ovale differ from other Indian population.
 - The different values of all parameters which were help for primary diagnosis or gives base line data for new researchers.
 - Sex determination of the skull is helpful in medico-legal cases.

7.2.4 Focus of the study:

- The study of metric analysis of foramen magnum, mastoid process, styloid process, and foramen ovale has a great importance to give primary data for investigation in day to day practice.
- The focus of the study is, to predict the data for various researchers.
- To evaluate all the dimension of all parameters and gives correct metric analysis.
- This study gives more advantage to Anatomist, radiologist, neurosurgeons for skull base surgeries, and anthropologists.

CHAPTER - VIII

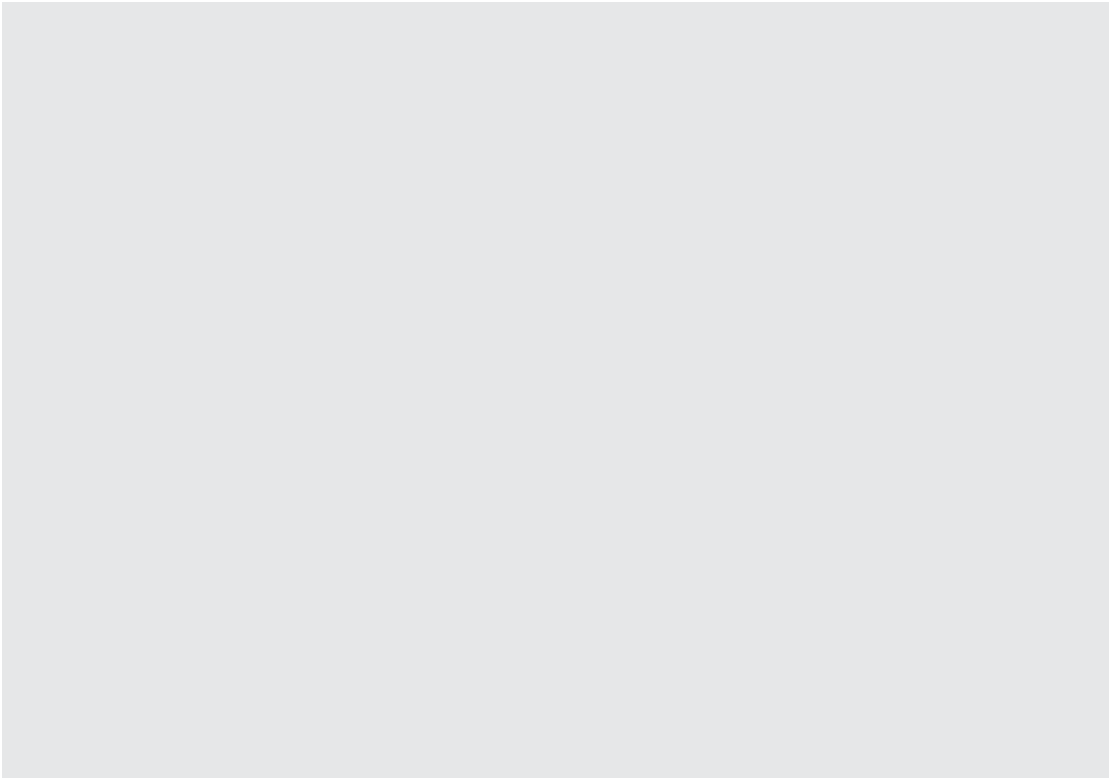
RECOMMENDATION

CHAPTER - VIII**RECOMMENDATIONS**

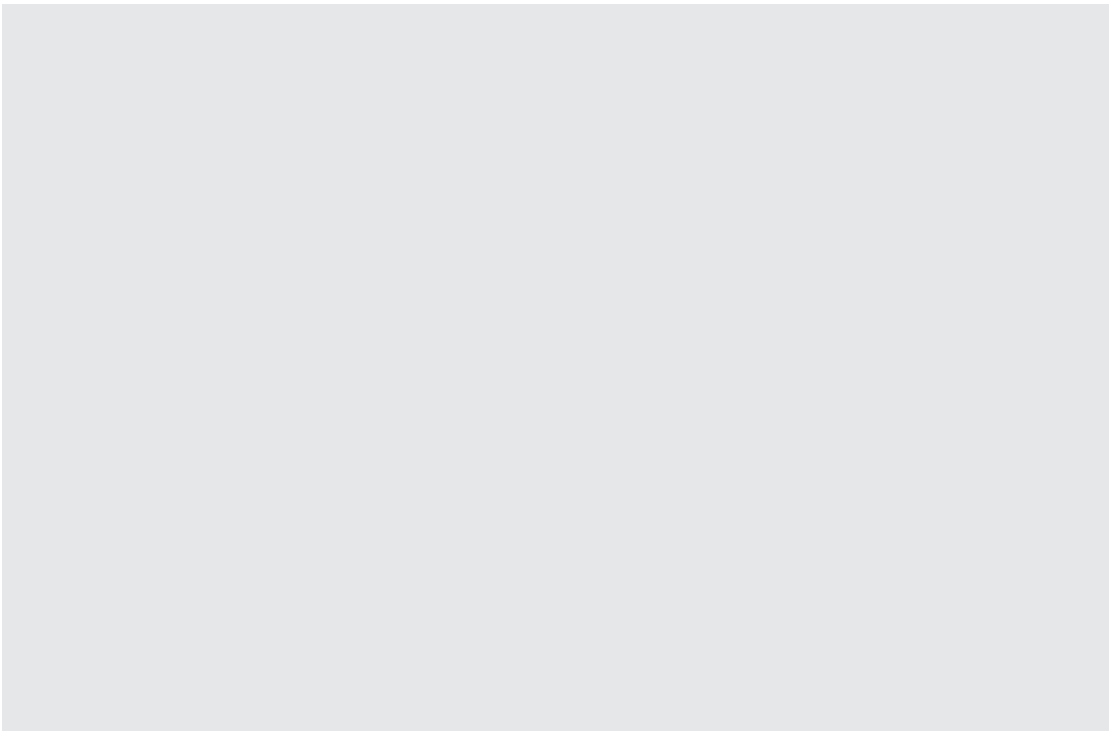
- The study carried out in D. Y. Patil Medical College, Kolhapur. The study samples used equal distribution of male and female. The standard data tabulated in percentage. The collected data were sorted and required as per inclusion criteria were taken and measured in SPSS VERSION 28.0.0
- The observations noted in excel sheet for analysis. The demographic parameters (gender) were used.
- In this study, geometric parameters were studied using human dry skull. Morphometric study of foramen magnum, mastoid process, styloid process, and foramen ovale the best tool for analysis the correct values and getting the good result.
- Statistical significance of all parameters is useful for new researchers. These variations have become significant because of newer imaging techniques such as computed tomography and magnetic resonance imaging in the field of diagnostic medicine.
- The study result is compared with previous scholars and evaluates the significance an increase in study sample size for more data analysis.
- To evaluate parameters in this study are helpful for anatomist, forensic experts, neurosurgeons, radiologists, and for anthropologist.
- The lack of statistical difference in all skull parameters with demographic parameters may be explained by small sample size. However large sample size may be statistical difference will find.
- In this study, all parameters of the skull in that area of foramen magnum, various shapes of foramen magnum, mastoid length, mastoid size, mastoid triangle, and length of styloid process, base of styloid process, antero- posterior diameter and transverse diameter of

foramen ovale are more significant in males as of females, and it is attracted to research the more data for more evaluations in details.

- For the future study and research all parameters of foramen magnum, mastoid process, styloid process, foramen ovale.
- The planning of future analyses the values between different ethnic groups within the Indian population.
- The studied geometric parameters measurements in our population could be useful to compare with other population and may be helpful.
- The study of metric analysis of foramen magnum, mastoid process, styloid process, and foramen ovale has a great importance to give primary data for investigation in day to day practice.
- The focus of the study is, to predict the data for various researchers.
- To evaluate all the dimension of all parameters and gives correct metric analysis.
- This study gives more advantage to Anatomist, radiologist, neuro-surgeons for skull base surgeries, and anthropologists.



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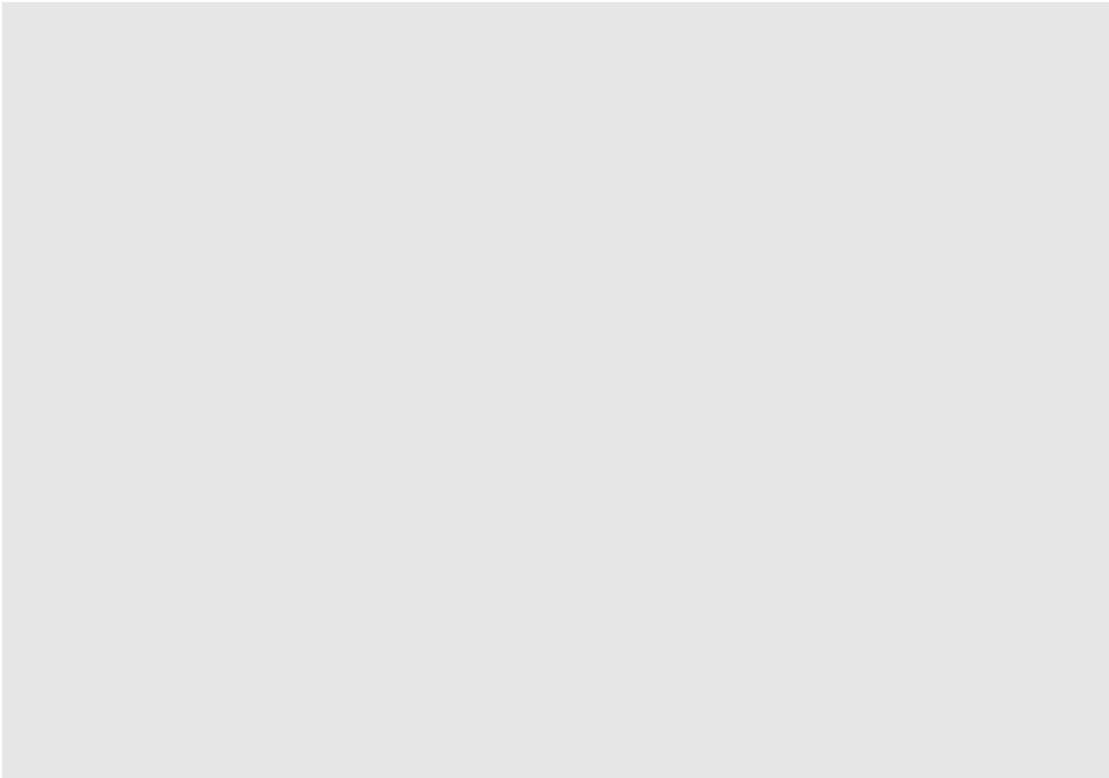
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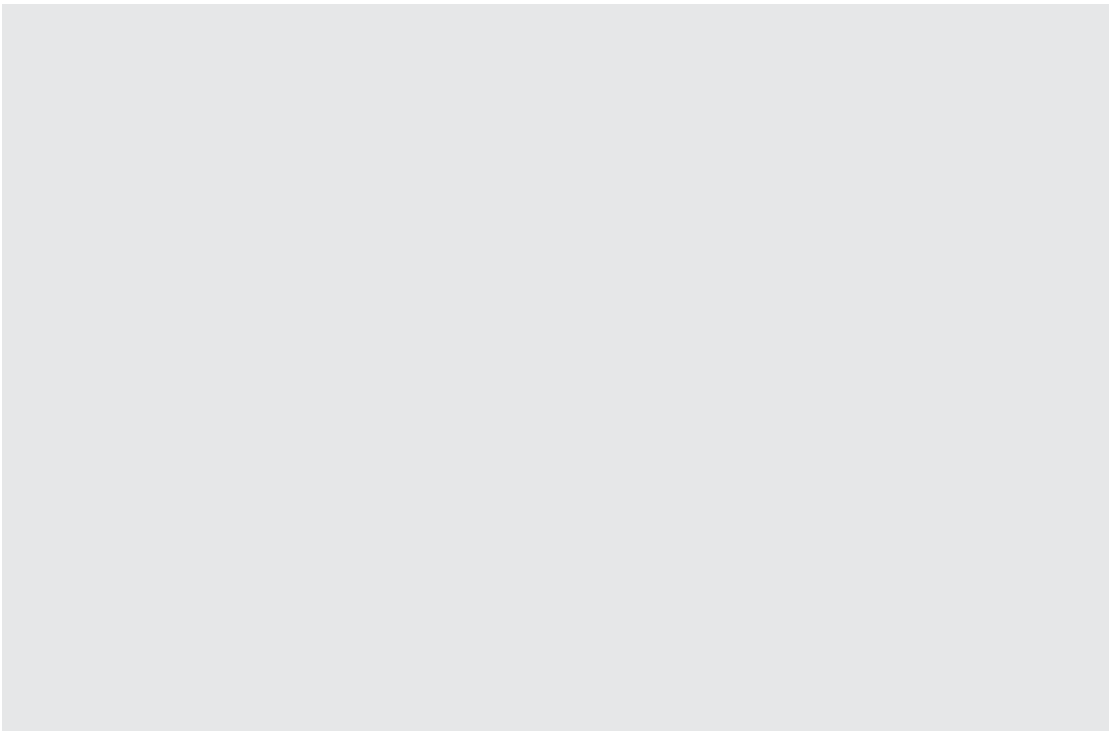
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ANNEXURE



ANNEXURE ETHICAL COMMITTEE CLEARANCE CERTIFICATE LIST OF PUBLICATIONS



D. Y. PATIL MEDICAL COLLEGE, KOLHAPUR
Constituent College of D.Y. Patil Education Society Deemed University, Kolhapur

Dr. Rakesh Kumar Sharma
Dean & Professor (Obst. & Gyn.)

Padmashree Dr. D. Y. Patil
Founder President

Dr. Sanjay D. Patil
President

Outward No. DMCK/255/2013/IEC

23 AUG 2019
Date :

INSTITUTIONAL ETHICS COMMITTEE, D. Y. PATIL MEDICAL COLLEGE, KOLHAPUR.

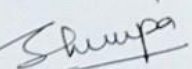
This is to certify that the research project titled, "Sexual Dimorphism and Morphometric Analysis of the Foramen Magnum, Mastoid, Styloid Process, Foramen Ovale, in Western Maharashtra".

Submitted by : **Mr. Parashuram S. Koli**

Under the supervision of appointed Guide (if any): **Dr. V. R. Nikam**

Has been studied by the Institutional Ethics Committee (IEC) at its meeting held on 21.08.2019 and granted approval for the study with due effect with the following caveats:

1. If you desire any change in the protocol or standard recording document at any time, please submit the same to the IEC for information and approval before the change is implemented.
2. All serious and/or unexpected adverse events due to the drug/procedures tested in the study must be informed to the IEC within 24 hours and steps for appropriate treatment must be immediately instituted.
3. In case of injury/disability/death of any participant attributable to the drug/procedure under study, all compensation is to be made by the sponsor of the study.
4. The Chief investigator/Researcher must inform the IEC immediately if the study is terminated earlier than planned with the reasons for the same.
5. The final results of the study must be communicated to the IEC within 3 months of the completion of data collection.
6. The researcher must take all precautions to safeguard the rights, safety, dignity and wellbeing of the participants in the study.
7. The researcher must be up to date about all information regarding the risk/benefit ratio of any drug/procedure being used and any new information must be conveyed to the IEC immediately. The IEC reserves the right to change a decision on the project in the light of any new knowledge.
8. Before publishing the results of the study, the researcher must take permission from the Dean of the Institution.
9. Annual progress report should be submitted for all sponsored projects to the committee.
10. Unethical conduct of research in non-sponsored projects will result in withdrawal of the ethical approval and negation of all data collected till that date.



Dr. Mrs. Shimpa R. Sharma
(Member Secretary, IEC)
Dr. (Mrs) Shimpa Sharma
Member Secretary,
Institutional Ethics Committee
D. Y. Patil Medical College,
Kolhapur - 416 006

869, 'E' Kasaba Bavada, Kolhapur-416 006 (MS) INDIA. Phone No. : (0231) 2601235-36, Fax : (0231) 2601235-36
Web: dypatilmedicalkop.org. E-mail : dypatilmedicalcollege@gmail.com

ANNEXURE

KMACON 2021, KOLHAPUR MEDICAL ASSOCIATION:
PAPER PRESENTATION



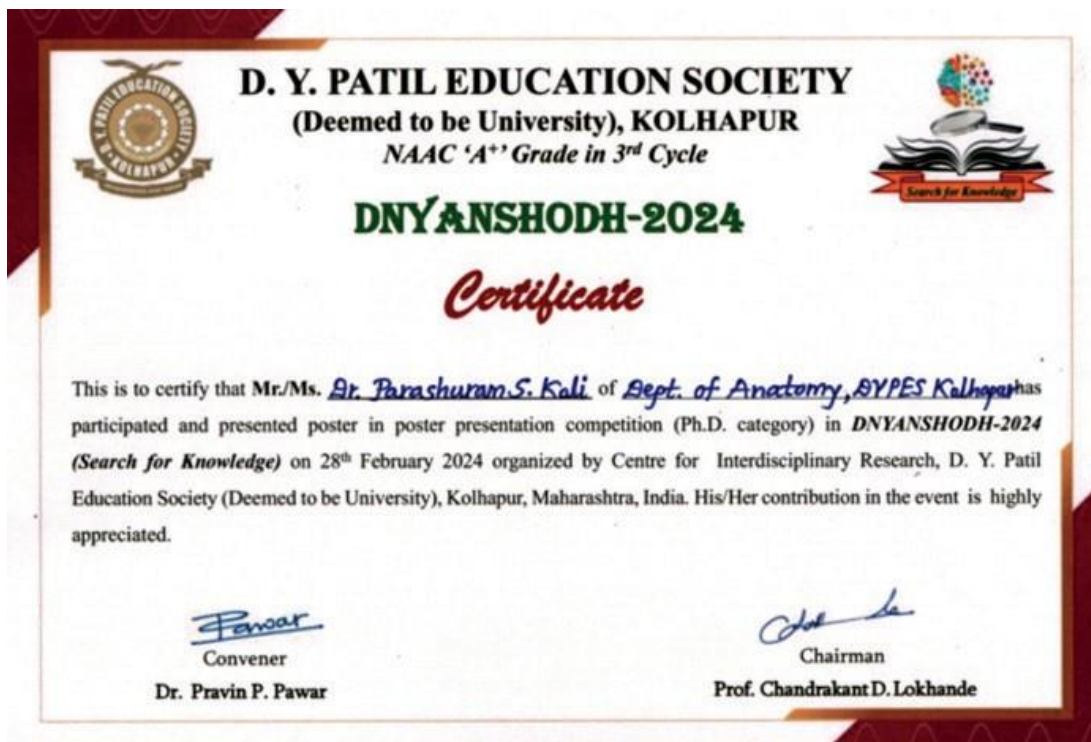
KMACON 2021, KOLHAPUR MEDICAL ASSOCIATION : POSTER PRESENTATION



MAHACON VI - D. Y. PATIL SCHOOL OF MEDICINE, NAVI MUMBAI
PAPER PRESENTATION 2024



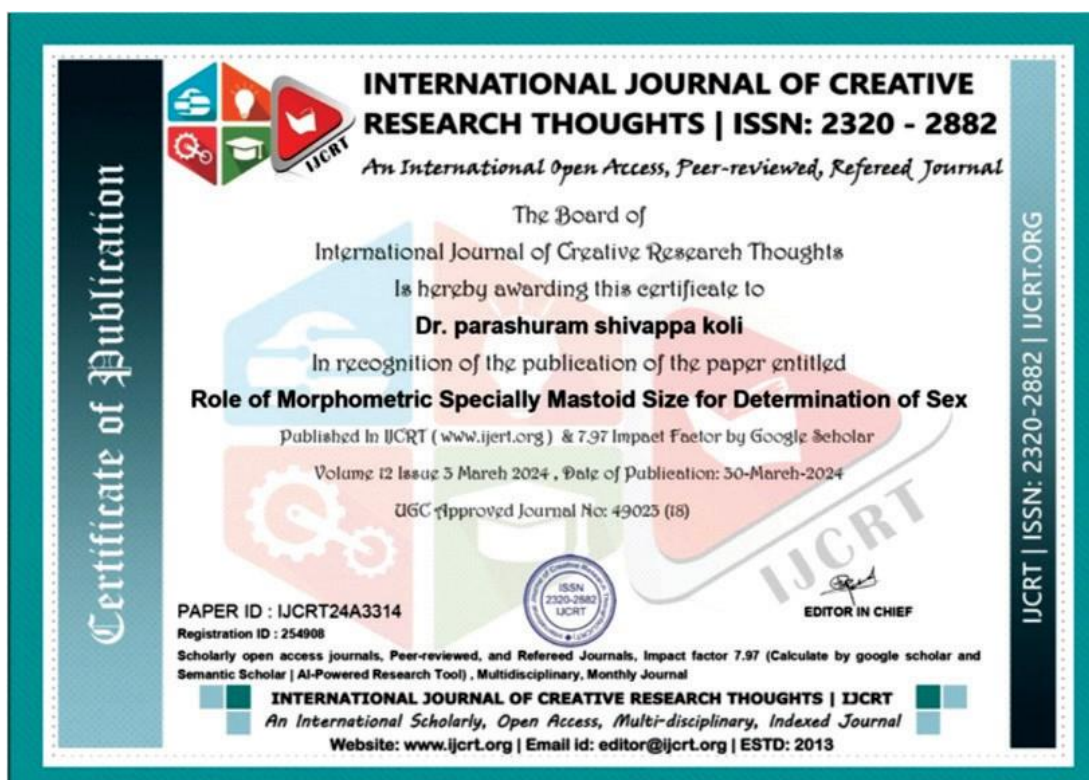
D. Y. PATIL EDUCATION SOCIETY KOLHAPUR
DNYANSHODH 2024 - POSTER PRESENTATION



PAPER PUBLICATIONS: FIRST



PAPER PUBLICATIONS: SECOND



PLAGIARISM CHECK REPORT

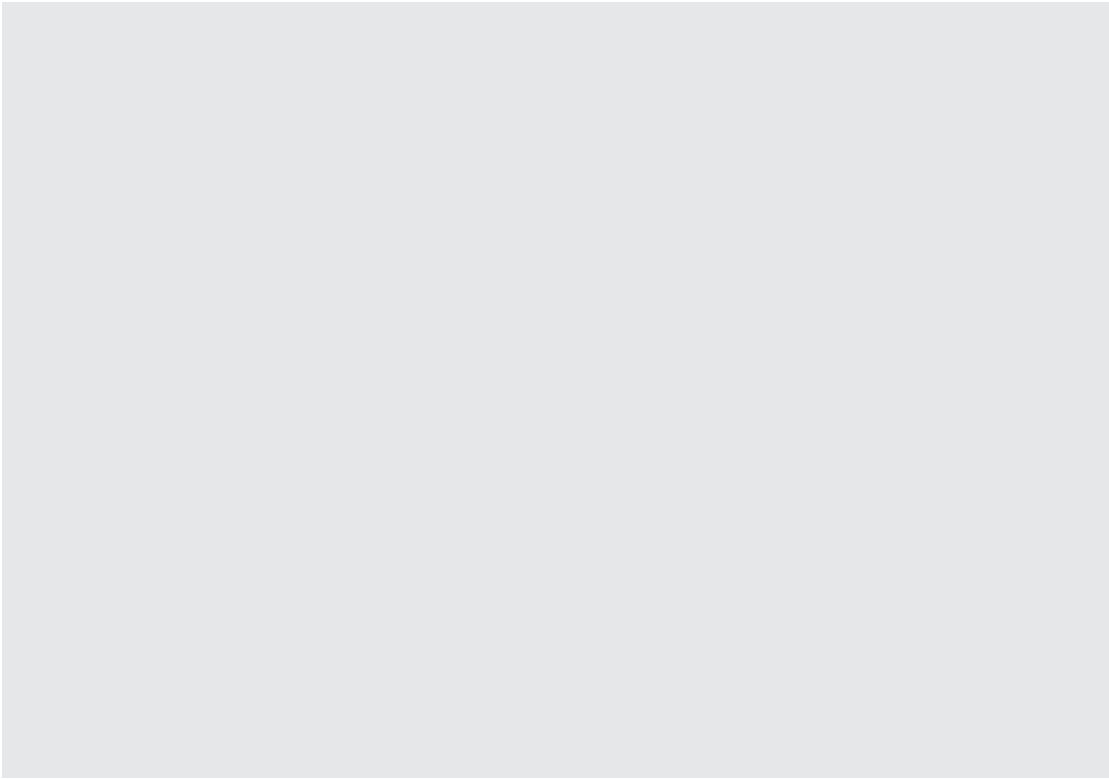
1.1.1 The foramen magnum

ORIGINALITY REPORT

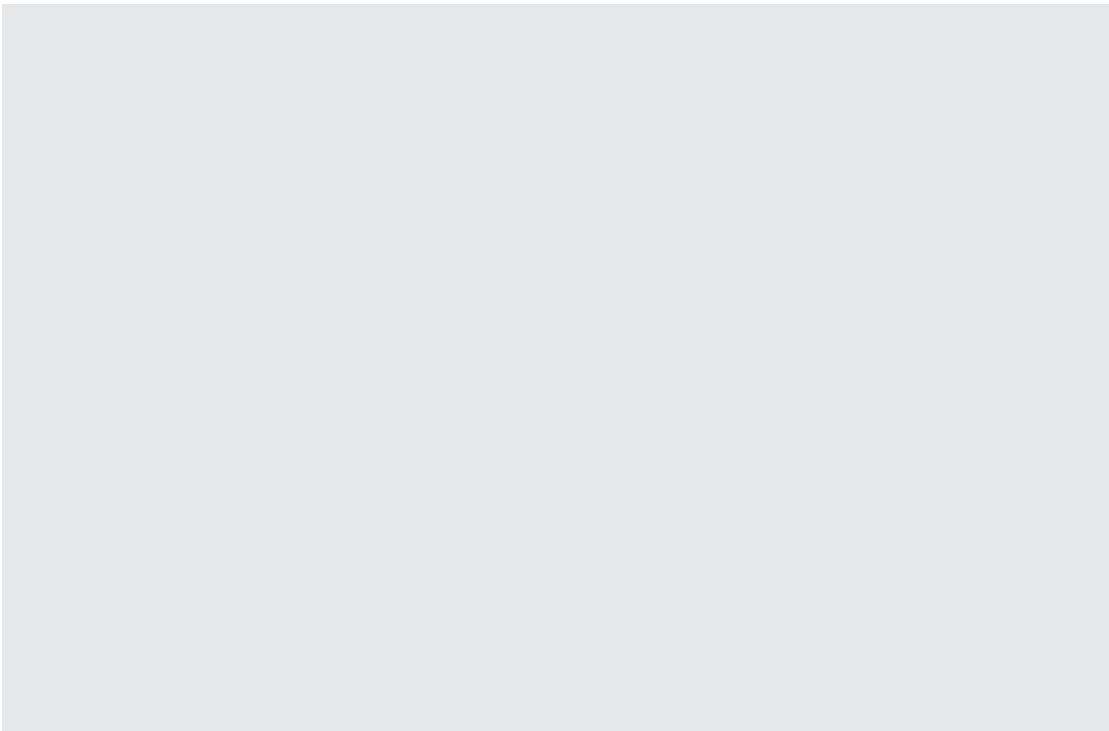
8 %	8 %	7 %	7 %
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MASTER CHART



FORAMEN MAGNUM

Male						
FORAMEN MAGNUM						
FML						SHAPE
	FMW	FMA	FMI	SHAPE	SHAPE	
1	33.27	28.22	737.0203	84.82	1.178951	round
2	29.04	24.73	563.755	85.16	1.174282	round
3	28.73	30.12	679.2979	104.84	0.953851	round
4	33.76	28.59	757.6807	84.69	1.180832	round
5	30.48	27.2	650.809	89.24	1.120588	round
6	31.37	28.07	691.2364	89.48	1.117563	round
7	33.55	28.13	740.8528	83.85	1.192677	round
8	35.98	28.2	796.4893	78.38	1.275887	oval
9	34.48	28.33	766.8024	82.16	1.217084	oval
10	36.14	34.17	969.3995	94.55	1.057653	round
11	34.86	29.07	795.5035	83.39	1.199174	round
12	36.42	30.41	869.4128	83.50	1.197632	round
13	33.91	31.05	826.5308	91.57	1.09211	round
14	31.83	26.37	658.8953	82.85	1.207053	oval
15	33.67	32.05	847.1119	95.19	1.050546	round
16	38.29	32.35	972.365	84.49	1.183617	round
17	35.22	28.51	788.2359	80.95	1.235356	oval
18	35.66	31.17	872.5449	87.41	1.144049	round
19	30.96	30.96	752.4395	100.00	1	round
20	37.84	32.27	958.561	85.28	1.172606	round
21	37.77	33.33	988.2162	88.24	1.133213	round
22	37.63	30.37	897.1161	80.71	1.239052	oval
23	39.75	31.89	905.0876	80.23	1.246472	oval
24	34.81	30.77	840.8164	88.39	1.131297	round
25	35.29	27.77	769.3026	78.69	1.270796	oval
26	38.12	30.41	909.9949	79.77	1.253535	oval
27	30.11	28.12	664.6542	93.39	1.070768	round
28	28.32	24.13	536.4389	85.20	1.173643	round
29	34.33	27.33	736.5175	79.61	1.256129	oval
30	32.46	30.96	788.8949	95.38	1.04845	round
31	33.45	30.12	790.8985	90.04	1.110558	round
32	32.12	29.07	732.9768	90.50	1.104919	round
33	31.18	30.17	738.45	96.76	1.033477	round
34	32.12	30.7	774.0759	95.58	1.046254	round
35	33.11	31.12	808.8508	93.99	1.063946	round
36	31.32	29.22	718.4088	93.30	1.071869	round
37	36.92	24.71	716.1502	66.93	1.494132	oval
38	33.62	31.04	819.1984	92.33	1.083119	round
39	35.81	28.76	808.468	80.31	1.245132	oval
40	33.87	30.12	800.8291	88.93	1.124502	round
41	28.48	31.05	694.1786	109.02	0.91723	round
42	26.32	24.09	497.7283	91.53	1.09257	round
43	24.48	28.72	551.9065	117.32	0.852368	round
44	22.33	29.13	510.6212	130.45	0.766564	round
45	32.42	20.17	513.3204	62.21	1.607338	oval
46	38.03	32.19	960.9858	84.64	1.181423	round
47	39.42	20.19	624.7735	51.22	1.952452	oval
48	29.18	28.62	655.5783	98.08	1.019567	round
49	36.82	31.72	916.8254	86.15	1.160782	round
50	34.92	23.64	648.0244	67.70	1.477157	oval

female						
FORAMEN MAGNUM						
FML						SHAPE
	FMW	FMA	FMI	SHAPE	SHAPE	
30.41	28.01	668.6505	92.10786	1.085684	round	
29.68	26.2	610.4286	88.27493	1.132824	round	
30.56	26.58	637.6436	86.97644	1.149737	round	
32.03	23.8	598.4165	74.30534	1.345798	oval	
31.4	27.19	670.2063	86.59236	1.154836	round	
31.75	30.01	747.9617	94.51969	1.057981	round	
30.37	24.43	582.4222	80.44122	1.243144	oval	
30.67	28.44	684.72	92.72905	1.078411	round	
31.12	27.51	672.0473	88.39974	1.131225	round	
28.79	23.56	532.4595	81.83397	1.221986	oval	
35.73	29.91	838.9172	83.71117	1.194584	round	
30.35	27.16	647.0802	89.48929	1.117452	round	
34.96	30.46	835.9321	87.12815	1.147735	round	
32.2	32.2	813.9194	100	1	round	
35.18	27.24	752.268	77.43036	1.291483	oval	
36.24	27.08	770.3827	74.72406	1.338257	oval	
29.49	21.88	506.5143	74.19464	1.347806	oval	
34.1	30.69	821.5253	90	1.111111	round	
35.7	32.27	904.3506	90.39216	1.106291	round	
35.53	27.42	764.7726	77.17422	1.29577	oval	
34.94	27.56	755.9129	78.87808	1.267779	oval	
28.18	22.5	497.7233	79.84386	1.252444	oval	
31.15	26.1	603.2168	83.76812	1.193487	round	
34.05	25.5	681.5959	74.88987	1.335294	oval	
32.26	20.5	519.1441	63.54619	1.573659	oval	
38.1	22.23	664.866	58.34646	1.7139	oval	
30.41	28.04	669.3667	92.20651	1.084522	round	
30.4	26.26	626.6686	86.38158	1.157654	round	
30.37	27.04	644.6458	89.03523	1.123151	round	
28.79	21.36	482.7392	74.19243	1.347846	oval	
30.15	26.16	619.1483	86.76617	1.152523	round	
34.96	30.96	849.6539	88.55835	1.129199	round	
23.5	32.01	590.5045	136.2128	0.734146	round	
32.4	21.9	557.0046	67.59259	1.479452	oval	
34.5	23	622.8975	66.66667	1.5	oval	
31.04	28.8	701.7523	92.78351	1.077778	round	
26.76	23.56	494.9155	88.04185	1.135823	round	
31.2	28.44	696.5525	91.15385	1.097046	round	
39.31	27.52	849.2218	70.00763	1.428416	oval	
30.71	28.44	685.613	92.60827	1.079817	round	
29.2	27.19	623.2492	93.11644	1.073924	round	
34.1	30.52	816.9746	89.50147	1.1173	round	
29.17	27.88	638.4088	95.57765	1.04627	round	
35.51	30.42	847.9681	85.66601	1.167324	round	
36.29	37.1	1056.892	102.232	0.978167	round	
28.11	22.5	496.4929	80.04269	1.249333	oval	
35.29	24.6	681.4852	69.70813	1.434553	oval	
25.13	25.69	506.7879	102.2284	0.978202	round	
34.15	30.56	819.2448	89.48755	1.117474	round	
28.24	27.8	616.2815	98.44193	1.015827	round	

MASTER CHART

						MALE			
	MASTOID PROCESS								
	RIGHT SIDE								
	ML	APD	MLD	MI	MS	AST-MS	AST-PO	PO-MS	
Sr. No.									S VALUE
1	28.86	25.17	7.78	87.21	56.51440236	54.68	43.52	28.56	63.38
2	31.95	23.99	5.58	75.09	42.7696119	47.36	35.13	27.01	54.75
3	24.92	19.01	5.04	76.28	23.87595168	49.05	38.78	26.02	56.925
4	25.03	16.69	5.21	66.68	21.76481147	45.67	41.84	21.15	54.33
5	42.15	20.72	5.69	49.16	49.6935012	55.21	40.02	37.6	66.415
6	37.62	22.56	7.36	59.97	62.46484992	52.18	37.62	29.33	59.565
7	33.56	21.7	4.95	64.66	36.048474	49.39	39.17	26.6	57.58
8	33.51	20.55	4.68	61.32	32.2279074	49.71	39.34	28.3	58.675
9	31.25	26.36	4.34	84.35	35.75075	50.84	44.13	27.48	61.225
10	36.05	18.56	5.81	51.48	38.8740128	53.55	43.24	27.21	62
11	31.54	24.11	5.75	76.44	43.7246905	50.8	39.26	26.9	58.48
12	29.06	20.52	4.88	70.61	29.09998656	50.65	41.18	25.54	58.685
13	38.39	23.41	7.15	60.98	64.25775785	47.74	34.17	29.61	55.76
14	32.83	21.17	6.29	64.48	43.71619819	46.96	37.85	26.32	55.565
15	39.33	24.59	5.26	62.52	50.87075922	54.01	38.93	31.23	62.085
16	49	34.91	6.29	71.24	107.596111	54.25	43.35	27.84	62.72
17	50.16	24.81	4.76	49.46	59.23675296	50.74	41.64	28.85	60.615
18	55.7	24.02	4.43	43.12	59.2695902	50.89	40.86	32.53	62.14
19	44.43	20.7	7.47	46.59	68.7016647	47.51	38.07	26.41	55.995
20	47.25	24.81	6.8	52.51	79.71453	51.32	38.73	26.44	58.245
21	41.51	20.59	12.61	49.60	107.7765225	58.7	46.66	28.41	66.885
22	50.51	23.84	6.69	47.20	80.55819696	50.26	40.34	25.18	57.89
23	54.17	24.78	9.81	45.74	131.6828281	57.39	40.17	29.45	63.505
24	50.29	20.08	6.09	39.93	61.49823288	50.69	38.28	26.83	57.9
25	54.61	24.48	7.52	44.83	100.5313306	53.53	46.78	25.83	63.07
26	36.05	25.16	6.12	69.79195562	55.5095016	48.12	42.11	27.12	58.675
27	39.39	16.4	7.18	41.63493272	46.3825128	45.13	40.5	29.3	57.465
28	33.83	22.1	6.11	65.32663317	45.6809873	49.6	38.9	26.12	57.31
29	47	26.4	6.14	56.17021277	76.18512	50.14	35.7	37.4	61.62
30	45	19.11	4.19	42.46666667	36.031905	54.12	37.6	28.33	60.025
31	25.93	20.4	4.12	78.67335133	21.7936464	47.8	39.33	26.5	56.815
32	28.3	20.41	5.15	72.12014134	29.7465545	54.85	44.25	28.41	63.755
33	31.23	20.12	6.12	64.42523215	38.45487312	48.52	41.5	25.55	57.785
34	34.46	24.15	4.19	70.08125363	34.8695571	56.11	39.55	32.56	64.11
35	36.12	20.7	6.12	57.3089701	45.7582608	47.51	40.24	29.4	58.575
36	29.82	26.18	8.01	87.79342723	62.53307676	62.6	40.43	27.53	65.28
37	38.3	21.7	5.52	56.65796345	45.877272	42.32	37.17	29.63	54.56
38	42.15	20.19	4.21	47.90035587	35.82745785	52.09	31.93	26.34	55.18
39	24.18	22.8	9.88	94.29280397	54.4688352	58.32	38.07	29.83	63.11
40	24.92	20.53	4.37	82.38362761	22.35725212	50.55	43.47	28.11	61.065
41	29.06	20.24	7.28	69.64900206	42.81909632	47.92	37.17	26.31	55.7
42	28.31	22.32	9.18	78.8413988	58.00651056	49.28	38.18	27.32	57.39
43	24.02	22.19	8.82	92.38134888	47.01093516	43.32	33.27	32.43	54.51
44	44.3	16.18	4.67	36.52370203	33.4733458	50.38	39.13	29.42	59.465
45	38.45	29.13	9.82	75.76072822	109.9887627	42.59	38.43	22.32	51.67
46	29.19	21.32	6.38	73.03871189	39.70470504	58.28	27.18	38.41	61.935
47	32.42	20.18	7.32	62.24552745	47.89004592	68.17	37.19	27.62	66.49
48	42.17	32.19	9.31	76.33388665	126.3788091	62.27	40.93	27.42	65.31
49	38.19	33.4	4.39	87.45744959	55.9964694	48.92	32.19	28.48	54.795
50	44.32	44.32	5.62	100	110.3915469	41.52	38.42	31.61	55.775

MASTER CHART

				LEFT SIDE						
	ML	APD	MLD	MI	MS	AST-MS	AST-PO	PO-MS		
Sr. No.										S VALUE
1	31.69	29.54	6.97	93.22	65.24774522	52.52	43.12	28.58		62.11
2	32.61	23.65	6.47	72.52	49.89835455	45.76	32.5	19.52		48.89
3	23.25	15.27	5.04	65.68	17.893386	45.04	38.19	24.98		54.105
4	24.15	18.01	4.18	74.58	18.1805547	43.06	40.8	22.97		53.415
5	37.75	21.91	3.76	58.04	31.099054	57.32	40.62	33.95		65.945
6	38.21	22.22	7.72	58.15	65.54482264	52.03	38.1	29.41		59.77
7	31.44	22.62	6.57	71.95	46.72405296	41.22	31.12	25.89		49.115
8	29.27	19.78	4.13	67.58	23.91107278	48.21	38.53	31.47		59.105
9	25.02	27.15	5.67	108.51	38.5159131	51.43	44.93	30.62		63.49
10	34.81	22.9	5.75	65.79	45.8360675	56.09	43.73	29.55		64.685
11	33.37	21.18	4.92	63.47	34.77340872	46.92	36.73	27.16		55.405
12	34.4	22.09	5.34	64.22	40.5784464	47.97	34.57	26.9		54.72
13	38.07	25.54	7.69	67.09	74.77046982	50.74	36.33	32.19		59.63
14	32.12	23.78	5.31	74.03	40.55850216	46.95	35.88	25.85		54.34
15	33.31	18.35	4.42	55.09	27.0167417	49.91	38.09	30.91		59.455
16	47.57	31.84	5.36	66.93	81.18410368	58.92	50.65	30.76		70.165
17	50.08	31.95	5.32	63.80	85.1229792	51.38	43.76	29.49		62.315
18	53.09	27.24	5.06	51.31	73.17628296	51.54	39.08	34.07		62.345
19	29.54	21.89	6.9	74.10	44.6175114	48.38	37.32	26.05		55.875
20	41.11	20.15	5.85	49.01	48.45944025	48	39.2	27.88		57.54
21	42.12	20.63	6.08	48.98	52.83128448	51.5	40.55	33.46		62.755
22	51.33	29.98	5.83	58.41	89.71631922	52.88	39.91	30.08		61.435
23	52.23	28.98	5.01	55.49	75.83263254	53.88	40.05	28.08		61.005
24	50.22	26.1	4	51.97	52.42968	52.53	40.1	26.01		59.32
25	37.63	19.25	6.89	51.16	49.90960975	51.71	47.26	25.07		62.02
26	30.69	21.09	4.6	68.72	29.7735966	41.62	39.91	26.06		53.795
27	24.16	25.8	6.72	106.79	41.8876416	55.84	50.62	34.03		70.245
28	38.2	22.94	5.8	60.05	50.825864	48.5	37.08	23.95		54.765
29	32.38	26.24	7.12	81.04	60.49516544	46.48	43.71	26.44		58.315
30	34.42	28.16	4.05	81.81	39.2553216	48.12	38.09	26.55		56.38
31	38.17	19.28	6.98	50.51	51.36704848	49.14	42.1	29.48		60.36
32	40.12	31.62	5.5	78.81	69.772692	51.15	36.44	24.94		56.265
33	50.08	20.19	7.78	40.32	78.66476256	48.07	43.74	19.52		55.665
34	39.1	25.7	4.9	65.73	49.23863	49.12	37.12	27.54		56.89
35	51.6	27.12	3.15	52.56	44.080848	48.78	38.52	21.93		54.615
36	30.62	28.5	7.02	93.08	61.261434	62.58	40.12	29.58		66.14
37	37.61	27.15	6.49	72.19	66.27013635	47.72	32.42	19.72		49.93
38	39.65	18.34	5.04	46.25	36.6499224	50.74	36.88	32.76		60.19
39	52.22	28.1	4.2	53.81	61.630044	47.1	25.08	25.07		48.625
40	32.41	27.9	6.74	86.08	60.9457086	59.01	38.91	29.62		63.77
41	34.4	23.72	6.31	68.95	51.4875808	47.92	35.33	25.87		54.56
42	52.61	27.15	7.31	51.61	104.4132257	48.74	36.02	29.17		56.965
43	32.41	26.18	9.22	80.78	78.23112836	42.52	48.12	32.12		61.38
44	39.82	29.03	8.13	72.90	93.98073498	62.71	38.81	25.16		63.34
45	30.61	19.73	8.42	64.46	50.85135226	72.8	26.92	29.78		64.75
46	18.27	22.14	6.29	121.18	25.44291162	49.26	32.81	22.1		52.085
47	38.22	21.9	6.28	57.30	52.5647304	58.28	33.42	32.1		61.9
48	32.42	26.8	7.32	82.67	63.6002592	72.08	41.32	34.2		73.8
49	58.31	18.36	8.42	31.49	90.14212872	38.32	39.41	24.06		50.895
50	30.62	27.32	9.38	89.22	78.46730192	42.19	28.51	32.32		51.51

MASTER CHART

				FEMALE					
				MASTOID PROCESS					
				RIGHT SIDE					
sr. No.	ML	APD	MLD	MI	MS	AST-MS	AST-PO	PO-MS	S Value
1	26.37	22.43	9.46	85.05877892	55.95392286	44.53	41.58	25.56	55.835
2	30.64	32.85	6.59	107.2127937	66.3299316	52.09	41.22	31.09	62.2
3	26.33	24.42	2.97	92.7459172	19.09646442	44.81	40.63	25.56	55.5
4	25.08	13.3	2.31	53.03030303	7.7053284	39.4	35.31	22.4	48.555
5	24.5	17.13	2.22	69.91836735	9.317007	47.38	38.74	22.46	54.29
6	39.28	20.54	4.99	52.29124236	40.25987888	50.28	32.49	31.28	57.025
7	30.32	24.5	4.63	80.80474934	34.393492	42.52	33.5	22.6	49.31
8	30.96	17.37	4.69	56.10465116	25.22165688	42.18	35.41	23.08	50.335
9	38.7	23.77	12.32	61.42118863	113.3315568	50.52	35.36	26.83	56.355
10	39.77	22.38	5.25	56.27357305	46.7277615	53.6	39.25	32.09	62.47
11	31.95	17.83	2.8	55.80594679	15.950718	46.69	40.6	25.82	56.555
12	35.52	22.56	3.7	63.51351351	29.6492544	42.82	28.27	26.82	48.955
13	54.17	32.76	8.85	60.47627838	157.0529142	54.61	43.33	30.16	64.05
14	54.5	28.07	6.47	51.50458716	98.9790305	54.86	40.92	31.45	63.615
15	44.29	24.45	6.99	55.20433506	75.69404595	52.61	39.99	30.7	61.65
16	29.73	21.99	5.76	73.96569122	37.65673152	42.15	25.52	30.04	48.855
17	31.6	18.7	3.5	59.17721519	20.6822	41.43	37.71	21.03	50.085
18	40.01	21.96	4.6	54.88627843	40.4165016	45.4	36.17	21.54	51.555
19	40.21	20.98	5.16	52.1760756	43.53005928	53.5	44.12	27.05	62.335
20	44.99	27.84	6.4	61.88041787	80.1613824	45.82	36.36	29.68	55.93
21	42.9	11.34	5.63	26.43356643	27.3891618	47.38	37.41	24.13	54.46
22	30.1	20.01	4.06	66.47840532	24.4534206	45.01	32.5	25.03	51.27
23	24.5	18.1	2.4	73.87755102	10.6428	42.1	32.4	26.5	50.5
24	29.1	16.36	3.12	56.21993127	14.8535712	43.5	31.5	22.1	48.55
25	30.45	18	4.4	59.11330049	24.1164	40.15	29.4	23.5	46.525
26	25.08	12.8	3.8	51.03668262	12.198912	45.2	33.4	26.1	52.35
27	32.6	18.01	3.16	55.24539877	18.5531816	50.1	40.12	28.1	59.16
28	40.5	22	4	54.32098765	35.64	46.12	39.12	23.4	54.32
29	38.5	19.76	5.1	51.32467532	38.79876	38.5	35.4	24.96	49.43
30	41.12	20	2.96	48.6381323	24.34304	39.52	40.5	25.9	52.96
31	37.96	17.96	3.1	47.31296101	21.1346096	40.5	41.58	22.5	52.29
32	39.4	19.15	2.82	48.60406091	21.277182	42.43	42.1	26.1	55.315
33	35.96	18.05	3.16	50.19466073	20.5108648	47.5	39.12	28.15	57.385
34	36.1	19.04	4.1	52.74238227	28.181104	39.5	40.1	26.26	52.93
35	32.13	18.5	4.82	57.57858699	28.650321	42.43	40.41	27.1	54.97
36	27.33	24.3	2.22	88.91328211	14.7434418	44.82	42.22	35.26	61.15
37	29.22	24.5	4.39	83.84668036	31.427571	50.29	32.5	23.09	52.94
38	30.5	23.37	4.16	76.62295082	29.651856	42.62	35.41	26.6	52.315
39	26.64	17.32	2.32	65.01501502	10.70459136	46.52	39.25	22.4	54.085
40	39.28	17.5	2.81	44.55193483	19.31594	42.62	36.81	26.32	52.875
41	36.96	24.43	4.22	66.09848485	38.10376416	48.81	38.28	38.4	62.745
42	37.3	22.4	6.2	60.0536193	51.80224	49.22	39.2	39.2	63.81
43	29.22	27.42	5.1	93.83983573	40.8618324	60.42	42.38	26.28	64.54
44	28.2	19.5	4.32	69.14893617	23.75568	40.32	38.3	32.06	55.34
45	32.64	21.47	6.32	65.77818627	44.28934656	39.42	26.29	37.1	51.405
46	43.9	18.37	7.6	41.84510251	61.289668	45.61	36.36	27.05	54.51
47	40.01	24.07	5.16	60.15996001	49.69290012	52.08	44.92	30.12	63.56
48	31.07	23.21	6.47	74.70228516	46.65741509	45.1	28.36	25.92	49.69
49	35.45	19.36	2.94	54.61212976	20.1775728	42.49	41.19	26.15	54.915
50	30.96	17.99	8.28	58.10723514	46.11714912	48.4	36.17	28.1	56.335

MASTER CHART

				LEFT SIDE					
sr. No.	ML	APD	MLD	MI	MS	AST-MS	AST-PO	PO-MS	S Value
1	26.78	23.35	12.19	87.19193428	76.2256547	42.09	42.5	25.94	55.265
2	21.69	34.58	5.12	159.428308	38.40205824	51.25	42.07	30.28	61.8
3	25.55	25.55	3.52	100	22.978648	46.71	39.43	25.17	55.655
4	20.86	14.65	1.87	70.23010547	5.7147013	39.55	36.58	22.02	49.075
5	22.69	17.72	3.64	78.09607757	14.63523152	43.63	36.06	23.8	51.745
6	28.91	17.63	4.83	60.98235905	24.61770339	49.9	34.2	27.36	55.73
7	34.42	26.7	6.37	77.57117955	58.5411918	40.41	34.24	22.75	48.7
8	30.18	17.67	5.16	58.54870775	27.51727896	44	32.52	23.68	50.1
9	36.04	21.24	10.5	58.9345172	80.376408	49.86	35.85	29.95	57.83
10	35.41	20.32	2.77	57.38491951	19.93101424	49.68	40.4	28.24	59.16
11	28.8	19.22	3.79	66.73611111	20.9790144	45.79	30.93	30.8	53.76
12	33.95	17.66	2.95	52.01767305	17.6869315	41.54	37.23	23.72	51.245
13	32.05	23.73	5.67	74.04056162	43.12298655	49.8	33.21	33.68	58.345
14	54.03	31.29	4.83	57.91227096	81.65591721	57.64	43.04	33.68	67.18
15	40.53	24.61	6.55	60.72045398	65.33253615	44.06	34.4	32.14	55.3
16	34	19.18	3.63	56.41176471	23.671956	40.77	36.25	22.06	49.54
17	42.82	18.21	4.59	42.52685661	35.79062598	46.72	40.62	24.07	55.705
18	42.55	15.88	5.88	37.32079906	39.7308072	44.9	36.02	23.2	52.06
19	48.21	20.98	6.16	43.51794234	62.30506128	52.8	46.91	28.31	64.01
20	49.96	22.9	7.2	45.83666934	82.374048	50.81	39.11	28.18	59.05
21	38.24	10.8	5.45	28.24267782	22.508064	47.81	40.1	20.22	54.065
22	38.4	15.22	10.05	39.63541667	58.737024	48.5	40.04	25.11	56.825
23	32.16	21.5	6.3	66.85323383	43.56072	45.46	32.12	22.5	50.04
24	35.1	18.96	5.5	54.01709402	36.60228	46.5	34.46	24.5	52.73
25	31.4	23.1	4.13	73.56687898	29.956542	38.5	29.46	28.1	48.03
26	29.5	25.1	4.5	85.08474576	33.32025	43.1	33.16	22.75	49.505
27	28.96	18.66	5.1	64.43370166	27.5600736	48.48	40.1	29.1	58.84
28	33.4	23.76	3.8	71.13772455	30.156192	45.76	38.4	27.24	55.7
29	35.1	22.96	3.01	65.41310541	24.2574696	41.4	30.96	32.1	52.23
30	34.9	16.22	2.5	46.4756447	14.15195	40.75	34.5	22.07	48.66
31	30.1	15.5	4	51.49501661	18.662	41.46	30.1	28.3	49.93
32	33.12	22.76	3.8	68.71980676	28.6448256	40.76	40	24.8	52.78
33	28.1	19.5	4.1	69.39501779	22.46595	46.12	35.5	23.76	52.69
34	25.5	20.96	3.3	82.19607843	17.63784	42.11	31.04	22.04	47.595
35	27.1	21.5	3.8	79.33579336	22.1407	40.06	32.5	23.43	47.995
36	28.69	17.65	2.82	61.51969327	14.2798737	42.72	37.43	25.17	52.66
37	30.28	17.62	3.67	58.19022457	19.58068312	44.41	36.2	27.8	54.205
38	30.91	25.61	3.19	82.85344549	25.25220269	44.41	34.52	23.75	51.34
39	35.41	26.24	4.5	74.10336063	41.812128	49.63	40.45	26.94	58.51
40	22.56	27.64	10.17	122.5177305	63.41588928	49.3	40.32	28.95	59.285
41	25.48	32.19	9.52	126.3343799	78.08315424	19.86	34.43	27.02	40.655
42	27.1	30.61	3.62	112.9520295	30.0290222	20.25	35.66	28.15	42.03
43	29.2	32.61	4.7	111.6780822	44.753964	27.3	36.92	20.82	42.52
44	35.41	37.27	9.32	105.2527535	122.9989012	19.9	42.52	29.32	45.87
45	36.91	28.62	9.67	77.53996207	102.1504181	16.6	35.43	32.17	42.1
46	49.16	22.98	6.17	46.7453214	69.70229256	52.6	46.92	28.18	63.85
47	26.1	20.98	3.72	80.38314176	20.3699016	44.77	40.43	24.17	54.685
48	35.41	22.17	3.82	62.60943236	29.98851654	49.72	39.09	28.68	58.745
49	28.4	25.05	3.71	88.20422535	26.393682	43.16	39.2	39.2	60.78
50	32.4	15.18	6.03	46.85185185	29.6574696	48.42	38.14	28	57.28

MASTER CHART

MALE										
STYLOID PROCESS										
RIGHT SIDE						LEFT SIDE				
DIRECTION		DISTANCE				DIRECTION		DISTANCE		
INWORD	OUTWORD	LSP	TIP	BASE	THICKNES	INWORD	OUTWOR	LSP	THICKNESS AT BASE AP	
1	✓		10.21	76.95	85.12	4.28	✓	19.91	4.6	
2	✓		18.2	78.8	84.1	3.26	✓	17.08	3.85	
3	✓		14.8	62.7	72.8	4.02	✓	16.08	3.16	
4	✓		20.8	72.8	70.2	4.12	✓	18.18	3.76	
5	✓		31.19	51.47	84.76	5.75	✓	4.67	4.84	
6	✓		17.2	66.31	81.51	4.33	✓	12.43	5.29	
7	✓		14.97	60.74	74.32	4.42	✓	26.05	5.45	
8	✓		16.12	63.24	77.35	4.04	✓	16.75	2.54	
9	✓		15.86	68.98	79.23	5.01	✓	8.63	2.61	
10	✓		20.47	72.39	90.33	4.76	✓	17.06	4.26	
11	✓		32.81	50.96	78.5	4.22	✓	29.62	4.79	
12	✓		46.11	59.79	82	5.81	✓	20.42	5.84	
13	✓		33.6	61.51	85.69	7.66	✓	23.3	5.31	
14	✓		20.5	66.31	78.91	3.87	✓	19.88	2.2	
15	✓		20.86	67.28	85.47	3.39	✓	18.38	4.28	
16	✓		25.91	66.85	87.29	4.19	✓	23.92	6.09	
17	✓		19.9	66.25	79.2	7.13	✓	25.12	6.8	
18	✓		24.02	66.93	79.53	6.62	✓	9.87	6.28	
19	✓		24.56	63.75	83.68	5.94	✓	28.77	6.02	
20	✓		9.36	69.38	83.54	7.69	✓	21.77	5.75	
21	✓		8.95	84.67	97.48	7.47	✓	16.73	3.84	
22	✓		10.85	71.26	82.79	5.31	✓	12.1	5.67	
23	✓		26.29	61.41	85.69	0.13	✓	28.29	9.04	
24	✓		12.08	64.1	78.1	6.12	✓	20.22	6.28	
25	✓		20.07	67.72	87.13	6.82	✓	20.08	6.38	
26	✓		20.5	66.84	71.89	3.26	✓	18.91	5.34	
27	✓		28.56	72.38	84.39	4.28	✓	42.67	3.89	
28	✓		28.5	63.24	79.32	5.9	✓	11.49	3.84	
29	✓		16.11	51.31	83.34	4.18	✓	18.09	4.28	
30	✓		14.86	63.24	86.31	3.42	✓	17.74	2.68	
31	✓		20.5	61.43	78.91	5.82	✓	18.21	5.48	
32	✓		46.11	66.21	86.28	6.81	✓	26.04	3.76	
33	✓		19.8	58.61	74.34	4.26	✓	18.21	3.86	
34	✓		46.11	55.41	79.21	7.29	✓	16.02	5.66	
35	✓		28.09	63.21	90.31	5.82	✓	26.12	2.58	
36	✓		9.18	72.92	86.12	5.28	✓	18.9	6.03	
37	✓		32.8	78.9	81.69	4.09	✓	32.3	3.16	
38	✓		20.5	66.51	78.47	6.39	✓	18.09	2.24	
39	✓		16.11	61.42	82.79	8.31	✓	18.1	4.28	
40	✓		12.18	68.98	91.33	3.76	✓	8.67	4.72	
41	✓		33.32	66.79	85.68	4.42	✓	17.82	2.31	
42	✓		16.18	61.72	82.12	8.08	✓	18.3	4.32	
43	✓		20.12	72.9	80.69	4.18	✓	22.68	3.42	
44	✓		9.18	61.48	72.62	6.31	✓	8.82	6.78	
45	✓		20.18	68.82	87.47	6.42	✓	312.4	4.32	
46	✓		32.2	60.7	71.8	5.18	✓	34.94	3.19	
47	✓		16.9	32.41	78.72	6.72	✓	28.32	4.12	
48	✓		9.12	34.46	61.7	8.18	✓	29.42	6.42	
49	✓		10.24	61.72	86.32	4.32	✓	16.72	7.21	
50	✓		34.12	82.42	72.62	6.47	✓	18.6	2.62	

MASTER CHART

FEMALE										
STYLOID PROCESS										
RIGHT SIDE						LEFT SIDE				
DIRECTION		DISTANCE				DIRECTION		DISTANCE		
INWORD	OUTWORD	LSP	TIP	BASE	THICKNES	INWORD	OUTWOR	LSP	THICKNESS AT BASE AP	
✓		22.5	57.12	85.18	3.8	✓		10.88	4.02	
✓		21.08	59.25	70.25	4.2	✓		15.25	3.88	
✓		16.75	64.13	74.25	4.28	✓		18.18	4.11	
✓		18.8	65.25	75.1	2.16	✓		16.18	3.12	
✓		19.12	62.12	74.13	3.84	✓		18.12	4.11	
✓		28.25	69.52	87.09	5.4	✓		25.39	5.42	
✓		19.16	56.15	70.74	5.11	✓		14.14	5.64	
✓		23.5	59.26	77.79	2.8	✓		20.7	3.72	
✓		27.02	66.09	79.54	4.14	✓		23.34	5.02	
✓		9.29	69.7	78.02	1.22	✓		10.25	1.87	
✓		10.58	81.44	89.02	2.18	✓		10.95	4.14	
✓		19.03	59.85	71.45	4.27	✓		10.54	5.23	
✓		25.01	70.11	81.05	4.29	✓		21.71	5.71	
✓		16.93	74.45	82.62	6.32	✓		10.99	8.03	
✓		20.26	71.48	78.9	6.74	✓		18.44	8.26	
✓		20.92	67.26	79.16	3.75	✓		14.47	5.08	
✓		16.12	65.01	75.16	3.36	✓		16.47	4.04	
✓		15.52	68.93	74.16	3.23	✓		12.22	4.75	
✓		16.68	71.86	83.84	4.92	✓		10.25	4.15	
✓		15.22	72.18	80.8	3.9	✓		14.2	3.85	
✓		18.18	74.48	82.12	4.01	✓		16.22	3.9	
✓		19.15	75.68	78.12	4	✓		12.1	3.8	
✓		15.14	68.7	77.13	3.5	✓		15.15	4.15	
✓		18.2	72.5	75.96	3.76	✓		17.1	3.46	
✓		20.12	78.1	79.8	4	✓		19.04	4.05	
✓		21.46	69.12	78.5	5.1	✓		20.25	4.25	
✓		23.5	65.43	80.12	2.22	✓		16.15	3.8	
✓		22.46	76.12	70.25	2.96	✓		19.1	3.42	
✓		19.5	71.21	78.33	4.22	✓		22.04	4.96	
✓		20.23	69.4	81.15	4.23	✓		25.5	4.1	
✓		20.12	70.12	83.13	3.8	✓		14.1	4.5	
✓		9.1	66.13	82.5	3.1	✓		16.2	3.96	
✓		15.12	68.13	79.75	4.12	✓		17.1	4.12	
✓		13.12	66.66	80.12	5.16	✓		15.04	5.1	
✓		18.19	70.4	70.75	6.1	✓		16.15	5.01	
✓		28.26	52.16	72.09	6.39	✓		16.12	6.72	
✓		19.12	69.52	86.13	3.24	✓		26.32	6.42	
✓		23.25	66.28	78.74	4.4	✓		10.54	5.72	
✓		9.58	62.12	89.13	4.58	✓		18.16	6.11	
✓		20.93	74.29	82.67	7.27	✓		10.09	1.72	
✓		29.58	81.59	89.02	6.4	✓		18.27	5.62	
✓		23.15	86.72	82.1	7.28	✓		19.12	6.72	
✓		29.19	78.2	87.13	8.24	✓		11.28	8.82	
✓		28.09	68.18	78.09	3.34	✓		16.2	7.17	
✓		30.1	69.16	72.8	6.24	✓		14.16	5.48	
✓		19.12	74.18	82.9	4.23	✓		12.19	3.94	
✓		15.28	67.63	82.09	5.28	✓		21.25	8.75	
✓		20.29	71.85	89.67	1.29	✓		10.18	4.28	
✓		20.5	69.78	83.12	4.19	✓		19.15	5.16	
✓		19.32	65.48	48.28	2.13	✓		16.2	4.96	

MASTER CHART

					MALE					
	FORAMEN OVALE									
	RIGHT SIDE					LEFT SIDE				
	APL	TW	D1-CF	D2-CF	SHAPE	APL	TW	D1-CF	D2-CF	SHAPE
sr. no.										
1	10.61	5.21	27.71	23.65	D	11.08	7.34	27.48	22.08	D
2	4.2	3.22	22.7	23.8	D	5.8	3.24	23.99	21.09	D
3	7.27	4.19	30.43	20.07	D	7.39	4.58	27.62	22.12	D
4	8.19	3.97	27.46	18.94	R	4.12	2.64	26.87	20.46	R
5	7.01	7.03	26.97	21.19	O	6.97	6.38	26.21	22.76	O
6	8.9	5.08	29.2	21.45	O	9.16	4.25	28.21	23.09	O
7	8.74	3.17	29.41	19.8	R	6.15	3.26	28.76	19.77	R
8	4.3	2.88	29.22	21.72	D	6.02	3.23	27.59	21.86	D
9	5.9	2.92	29.64	23.39	O	10.04	3.74	30.06	20.05	O
10	6.8	4.02	27.22	23.38	O	8.15	4.13	28.01	23.25	O
11	7.17	3.25	32.4	19.93	O	5.4	2.58	29.94	21.29	O
12	6.6	4.13	31.51	21.3	O	5.33	4.09	31.58	22.77	O
13	8.01	3.39	32.02	18.78	D	8.71	4.18	33.18	19.21	D
14	7.6	3.42	26.29	21.85	O	6.51	3.62	24.19	20.94	O
15	6.57	3.4	24.99	22.88	O	6.71	4.82	24.39	25.18	O
16	8.2	4.06	22.87	24.64	D	8.21	4.83	23	23.07	D
17	8.14	4.66	19.79	23.19	D	5.38	3.65	22.17	22.22	D
18	8.8	4.45	20.95	22.9	O	7.74	3.99	20.03	22.05	O
19	10.9	6.46	22.58	22.67	D	8.8	4.17	20.72	22.35	D
20	9.33	4.33	21.12	21.12	O	8.14	4.1	19.26	22.01	O
21	7.66	4.4	24.33	24.75	O	7.69	4.58	20.17	24.8	O
22	7.27	5.4	23.01	22.94	O	6.95	4.85	20.8	23.67	O
23	8.73	5.16	20.4	25.8	D	6.88	4.8	21.77	23.82	D
24	8.22	5.49	21.21	23.72	O	8.79	5.51	20.76	23.03	O
25	11.39	5.68	21.34	25.19	O	11.79	5.99	19	24.71	O
26	8.71	3.41	31.53	18.94	O	8.15	3.74	28.61	19.46	O
27	6.58	5.09	24.92	21.76	O	6.04	5.99	29.21	21.44	O
28	7.19	3.91	27.21	20.19	O	7.51	4.17	31.58	22.78	O
29	8.96	2.84	29.19	20.3	O	9.12	6.88	28.07	20.47	O
30	7.13	3.91	26.94	18.8	O	4.15	4.8	24.19	21.08	O
31	10.16	4.18	27.42	21.45	O	11.14	4.07	33.77	21.81	O
32	7.29	5.28	24.44	22.64	O	10.88	3.24	34.58	20.35	O
33	29.13	2.29	29.41	18.92	O	6.42	3.46	29.71	18.77	O
34	8.61	6.49	30.49	24.68	O	11.09	3.62	28.76	19.82	O
35	7.29	3.32	22.68	30.19	O	8.23	4.81	25.59	22.84	O
36	9.61	6.2	28.21	21.63	O	9.09	7.3	28.09	21.08	O
37	6.62	4.19	30.43	20.7	O	7.32	4.3	29.01	28.09	O
38	6.58	3.4	20.94	22.94	O	8.71	4.65	24.17	22.01	O
39	8.92	4.42	20.4	29.67	O	9.12	3.67	20.72	22.44	O
40	8.18	4.25	31.4	19.38	O	6.32	2.51	27.52	21.28	O
41	8.7	3.42	27.29	21.82	O	7.51	4.62	24.18	22.94	O
42	7.52	4.39	27.96	29.93	O	9.1	6.71	26.32	32.42	O
43	8.32	4.37	28.9	22.63	O	8.1	5.42	25.28	27.48	O
44	9.38	4.3	28.29	22.94	O	8.32	6.3	29.03	28.42	O
45	6.32	6.19	32.42	21.62	O	9.32	2.72	21.36	42.37	O
46	7.32	6.23	39.4	28.9	O	7.32	4.7	26.12	20.42	O
47	8.42	7.4	29.4	24.8	O	7.08	3.21	20.18	24.17	O
48	8.61	5.21	32.42	32.14	O	9.12	3.68	24.2	29.12	O
49	6.58	4.32	40.11	28.2	O	8.21	5.02	29.18	22.24	O
50	7.68	3.1	39.32	28.12	O	9.09	4.8	28.19	28.32	O

MASTER CHART

FORAMEN OVALE										
Sr. No.	RIGHT SIDE					LEFT SIDE				
	APL	TW	DISTANCE		SHAPE	APL	TW	DISTANCE		SHAPE
			D1-CF	D2-CF				D1-CF	D2-CF	
1	10.52	7.15	24.12	21.42	O	9.16	7.01	26.22	22.69	D
2	5.79	4.2	25.91	21.8	O	6.3	4.01	27.77	23.04	D
3	7.31	3.48	26.32	20.96	O	8.06	4.57	27.73	27.68	D
4	6.48	2.97	27.7	18.86	O	6.12	2.96	26.95	19.25	R
5	7.72	4.47	26.35	18.51	O	6.26	4.4	21.22	22.13	O
6	7.76	3.9	29.55	23.82	O	8.53	4.51	28.2	22.4	O
7	6	4.42	26.75	18.35	O	10.32	4.33	29.11	17.86	R
8	6.94	2.5	23.72	20.64	O	5.95	3.32	23.78	23.74	D
9	6.3	3.3	27.22	21.33	O	6.63	2.31	27.17	19.16	O
10	6.52	1.9	26.32	21.05	O	6.94	2.72	26.63	21.48	O
11	7.43	4.56	26.6	23.59	O	6.59	5.59	19.9	21.82	O
12	7.52	4.3	23.07	185.18	O	8.64	5.79	24	18.32	D
13	8.75	5.97	23.2	23.19	O	8.2	4.45	21.05	24	O
14	10.18	5.71	21.92	24.02	O	8.55	5.2	23.92	23.68	O
15	8.8	4.76	21.49	23.93	O	8.3	4.78	23.33	26.68	O
16	9.16	3.35	21.79	21.03	O	5.86	3.1	19.83	19.3	O
17	6.83	5.41	18.48	22.99	O	6.24	3.61	19.5	24.14	D
18	7	3.51	22.86	22.86	O	7.49	4.3	22.85	22.84	O
19	7.49	3.8	21.06	23.09	O	7.52	3.81	22.09	21	O
20	9.49	4.32	21.91	21.6	O	7.05	4.47	23.03	23.38	O
21	6.8	4.4	20.21	18.22	O	6.85	4.01	21.18	16	O
22	5.8	3.4	28	18	O	7.5	3.1	22.5	17	O
23	4.8	3.1	22.1	23.2	O	5.85	3.96	20.1	19.1	D
24	3.9	2.23	22.5	21.5	O	5.13	4.2	21.5	20.1	R
25	3.8	2.1	26.1	23.5	O	6.12	3.3	23.5	21.5	R
26	2.9	1.96	24.1	23.1	O	4.8	4.01	21.9	21.05	R
27	4	3.1	23.1	21.5	O	5.12	3.92	22.1	21.5	R
28	4.2	3.8	26.01	22.2	O	6.83	4.12	23.3	20.23	O
29	3.96	2.92	25.61	24.1	O	5.95	4.5	24.015	22	O
30	3.46	2.96	22.15	22.5	O	4.92	3.96	21.05	22.1	O
31	5	3.46	19.2	18.96	O	6.4	5.01	25.16	24.1	O
32	5.1	4.01	23	21.96	O	5.92	2.91	22.5	23.2	O
33	4.12	3.12	22.5	20.53	O	6.2	3	23.1	25.1	O
34	4.15	3.3	23	21.04	O	5.5	4.1	23.23	24.25	O
35	5.1	3.96	21	20.01	O	5.01	4.55	21.5	20.12	O
36	7.9	3.4	27.26	21.82	O	7.87	2.36	28.17	19.23	O
37	6.62	3.48	29.32	28.18	O	5.56	4.57	29.11	17.25	O
38	7.54	4.42	26.5	28.67	O	6.64	3.39	19.78	22.4	O
39	8.76	5.47	23.22	18.39	O	8.29	5.33	24.19	24.29	O
40	8.52	4.3	29.55	25.75	O	7.18	4.39	25.2	19.74	O
41	9.43	3.47	26.35	29.72	O	5.95	3.95	19.9	23.13	O
42	9.54	4.41	27.3	29.18	O	8.56	3.52	18.2	22.29	O
43	6.16	6.42	28.17	21.82	O	9.31	4.38	24.78	29.32	O
44	7.17	3.04	32.17	18.39	O	7.29	3.32	29.11	26.23	O
45	8.19	6.4	26.29	21.82	O	9.18	4.57	19.3	26.29	O
46	6.49	3.41	20.29	18.31	O	7.5	3.1	23.19	19.28	O
47	5.83	4.76	21.2	20.23	O	6.87	3.62	18.5	24.3	O
48	5.49	5.8	23.41	22.18	O	6.24	3.18	25.2	19.42	O
49	5.82	3.5	23.21	20.19	O	6.92	4.18	26.2	24.5	O
50	4.46	4.83	23.28	28.62	O	3.32	3.72	21.55	19.3	O