"COMPARISON OF THE POSITION AND DIMENSIONS OF INFERIOR ALVEOLAR NERVE CANAL AMONG MALES AND FEMALES USING CONE BEAM COMPUTED TOMOGRAPHY - A RETROSPECTIVE STUDY"

By
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ABBREVIATIONS

CBCT	Cone Beam Computed Tomography
CT	Computed Tomography
MDCT	Multidetector Computed Tomography
OPG	Orthopantomogram
FOV	Field of View
DICOM	Digital Imaging and Communications in Medicine
2-D	2 Dimensional
3-D	3 Dimensional
DFA	Discriminant Function Analysis
IAN	Inferior Alveolar Nerve
MC	Mandibular canal
MST	Masseter muscle
BMC	Bifid mandibular canal
MF	Mandibular foramen
SD	Standard Deviation
ICC	Intraclass correlation coefficients
MANOVA	Multivariate Analysis of Variance
ROC	Receiver Operating Characteristic
CI	Confidence intervals
AMAF	The distance from the most anterior point of the mandibular foramen to the most anterior part of the mandibular ramus. (anterior mandibular foramen)
PMAF	The distance from the most anterior point of the mandibular foramen to the most posterior part of the ramus. (posterior mandibular foramen)

SIAC	The distance from the most superior point of the inferior alveolar canal to the midpoint of the alveolar ridge. (superior inferior alveolar canal)
IIAC	The distance from the most inferior point of the inferior alveolar canal to the lowest point of the inferior border of the mandible. (inferior inferior alveolar canal)
LIAC	The distance from the most lingual point of the inferior alveolar canal to the mandibular lingual cortical plate. (lingual inferior alveolar canal)
BIAC	The distance from the most buccal point of the inferior alveolar canal to the mandibular buccal cortical plate. (buccal inferior alveolar canal)
SMEF	The distance from the most superior point of the mental foramen to the midpoint of the alveolar ridge crest. (superior mental foramen)
IMEF	The distance from the most inferior point of the mental foramen to the lowest point of the inferior border of the mandible. (inferior mental foramen)
SC-IC	The distance from the most superior point of the IAC to the most inferior point at the first molar furcation area. (supero-inferior dimensions of IAC)
BC-LC	The distance from the most buccal point of the IAC to the most lingual point at the first molar furcation area. (bucco-lingual dimensions of IAC)

ABSTRACT

Background and Objectives: Forensic dentistry is a complex and intriguing part of forensic science that involves utilizing of dental sciences to identify deceased individuals. In cases where the skeletal remains and damaged or disfigured body parts are retrieved from crime scenes or areas of natural disasters, it is the responsibility of a forensic anthropologist to evaluate the evidence and determine the biological profile of the deceased. Gender determination categorizes an individual as male or female and is a key component in establishing identity and reconstructing an individual's biological profile, particularly from skeletal and fragmented remains discovered in mass disasters. A person's gender is determined by evaluating the biological traits of his or her skeletal system, which differ among the genders as they are function-dependent. As it is a simple, quick, and non-invasive way to get crucial information without damaging evidence, radiological examination of human skeletons is frequently used in forensic anthropology. Cone Beam Computed Tomography (CBCT) permits accurate skeletal measurements for gender determination by providing precise images with high resolution and minimal faults.

The present study was conducted to evaluate and compare the position and dimensions of the Inferior alveolar nerve (IAN) canal among males and females using CBCT images in the North Karnataka population.

Methods: A total of 226 CBCT scans consisting of 113 males and 113 females of the North Karnataka population in the age group of 18-60years fulfilling the inclusion criteria were assessed in this study. A total of 20 linear parameters were measured, 10 from either side of the mandible pertaining to the location and dimensions of the IAN

Canal. Results were tabulated and statistically analyzed using STATA software and step-wise discriminant function analysis was carried out.

Results: The results revealed statistically significant differences ($P< 0.05$) between the genders in most of the variables. The mean values of the parameters assessed were higher in males except for BIAC_R, SCIC_R, and SCIC_L which were found to be higher in females whereas, IMEF_R was found to be equal in both genders. The overall predictive accuracy for the entire study group was 94.69% for males and 98.23% for females.

Conclusion:

The location and dimensions of the IAN canal can be accurately used for sex determination and the discriminant analysis model used for the study group can be of great assistance in the identification of unknown.

Keywords: Inferior alveolar nerve canal, Mandibular canal, Sex Determination Analysis, X-ray Cone Beam Computed Tomography.

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INTRODUCTION

The discovery of x-rays ranks alongside a few outstanding contributions in the field of medical science. The expansion of diagnostic roentgenology has taken place at a rapid rate and has thus become an integral and essential part of medical and dental practice. Forensic odontology is one such imminent branch of Dentistry that plays an important role in establishing the identity of a deceased individual. It is of prime importance in cases of natural calamities, mass disasters, mishaps and criminal offenses [(1)]. Forensic odontologists are appointed by the legal system to provide their expertise which serves as evidence in the court of law for the effective administration of justice. In cases of mass disasters or at a crime scene when a skeleton is discovered, it is imperative to create a biological profile of the deceased so as to determine the sex, ancestry and also to estimate the stature and age at the time of death [(1)]. In forensic investigation among all the parameters assessed, determining the sex of the deceased is very important as all the other biological parameters like age are dependent on the gender and cannot be accurately identified [(2)].

Sex determination is a process of establishing the identity of an individual by linking the deceased with the stream of data present in the information system. This is not a simple process as during criminal acts or in cases of physical injuries inflicted, it is difficult to have an intact face and crania as attempts are made to hide the identity by damaging the face [(3)]. Thus, in a case when only the damaged or shattered skull is retrieved, determining sex becomes incredibly challenging and complex.

In such cases, it is also essential to develop a discriminant function model to evaluate the accuracy and quality of each bone individually during the process of sex determination, as the investigator has no control over which part of the skeleton will

be available for analysis. It is a well-known fact that a discriminant function model devised for a particular population cannot be generalized and applied to any other population as sexual differences vary significantly among populations of different geographic locations. Keeping this in mind it was crucial to develop population-specific discriminant function models for accurate sex estimation in North Karnataka population. Discriminant Function Analysis (DFA) generates rules to classify individuals into a defined group based on a set of measurements of the individuals [(4)]. In the present study, DFA was used for sex determination.

Skull is the second most sexually dimorphic portion of the body after the pelvis [(5)]. The inferior alveolar canal is an intra-bony structure in the mandible that contains a neurovascular bundle that runs obliquely downward and forward in the ramus and then travels horizontally forward and ends at the mental foramen [(2)]. A literature search in forensic studies has substantiated evidence of various studies conducted on sexual dimorphism in inferior alveolar canal locations and dimensions among different ethnic populations. There is an indication that the canal position and dimensions vary among males and females [(2)]. Thus, the inferior alveolar canal can be considered a reliable tool in gender determination.

Traditionally evaluation of various macroscopic and morphological changes of the bone for example pubic symphysis region, sternal end of ribs, cranial sutures, and articular surfaces were used for sex determination [(6)]. However, this was very time consuming as it requires the preparation of the bone.

The evolution of radiology has revolutionized the field of Dentistry where images of the bone can be acquired with Cone Beam Computed Tomography scans (CBCT scans) following which appropriate measurements could be applied. The

applicability of radiological imaging in various legal matters has been discussed extensively in the literature and substantiated the use of CBCT scans for human identification. The advantages of CBCT include multiplanar reconstruction, easy manipulation of the image, and assessment of the craniometric points. Apart from this, disadvantages like the superimposition of anatomic structures can also be avoided [7]. One of the biggest advantages is that it is less time-consuming. This is beneficial, especially in cases of mass disasters, where anthropometric processes involving direct measurement of the skull will be time-consuming as it involves the tedious process of soft tissue removal. Thus, in such situations, sex determination using CBCT scans will be much faster, easier, and more reliable.

Panoramic radiography has been used for gender determination in the past. CBCT overcomes the limitations of panoramic radiography like distortion, magnification, and overlapping, and can provide accurate details [6].

There is a paucity of studies in this regard among the Indian population, hence the current study is aimed to compare the differences in the location and dimensions of the inferior alveolar canal among male and female adults using CBCT scans. In view of this, the region of the mandibular canal can be considered an aid in sex determination due to its protected anatomical position. Additionally, it is an important landmark to be analyzed in a population in which discriminant function model involving the mandibular canal region has not been derived.

Thus, the present study was undertaken to provide data on the inferior alveolar nerve canal for sex determination, which can be used as a reference sample for establishing the identity in cases of unknown fragmented skulls.

AIM AND OBJECTIVES

Aim of the study

- The aim of the study was to evaluate and compare the position and dimensions of the inferior alveolar canal among males and females using Cone Beam Computed Tomography (CBCT) images

Objectives of the study

- To evaluate the location, width and height of the inferior alveolar canal in males using CBCT images.
- To evaluate the location, width and height of the inferior alveolar canal in females using CBCT images.
- To compare the location, width and height of the inferior alveolar canal among males and females.
- To derive a discriminant equation for determining the sex of an individual in the North Karnataka population

REVIEW OF LITERATURE

THE MANDIBLE

The mandible is the strongest bone of the face, which has a horizontal portion, two perpendicular portions, the body, and the rami, which unite with the body of the mandible and the angle region.

DEVELOPMENT OF THE MANDIBLE

The mandible develops bilaterally within the mandibular processes of the first branchial arch, where it is preceded by the cartilage of the primary cartilaginous skeleton,the Meckel's cartilage. Each embryonic mandibular process contains the rod-like cartilaginous Meckel's cartilage core, which is an extension of the chondrocranium into the viscerocranium, and its accompanying inferior alveolar artery, vein and nerve. Meckel's cartilage does not take a direct part in the formation of the corpus of the mandible but acts as a support for the mandibular nerve as well as for the membrane bone that develops later. Meckel's cartilage articulates with the cranial base in the petrous part of the temporal bone, giving rise to the malleus and incus bones of the inner ear.

Meckel's cartilage completely disappears by approximately 24 weeks of gestation, and remains as the dense spheno-mandibular ligament, giving rise to the malleus and incus [(8)].

Development by intra-membranous ossification:

The mandibular division of the trigeminal nerve is the first structure to develop in the region of the lower jaw is that precedes the ectomesenchymal condensation forming the mandibular arch. The first development of the nerve is a requisite for inducing osteogenesis

by the production of neurotrophic factors. This mandibular ectomesenchyme must interact initially with the epithelium of the mandibular arch before primary ossification can occur [9].

- At 6 weeks of gestation – Mesenchymal condensation occurs in the angle formed by the division of IAN and its branches.

- At 7 weeks- A center of ossification appears in the perichondral membrane lateral to Meckel's cartilage [10].

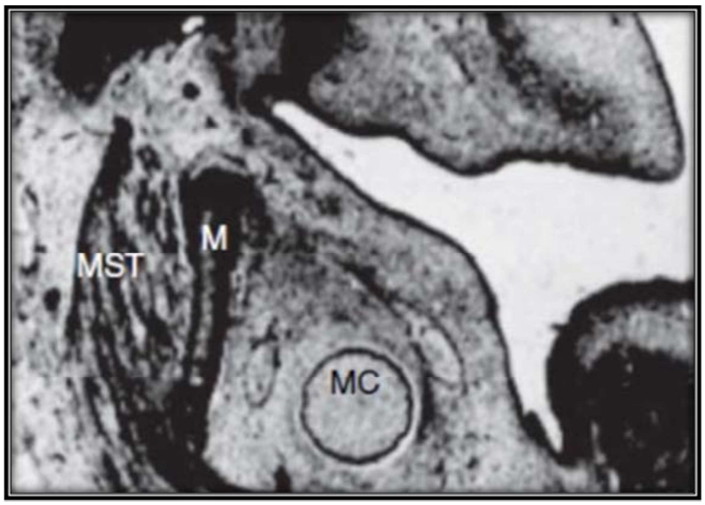


Fig. 1: Histological section showing Meckel's cartilage medial to the developing mandible(M). MST = Masseter muscle

Intramembranous ossification of the body of the mandible starts as a mass of fibrous tissue lateral to the bifurcation of the incisive and mental nerves and proceeds distally to the mental foramen region and proximally to the mandibular foramen region. As it does so, Meckel's cartilage begins to degenerate and involute as the infero-alveolar neurovascular bundle becomes enveloped by the developing mandibular bone [11].

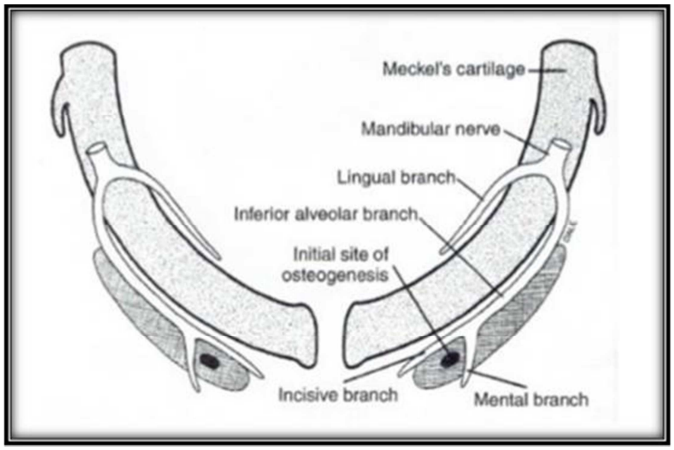


Fig. 2: Relationship of Meckel's cartilage to the mandibular nerve and the site where membrane bone formation is initiated

The membranous bone comprising the mental nerve in a groove is spread to form a plate that extends laterally to the inferior alveolar nerve. Below the groove containing the mental nerve, bone formation occurs below the incisive nerve and above between the incisive nerve and Meckel's cartilage.

The groove containing the mental nerves becomes the mental foramen by the extension of the bone over the nerve. With the formation of bone over the incisive nerve, the incisive canal is formed [8,10].

The development of ramus of the mandible occurs by a process of rapid ossification spreading posteriorly into the mesenchyme of the 1st pharyngeal arch, deflecting from Meckel's cartilage. This point of deflection is characterized by the lingula in the adult mandible, from where the inferior dental nerve enters the body of the mandible.

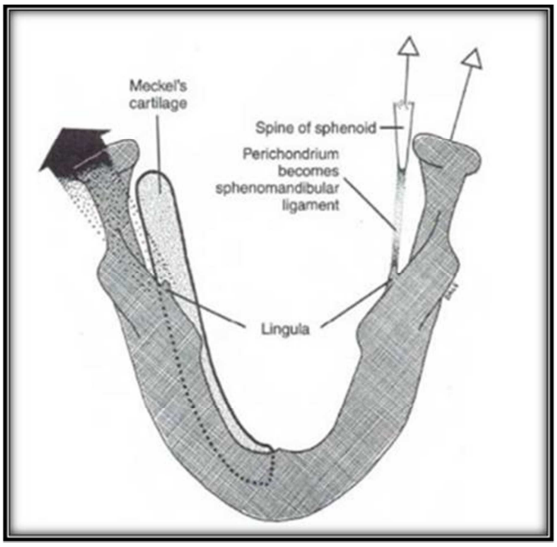


Fig. 3: Spread of mandibular ossification away from Meckel's cartilage at the lingula

There is a formation of a plate lateral to the inferior alveolar nerve due to bone formation. The developing dental lamina is away from the bone of the mandible at this stage.

Later, as the tooth germs differentiate, they will be surrounded by the lateral and medial plates of the mandible. These plates will extend above the level of the roof of the canals for the incisive and inferior dental nerves to form the alveolar plates. The tooth germs become encompassed in a channel that is divided by septa extending mediolaterally and forms crypts or alveoli.

The bone of the right and left halves of the mandible comes into contact in the midline where they are separated by fibrous tissue to form symphysis of the mandible. Complete bony union to form synostosis does not happen until the end of the first year after birth.

Postnatal growth of mandible:

It is defined as 20 years of growth from birth. It is comprised of 3 periods:

1. Infancy - is the first postnatal year of life,

2. Childhood - from 1^{st} to 15^{th} or 16^{th} year postnatal and is divided into 3 stages: Early Phase (from 1 to 6 years), Middle Phase (from 6 to 10 years) and Late Phase (from 10 to 15-16 years),

3. Adolescence from 13^{th} (14^{th}) to 20^{th} year postnatal. Puberty occurs between about 13 to 14 years in males and 12 to 13 years in females.

Both endochondral and periosteal activities are important in mandibular growth. The surface of the mandibular condyle is covered by cartilage. All other areas of the mandible are developed by direct surface apposition. The rami of the mandible are short at birth. There is minimal condylar development and almost no articular eminence in the glenoid fossa. The midline of the symphysis is separated into right and left mandibular bodies by a thin line of fibrocartilage and connective tissue. Between four months of age and the end of the first year, the Symphyseal cartilage is replaced by bone. Although growth is quite general during the first year of life, appositional growth is especially active at the alveolar border, at the distal and superior surfaces of the ramus, at the mandibular condyle, and along the inferior border of the mandible.

Translation of the mandible happens in a downward and forward direction and grows upward and backward direction. An important remodeling transition occurs at the junction between the ramus and the body of the mandible. Several major components in the posterior region of the mandible become progressively relocated in a general posterior course during

growth. Thus, the condyle, coronoid process, ramus, gonial angle, lingual and its fossa, lingual tuberosity, posterior end of the body, trihedral eminence, and the antegonial notch successively move backward [(12)].

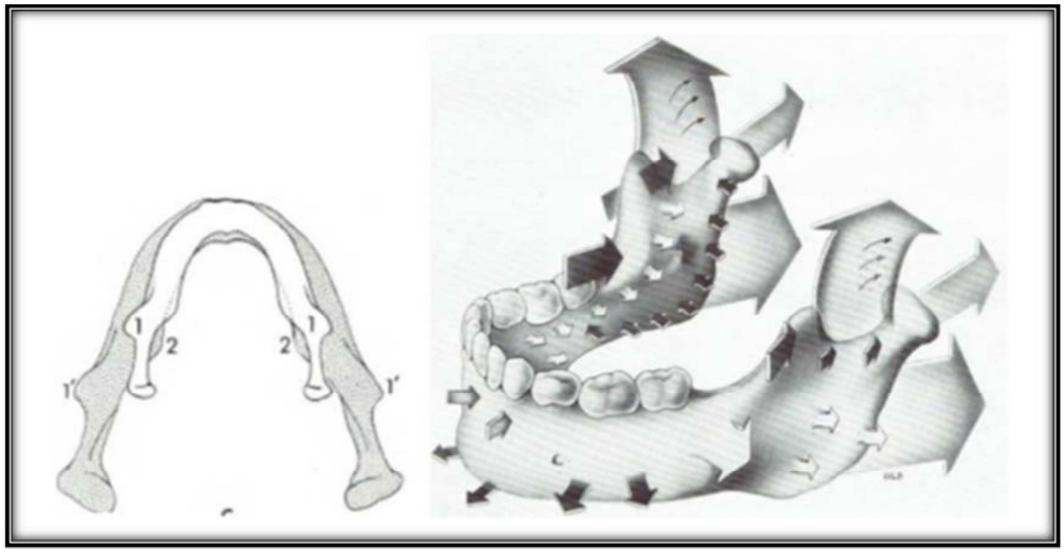


Fig. 4: Schematic diagram showing an overview of the growth directions ofthe Mandible

Timing of growth in width, length and height:

Growth occurs in a definite sequence. Growth of the mandible occurs three dimensionally. Growth in width is completed first followed by growth in length and finally, growth in height.

Growth in width

Growth in the width of the maxilla and mandible as well as the width of the dental arches are expected to be completed before the adolescent growth spurt. In the case of the mandible, both the molar and bicondylar widths show a small increase until the end of growth in length. The anterior width dimensions of the mandible stabilize earlier. As the corpus of the mandible and inferior portion of the ramus increase in width by deposition

along the buccal surface, the buccal surface on the superior portion of the ramus is resorptive, while the lingual and superior surfaces are depository.

Growth in length

Condylar growth and remodeling of the superior aspects of the ramus are directed posteriorly and superiorly during the initial years. It is important to note the orientation of growth as it rapidly increases the length of the corpus to create space for the rapidly developing dentition. After the first few postnatal years, growth of the condyle and superior ramus slows down dramatically and changes orientation toward a predominant superior direction.

Growth in height

Growth in height and length of both the maxilla and mandible continues throughout the period of puberty. Growth in vertical height of the face lasts longer than growth in length with the later vertical growth primarily in the mandible. Growth of the mandible continues at 9 years and relatively becomes steady before puberty. The height ofthe ramus increases by 1 to 2 mm every year and the length of the body of the mandible increases by 2 to 3 mm every year. Among all the facial bones, the mandible encounters increased growth postnatally and also experiences the largest morphological variations.

Changes Produced in the Mandible by Age:

At birth, the body of the bone is a mere shell, containing the sockets of the two incisors, the canines, and the two deciduous molar teeth, imperfectly partitioned off from one another. The mandibular canal is of larger size, and runs adjacent to the lower border of the bone; the mental foramen opens below the socket of the first deciduous molar tooth. The

angle is obtuse (175°), and the condylar portion is nearly in line withthe body. The coronoid process is of comparatively larger size and projects superior to the level of the condyle.

In the **first year after birth**, the two segments of the bone fuse at the symphysis, from below upward; however, a sign of separation may be evident nearthe alveolar margin at the beginning of the second year. The body lengthens along its entire length, but particularly behind the mental foramen, to make room for the three additional teeth that grow here. The depth of the body increases as the alveolar portion becomes larger to accommodate the roots of the teeth, and the sub-dental portion thickens to allow the jaw to survive the powerful action of the masticatory muscles; nevertheless, the alveolar portion is the deeper of the two and, consequently, the main part of the body lies above the oblique line. The mandibular canal, after the second dentition, is situated just above the level of the mylohyoid line; and the mental foramen occupies the position usual to it in the adult. The angle becomes less obtuse, due to the separation of the jaws by the teeth; at about the fourth year, it is 140°.

In the adult, the alveolar and sub-dental portions of the body are usually of equal depth. The mental foramen opens midway between the upper and lower borders of the bone, and the mandibular canal runs nearly parallel with the mylohyoid line. The ramus is almost vertical in direction, the angle measuring from 110° to 120°.

In old age, the bone becomes greatly reduced in size, for with the loss of the teeth the alveolar process is absorbed, and, consequently, the chief part of the bone is below the oblique line. The mandibular canal, with the mental foramen opening from it, is close to the alveolar border. The ramus is oblique in direction, the angle measures about 140°, and the neck of the condyle is more or less bent backward.

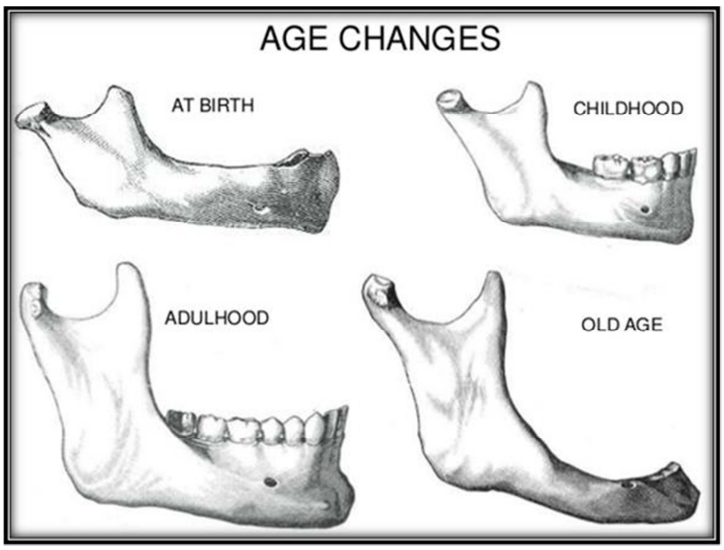


Fig. 5: Age Changes of the Mandible

Masticatory Muscle Influence on Craniofacial Growth:

Bones undergo continual remodeling during postnatal development to preserve a shape that is suitable for their biomechanical role. Masticatory muscle function is thus regarded as a local environmental factor that regulates craniofacial development. Excessive attrition of the teeth was found in analyses of medieval skulls, indicating that the masticatory muscles were used extensively. The authors attributed this to the strong functional demands placed on the individual masticatory muscles, as well as the morphological features of their skulls. It was also observed that medieval skulls had a narrow inter-maxillary angle, a narrow gonial angle, and wide jaws. Subjects with solid or thick mandibular elevator muscles have larger transverse head lengths, according to both of these findings [8,13,14].

The masticatory muscles will thus affect the craniofacial development provided that the tension they apply to the facial bone structures is above a certain threshold, reaching what Frost calls 'the mild overload window' [15].

ANATOMY OF MANDIBLE

The mandible, the largest and strongest bone of the face, serves for the housing of the lower set of teeth. It consists of a curved, horizontal portion, the body, and two perpendicular portions, the rami, which unite with the ends of the body nearly at right angles [16].

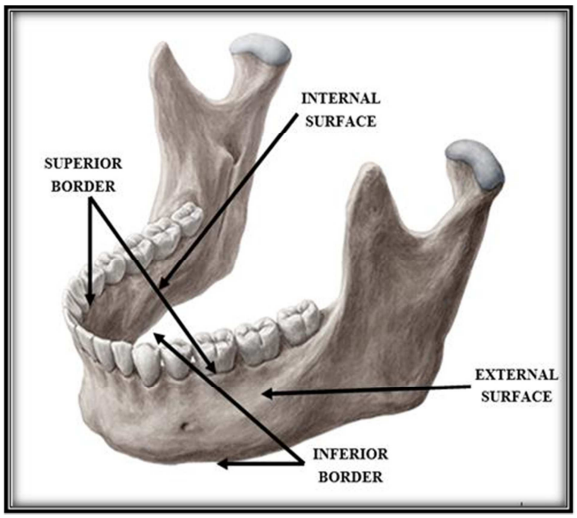


Fig. 6: Surfaces and Borders of the Mandibular Body

A) The Body (corpus mandible): The body is curved somewhat like a horseshoeand has two surfaces and two borders. **(*Fig. 6*)**

Surfaces:

1. The external surface (*Fig. 7*) is marked in the median line by a faint ridge,indicating the symphysis or line of junction of the two pieces of which the bone is composed at an early period of life. This ridge divides below and encloses a triangular eminence, the mental protuberance, the base of which is depressed in the center but raised on either side to form the mental tubercle. On either side of the symphysis, just below the incisor teeth, is a depression, the incisive fossa. Below the second premolar tooth, on either side, midway between the upper and lower borders of the body, is the mental foramen, for the passage of

the mental vessels and nerve. Running backward and upward from each mental tubercle is a faint ridge, the oblique line, which iscontinuous with the anterior border of the ramus.

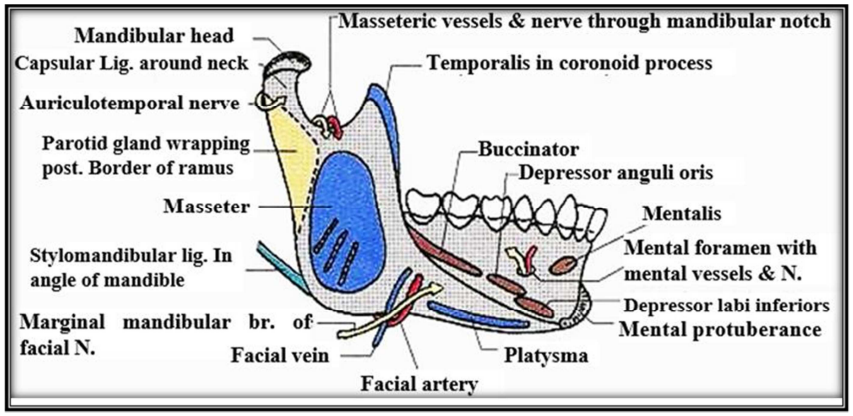


Fig. 7: External Surface of the Mandible

2. The internal surface (*Fig. 8*) is concave from side to side. Near the lower part of the symphysis is a pair of laterally placed tubercles, termed the genial tubercles. Immediately below these is the second pair of tubercles, or more frequently a median ridge or impression.

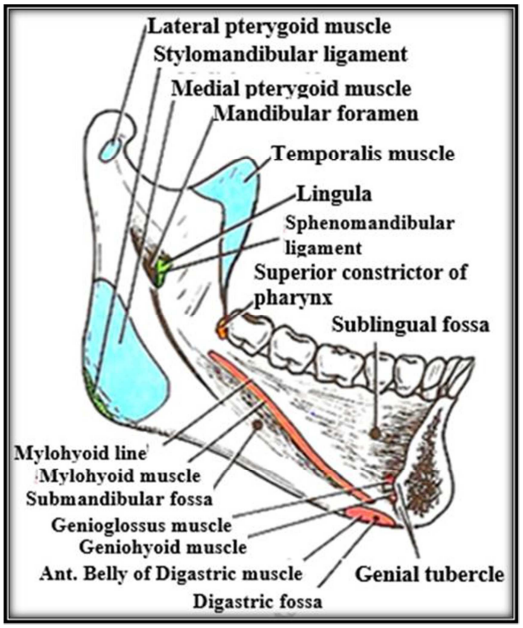


Fig. 8: Internal Surface of the Mandible

In some cases, the genial tubercles are fused to form a single eminence, in others they are absent and their position is indicated merely by an irregularity of the surface. Above the genial tubercles a median foramen and furrow are sometimes seen; they mark the line of union of the halves of the bone. Extending upward and backward on either side from the lower part of the symphysis is the mylohyoid line. Above the anterior part of this line is a smooth triangular area against which the sublingual gland rests, and below the hinder part, an oval fossa for the submaxillary gland.

Borders:

1. **The superior or alveolar border,** wider behind than in front, is hollowed into cavities, for the reception of the teeth; these cavities are sixteen in number, and vary in depth and size according to the teeth which they contain.

2. **The inferior border** is rounded, longer than the superior, and thicker in front than behind.

B) The Ramus (ramus mandibule; perpendicular portion): The ramus is quadrilateral in shape, and has two surfaces, four borders, and two processes.

Surfaces:

1. **The lateral surface** is flat and marked by oblique ridges at its lower part.

2. **The medial surface** presents about its center the oblique mandibular foramen, for the entrance of the inferior alveolar vessels and nerve. The margin of this opening is irregular; it presents in front a prominent ridge, surmounted by a sharp spine, the lingula of the mandible. The mandibular canal runs obliquely downward and forward in the ramus, and then horizontally forward in the body, where it is placed under the

alveoli and communicates with them by small openings. On arriving at the incisor teeth, it turns back to communicate with the mental foramen, giving off two small canals which run to the cavities containing the incisor teeth. In the posterior two-thirds of the bone the canal is situated nearer the internal surface of the mandible; and in the anterior third, nearer its external surface. It contains the inferior alveolar vessels and nerves, from which branches are distributed to the teeth.

Borders:

1. **The lower border** of the ramus is thick, straight, and continuous with the inferior border of the body of the bone. At its junction with the posterior border is the angle of the mandible, which may be either inverted or everted and is marked by rough, oblique ridges on each side.

2. **The anterior border** is thin above, thicker below, and continuous with the oblique line.

3. **The posterior border** is thick, smooth, rounded, and covered by the parotid gland.

4. **The upper border** is thin and is surmounted by two processes, the coronoid in front and the condyle behind, separated by a deep concavity, the mandibular/sigmoid notch. The sigmoid notch, separating the two processes, is a deep semilunar depression, and is crossed by the masseteric vessels and nerve.

MANDIBULAR CANAL (MC)

I. ANATOMY AND CONTENTS:

The mandibular canal (MC) is a bony structure that begins in the mandibular foramen on the medial face of the mandibular ramus on each side of the mandible. Its pathway follows the inferior and anterior direction passing to the mandible body, describing ananterior superior curve. It is related to the roots of the lower teeth, whose cross- sectional examination reveals an oval, circular or piriform shape [17]. It may constitute a conduit with well-defined walls, or describe a trajectory through the trabeculae formed of spongy bone tissue [18]. It is not a single canal but an anatomical structure withmultiple branches and variations. It carries the inferior alveolar neurovascular bundle (**inferior alveolar artery, nerve and vein). Inferior Alveolar Artery: (*Fig. 9*)**

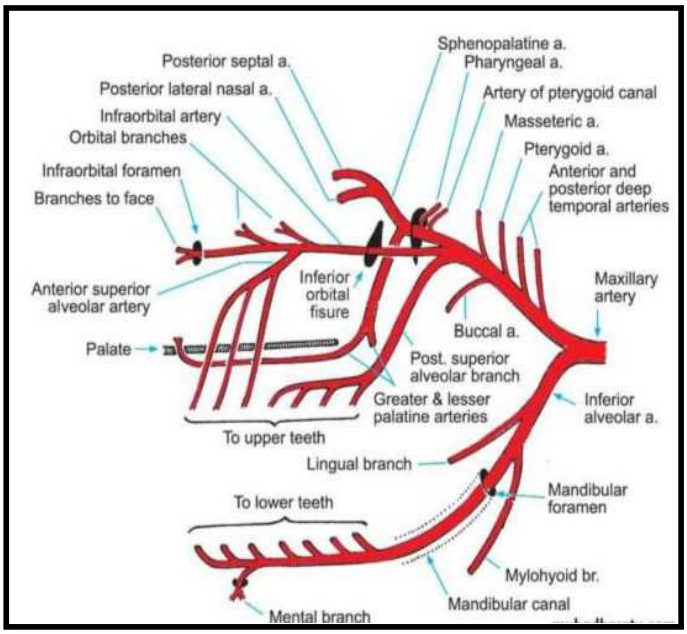


Fig. 9: Inferior Alveolar Artery

This artery is one of the five branches of the first section of the maxillary artery. The artery descends with the inferior alveolar nerve, and just before it enters the mandibular foramen, it gives off a small branch that runs in the mylohyoid groove and supplies the mylohyoid muscle. The Mylohyoid is the muscle that forms the floor of the oral cavity. The inferior alveolar artery then continues and runs within the substance of the mandibular bone. The artery gives off an incisor branch, which continues to run below the teeth as far as the midline, where the branch anastomoses with the artery of the opposite side. The mental branch of the artery leaves the mandible through the mental foramen and provides branches to the chin, and also forms anastomoses with the inferior labial arteries (branches of the facial artery), and the submental arteries (also branches from the facial artery). **Inferior Alveolar Nerve: (*Fig. 10*)**

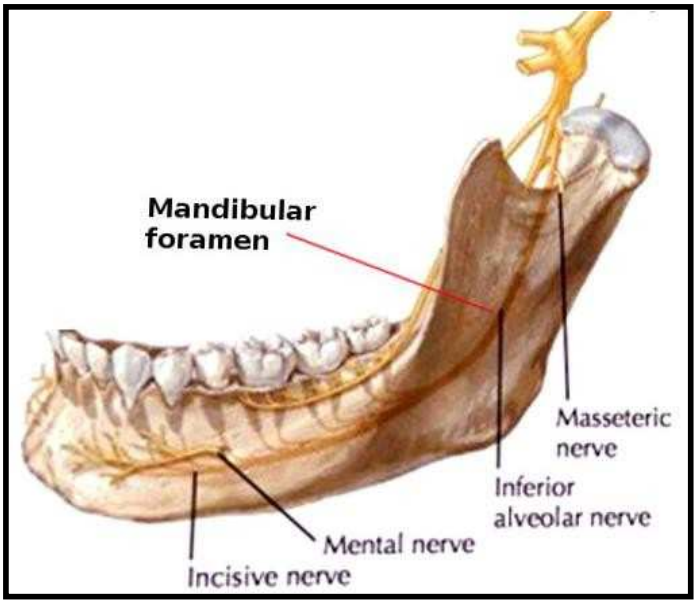


Fig. 10: Inferior Alveolar Nerve

The second structure that enters the mandibular foramen is the inferior alveolar nerve, which is a sensory branch of the mandibular division of the trigeminal nerve (V3). The trigeminal nerve is a large nerve that arises from the pons and divides into three major branches. V1 is the ophthalmic division, and leaves the skull through the superior orbital fissure. It supplies sensation to the superior surface of the face. It also supplies sensation to the surface of the eye and therefore provides the afferent limb ofthe corneal reflex. V2 is the maxillary division, and leaves the skull through the foramen rotundam. V2 supplies sensation below the V1 division, to the middle section of the face. The inferior alveolar nerve is a sensory branch of the mandibular division of the trigeminal nerve. The nerve to mylohyoid arises just before the nerve enters into the foramen. It runs within the substance of the mandible, and as it approaches the apex of the second molar, the nerve divides into a mental and incisive branch. The incisive branch supplies sensation to the lower teeth and the mental branch continues in the mandibular foramen eventually leaving the mental foramen on either side of the midline of the chin. It then supplies sensation to a small region of skin on the lowerlip and lower face.

Inferior Alveolar Vein:

The alveolar veins include the inferior alveolar vein and the posterior alveolar vein. Both of these veins are also considered dental veins. The inferior alveolar vein drains blood from the lower teeth and jaw, and the posterior alveolar artery assists it in completing this function. The inferior alveolar vein can also drain blood to the pterygoid plexus, a network of veins located near the cheek. The posterior alveolar vein, on the other hand, works to drain blood from the molars and gums.

The alveolar veins are located in the mandibular canal. This canal is a horizontal chamber located inside the ramus, which is the back portion of the mandible. The inferior and posterior alveolar veins are arranged in a network of veins, allowing themto empty blood out into a series of veins and muscles, including the pterygoid muscles, which serve as tributaries (drainages) for the facial vein. The mental foramencan be seen below the second premolar tooth; it transmits the terminal branches of the inferior alveolar nerve and vessels.

II. ANATOMIC LOCATION OF MANDIBUAR CANAL

The knowledge regarding the location of the Mandibular Canal in both vertical and horizontal planes is important. This helps in the orientation of the neurovascular bundle which should be ascertained pre-operatively in order to avoid inadvertent injury to the neurovascular bundle in case of different anatomic configurations in both planes. ***In the literature, it is mentioned that the MC might have different anatomic configurations in the vertical plane*** [(19)]**.** For example, the canal may run lower when it proceeds anteriorly or may have a sharp decline, or drape downward in catenary fashion.

Table 1: List of studies performed to study the anatomy of the mandibular canal in the vertical plane

Sr.no	Study	n	Variable	Results
1	***Nortjé CJ, Farman AG, Grotepass FW.***[20]	3612	C-M	**48%** - High canals **49%** - Low canals
2	***Heasman PA.***[21]	96	C-M	**67.7 % - Type II (Nortje et al., 1977) - Intermediate course**
3	***Littner MM, Kaffe I, Tamse A, Dicapua P.***[22]	46	C-M	MC was located **3.5 to 5.4 mm** belowthe apices of both 1st and 2nd molars
4	***Levine MH, GoddardAL, Dodson TB***[23]	50	C-Alveolar crest	Superior aspect of the MC was **17.4mm** inferior from the alveolar crest
5	***Watanabe H, Abdul MM, Kurabayashi T,Aoki H.***[24]	79	C - Alveolar crest	Distance from alveolar crest to MCranged from **15.3 to 17.4 mm**
6	***Denio D, TorabinejadM, Bakland LK.***[24]	22	A5, A6, A7	2nd premolar and 2nd molar had the closest distances to the MC with a meanof 4.7 mm and 3.7 mm
7	***Sato I, Ueno R, KawaiT, Yosue T.***[25]	75	C-IMBC-M IMB-MMVD	**Vertical position of MC** was closer to the apices of the 1st & 2nd molars than that to the distance of IMB. The distance from the MC to the apex of the 1st molar tooth root was larger than that of 2nd molar

(***A5** - The closest distance from the apical foramen to the inside edge of bone within the mandibular canal to determine the distance between the apical foramen and the mandibular canal.*

***A6** - The distance between the apical line and the canal line.*

***A7** - The distance from the center of the mandibular canal to the root long axis.*

***C-IMB** -The distance between the lower border of the mandibular canal and the inferior border of the mandible*

***MVD** - The vertical diameter of the mandibular canal*

***C-M** - The distance between the upper border of the mandibular canal to the apex of the tooth root*

***IMB-M** - The distance from the inferior border of the mandible to the apex of the tooth root)*

Nortjé CJ, Farman AG, Grotepass FW [20] described the appearance of mandibular canal as a dark ribbon of radiolucency flanked by two radiopaque white lines. The radiographs were divided into four categories: 1) High MC (within 2 mm of the apicesof the first and second molars), 2) Intermediate MC, 3) Low MC, and 4) Other variations – these included duplication or division of the canal, apparent partial or complete absence of the canal or lack of symmetry.

Pucilo M, Lipski M, Sroczyk-Jaszczyńska M, Pucilo A, Nowicka A [26] performed a study to review the literature on the position of the mandibular canal (MC) relative to the root apices (RA) of neighboring teeth using cone beam computed tomography (CBCT). The researchers found three groups based on the measuring methods. In the first and second groups, the shortest distances to the canines, first premolars, second premolars, first molars, second molars, and third molars were 3.8 mm, 4.76 mm, 1.65 mm, 1.23 mm,0.64 mm, and 1.28 mm, respectively. In the third group, the shortest distances to the second premolars, first molars,

and second molars were 2.71 mm, 3.82 mm, and 1.4 mm, respectively. The distance from the MC to the root apex was generally shorter in females and younger people, with decreasing distances in patients over 60 years old, and depended on the tooth type.

In literature, it is also mentioned that the MC might have different anatomicconfigurations in the horizontal plane.[(19)] Buccolingual orientation is an important parameter which should be analysed prior to surgical procedures.

Usually, the MC crosses from the lingual to the buccal side of the mandible and in most cases the midway between the buccal and lingual cortical plates of bone is by the first molar[(27)]**.**

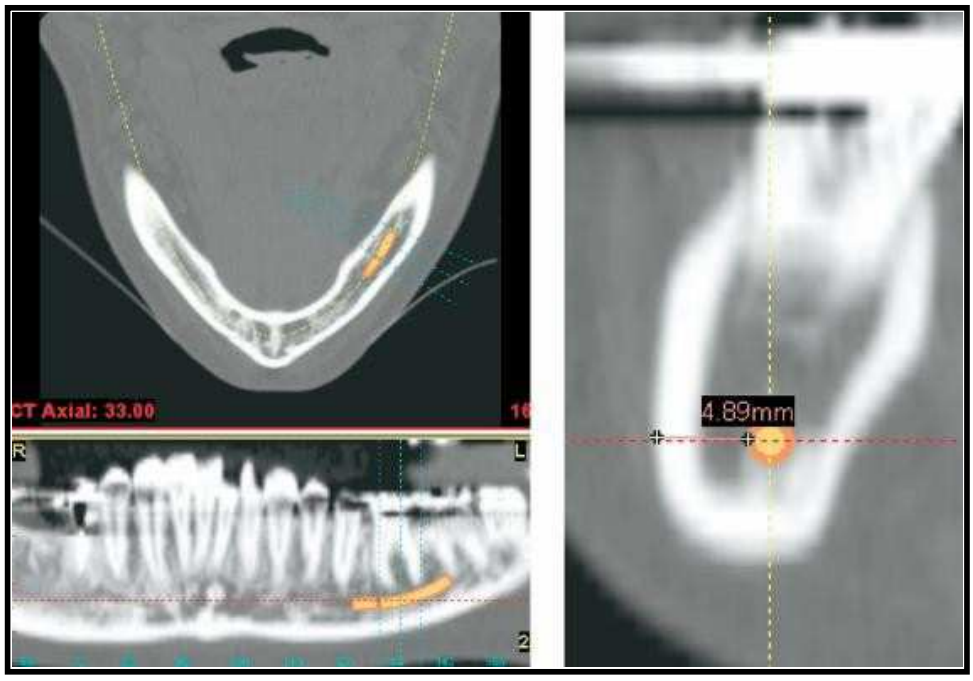
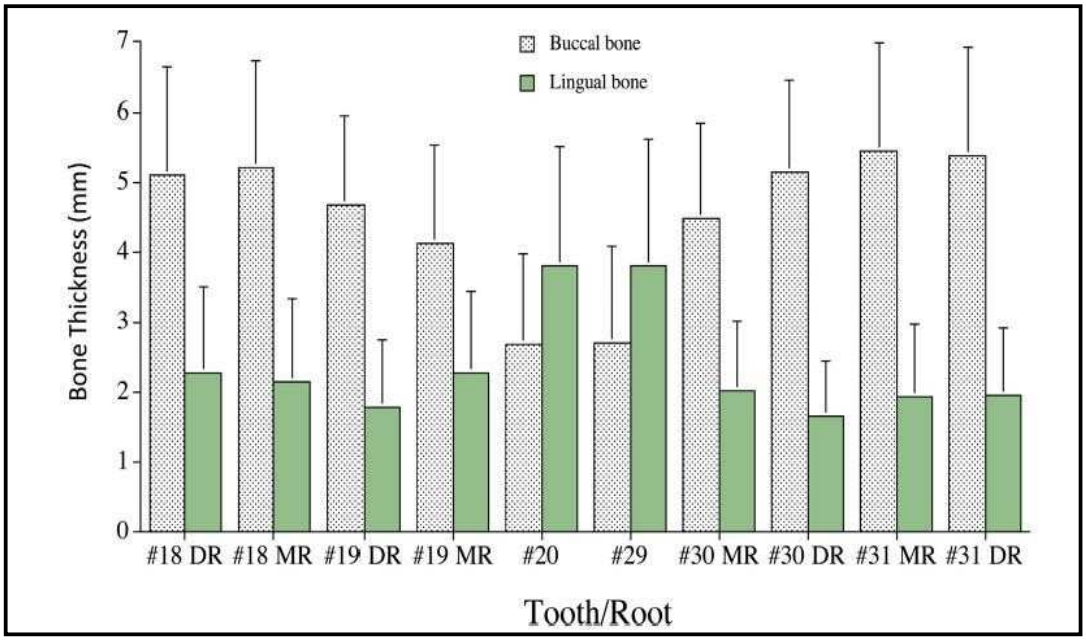


Fig. 11: The canal was identified and the lineardistance between the buccalaspect of the canal and the outer buccal cortical margin ofthe mandible was measured



Graph 1*: *Buccal and lingual bone thickness over the mandibular canal. DR,distal root; MR, mesial root

***Table 2: Mean Distance (in mm) between the buccal outer cortex to the outer surfaceof the IAC along the buccal side*.**

	Male (n=110)		**Female (n=122)**	
Region	**Right**	**Left**	**Right**	**Left**
2nd Premolar	3.1	2.9	2.7	2.6
1st Molar	5.2	5.57	4.85	4.94
2nd Molar	**5.64**	**6.02**	**4.93**	**5.03**

Table 3: Mean Distance (in mm) between the lingual outer cortex to the outersurface of the IAC along the lingual side.

	Male (n=110)		**Female (n=122)**	
Region	**Right**	**Left**	**Right**	**Left**
2nd Premolar	4.3	4.5	3.9	3.7
1st Molar	**3.42**	**3.21**	**3.17**	**3.03**
2nd Molar	2.78	3.02	2.34	2.78

This shows that the lingual cortex is thicker at the first molar level, while the buccal cortex is much thicker at the second molar level. This probably could be due to consistent remodeling owing to the oral musculature attachments in the region. The mylohyoid line that serves to attach the mylohyoid musculature is oriented at a higher position in 2nd molar region than 1st molar region, thus explaining the greater thickness of the lingual cortex at the first molar level. On the buccal surface, the attachment of the masseter at the 2nd Molar region causes the greater thickness there.

III. ANATOMICAL VARIATIONS IN MANDIBULAR CANAL

Various researchers mentioned the branching of the inferior alveolar nerve before it enters the mandibular foramen. This branch enters the lingual surface of the mandibular ramus before it enters the mandibular foramen at a point superior and anterior to the mandibular foramen. It will then form its own canal, which will progress to the third molar and innervate that tooth.

Some case reports have described supplemental, enlarged, branched canals, a bifid canal through the ramus and the body of the mandible, a bifid canal in the distal region of the third molar area, and a duplicated mandibular canal [(28)].

1. BIFID MANDIBULAR CANAL (BMC)

The term bifid is derived from the Latin word meaning a cleft into two parts or branches. Bifid mandibular canals originate at the mandibular foramen and might each contain a neurovascular bundle. The various types of bifid mandibular canals have been classified according to anatomical location and configuration. Smaller accessory canals might be seen in association with normal or bifid mandibular canals.

Chávez-Lomeli ME, Mansilla Lory J, Pompa JA, Kjaer I. [(29)] described that the MC derives from three individual nerve branches from different origins at different stages of development. Further fusion of branches occurs, and bony canals develop around such nerve paths. During rapid prenatal growth and bone remodeling, there is a spread of intramembranous ossification that eventually forms the MC. This theory explains that the occurrence of bifid MC is secondary to incomplete fusion of these three nerves.

The bifid and trifid variations of the mandibular canal have been reported using different imaging modalities. Studies using panoramic radiographs have demonstrated the prevalence of the bifid mandibular canal at low rates ranging from 0.08% to 0.95%. However, those using CT and CBCT images have reported incidence rates of the bifid mandibular canal ranging from 10.2% to 65%.

THE CLASSIFICATION AND PREVALENCE OF DIFFERENT TYPES OF BMC OBSERVED IN PANORAMIC RADIOGRAPHS

Several classifications of the mandibular canal according to the anatomical location and configuration have been used in various studies.

Carter RB, Keen E. [30] examined dissected human mandibles and described three types of inferior alveolar nerve arrangement (***Fig. # 3.12 to 3.14***)

Type I: The inferior alveolar nerve is a single large structure lying in a bony canal;

Type II: The inferior alveolar nerve is situated substantially lower down in themandible;

Type III: The inferior alveolar canal is separated posteriorly into two large branches, which together could be regarded as equivalent to an alveolar branch.

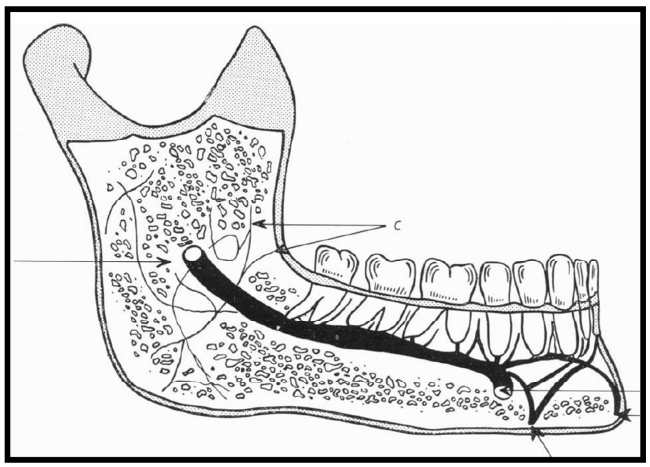


Fig. 12: Type 1 arrangement of the inferior alveolar nerve

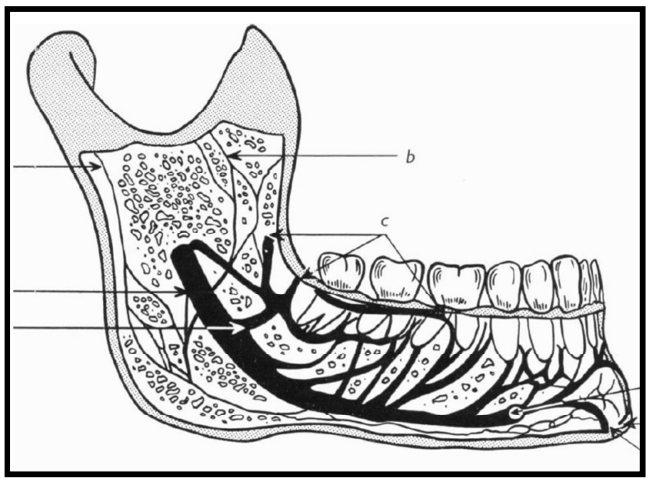


Fig. 13: Type 2 arrangement of the inferior alveolar nerve

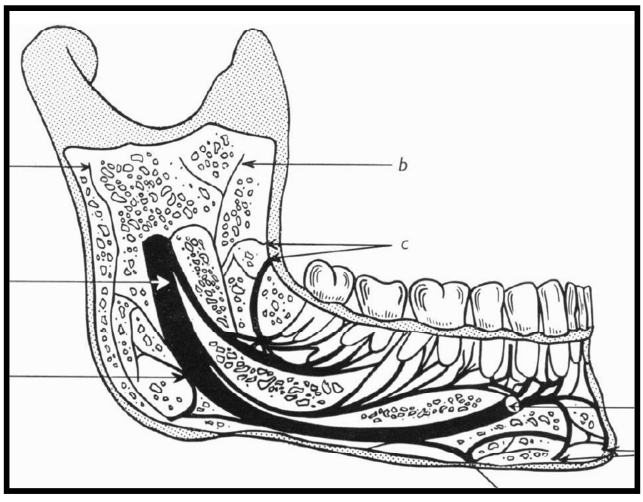


Fig. 14: Type 3 arrangement of the inferior alveolar nerve

N*ortjé CJ, Farman AG, Grotepass FW.* [20] described three main patterns ofduplication (***Fig. 15 to 19***)

Type I: (most common) – duplicate canals originating from a single mandibular foramen, usually the same size;

Type Ia: The lower canal is sometimes smaller;

Type Ib: The upper canal is the smallest of the two canals;

Type II: A short upper canal extending to the second or third molar areas;

Type III: (least common) – two canals of equal size, arising from separate foramina, that join in the molar area;

Type IV: is a double-canal variation in which the supplemental canals arise from the retromolar pad area and join the main canals in the retromolar areas.

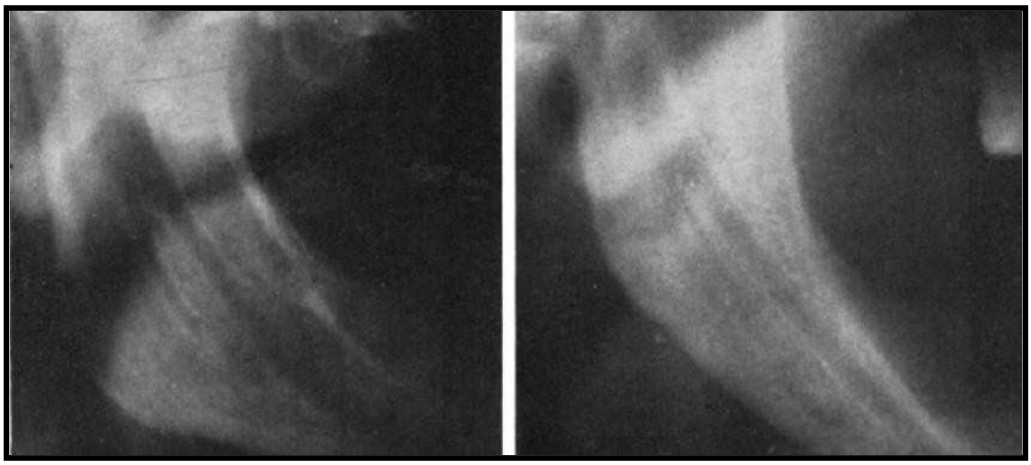


Fig. 15: Type 2 'double canal' with supplemental canal extending deep to thethird molar tooth

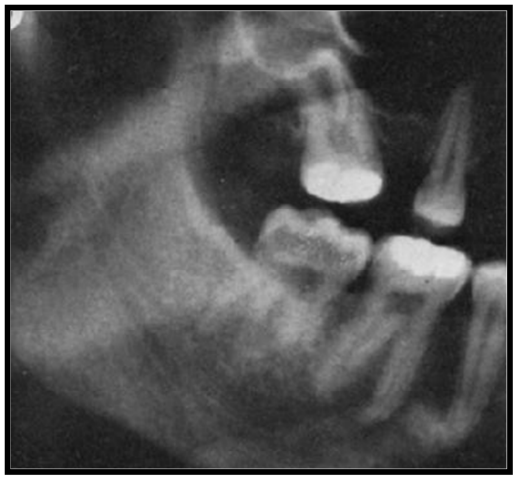


Fig. 16: Type 2 'double canal' with supplemental canal extendingtowards a three-rooted second permanent molar

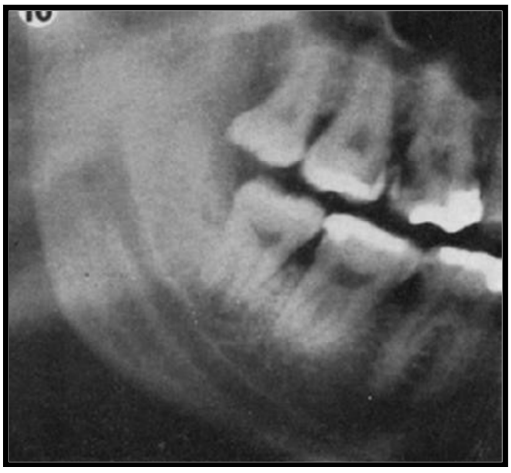


Fig. 17: Type 1 'double canal' with both canals being of an approximately similar size

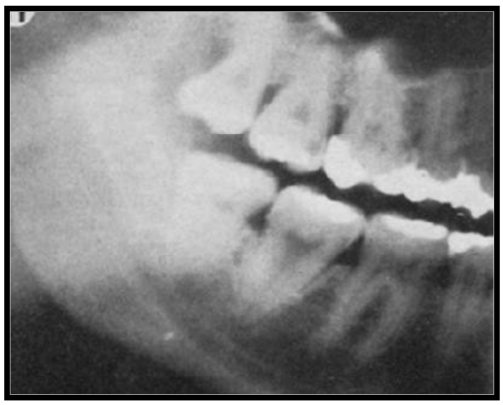


Fig. 18: Type 2 'double canal' with short supplemental canal extending towards the third molar

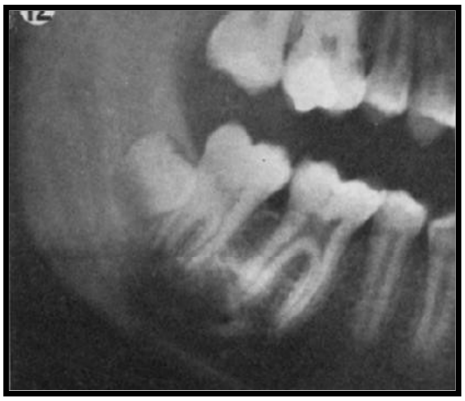


Fig. 19: Type 3 'double canal'

Langlais RP, Broadus R, Glass BJ. [31] developed a classification system according to anatomical location and configuration (***Fig. 20 to 22***)

Type I: Represents unilateral or bilateral bifid canals that extend to the mandibular third molar area or the immediately surrounding area (38.6% of bifids);

Type II: Includes unilateral or bilateral bifid canals that re-join within the ramus of the mandible (54.4% of bifids);

Type III: Combination of types 1 and 2 (3.5% of bifids);

Type IV: Two canals, each of which originates from a separate mandibular foramen, join to form one larger canal (3.5% of bifids).

Langlais RP, Broadus R, Glass BJ. [31] also stated that normal canals or bifid canals may have additional smaller accessory canals.

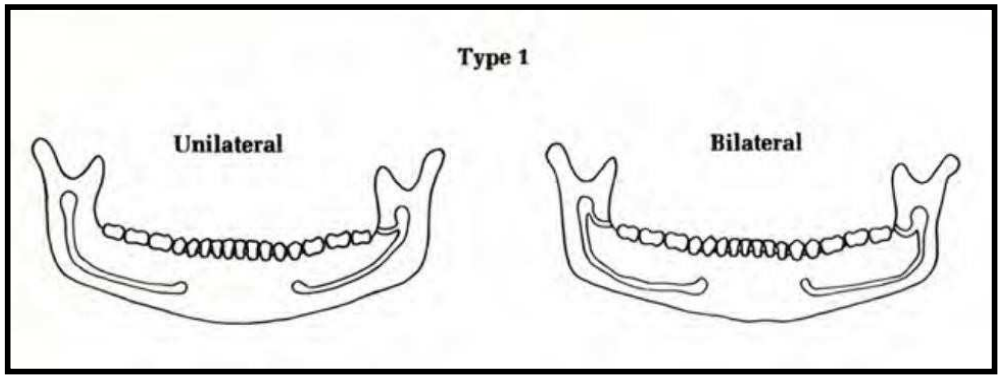


Fig. 20: Classification of BMC according to Langlais et al (Type I)

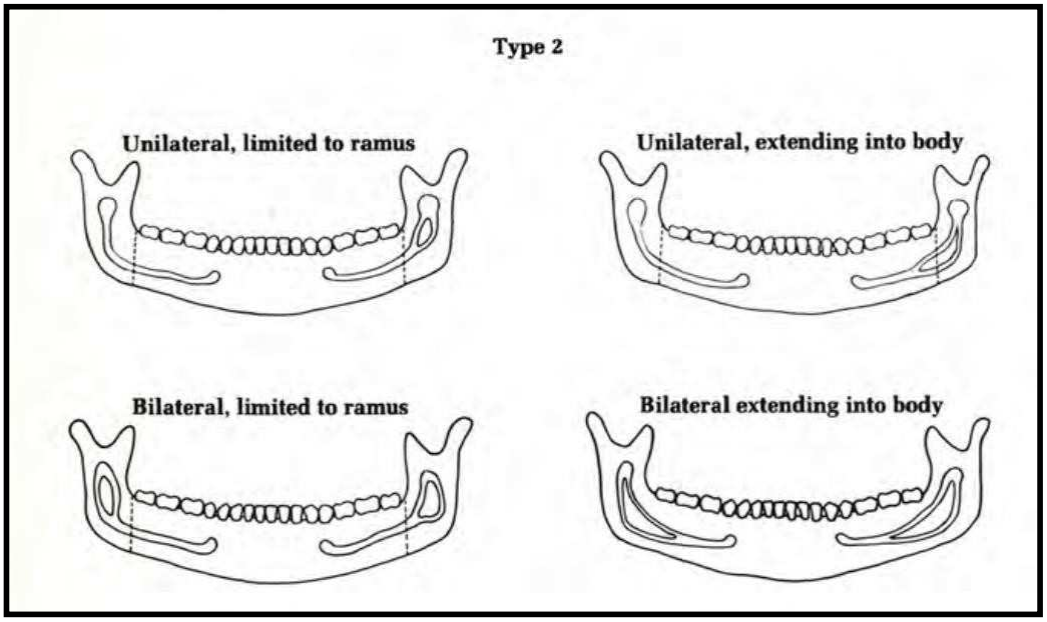


Fig. 21: Classification of BMC according to Langlais et al (Type II)

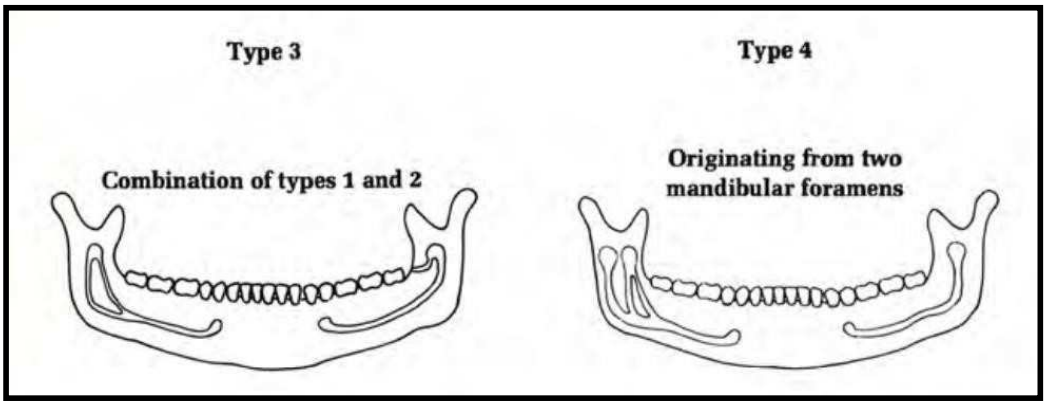


Fig. 22: Classification of BMC according to Langlais et al (Type III, IV)

THE CLASSIFICATION AND PREVALENCE OF DIFFERENT TYPES OF BMC OBSERVED USING CONE BEAM COMPUTED TOMOGRAPHY

A different classification of BMCs on CBCT was proposed by ***Naitoh M, Hiraiwa Y, Aimiya H, Ariji E. (2009)***[32], who distinguished four types according to the site of origin and the direction of the bifurcated canal from the mandibular canal. These types were the **Forward *(Fig. 23),* Dental *(Fig. 25),* Buccolingual *(Fig. 24),* and Retromolar canals *(Fig. 26)***. There were similarities to the system of Langlais et al. (1985) but with the addition of buccal or lingual bifurcation, which could not have been identified by panoramic radiography.

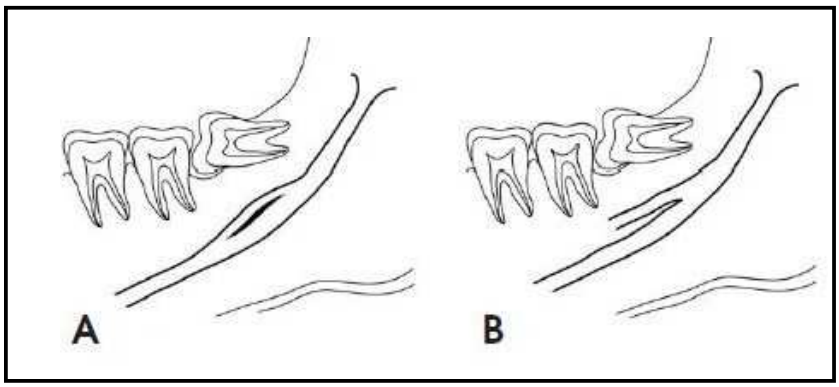


Fig. 23: Classification of BMC according to Naitoh et al (2009): The forwardcanal included with confluence (A) or without confluence (B) – (Type 3)

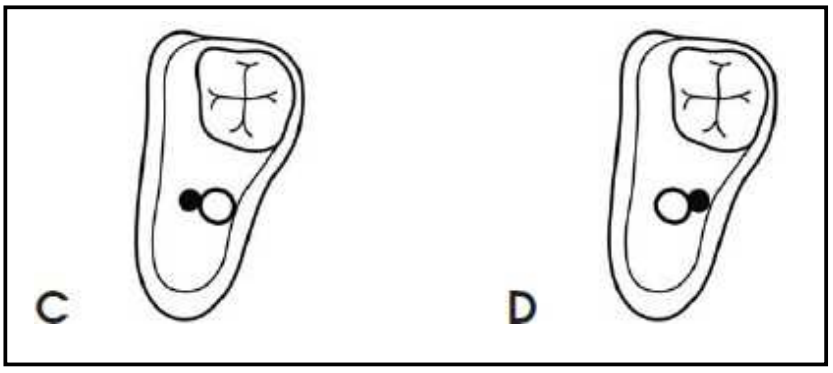


Fig. 24: Classification of BMC according to Naitoh et al (2009):Buccolingual canal (Type 4)

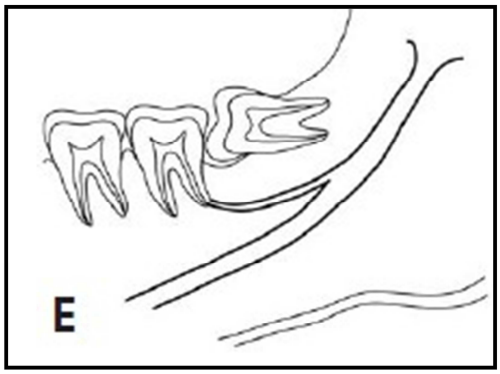


Fig. 25: Classification of BMC according to Naitoh et al (2009): Dental canal (Type 2)

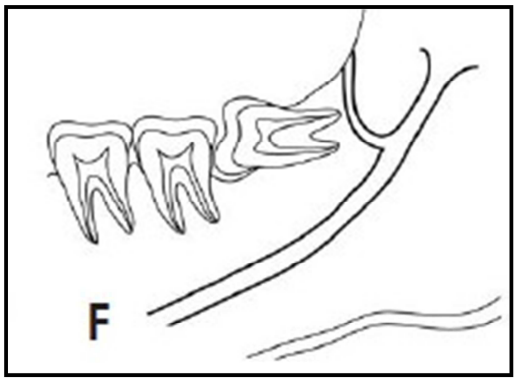


Fig. 26: Classification of BMC according to Naitoh et al (2009): Retromolar canal (Type 1)

For studying the types of BMC detected by CBCT, ***Correr GM, Iwanko D, Leonardi DP, Ulbrich LM, Araujo MR, Deliberador TM. (2013)***[33] added four new categories to the Langlais et al. (1985) classification to depict the proximity of the third molar to the nerve bifurcation:

Class A: No involvement of the bifid mandibular canal with the third molar;

Class B: Close relationship of the third molar root to the mandibular canal bifurcation (the bifurcation is close to the third molar root but does not touch it);

Class C: Intimate relationship between the third molar root and the mandibular canal bifurcation (the bifurcation touches the third molar root);

Class D: Absence of third molars.

Many authors have used the Naitoh et al. classification system to determine the prevalence of BMC in their respective populations.

***Rashsuren O, Choi JW, Han WJ, Kim EK.*[34]** performed a study using Naitoh et al classification of BMCs Few cases of trifid mandibular canals have been reported. In addition, the length, diameter, angle, of the bifid mandibular canals measured according to type were reported. In this study, the bifid mandibular canal was classified into five types by anatomic location and configuration as described below. One group of the trifid canal type was added to the classification of Naitoh et al.

Type 1 (Retromolar canal type): The retromolar canal, which bifurcates from the mandibular canal in the mandibular ramus region, courses forward at first, reaching the retromolar region after the crook. (***Fig. 27*****)**

Type 2 (Dental canal type): The dental canal, which bifurcates from the mandibular canal in the mandibular ramus region, courses forward, reaching the root of the molar.***(Fig. 28)***

Type 3 (Forward canal type): A. Forward canal without confluence: The forward canal, which bifurcates from the mandibular canal in the mandibular ramus region, courses forward to the second molar region. B. Forward canal with confluence: The forward canal, which bifurcates from the mandibular canal in the mandibular ramus, courses anteriorly and then, joins the main mandibular canal. ***(Fig. 29)***

Type 4 (Buccolingual canal type): ***A. Lingual canal:*** Bifurcates from the mandibular canal in the mandibular ramus, courses lingually and then penetrates through the lingual cortical bone. ***B. Buccal canal:*** Bifurcates from the mandibular canal in the mandibular ramus, courses bucco-inferiorly.

Type 5 (Trifid canal type): A. Two accessory canals of the retromolar canal type. B. Two accessory canals of one retromolar and one dental canal type. C. Two accessory canals of the dental canal type. D. Two accessory canals of one dental and one forward canal type. E. Two

accessory canals of the retromolar canal type with two mandibular foramina. ***(Fig. 30 to 35)*** It was observed that the retromolar canal type was the most common (71.3%), followed by the dental canal type (18.8%), the trifid type (5.8%), and the forward type(4.1%).

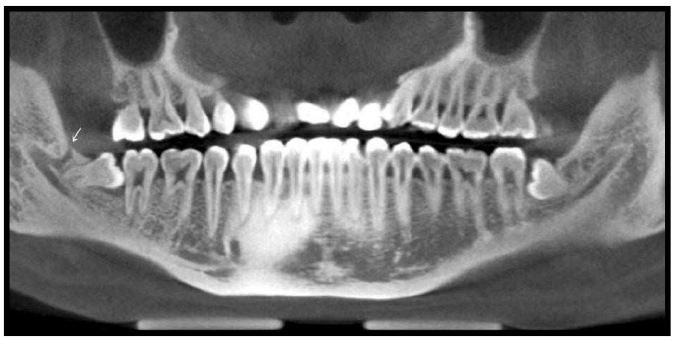


Fig. 27: Cone-beam computed tomography (CBCT) image showscanal type 1 (retromolar canal type)

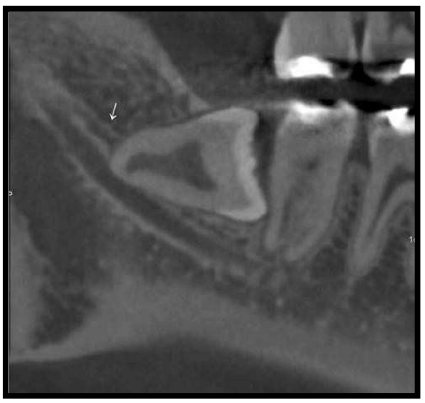


Fig. 28: CBCT image shows canal type 2 (dental canal type)

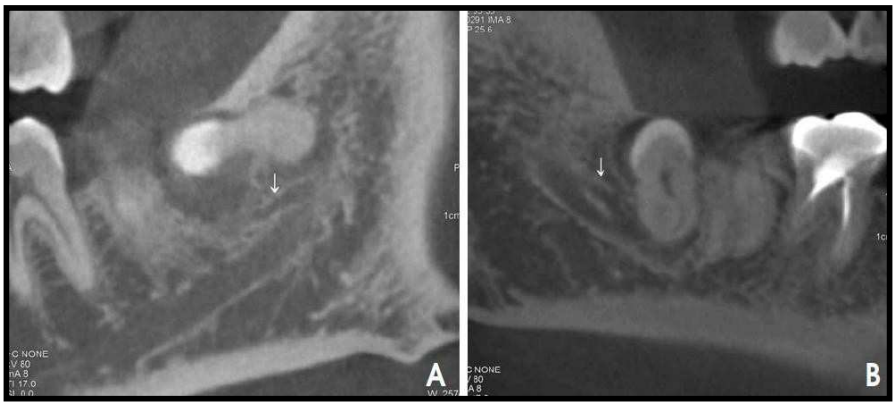


Fig. 29: CBCT images show canal type 3 (forward canal type A withoutconfluence, B with confluence)

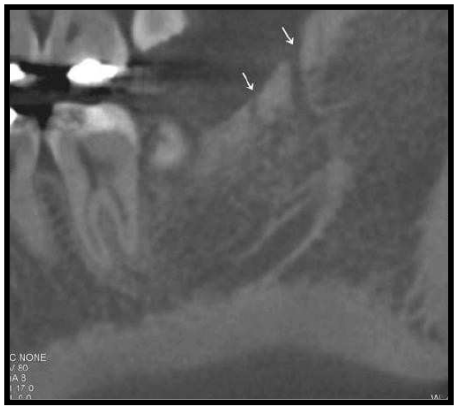


Fig. 30: CBCT image shows canal type 5A (trifid canal type: twoaccessory canals of the retromolar canal type)

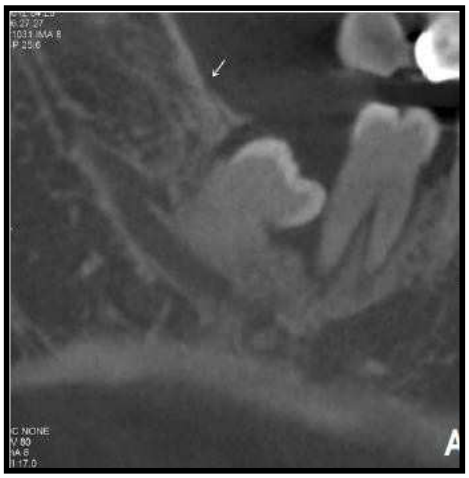


Fig. 31: CBCT images show canal type 5B (trifid canal type: two accessory canals of one retromolar type)

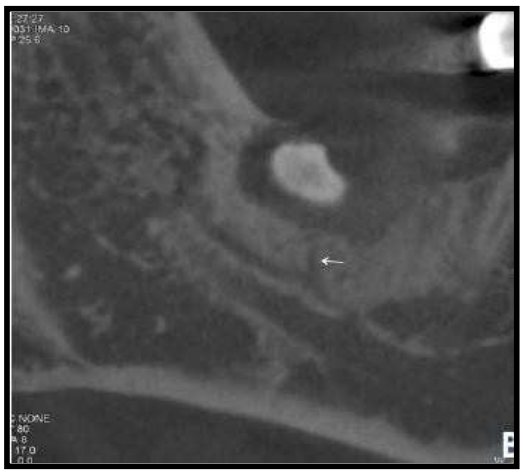


Fig. 32: CBCT images show canal type 5B (trifid canal type: two accessory canals of one dental type)

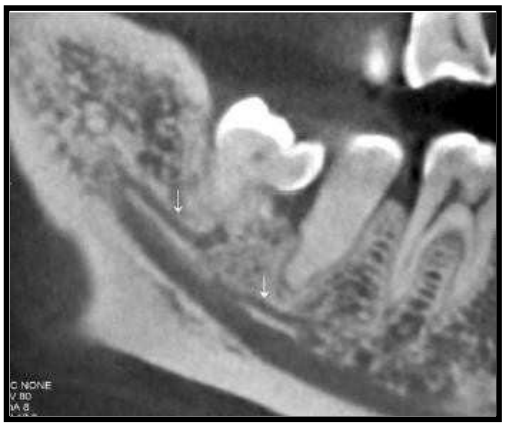


Fig. 33: CBCT image shows canaltype 5C (trifid canal type: two accessory canals of the dental canal type)

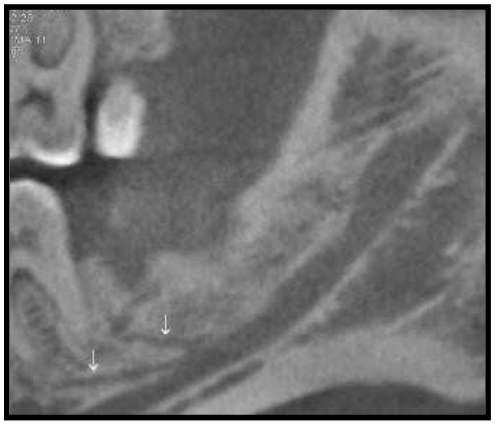


Fig. 34: CBCT image showscanal type 5D (trifid canal type: two accessory canals of one dental andone forward canal type)

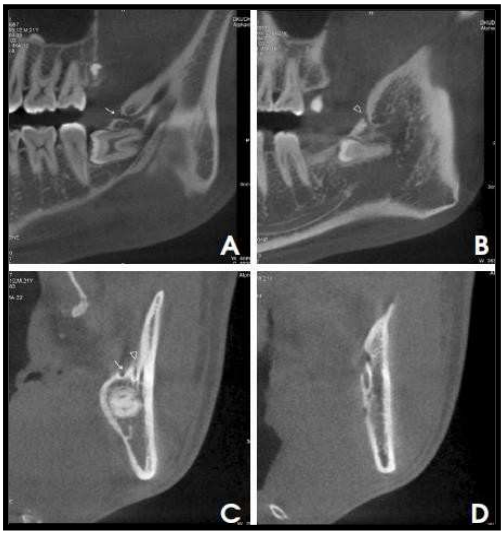


Fig. 35: CBCT images show canal type 5E (trifid canal type: twoaccessory canals of the retromolar canal type (A-C) with two mandibular foramina (D))

2. TRIFID MANDIBULAR CANAL (TMC)

A rare variant of the bifid mandibular canal is the trifid canal, accounting for less than 6%of all bifid canals.

The first case of a TMC was reported in 2005. It was found incidentally, adjacent to an impacted lower left third molar, during pre-orthodontic **screening *(Auluck A, Pai KM* [35]).** The authors confirmed the presence of these canals using CT, one accessory canal showing perforation of the lingual plate. Most of the cases in the literature were reported to explain failures to achieve adequate local anesthetic blocks, though this problem could also result from the central core effect of IAN.

Wadhwani P, Mathur RM, Kohli M, Sahu R. (2008) [36] reported a case of an unusual variant of the mandibular canal wherein a panoramic radiograph ***(Fig. 36)*** indicated the presence of bifurcation of the mandibular canal on the right side and trifurcation of the mandibular canal on the left side of the mandible. The right side showed distinct radiographic images of the canals with separate origins that appeared to join anteriorly to form a single canal in the area below where the 47 would be located. The two canals appeared to be distinct, originating from two separate foramina. The left side of the mandible also displayed an apparent trifurcation of the mandibular canal. The two canals appeared to be distinct, originating from two separate foramina similar to that observed on the right side [37].

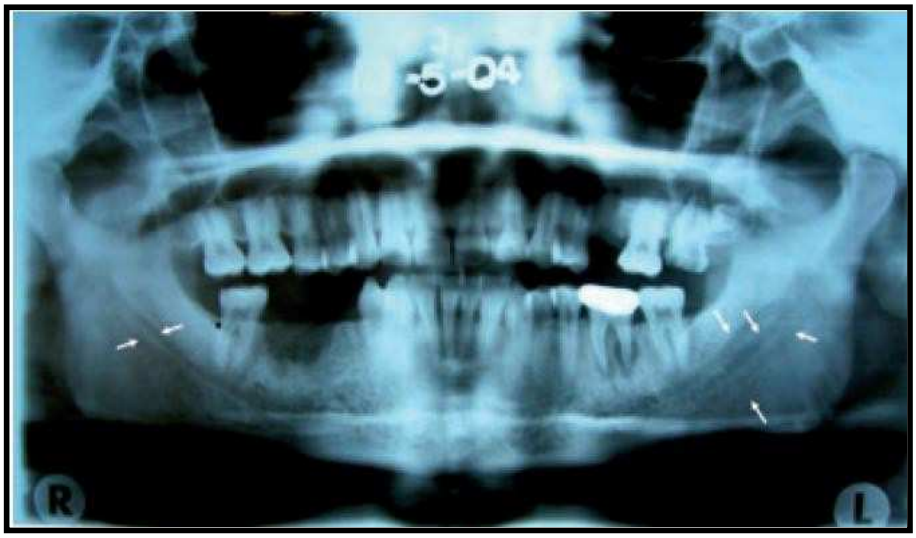


Fig. 36: OPG illustrating the bifid mandibular canal on the rightside and trifurcation on the left side

Mizbah K, Gerlach N, Maal TJ, Bergé SJ, Meijer GJ. (2010) [37] reported a unique case of accessory canals in a patient with a BMC on the right mandible that turned outto be a TMC when further examined using CBCT (**Fig. 37**).

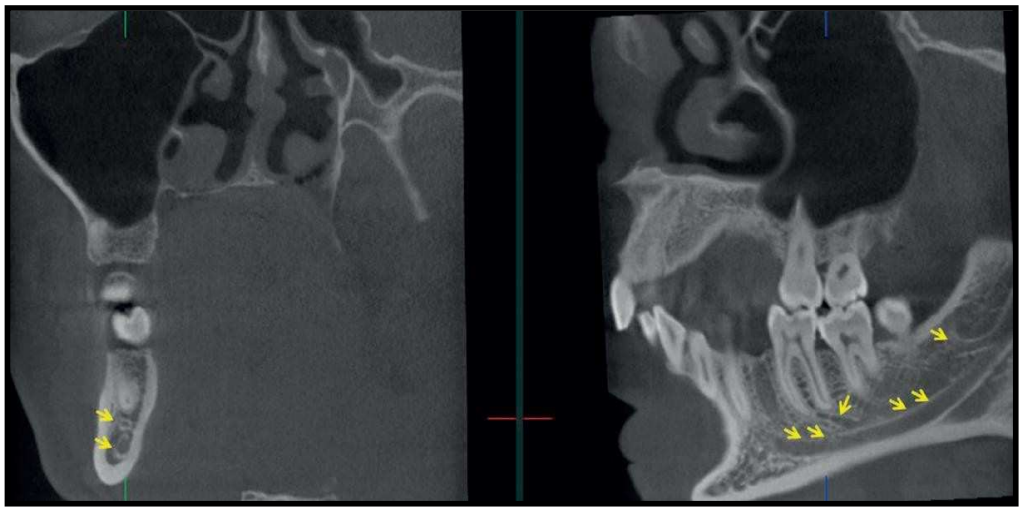


Fig. 37: Sagittal and coronal view of a CBCT image of a 30-year-old man.Arrows show unilateral MC variation described as TMC

Aljunid S, Al Siweedi S, Nambiar P, Chai WL, Ngeow WC. (2016)[38] reported a rare case in which one of the accessory canals in a patient with a TMC became impinged following implant insertion, leading to pain and discomfort.[39]

Borghesi A, Bondioni MP (2020)[40] reported a rare case with CBCT images (***Fig. 38, Fig. 39***) of an unexpected anatomical variant characterized by unilateral triple mandibular canal with double mandibular foramen in a young Caucasian woman.[40]

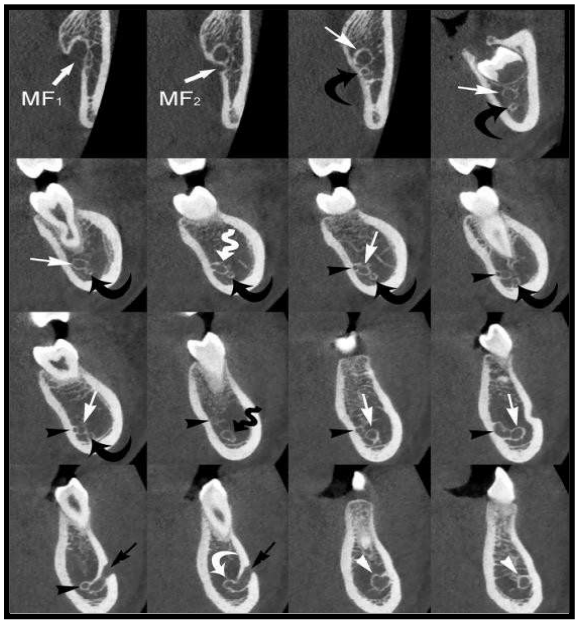


Fig. 38: Cross-sectional CBCTimages show the buccolingual position ofthe three MC (MCmain, AMC1, AMC2).

MCmain – Main Mandibular Canal (whitewavy arrow)

AMC1 – Accessory Mandibular Canal(black arrowheads)

AMC2 – Accessory Mandibular Canal(black curved arrows)

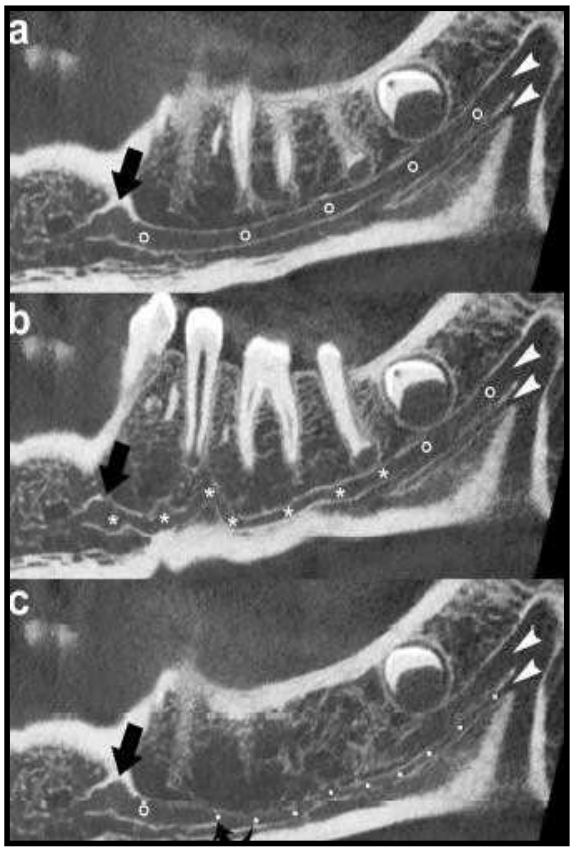


Fig. 39: Pan CBCT images demonstrating the distomesial course of the three MC (MCmain, AMC1, AMC2).(a, c) The intra-mandibular course of MCmain (circles) and AMC2 (dots) forms an upward-facing curve. AMC2 joins MCmain at the level of the 2nd premolar (curved arrow). (b) The intra- mandibular course of AMC1 (asterisks) shows a serpiginous shape in its anteriorportion. AMC1 originated from MCmain at the level of 2nd premolar. Double mandibular foramen is also shown (arrowheads). Large black arrows, mental foramen

CLASSIFICATION OF TRIFID MANDIBULAR CANAL (TMC)

Yang X, Lyu C, Zou D. (2017) [42] used the Naitoh et al. (2009) classification to describe the TMCs. The researchers used narrative descriptions to distinguish TMCs as dual forward, buccolingual, dental or retromolar canals, or a combination of those four variants.

Only ***Rashsuren O, Choi JW, Han WJ, Kim EK.*** [34] have proposed a classification of TMCs. Their five subtypes are:

A. Two accessory canals of the retromolar type;

B. Two accessory canals, one retromolar and one dental;

C. Two accessory canals of the dental type;

D. Two accessory canals, one dental and one forward;

E. Two accessory retromolar canals with two mandibular foramina.

3. CORTICALIZATION OF MANDIBULAR CANAL

Visibility of the MC may vary between patients and even between different areas of the mandible. The canal is usually more readily identified in posterior areas and the visibility tends to decrease gradually towards the mental foramen. Near the mental foramen, the MC has been shown to be "clearly visible" on CBCT cross-sections in around 53% to 65% of the cases. Similarly, clear visibility of the MC in the first molar region may be found in 66%of the cases.

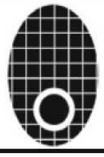
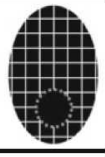
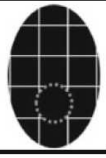
Trabeculation n (% from total hemimandibles)	**Normal** 29 (15%)		**Decreased** 107 (53%)		**Not visible** 54 (27%)		**Increased density** 10 (5%)
Corticalization of Mandibular Canal	**Present**	**Not visible**	**Present**	**Not visible**	**Present**	**Not visible**	**Present**
Schematic representation							
n (% by trabeculation)	23 (79%)	6 (21%)	67 (63%)	40 (37%)	18 (33%)	36 (67%)	10 (100%)

Fig. 40: Association between corticalization of mandibular canal andtrabeculation pattern of the submandibular gland fossa (SGF) region

In a study, performed by ***De Oliveira-Santos C. et al*** [(43)], the diameter of MC was measured on cross-sections in the first molar region, where in 18% of the cases the canal could not be visualized **(*Fig. 40*).** This finding must be interpreted carefully, because only cross-sections were analyzed, and in one specific region. Combination with other views could have helped detect the MC. This demonstrates **the importance of analyzing the different available views when assessing mandibularanatomy [(44)].**

Additionally, bone trabeculation in SGF region, as observed in the above-mentioned study, seems to influence the corticalization of MC. Visibility of the MC in the SGF region may be further affected by the absence of corticalization of the MC, which correlated with decreased bone trabeculation.

Literature search

Arwa Mousa et al (2020)[67] conducted a retrospective study to assess variations in the position of the inferior alveolar canal between males and females as determined by radiographic localization using CBCT. 210 CBCT scans of Egyptian people (18-70 years old) were assessed. 8 linear dimensions were measured to determine the location of the inferior alveolar canal: two for the horizontal localization of the mandibular foramen, two for the vertical localization of the mental foramen (superior and inferior to the mental foramen), and four at the first molar bifurcation for the vertical and horizontal localization of the inferior alveolar canal (superior, inferior, buccal, and lingual to the inferior alveolar canal) (anterior and posterior to the mandibular foramen). Comparative analysis, stepwise logistic regression, and receiver operating characteristic (ROC) curve analysis were used to statistically assess the measurements. Six of the eight tested distances showed statistically significant gender differences. The prediction power was enhanced to 84% by combining these 6 indicators. In the Egyptian population, there were considerable sex-specific differences in the position of the inferior alveolar canal.

Trustiya Tudtiam et al. (2019)[68] conducted a study to measure the distance between the impacted mandibular third molar (IMTM) and the inferior alveolar canal (IAC). Using panoramic radiographs and CBCT on 90 male and female subjects (45 each) with bilateral impacted mandibular third molars at a mean age of 27 years, measuring the widths of the

mandible, buccal bone, IAC, lingual bone, height of the IAC, the height of the alveolar bone, and the distance from the lowest part of the IMTM to the superior border of the canal. The Mann-Whitney U test and independent samples t-test were used in statistical analysis to determine whether there was a gender difference. At a P value of 0.05, the Wilcoxon signed-rank test and the paired t-test were used to compare the two sides. Male and female patients had different mandibular widths, IAC widths, and IAC heights. In terms of width and height, the IAC in men had a significantly larger diameter than in women.

Thiago de Oliveira Gamba et al (2014)[59] conducted a study to evaluate sexual dimorphism by locating the mandibular canal in images of cone-beam computed tomography (CBCT) on 160 Brazilian individuals (74 men and 86 women), aged between 18 and 60 years. In the CBCT images 8 measurements were taken from the CBCT images: the distances between the mandibular foramen and the most anterior and posterior parts of the ramus, the upper channel's distance from the alveolar ridge of the mandible, the upper channel's distance from the bottom of the mandibular canal, the channel's distance from the mandibular alveolar ridge (lingual), and the channel's distance from the mandibular alveolar ridge (buccal), distance from the mental foramen to the top of the alveolar ridge and base of the mandible. The binary logistic regression model was created to predict the sex and was used to test whether there were differences in the mean values of the eight measurements that were used amongst males and females. 4 parameters demonstrated better sex estimation among the evaluated variables. Except for one, none of the measurements revealed statistically significant gender differences. Thus, forensic dentistry can use the formula created in this study for sexual dimorphism.

Jacqueline S. Angel et al (2011)[69] conducted a study to determine the influence of age and sex on the relative position of the inferior alveolar canal and its foramina in cone-

beam computed tomography (CBCT). Random 165 CBCTs were selected from ages 18-80 years (110 women and 55 men). The following measurements were made at each location: the superior and inferior positions of the mental foramen in the coronal view; the superior and inferior positions of the mandibular foramen in the axial view; and the buccal and lingual positions of the inferior alveolar canal at the crest of the inter-radicular bone at the mandibular first molar. The variables were analyzed using regression analysis to examine the effects of age and sex. Overall, the findings showed that regardless of age or gender, the relative location of the inferior alveolar canal and associated foramina in adults remains fairly constant.

Gloria Cartes et al (2018)[70] conducted a descriptive, retrospective, cross-sectional study to analyze the Mandibular Canal Course and the Position of the Mental Foramen by Panoramic X-Ray in Chilean Individuals. 442 panoramic X-rays, (262 females and 180 males) were examined. Of the 262 females, 191 were aged between 18 and 34 years, 71 were aged over 35 years; of the 180 males, 145 were aged between 18 and 34 years, and 35 were aged over 35 years, Vertical linear measurements, the relationship between the MC and the roots of the mandibular teeth, and the position of the MF in relation to the inferior premolar roots (MCR). MF typically lies below the inferior second premolar apex in older people and between the first and second premolar apices in younger people. MC was in close proximity to the third molar, and neither gender nor age had an impact on this relationship. The analysis of distances revealed symmetry and clear gender differences, with males showing larger values than females. Age, however, did not appear to have much of an impact on these measurements. Different ethnic groups take different MC courses.

Sura A. Rashid et al (2011)[71] evaluated the validity of the linear measurements related to the mental and mandibular foramina vertical positions on digital panoramic images

in sex determination. A total of 300(150 male,150 female) Iraqi subjects in the age group 20-49 were examined. 4 linear vertical measurements were performed on the radiographic image on both the right and left sides of the mandible (600) sides, to assess the reliability of the linear measurements used to determine sex that is related to the vertical positions of the mandibular and mental foramina. SPSS (Statistical Package for Social Sciences) samples were used in computer-assisted statistical analyses, which resulted in Males having almost higher measurements than females in all of the linear measurements where there are significant differences between the sexes. Measurements made in this study could successfully determine the patient's sex.

Jay D. Simonton et al (2009) [72] evaluated the differences in the relative location of the inferior alveolar nerve (IAN) compared with the roots of the mandibular first molar in the predictability of gender or age. 200 (100 male, 100 female) patients between 30–69 years of age; A total of 14 measurements were made at the IAN, the mesial root apices, and the distal root apices. Age and sex-based 2-way analysis of variance with the Bonferroni post hoc test were used to analyze the data. The total width of the mandibular bone at the mesial and distal apices was significantly shorter in females, regardless of age, both horizontally and vertically from the IAN. Additionally, from the third to the sixth decade of life, the mandibular bone's overall width decreased in both sexes. According to the study's findings, females have significantly smaller horizontal mandibular bones than males and the root apices are significantly closer to the IAN in females.

Marci H. Levine et al (2006) [23] conducted a cross-sectional study to determine patient factors related to the position of inferior alveolar nerves (IAN) in dentate patients and to document an IAN position that is clinically relevant. mandibular axial computed tomography was enrolled. The 3 measurements were made at the position of the mandibular

first molar furcation (linear distances between the buccal aspect of the IAN canal and the outer buccal cortical margin of the mandible, and the superior aspect of the IAN canal and the alveolar crest). To evaluate the correlations between the predictor and outcome variables, bivariate statistics were computed. Multiple linear regression techniques were used to develop an adjusted model assessing the relationships between the two. The results indicated that older patients and white patients have a closer relationship between the buccal aspect of the nerve canal and the mandibular buccal border.

Avinash Kavarthapu et al (2018)[73] conducted a study in the South Indian population to evaluate the course and position of IAN in relation to the alveolar crest, buccal cortical bone, lingual cortical bone, and inferior border of the mandible using CBCT. A total of 139 (106 males and 33 females) CBCT scans were assessed in the age group of 15–75 years. 4 Sectional images were measured using the tools provided in the Sirona Galaxis Galileos Viewer Version 1.9 software from Sirona dental systems, GmbH, Bensheim, Germany. A two-way analysis of variance was used to analyze the data that had been obtained (ANOVA). IAN was positioned inferiorly in males compared to females and displayed a wavy pattern from posterior to anterior in relation to the alveolar crest. Females displayed more bone near the first molar region's lingual nerve.

Madhiha Khalid et al (2020)[74] conducted an observational study to evaluate the radiographic location of the inferior alveolar canal and its correlation with gender and age. 70 Radiographs with the presence of the First molar, first and second premolars, and canines were considered in the age group above 18 years. The data was entered into a self-made proforma and analyzed using the SPSS 20th version. Age and gender had no statistically significant impact on how the inferior alveolar nerve appeared.

Rachna Rath et al (2022)[75] performed a retrospective study to determine the relative position of the IAC at three different locations in the mandible to assess sex differences in an eastern Indian population. A total of 120 CBCT of dentate individuals, 60 males and 60 females, with ages ranging from 18 to 60, had taken. 10 measurements concerning the mandibular canal were made (8 in coronal and 2 in axial slices) at 3 landmarks. Calculated descriptive statistics included mean and standard deviation. Mean difference and the Unpaired Student's t-test was used to compare study variables between genders. Except in two areas, males had higher mean values than females. In an adult population of eastern Indians, sexual dimorphism can be seen in the relative position of the mandibular canal and its associated foramina.

Hooman Khorshidi et al (2017)[76] conducted a cross-sectional study to investigate the anatomic location and radiographic course of the mandibular canal compared to anatomic landmarks on CBCT and to determine correlations between the position and the age. 242 CBCT (99 males and 143 females) were selected. To compare the gender differences in the mean distance from the mandibular canal to the mandibular cortices, the location of the canal was assessed in 4 different regions. SPSS software version 15 was used to analyze the data. To assess the relationship between gender and the relative position of the IAN canal, a student t-test was used. In both vertical and horizontal dimensions, the mean bone thickness of the female group was significantly lower than that of the male group. A significant correlation existed between the anatomic course of the canal and gender.

Kyung-Hwan Kwon et al (2012)[77] conducted a study using cone beam computed tomography to assess the path of the inferior alveolar canal in the mandibular ramus. The plane of a line connecting the mandibular foramen and the mental foramen and the vertical to the occlusal plane was set as the sagittal plane in 20 CBCT (9 men and 11 women) all older

than 19 years. To determine the closest distance from the exterior of the cortical bone to IAC, the mandibular foramen and mental foramen were located in the trabecular bone. 5 measurements were assessed. Using SPSS for data analysis, the independent t-test was run to check the statistical significance of differences in length based on gender and both sides of the arch. The findings were considered statistically significant.

Esraa A. Elmekkawy et al (2020)[78] conducted a retrospective study to assess the role of cone beam computed tomography (CBCT) in gender determination through the measurements of the location of the mental foramen in the Egyptian population. 200 CBCT (100 males and 100 females) between the ages of 18 and 60. Two measurements were taken for the mental foramen of the right side, with the results used to compare gender differences. The student t-test was used to evaluate their differences. The statistical program IBM SPSS was used to analyze the data. Based on this study, it is possible to draw the conclusion that in the studied sample of the Egyptian population, there was sexual dimorphism in the distances between the superior and inferior borders of the right side's mental foramen and the lower border of the mandible.

Messina Ebogo et al (2021)[79] conducted a retrospective study on a population of Cameroonian people to determine the morphometric features of the mandibular foramen as a characteristic of sex. Between the ages of 13 and 69, 105 cerebral CT-Scans (78 men and 27 women) were performed. In relation to gender, 5 distances from the MF were measured. Software Radiant DICOM Viewer was employed for the evaluation. Using SPSS version 24 software, the intra- and inter-examiner agreement of the results was evaluated using Cohen's kappa test. According to the distribution law, the Student's T test or the Mann-Whitney test was used to examine the relationship between a binary qualitative variable and a quantitative variable. According to statistics, males had higher results for all 5 measurements than females.

Michał Puciło et al (2021)[80] 300 CBCTs of patients aged between 20 and 79 years old (167 women and 133 men) were examined. On coronal CBCT images, the horizontal and vertical distances between dental root apices and the internal border of the MC were measured. The Pythagorean formula was then used to calculate the actual distance. The Mann-Whitney test was used to determine whether differences between men and women were statistically significant. The Spearman rank correlation coefficient was used to assess correlations with patient age. Men measured mean distances were greater than those of women. The measured distances and age had a positive correlation.

Malabika Shil et al (2022)[81] retrospective cross-sectional study was done to analyze sexual dimorphism by identifying the relative location of the mandibular canal and the mandibular and mental foramina using cone beam computed tomography images in a sample of south Indian inhabitants. 120 CBCT images (60 males and 60 females) with an age range of 20-60 years. 8 measurements were performed (6 in the coronal and 2 in the axial view). A student's t-test was used to compare the variables between the genders. With the exception of one measurement, the mean values of all the measurements were higher in men. Version 21 of SPSS was used for the statistical analysis. All predictors underwent an analysis using a linear discriminant function. To determine which predictor can discriminate between genders, Wilk's lambda and the F test were performed. For both men and women, a canonical discriminant function coefficient was obtained at an average discriminant score for all measurements and functions. Gender could be predicted by all eight predictors in a significant way.

Fahrettin Kalabaliket et al (2019)[82] conducted a retrospective cone-beam computed tomography study on 300 (148 males and 152 females) Turkish patients with ages ranging from 15 to 74 years to identify the mandibular canal's location at the mental foramen region.,

At a distance of 2 mm from the mental foramen, the mandibular canal was measured at 4 locations. The SPSS v.22 (SPSS Inc, IBM, USA) was used for the statistical analysis. The means and standard deviations for each measurement were calculated using descriptive statistics for both sides and gender. The t-test for independent samples was used to determine gender differences and differences between the left and right sides. At the location of the mental foramen, the mandibular canal was situated vertically closer to the inferior cortical border and horizontally closer to the lingual cortical border of the mandible. On both left and right sides, 3 measurements were significantly larger in males than in females.

METHODOLOGY

SOURCE OF DATA: The present study was a retrospective study where in 226 CBCT scans of North Karnataka population based on the demographic details of the subjects were retrieved from the database of the Department of Oral Medicine and Radiology KLE VK Institute of Dental Sciences.

METHOD OF COLLECTION OF DATA: The study group included 226 CBCT scan images (113 males and 113 females) in the age range of 18-60 years fulfilling the inclusion and exclusion criteria.

ARMAMENTARIUM

1. Dentsply Sirona Axeos CBCT machine. (Fig. 41)
2. Electronic caliper inbuilt in Sidexis 4 Galileos Implant software (Fig. 44)
3. Guideline sheet depicting the parameters to be measured.
4. Scoring sheet for recording the observations.

SELECTION CRITERIA:

Inclusion criteria:

1. CBCT scans in the age group of 18-60 years.
2. CBCT scans showing full extension of the dentate mandible.
3. CBCT scans with presence of premolar & first molar.
4. Mandibular CBCT scans with normal alveolar bone height or mild bone loss (up to 3mm).

Exclusion criteria:

1. Radiographs revealing displaced fracture of the body, angle and ramus of the mandible.
2. Radiographic evidence of diseases and anomalies causing deformities.
3. Poor quality radiographs (blurred image, motion artifacts, low resolution)

METHOD: The study was conducted in the Department of Oral Medicine and Radiology of KLES Vishwanath Katti Institute of Dental Sciences, Belagavi.

CBCT images were retrieved from the database of the Department of Oral Medicine and Radiology of KLES Vishwanath Katti Institute of Dental Sciences, with a voxel size of 0.2 mm, and a field of view of 8 cm×8 cm and above using Dentsply Sirona Axeos CBCT machine. A total sample of 226 CBCT scans (113 males and 113 females) belonging to the age group of 18-60 years were randomly selected.

A. Radiographic Technique

The CBCT images were acquired using a Dentsply Sirona Axeos CBCT machine with the following protocol: a peak kilovoltage of 85kVp, a current of 10-12 mA, a voxel size of 0.2 mm, and a field of view of 8 cm×8 cm and above. According to the manufacturer's instructions, all images were obtained with patients standing in an upright position, with the head adjusted using the machine's head support aids and with the use of system light localizers to ensure that the midsagittal plane was vertically oriented and the occlusal plane was perfectly horizontal.

Only scans that included the full extension of the mandible, had no evidence of bone fractures or pathological lesions and showed at least the premolars and first molars were selected. Moreover, only scans with normal alveolar bone height or mild bone loss (<3 mm from the cementoenamel junction) were accepted.

The Sidexis 4 Gallileos Implant software was used for the reconstruction and measurement of the included scans. The measurements were made on coronal, sagittal and axial orthogonal planes of the scan after selecting the smallest slice thickness of 0.2mm.

Fig 41. Dentsply Sirona Axeos CBCT scan machine

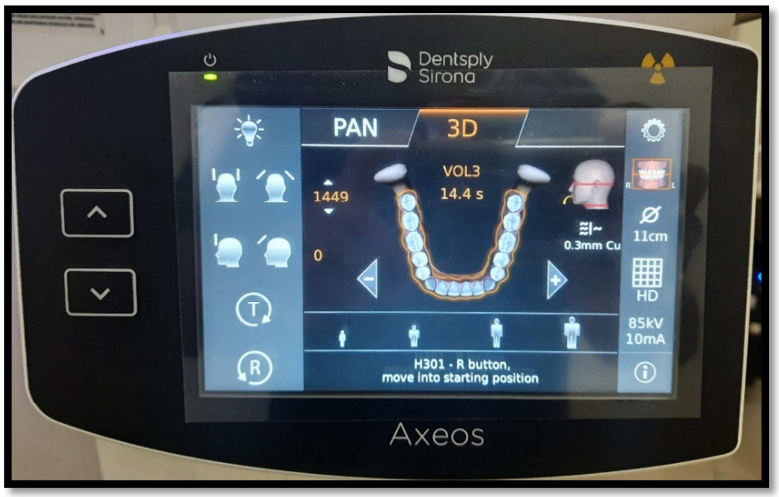


Fig 42. Control panel

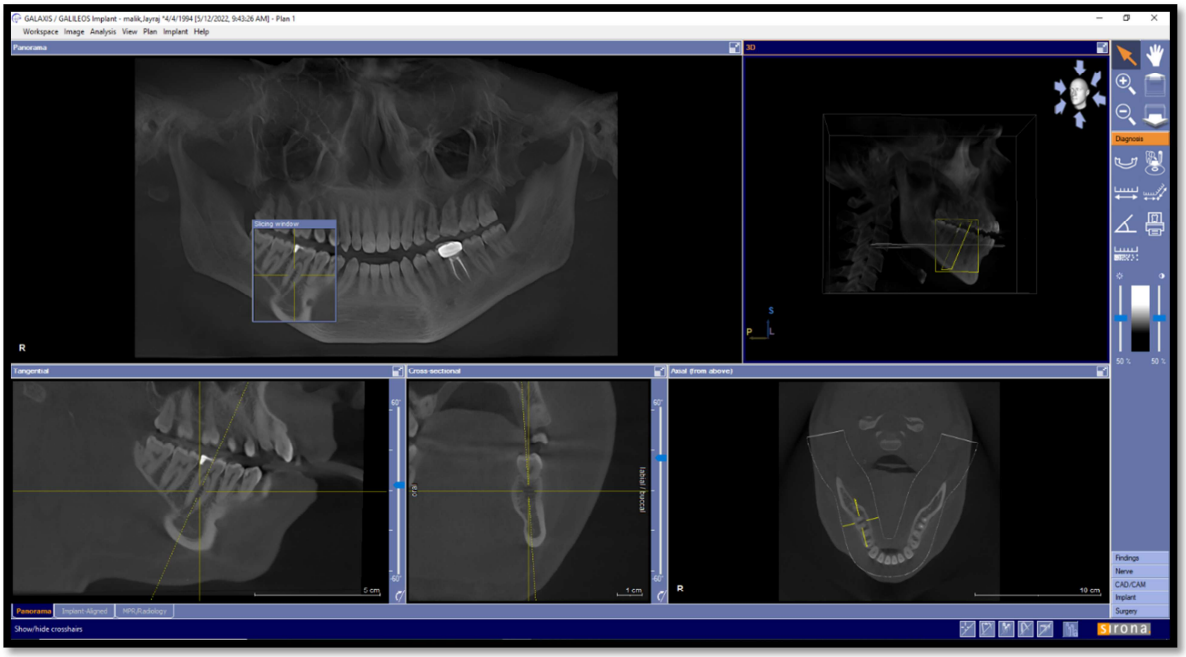


Fig 43. 3D Images viewed in the software in different planes

B. Measurements of Inferior alveolar nerve canal

The CBCT scans were arranged according to the study requirements and were provided for analysis without the demographic details of the subjects. The measurements were performed by two radiologists twice at an interval of 10 days in order to avoid inter-observer and intra-observer bias. In case of difference in the measurement, mean value was obtained for increased accuracy.

Fig 44. Measurement tool inbuilt in the software

The measurements were performed by the radiologists on DICOM images using the sliding electronic caliper inbuilt into the software. The assessment of the location of the inferior alveolar canal was guided by the same eight linear measurements and their abbreviations on either side of the mandible as follows.

For horizontal localization of the mandibular foramen, two measurements were made on the CBCT axial image that showed the maximum width of the mandibular foramen. First, the distance from the most anterior point of the mandibular foramen to the most anterior part of the mandibular ramus was measured (Fig. 45) and recorded as the anterior mandibular foramen (AMAF).

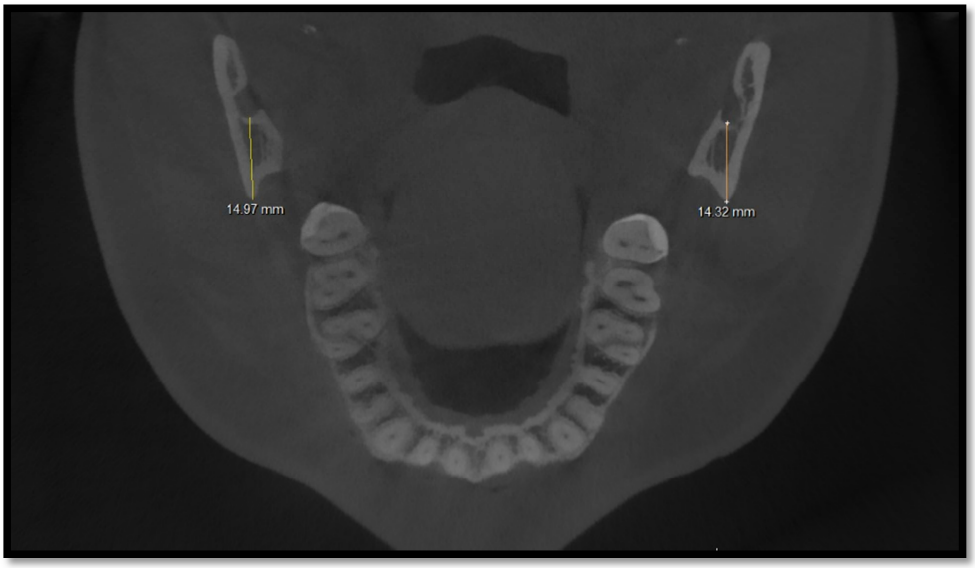


Fig 45. AMAF (anterior mandibular foramen) The distance from the most anterior point of the mandibular foramen to the most anterior part of the mandibular ramus.

Then, the distance from the most anterior point of the mandibular foramen to the most posterior part of the ramus was measured (Fig. 46) and recorded as the posterior mandibular foramen (PMAF).

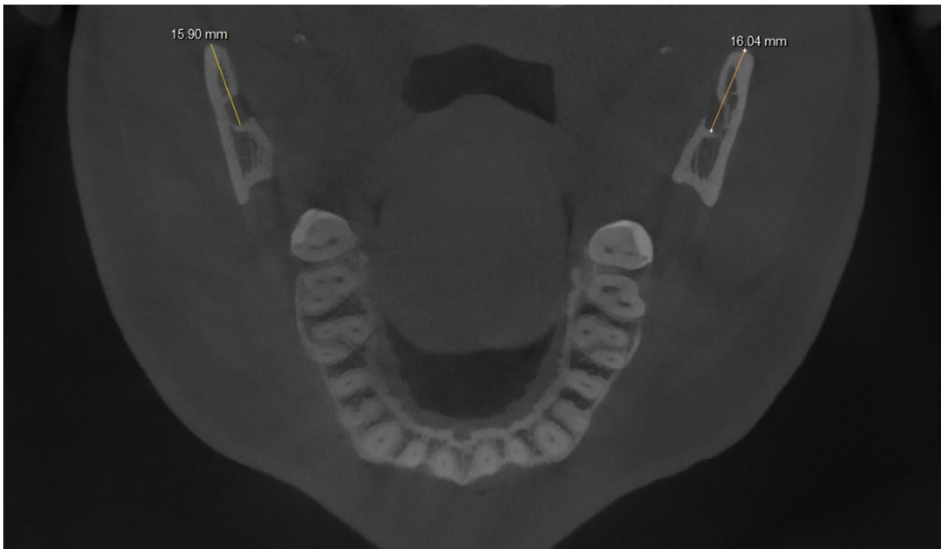


Fig 46. Showing PMAF (posterior mandibular foramen) The distance from the most anterior point of the mandibular foramen to the most posterior part of the ramus.

For vertical and horizontal localization of the inferior alveolar canal, four measurements were done on the CBCT coronal cut section at the region of the first molar bifurcation.

The first measurement was the distance from the most superior point of the inferior alveolar canal to the midpoint of the alveolar ridge crest (Fig. 47), which was recorded as the superior inferior alveolar canal (SIAC).

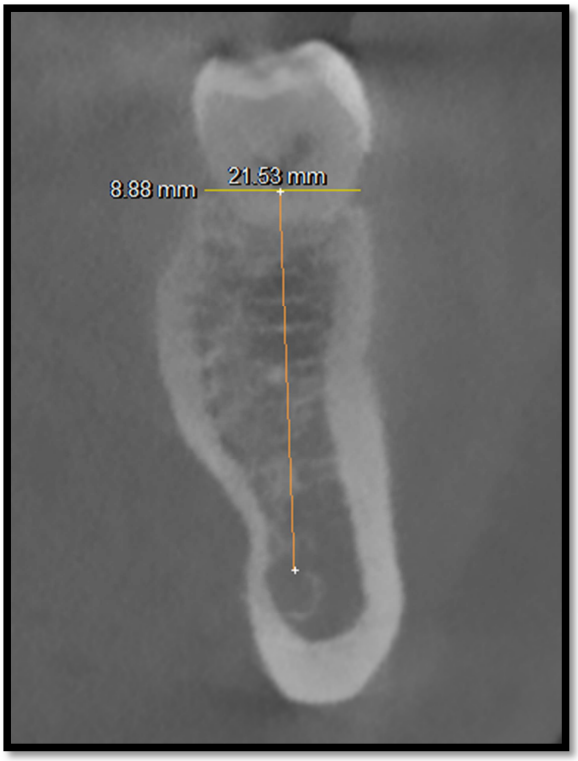


Fig 47. SIAC (superior inferior alveolar canal) The distance from the most superior point of the inferior alveolar canal to the midpoint of the alveolar ridge crest.

The second was the distance from the most inferior point of the inferior alveolar canal to the lowest point of the inferior border of the mandible (Fig. 48), termed the inferior inferior alveolar canal (IIAC).

Next was the distance from the most lingual point of the inferior alveolar canal to the mandibular lingual cortical plate (Fig. 49), which was recorded as the lingual inferior alveolar canal (LIAC).

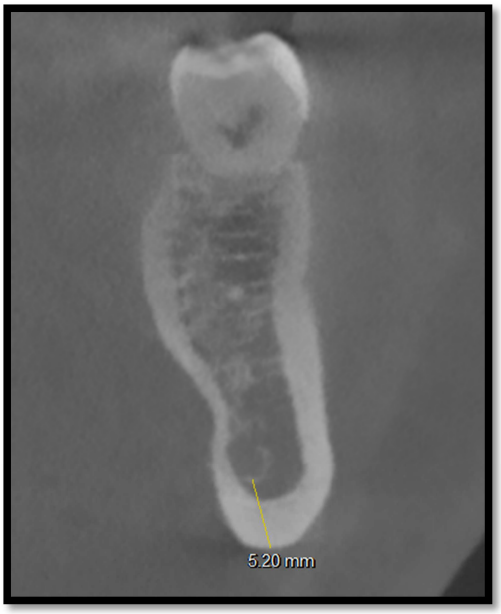


Fig 48. IIAC (inferior inferior alveolar canal) The distance from the most inferior point of the inferior alveolar canal to the lowest point of the inferior border of the mandible.

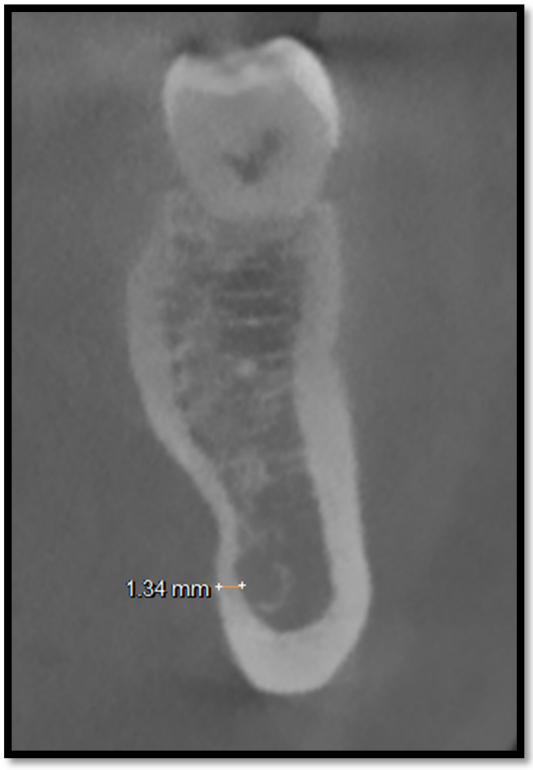


Fig 49. LIAC (lingual inferior alveolar canal) The distance from the most lingual point of the inferior alveolar canal to the mandibular lingual cortical plate.

The last measurement was the distance from the most buccal point of the inferior alveolar canal to the mandibular buccal cortical plate (Fig.50), defined as the buccal inferior alveolar canal (BIAC).

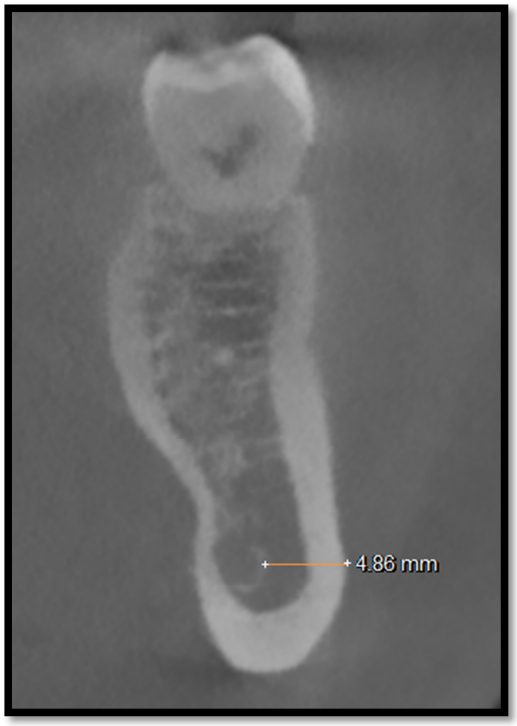


Fig 50. BIAC (buccal inferior alveolar canal) The distance from the most buccal point of the inferior alveolar canal to the mandibular buccal cortical plate.

For vertical localization of the mental foramen, two measurements were taken on the coronal cut on which the mental foramen was the widest.

The first was the distance from the most superior point of the mental foramen to the midpoint of the alveolar ridge crest (Fig. 51), recorded as the superior mental foramen (SMEF), and the second was the distance from the most inferior point of the mental foramen to the lowest point of the inferior border of the mandible (Fig. 52), termed the inferior mental foramen (IMEF).

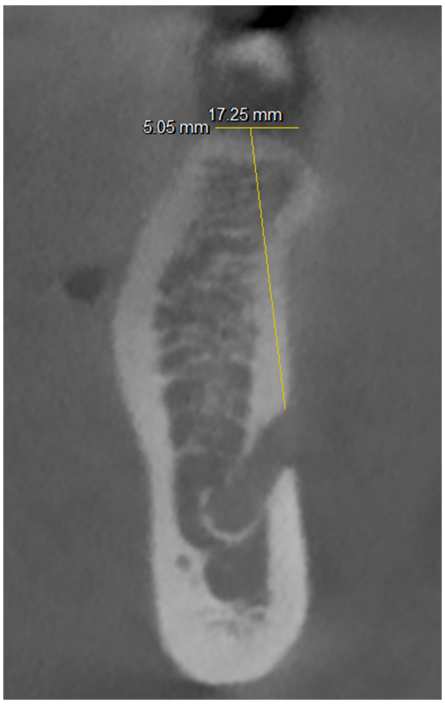


Fig 51. SMEF (superior mental foramen) the distance from the most superior point of the mental foramen to the midpoint of the alveolar ridge crest.

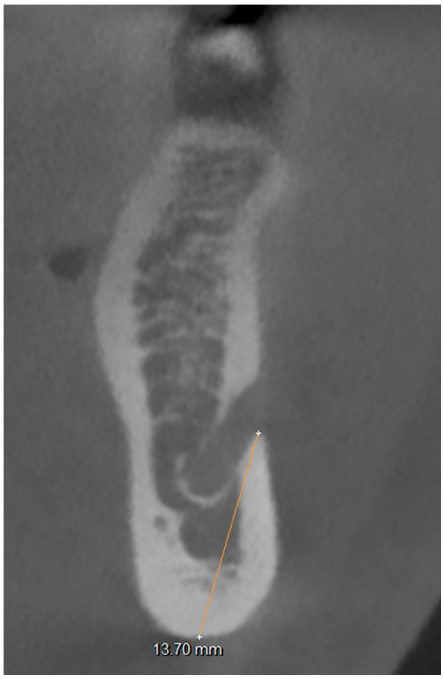


Fig 52. IMEF (inferior mental foramen) the distance from the most inferior point of the mental foramen to the lowest point of the inferior border of the mandible.

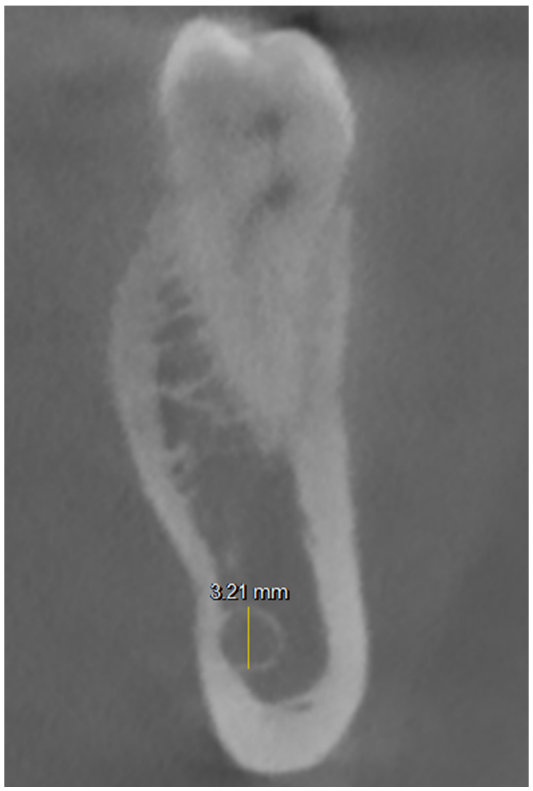


Fig 53. SC-IC (supero-inferior dimensions of IAC) the distance from the most superior point of the IAC to the most inferior point at first molar furcation area.

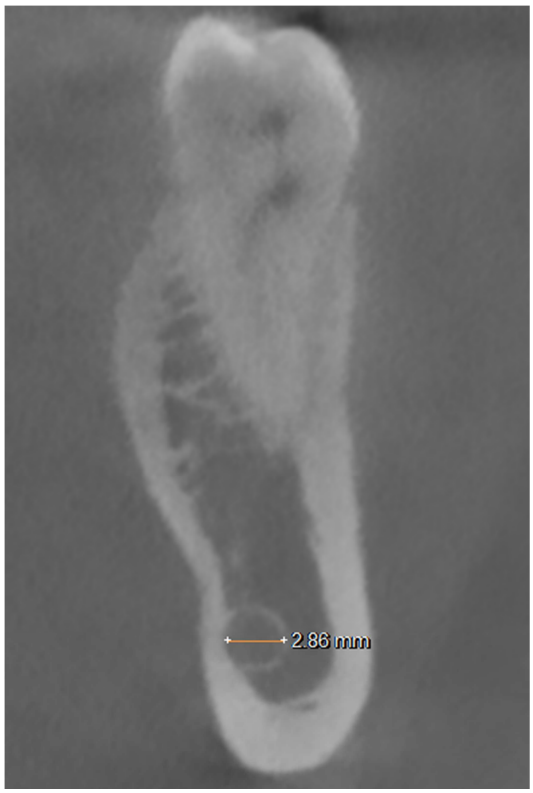


Fig 54. BC-LC (bucco-lingual dimensions of IAC) the distance from the most buccal point of the IAC to the most lingual point at first molar furcation area.

To evaluate the dimensions of the IAC, two measurements were taken on the coronal cut at the point of the first molar furcation area, Bucco-lingually (BC-LC) (Fig. 53) and Supero-inferiorly (SC-IC) (Fig. 54).

The IAC was marked and vertical and horizontal reference planes were traced.

To assess reliability, 94 scans (47 of female and 47 of male participants, representing 30% of the total sample) were evaluated once by the first observer and once by a second observer, who had >15 years of experience in oral and maxillofacial radiology.

Prior to image analysis, the personal data on all scans was concealed and coded, and a master chart (consisting of each scan code with its associated personal data) was made and sealed by the technician who was unaware of the image assessment procedures. Each observer evaluated the scans separately and the results obtained were not discussed by the observers to maintain blinding.

STASTISTICAL ANALYSIS

The results obtained were tabulated and statistically analysed using STATA statistics/ Data analysis 15.0 special edition software. The mean and standard deviation (SD) were calculated for each parameter in both sexes. Intraobserver and Interobserver reliability was assessed using intraclass correlation coefficients (ICCs) with 95% confidence intervals. The Shapiro–Wilk test was used to check whether the measured variables were normally distributed. Kruskal Wallis test was done to compare the different variables and the significance of the sex differences in the mandibular parameters was assessed using the Mann–Whitney U test. Univariate discriminant function analysis (DFA) was performed to develop a model for sex determination based on individual mandibular measurements. The diagnostic accuracy of the studied linear measurements as sex predictors was tested using ROC curves and ROC area under the curve.

RESULTS

This retrospective observational study was carried out at the Oral Medicine and Radiology Department of the KLE VK Institute of Dental Sciences, Belagavi-Karnataka. The source of the data was retrospective CBCT scans obtained from the Oral Medicine & Radiology Dept. This included a total of 226 CBCT images (113 males and 113 females) between the age group 18-60 years at the time of examination.

CBCT scans were collected and grouped according to the genders. All the measurements were recorded in millimeters up to two decimals. The values derived were tabulated as shown in the Master Charts (Annexure II) and subjected to statistical analysis using STATA statistics/ Data analysis 15.0 special edition software. Bilateral measurements were noted in each CBCT scan and shown in a tabular form.

Normality tests:

Shapiro Wilk test was performed to check the normality of the data which revealed that the data was not normally distributed.

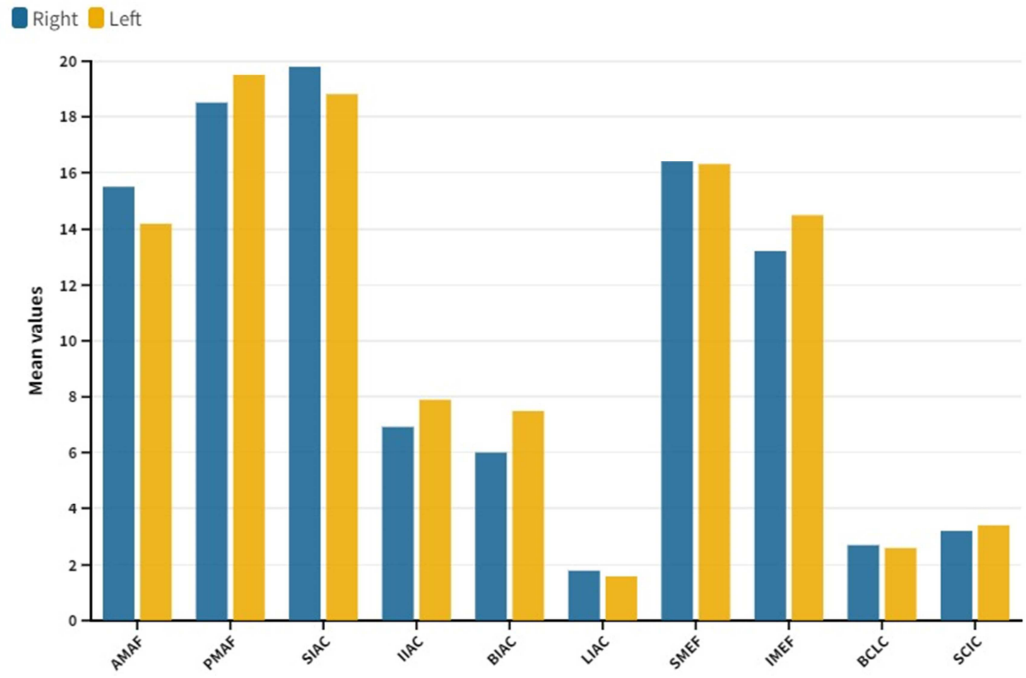
Table 4: Descriptive measures of variables and normality test

Variable	Males				Females				Shapiro Wilk	
	Mean	Std. Dev	Median	Range	Mean	Std. Dev	Median	Range	W	p
AMAF_R	15.5	1.2	15.7	13 – 18.7	14.7	0.6	14.9	13.1 – 16.3	0.95	<0.0001
PMAF_R	18.5	1.4	18.7	15.4 – 22.5	16.2	1.1	15.6	14.2 – 19.8	0.94	<0.0001
SIAC_R	19.8	1.6	20.1	15 – 21.9	15.3	1.7	15	3.9 – 19.6	0.9	<0.0001
IIAC_R	6.9	1.1	7.3	3.4 – 8.7	5.2	0.8	5.0	4.0 – 8.7	0.93	<0.0001
BIAC_R	6.0	0.6	6.0	4.7 – 9.1	6.0	0.9	6.1	3.5 – 8.2	0.86	<0.0001
LIAC_R	1.8	0.3	1.9	1 – 2.8	1.6	0.3	1.7	1.3 – 3.2	0.89	<0.0001
SMEF_R	16.4	1.7	16.8	12.2 – 18.9	13.3	1.6	13.3	11.1 – 18.7	0.94	<0.0001
IMEF_R	13.2	0.7	13.1	12.2 – 17.0	13.2	1.2	13.3	10.0 – 14.9	0.95	<0.0001
BCLC_R	2.7	0.3	2.8	2.2 – 3.8	2.6	0.2	2.6	2.2 – 3.1	0.96	<0.0001
SCIC_R	3.2	0.2	3.2	2.7 – 4.2	3.5	0.5	3.6	2.0 – 4.7	0.95	<0.0001
AMAF_L	14.2	1.3	13.8	12.4 – 18.6	14.1	0.8	13.7	12.2 – 17.9	0.66	<0.0001
PMAF_L	19.5	1.3	19.7	13.6 – 21.5	16.7	1.2	16.8	12.5 – 18.5	0.98	0.00302
SIAC_L	18.8	1.3	19.2	15.8 – 20.8	15.5	2.8	14.7	11.0 – 20.7	0.9	<0.0001

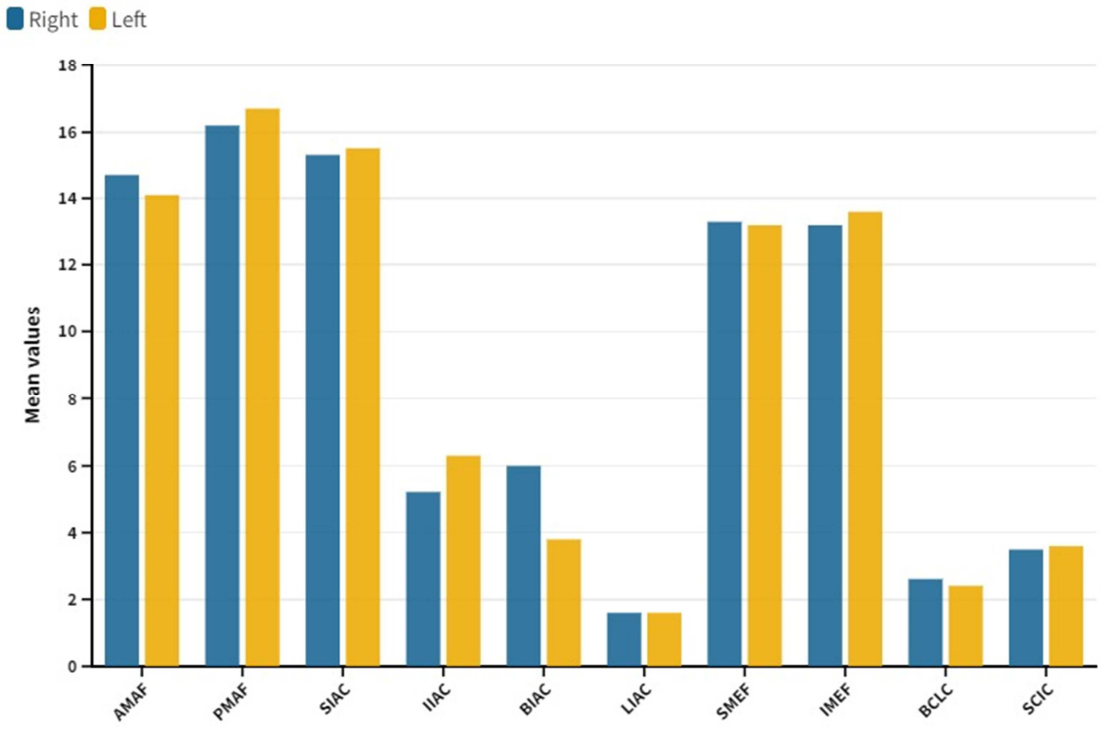
IIAC_L	7.9	1.4	8.2	4.9 – 9.9	6.3	1.1	6.2	4.3 – 9.9	0.95	<0.0001
BIAC_L	7.5	1.4	7.6	4.4 – 9.9	3.8	1.2	3.8	1.2 – 6.4	0.96	<0.0001
LIAC_L	1.6	0.3	1.6	1.1 – 2.8	1.6	0.4	1.5	0.9 – 2.8	0.92	<0.0001
SMEF_L	16.3	1.5	16.6	12.6 – 18.9	13.2	2.3	12.3	10.9 – 19.9	0.93	<0.0001
IMEF_L	14.5	0.9	14.6	11.9 – 21.3	13.6	1.5	13.8	8.3 – 16	0.79	<0.0001
BCLC_L	2.6	0.4	2.8	0.4 – 3.2	2.4	0.2	2.4	2.0 – 3.1	0.88	<0.0001
SCIC_L	3.4	0.4	3.5	2.2 – 3.9	3.6	0.3	3.7	2.8 – 3.9	0.90	<0.0001

The p-value for the test was found to be less than 0.05, hence the non-parametric tests were performed.

The mean values of the parameters AMAF_R, PMAF_R, SIAC_R, IIAC_R, LIAC_R, SMEF_R, BCLC_R, AMAF_L, PMAF_L, SIAC_L, IIAC_L, BIAC_L, LIAC_L, SMEF_L, IMEF_L, BCLC_L were higher in males than in females. Whereas the parameters BIAC_R, SCIC_R, and SCIC_L were found to be higher in females than in males and the mean of IMEF_R was found to be equal in both genders. Additionally, all of the linear measurements have shown statistically significant differences between males and females.



Graph 2: Mean values for right and left parameters for males



Graph 3: Mean values for right and left parameters for females

Kruskal Wallis test

Table 5: Comparison of parameters

Variable	χ^2	P value
AMAF_R	46.2	0.0001
PMAF_R	105.7	0.0001
SIAC_R	144.9	0.0001
IIAC_R	102.7	0.0001
BIAC_R	4.9	0.0271
LIAC_R	13.2	0.0003
SMEF_R	10.3.3	0.0001
IMEF_R	0.8	0.3679
BCLC_R	23.4	0.0001
SCIC_R	44.2	0.0001
AMAF_L	0.01	0.918
PMAF_L	134.6	0.0001
SIAC_L	68.5	0.0001
IIAC_L	55.4	0.0001
BIAC_L	156.1	0.0001
LIAC_L	1.3	0.2609
SMEF_L	92.3	0.0001
IMEF_L	25.6	0.0001
BCLC_L	32.2	0.0001
SCIC_L	17.1	0.0001

Kruskal Wallis test was done to compare the different variables and it was found that BIAC_R, IMEF_R, AMAF_L, and LIAC_L were statistically insignificant.

Comparison of Pair-wise parameters by gender

Table 6: Mann-Whitney U test (Female to male)

Variable	z	P value
AMAF_R	-6.8	0.000
PMAF_R	-10.3	0.000
SIAC_R	-12.0	0.000
IIAC_R	-10.1	0.000
BIAC_R	2.2	0.027
LIAC_R	-3.6	0.0003
SMEF_R	-10.2	0.000
IMEF_R	0.9	0.367
BCLC_R	-4.8	0.000
SCIC_R	6.7	0.000
AMAF_L	-0.1	0.918
PMAF_L	-11.6	0.000
SIAC_L	-8.3	0.000
IIAC_L	-7.4	0.000
BIAC_L	-12.5	0.000
LIAC_L	-1.1	0.260
SMEF_L	-9.6	0.000
IMEF_L	-5.1	0.000
BCLC_L	-5.7	0.000
SCIC_L	4.1	0.000

The Mann-Whitney U test was used to compare the parameters between males and females. The results showed a statistically significant difference in the total of 17 parameters between males and females ($p < 0.001$) and parameters, IMEF_R, AMAF_L, and LIAC_L revealed statistically insignificant results with a p-value> 0.05.

Table 7: Significant multivariate Effects for gender (Wilks' lambda)

Test of functions	Wilks' Lamda	df	Sig.
1	0.1375	1	<0.0001

Table 8: Significant univariate Effects for gender [MANOVA univariate test]

Variable	W	p-value
AMAF_R	0.9	<0.0001
PMAF_R	0.6	<0.0001
SIAC_R	0.4	<0.0001
IIAC_R	0.6	<0.0001
BIAC_R	1.0	0.8962
LIAC_R	1.0	0.6005
SMEF_R	0.5	<0.0001
IMEF_R	1.0	0.7864
BCLC_R	0.9	<0.0001
SCIC_R	0.9	<0.0001
AMAF_L	1.0	0.3914
PMAF_L	0.4	<0.0001
SIAC_L	0.6	<0.0001
IIAC_L	0.7	<0.0001
BIAC_L	0.3	<0.0001
LIAC_L	1.0	0.1866
SMEF_L	0.6	<0.0001
IMEF_L	0.9	<0.0001
BCLC_L	0.9	<0.0001
SCIC_L	0.9	0.0001

Screening tests were conducted to determine which variables should be included in a logistic regression model for sexual differentiation, and accordingly, 15 linear mandibular measurements were included in the final model.

Out of 20 parameters, 15 parameters were significant (Table 8), thus discriminant analysis was conducted to measure the accuracy among these parameters.

Discriminant analysis:

Table 9: Standardized canonical discriminant function coefficients

Variable	Function 1 (Overall)	Function 1 (Left side)	Function 1 (Right side)
AMAF_R	-0.04		-0.11
PMAF_R	-0.16		-0.19
SIAC_R	-0.27		-0.66
IIAC_R	-0.19		-0.38
SMEF_R	-0.10		-0.17
BCLC_R	-0.02		-0.05
SCIC_R	-0.08		-0.13
PMAF_L	-0.14	-0.28	
SIAC_L	-0.18	-0.24	
IIAC_L	0.02	-0.06	
BIAC_L	-0.49	-0.66	
SMEF_L	-0.29	-0.42	
IMEF_L	-0.37	-0.32	
BCLC_L	0.13	0.10	
SCIC_L	0.33	0.33	

Overall Equation (right + left) for the mandible:

(-0.04)*AMAF_R + (-0.16)*PMAF_R + (-0.27)* SIAC_R + (-0.19)* IIAC_R + (-0.10)*SMEF_R + (-0.02)*BCLC_R + (-0.08)*SCIC_R + (-0.14)*PMAF_L + (-0.18)* SIAC_L +0.02* IIAC_L + (-0.49)*BIAC_L + (-0.29)*SMEF_L + (-0.37)*IMEF_L + 0.13*BCLC_L + 0.33*SCIC_L

The equation for the right side of the mandible:

(-0.11)*AMAF_R + (-0.19)*PMAF_R + (-0.66)* SIAC_R + (-0.38)* IIAC_R + (-0.17)*SMEF_R + (-0.05)*BCLC_R + (-0.13)*SCIC_R

The equation for the left side of the mandible:

(-0.28)*PMAF_L + (-0.24)* SIAC_L +(-0.06)* IIAC_L + (-0.66)*BIAC_L + (-0.42)*SMEF_L + (-0.32)*IMEF_L + 0.10*BCLC_L + 0.33*SCIC_L

A negative logit indicates a male anatomic mandibular landmark, while a positive logit indicates a female landmark.

Accuracy test:

Table 10: Accuracy test for gender

	Accuracy					
	Overall		Left		Right	
Sex	True Positive (%)	False negative (%)	True Positive (%)	False negative (%)	True Positive (%)	False negative (%)
Male	94.69	5.31	92.92	7.08	89.38	10.62
Female	98.23	1.77	96.46	3.54	92.92	7.08

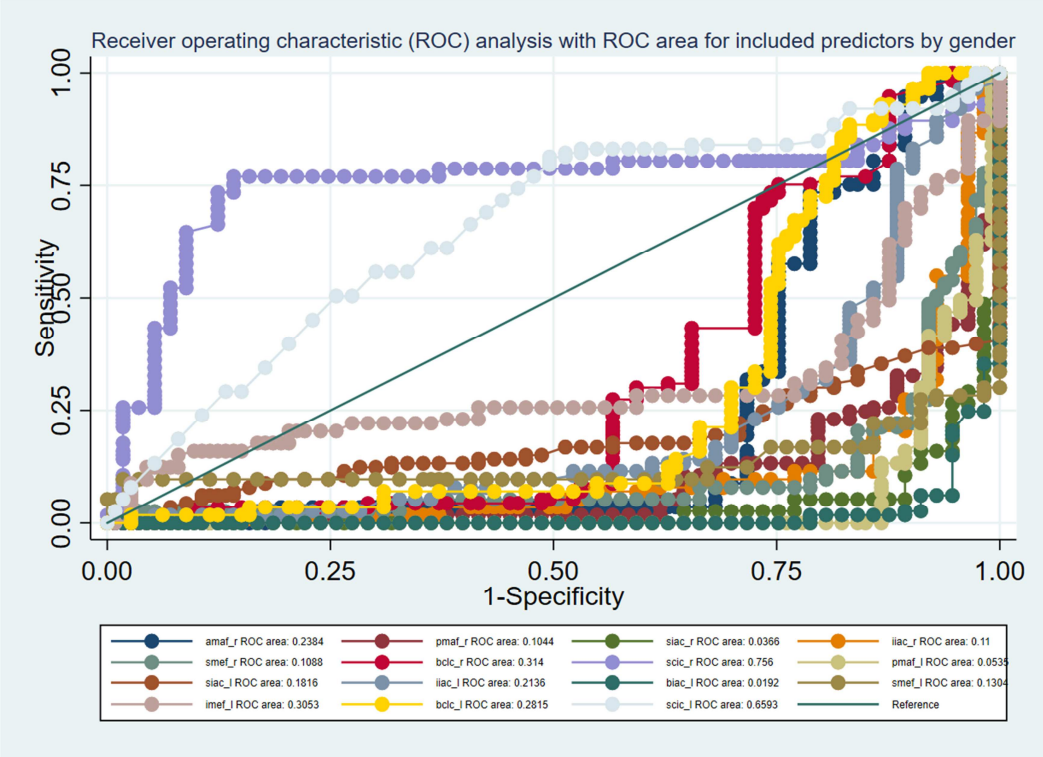
The accuracy was 94.69% among males and 98.23% among females. Identification could not be established in 5.31% of males and 1.77% of females.

Receiver Operator Characteristic Curve (ROC Curve):

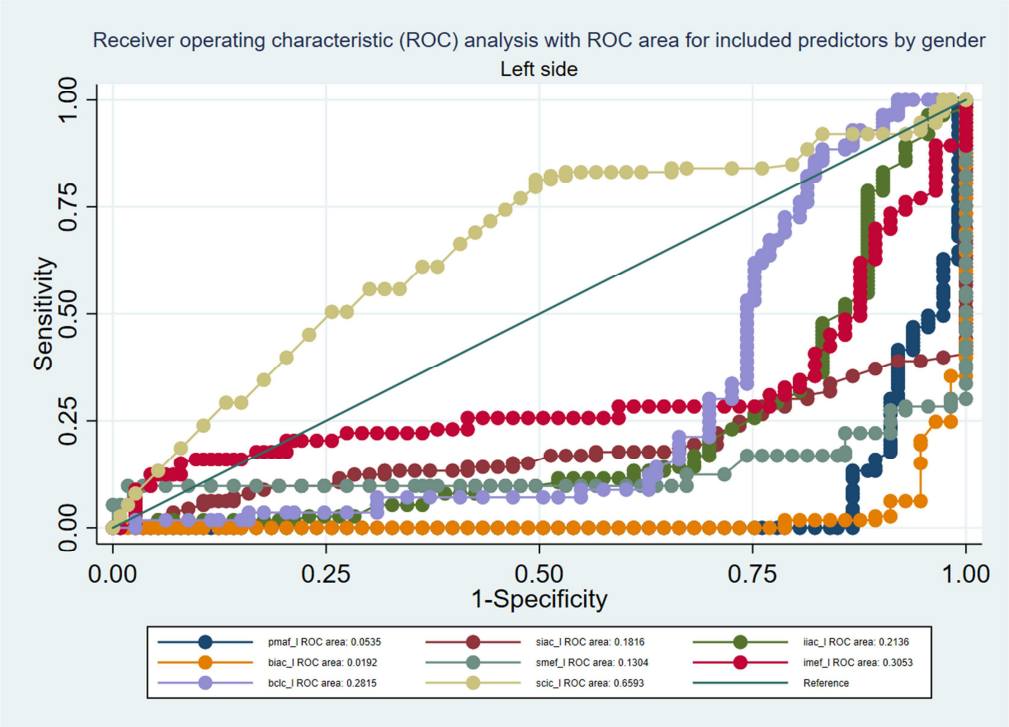
The diagnostic accuracy of the studied linear measurements as sex predictors was tested using Receiver Operator Characteristic (ROC) curves and Area Under the Curve (AUC).

The test offers a graphical representation of the trade of between sensitivity (Se) and specificity (Sp) in a test. The general structure of a ROC curve is simple. The curve is confined in a unit square. The left-lower corner (Se = 0, Sp = 1) corresponds to the highest possible test cut-off value. As the cut-off value decreases, the test Se increases and Sp decreases, moving on the curve from the left-lower corner up and to the right to ultimately reach the right-upper corner of the square where Se = 1 and Sp = 0, corresponding to the lowest possible. The area under the curve (AUC) is indicative of the reliability of the test. An AUC of 0.5 would mean a worthless test on the other hand an AUC of 1 depicts a perfect test.

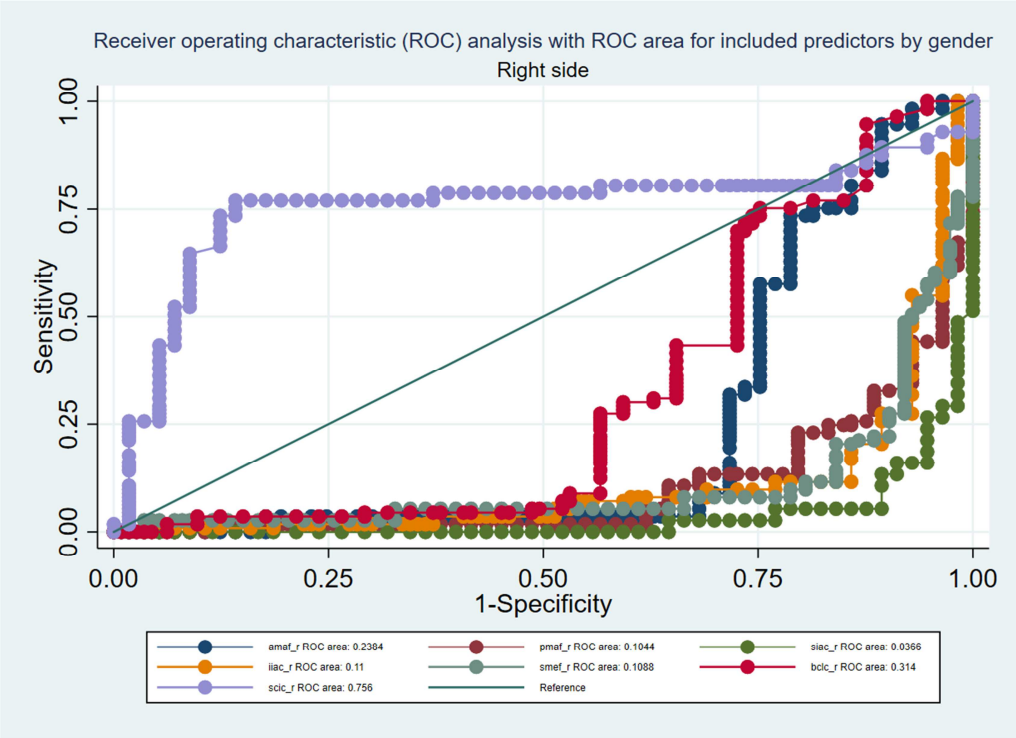
As seen in the below 3 graphs, SCIC_R and SCIC_L curves were seen to be lying closer to the left upper corner of the graph. Thus, having the highest area under the ROC curve with 0.756 and 0.6593, respectively which are closer to 1. Therefore, SCIC_R and SCIC_L have the highest sensitivity to gender as compared to the other parameters.



Graph 4: Receiver Operator Characteristic Curve with area for included predictors for both genders (overall parameters)



Graph 5: Receiver Operator Characteristic Curve with area for included predictors for both genders (right side parameters).



Graph 6: Receiver Operator Characteristic Curve with area for included predictors for both genders (left side parameters).

Error analysis:

Inter-Observer and Intra-Observer reliability was calculated on 94 scans out of the total sample size of 226 scans. The subjects chosen for analysis were 30% of the total sample size and were chosen by random sampling. Statistical analysis was done using the Interclass Correlation Coefficient (ICC) to indicate the measure of agreement of both observers for inter-observer reliability and agreement of the same observer (Observer 1) for intra-observer reliability.

Table 11: Kappa's Cohen values, ICC

Variable	Intra-examiner	Inter-examiner
AMAF_R	0.9231	0.9231
PMAF_R	0.923	0.9384
SIAC_R	0.9077	0.9077
IIAC_R	0.9383	0.9383
BIAC_R	0.9384	0.9384
LIAC_R	0.9538	0.9846
SMEF_R	0.9538	0.9538
IMEF_R	0.9384	0.9384
BCLC_R	0.9380	0.9535
SCIC_R	0.9537	0.9536
AMAF_L	0.938	0.938
PMAF_L	0.9538	0.9538
SIAC_L	0.9535	0.9534
IIAC_L	0.9533	0.9533
BIAC_L	0.9384	0.9384
LIAC_L	0.9384	0.9383
SMEF_L	0.9381	0.9536
IMEF_L	0.9385	0.9385
BCLC_L	0.9385	0.9385
SCIC_L	0.9224	0.9225

Intraobserver reliability was indicated by intraclass correlation coefficients (ICCs) with 95% confidence intervals (CIs) and *p*-values and Interobserver reliability as indicated by intraclass correlation coefficients (ICCs) with 95% confidence intervals (CIs) and *P* values.

Very strong levels of intraobserver and interobserver agreement were found (with ICCs ranging from 0.90 to 0.96), indicating high reliability and reproducibility for all evaluated measurements (Table 11).

DISCUSSION

Forensic odontology has been utilizing different arduous techniques over decades for human identification purposes. In cases of mass disasters and crime scenes when skeletal remains are found determining the sex of an individual is very important while constructing a biological profile of the victim, as all other biological parameters are dependent on gender. Sexual difference is one method of facilitating human identification. Numerous research has been carried out over a period of time to determine the sex of unknown subjects. However, there is a need to analyze the specific traits of the population because they differ in terms of morphologic patterns when compared to people from other ethnicity and geographic location.

Osseous structures such as the human pelvis, the foramina of the skull, and bones aid in identifying a person's gender more easily. It has been stated that the accuracy rate for sex determination is 100% from a skeleton, 98% from the pelvis and the cranium, 95% from the pelvis alone or from the pelvis and the long bones, 90%-95% from the skull and the long bones, and 80%-90% from the long bones alone [(45,46)].

The two main ways Dentistry contributes to human identification are post-mortem dental profiling in the absence of antemortem records and the identification of human remains in accordance with pre-existing dental records [(47)]. Post-mortem dental profiling provides a solution when comparing antemortem and post-mortem information fails to reveal common features, the antemortem information is unavailable, or the condition of the remains prevents identification. Age, ancestry, sex, socioeconomic status, and occasionally occupation, diet, habits, and diseases can be recognized as characteristics [(48)]. Because of its stable relationship with the

mandibular base, the mental and mandibular foramina have been used as a point of reference in morphometric analyses of this bone [49].

Forensic dentistry has often relied on time-consuming methods similar to those deployed by dental investigators for human identification and sex determination is considered a reliable method and facilitates human identification. Much research has been undertaken over the years to determine the sex of unknown individuals [50,51,52]. However, there is a need to investigate the distinctive characteristics of a community, because this varies in relation to morphometric tendencies when compared to communities across the globe.

The IAN canal, an internal mandibular anatomic landmark, shows significant morphological differences across individuals and has been shown to vary according to age and sex. The authors of the current study were encouraged by the distinctiveness of this anatomic marker to evaluate its location throughout its course and to correlate its association with its position, diameter, and the person's sex in a sample of the North Karnataka population [53,54]. It is a well-known fact that a discriminant function model devised for a particular population cannot be generalized and applied to any other population as sexual differences vary significantly among populations of different geographic locations. Keeping this in mind it was crucial to develop a population-specific discriminant function models for accurate sex estimation in the North Karnataka population.

CBCT has revolutionized the field of dentistry with its accuracy, due to 3D imaging and has been widely used in forensic investigation [54]. It produces excellent images and enables accurate 1:1 anatomic 3-D reconstructions of the dentomaxillofacial complex. The anatomic features are distorted and magnified in

other conventional radiography modalities, varying from 3.4% for periapical radiographs to even more than 14% with panoramic radiographs [54].

Additionally, the conventional techniques for determining the position of the roots and IAN only permit a 2-D position and do not provide data in the mandibular buccolingual axis [55,56,57]. Before the advent of CBCT, the only method for obtaining the same information was through cadaver research [57]. The lacunae with this method was the small sample size which was unable to ensure the normal distribution of data. Additionally, it was difficult to assess gender and age disparities with the small sample size available. [57]. Information that was previously unattainable by other technologies could be gathered and studied in significant quantities in CBCT as it offers a trustworthy new source of anatomical knowledge [58].

In the current study, a total of 20 linear parameters were assessed, 10 parameters from either side of the mandible and 17 linear measurements exhibited statistically significant differences between sexes, while IMEF_R, AMAF_L, and LIAC_L have shown statistically insignificant results with a p-value > 0.05. Similar findings were obtained in a study of the Brazilian population by **de Oliveira Gamba et al**., who discovered that only BIAC showed a statistically insignificant difference between males and females in comparison to the other seven measurements.

Gopal and Sundaram discovered that AMAF, PMAF, IIAC, SIAC, and BIAC exhibited statistically significant variances between sexes in their investigation of an Indian population, although the differences in LIAC, SMEF, and IMEF were inconsequential.

Similarly, **Uppal et al**. discovered that only three parameters (SMEF, SIAC, and IIAC) differed significantly among males and females. Yet another study,

conducted by **Angel et al**. among American volunteers, was the only study in which most of the measured distances revealed no significant difference between males and females; in fact, only AMAF and SIAC revealed even near-statistically significant differences with some minor effects. Different groups of the population were studied, and differences in genetics, diets, lifestyle and traditions resulted in variations in anatomic traits [59, 60, 61, 62, 63].

Male subjects had IACs with considerably higher average diameters than female participants. This is comparable to the earlier study by **Liu et al**, which involved Chinese participants. The consistency of these findings could be explained by the comparable racial composition of the individuals in the two investigations [64].

A stepwise logistic regression model was formed by combining the 15 significant variables of either side of the mandible resulting in the predictive accuracy of 95% in males and 98% in females. In a study conducted by **Arwa Mousa et al** IMEF, SIAC, IIAC, LIAC, AMAF, and PMAF values were included in the stepwise logistic regression model, which was executed using variable parameter selection. When these 6 variables were combined, a concordance index of 84% was obtained. Similarly, **De Oliveira Gamba et al** and **Gopal and Sundaram** (59) included just 5 variables—the AMAF, PMAF, SIAC, IIAC, and BIAC in the models created by them and a concordance index of 86.1% was found in the study, which is remarkably comparable to our findings.

As a result, it is evident that the predicted accuracy for sex determination found in the current study is high in comparison to the prior studies in various populations. It offers a quick and highly accurate technique using CBCT scans and hence can help specialists in human forensic identification. Additionally, it provides

the option of applying a formula that determines a person's sex based on measurements of their mandibular anatomical components.

Limitation

1. Age estimation can be analyzed by utilizing the same radiographic localization parameters of the IAN canal and could be addressed in follow-up studies.
2. The study includes samples in the age group of 18-60yrs of age, hence this study model might not be applicable to the younger age group due to age-related variations.
3. The study criteria may not apply to patients with excessive alveolar bone loss either due to severe periodontitis or tooth loss in the molar and premolar regions.

Suggestions

1. The study sample can be subdivided into various age groups to include infants as well as elderly patients.
2. Additional parameters may be included in improving the predictive accuracy of the gender.
3. The same mandibular parameters could be used for age estimation also.

SUMMARY AND CONCLUSION

The present study was undertaken to assess the reliability of the morphometric evaluation of the Inferior alveolar nerve canal using 3-Dimensional Cone Beam Computed Tomography scans in determining the gender of an individual. A total of 20 linear dimensions pertaining to the position and dimensions of the IAN canal were compared between males and females and it was observed that 15 parameters were significant determinants of sex with statistically significant differences ($P< 0.05$) between the genders. The mean values of the parameters assessed were higher in males except for BIAC_R, SCIC_R, and SCIC_L which were found to be higher in females. Whereas, IMEF_R was found to be equal in both genders.

The growth and development of the mandible tend to stabilize in adulthood therefore a sample between the age group of 18-60 years was chosen for this study. The overall predictive accuracy for the entire study group was 94.69% for males and 98.23% for females which indicates that the IAN canal can be successfully used for gender determination.

In case where a fragmented, damaged or fleshed mandible is recovered, radiographic evaluation can be employed to study the IAN canal and determine the gender of the individual by surpassing the strenuous process of soft tissue removal. CBCT is a modern diagnostic modality that helps in rapid and precise measurements of the IAN canal thus increasing its accuracy and reliability in gender determination. In conclusion, the present study proves that the position and dimensions of the IAN canal can be precisely used for gender determination with high accuracy and the discriminant analysis model employed for the study group can be of valuable help in identifying the unknown.

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ANNEXURE-I

ETHICAL CLEARANCE CERTIFICATE

Research and Ethics Committee
KLE V K INSTITUTE OF DENTAL SCIENCES
KLE University
Accredited 'A' Grade by NAAC Placed in Category 'A' by MHRD (GoI)
Nehru Nagar, Belagavi - 590 010, Karnataka State
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Sl. No. : 1449

CERTIFICATE

This is to Certify that the synopsis titled

Comparison of the Position and dimensions of Infesios Alveolas Canal among males and females using cone beam computed tomography - A Retrospective study *Submitted by*

Dr. _____ *P. G. Student /*

Staff, Guided by _____ *from Department of*

Oral Medicine & Radiology *has been critically evaluated by committee members and granted ethical clearance to conduct the above mentioned study*

Date : 5/5/21

Member Secretary
Research and Ethical Committee
KLEVK Institute of Dental Sciences
Belagavi

MEMBER SECRETARY
Research & Ethical Committee
KLEVK Institute of Dental Sciences
BELAGAVI.

Chairman
Research and Ethical Committee
KLEVK Institute of Dental Sciences
Belagavi

Chairman
Research and Ethical Committee
KLE VK Institute of Dental Sciences
Belgaum

ANNEXURE-II
MASTER CHART – METRIC PARAMETERS IN THE MALE POPULATION ON THE RIGHT SIDE

*All the measurements are made in millimeters.

Sr. no	Gender	AMaF_R	PMaF_R	SIAC_R	IIAC_R	BIAC_R	LIAC_R	SMeF_R	IMeF_R	BC-LC_R	SC-IC_R
1	Males	13.10	17.55	16.89	3.36	5.76	2.05	15.57	13.81	2.20	4.22
2	Males	18.71	19.56	17.80	5.81	7.32	1.30	15.00	14.02	2.60	2.90
3	Males	13.69	16.71	21.19	4.57	4.69	1.18	17.40	13.18	2.60	3.10
4	Males	14.40	16.70	17.90	5.79	5.40	1.88	15.30	13.60	2.60	3.40
5	Males	16.45	16.85	16.98	6.00	5.00	1.70	13.96	14.26	2.44	3.50
6	Males	17.22	19.06	18.26	6.34	6.74	1.40	13.82	14.13	2.64	3.03
7	Males	17.13	18.72	18.23	6.31	5.74	1.60	14.68	13.82	2.50	2.90
8	Males	14.24	18.71	18.28	7.07	5.68	1.50	13.89	14.02	2.63	2.82
9	Males	14.94	15.43	15.76	5.31	6.89	1.04	12.95	13.07	2.51	3.81
10	Males	13.00	16.10	15.00	7.70	7.32	1.08	12.18	14.32	2.27	2.90
11	Males	16.65	19.87	15.72	8.77	4.94	2.81	15.98	13.18	3.05	3.60
12	Males	14.28	17.66	18.38	7.53	9.06	1.00	13.66	13.22	2.63	3.13
13	Males	14.80	17.93	21.84	6.45	5.88	1.80	17.24	17.04	2.20	2.66
14	Males	15.24	19.66	20.69	8.27	4.98	1.05	18.55	13.09	2.25	2.83
15	Males	15.46	20.11	17.48	5.84	6.90	2.00	15.55	12.38	2.94	3.80
16	Males	15.89	17.77	17.85	5.01	5.75	1.81	14.67	13.78	2.47	3.50
17	Males	16.07	16.45	19.83	5.38	4.72	2.45	16.21	13.26	3.20	3.66
18	Males	16.05	22.46	19.71	6.93	5.75	1.50	16.99	12.93	2.82	3.22
19	Males	13.20	17.57	19.01	7.18	5.87	1.77	15.94	13.47	2.77	3.26
20	Males	18.65	19.55	19.09	7.28	5.32	1.79	16.01	13.44	2.79	3.25
21	Males	13.71	16.74	19.17	7.38	5.78	1.80	16.09	13.41	2.81	3.25
22	Males	14.43	17.73	19.26	7.48	6.03	1.82	16.17	13.39	2.82	3.25
23	Males	16.47	16.86	19.34	7.57	6.02	1.83	16.25	13.36	2.84	3.25

24	Males	17.23	19.08	19.42	7.67	6.02	1.85	16.33	13.33	2.86	3.25
25	Males	17.14	18.76	19.51	7.77	6.02	1.86	16.40	13.31	2.88	3.24
26	Males	14.71	18.26	19.59	7.87	6.02	1.88	16.48	13.28	2.90	3.24
27	Males	14.96	15.47	19.68	7.97	6.02	1.90	16.56	13.25	2.92	3.24
28	Males	13.30	16.12	19.76	7.07	6.02	1.91	16.64	13.22	2.94	3.24
29	Males	16.67	19.89	19.84	5.31	6.02	1.93	16.71	13.20	2.96	3.24
30	Males	14.37	17.68	19.93	7.70	6.02	1.94	16.79	13.17	2.98	3.23
31	Males	14.81	17.95	20.01	8.77	6.02	1.96	16.87	13.14	3.00	3.23
32	Males	15.25	19.65	20.09	7.53	6.02	1.98	16.95	13.12	2.82	3.23
33	Males	15.47	20.13	20.18	6.45	6.02	1.99	17.02	13.09	2.77	3.23
34	Males	15.90	17.79	20.26	8.27	6.02	1.45	17.10	13.06	2.79	3.23
35	Males	16.09	16.47	20.34	5.84	6.02	1.50	17.18	13.03	2.81	3.22
36	Males	16.06	22.47	20.43	5.01	6.02	1.77	17.26	13.01	2.82	3.22
37	Males	15.71	18.51	20.51	5.38	6.02	1.79	17.33	12.98	2.84	3.22
38	Males	15.70	18.55	20.60	6.93	6.02	1.80	17.41	12.95	2.86	3.22
39	Males	15.70	18.59	20.68	7.18	6.02	1.82	17.49	12.92	2.88	3.21
40	Males	15.70	18.62	20.76	7.28	6.02	1.83	17.57	12.90	2.90	3.21
41	Males	15.69	18.66	20.85	7.38	6.02	1.85	17.64	12.87	2.92	3.21
42	Males	15.69	18.70	20.93	7.48	6.02	1.86	17.72	12.84	2.94	3.21
43	Males	15.68	18.73	21.01	7.57	6.02	1.88	17.80	12.82	2.96	3.21
44	Males	15.68	18.77	21.10	7.67	6.02	1.45	17.88	12.79	2.98	3.20
45	Males	15.68	18.81	21.18	7.22	6.02	1.91	17.95	12.76	3.00	3.20
46	Males	15.67	18.84	21.27	7.24	6.02	1.93	18.03	12.73	3.28	3.20
47	Males	15.67	18.88	21.35	7.27	6.02	1.94	18.11	12.71	3.30	3.20
48	Males	15.66	18.92	21.43	7.30	6.02	1.96	18.19	12.68	3.32	3.20
49	Males	15.66	18.95	21.52	7.32	6.02	1.98	18.27	12.65	3.34	3.19
50	Males	13.10	17.55	16.89	3.36	5.76	1.99	15.57	13.81	2.20	4.22

51	Males	18.71	19.56	17.80	5.81	7.32	1.30	15.00	14.02	2.60	2.90
52	Males	13.69	16.71	21.19	4.57	4.69	1.18	17.40	13.18	2.60	3.10
53	Males	14.70	16.40	17.90	5.79	5.40	1.88	15.30	13.60	2.60	3.40
54	Males	16.45	16.85	16.98	6.00	5.00	1.70	13.96	14.26	2.44	3.50
55	Males	17.22	19.06	18.26	6.34	6.74	1.40	13.82	14.13	2.64	3.03
56	Males	17.13	18.72	18.23	6.31	5.74	1.60	14.68	13.82	2.50	2.90
57	Males	14.24	18.17	18.28	7.07	5.68	1.50	13.89	14.02	2.63	2.82
58	Males	14.94	15.43	15.76	5.31	6.89	1.04	12.95	13.07	2.51	3.81
59	Males	13.00	16.10	15.00	7.70	7.32	1.08	12.18	14.32	2.27	2.90
60	Males	16.65	19.87	15.72	8.77	4.94	2.81	15.98	13.18	3.05	3.60
61	Males	14.28	17.66	18.38	7.53	9.06	1.00	13.66	13.22	2.63	3.13
62	Males	14.80	17.93	21.84	6.45	5.88	1.80	17.24	17.04	2.20	2.66
63	Males	15.24	19.66	20.69	8.27	4.98	1.05	18.55	13.09	2.25	2.83
64	Males	15.46	20.11	17.48	5.84	6.90	2.00	15.55	12.38	2.94	3.80
65	Males	15.89	17.77	17.85	5.01	5.75	1.81	14.67	13.78	2.47	3.50
66	Males	16.07	16.45	19.83	5.38	4.72	2.45	16.21	13.26	3.20	3.66
67	Males	16.05	22.46	19.71	6.93	5.75	1.50	16.99	12.93	2.82	3.22
68	Males	13.20	17.57	19.01	7.18	6.03	1.77	15.94	13.47	2.77	3.26
69	Males	18.65	19.55	19.09	7.28	6.03	1.79	16.01	13.44	2.79	3.25
70	Males	13.71	16.74	19.17	7.38	6.03	1.80	16.09	13.41	2.81	3.25
71	Males	14.43	16.73	19.26	7.48	6.03	1.82	16.17	13.39	2.82	3.25
72	Males	16.47	16.86	19.34	7.57	6.02	1.83	16.25	13.36	2.84	3.25
73	Males	17.23	19.08	19.42	7.67	6.02	1.85	16.33	13.33	2.86	3.25
74	Males	17.14	18.76	19.51	7.77	6.02	1.86	16.40	13.31	2.88	3.24
75	Males	14.71	18.26	19.59	7.87	6.02	1.88	16.48	13.28	2.90	3.24
76	Males	14.96	15.47	19.68	7.97	6.02	1.90	16.56	13.25	2.92	3.24
77	Males	13.30	16.12	19.76	6.31	6.02	1.91	16.64	13.22	2.94	3.24

78	Males	16.67	19.89	19.84	7.07	6.02	1.93	16.71	13.20	2.96	3.24
79	Males	14.37	17.68	19.93	5.31	6.02	1.94	16.79	13.17	2.98	3.23
80	Males	14.81	17.95	20.01	7.70	6.02	1.96	16.87	13.14	3.00	3.23
81	Males	15.25	19.65	20.09	8.77	6.02	1.98	16.95	13.12	2.60	3.23
82	Males	15.47	20.13	20.18	7.53	6.02	1.99	17.02	13.09	2.60	3.23
83	Males	15.90	17.79	20.26	6.45	6.02	1.85	17.10	13.06	2.44	3.23
84	Males	16.09	16.47	20.34	8.27	6.02	1.86	17.18	13.03	2.64	3.22
85	Males	16.06	22.47	20.43	5.84	6.02	1.88	17.26	13.01	2.50	3.22
86	Males	15.71	18.51	20.51	5.01	6.02	1.90	17.33	12.98	2.63	3.22
87	Males	15.70	18.55	20.60	5.38	6.02	1.91	17.41	12.95	2.51	3.22
88	Males	15.70	18.59	20.68	6.93	6.02	1.93	17.49	12.92	2.27	3.21
89	Males	15.70	18.62	20.76	7.18	6.02	1.94	17.57	12.90	3.05	3.21
90	Males	15.69	18.66	20.85	7.28	6.02	1.96	17.64	12.87	2.63	3.21
91	Males	15.69	18.70	20.93	7.38	6.02	1.98	17.72	12.84	2.20	3.21
92	Males	15.68	18.73	21.01	7.48	6.02	1.99	17.80	12.82	2.25	3.21
93	Males	15.68	18.77	21.10	7.57	6.02	1.45	17.88	12.79	2.94	3.20
94	Males	15.68	18.81	21.18	7.12	6.02	1.50	17.95	12.76	2.47	3.20
95	Males	15.67	18.84	21.27	7.15	6.02	1.77	18.03	12.73	3.80	3.20
96	Males	15.67	18.88	21.35	7.17	6.02	1.79	18.11	12.71	2.82	3.20
97	Males	15.66	18.92	21.43	7.19	6.02	1.80	18.19	12.68	2.77	3.20
98	Males	15.66	18.95	21.52	7.22	6.02	1.82	18.27	12.65	2.77	3.19
99	Males	15.66	18.99	21.60	7.24	6.02	1.83	18.34	12.62	2.79	3.19
100	Males	15.65	19.03	21.68	7.27	6.02	1.85	18.42	12.60	2.81	3.19
101	Males	15.65	19.06	21.77	7.29	6.02	1.86	18.50	12.57	2.82	3.19
102	Males	15.64	19.10	21.85	7.31	6.02	1.88	18.58	12.54	2.84	3.18
103	Males	15.64	19.14	21.94	7.34	6.02	1.45	18.65	12.52	2.51	3.18
104	Males	15.64	19.17	20.76	7.36	6.02	1.91	18.73	12.49	2.27	3.18

105	Males	15.63	19.21	20.85	7.38	6.02	1.93	18.81	12.46	3.05	3.18
106	Males	15.63	19.25	20.93	7.41	6.02	1.94	18.89	12.43	2.63	3.18
107	Males	15.62	19.28	21.01	7.43	6.02	1.96	18.96	12.41	2.20	3.17
108	Males	15.62	19.32	21.10	7.46	6.01	1.98	13.90	12.38	2.25	3.17
109	Males	15.62	19.36	21.18	7.48	6.01	1.99	13.11	12.35	2.94	3.17
110	Males	15.61	19.39	21.27	7.50	6.01	1.82	13.19	12.32	2.47	3.17
111	Males	15.61	19.43	21.35	7.53	6.01	1.83	13.27	12.30	2.55	3.17
112	Males	15.60	19.47	21.43	7.55	6.01	1.85	13.35	12.27	2.56	3.16
113	Males	15.60	19.50	21.66	7.57	6.01	1.86	12.63	12.24	2.56	3.16

MASTER CHART – METRIC PARAMETERS IN THE MALE POPULATION ON THE LEFT SIDE

*All the measurements are made in millimeters.

Sr. no	**Gender**	**AMaF_L**	**PMaF_L**	**SIAC_L**	**IIAC_L**	**BIAC_L**	**LIAC_L**	**SMeF_L**	**IMeF_L**	**BC-LC_L**	**SC-IC_L**
1	Males	13.38	17.21	16.70	5.15	5.76	1.17	14.96	14.10	1.95	3.03
2	Males	18.59	20.35	19.17	6.74	5.47	2.25	16.62	14.82	2.93	3.12
3	Males	13.10	17.04	20.70	4.86	4.69	1.18	16.38	13.07	3.00	3.70
4	Males	17.40	13.55	18.56	6.15	5.27	2.38	14.20	14.74	1.90	3.20
5	Males	16.43	16.83	16.95	6.10	5.10	1.60	13.95	14.25	0.43	3.40
6	Males	18.02	21.49	18.21	6.52	6.33	1.65	15.16	14.37	3.00	3.20
7	Males	13.90	20.50	16.81	6.61	5.85	2.38	13.35	14.88	2.78	3.25
8	Males	14.82	18.67	17.39	6.76	5.84	2.21	13.49	14.69	2.29	3.35
9	Males	12.40	16.52	15.77	5.32	6.88	1.05	12.93	13.08	2.50	3.80
10	Males	13.90	17.90	15.75	8.81	7.32	1.57	12.90	16.00	2.90	3.32
11	Males	18.09	19.78	16.46	8.63	5.88	2.77	15.52	13.91	2.63	3.63
12	Males	15.55	18.68	20.78	6.58	9.10	1.15	17.22	13.47	2.84	3.30
13	Males	14.62	20.56	19.80	8.15	6.94	1.44	17.42	15.02	2.52	2.78

14	Males	13.70	20.22	18.97	8.80	4.41	1.55	17.91	13.21	2.83	2.88
15	Males	16.00	18.55	17.66	8.00	8.10	2.10	15.77	12.38	2.56	3.00
16	Males	15.87	17.84	19.41	4.88	6.63	1.16	12.57	14.91	2.15	2.20
17	Males	16.51	17.89	19.83	5.38	4.72	2.45	16.21	13.26	3.20	3.66
18	Males	13.56	18.99	18.09	7.27	6.19	1.22	18.16	11.96	2.09	3.30
19	Males	13.80	18.74	18.69	7.50	6.80	1.69	16.17	14.46	2.69	3.01
20	Males	14.04	18.80	18.74	7.58	6.87	1.68	16.27	14.47	2.72	3.12
21	Males	13.98	18.86	18.80	7.67	6.94	1.67	16.36	14.48	2.74	3.14
22	Males	13.43	18.92	18.85	7.75	7.01	1.67	16.46	14.49	2.76	3.21
23	Males	13.78	18.98	18.91	7.83	7.08	1.66	16.56	14.50	2.79	3.10
24	Males	13.76	19.04	18.96	7.92	7.14	1.66	16.65	14.51	2.81	3.24
25	Males	13.76	19.11	19.02	8.00	7.21	1.65	16.75	14.52	2.83	3.21
26	Males	13.75	19.17	19.07	8.08	7.28	1.65	16.84	14.53	2.86	3.24
27	Males	13.75	19.23	19.13	8.17	7.35	1.64	16.94	14.54	2.88	3.65
28	Males	13.75	19.29	19.18	8.25	7.42	1.64	17.04	14.55	2.90	3.24
29	Males	13.75	19.35	19.24	8.33	7.49	1.63	17.13	14.56	2.93	3.17
30	Males	13.75	19.42	19.29	8.42	7.56	1.62	17.23	14.57	2.95	3.38
31	Males	13.74	19.48	19.35	8.50	7.63	1.62	17.32	14.58	2.97	3.40
32	Males	13.74	19.54	19.40	8.58	7.70	1.61	17.42	14.59	3.00	3.43
33	Males	13.74	19.60	19.46	8.67	7.77	1.61	17.51	14.60	2.05	3.46
34	Males	13.74	19.66	19.51	8.75	7.84	1.60	17.61	14.61	2.67	3.48
35	Males	13.74	19.72	19.57	8.84	7.91	1.60	17.71	14.62	2.31	3.51
36	Males	13.73	19.79	19.62	8.92	7.98	1.59	17.80	14.63	2.56	3.54
37	Males	13.73	19.85	19.68	9.00	8.05	1.59	17.90	14.64	2.34	3.57
38	Males	13.73	19.91	19.73	9.09	8.12	1.58	17.99	14.65	2.40	3.59
39	Males	13.73	19.97	19.79	9.17	8.19	1.57	14.20	14.66	2.35	3.62
40	Males	13.73	20.03	19.84	9.25	8.26	1.57	13.95	14.67	2.31	3.65

41	Males	13.72	20.09	19.90	9.34	8.32	1.56	15.16	14.68	2.27	3.68
42	Males	13.72	20.16	19.95	9.42	8.39	1.56	13.35	14.69	2.22	3.70
43	Males	13.72	20.22	20.01	9.50	8.46	1.55	13.49	14.70	2.18	3.73
44	Males	13.72	20.28	20.06	9.59	8.53	1.55	12.93	14.71	2.14	3.76
45	Males	13.72	20.34	20.12	9.67	8.60	1.54	12.90	14.72	2.10	3.78
46	Males	13.71	20.40	20.17	9.75	8.67	1.54	15.52	14.73	2.05	3.81
47	Males	13.71	20.46	20.23	9.84	8.74	1.53	17.22	14.74	2.01	3.84
48	Males	13.71	20.53	20.28	9.92	8.81	1.52	17.42	14.75	1.97	3.87
49	Males	13.71	20.59	20.34	9.00	8.88	1.52	17.91	14.76	1.92	3.89
50	Males	13.38	17.21	16.70	5.15	5.76	1.17	15.77	14.10	1.95	3.03
51	Males	18.59	20.35	19.17	6.74	5.47	2.25	16.62	14.82	2.93	3.12
52	Males	13.10	17.04	20.70	4.86	4.69	1.18	16.38	13.07	3.00	3.70
53	Males	14.60	17.55	18.56	6.15	5.27	2.38	15.33	14.74	1.90	3.20
54	Males	16.43	16.83	16.95	6.10	5.10	1.60	15.27	14.25	0.43	3.40
55	Males	18.02	21.49	18.21	6.52	6.33	1.65	15.21	14.37	3.00	3.20
56	Males	13.90	20.50	16.81	6.61	5.85	2.38	15.15	14.88	2.78	3.25
57	Males	14.67	18.82	17.39	6.76	5.84	2.21	15.09	14.69	2.29	3.35
58	Males	12.40	16.52	15.77	5.32	6.88	1.05	12.93	13.08	2.50	3.80
59	Males	13.90	17.90	15.75	8.81	7.32	1.57	12.90	16.00	2.90	3.32
60	Males	18.09	19.78	16.46	8.63	5.88	2.77	15.52	13.91	2.63	3.63
61	Males	15.55	18.68	20.78	6.58	9.10	1.15	17.22	13.47	2.84	3.30
62	Males	14.62	20.56	19.80	8.15	6.94	1.44	17.42	15.02	2.52	2.25
63	Males	13.70	20.22	18.97	8.80	4.41	1.55	17.91	13.21	2.83	2.88
64	Males	16.00	18.55	17.66	8.00	8.10	2.10	15.77	12.38	2.56	3.00
65	Males	15.87	17.84	19.41	4.88	6.63	1.16	12.57	21.28	2.15	2.20
66	Males	16.51	18.88	19.83	5.38	4.72	2.45	16.21	13.26	3.20	3.66
67	Males	15.99	18.99	18.09	7.27	6.19	1.22	18.16	11.96	2.09	3.30

68	Males	13.56	18.74	18.69	7.50	6.80	1.69	16.17	14.46	2.69	3.01
69	Males	13.80	18.80	18.74	7.58	6.87	1.68	16.27	14.47	2.72	3.01
70	Males	14.04	18.86	18.80	7.67	6.94	1.67	16.36	14.48	2.74	3.12
71	Males	13.98	18.92	18.85	7.75	7.01	1.67	16.46	14.49	2.76	3.14
72	Males	13.43	18.98	18.91	7.83	7.08	1.66	16.56	14.50	2.79	3.21
73	Males	13.78	19.04	18.96	7.92	7.14	1.66	16.65	14.51	2.81	3.10
74	Males	13.76	19.11	19.02	8.00	7.21	1.65	16.75	14.52	2.83	3.24
75	Males	13.76	19.17	19.07	8.08	7.28	1.65	16.84	14.53	2.86	3.21
76	Males	13.75	19.23	19.13	8.17	7.35	1.64	16.94	14.54	2.88	3.24
77	Males	13.75	19.29	19.18	8.25	7.42	1.64	17.04	14.55	2.90	3.65
78	Males	13.75	19.35	19.24	8.33	7.49	1.63	17.13	14.56	2.93	3.24
79	Males	13.75	19.42	19.29	8.42	7.56	1.62	17.23	14.57	2.95	3.17
80	Males	13.75	19.48	19.35	8.50	7.63	1.62	17.32	14.58	2.97	3.38
81	Males	13.74	19.54	19.40	8.58	7.70	1.61	17.42	14.59	3.00	3.40
82	Males	13.74	19.60	19.46	8.67	7.77	1.61	17.51	14.60	2.90	3.43
83	Males	13.74	19.66	19.51	8.75	7.84	1.60	17.61	14.61	2.63	3.46
84	Males	13.74	19.72	19.57	8.84	7.91	1.60	17.71	14.62	2.84	3.48
85	Males	13.74	19.79	19.62	8.92	7.98	1.59	17.80	14.63	2.52	3.51
86	Males	13.73	19.85	19.68	9.00	8.05	1.59	17.90	14.64	2.83	3.54
87	Males	13.73	19.91	19.73	9.09	8.12	1.58	17.99	14.65	2.56	3.57
88	Males	13.73	19.97	19.79	9.17	8.19	1.57	15.77	14.66	2.15	3.59
89	Males	13.73	20.03	19.84	9.25	8.26	1.57	16.62	14.67	3.20	3.62
90	Males	13.73	20.09	19.90	9.34	8.32	1.56	16.38	14.68	2.09	3.65
91	Males	13.72	20.16	19.95	9.42	8.39	1.56	15.33	14.69	2.69	3.68
92	Males	13.72	20.22	20.23	9.50	8.46	1.55	15.27	14.70	2.72	3.70
93	Males	13.72	20.28	20.28	9.59	8.53	1.55	15.21	14.71	2.74	3.73
94	Males	13.72	20.34	20.34	9.67	8.60	1.54	15.15	14.72	2.76	3.76

95	Males	13.72	20.40	16.70	9.75	8.67	1.54	15.09	14.73	2.79	3.78
96	Males	13.71	20.46	19.17	9.84	8.74	1.53	18.86	14.74	2.81	3.81
97	Males	13.71	20.53	20.70	9.92	8.81	1.52	18.95	14.75	2.83	3.84
98	Males	13.71	20.59	18.56	9.84	8.88	1.52	17.13	14.76	2.86	3.87
99	Males	13.71	20.65	16.95	9.92	8.95	1.51	17.23	14.77	2.88	3.89
100	Males	13.56	20.71	18.21	9.00	9.02	1.51	17.32	14.78	2.90	3.62
101	Males	13.80	20.77	16.81	5.15	9.09	1.50	17.42	14.79	2.93	3.65
102	Males	14.04	20.83	17.39	6.74	9.16	1.50	17.51	14.80	2.95	3.68
103	Males	13.98	20.90	15.77	4.86	9.23	1.49	17.61	14.81	2.97	3.70
104	Males	13.43	20.96	15.75	6.15	9.30	1.49	17.71	14.82	3.00	3.73
105	Males	13.78	21.02	16.46	6.10	9.37	1.48	17.80	14.83	2.79	3.76
106	Males	13.76	21.08	20.78	6.52	9.44	1.48	17.90	14.84	2.81	3.78
107	Males	13.76	21.14	19.80	6.61	9.51	1.47	17.99	14.85	2.83	3.81
108	Males	13.75	21.20	18.97	6.76	9.57	1.46	15.77	14.86	2.86	3.84
109	Males	13.75	21.27	17.66	5.32	9.64	1.46	16.62	14.87	2.88	3.87
110	Males	13.75	21.33	19.41	8.81	9.71	1.45	16.38	14.88	2.90	3.89
111	Males	13.75	21.39	19.83	8.63	9.78	1.45	17.14	14.89	2.93	3.92
112	Males	13.75	21.45	18.09	6.58	9.85	1.44	17.15	14.90	2.95	3.95
113	Males	13.74	21.51	18.69	8.15	9.92	1.44	17.16	14.91	2.97	3.98

MASTER CHART – METRIC PARAMETERS IN THE FEMALE POPULATION ON THE RIGHT SIDE

*All the measurements are made in millimeters.

Sr. no	Gender	AMaF_R	PMaF_R	SIAC_R	IIAC_R	BIAC_R	LIAC_R	SMeF_R	IMeF_R	BC-LC_R	SC-IC_R
1	Female	14.29	16.27	14.90	5.10	5.08	1.88	11.90	11.90	2.70	4.70
2	Female	13.37	18.50	19.55	7.15	6.51	1.45	18.68	10.04	2.77	2.83
3	Female	14.25	18.33	14.85	7.26	3.94	1.91	14.31	12.17	2.36	3.44
4	Female	13.93	19.76	17.05	7.66	4.04	1.74	17.37	11.64	2.27	2.40
5	Female	13.75	16.33	13.55	5.56	6.00	1.72	11.65	13.46	2.44	2.85
6	Female	14.85	16.22	14.66	7.24	5.13	1.70	13.63	12.38	2.80	2.00
7	Female	16.30	17.80	17.65	5.56	8.15	1.69	12.70	13.00	2.73	3.90
8	Female	14.15	14.21	14.14	4.02	5.94	1.67	11.26	12.77	2.30	3.28
9	Female	14.00	15.62	17.49	4.82	3.50	1.66	13.97	12.15	3.00	3.15
10	Female	15.25	16.50	15.49	6.71	5.95	1.64	16.11	10.45	2.30	3.87
11	Female	13.12	14.90	15.79	4.38	5.48	1.62	12.84	12.11	2.32	2.38
12	Female	16.20	17.90	17.65	5.56	8.15	1.61	12.70	13.00	2.73	3.90
13	Female	15.10	17.27	16.40	5.32	5.16	1.59	13.80	12.20	2.22	3.07
14	Female	15.20	16.70	15.00	7.38	5.58	1.58	13.18	13.49	2.41	3.32
15	Female	15.30	16.40	18.52	6.07	4.90	1.40	15.29	12.29	2.25	2.60
16	Female	15.40	16.70	16.78	5.50	5.89	1.91	13.90	12.78	2.35	3.01
17	Female	15.10	16.15	14.55	5.43	5.93	1.91	13.11	12.85	2.65	3.70
18	Female	14.25	17.22	15.36	5.36	5.97	1.90	13.19	12.93	2.41	3.50
19	Female	14.29	17.35	15.11	5.30	6.00	1.89	13.27	13.00	3.10	3.10
20	Female	14.90	16.14	15.21	5.23	6.04	1.88	13.35	13.07	2.67	3.21
21	Female	13.45	16.82	14.45	5.16	6.08	1.87	13.99	13.14	2.59	3.14
22	Female	13.88	15.64	14.59	5.09	6.12	1.86	13.80	13.22	2.78	3.23
23	Female	14.33	15.91	14.39	5.02	6.16	1.85	13.27	13.29	2.44	3.88

24	Female	14.21	18.13	15.75	4.95	6.20	1.84	13.89	13.36	2.50	3.71
25	Female	15.10	18.15	15.98	4.88	6.24	1.83	13.45	13.43	2.35	3.87
26	Female	14.70	15.57	15.21	4.81	6.28	1.82	14.60	13.51	2.55	3.46
27	Female	14.71	15.56	15.16	4.74	6.32	1.81	13.68	13.58	2.55	3.48
28	Female	14.72	15.54	15.12	4.68	6.36	1.81	13.67	13.65	2.56	3.49
29	Female	14.73	15.52	15.07	4.61	6.40	1.80	13.65	13.72	2.56	3.50
30	Female	14.74	15.50	15.03	4.54	6.44	1.79	13.64	13.80	2.56	3.52
31	Female	14.76	15.49	14.98	4.47	6.48	1.78	13.63	13.87	2.57	3.53
32	Female	14.77	15.47	14.94	4.40	6.52	1.77	13.62	13.94	2.57	3.55
33	Female	14.78	15.45	14.89	4.33	6.56	1.76	13.60	14.01	2.57	3.56
34	Female	14.79	15.43	14.85	4.26	6.60	1.75	13.59	14.08	2.57	3.57
35	Female	14.80	15.42	14.80	4.19	6.64	1.74	13.58	14.16	2.58	3.59
36	Female	14.81	15.40	14.76	4.12	6.68	1.73	13.57	14.23	2.58	3.60
37	Female	14.82	15.38	14.71	4.06	6.72	1.72	13.55	14.30	2.58	3.62
38	Female	14.83	15.37	14.66	5.36	6.76	1.72	13.54	14.37	2.59	3.63
39	Female	14.84	15.35	14.62	5.30	6.80	1.71	13.53	14.45	2.59	3.64
40	Female	14.86	15.33	14.57	5.23	6.84	1.70	13.52	14.52	2.59	3.66
41	Female	14.87	15.31	14.53	5.16	6.88	1.69	13.50	14.59	2.59	3.67
42	Female	14.88	15.30	14.48	5.09	6.92	1.68	13.49	14.66	2.60	3.69
43	Female	14.89	15.28	14.44	5.02	6.96	1.67	13.48	14.74	2.60	3.70
44	Female	14.90	15.26	14.39	4.95	7.00	1.66	13.47	14.81	2.60	3.71
45	Female	14.91	15.25	14.35	4.88	6.04	1.65	13.46	14.88	2.61	3.73
46	Female	14.92	15.23	14.30	4.81	6.08	1.64	13.44	14.95	2.61	3.74
47	Female	14.29	16.27	13.90	4.74	5.08	1.80	13.43	11.90	2.70	4.70
48	Female	13.37	18.50	19.55	4.68	6.51	2.55	18.68	10.04	2.77	2.83
49	Female	14.25	18.33	14.85	7.26	3.94	2.20	14.31	12.17	2.36	3.44
50	Female	13.93	19.76	17.05	8.66	4.04	3.25	17.37	11.64	2.27	2.40

51	Female	13.75	16.33	13.55	5.56	6.00	2.66	11.65	13.46	2.44	2.85
52	Female	14.85	16.22	14.66	7.24	5.13	1.44	13.63	12.38	2.90	2.00
53	Female	16.20	17.10	17.65	5.56	8.15	1.50	12.70	13.00	2.73	3.90
54	Female	14.15	14.21	14.14	4.02	5.94	1.30	11.26	12.77	2.30	3.28
55	Female	14.00	15.62	17.49	4.82	3.50	2.35	13.97	12.15	3.00	3.15
56	Female	15.25	17.23	15.49	6.71	5.95	2.25	16.11	10.45	2.30	3.87
57	Female	13.12	16.60	15.79	4.38	5.48	1.78	12.84	12.11	2.32	2.38
58	Female	16.20	18.10	17.65	5.56	6.15	1.50	12.70	13.00	2.73	3.90
59	Female	15.10	17.23	16.40	5.32	5.16	2.25	13.80	12.20	2.22	3.07
60	Female	15.20	17.84	15.00	7.38	5.58	2.58	13.18	13.49	2.41	3.32
61	Female	15.30	17.41	18.52	6.07	4.90	1.40	15.29	12.29	2.25	2.60
62	Female	15.40	17.98	16.78	5.50	5.89	1.91	13.37	12.78	2.35	3.01
63	Female	15.10	16.15	14.55	5.43	5.93	1.91	13.29	12.85	2.65	3.70
64	Female	14.25	17.22	15.36	5.36	5.97	1.90	13.22	12.93	2.41	3.50
65	Female	14.29	17.35	15.11	5.30	6.00	1.89	13.15	13.00	3.10	3.10
66	Female	14.90	16.14	15.21	5.23	6.04	1.88	13.07	13.07	2.67	3.21
67	Female	13.45	16.82	13.45	5.16	6.08	1.87	13.00	13.14	2.59	3.14
68	Female	13.88	15.64	13.59	5.09	6.12	1.86	12.92	13.22	2.78	3.23
69	Female	14.33	15.91	3.99	5.02	6.16	1.85	12.85	13.29	2.44	3.88
70	Female	14.21	18.13	15.75	5.36	6.20	1.84	12.78	13.36	2.50	3.71
71	Female	15.10	18.15	15.98	5.30	6.24	1.83	12.70	13.43	2.35	3.87
72	Female	14.70	15.57	14.90	5.23	6.28	1.82	12.63	13.51	2.55	3.46
73	Female	14.71	15.56	19.55	5.16	6.32	1.81	12.55	13.58	2.55	3.48
74	Female	14.72	15.54	14.85	5.09	6.36	1.81	12.48	13.65	2.56	3.49
75	Female	14.73	15.52	17.05	5.02	6.40	1.80	12.41	13.72	2.56	3.50
76	Female	14.74	15.50	13.55	4.95	6.44	1.79	12.33	13.80	2.56	3.52
77	Female	14.76	15.49	14.66	4.88	6.48	1.78	12.26	13.87	2.57	3.53

78	Female	14.77	15.47	17.65	4.81	6.52	1.77	12.18	13.94	2.57	3.55
79	Female	14.78	15.45	14.14	4.74	6.56	1.76	12.11	14.01	2.57	3.56
80	Female	14.79	15.43	17.49	4.68	6.60	1.75	12.04	14.08	2.57	3.57
81	Female	14.80	15.42	15.49	4.19	6.64	1.74	11.96	14.16	2.58	3.59
82	Female	14.81	15.40	15.79	4.12	6.68	1.73	11.89	14.23	2.58	3.60
83	Female	14.82	15.38	17.65	4.06	6.72	1.72	11.81	14.30	2.58	3.62
84	Female	14.83	15.37	16.40	5.36	6.76	1.72	11.74	14.37	2.59	3.63
85	Female	14.84	15.35	15.00	5.30	3.94	1.71	11.67	14.45	2.59	3.64
86	Female	14.86	15.33	18.52	5.23	4.04	1.70	11.59	14.52	2.59	3.66
87	Female	14.87	15.31	16.78	5.16	6.00	1.69	11.52	14.59	2.59	3.67
88	Female	14.88	15.30	14.55	5.09	5.13	1.68	11.44	14.66	2.60	3.69
89	Female	14.89	15.28	15.36	5.02	8.15	1.67	11.37	14.74	2.60	3.70
90	Female	14.90	15.26	15.11	5.36	5.94	1.66	11.30	14.81	2.60	3.71
91	Female	14.91	15.25	15.21	5.12	3.50	1.65	11.22	14.88	2.61	3.73
92	Female	14.92	15.23	14.45	5.09	5.95	1.64	11.15	14.95	2.61	3.74
93	Female	14.93	15.21	14.59	5.07	5.48	1.63	11.07	14.81	2.61	3.76
94	Female	14.94	15.19	14.39	5.04	6.15	1.62	13.18	14.88	2.61	3.77
95	Female	14.96	15.18	15.75	5.02	5.16	1.62	11.22	14.95	2.62	3.78
96	Female	14.97	15.16	15.98	5.00	5.58	1.61	11.15	11.90	2.62	3.80
97	Female	14.98	15.14	15.21	4.97	4.90	1.60	11.90	10.04	2.62	3.81
98	Female	14.99	15.12	15.16	4.95	5.89	1.59	18.68	12.17	2.63	3.83
99	Female	15.00	15.11	15.12	4.92	5.93	1.58	14.31	11.64	2.63	3.84
100	Female	15.01	15.09	15.07	4.90	5.97	1.57	17.37	13.46	2.63	3.85
101	Female	15.02	15.07	15.03	4.87	6.00	1.56	11.65	12.38	2.64	3.87
102	Female	15.03	15.06	14.98	4.85	6.04	1.55	13.63	13.00	2.64	3.88
103	Female	15.05	16.70	14.94	4.82	6.08	1.54	12.70	12.77	2.64	3.90
104	Female	15.06	16.02	14.89	4.80	6.12	1.53	11.26	12.15	2.64	3.91

105	Female	15.07	16.45	14.85	4.77	6.19	1.52	13.97	10.45	2.65	3.92
106	Female	15.08	16.98	14.80	4.75	6.25	1.52	16.11	12.11	2.65	3.94
107	Female	15.09	16.38	14.76	4.72	6.30	1.51	12.84	13.00	2.65	3.95
108	Female	15.10	15.98	14.71	4.70	6.36	1.50	12.70	12.20	2.66	3.97
109	Female	15.11	16.93	14.66	4.68	6.41	1.49	13.80	13.49	2.66	3.98
110	Female	15.12	16.49	14.79	4.65	6.24	1.48	14.46	11.51	2.66	3.99
111	Female	15.13	16.57	14.78	4.62	6.27	1.47	14.60	11.37	2.66	4.01
112	Female	15.15	16.65	14.76	4.60	6.30	1.46	14.73	11.23	2.67	4.02
113	Female	15.16	16.73	14.74	4.57	6.33	1.45	14.87	11.08	2.67	4.04

MASTER CHART – METRIC PARAMETERS IN THE FEMALE POPULATION ON THE LEFT SIDE

*All the measurements are made in millimeters.

Sr. no	Gender	AMaF_L	PMaF_L	SIAC_L	IIAC_L	BIAC_L	LIAC_L	SMeF_L	IMeF_L	BC-LC_L	SC-IC_L
1	Female	13.74	15.89	18.74	8.48	6.34	2.57	19.98	8.25	2.66	3.17
2	Female	13.74	17.72	18.13	7.61	6.44	2.38	18.25	10.31	2.75	3.14
3	Female	13.74	18.00	17.02	5.31	4.75	2.06	15.52	10.60	2.88	2.95
4	Female	13.74	16.60	18.66	5.16	5.75	1.94	14.29	13.55	2.95	3.00
5	Female	13.73	15.62	19.73	4.95	5.31	1.47	11.38	13.78	2.46	2.75
6	Female	13.73	15.56	19.79	5.03	5.07	1.65	11.72	13.40	2.51	2.79
7	Female	13.73	15.50	19.84	5.03	5.07	1.65	12.06	13.01	2.56	2.84
8	Female	13.73	14.56	19.90	4.32	5.06	2.00	10.88	13.29	2.63	2.75
9	Female	13.73	18.15	19.95	5.29	4.50	1.40	13.47	12.95	2.69	3.29
10	Female	13.72	14.26	20.23	7.38	3.77	2.81	15.87	9.80	2.87	2.77
11	Female	13.72	16.53	20.28	9.84	4.49	2.11	11.65	10.82	2.31	2.82
12	Female	13.72	17.06	20.34	9.92	3.92	1.88	13.48	12.43	3.07	3.20
13	Female	13.72	14.69	16.70	9.00	3.72	1.86	11.01	12.76	2.69	3.48
14	Female	13.72	14.50	19.17	5.15	4.10	1.82	14.70	13.62	2.36	3.51

15	Female	13.71	14.30	20.70	6.74	3.48	1.81	11.26	13.25	2.59	3.54
16	Female	13.71	14.11	18.56	4.86	4.72	1.91	13.25	10.80	2.55	3.57
17	Female	13.71	13.92	16.95	6.15	3.47	1.80	11.15	12.92	2.56	3.59
18	Female	13.71	13.72	18.21	6.10	3.31	1.78	10.85	13.02	2.55	3.62
19	Female	14.65	17.53	16.81	6.52	3.16	1.76	19.98	13.12	2.54	3.65
20	Female	14.75	16.50	17.39	6.61	3.00	1.75	18.25	13.23	2.53	3.68
21	Female	14.84	16.13	15.77	6.76	2.85	1.73	15.52	13.33	2.52	3.70
22	Female	14.93	16.23	14.57	5.32	2.69	1.71	14.29	13.43	2.51	3.73
23	Female	13.56	17.75	14.47	8.81	2.54	1.69	11.38	13.54	2.50	3.76
24	Female	13.80	15.55	14.37	8.63	2.38	1.67	11.72	13.64	2.49	3.78
25	Female	14.04	16.23	14.26	6.58	2.23	1.65	12.06	13.74	2.48	3.81
26	Female	13.98	16.57	14.16	8.15	2.07	1.64	10.88	13.85	2.47	3.84
27	Female	13.43	16.70	14.05	7.80	1.92	1.62	13.47	13.95	2.45	3.87
28	Female	13.78	16.54	13.95	5.15	1.77	1.60	15.87	14.05	2.44	3.89
29	Female	13.76	15.87	20.34	6.74	1.61	1.58	11.65	14.16	2.43	3.62
30	Female	13.76	17.84	16.70	4.86	1.46	1.56	13.48	14.26	2.42	3.65
31	Female	13.75	17.07	19.17	6.15	1.30	1.54	12.69	14.36	2.41	3.68
32	Female	13.75	17.16	20.70	6.10	1.15	1.52	12.63	14.47	2.40	3.70
33	Female	13.75	17.26	18.56	6.52	5.31	1.51	12.57	14.57	2.39	3.73
34	Female	13.75	17.36	16.95	6.61	5.07	1.49	12.50	14.67	2.38	3.76
35	Female	13.75	17.45	18.21	6.76	5.07	1.47	12.44	14.78	2.37	3.78
36	Female	13.74	17.55	16.81	5.32	5.06	1.45	12.38	14.88	2.35	3.81
37	Female	13.74	17.64	18.39	8.81	4.50	1.43	12.32	14.98	2.34	3.84
38	Female	13.74	17.74	18.59	8.63	3.77	1.41	12.26	15.09	2.33	3.87
39	Female	13.74	17.83	18.79	6.58	4.49	1.40	12.20	15.19	2.32	3.89
40	Female	13.74	17.93	18.99	7.11	3.92	1.38	12.13	15.29	2.31	3.92
41	Female	13.73	18.03	19.18	7.16	3.72	1.36	12.07	15.40	2.30	3.95

42	Female	13.73	18.12	19.38	7.21	4.10	1.34	12.01	15.50	2.29	3.98
43	Female	13.73	18.22	19.58	8.14	3.48	1.32	11.95	15.60	2.28	3.17
44	Female	13.73	18.31	19.78	7.79	4.72	1.30	11.89	15.71	2.27	3.14
45	Female	13.73	18.41	19.98	7.45	3.47	1.29	11.83	15.81	2.25	3.48
46	Female	13.72	18.51	20.17	5.55	3.31	1.27	11.76	15.91	2.24	3.51
47	Female	13.72	15.89	17.41	8.48	4.50	2.57	19.98	8.25	2.66	3.54
48	Female	13.72	17.72	18.13	5.15	3.77	2.38	18.25	10.31	2.75	3.57
49	Female	13.72	18.00	17.02	6.74	4.49	2.06	15.52	10.60	2.88	3.59
50	Female	13.72	16.60	18.66	6.86	3.92	1.94	14.29	13.55	2.95	3.62
51	Female	13.71	15.62	14.77	6.15	3.72	1.47	11.38	13.78	2.46	3.65
52	Female	13.71	15.56	14.93	6.10	5.07	1.65	11.72	13.40	2.51	3.68
53	Female	13.71	15.50	14.93	6.52	5.07	1.65	12.06	13.01	2.56	3.70
54	Female	13.71	14.56	15.01	6.61	5.06	2.00	10.88	13.29	2.63	3.73
55	Female	12.17	18.15	15.58	6.76	4.50	1.40	13.47	12.95	2.69	3.76
56	Female	14.78	17.86	14.88	5.32	3.77	2.81	15.87	9.80	2.87	3.78
57	Female	12.42	12.53	15.75	8.81	4.49	2.11	11.65	10.82	2.31	3.81
58	Female	17.90	16.80	14.31	8.63	3.92	1.88	13.48	12.43	3.07	3.84
59	Female	14.09	14.69	14.01	6.58	3.72	1.86	12.57	12.76	2.69	3.87
60	Female	14.18	14.50	17.93	6.28	4.10	1.82	12.50	13.62	2.36	3.89
61	Female	14.28	14.30	14.62	6.61	3.48	1.81	12.44	13.25	2.59	3.62
62	Female	14.37	18.51	17.76	6.58	4.72	1.91	12.38	10.80	2.55	3.65
63	Female	14.46	15.89	15.10	6.55	3.47	1.80	12.32	12.92	2.56	3.68
64	Female	14.56	17.72	14.99	6.52	3.31	1.78	12.26	13.02	2.55	3.70
65	Female	14.65	18.00	14.89	6.49	3.16	1.76	12.20	13.12	2.54	3.73
66	Female	14.75	16.60	14.78	6.46	3.00	1.75	12.13	13.23	2.53	3.76
67	Female	14.84	15.62	14.68	6.42	2.85	1.73	12.07	13.33	2.52	3.78
68	Female	14.93	15.56	14.57	6.39	2.69	1.71	12.01	13.43	2.51	3.81

69	Female	15.03	15.50	14.47	6.36	2.54	1.69	11.95	13.54	2.50	3.84
70	Female	15.12	16.80	14.37	6.33	2.38	1.67	11.89	13.64	2.49	3.87
71	Female	15.22	18.15	14.26	6.30	2.23	1.65	11.83	13.74	2.48	3.89
72	Female	15.31	17.86	14.16	6.27	2.07	1.64	11.76	13.85	2.47	3.92
73	Female	15.40	15.90	14.05	6.24	1.92	1.62	19.98	13.95	2.45	3.95
74	Female	15.50	16.80	13.95	6.21	1.77	1.60	18.25	14.05	2.44	3.98
75	Female	15.59	16.92	13.85	6.18	1.61	1.58	15.52	14.16	2.43	3.17
76	Female	15.69	16.97	13.74	6.15	1.46	1.56	14.29	14.26	2.42	3.14
77	Female	15.78	17.02	13.64	6.12	1.30	1.54	12.57	14.36	2.41	3.48
78	Female	15.87	17.07	13.53	6.08	5.31	1.52	12.50	14.47	2.40	3.51
79	Female	15.97	17.12	13.43	6.05	5.07	1.51	12.44	14.57	2.39	3.54
80	Female	16.06	17.17	13.33	6.02	5.07	1.49	12.38	14.67	2.38	3.57
81	Female	16.16	17.22	13.22	5.99	5.06	1.47	12.32	14.78	2.37	3.59
82	Female	16.25	17.28	13.12	5.96	4.50	1.45	12.26	14.88	2.35	3.62
83	Female	16.34	17.33	13.01	5.93	3.77	1.43	12.20	14.98	2.34	3.65
84	Female	13.56	17.38	12.91	5.90	4.49	1.41	12.13	14.82	2.33	3.68
85	Female	13.80	17.43	12.80	5.87	3.92	1.40	12.07	13.07	2.32	3.70
86	Female	14.04	17.48	12.70	5.84	3.72	1.38	12.01	14.74	2.31	3.73
87	Female	13.98	17.53	12.60	5.81	4.10	1.36	11.95	14.25	2.30	3.76
88	Female	13.43	17.58	12.49	5.77	3.48	1.34	11.89	14.37	2.29	3.78
89	Female	13.78	17.63	12.39	5.74	4.72	1.32	11.83	14.88	2.28	3.81
90	Female	13.76	17.68	12.28	5.71	3.47	1.30	11.76	14.69	2.27	3.84
91	Female	13.76	17.73	12.18	5.68	3.31	1.29	19.98	13.08	2.25	3.87
92	Female	13.75	17.78	12.08	5.65	2.38	1.27	18.25	16.00	2.24	3.89
93	Female	13.75	17.83	11.97	5.62	2.23	1.25	15.52	13.91	2.23	3.62
94	Female	13.75	17.88	11.87	5.59	2.07	1.23	14.29	13.47	2.22	3.65
95	Female	13.75	17.93	11.76	5.56	5.31	1.21	12.57	15.02	2.21	3.68

96	Female	13.75	17.53	11.66	5.53	5.07	1.19	12.50	13.21	2.20	3.70
97	Female	13.74	16.50	11.55	5.50	5.07	1.18	12.44	14.16	2.19	3.73
98	Female	13.74	16.13	11.45	5.46	5.06	1.16	12.38	14.26	2.18	3.76
99	Female	13.74	16.23	11.35	5.43	4.50	1.14	12.32	14.36	2.17	3.78
100	Female	13.74	17.75	11.24	5.03	3.77	1.12	12.26	14.47	2.15	3.81
101	Female	13.74	15.55	11.14	5.03	4.49	1.10	12.20	14.57	2.14	3.84
102	Female	13.73	16.23	11.03	4.32	3.92	1.08	12.13	14.67	2.13	3.87
103	Female	13.73	16.57	13.53	5.29	3.72	1.07	12.07	14.78	2.12	3.89
104	Female	13.73	16.70	13.43	7.38	4.10	1.05	12.01	14.88	2.11	3.92
105	Female	13.73	16.54	13.33	5.43	3.48	1.03	11.95	14.98	2.10	3.95
106	Female	13.73	15.87	13.22	5.42	4.72	1.01	11.89	14.82	2.09	3.98
107	Female	13.72	17.84	13.12	5.40	3.47	0.99	11.83	13.07	2.08	3.17
108	Female	13.72	16.62	13.01	5.39	3.31	0.97	11.76	14.74	2.07	3.14
109	Female	13.72	16.62	12.91	5.38	3.65	0.95	19.98	14.25	2.05	2.88
110	Female	13.72	16.22	12.89	5.38	4.05	0.94	12.50	14.45	2.04	3.48
111	Female	13.71	16.14	12.95	5.37	4.07	0.92	12.42	14.45	2.03	3.46
112	Female	13.71	16.07	13.01	5.35	4.08	0.90	12.33	14.46	2.02	3.44
113	Female	13.71	16.00	13.08	5.34	4.09	0.88	12.25	14.46	2.01	3.42