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EVALUATION OF PREVALENCE AND LENGTH OF THE ANTERIOR LOOP OF MENTAL NERVE USING CONE BEAM COMPUTED TOMOGRAPHY

BY

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To my beloved friends in Turkey and Palestine.

DEDICATION

This thesis is dedicated to:

My beloved family: My late father, My mother, My husband, My kids, My brotheres.

My Country men – the people of Palestine

My people that I watched and empathized with from afar. This is for you

ABSTRACT

SardiT. Evaluation of Prevalence, Length and Types of the Anterior Loop of Mental Nerve Using Cone Beam Computerized Tomography. Baskent University, Institute of Health Sciencesi, Anatomy Master Program, 2023.

INTRODUCTION: The anterior loop is defined as where the mental neurovascular bundle passes inferior and in front of the mental foramen then turns back to exit the mental foramen. This anatomical feature is crucial in evaluating the best location of dental implants in the mandibular premolar area. Also, the mental foramen is a significant landmark. Knowing where it is essential to block the mental nerve's anesthesia or to prevent nerve damage when performing surgery on the premolar region of the mandible. CBCT allows for better observation of key anatomical features, such as their location, exact delineation, and relationships to other nearby structures. Therefore, CBCT should be suggested when the clinician determines that more anatomical information is necessary such as differentiating the AnL of the mental nerve

AIM: Our study was conducted in order to assess the vertical and horizontal location of mental foramen, the visibility, length and types of anterior loop on CBCT in dentate and edentate patients of various age groups.

MATERIALS AND METHODS: This retrospective study evaluated 260 mandibular CBCT scans for the location of mental foramen, anterior loop prevalence, length and types. The effect of age, gender, side of the mandible and dental state of subjects on these variables was also analyzed.

RESULTS: There were found to be 7.7%, 20.8%, and 71.5% total frequencies of type 1, type 2, and type 3 respectively. The mean length of AL was 2.75 mm with minimal and maximal length of 0.6mm and 6.7mm. Significant differences were observed in prevalence between age and dental state groups. Significant differences were observed in length between gender, age and dental state groups. A relation was observed between vertical position of mental foramen and prevalence and length of anterior loop.

CONCLUSIONS: The results of this study showed that there is a significant likelihood of AnL in instances, and that AnL length should be assessed before to maxillofacial surgical treatments.

Keywords: Mental foramen, metnal nerve, anterior loop, CBCT, implant

This study was approved by Baskent University Institutional Review Board and Ethics Committee (Project no: KA22/260) and supported by Baskent University Research Fund.

ÖZET

Sardı T, Nervous mentalisin ön halkasının prevalansı ve uzunluğunun değerlendirilmesi: Koni ışınlı bilgisayarlı tomografi çalışması. Başkent Universitesi Sağlık Bilimleri Enstitüsu Anatomi, Tezli Yüksek Lisans Programı. 2023.

GİRİŞ: A.v.n. alveolarisinferior'un distal kısmının for. mentale alt sınırı altından geçerek mediale doğru ilerledikten sonra geri dönerek for.mentale'den çıkmak için oluşturduğu kıvrım "anteriorloop" olarak tanımlanır. Söz konusu yapı premolar bölgede uygulanması planlanan implantların konumlarının hesaplanması açısından önem taşımaktadır. Aynı zamanda for. mentale n. mentalis'e yönelik anestezinin hangi bölgeye uygulanacağı açısından önemli bir referans noktası olmanın yanı sıra mandibula üzerinde premolar bölgeye yönelik cerrahi girişimler sırasında sinirin zarar görmemesi için de önem taşımaktadır. ConeBeam CT (CBCT) önemli anatomik yapıların konumları, sınırları ve çevre yapılarla komşuluklarına ilişkin önemli ve güvenilir bilgiler sağlar. Dolayısıyla diş hekiminin "anteriorloop" uzunluğu gibi detaylı anatomik bilgiye ihtiyaç duyduğu durumlarda CBCT görüntülerinin değerlendirilmesi önerilmektedir. Bu çalışmanın amacı farklı yaş gruplarında yer alan dişli ve dişsiz hastalarda for. mentale'ninmandibula üzerinde dikey ve yatay doğrultudaki konumunun değerlendirilmesinin yanı sıra "anteriorloop" bulunma insidansı, bulunduğu durumlarda uzunluğu ve n. Mentalistiplerinin değerlendirilmesidir.

GEREÇ VE YÖNTEM: Retrospektif olarak planlanmış olan bu çalışmadamandibula'dan alınan 260 CBCT görüntüsü üzerinde for. mentale konumu, n. mentalis tipleri "anteriorloop" görülme sıklığı, bulunduğu durumlarda uzunluğu yaş, cinsiyet, taraf farklılıkları ve bireylerin diş durumları göz önünde bulundurularak değerlendirilmiştir.

BULGULAR: N. Mentalistiplendirmesinde Tip 1, Tip 2 ve Tip 3 görülme oranı sırasıyla %7.7, %20.8 ve %75.1 olarak saptanmıştır. "Anteriorloop" ortalama uzunluğu 2.75mm olup minimum 0.6mm, maksimum 6.7mm olarak saptanmıştır. Farklı yaş grubunda yer alan ve farklı diş durumuna sahip bireyler arasında "anteriorloop" görülme sıklığı açısından anlamlı farklılıklar saptanmıştır. "Anteriorloop" uzunluğu da farklı yaş, cinsiyet ve diş durumu grupları arasında anlamlı farklılıklar göstermiştir. For. mentale dikey konumu ile "anteriorloop" bulunma olasılığı ve uzunluğu arasında bir ilişkinin varlığı da ortaya konulmuştur.

SONUÇ: Çalışmanın sonuçları toplumda "anteriorloop" görülme olasılığının oldukça yüksek olduğunu ve maksillofasial cerrahi girişimlerden önce uzunluğunun değerlendirilmesi gerektiğini vurgulamaktadır.

Anahtar Kelimeler: For. mentale, n. mentalis, ön halka, CBCT, implant

Bu çalışma Başkent Üniversitesi Tıp ve Sağlık Bilimleri Araştırma Kurulu ve Etik Kurulu tarafından onaylanmış (Proje no: KA22/260) ve Başkent Üniversitesi Araştırma Fonunca desteklenmiştir.

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LIST OF ABBREVIATIONS AND ACRONYMS

AMF	accessory mental foramen
AnL	anterior loop
AnLL	anterior loop length
CBCT	cone beam computed tomography
CT	computed tomography
IAN	inferior alveolernevre
MF	mental foramen
MN	mental nevre
N	nerve
PR	panoramic Radiograph
TMJ	temporomandibular joint
X1	the distance between superior boarder of MF and superior alveolar crest
X2	the distance between MF and lower boarder of the mandible
X3	the distance between MF and middline

1. INTRODUCTION

In Classical Anatomy textbooks, mental nerve (MN) is considered the terminal branch of the inferior alveolar nerve (IAN). Especially as soon as it comes out of the mental foramen (MF) (1) deep in the depressor anguli oris muscle, it is divided into three branches without mentioning their names (2).

Sometimes, the terminal segment of the IAN passes beneath the lower and mesial walls of the MF and, after emitting a short, incisive branch, It turns back to pass through the foramen and emerge to the soft tissues, where it becomes the mental nerve. Anterior loop (AnL) of the inferior alveolar nerve is another name for this anatomical feature (3) (Fig. 1.1).

Sicher's book defines the anterior loop as "the mental canal that separates from the mandibular canal and goes inward, then curves upwards and backwards and terminates in the mental foramen" (4). Bavitz et al. and Misch defined it as the region where the mental neurovascular bundle extends front to the mental foramen before turning around and passing through it (5). The backward movement of the MF from the deciduous canine area to the deciduous molar area during mandibular growth may be to blame for this deviation (6).

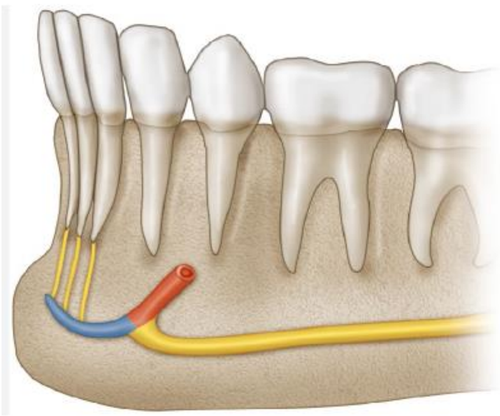

Figure 1.1. Yellow part is the (IAN), red part is the anterior loop of (MN) and the blue part is the incisive nevre.

The MN branching can be categorized into three different types:

1. Type I: the anatomy is Y-shaped, the AnL is hardly perceptible, and there isn't a loop to be found. The mental branch emerges from the IAN posterior to the mental foramen's entrance.

2. Type II: the anatomy is T-shaped in and the AnL is lacking. The mental branch enters the mental foramen on a perpendicular pattern, while the incisive branch runs perpendicular to the main branch.

3. Type III: the anatomy is Y-shaped and the AnL is apparent (Fig.1.2) (7).

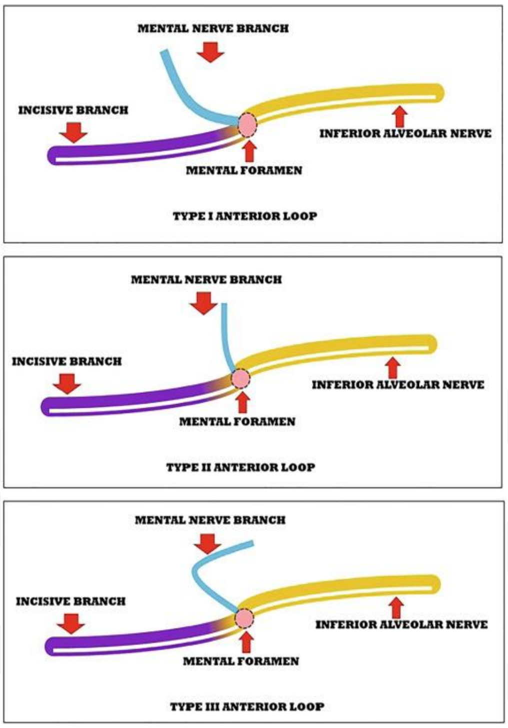

Figure 1.2. Types of mental nerve branching (7).

When designing a fixed prostheses supported by dental implant, the position of the MF and the AnL of the mental neurovascular bundle define where the most distant implants should be placed in the interforaminal region (8). To increase the anterio-posterior spread and decrease distal cantilever, it is essential to position the implant closest to the MF while paying attention to the AnL (9). After implant implantation, however, neurosensory abnormalities and impaired feeling of the lower lip and chin can occur after a surgical procedure on the MN (10).

Surgeons run a high risk of violating the AnL when it is present if they don't know how long it is (11). Although the location of the MF can be identified by radiological imaging techniques, Kuzmanovic et al came to the conclusion that panoramic radiographs are unreliable and frequently indicate the AnL in the wrong place (12).

Panorama x-rays are still a traditional approach that can be used to analyze and study jaw anatomy, such as the bifid mandibular canals.Even though CBCT presents better observation of important anatomical structures, including position, detailed distinction and interactions with adjacent structures. Therefore, CBCT should be suggested when the clinician determines that more anatomical information is necessary such as AnL and MF (13).

The aim of this study was to evaluate the prevalence and length of the AnL measured by CBCT. This study is to define, evaluate types of AnL and measure the length of it according to mandible side (right/left), age, gender, MF position and the dental status of the patients.

2. LITERATURE REVIEW

2.1. Mandible

2.1.1. Mandibular embryology

Head and neck structures are formed by the pharyngeal arches. When the embryo is 4 weeks old, pharyngeal arches begin to appear as neural crest cells migrate to regions that will form the head and neck in the future. The neural crest cells are the source of the most connective tissue and skeletal structure of the rostral region of the head. The maxilla contains mesenchymal cells derived from neural crest cells of the forebrain and midbrain, while the mandible is derived from the mid and hindbrain (14).

The first pair of pharyngeal arches in the 4-week embryo is called the "mandibular arch". From the mandibular arch; mandible, maxilla, zygomatic arch and pars squamosa of the temporal bone occur. As an extension of the chondrocranium, also known as the cartilage neurocranium, at the beginning of the 4th week of embryonic life, the “Meckel Cartilage” consisting of hyaline cartilage tissue and surrounded by thick perichondral fibrous mesenchyme tissues is seen in the center of the 1st pharyngeal arch. The dorsal end of the Meckel cartilage is directly related to the developing ear structures. Two nodules separated from the proximal end of the cartilage form the melleus and incus, which are the middle ear bones (15) (Figure 2.1).

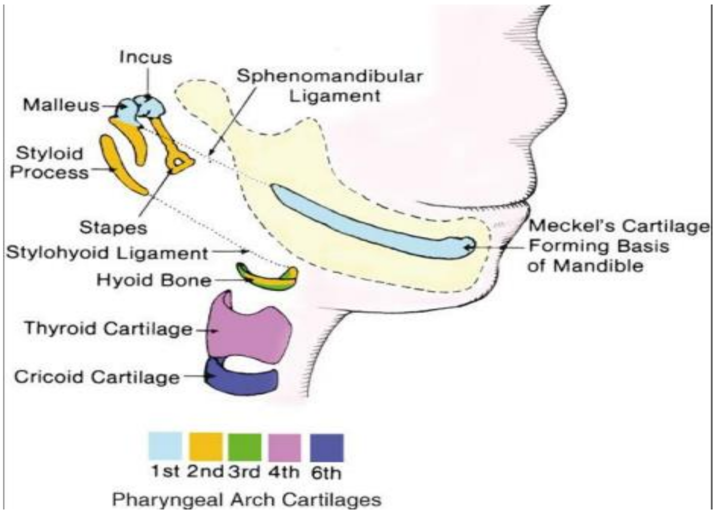

Figure 2.1. Origins of primordial cartilages developing from pharyngeal arches (16).

The distal part of the cartilage joins in the midline and guides the bone structure to be formed. The first structure seen in the first pharyngeal arch is the structures of the trigeminal nerve. One function of the nerve's early appearance has been thought to initiate ossification with neurotrophic factors (17). In the region where the mandibular nerve divides into mental and incisive terminal branches, mesenchyme condensation occurs in the 6th week. In the 7th week, the center of intramembranous ossification appears, originating from the fibrous mesenchymal membrane around the Meckel cartilage (Fig. 2.2).

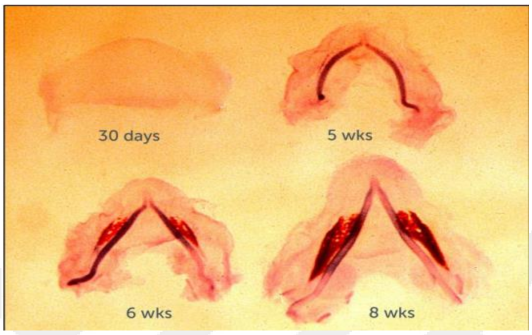

Figure 2.2. Intramembranous mandibular bone formation adjacent to Meckel cartilage (16).

In the mandible, the lateral surface ossifies first and ossification proceeds to the medial surface, continuing from the lower part of the dental lamina extending from the oral epithelium and the inferior alveolar vascular nerve bundle, remains lateral to the Meckel cartilage. Inferior to the inferior alveolar vascular nerve bundle, a venous structure is surrounded by bone (Fig. 2.3). This formed channel is called the "Serre" channel and disappears with the development. Bone formation continues by spreading towards the symphysis and corpus, the MN is surrounded by bone and remains in the newly formed MF.

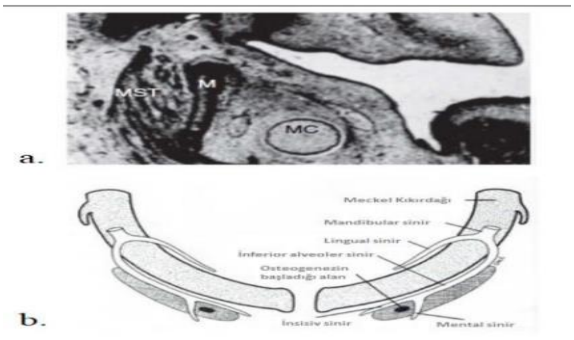

Figure 2.3. a. Meckel cartilage remaining medial to the developing mandible in histological sections MST: Masseter, M: Mandible, MC: Meckel Cartilage b. The relationship of Meckel cartilage with the mandibular nerve and where bone formation begins (18).

There are also two separate ossification centers at the jaw tip. Although the centers in this region provide continuity with the corpus of the same side before birth, the union between the right and left ossification centers is completed only 1 year after birth. Meckel's cartilage, which is a primordial cartilage, is separated from all structures of the mandible (muscle, nerve, bone) at the 12th week and completely disappears by the apoptosis of the cartilage cells by the 24th week (19).

The fibrous connective tissue surrounding the Meckel cartilage then forms the sphenomandibular ligaments and anterior ligaments of the malleus bone. At about 10-12 weeks, secondary cartilages begin to appear in the mandible. These are the condylar, gonial, coronoid and symphyseal cartilages of the right and left mandibles. Secondary cartilages arise in areas of intense stress and tension of intramembranous bones or in centers of rapid growth and development (15).

Endochondral bone formation of gonial and coronoid cartilages is completed before birth and they disappear by leaving their place to bone tissue. Condylar cartilage is the most important of the secondary cartilages in relation to growth and development, and it contributes to the growth and development of the lower jaw for a long time after birth. The temporomandibular joint (TMJ) begins to become evident after the 12th week (19, 20-22).

At birth, the mandible is smaller than the maxilla, the ramus is short, the condyle is not developed and the alveolar bone is not formed. The mandibular condyle is at the occlusal level and the articular eminence is not prominent. Considering its development and physiology, the lower jaw can be examined in three parts. These are the basal part, which ends at the condyle by following the IAN from the tip of the chin, the muscular part where the masticatory muscles are attached and the alveolar bone that has not yet formed at birth. The formation of the alveolar part is completely dependent on the development of the teeth (21).

After birth, the mandible grows with two types of bone formation. These are endochondral ossification, which is the activity of the condyle cartilage and intramembranous ossification formed by the periosteum surrounding the mandible. Condylar cartilage, which grows rapidly until the 20th week before birth, decreases in size (1.25-1.5 mm) during birth, but its size becomes narrower (0.3 mm) with the mixed dentition period and continues to grow and adapt to its activity until the age of 20-30. The gonial angle, which is approximately 175° at birth, regresses to 110-120° in adults from 130° in adolescence (Figure 2.4).

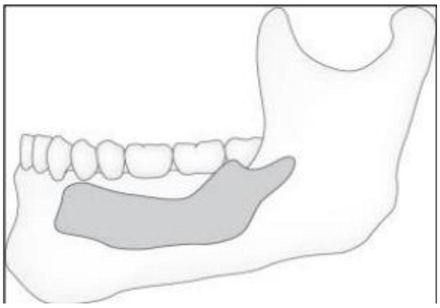

Figure 2.4. Difference between neonatal and adult mandibles with development (23).

After birth, the mandibular condyle, coronoid process and ramus are displaced by apposition and resorption according to the V principle, and by moving away from the structures in the opposite mandibular half, it contributes to the growth and development of the mandible in the transverse, vertical and horizontal directions. The mandibular condyle and condyle neck also show slight supero-posterior growth endosteally according to the V principle. With the relocation of the mandibular ramus, the bone remaining at the anterior border of the ramus joins the mandibular corpus and the mandibular corpus elongates in the horizontal direction (24). The mandible's shape continues to change after birth. The canine tooth, two molars, and both deciduous incisors have not yet fully separated from one another in the corpus of the mandible in neonates (25).

Because it contains the IAN and arteries, which have not yet been separated, the mandibular canal is particularly broad during this time. It is situated close to the mandibular corpus' lower margin. Only during the newborn period does this type of distinct innervation of the canine tooth, premolar, and molar sites exist. The Serres vein is held in the canal of Serres, which is present posterior to the mandibular foramen in the persistent form. The MF is situated beneath the first molar bud, low and somewhat far to the posterior (26). The jaw's two parts fuse together after birth. This procedure occurs from the bottom to the top of the mandibular symphysis. The corpus extends posteriorly from the MF due to the growing buds of permanent teeth (27). The mandibular corpus height increases together with the growth of the alveolar portion to accommodate the lengthening tooth roots.

The mandibular canal is situated directly above the mylohyoid sulcus when the permanent teeth begin to erupt and the MF moves anteriorly, eventually ending up on the level of the second premolar tooth (25). By the age of 4, the mandibular angle has roughly 140º and is less acute (27). Adults have various mandibular proportions and both the alveolar area and the base of the mandible are around the same height. The mandibular foramen relocates cranially and settles in the middle of the body of the mandible (28). The mandibular canal is nearly parallel to the mylohyoid line (29). The angle between the body of the mandible and the ramus becomes increasingly perpendicular, between 120° and 130° (30).

The mandible shrinks as people get older and lose their teeth (4). There is atrophy in the alveolar region. As a result of those modifications, the majority of the corpus is now located below the oblique line, and the mandibular canal and MF are moving comparatively upward and toward the dental arch. The mandibular angle rises when the mandibular ramus tilts posteriorly and is once more around 140 degrees. Condyloid process neck has a posterior tilt (29).

2.2. Development of Mental Foramen

The development of the prenatal MF is not well documented. Kjaer (31) explains how it formalized and altered its position in an adistal direction. Sperber (32) proposed that the functioning of neurons is what caused this transformation.It is still unknown how foramina are patterned throughout development. With regard to the induction of bone formation and the synthesis of neurotrophic factors, there appears to be a strong interdependence between nerves, bone and innervation fields (33) and nerve tissue appears to be a precondition for osteogenesis (32). Moreover, nearby structures may be a source of regional epigenetic elements that affect morphogenesis. The bone that surrounds all of these structures to form the foramen, as well as nerves, blood vessels, connective tissue and other tissues, are all involved in the creation of the MF (17).

In contrast to a perforation or a fixed hole, the MF, which provides a pathway for the MN in the bone, is a flexible structure with a defined the spatial dimension throughout fetal morphogenesis. During several developmental phases, it experiences dynamic morphological changes. Also, it appears that the bone surrounding the MF is prepatterned in expectation of eventual growth requirements given the initial spatial interaction of the foramen with the neurovascular bundle (34). The MF is situated anteriorly throughout the first three years of life as opposed to its more posterior position during the later years (35). The loose mesenchymal cells' interactions with the tissues around them regulate the essential alterations in the MF's shape (34).

2.3. Anatomy of the Mandible

The mandible is the only movable bone of the cranial skeleton and consists of the condyle, which forms the TMJ and articulates with the temporal bone, the ramus that extends vertically up to the TMJ and the masseter junction and the body that contains the dentoalveolar structure and the inferior alveolar vascular nerve bundle extending in the horizontal direction (Figure 2.5). When viewed from the lateral, the mental protuberance, to which the mental region muscles adhere, is seen at the front, and the MF, where the mental neurovascular bundle exits from the mandibular bone, is seen just behind it. Triangular mental tuberance is a projection consisting of triangular mental tubercles and forms the tip of the chin. The mandibular body consists of the alveolar prominence and mandibular basis containing the teeth (16).

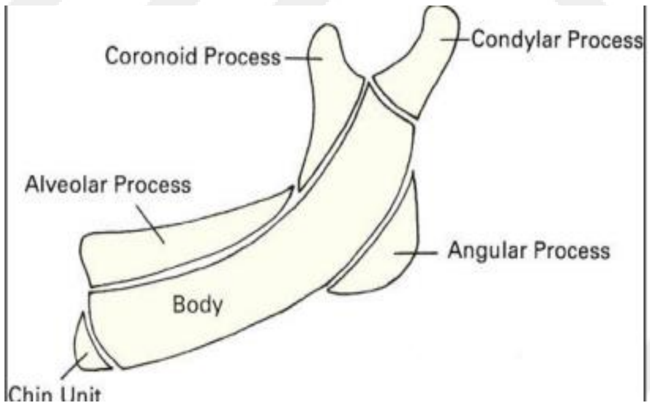

Figure 2.5. Skeletal units of the mandible (16).

The MF is in the border position between the alveolar process and the basal part of the mandible. The protuberances formed in the areas where the teeth in the alveolar prominence are located are called juga alveolaris. At the junction of the coronoid process with the corpus, there is an external oblique ridge that progresses towards the protuberance mentalis. On the lateral aspect of the mandibular ramus is the tuberositamasseterica, to which the masseter muscle attaches, and just anteriorly there is an antegonial notch, where the facial artery and vein are located and whose depth varies with the amount and pattern of growth of the mandible (36).

The recess between the condylar and coronoid process is also called the mandibular notch or coronoid notch. The temporal muscle is attached to the coronoid process, mostly from the lateral aspect of the masticatory muscles. The lateral and medial pterygoid muscles attach to the medial surface of the condylar process. Just behind the third molars, the lowest border to which the temporal muscle attaches is called the retromolar triangle. The inner part of the triangle is formed by the internal oblique ridge and the outer part by the external oblique ridge (37).

When viewed medially, there is the IAN carrying the efferent neurons of the structures of the mandible, the inferior alveolar artery and the mandibular foramen, where the inferior alveolar vein, a branch of the plexus pterygomaxillaris, enters the mandibular bone. Just in front of it is the bony prominence called the lingula mandible to which the sphenomandibular ligament attaches, which is the point where the mandible begins to angle towards the lateral with endochondral ossification in the embryological period. Proceeding from the foramen manbibula to the submandibular fossa, there is the mylohyoid groove, where the nerve of the same name is located.

The mylohyoid muscle, which forms the floor of the mouth, separating the structures of the oral cavity and the suprahyoid space, attaches to the mylohyoid line, and just below is the submandibular fossa where the submandibular gland is located. Inferior alveolar artery opens to the lingual area near the midline through the lingual foramen, where it anastomoses with the arterial structures of the tongue. In the midline, on the upper side of the mylohyoid muscle, there are 2 superior and inferior genial tubercles, to which the geniohyoid and genioglossus muscles attach. Below the genial tubercule region, the digastric fossa is located under the mylohyoid muscle (20) (Figure 2.6).

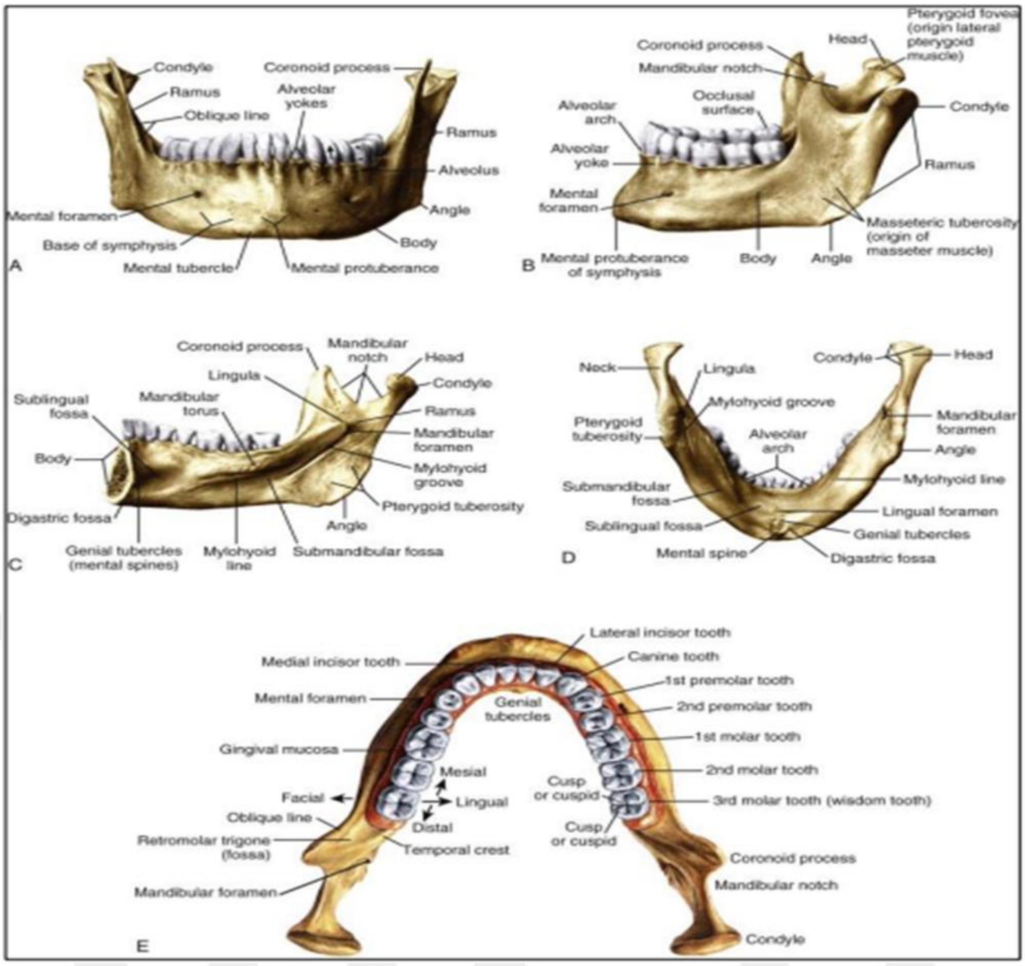

Figure 2.6. Antomy of the mandibular bone (20)

The mandibular and maxillary teeth are arranged on the horseshoe-shaped alveolar prominence that divides the oral cavity into the tongue-floor and vestibular area (38). They are innervated by the mandibular and maxillary branches of the trigeminal nerve and take part in important functions such as speaking, chewing and swallowing.

2.4. Mental Foramen

The MF is located on the lateral surface of both mandibular corpuscles, usually at the level of the apex of the 1st and 2nd premolar teeth, between the alveolar bone and the mandibular base. MF, together with the mental canal, forms the passageway of the neurovascular bundle, which includes the mental nerve, artery, and vein, to the outer surface of the mandible (39). In determining the sagittal position of the MF, unit measurements in millimeters on the teeth and mandibular bone, which it is in contact with, were used.

Tebo et al. evaluated the position of the MF in 6 classes in the sagittal direction (40) (Fig. 2.7). The position of the MF on the mandible has been reported to be generally between the roots of the 1st and 2nd premolars or at the level of the root of the 2nd premolars (41). It has been observed that MF is associated with more posterior teeth in advanced age groups, and this has been evaluated as a result of the lifelong mesial displacement of the teeth arising from the jaw relationships and the attrition that occurs over time on the proximal surfaces of the teeth (42).

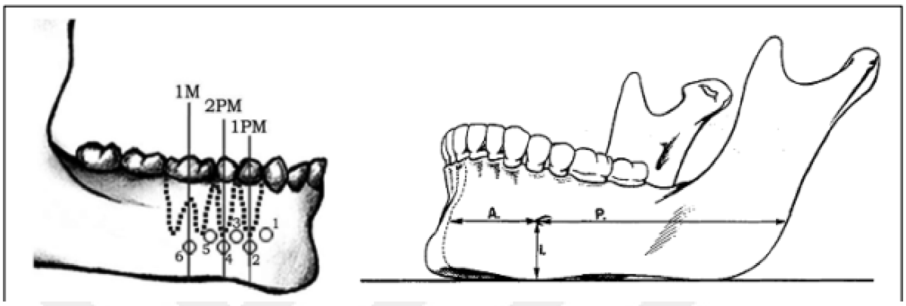

Figure 2.7. Dental-related and morphological location classification of the MF (40).

Alveolar bone is formed by the development of the teeth it contains and through the periodontal ligaments it adapts to the growth, development and functions of the jaws. Postnatal alveolar bone development is highly affected by the movement of the teeth and the growth and development pattern of the mandible, so the position of MF to the lower and upper border changes (21). Alveolar bone is called residual alveolar bone after tooth extraction. After tooth extraction, 3-4 times faster in the mandible than in the maxilla; resorption is observed depending on local, anatomical and systemic factors (43,44). Resorption is most common in the first year after tooth loss, and occurs 4 times faster in the anterior region (45). MF may remain at the top of the crest as a result of resorption of the alveolar bone with tooth loss (46).

It is known that both the dimensions of the MF and its distance from the top of the crest and lower border of the mandible are less in women than in men. It has been reported that while MF approaches the crest with loss of periodontium with age, its distance from the lower border of the mandible does not change (47).In the mixed dentition, it is closer to the inferior base (48).

2.4.1. Accessory mental foramen (AMF)

In many anatomy textbooks, the presence of small foramina in the region around the MF is frequently bypassed or given minimal attention (e.g. accessory mental foramen (AMF), nutrient foramina) (49).AMF in the proximity of the MF have been observed, although they are not well understood (50). The AMF, which is related with the MN and smaller than the MF, has been thought to be the result of the MN branching before it leaves the MF (49). AMFs frequently approximate the size of the MF and can range in size from 0.1 mm to 1.5 mm (51). Various inclusion criteria for size and various methods for assessment may explain for these variations in size and number (49). However, CT analyses of the AMF have shown more significant validity and precision than those using conventional radiography, even though researchers claim that the dissection and probe into dry mandibles allows for the detection of much more and more precise number of foramina than do studies that only rely on radiographic analysis because many foramina are not noticeable on conventional radiographs (52).

The branching site and accessory branch length both have an impact on where the AMF is located. The distance between the AMF and the MF is extended by longer branching nerves. AMF's position in relation to MF exhibits more horizontal than vertical variability (53). The AMF was most frequently detected anteroinferior to the MF by Kalender et al (50) despite Naitoh et al's finding that it was posteroinferior in a Japanese sample (54).

2.5. Trigeminal Nerve Branches

Trigeminal nevre is the largest of the cranial nerves. After separating from the anterior surface of the pons as two roots, a sensory and a small motor, it forms the trigeminal ganglion on the “Meckel space” on the cranial surface of the temporal bone. Trigeminal ganglion is a sensory ganglion formed by the first neurons of sensory fibers belonging to trigeminal N. After trigeminal N. forms the trigeminal ganglion, it divides into 3 branches as ophthalmic N. (V1), maxillary N. (V2) and mandibular N. (V3). These branches carry the senses of pain-temperature, pressure-touch and vibration to the central nervous system. There are also motor axons that go to the muscles. Proprioceptive sensations from the muscles, TMJ and periodontal ligaments are carried by the maxillary and mandibular branches of the trigeminal nerve. The trigeminal nerve, which contains afferent and efferent fibers, also mediates the transport of parasympathetic fibers of the facial nerve.

A small motor branch enters the mandibular N., which arises from the lateral aspect of the ganglion and carries sensory branches, after leaving the cranium through the foramen ovale. Mandibular N., after giving the spinos n. branch that innervating the middle cranial fossa, it divides into two branches, small anterior and large posterior. The anterior group includes the motor fibers of the chewing muscles and the sensory fibers of the buccal mucosa. The posterior group divided into 3 main branches Auriculotemporal n., Lingual n. and IAN.

The afferent fibers of the mandibular N. receive sensation from the temporal region skin, the external meatus and tympanic membrane in the ear region, the teeth and gums in the related half of the mandible, the floor of the mouth and the anterior 2/3 of the tongue (32) (Fig. 2.8).

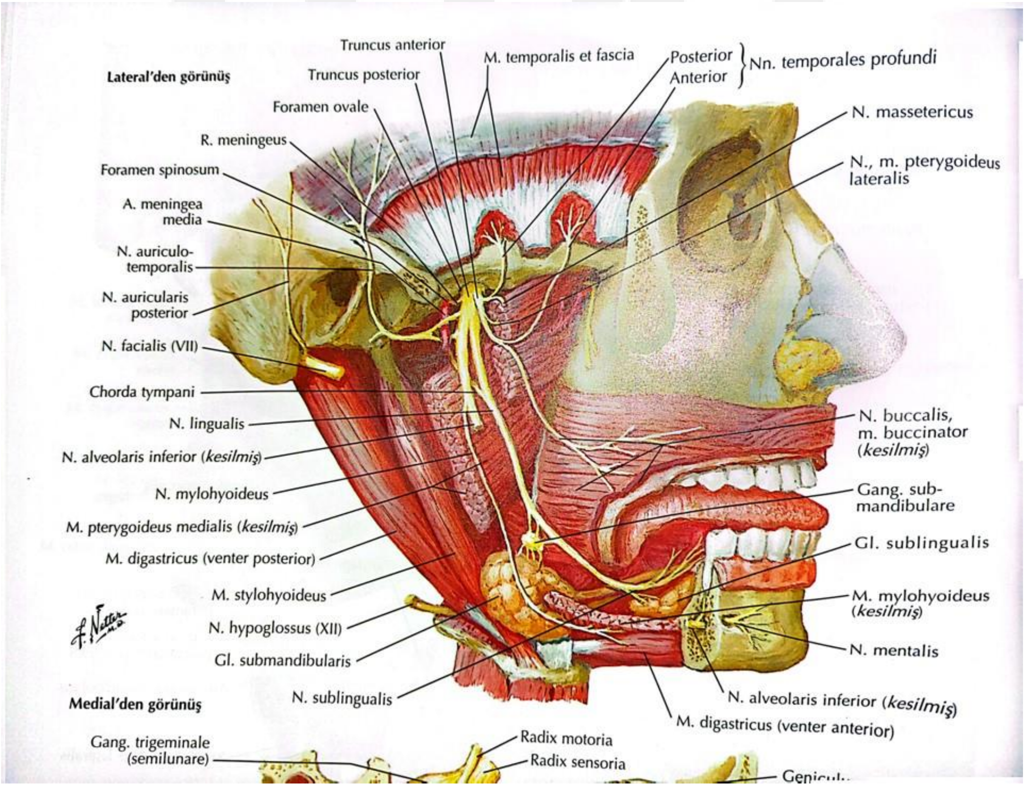

Figure 2.8. Mandibular nerve branches (55).

IAN provides the motor innervation of the venter anterior of the mylohyodeus and digastricus muscle. It enters the mandibular foramen immediately after giving the mylohyoideus branch. It usually courses close to the lingual bone cortex (70%) in the mandibular canal. The IAN has been shown to be located in the vascular nerve bundle, superior to the mandibular canal from the mandibular foramen to the angle of the mandible and inferior to the angle of the mandibule to the MF (56–58). In the mandibular foramen, the nerve is located anteriorly and medially to the inferior alveolar artery. This arrangement is present in 60% of instances. In 20% the nerve is lateral and in 10% it is posterior to the artery. In 10%, nerves are independent of arteries. Then the nerve enters into the mandibular canal below the inferior alveolar vein. İnferior alveolar artery runs more cranially (29). The mean diameters of the mandibular canal, inferior alveolar nerve, artery and vein were specified as; 2.52, 1.84; 0.42; 0.58 mm respectively (59). After the IAN forms the plexus dentalis, it divides into two terminal branches, the MN and incisive nerve. After leaving the IAN, the MN usually folds caudally and anteriorly and follows a path in the posterosuperior direction (60).

The MN, which contains entirely sensory fibers, exits through the MF. It is divided into 3 main branches to receive general sensation from the gingival and vestibular mucosa of the lower incisors and premolars, deep to the depressor anguli oris muscle. These branches are named according to their distribution areas and it has been shown that all of them play a role in the innervation of the mental region skin. These branches, which are generally grouped into 3 branches by combining in different configurations; Angular, medial inferior labial, lateral inferior labial and mental. MN anastomoses with neighboring nerves such as buccal and facial (marginal mandibular, cervical). It has been shown that the buccal nerve can participate directly in the innervation of the entire lower lip by anastomoses (61, 62).

The buccal two-thirds of the IAN within the mandibular canal consist of fascicles belonging to the MN. While these fascicles are located inferolingual at the level of the third molar, they are located in the buccal region at the level of the first molar and are separated from the dental nerves. The cross-sectional area of the IAN at the level of the first molar is 4.02 mm2, of which 2.16mm2 is the MN (58, 63) (Figure 2.9).

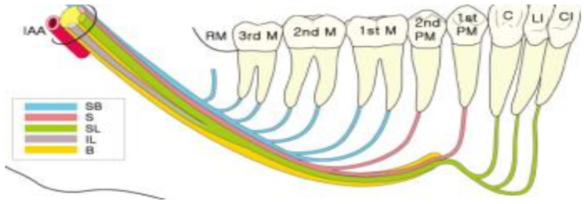

Figure 2.9. Fasicular topography of the inferior alveolar nerve, lingual view. Intracanal course of the mental nerve located in the buccal (B) 2/3. Superior buccal (SB), superior (S), superior lingual (SL) inferior lingual (IL) (58).

The number of fascicles in the relevant region gains importance in the degree of nerve damage. Nerve fascicles of the MN can be damaged in the mandibular canal or in the soft tissue. With the lingual nerve, the IAN contains an average of 12000 to 7000 axons (64). While the lingual nerve contains a single fascicle at the level of the lingula-mandible in 33% of patients, it divides into 7 to 39 fascicles at the level of the third molar (65). The IAN travels in at least 3 fascicles in the mandibular canal. Therefore, lingual nerve damage that develops after anesthesia gives symptoms in the entire tongue, while injuries associated with the IAN usually show symptoms in a certain part of the dermatome area (66).

2.6. Anterior Loop of Mental Nerve

The final part of the IAN may pass under the inferior margin and mesial wall of the MF and, after giving off a small incisive branch, turns back into MF to access the soft tissue that becomes the MN. To do, this skeletal characteristic is also known as the anterior loop (AnL) of the IAN (3).Sicher's Oral Anatomy defines the AnL as "the mental canal that begins in the mandibular canal, progresses medially to laterally, ascends back and terminates in the MF" (4). Bavitz et aland Misch reported a more accurate explanation that is `where the mental neurovascular bundle begins anterior to the MF, then doubles posteriorly to pass through the MF (5).

Several cadaveric investigations were presented in the context of the AnL description to show how the path the MN takes to reach the MF in the mandibular bone narrows. The directed pathways were categorized using Solaret al. simple "type" definition (Figure 2.10). This categorization describes Type 1 as lacking an anterior loop, having a Y-shaped structure, and having an incisive branch that is typically as wide as the main branch. After the MF opens, the mental branch departs from the IAN. Type 2 is defined as lacking an AnL, having a T-shaped structure, and having an incisive branch that is often perpendicular to the main branch. The IAN's mental branch splits out perpendicular to the MF. Type 3 is defined as having an AnL, a Y-shaped morphology, and an incisive branch that is typically as small as the main branch (7).

Neurosensory abnormalities may develop from surgery on the anterior mandible that damages the AnL of the MN, such as implant insertion in the interforaminal region or chin grafting. In order to see where the MN is located during surgery, the surgeon typically exposes the MF. However, surgeons run a high risk of violating the AnL when it is present if they don't know how long it is (11).

When designing a fixed prosthese over dental implants, the position of the MF and the AnL of the mental neurovascular bundle define where the most distant implants should be placed in the interforaminal region (8). To increase the anterio-posterior spread and decrease distal cantilever, it is essential to position the implant closest to the MF while paying attention to the AnL (9). After implant implantation, however, neurosensory abnormalities and altered sensation of the lower lip and chin can occur as a result of surgical trauma to the MN (10).

Although the AnL cannot be observed clinically, it can be visible on spiral CT, CBCT, panoramic radiography and magnetic resonance imaging (MRI). However, the authors of the study by Arzouman et al. (4) found that compared to anatomic assessment, considerably fewer loops were seen in panoramic radiographs. Additionally, compared to direct measurements, panoramic radiography showed AnL to be much shorter. Furthermore, Kuzmanovic et al. (12) demonstrated that 62% of the anatomically described loops were not revealed radiographically, whereas 50% of the radiographically revealed AnL of the mental canal were misread by observers with panoramic radiography. They came to the conclusion that panoramic radiographs are inaccurate and frequently indicate the AnL in the wrong place.

2.7. Panoramic Radiography Role in Practice

Panoramic radiographs are frequently used in daily dental procedures. Different practitioners employ panoramic radiography for implant procedures besides examining the teeth and the skeletal structures around them (67).The most popular kind of radiographs are panoramic radiographs because of their availability, low cost and low radiation exposure (in comparison to more advanced imaging procedures like CT or CBCT) (68).However, there are also several drawbacks, mostly those that affect the sharpness and clarity of the image, such as distortion, vertical or horizontal magnification and the resulting measurement disagreement, 2-dimensional restrictions, focal trough restrictions and overlapping (69).

The radiographic method to be used in implant procedures, according to a report, should enable appropriate assessment of the therapeutic diagnosis, potential pathologies discovered in the bone, the location and distances of important anatomical features and the extent of bone with proper measurements in the vertical, horizontal, and buccolingual directions. This knowledge is required to select the proper implant's length and width (70).Utilizing panoramic radiography for pre- and post-implant evaluation has a number of restrictions and disadvantages. These include the two-dimensional restrictions, the inability to gauge bone width and the potential for intrinsic image abnormalities, such as distortion in the horizontal plane and possible vertical plane magnification. The degree of precision and distortion, they continued, would mostly rely on the knowledge of the operator and the location of the patient (71).

2.8. Cone Beam Computed Tomography

The creation and use of accessible CBCT into dental practice in recent years have added a new dimension to dentists' diagnostic abilities. This enables surgical planning in three dimensions and the application of computer assisted surgical techniques. Additionally, highly repeatable dimensions are added to the reconstructed multiplanar images as a result (72).

Dental CBCT uses a cone or pyramidal X-ray beam aimed at the tracked maxillofacial field of view (FOV). Most modern CBCT scanners use a flat panel detector (FPD) consisting of an amorphous silicon thin film transistor (TFT) or complementary metal oxide semiconductor (CMOS) pixel array. In both cases, the X-rays are first converted into photons of light by the scintillator material. The scintillator material is thallium-doped cesium iodide (CsI:Tl) or terbium-activated gadolinium oxysulfide (Gd2O2S:Tb). The light is then detected by photodiodes and finally read by the entire detector array to assemble a raw digital projection data image. The flat panel detector offers higher spatial resolution and dynamic range compared to the obsolete image intensifier (II) and charge-coupled device (CCD) for CBCT detectors is less bulky and It's not complicated (73).

The CBCT imaging modality is recognized as the best imaging technique currently used in dentistry practice for an accurate evaluation of the location, morphology and demarcations of the MF. Additionally, they explored the drawbacks and potential drawbacks that might arise in practice, such as radiation biological impacts, costly expenditures and time delays brought on by the computer's reconstruction process of data (74). Additionally, the presence of extremely dense structures may degrade the clarity of the CBCT image. On the resulting views, this will produce scatter and beam hardening artifacts. Additionally, the Hounsfield Units distortion in the CBCT modality makes it difficult to estimate bone density (72).

In one study employing dried human skulls and CBCT, demonstrated that the authors used a calliper to measure specific landmarks on the skulls before comparing those measurements to measurements derived from the CBCT. The outcomes demonstrated that CBCT was extremely accurate and could recreate the linear measurements in the axial and coronal planes. When linear measurements assessment is necessary, the scientists also suggested using larger voxel sizes because they do not affect measurement accuracy while reducing radiation exposure and speeding up volume depiction time (75).

To compare CBCT with physical measurements, another study was conducted in Japan. The scientists came to the conclusion that, when compared with the actual linear measurements taken from human skulls, CBCT provided highly accurate data and values with less than a 1% relative error (76).

In a study carried out in Thailand, the authors compared CBCT, panoramic radiographs of fifty implant sites from six skulls with physical measurements made with a digital calliper. The authors discovered that CBCT is an accurate and repeatable approach for assessing vertical measures. The study also discovered that while in panoramic radiography precision of linear measures is only achieved when the patient is correctly positioned, in CBCT the position of the head during radiography had no effect on the measurements (77).

In order to evaluate the mental loop, a study carried out in Spain in 2015 contrasted CBCT with panoramic radiography. Comparing the pictures produced from CBCT with panoramic radiography, magnified images were discovered. The authors discovered that there were no statistically significant variations in the length or identification of mental loops between panoramic radiography and CBCT. They stated that it is not always possible to anticipate 2D picture evaluation to be effective. Therefore, this study recommends using CBCT when scheduling dental treatments close to important structures like the MN (3).

Panorama x-rays are still the traditional technique that can be effectively used in the assessment and study of jaw anatomy, even though CBCT offers enhanced observation of important anatomical structures, including; position, exact delineation and connections to other structures. When the clinician decides that more anatomical information is required, CBCT should be recommended (78).

3. MATERIALS AND METHODS

3.1. Study Design

The study was a retrospective cross-sectional analytical study in which the tomography data of the referred persons were examined by a single observer. It was conducted on CBCT that were taken earlier in a special imaging center between July 2020 and January 2022 for the goal of receiving general dental care. Patients who met the inclusion criteria were chosen for analysis after the database was analyzed. All the measurements were performed virtually using the software provided by the manufacturer on the computers of the relevant center, with the written consent of the patients, with the knowledge and permission of the imaging center officials.

3.2. Instruments and Machines

In the study, images obtained with a single device of HDXWILL brand, Dentri S model (HDXWILL CORP. Seoul, South Korea) of the imaging center were used.

All imaging was performed according to manufacturer's standards on a standard 0.2 mm voxel, 16x8 cm field of view (FOV). In this device where standing images were taken, the laser planes, bite sticks, head stabilizers and patient position were standardized. The occlusal plane of the patient was positioned parallel to the ground. The following exposure settings were used: tube voltage peak 90 kVp, current 8 mAs and exposure time 24 sec. Data in DICOM files were processed and edited on OnDemand 3D App Information (Cyber Med, Ver 1.0) software.The slice thickness used in CBCT reconstruction was 0.2 mm.

3.3. Target Population

The patients who presented at “Dentistomo radiology centre –Ankara City, Turkey” between July 2020 and January 2022. The CBCT volumes for the patients were selected.

3.4. Sample Selection Process and Size

Samples were chosen using systematic random selection methods from database entries. After considering the inclusion and exclusion criteria listed below and reviewing each patient's medical and personal background, the sample patients were chosen. The study was done using CBCT records of two hundreds and sixty individuals (145females and 115males). The mean age of the individuals included in the study was 44.77 ±13.5. Cases were divided into groups as dentate/edentate, male/female, right/left, 40 years or older/under 40 years of age.

3.5. Inclusion criteria

1. Patients over 20 years.

2. Patients with a CBCT volume displaying the area of the MF.

3. CBCT images with high resolution and acceptable diagnostic clarity (clear and distortion-free).

4. The MF should be clearly distinguishable and apparent on CBCT views (all foramen edges must be defined).

3.6. Exclusion Criteria

1. Existence of diseases in the study area, such as radiolucencies in the jaw, periodontal lesions, orthodontic treatment, and implants.

2. The MF is not visualized well (images should be sufficiently clear to demonstrate the MF's delineation).

3. Images in the study area with obvious distortion, artifacts, and metal items.

3.7. The proposed methodology

3.7.1 Conditions of measurements

The offered program was used to study the CBCT views, and the virtual ruler made available by the same software allowed all measurements to be made simultaneously.

The curved slicing mode was used to study the CBCT views. Slices were redesigned with a 15mm thickness for the panoramic views. To reconstruct the panoramic trough area, multiple sites on the axial view (at the level of the MF) have been chosen. These spots were chosen buccolingually in the middle of the ridge. Brightness and contrast adjustments by the observers were permitted throughout the trial in order to enhance the image and facilitate more accurate anatomical structure's recognition onCBCT modality.

3.7.2. Mental foramen delineation and measuring process

The MF vary in size, shape, and structure. Regardless of whether they have a regular or irregular shape, they typically display round or ovoid architecture on a radiograph. We made the decision to base our measurements on the distal and mesial foramen boundaries' outer points to standardize the method. So, on the outermost edges of the MF, we drew a mesial (MT), distal (DT), superior (ST) and inferior tangent (IT). The starting point for our distance measurements was these MF tangents.

3.7.3. Horizontal measurement of mental foramen position

Using the software's Implant Screen windowpane, the panoramic image was created. The numerous measurement sites on a CBCT scan's panoramic view are shown in (Fig.3.1). Before the measurements, two reference points were drawn. The mandible's left and right sides were separated by a straight line that was drawn from the nasal spine down to the symphysis metni.A straight horizontal line was drawn from the anterior border of the mental foramen to the reference line in order to measure the distance between the symphysis menti and the MF (MF-Midline) (X3) (79).

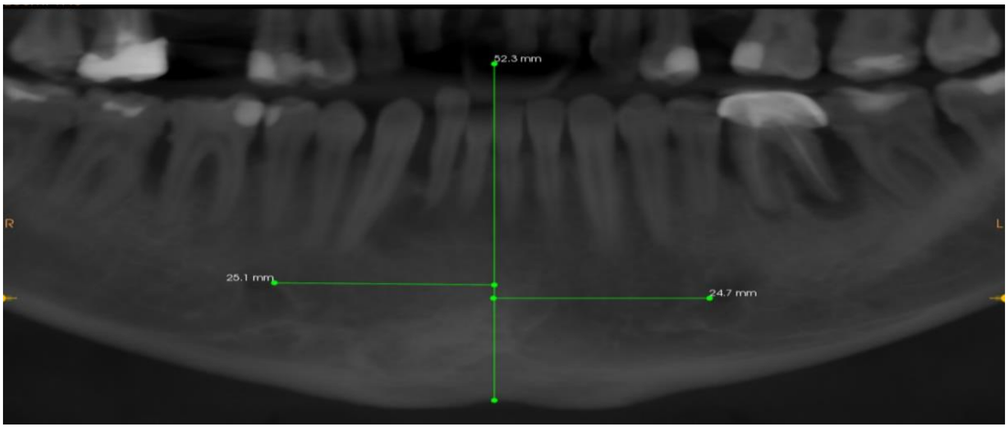

Figure 3.1. MF-Midline distance : mesial wall of MF to the symphysis.

3.7.4. Vertical measurements of mental foramen position

In this study, the distance of the highest and lowest points of the MF to the upper and lower borders of the mandibular bone was measured in both hemimandible, taking the occlusal plane as a reference.A vertical straight measured line was drawn from the superior tangent (ST) of the most superior point of MF up to the upper alveolar cortex of the mandible (X1) and from the inferior tangent (IT) of the most inferior point of the MF down to the lower cortex of the mandible (X2) to measure the vertical position of the MF (Fig 3.2.) and (Fig 3.3.).

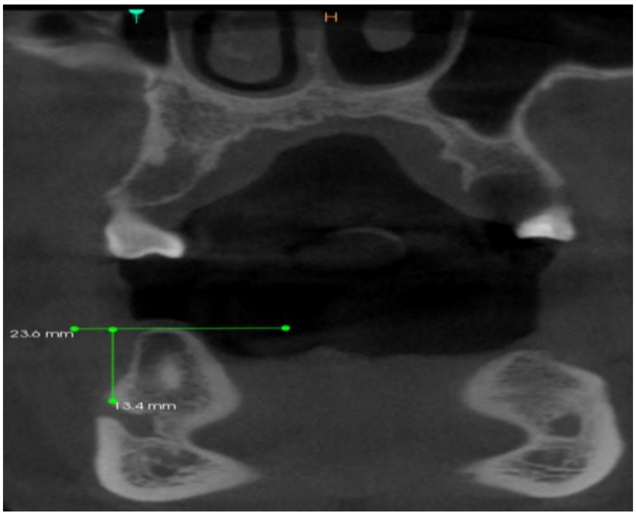

Figure 3.2. The distance between superior boarder of MF to superior boarder of the alveolar crest.

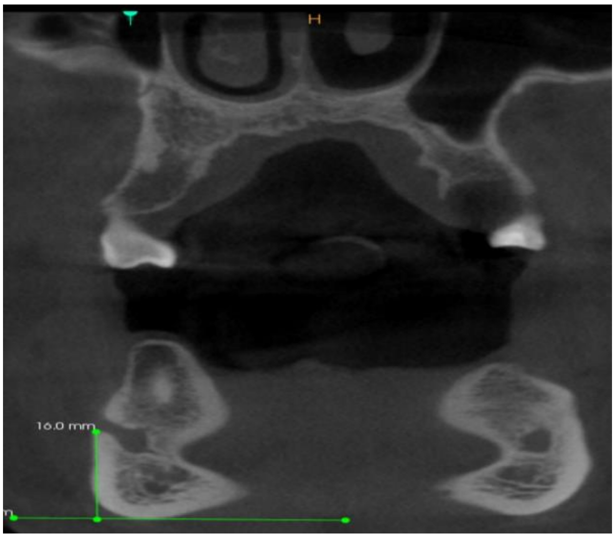

Figure 3.3. The distance between inferior boarder of MF to lower boarder of the alveolar crest.

3.7.5. Indentification and measurement of length of AnL:

Images can be produced using multiplanar reconstruction from the original axial plane in the coronal, sagittal, or oblique planes.First, to get the optimal view of the MF in the axial plane, the axial cut in the sagittal plane was first adjusted (Figure 3.4.1).

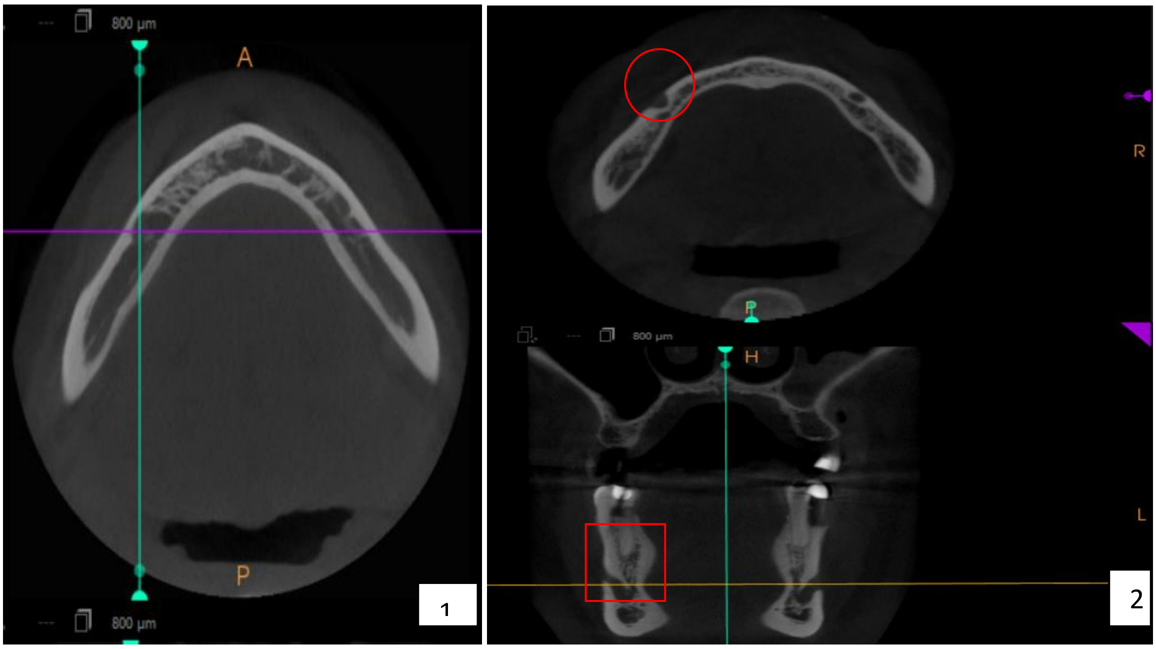

Figure 3.4. How to move the axial cut (1) until the best view of MF is attained (red circle) (2). Modification of the coronal cut to obtain best view of MF in the coronal plane (red sequare) (2).

Second, the coronal cut (purple line) in the axial plane was modified in the meantime in order to obtain the best view of the mental foramen in the coronal plane (Figure 3.4.2).

Third, the coronal plane was extended, and an oblique cut was performed to produce an oblique plane that crossed across the mental foramen's center, allowing simultaneous vision of the anterior loop and mental foramen (Figures 3.5). Fourth, to allow for measurements to be taken to the nearest 0.4 mm, this picture was magnified.

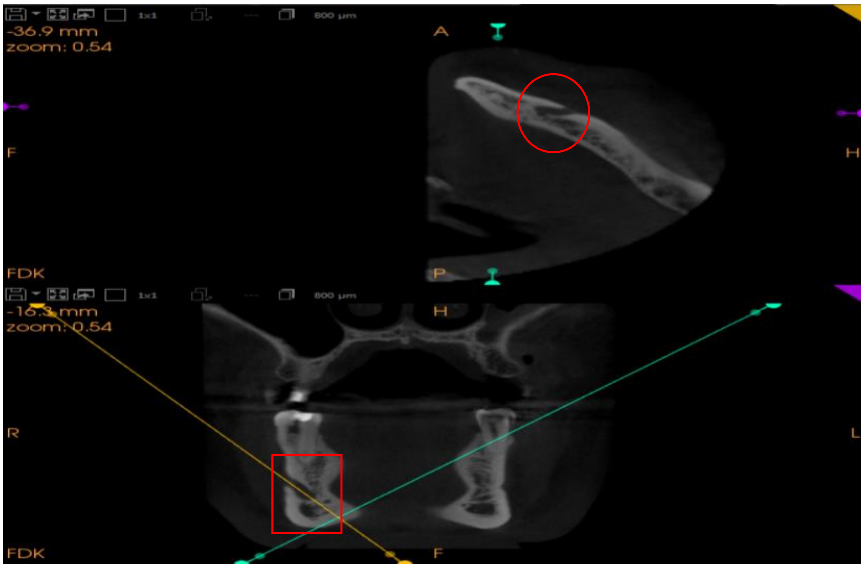

Figure 3.5. An oblique cut was performed to produce an oblique plane that crossed across the MF's center (red seuare), allowing simultaneous vision of the anterior loop and MF (red circle)

Fifth, the most anterior point of the AnL was crossed by a line (red line) that was drawn perpendicular to the buccal plate and a line (yellow line) that was parallel to red line. (It might be the starting point of the incisive canal or the furthest forward portion of the mental loop).From the MF's most anterior point to red line, AnLL was measured (11) (Figure 3.6).

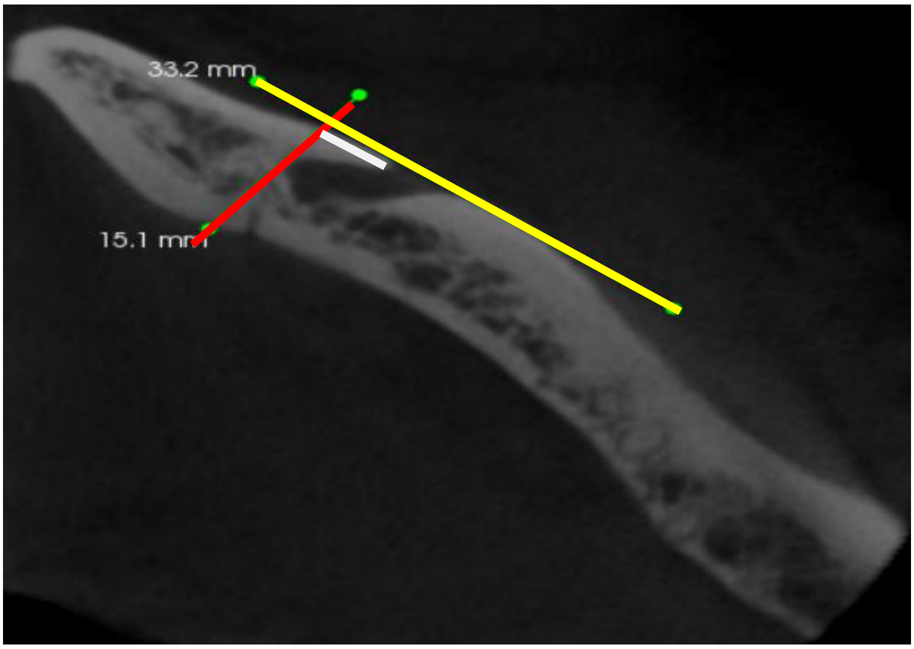

Figure 3.6. Yellow line is paralel to the buccal plate. Red line is perpendicular to yellow line and passes through the most anterior point of the anterior loop. White line shows AnLL.

Negative values were noted when the AnL was absent or the incisive canal's origin was situated behind the MF.

Figure 3.7. Type 1 of mental branching, there is no AnL. Red circle is the incisive canal

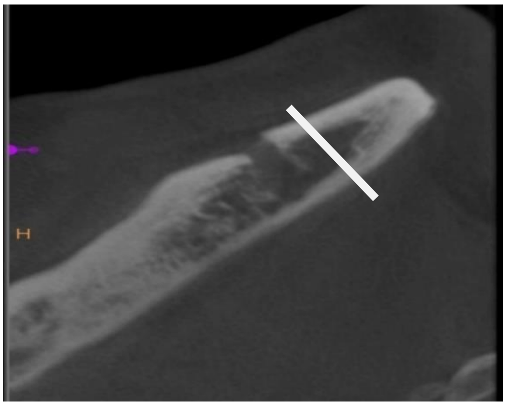

Figure 3.8. Type 2 of mental branching, there is no AnL. White line is the end of MN.

3.8. Statistical Analysis

All statistical analysis were made using IBM SPSS Statistics software version 23.0 (IBM Corp., Armonk, NY). Quantitative variables were expressed as mean, standard deviation, median, minimum, maximum, and qualitative variables were expressed as frequency and percentage. The chi-square test for qualitative variables and the independent samples t-test for quantitative variables were used to compare the differences between the two groups. The relationship between two numerical variables was analyzed using the Pearson correlation coefficient. Interobserver agreement was evaluated with the intraclass correlation coefficient. P value <0.05 was considered statistically significant.

3.9. Ethical Consideration

The director of the "DentisTomo Dental and Maxillofacial Radiology Center" in Turkey gave his consent for the use of the patient records. No personal information about the patients was revealed, and all the information gathered during this study was kept confidential. Assigned numbers were recorded for each and every CBCT. There is no conflict of interest between the author and any of the brands or products used in the study.

This study was approved by Baskent University Institutional Review Board and Ethics Committee (Project no: KA22/260).

4. RESULTS

A total of 600 patients' files were examined, among whom only 260 patients (145 female, 115 male) were selected as those patients met the inclusion criteria. The age range is between 20-71. The mean age was 44.77±13.5 years. When the mandible was evaluated as two halves, 133 individuals were classified as dentate and 127 individuals as edentate. There were found to be 7.7%, 20.8%, and 71.5% total frequencies of type 1, type 2 and type 3 respectively. Distribution values for types 1, 2, and 3 were evaluated as follows: 7.7%, 21.9%, and 70.4% for the right side and 7.7%, 19.6%, and 72.7% for the left side respectively (Table 4.1).

Table 4.1. The distribution of the mental branching types

		N	%
Right side	Type1	20	7.7
	Type2	57	21.9
	Type3	183	70.4
Left side	Type1	20	7.7
	Type2	51	19.6
	Type3	189	72.7
Total	Type1	20	7.7
	Type2	54	20.8
	Type3	186	71.5

There were significant differences between the three types of mental branches according to age and dental state and no significant differences according to gender and sides. Type three is found more in (20-40) age group and in dentate cases while type one and type two is found more in (41-70) age group and edentate cases (Table 4.2.).

Table 4.2. The frequency of mental branch types according to variables

		Type ı		Typeıı		Typeııı			
		n	%	n	%	n	%	Chi-square	p
Gender	Male	17	42,5	43	39,8	170	45,7	1,227	0,541
	Female	23	57,5	65	60,2	202	54,3		
Age_groups	20-40	1	2,5	4	3,7	197	53,0	109,5	<0,001*
	41-70	39	97,5	104	96,3	175	47,0		
Dental state	Dentate	5	12,5	12	11,1	249	66,9	130,3	<0,001*
	Edentate	35	87,5	96	88,9	123	33,1		
side	Right	20	50,0	57	52,8	183	49,2	0,43	0,806
	Left	20	50,0	51	47,2	189	50,8		

The AnL was visualized in 372 (71.5%) of the 520 hemimandibles analyzed.The bilateral presence of AnL was observed in 167 (81.5%) of the hemimandibles, followedby 22(10.7%) in the left unilateral side and 16(7.8%) in the right unilateral side (Table 4.3.).

Table 4.3. The presence of anterior loop according to sides

Anteriorloop	n	%
Bilateral	167	81,5
Unilateral: left	22	10,7
Unilateral: right	16	7,8
All	205	100,0

Among gender groups the prevalence of AnL was 73.9% among males and 69.7% among female individuals. There was no statistically significant difference between the two sexes in the prevalence of AnL (P=0,285). No significant differences were observed in prevalence (p=0. 0,560) between the right and left sides. Among the age groups, chi-square statistical analysis showed a significant difference between the two groups (P=<0,001). AnL was evaluated in 97.5% in (20-40) age group and 55.0% in (41-70) age group. According to the dental state of the patients, the analysis showed a significant difference between dentate and edentate groups (P=.001). AnL was evaluated in 93,6% in dentate group and 48.4% in edentate group (Table 4.4.).

Table 4.4. The presence of anterior loop according to the included variables

Variables		Loop				Total	Chi-square	P
		Absent		Present				
		n	%	n	%			
Gender	Male	60	26,1	170	73,9	230	1,142	0,285
	Female	88	30,3	202	69,7	290		
Side	Right	77	29,6	183	70,4	260	0,340	0,560
	Left	71	27,3	189	72,7	260		
Age_groups	20-40	5	2,5	197	97,5	202	109,55	<0,001*
	41-70	143	45,0	175	55,0	318		
Dental state	Dentate	17	6,4	249	93,6	266	130,28	<0,001*
	Edentate	131	51,6	123	48,4	254		
All sample		148	28,5	372	71,5	520		

*p<0.05= statistically different

The AnLL mean of the 260 subjects (520 hemimandibles) was 2.75±1,07 mm. The maximal and minimal AnLL were 6.7 mm and 0.6 mm. The mean AnLL on the right side was 2.78±1,08 mm with maximal and minimal values of 6.7 mm and 0.7 mm respectively. The mean AnLL on the left side was 2.72± 1.05mm with maximal and minimal values of 5.8 mm and 0.6 mm respectively. No significant differences were observed in length (p=0,556) between the right and left sides. The mean of AnLL for males was 2.99 mm and 2.55 mm for females. The mean length of AnL is significantly higher for male individuals than females (p =<0,001).The AnLL of the 20–40 age group was significantly longer than group 41–70 age group (P=0,001). The mean AnLL in the 20–40 year group was (2.93 mm) and the AnLL in the 41–60 year group was (2.55 mm). The AnLL of the dentate group was significantly different from edentate group. The mean AnLL in the dentate group (2,91 mm) was larger than the AnLL in the edentate group (2.4 mm) (Table 4.5.).

Table 4.5. The length of anterior loop according to the included variables

		Loop Length (mm)					t	p
		Mean	SD	Median	Min	Max		
Gender	Male	2,99	1,13	3	0,6	5,9	4,014	<0,001
	Female	2,55	0,96	2,4	0,8	6,7		
side	Right	2,78	1,08	2,6	0,7	6,7	0,589	0,556
	Left	2,72	1,05	2,7	0,6	5,8		
Age_groups	20-40	2,93	1,1	2,8	0,8	5,9	4,411	0,001
	41-70	2,55	1	2,5	0,6	6,7		
Dental state	Dentate	2,91	1,1	2,9	0,8	6,7	4,229	<0,001
	Edentate	2,43	0,92	2,4	0,6	5		
All sample		2,75	1,07	2,7	0,6	6,7		

SD=standard deviation
*p<0.05=statistically different

The mean value of X3 was 23.18mm with minimal value of 12.2 mm and maximal value of 28.7 mm. A significantly higher length of X3 was found among males (mean=23.7 mm) than among females (mean=22.77 mm) (p =<0,001). There was no difference in length of X3 among sides, age groups and dental state group. There was no correlation between the vertical and horizontal position of the MF (Table 4.6).

Table 4.6. The relation between X3 and the included variables

		The distance between MF and midline (X3)(mm)						
		Mean	SD	Median	Min	Max	t	p
Gender	Male	23,7	1,89	23,6	18,1	27,9	4,821	<0,001*
	Female	22,77	2,39	22,7	12,2	28,7		
side	Right	23,14	2,34	23,1	12,2	28,5	-0,493	0,622
	Left	23,23	2,11	23,35	17,9	28,7		
Age_groups	20-40	22,99	2,2	23,1	17,9	28,7	-1,556	0,120
	41-70	23,3	2,24	23,35	12,2	27,9		
Dental state	Dentate	23,08	2,11	23,1	17,9	27,8	-1,08	0,282
	Edentate	23,29	2,35	23,3	12,2	28,7		
All sample		23,18	2,23	23,2	12,2	28,7		

SD=standard deviation
*p<0.05=statistically different

The mean value of X1 was 11.91 mm with minimal value of 1.8 mm and maximal value of 19.1 mm. A significantly higher length of X1 was found among males (mean=12.6mm) than among females (mean=11.36) (p =<0,001). Also a significantly higher length of X1 was found among 20-40 age group (mean=13.41mm) than among 41-70 age group (mean=10.96 mm) (p =0,001). A significantly higher length of X1 was found among dentates (mean=13.37 mm) than among edentates (mean=10.39) (p =<0,001). There was no difference in length of X1 among sides (Table 4.7.).

Table 4.7. The relation between X1 and the included variables

		The distance between MF and superior boarder of the mandible(X1) (mm)						
		Mean	SD	Median	Min	Max	t	p
Gender	Male	12,6	2,77	13	5,1	19,1	5,132	<0,001*
	Female	11,36	2,72	11,9	1,8	17,7		
Side	Right	11,91	2,87	12,25	3,3	19,1	-0,036	0,971
	Left	11,91	2,75	12,2	1,8	17,7		
Age_groups	20-40	13,41	2,08	13,5	6,9	19,1	11,458	0,001*
	41-70	10,96	2,8	11,15	1,8	16,6		
Dentalstate	Dentate	13,37	2,01	13,5	6,9	17,9	14,143	<0,001*
	Edentate	10,39	2,72	10,7	1,8	19,1		
Allsample		11,91	2,81	12,2	1,8	19,1		

SD=standard deviation
*p<0.05=statistically different

The mean value of X2 was 13.56 mm with minimal value of 9.3 mm and maximal value of 22.4 mm. A significantly higher length of X2 was found among males (mean=14,37 mm) than among females (mean=12,92) (p =<0,001). There was no difference in length of X2 among sides, age groups and dental state group (Table 4.8).

Table 4.8. The relation between X2 and the included variables

		The distance between MF and lower boarder of the mandible(X2) (mm)						
		Mean	SD	Median	Min	Max	t	p
Gender	Male	14,37	1,68	14,25	10,4	22,4	11,011	<0,001*
	Female	12,92	1,32	12,9	9,3	16,6		
Side	Right	13,49	1,7	13,3	9,3	22,4	-1,019	0,309
	Left	13,64	1,61	13,5	10,3	20,6		
Age_groups	20-40	13,64	1,94	13,45	9,3	22,4	0,878	0,380
	41-70	13,51	1,44	13,4	10,2	18,4		
Dental state	Dentate	13,71	1,68	13,5	9,3	19	2,099	0,036
	Edentate	13,41	1,61	13,3	10	22,4		
All sample		13,56	1,65	13,4	9,3	22,4		

SD=standard deviation
*p<0.05=statistically different

There was no significant difference between X3 and the prevalence of AnL. There was a significant difference between X1 and the prevalence of AnL (p =<0,001). There was a significant difference between X2 and the prevalence of AnL (p =0,011) (Table 4.9).

Table 4.9. The relation between MF position and AnL frequency

Variable	loop	Mean	SD	Median	Min	Max	t	p
X1	Absent	10,7453	2,62158	10,8	1,8	16,6	-6,173	<0,001*
	Present	12,3737	2,75008	12,8	3,3	19,1		
	Total	11,9102	2,80959	12,2	1,8	19,1		
X2	Absent	13,2709	1,38009	13,1	10,2	17,9	-2,552	0,011*
	Present	13,6788	1,73833	13,5	9,3	22,4		
	Total	13,5627	1,65332	13,4	9,3	22,4		
X3	Absent	23,3655	2,2219	23,4	12,7	27,9	1,176	0,24
	Present	23,1108	2,23222	23,2	12,2	28,7		
	Total	23,1833	2,23012	23,2	12,2	28,7		

SD=standard deviation
*p<0.05=statistically different

There was no correlation between X3 and the length of AnL. There was a significant correlation between X1 and the length of AnL (p =0,001) (Fig.4.1). There was a significant correlation between X2 and the length of AnL (p =0,001) (Fig.4.2). There was acorrelation between X1 and X2 (Table 4.10.).

Table 4.10. The relation between position of MF and AnLL

Variables	r	p	n
Loop length- X1	0,173	0,001*	372
Loop length–X2	0,324	<0,001*	372
Loop length – X3	0,006	0,910	372
X1–X2	0,187	<0,001*	520
X1–X3	0,086	0,051	520
X2–X3	0,0029	0,512	520

*p<0.05=statistically different

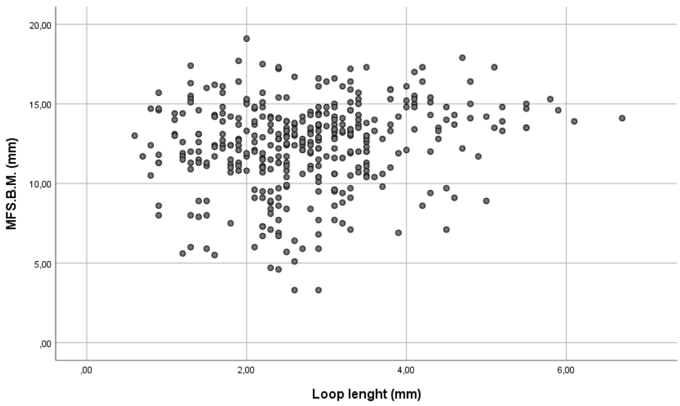

Figure 4.1. The correlation between X1 and AnLL.

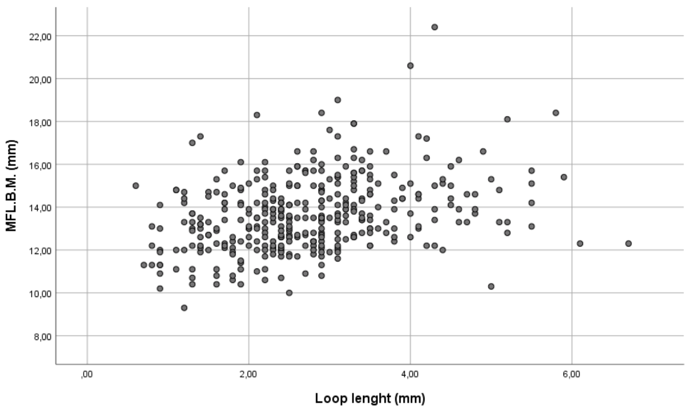

Figure 4.2. The correlation between X2 and AnLL.

The degree of agreement between the two observers in this investigation was examined using the intra-class correlation coefficient (ICC). An oral and maxillofacial radiologist used the designated approach to perform the re-analysis on thirty patients who were chosen at random. With ICC ranging from [0,901-1,000], all the examined variables showed "excellent" agreement between the two observers (Table.4.11).

Table 4.11. Interobserver agreement

Variables	ICC	Agreement
MF/X1 R	1,000	Excellent
MF/X1 L	0,999	Excellent
MF/X2 R	0,999	Excellent
MF/X2 L	1,000	Excellent
MF/X3 R	0,901	Excellent
MF/X3 L	1,000	Excellent
loop R	0,997	Excellent
loop L	0,999	Excellent
	Kappa	
loop R Type	1,000	Excellent
loop L Type	1,000	Excellen

ICC: Intraclasscorrelationcoefficient, Kappa: Cohen'sKappacoefficient

5. DISCUSSION

Radiographic screening is required before the dental implant procedure in the interforaminal region in order to prevent neurological trauma. One of the most severe side effects of lower jaw implant surgery is dysestesia of the lower lip due to MN damage (3).When implants are inserted 3 mm anterior to the mesial border of the foramen, there is a 7% chance of sensory disruption, which is a problem (13). However, the incidence of impaired sensation following procedures in the lower jaw falls to 1% when this distance is higher, as it is when inserting two implants in the anterior part of the lower jaw (80).

The assessment of AnL extensions has been done using a variety of methods, including radiographic methods and cadaveric studies. Large discrepancies in frequency and measurement of AnLL across the literature are likely caused by various definitions and measurement techniques. In cadavric studies Naber's probe could be used to probe the mental loop after surgical exposure of MF. However, such a method can not be used for every patient (81). Periapical radiographs could also be used to the mental loop. However due to the film's high degree of flexibility and frequently poor processing, periapical radiographs suffer negatively in terms of image quality. Furthermore, periapical film or a digital sensor cannot find the MF when it is positioned lower (82). Before mandibular procedures, panoramic radiograph is still extensively utilized because it may give extensive coverage of oral structures while using equipment that costs relatively less and emits relatively less radiation.

CBCT has recently taken on a more significant role in dentistry diagnosis thanks to its advantages of lower radiation exposure in comparison to CT with equivalent resolution and precision as well as its accessibility and affordability (81). Three-dimensional reconstruction models created with tomography data in the virtual environment are used in surgical practice, especially in the diagnosis and treatment stages of implant and orthognathic surgery applications, in linear measurements and volumetric calculations, to visualize the operation plan and to predict the postoperative results to be obtained from treatment options (83).

In the studies that investigate the prevalence of the anterior loop, the length of AL is also examined in general, and evaluations with different methods and techniques are also in question here, as in the prevalence evaluations. When examining the length of the AnL, it is necessary to define the starting and ending points. As in our study, the distance between the anterior border of the mental foramen and the end of the anterior loop was measured. However, it may be difficult to determine the point where the anterior loop ends or the region where the mandibular incisive canal begins. As an issue to be considered here, the researchers say that the diameter of the mandibular incisive canal should be smaller than the canal from which it splits. For this reason, researchers considered the mandibular incisive canal diameter as less than 3 mm in their investigations and included the parts larger than this size in the AnL borders (84, 60).

The presence of AnL has been demonstrated in several studies using anatomical and radiographic imaging of cadavers. Solar et al. reported that in a study of 37 cadaveric mandibles, AnLs in 60% of the cases (7). Neiva et al. showed an AL in 88% of 22 cadavers (85). Rosenquist found AnLs in 26% (15/58) of mandibular cadavers (86). Greenstein and Tarnow recommended using a probe to find the AnL. They came to the conclusion that it was impossible to tell whether the AnL or the incisive canal was being evaluated (46). Moreover, preoperative assessment could not be done using this procedure.

Eskenazi et al. found that an AnL was present in 48.8% of CBCT cases, compared to 36.6% of panoramic radiograph (PR) images (3). PR and anatomical dissection of 22 patients were compared in a study by Kuzmanovic et al. "Clinicians should not rely on PR for detecting the AnL of the MN before implant procedure," was their resounding recommendation (12). The idea that the MF or the extension of AnL cannot be precisely identified by PR. Depending on the area, these frequently have severe size distortions and low resolution (3).

CBCT studies revealed an AnL prevalence of 48-85.2% (84, 11). Apostolakis et al. in their study of 93 patients with CBCT images, AnLs were found to have a 48% frequency mostly bilaterally (84). By Nascimento et al AnL was identified in 41.6% of the cases, with most of the AnL were observed bilaterally, followed by the left and right sides, respectively (87). In our study the prevelence of AnL was identified in 71.5% of the cases with 81.5% of the loops were observed bilaterally followed by the left and right sides respectively. These results coincide with those mentioned by Filo et al. (69.73%) (60). There were found to be 7.7%, and 20.8%, total frequencies of type 1 and type 2, respectively.

The highest prevalence of the AnL was observed by Parnia et al in Iranian population (88) in 96 CBCT scans, AnL was seen in 84.4% of the cases. The 1 mm CBCT slice thickness used in this investigation may be the cause of this disparity. The less percentage of prevalence of AnL in our study was because of the 2 mm CBCT slice thickness. Similar prevalence statistics (85.2 %, n = 366) were obtained in USA by Lu et al (11). The different properties of the machine that has been used and the larger sample size (366) could be the reason of the higher prevalence of AnL than that found in our study.

In studies on Turkish population according to Kaya et al. 34% of the anterior loop could be detected on CT scan (89). In the study by Demir et al (5), the anterior loop was seen by CBCT in more than half of the cases (59.5%) along with type 2 (31.9%), and type 1 (8.6%). It is found to be less than the results of our study because in our investigation, oblique slices that allowed for simultaneous visualization of the mandibular canal, anterior loop, incisive canal, and MF were employed (11). In Demir et al study (5) vertical cross sectional slices were used. Apostolakis and Brownfound it challenging to recognize the most frontal portion of the MN on cross-section views, particularly when the bone density was low (84).

In our study no significant differences in frequancy of AnL between the right and left sides and between males and females were found. Similar to the results of the present study Filo et al. (60), Lu et al (11) and Sahman and Sisman (90) concluded that neither side of mandible nor sex had an impact on frequency of AnL.

In the present study the frequancy of AnL in (20-40) age gruop was 97.5% while in (41-70) age gruop was 55.0%. Older subjects may have trouble seeing the AnL since there is less calcification of the cortex as people get older. Bone goes through a variety of quantitative and qualitative changes, although the process of remodeling seems to slow down with age (81, 91). Cortical porosity and the fraction of Haversian canals resorb both obviously after the age of 50 (81, 92). This resorption causes the marrow space to widen and the presence of disorganized trabeculae frequently, which makes it difficult to recognize the anterior loop (81,93). As a result of the bone canals becoming radiolucent, this may help to explain why a large majority of people older than 50 did not have the AnL visible.

Since the visibility and course of AnL have been documented to change with the alveolar bone resorption that occurs after tooth loss (94), we decided to evaluate the AnL in dentate and partially or entirely edentate patients. Because the presence of MF is linked to the area of the premolar teeth, patients who were missing teeth in this area of the mandible were depicted in images as somewhat edentulous. The MF has been identified in several investigations as being in the horizontal plane, typically near the second mandibular premolar's apex or in between the premolars. In our study, we found that prevelence of AnL in dentate cases was 93.6% and 48.4% in edentate cases. These results consistent with research findings (12,81,91). According to Kuzmanovic et al. (12), edentulous patients' poor bone quality may have a negative impact on the radiographic imaging of the mental canal. In edentulous patients, resorption of the remaining alveolar ridges may advance to the point where the mental canal is resorbed and the mental neurovascular bundle is revealed (94).

Solar et al. reported that in a study of 37 cadaveric mandibles, AnLs with a mean length of 1 mm ranged from 0.5 to 5 mm (7).Apostolakis et al. in their study of 93 patients with CBCT images, AnLs were found to havea mean length of 0.89 mm (range: 0–5.7mm) (84).Parnia et al in their study on Iranian population (88) in 96 CBCT scans, found that the AnL had an average length of 3.54 mm. In another CBCT study that was obtained in USA by Lu et al, the mean length was different (1.46 mm) (11). In our study the AnLL mean of the 260 subjects was 2.75 mm with maximal and minimal value of 6.7 mm and 0.6 mm.

In our study no significant differences in length of AnL between the right and left side were found. Filo et al.(60), Lu et al. (11) and Sahman and Sisman (90) concluded that neither side of mandible nor sex had an impact on length of AnL, but in our study the mean length of AnL was larger in males (2.99 mm) than in females (2.55 mm) ($P<0.001$).These outcomes match those that mentioned by Sinha et al. (95), Wei et al. (96),Nascimento et al.(87) and Uchida et al (97).

We discovered that the AnLL of the age groups of (20- 40) was significantly higher than those of (41-70). This is also in line with the findings of Lu et al. (11), Ngeow et al (91) and Uchida et al (97) who claimed that as participants got older, the AnL became less visible. The MF advances upwards toward the alveolar border with tooth loss and bone resorption, according to a study by Gershenson et al. (98). Depending on the level of resorption, the MN emerged from the MF closer to or near the alveolar boundary. The MF moves toward the anterior portion of the mental loop as a result of bone resorption when teeth are removed, and the AnLL diminishes (11, 98). Chen et al. investigated 200 CBCT scans and compared age intervals between the American and Taiwanese populations, and found no noticeable changes in the length of the AnL (99).

In the present study the mean length of AnL was 2.91 mm in dentate subjects and 2.43 mm in edentate subjects, and the difference between the groups was significant (P<0.001). No signifigant differences in AnLL were found between edentuluos and dentate subjects by Rosa et al. (100) and Prados-Frutoset et al. (101). The location of MF can change during jaw development (102). Throughout life, MF can be found in various places. Children exhibit MFs closer to the alveolar crest prior to tooth eruption. In dentate adults, the location is closer to the inferior mandibular boundary and lowers to an intermediate position between the alveolar crest and the border during eruption (98). Since the MF during the mixed dentition may be hidden by permanent tooth roots (103), only the young adults over 20 were investigated in the present study. Also, we must be aware that a variety of variables, including periodontal disease, post-extraction bone loss, and bone loss due to trauma, may influence the MF position (98).

The distance between MF and superior boarder of the mandible (X1) value have been investigated in this study and it has been stated that it is affected by age, gender and dental status (104). In our study, the mean value of X1 was 11.91mm that is consistent wih the previous research by Muinelo-Lorenzo using CBC which it was found to be 11.84mm (104) and Von et al. reported that the mean distance between the MF and the alveolar crest was 12.6 mm (105). 100 dentulous patients were evaluated by Haktanir et al (106) using CT. The average distance was 14.2 mm (range, 10.7–29.8 mm). Values by side and gender did not differ significantly. However, due to crestal bone loss, this distance might not be stable and other writers have advised using the cementoenamel junction of nearby teeth as a more accurate reference point. The average distance in cadavers was between 15.5 and 16.6 mm from the MF to the cement-enamel junction (107, 85).

We discovered no appreciable differences in X1 distance with respect to hemimandible side, similar to prior research (105,106,108). According to prior studies, females had significantly lower X1 distance than males (50,105,109), in line with the results of our study. The mean value of X1 in males was 12.6 mm and 11.36 mm in females in the current study. Regarding dental status, an expected decrease in X1 value was observed in edentulous cases in our study, which is consistent with the literature (50, 98, 104). The X1 value in our study was found to be 13.37 mm in dentate individuals, and 10.39 mm in edentulous individuals. The interesting concept that mandibular edentulism may be connected to particular form alterations in the mandible is raised by the fact that the patient´s dental state can affect mandibular shape (110). According to Soikkonen et al. (111), X1 was 3.8 mm less in edentulous mandibles than in dentate mandibles. According to Muinelo-Lorenzo et al. (104), dental status predicts the distance between MF and mandibular superior border. Therefore, dentate patients are 10 times more likely than edentulous patients to experience long X1 distances. The apparent changes of the position of MF relate to and affects the deposition of alveolar bone. The alveolar crest moves downward and toward the MF as a result of tooth loss and bone resorption. The MF and the nearby portion of the mandibular canal are open at the alveolar edge in severe cases of resorption (112). The distance X1 was found to be affected by age. Due to bone resorption brought on by tooth loss, which is increasingly common as people age increases, the X1 distance is shorter in the older age group (10.96 mm) than in younger age group (13.41mm) in our study. Age affects the X1 distance and MF vertical position in patients with completely dentate teeth. Therefore, the X1 distance decreased with age. Bone loss becuaseof periodontal diseases are one of the causes that could help to explain these findings (104). Some authors (98, 110) have shown similar differences; however, other authors (105,113,114) found no relationship between age and X1 distance in individuals with all of their teeth in the MF region. They assert that regardless of age or gender, the mandibular canal and the MF stay in a largely constant location (113,114).

The distance of the MF to the lower border of the mandible (X2) has been evaluated in many studies. The MF has been demonstrated to be precisely at the same position on the majority of persons (13–15 mm above the inferior border of the mandible) (115). Agthong et al. reported the mean distance of X2 as 14 mm (116), similar to the result of our study which it was 13.56 mm and Neiva et al. reported it as 12 mm on average (85).

We discovered no appreciable differences in X2 distance with respect to hemimandible side, similar to prior researches (105,106,108). According to prior studies, females had significantly lower X2 distance than males (50,105,109), in line with the results of our study.

The mean value of X2 in males was 14.37 mm and 12.92 mm in females in the current study.

In Turkish population, Hasanoğlu Erbaşar et al. discovered that males had a substantially greater distance from the MF to the mandibular basis than females (117). Pires et al. (118) and Pereira-Maciel et al. (119) also discovered that X2 is greater in males than in females. It was related to the fact that females's mandibles were smaller than males's (118,119). Males grow more quickly and at a faster rate during the adult phase, which causes their craniofacial dimensions to be 5-9% larger than those of females. The development of craniofacial morphologic distinctions between genders is influenced by the speed of bone growth during this phase, which is influenced by sex hormones like progesterone and estrogen (120).

However, in contrast to Muinelo-Lorenzo et al. (104) who found no variation in the X2 distance with respect to dental status, we discovered asignificantdifference in the X2 distance with regard to dental status. Chrcanovic et al. (112) reported areduction in X2 distance in edentate subjects. These authors explain that presence and absence of teeth has a higher impact on the mandibular morphology than does gender, and that dental loss causes greater alterations in mandibular height than mandibular width dimensions. Additionally, they note that there are statistically significant variations between dentate and edentulous patients in terms of the relative MF position in the mandible (112,121).

The distance X2 was not affected by age in current study, in similar to findings by Lim et al. (122) and Bhardwaj et al (120). The later two researchers also reported that there were no statistically significant differences in the mean value of the distance between the MF and the tangent drawn to the base of the mandible for the various age groups (120). While the position of the MF varied throughout primary dentition, it largely remained consistent during the eruption of the permanent and mixed dentitions (122). Because our samples were older than 20 years old, the space between the MF and the inferior border of the mandible remained constant with age. Our CBCT results corroborated the literature's assessment of PR, which indicated that despite the resorption of the alveolar process above the foramen, the distance from the foramen to the inferior border of the mandible remains largely consistent throughout life (123).

Most studies determined the horizontal location of MF according to adjacent teeth apices. The approach suggested by Chong et al. (124) served as the foundation for the method used to assess the relationship between the MF and the roots of the mandibular posterior teeth.Although in a clinical setting it is more suitable to link the MF to lower teeth, mesial tooth drift may be brought on by tooth extraction, proximal caries, or proximal attrition (125). Hence, comparing the MF position to the surgically encountered anatomical markers on the mandible is an accurate way to record its position. In the present study, the horizontal positions of the MF were determined relative to the symphysis metni. This approach has been used by Tebo&Telford and then by several authors to determine the location of the MF (40). The distance between MF and symphysis metni was observed to be the lowest (19.0 mm) in Turkish population (126) and the highest (29.0 mm) in the Pakistani (127). In our study, the mean value of X3 distance was 23.18 mm and showed great values only in males. It was related to the fact that women's mandibles were smaller than men's (118,119). It was no significant difference between X3 distance and side of the mandible, age and dental state. The distance from MF to midline was constant between different ages according to Guler et al. (123) and Lindh et al (128). The surface of the mental protuberance is still used as an area of bone deposition with the total loss of dentition and age (or at least the bone there does not actively resorb), according to Enlow et al. (129), so overall mandibular arch length is not lowered.

A study made by Kalender et al (50) to asses the incidence of AMFs in a Turkish population. AMFs were seen in 6.5% of examined patients. Between 1.8 to 16.7% of cases of accessory MF was reported in the literatures (110,130). In the current investigation, the frequency of multiple MF was 1.9%. While examining 1,435 dry human mandibles, Freitas et al. (131) discovered that two of the right side's (0.06%) and one of the left side's (0.03%) of the skulls lacked mental foramina.

6. CONCLUSION

CBCT is the procedure that truly correlates to clinical practice and properly satisfies pre-surgical planning criteria, even if anatomical investigations on cadavers offer significant and precise data on the frequency and length variations of the anterior loop.Additionally, due to its benefits, which include less expense and a lower radiation dose, CBCT images have been demonstrated to exhibit good accuracy and consistency in the diagnosis and definesion of the position of the MF, IAN, MN, AnL and other anatomical landmarks in the mandiblein order to effectively prevent harming the nerve during surgery and to lessen postoperative problems of nerve injury.

After evaluation of 260 CBCT scans of the patients,

1. There were found to be 7.7%, 20.8%, and 71.5% total frequencies of type 1, type 2 and type 3 respectively.

2. Of the scans 71.5% showed an AnL of the MN to be present.

3. There were no statistically significant differences between the left- and right-side prevalence or between the sexes, although the AnL prevalence was considerably higher in the age groups of 20 to 40 than it was in the groups of 41 to 70 and was considerably higher in the dentate group than it was in the edentate group.

4. The AnLL was measured in a wide range, from 0.6 mm to 6.7 mm, with a mean of 2.75 mm.

5. There were no statistically significant differences between the left and right side measurements of AnLL, although the AnLL was considerably higher in the age groups of 20 to 40 than it was in the groups of 41 to 70, higher in males than in females and higher in dentate subjects than in edentates.

6. The mean value of X1 was 11.91 mm. A significantly higher length of X1 was found in males than females. Also longer in 20-40 age group than in 41-70 age group and

longer among dentates among edentates. There was no difference in length of X1 among sides.

7. The mean value of X2 was 13.56 mm. A significantly higher length of X2 was found in males than in females. There was no difference in length of X2 among sides, age groups and dental state group.

8. The mean value of X3 was 23.18mm. A significantly higher length of X3 was found in males than in females. There was no difference in length of X3 among sides, age groups and dental state group. There was no correlation between the vertical and horizontal position of the MF.

9. There was no significant difference between X3 and the prevalence of AnL. There was a significant difference between X1 and the prevalence of AnL and a significant difference between X2 and the prevalence of AnL

10. There was no correlation between X3 and the length of AnL. There was a significant correlation between X1 and the length of AnL anda significant correlation between X2 and the length of AnL.

The AnL of the MN becomes a crucial surgical reference point during treatment planning before placing implants in the interforaminal area. Due to the AnLL and emergency pattern having been shown to have a large range of variability in our study, no defined distance mesially or anteriorly from the MF should be thought of as a "safe" distance to prevent harm to the MN and its neurovascular bundle. So, we suggest performing a tridimensional and individual investigation by CBCT in each patient.Using the technique outlined in this article to analyze CBCT images can help prevent complications from implant surgery. We suggest that, during absence of CBCT or 3D reconstructs of the AnL, it would be safe to place an implant 7 mm anterior to the MF According to authors. It is essential to examine the mandibular, mental, and incisive nerves' three-dimensional locations in addition to the AnL of the MN's length.

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APPENDIX 1

Ortak Ar-Ge ve Arşiv veri kullanım Sözleşmesi

1- Sözleşmenin Tarafları

Bu sözleşme, Dentistomo Dental Görüntüleme Müessesesi (bundan sonra Dentistomo olarak zikredilecektir) ile aşağıda unvan ve isimleri yazılı araştırmacı Şahıs/Kurum lar (Bundan sonra araştırmacı/araştırıcı olarak zikredilecektir) arasında akdedilmiştir.

2- Taraflara İlişkin Bilgiler

A- Dentistomo Dental görüntüleme müessesesinin bilgileri aşağıdaki gibidir.

Araştırmacılar	İmza
3.	
4.	
5.	

3- İşin konusu, Araştırma adı, Yapılma Yeri

Sözleşme konusu iş: Bilimsel ve/veya Teknolojik araştırma ve geliştirme işidir.

Araştırmanın Adı:

Nervus Mentalis'in Ön Halkasının Prevalansı ve Uzunluğunun Değerlendirilmesi: Koni Işınlı Bilgisayarlı Tomografi Çalışması (CBCT).

İşin yapılma yeri: Dentistomo Dental Görüntüleme Müessesesi- Ankara

4- Dentistomo'nun yükümlülükleri

Bu iş için gerekli tıbbi cihaz, ekipman ve data alt yapısını sağlamakla yükümlüdür. Araştırma amacıyla yapılacak görüntüleme hizmetini iyi niyetle ve eldeki imkanların en iyi standardıyla sağlamakla yükümlüdür.

5- Araştırıcıların yükümlülükleri

a- Araştırıcı, araştırma amacıyla kullanılan cihaz, ekipman ve data alt yapısına maksimum özeni göstermekle yükümlüdür. Aksi durumda doğabilecek zararları tazmin edeceğini kabul ve taahhüt eder.

b- Araştırıcı, araştırma amacıyla Dentistomo'da bulunacağı gün ve saatler için Dentistomo'nun onayını almakla yükümlüdür.

6- Ücretsiz Araştırma ve arşiv veri kullanımı

a- Dentistomo'nun kendisine ait arşiv verilerini bilimsel araştırma amacıyla ücretsiz kullanan araştırıcıların hepsi, Dentistomo'nun uygun gördüğü bir araştırmacıyı bilimsel çalışmada araştırmacı olarak göstermeyi ve çalışmadaki katkısı nedeniyle kuruluşa teşekkür yayınlamayı kabul ve taahhüt eder. Aksi bir durumun etik ihlal olduğunu kabul eder. Etik ihlal nedeniyle her türlü sorumluluk araştırıcılara aittir.

b- Her araştırmacı çalışma amacıyla Dentistomo arşivinden elde edilen verileri ve bu verilerden elde edilen kimlik bilgilerini üçüncü şahıslarla paylaşmayacağını kabul ve taahhüt eder. Aksi durumda Dentistomo'nun verilerinin kopyalanması, çalınması, kaybolması veya üçüncü şahıslara aktarılması nedeniyle ortaya çıkabilecek bütün maddi ve hukuki zararları araştırcılar müteselsilen tazmin etmekle yükümlü olduğunu kabul ve taahhüt eder.

c- Araştırmacı/lar, Dentistomo'nun ücretsiz oalrak sağladığı arşiv verilerini Dentistomo'nun yazılı izni olmaksızın başka bir araştırmada kullanamaz. Aksi tespit edilen araştırıcı/lar şahsen ve müteselsilen bütün verilerin rayiç görüntüleme ücret bedellerinin en az 10 katını cezai şart olarak ödemeyi kabul ve taahhüt eder.

d- Araştırmacı/lar Dentistomo'ya ait verileri izin almak suretiyle dahi olsa ücret ödemeden kullandığı takdirde, herhangi bir sempozyum, kongre, toplantı, bilimsel araştırma/makale, vaka raporu, editöre mektup, sözlü tebliğ, poster sunumu, uzmanlık tezi, doktora tezi vs. mecralarında Dentistomo'ya teşekkür yayınlamayı kabul ve taahhüt eder. Aksi durumların cereyan etmesi halinde "Conflict interest" kapsamında ilgili dergi editorüne bildirilecektir.

e- Araştırma amacıyla kullanılan/kullanılacak arşiv verileri, Dentistomo'nun onayı olmaksızın konu başlığı farklı olsa bile başka bir çalışmada kullanılamaz ve başka verilerle birleştirilemez. Aksi durumun cezai şartı gerektirdiği bütün araştırıcılar tarafından müteselsil kefaletle kabul edilir.

7- Cezai Şartlar

Sözleşme hükümlerine uymayan taraf karşı tarafın zararını tazmin etmekle yükümlüdür. Her iki taraf dürüst ve iyi niyetle davranmayı kabul ve taahhüt eder.

8- Anlaşmazlıkların Çözümü

Bu sözleşmenin uygulanmasından doğabilecek her türlü anlaşmazlığın çözümünde Ankara mahkemeleri ve icra daireleri yetkilidir.

9- Yürürlük

Bu sözleşme; taraflarca imzalandığı tarihte yürürlüğe girer.

9 maddeden ibaret olan bu sözleşme; İdare ve Yüklenici tarafından tam olarak okunup anlaşıldıktan sonra .... tarihinde imza altına alınarak (BİR'er) nüshası taraflarca (Dentistomo ve Araştırıcı/lar) alıkonulmuştur.

Dentistomo Görüntüleme

Araştırıcıları temsilen
Sorumlu araştırmacı