Assessment of Anterior Loop of Inferior Alveolar Nerve at the Mental Foramen – A CBCT study

Dissertation submitted to

THE TAMILNADU DR. M.G.R MEDICAL UNIVERSITY

In partial fulfillment for the Degree of

MASTER OF DENTAL SURGERY

BRANCH III

ORAL AND MAXILLOFACIAL SURGERY

2016-2019

RAJAS DENTAL COLLEGE AND HOSPITAL

KAVALKINARU, TIRUNELVELI – 627 105.

DCI Recognition No. : DE-3 (44)-93/2246 Dated 09/11/1993

Affiliated to The Tamilnadu Dr. M.G.R. Medical University, Chennai.

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This is to certify that this dissertation entitled **"ASSESSMENT OF ANTERIOR LOOP OF INFERIOR ALVEOLAR NERVE AT THE MENTAL FORAMEN – A CBCT STUDY"** is a bonafide work done by **Dr. PRIYANTHI.M** under my guidance during her postgraduate study period between **2016 – 2019.**

This Dissertation is submitted to **THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY**, *in partial fulfillment for the degree of* **MASTER OF DENTAL SURGERY** in **ORAL AND MAXILLOFACIAL SURGERY - BRANCH III.** *It has not been submitted partially or fully for the award of any other degree or diploma.*

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ACKNOWLEDGEMENT

I thank **GOD THE ALMIGHTY** for **HIS** blessings and grace all throughout my life in achieving unexpected goals and proceed towards new height of destination.

I consider it a great privilege and honour to express my profound gratitude to **Dr. I. PACKIARAJ MDS**, Professor and Head, Department of Oral and Maxillofacial surgery for his inspiring guidance, constant encouragement, sound advice, unlimited help and kind support throughout the course of this study as well as during my entire course. More words cannot express my gratitude to him for honing my surgical skills and for his professional guidance throughout my post-graduation.

It is with supreme sincerity and deep sense of appreciation that I thankfully acknowledge my guide, **Dr. N. DHINEKSH KUMAR MDS., MOMSRCPS (UK)** Professor, Department of Oral and Maxillofacial surgery, for his inspiring guidance, valuable counsel, and constructive suggestions and throughout the course of my study.

It is my pleasure to express my sincere thanks to **Dr. M. Bhaskaran MDS., FDSRCS (Eng)** former Head, Department of Oral and Maxillofacial surgery for his guidance , timely help, suggestions, valuable advice throughout my course.

I express my sincere thanks to **Dr. Gen Morgan MDS,** Reader for his guidance, **Dr. Alaguvel Rajan MDS**, former Reader**, Dr. Divakar .T.K MDS** former Senior Lecturer, **Dr. Suresh. C MDS,** and **Dr.Vinit MDS**, senior lecturers, Department of Oral and Maxillofacial surgery, for their advice and suggestions throughout the study.

I thank **Dr. ANGELINE DEEPTHI MDS**, Professor and Head, Department of Oral Medicine and Radiology, for her kind help and support throughout my study. My special and sincere thanks to Reader **Dr. Saravana Barathi MDS,** Senior Lecturer **Dr. John Hearty Deepak MDS, Department of Oral Medicine and Radiology** for their teaching and guidance that was so helpful to understand and complete my study.

It is my extreme pleasure to extend my gratitude to **Dr. Jacob Raja MDS**, our beloved chairman for his valuable support and constant encouragement throughout the period of my study. It gives me immense pleasure to convey my deep indebtness to our respected Principal, **Dr. Anisha Cynthia Sathiasekhar MDS,** Vice principal (Academics), **Dr. Antony Selvi,** Vice principal (Administration), **Dr. J. Johnson Raja MDS,** Administrative Director, and other Members of the **Ethical Committee and Review Board** for the permission, help and guidance throughout the course.

I am grateful to my colleague **Dr. Kala Bagavathy** for the co-operation and support she offered me during my postgraduate course. My very sincere thanks to my junior colleagues **Dr. Jenin. N.T.** and **Dr. Chandoorya. C** for the kindness they have shown to me. I also thank **Dr. Jebina Dennis**, **Dr. Saravanan. G** for their kind help and support. I extend my sincere thanks to my senior colleagues **Dr.Vimal Joseph, Dr. Kavitha**, **Dr. Suresh. C**, **Dr. Magleen Kingsly** for all their timely advices that tuned me. I also thank **Dr. Divya Jose R** postgraduate**, Department of Oral Medicine and Radiology** for her kind help throughout my research.

I also want to thank all the non-teaching staff of Department of Oral and Maxillofacial Surgery for the helping hands they have extended to me throughout the course of my study.

I dedicate this dissertation to my beloved husband **Dr. Pradeep Kumar. R MDS, MBBS,** my father-in-law **Dr. Ravindran. G PhD, former Dean, Sports, Annamalai University**, and my mother in law **Dr. Vijayalakshmi. K**, my sweet little son **Pradhumnaa. P** for their love, sacrifice, motivation and encouragement. I thank my care taker **Mrs. Pushpam** who have been supporting throughout my study. I also thank them for valuing my dreams and aspiration.

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ETHICAL CLEARANCE

The Study titled **"Assessment of Anterior Loop of Inferior Alveolar Nerve at the Mental Foramen – A CBCT Study"** by **Dr. Priyanthi M**, Department of Oral and Maxillo-Facial Surgery, Rajas Dental College & Hospital, on scrutiny by the Rajas Dental College Ethics Committee (RDCEC) has been given Ethical Clearance to conduct the study.

Recommended for a period of 3 years

Date of Review: 12/12/2017

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- Annual report has to be submitted to RDCEC.
- Members of the IEC have the right to monitor the trial with prior intimation.

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Analysed Document: thesis wite up.docx (D61792431)
Submitted: 03/01/2020 07:50:00
Submitted By: rupeshnavin2014@gmail.com
Significance: 11 %

Sources included in the report:

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CERTIFICATE – II

This is to certify that this dissertation work titled **"ASSESMENT OF ANTERIOR LOOP OF INFERIOR ALVEOLAR NERVE AT THE MENTAL FORAMEN - A CBCT STUDY"** by the candidate **Dr. Priyanthi. M** with the Registration Number **241615202** is submitted for the award of **Master of Dental Surgery** in the branch of **Oral and Maxillofacial Surgery - Branch III.** I personally verified the urkund.com website for the purpose of plagiarism check. I found that the uploaded thesis file has contents from Introduction to Conclusion pages and its result shows 11 percentage of plagiarism in the dissertation.

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ABSTRACT

Purpose :

Sufficient area in the interforaminal region is required for dental implant placement, anterior mandibular surgeries and the anterior loop of the IAN is located within the limits of this area. The aim of this study was to evaluate the prevalence and extent of the anterior loop in patients reporting to Rajas Dental College and Hospital by using cone-beam computed tomography (CBCT).

Materials & Methods:

CBCT images from 127 patients (254 hemimandibles) obtained for various clinical indications were randomly selected and evaluated to determine the presence and length of the anterior loop. The length of the anterior loop was then compared based on gender, side and age of the mandible. The data were analyzed using the Pearson chi-square test and linear regression analysis.

Results:

An anterior loop was identified in 55.9% of the cases, and its length ranged from 0.25 mm to 3.25 mm (mean - 1.00±0.79mm). The loop had a greater mean length and was significantly more prevalent in females (p=0.02). Significant differences were found among different age groups (p=<0.0001). Anterior loop was found commonly in the age group of 36-45, 46-55 (p= 0.02, p=0.02).

Conclusion:

In this study, a high prevalence of the anterior loop of IAN was found, and its length varied greatly, in most cases it was less than 1 mm long. Although this is a prevalent anatomical variation, safety limits for the placement of implants in this region cannot be established before an accurate evaluation using imaging techniques in order to identify and preserve the neurovascular bundles.

Keywords:

Anterior Loop, Mental Foramen, Cone Beam Computed Tomography, Inferior Alveolar Nerve, Mental Nerve, Computed Tomography.

ABBREVIATIONS

MF	-	Mental Foramen
IAN	-	Inferior Alveolar nerve
CT	-	Computed Tomography
CBCT	-	Cone beam computed tomography
PR	-	Panoramic radiography
3D	-	Three dimension
SSO	-	Saggital split osteotomy
MN	-	Mental nerve
FOV	-	Field of view
MSCT	-	Multi- Slice CT
OPG	-	Orthopantamogram

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INTRODUCTION

Human face is highly innervated. The sensation of the face is by the 5^{th} cranial nerve i.e. Trigeminal nerve. The sensory part of the trigeminal nerve has its origin from trigeminal ganglion which is situated in the Sella Turcica of the Middle Cranial Fossa. Then it divides in to Ophthalmic, Maxillary and Mandibular branch that innervates the upper, middle and lower third of the face respectively.

Mandibular nerve is the third division of the trigeminal nerve and it enters the mandible through mandibular foramen[50]. After entering the mandibular foramen it is called the inferior alveolar nerve. The terminal part of the inferior alveolar nerve sometimes passes below the lower border and extend beyond the mental foramen as an intraosseus anterior loop. Mental foramen in the embryonic period is at the apical area of the canine and first deciduous molar and is displaced anteriorly but after eruption of second deciduous molar it redirects posteriorly, that displacement is a possible cause for development of anterior loop of inferior alveolar nerve before it emerges as mental nerve[8]. Though it is a benign anatomical variation its accurate identification is necessary for surgical planning like implant placement[15]and anterior mandibular surgeries like genioplasty, surgical rehabilitation after mandibular trauma, bone harvesting from chin, root resection of mandibular premolars[20].

The placement of endosseus dental implants to replace the lost teeth over the decades had become an extremely predictable treatment modality. Dental implant placement in the anterior mandible had become the standard of care for edentulous mandibles. Although it is generally regarded as a safe procedure, there were anatomical risks in the anterior mandible[16.] The most anatomical risk was the possible damage to the anterior loop of the inferior alveolar nerve (IAN) just before it emerges through the mental foramen[37.]

Failure to identify the IAN preoperatively might result in iatrogenic damage to the nerve. Damage to the anterior loop would result in mental nerve damage. This may present as anaesthesia, paraesthesia, dysesthesia, of the mental nerve[37]. The mental nerve supplies sensation to labiomental area and gingival tissue up to the mandibular second premolar[18]. Altered sensation in this region may impede the ability to perform routine activities such as eating, speaking and even tooth brushing[37].

The prevalence of anterior loop varies.[48] In a cadaver study Bavitz et al[9] found anterior loop in 11% of cases. Li et al[47] using spiral CT identified the anterior loop in 84% of cases. Leonardo et al[15] identified the anterior loop in 41.6% of cases where as Parnia et al[16] found anterior loop in 84% of cases by using CBCT .The large variations in incidence highlight the fact that conventional two dimensional radiological methods are unreliable in identifying the anterior loop.

To avoid injury to the mental nerve, many authors have advocated varying safety margins from the mental foramen. They have recommended implants to be placed in 1mm,[9]4mm,[45] 3mm,[13]6mm.[30] Parnia et al[16] recommended that the foramen and the loop should be determined on a case by case basis to exploit the appropriate location for each individual by using CBCT.

Cone-beam Computed Tomography (CBCT) presents several advantages, such as allowing the three-dimensional (3D) assessment of craniofacial structures without distortion or overlapping images, in addition to a lower radiation dose than multislice CT. Moreover, CBCT is considered the standard method for assessing bone tissue [40,47] and is able to determine the presence and length of the anterior loop with precision and reliability[27,29], in a single scan both bone and soft tissue are analyzed[11]. It should be highlighted that significant individual anatomical variations are present to various extent and it is very important to precisely identify and to preserve neurovascular bundles in order to avoid sensorineural damage in the interforaminal region.

AIMS AND OBJECTIVES

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AIMS:

The purpose of this descriptive study was to assess the prevalence and extent of Anterior Loop of Inferior Alveolar Nerve at the Mental Foramen by using CBCT.

OBJECTIVES:

The objective of the study was to evaluate the prevalence & variations in length of anterior loop of the inferior alveolar nerve and to make clinical applications in anterior mandibular surgeries by using CBCT.

REVIEW OF LITERATURE

1. **Anthony P.Joyce** et al (1993)[5] given bilateral injections for thirty volunteer subjects. Pain and preference for either injection type were evaluated via questionnaire. Successful incisive nerve anaesthesia without entering mental foramen ranged from 58 to 76% for the three types tested. There was no significant difference in pain perception if the injection was given inside or outside the foramen and concluded that successful anaesthesia is effective for all teeth innervated by incisive nerve.

2. **Bruce Bavitz J** , DMD et al (1993)[9] suggested that no damage to the mental nerve will result if the posterior portion of the implant is placed 1mm anterior to the anterior border of the foramina.

3. **Jaaskelainen S K** et al (1996)[23] performed on 23 patients undergoing orthognathic surgery of the mandible, most of them (20) with bilateral saggital split osteotomies. The function of the inferior alveolar nerve was studied preoperatively, and 2 weeks, 2 months, 6 months and 1 year postoperatively with both mental nerve blink reflex test and clinical neurosensory testing and demonstrated that pain sensation recovers later than tactile sensation after IAN injuries and that reduced pain sensation is a more sensitive indicator of permanent nerve damage after SSO than hypoesthesia.

4. **Wismeijer D** et al(1997)[45] did a randomized controlled clinical trial 110 edentulous patients with severe mandibular bone loss have been treated with ITI-

dental implants using three different treatment strategies: (1) a mandibular overdenture supported by two implants with ball attachments, (2) two implants with an interconnecting bar or (3) by four interconnected implants and concluded that the risk of sensory disturbance after implant insertion in the intraforaminal area of an edentulous mandible and the wearing of an implant-supported overdenture is a complication that develops in about 7% of cases which means that patients must be warned about it before treatment. Results of this study have also shown that a sensory disturbance of the lower lip present before implant insertion and overdenture treatment, in an edentulous patient who has not undergone previous pre-prosthetic surgery, disappears in most cases.

5. **Westmark A** et al (1998)[28] did a study to evaluate possible influence on the function of the inferior alveolar nerve after SSO of the mandible in a pool of 1034 patients. Of these patients, 274 had SSOs, giving 548 operated sides after exclusion criteria had been taken into consideration 496 operated sides remained for analysis. Age, (in years), was the age that the patient reached during the year of operation and showed no sex-related differences in nerve dysfunction after SSO but did show an age related difference. The risk of developing any type of neurosensory dysfunction after SSO as 40% on one side and equally 40% on the other side of the lower lip and chin. It may also exist on both sides simultaneously so the risk of developing any degree of dysfunction on either side, or both, of the lower lip and chin.

6. **Lipa Bodner, DMD** et al (1998)[43] evaluated the use of images obtained by a dental computed tomography (CT) software program in the diagnosis and treatment of trigeminal neuropathy associated with jaw abnormality. Twelve patients with jaw abnormality associated with trigeminal neuropathy,as the presenting symptom were studied by plain film radiography (PFR) and by a dental CT software program (DS) that displays multiple panoramic and cross-sectional views of the mandible and maxilla. The two modalities were compared for delineation of the integrity of mandibular foramen, mandibular canal, mental foramen, incisive foramen, and incisive canal. Also, displacement of the neurovascular bundle was evaluated and scored. Study shows that DS can also be applied to the diagnosis and treatment of trigeminal nerve neuropathies associated with jaw bone abnormality. DS permits the visualization of the maxilla and mandible in three planes: panoramic, axial, and cross-sectional (bucco-lingual).Using this software program, anatomic structures such as the mandibular foramen and canal, the mental foramen, and the incisive foramen and canal, as well as the maxillary sinus, can be seen in cross section. This information can be crucial for the proper management of patients.

7. **Richer Bartling DDS** et al (1999)[36] did a study in ninety-four patients who underwent placement of mandibular implants. The patients excluded from this study were those who had pre-existing injury to the trigeminal nerve. Implant length was based on panoramic radiograph in 43 male and 51 female patients and in 13 patients where the mandibular canal was not adequately visualized by

panoramic radiographs. CT was used to plan the implant locations. Implants were selected 2 mm above the inferior alveolar canal based on panoramic radiograph and 1mm above based on CT images. Patients were divided in to 2 zones. In zone 1 implants were placed after mental nerve visualization with the posterior portion of implant 3 mm anterior to the most anterior portion of the mental foramen. In zone 2 implants using a CT scan, 1 mm was the planned distance from the implant apex to the inferior alveolar canal. Three of the patients had altered sensation of an area approximately 1 cm in diameter near the midline of the chin/lip area of the affected side. Patients who had complete anaesthesia of mental nerve had implants placed in zone 2 but none of the patients experienced permanent altered sensation after implant placement.

8. **Alp Alan tar** et al (2000)[6] did a study to determine the cause of injuries to the lower labial branches (LLB) of the mental nerve (MN) after biopsy of minor salivary glands , labial nodule excision , or symphyseal bone grafts using a labial approach. They did a study in 16 cadavers by dissected thirty two mental nerves and recorded 1) number of LLB, 2) the angle between the medial LLB and the fibres of orbicularis oris 3) the anastomoses between the lateral branches and 4) the midline crossover innervations of LLB and suggested that injuries to LLB can be prevented if the incisions are made horizontally on the dorsal aspect of lower lip , and the angle between the incision and the long axis of the lip is approximately 36º.In case of symphyseal bone procedures using a labial route , a “U” shaped incision parallel to LLB is suggested.

9. **Ofer madinger** et al (2000)[34] did a study to evaluate the physical dimension of mental canal and its course to determine the accuracy of conventional plain film radiographs in identifying anterior loop of the mental canal, and determined the mean distance of its extension from the location of the mental foramen on the buccal surface of mandible in a study group consisted of 46 hemimandibles (20 human cadaver mandibles divided in to two and six additional hemimandibles) fixed in 10% formalin and ranged in age from 63 years to 96 years .Radiographs of mental foramen and midline were obtained for each hemimandibles before dissection and observed anterior loop in 13 hemimandibles (28%) and the length of the anterior loop mesially ranged from 0.4 to 2.19 mm. The mean diameter of incisive canal at its entrance was 2.09 ± 0.42 mm. A safe zone of at least 3mm should be observed. Dental computer tomography or conventional tomography should be performed to determine the exact existence and extent of anterior loop of the mental canal. This will prevent sensory damage to neurovascular bundle in mental area close to ramification of the mandibular nerve.

10. **Karen e Polland** et al (2001)[24] conducted a study in cadavers in the Laboratory of Human Anatomy. Five were from male subjects aged 64–91, and two from females aged 74 and 90. Most of the attached soft tissue was removed but care was taken not to scratch the bones. Panoramic radiographs of the mandibles were taken at the Glasgow Dental Hospital using a Siemens Orthophos X-ray machine (Siemens, Erlangen, Germany). The seven mandibles were placed on a chin rest during the X-ray procedure. The mandibles were divided at the mental symphysis

and concluded that in panoramic radiographs of edentulous mandibles, little of the internal bony structure can be discerned medial to the mental foramina. This study shows that the mandible is not hollow in this region but contains a labyrinth of cancellous bone, but probably no canal, any persisting nerve bundles running through the intertrabecular spaces. It also shows that, medial to the mental foramen, implants would be placed into cancellous bone containing small nerve bundles in the intertrabecular spaces.

11. **Jules Kieser** et al (2002)[19] investigated the path of emergence of mental nerve in number of human population groups. The study included 117 Negro skulls (53 males) , 114 caucasoid skulls (62 males) and 100 pre-contact Maori skulls (70 males).in all the cases , the path of emergence was classified into posterior, anterior, right-angled or multiple.56 cadaveric mandibles were examined , in which that was osteotomised on either side of mental foramen of about 1 cm to expose the nerve and confirmed that the mental nerve emerges as a Y-shaped divergence between the terminal branches of the inferior alveolar nerve. Nerve emergence is posterior in both Caucasoid and Maori skulls. Nerve emerges as T-shaped divergence between the mental and incisive nerves for Negros. This study does not support the notion of a loop in emergence of mental nerve and hence negates its significance in treatment planning for dental implants in the anterior mandible.

12. **R Jacob** et al (2002)[21] assessed the appearance, location and course of the incisive canal as compared to other anatomical landmarks on spiral CT of mandible. The study included 230 spiral CT scans taken for preoperative planning of implant placement in posterior mandible. Axial, panoramic and reformatted cross-sectional images were carefully examined and found incisive canal in 93% of all cases with good visibility in 22% of cases and concluded that a well – defined incisive canal is found in majority of spiral CT scans. Visualization of incisive canal and presence of anterior looping, demonstrates the potential value of cross-sectional imaging of the anterior mandible for presurgical planning purposes.

13. **Chinami** et al (2004)[10] found a double mental foramina in a 52 year old patient who visited for implant therapy for whom the preoperative panoramic radiography and CT were taken. A reconstructed saggital image showed two mental foramina leading to the mandibular canal on the right side of the mandible. The images demonstrated the presence of an obvious connection to the mandibular canal, confirming that the openings were double mental foramina. Clinicians should be aware that during dental or surgical treatment the mental nerves in the mental foramen may transmit in various directions.

14. **Rodrigo F** Neiva et al (2004)[35] did a morphometric analysis in 22 Caucasian skulls and measured the mental foramen including the height, width and location in relation to other known anatomical landmarks. Presence or absence of anterior

loop of inferior alveolar nerve was determined and the mesial extent of the loop was measured and found that most common location of the mental foramen in relation to the teeth was found to be below the apices of the mandibular premolars. A high prevalence of anterior loop was found (88%) , a symmetric occurrence was a common finding (76.2%0) with a mean length of 4.13 ± 2.04 mm and said that implant related anatomy must be carefully evaluated before treatment due to considerable variations among various individuals in order to prevent injury to surrounding anatomical structures.

15. **Sithiporn Agthong** et al (2005)[38] did a study to examine the different anatomical variations of the supraorbital, infraorbital, and mental foramina related to gender and side. The measurements were made on 110 adult skulls without mandibles and isolated mandibles with gender determination for each skull. The parameters measured bilaterally included the distances from the supraorbital and mental foramina to midline, from the infraorbital foramen to the anterior nasal spine, from the infraorbital foramen to the inferior orbital rim, and from the mental foramen to the inferior rim of the mandible and the angle between the line linking the infraorbital foramen with the anterior nasal spine and horizontal plane. The authors used 70 male and 40 female crania for their study and found that the average distance from the left supraorbital foramen to midline in females was significantly lower than that in males (2.42 ±0.04 versus 2.56 ± 0.05). The mean distances from the bilateral infraorbital foramina to anterior nasal spine in females were also significantly lower relative to those in males (3.28 ± 0.03 versus 3.48 ±

0.03 right and 3.31 ± 0.03 versus 3.50 ± 0.03 left). There were also considerable differences between sides in the average angle of the infraorbital foramen in both genders and concluded that difference in measurement suggest that gender and side should be considered when applying the anatomical variation data to individual subject.

16. **Gary Greenstein** et al (2006)[18] proposed that mental foramen is strategically important landmark during osteotomy procedures. Its location and the possibility that an anterior loop of mental nerve may be present mesial to the mental foramen needed to be considered before implant surgery to avoid mental nerve injury with articles that addressed the position, number, and size of the mental foramen , mental nerve anatomy , and consequences of nerve damage were evaluated for information pertinent to clinicians performing implant dentistry and found that mental foramen may be oval or round and is usually located apical to the second mandibular premolar or between apices of premolars .However, its location can vary from mandibular canine to the first molar. Computerized tomography (CT) scans are more accurate for detecting the mental foramen than conventional radiographs and authors said that to avoid nerve injury during surgery a 2mm of safety margin should be considered between an implant and coronal aspect of the nerve. Once a safety zone is identified, implants can be placed anterior to, posterior to, or above the mental foramen.

17. **Apinhasmit W** et al (2006)[1] used 69 adult mandibles (45 male, 24 female) of Thai dry skull to assess and determine the size, orientation and the location of the mental foramen (MF) related to gender and side. Each skull was assessed by using direct inspection and computerized imaging analysis. Measurements were made in the center of each foramen. The variability of position of the MF should be always considered when diagnosing radiographic periapical areas and during procedure involving the endodontic or periodontal surgeries in area from first premolar to the mesial root of the first molar. The data is of clinical relevance for practice and teaching.

18. **Yuki Uchida**, DDS, PhD et al (2007)[48] measured the anterior loop length for mandibular canal and the diameter of the mandibular incisive canal using 38 cadavers (75 hemimandibles) to confirm the mesial distance from the mental foramen and the safest point to the installation of endosseus implants in the most distal area of the interforaminal region and concluded that there are large variations in the anterior loop length and diameter of incisive canal. So, there should not be any fixed distance mesially from the mental foramen for safety purpose. Not only the anterior loop length (ALL) but also the diameter of the incisive canal should be investigated on a case by case basis to determine the appropriate location for each individual.

19. **David.J.Brenner** et al (2007)[14] explained about CT and its use, common type of CT scans, radiation doses from CT scans ,typical organ doses, Biologic effects of

low doses of ionizing radiation ,risks associated with low doses of radiation, cancer risks associated with CT scans and proposed three way reduce overall radiation dose from CT in United States and Japan. The first is to reduce the CT-related dose in individual patients. The automatic exposure-control option on the latest generation of scanners is helping to address this concern. The second is to replace CT use, when practical, with other options, such as ultrasonography and magnetic resonance imaging (MRI).Although the cost of MRI is decreasing, making it more competitive with CT, there are not many common imaging scenarios in which MRI can simply replace CT, although this substitution has been suggested for the imaging of liver disease. The third and most effective way to reduce the population dose from CT is simply to decrease the number of CT studies that are prescribed.

20. **Kyung –Seok Hu** et al (2007)[26] did a study to clarify the branching patterns of mental nerve (MN) and intraosseus course of MN branches , and to determine the clinical relevance of the various courses of MN branches by dissecting 31 hemifaces of Korean cadavers. The distribution area of the MN was divided into angular (A), medial inferior labial (ILm), lateral inferior labial (ILl), and mental (M) branch and classified the branching patterns of the 4 branches of the MN into 5 types and found that type II – MN in to A, ILm and M branches with the ILI branch separating from A branch was most common and concluded that these observations can help clinicians to predict the location or extend of paraesthesia in the facial region during dental implant surgery or genioplasty.

21. **John B.Ludlow** et al (2008)[22] compared two measures of effective dose, E_{1990} and E_{2007}, for 8 dentoalveolar and maxillofacial cone-beam computerized tomography (CBCT) units and a 64-slice multidetector CT (MDCT) unit by average tissue-absorbed dose, equivalent dose, and effective dose were calculated using thermoluminescent dosimeter chips in a radiation analog dosimetry phantom. Effective doses were derived using 1990 and the superseding 2007 International Commission on Radiological Protection (ICRP) recommendations and found that large-field of view (FOV) CBCT E_{2007} ranged from 68 to 1,073 µSv. Medium-FOV CBCT E_{2007} ranged from 69 to 560 µSv, whereas a similar-FOV MDCT produced 860 µSv. The E_{2007} calculations were 23% to 224% greater than E_{1990} and concluded that the 2007 recommendations of the ICRP, which include salivary glands, extrathoracic region, and oral mucosa in the calculation of effective dose, result in an upward reassessment of fatal cancer risk from oral and maxillofacial radiographic examinations. Dental CBCT can be recommended as a dose-sparing technique in comparison with alternative medical CT scans for common oral and maxillofacial radiographic imaging tasks.

22. **Kaori Katakami** et al (2008)[25] did a study to elucidate the anatomic characteristics of the accessory mental foramina(AMF) and accessory branch of mandibular canal on CBCT images of mandibles taken from precise assessment between January 2005 and December 2007.Edentulous cases without stent indicative of each tooth position was excluded from the study. The location of mental foramen (MF) and AMF was determined according to each tooth area. If

both existed in the missing teeth area, the location was determined by surgical stent, which indicated each tooth position. The accessory branch of mandibular canal and AMF was observed with respect to its direction, branched position, and length and found seventeen AMF in 16 patients including 1 patient with double AMF and concluded that confirmation of existence of AMF could avoid nerve injury during periapical surgery. The sensory disturbance is low in root canal treatment unless the MF and mandibular canal are injured. In dentoalveolar treatment, limited CBCT is effective as pre-surgical 3-D assessment of neurovascular structures.

23. **Munetaka Naitoh, DDS, PhD** et al (2009)[31] did a study to assess the accessory mental foramen using cone-beam computed tomography (CBCT) images with total of 157 patients. The mental and accessory mental foramina, that showed continuity with the mandibular canal, were assessed using the axial and cross-sectional, 2-dimensional CBCT images. The size, distance between the mental and accessory mental foramina was measured. The accessory mental foramina was observed in 7% of patients and the mean distance between mental and accessory mental foramina was 6.3 mm.

24. **Anthony Pogrel M** et al (2009)[2] dissected inferior alveolar neurovascular bundle from 8 cadaveric mandibles and examined for the arrangement of inferior alveolar artery , vein , nerve and confirmed that the inferior alveolar vein lies superior to the nerve and that there are often multiple veins.

The artery appears to be solitary and lies on lingual side of the nerve, slightly above the horizontal position. And the arrangement of inferior alveolar artery, vein and nerve within the inferior alveolar canal can be of importance in surgical procedure that may involve these structures.

25. **Wei Cheong Ngeow** et al (2009)[44] did a study in two hundred and forty panoramic radiographs of Malay patients of different age groups , taken between 2003 and 2005.The age groups were 20-29 years, 30-39 years, 40-49 years, and 50 years and older. Anterior Loop was divided in to four categories: I. Present on both sides II. Present on right side only III. Present on left side only IV. Absent. The anterior loop was visible in 39 dental panoramic radiographs and most often observed bilaterally, followed by on the right side only. Anterior loops reduced as the age of subjects increased. Panoramic radiographs was not sufficient for presurgical implant planning in the mental region and may need to be supplemented with other modalities such as CT for better visualization of the area.

26. **Suomalainen A** et al (2009)[40] did a study to evaluate the radiation dose and image quality of four dental cone beam CT (CBCT) scanners, and compared them with two multislice CT (MSCT) scanners by measuring the with the tissue doses using a tissue-equivalent anthropomorphic RANDO Head Phantom with thermo luminescence dose meters (TLD) An RSVP Head Phantom[tm] with a specially designed cylindrical insert was used for comparison of image quality and

absorbed dose. Image quality was evaluated in the form of contrast-to-noise ratio (CNR) and modulation transfer function (MTF) and found that the effective doses varied between 14 µSv and 269 µSv (International Commission on Radiation Protection (ICRP) 1990) and 27 µSv and 674 µSv (ICRP 2008) with the CBCT scanners, and between 350 µSv and 742 µSv (ICRP 1990) and 685 µSv and 1410 µSv (ICRP 2008) with the MSCT scanners. The CNR of the CBCT and MSCT scanners were 8.2–18.8 and 13.6–20.7, respectively. Low-dose MSCT protocols provided CNRs comparable with those from CBCT scanners. The 10% MTF of the CBCT scanners varied between 0.1 mm21 and 0.8 mm21, and was 0.5 mm21 for all the MSCT protocols examined and found that CBCT scanners provide adequate image quality for dentomaxillofacial examinations, delivering considerably smaller effective doses to the patient.

27. **Yuki Uchida, DDS, PhD** et al (2009)[49] measured and compared the anterior loop length for the mandibular canal and mandibular incisive canal diameter at its origin in 71 cadavers using anatomy and in 4 cadavers by using CBCT and ensured the safety installation of endosseous implants in the most distal area of interforaminal region and concluded that preoperative CBCT measurement yields important information for each case. The ranges and mean SD for the anatomic measurements were: anterior loop length (ALL), 0.0 to 9.0 mm and 1.9±1.7 mm; incisive canal diameter (ICD), 1.0 to 6.6 mm and 2.8±1.0 mm. The average discrepancies between CBCT and anatomic measurements were 0.06 mm or less for both the ALL and the ICD, which were less than the resolution of CBCT.

28. **Gintaras Juodzbalys** et al (2010)[17] presented a study to review the literature of how to identify the mental foramen , mandibular incisive canal and associated neurovascular bundles during implant surgery and how to detect and avoid the damage of these vital structures during implant therapy. Forty-Seven literatures were reviewed in total. The morphology and variations of the mandibular incisive canal, mental foramen and associated neurovascular bundles were presented as two entities and the structures exist in different locations and possess many variations. Individual gender, age, race, assessing technique used and degree of edentulous alveolar bone atrophy largely influence these variations. It suggests that the clinicians should carefully identify these anatomical landmarks, by analyzing all influencing factors, prior to their implant surgical operation.

29. **Xin Liang** et al (2010)[47] compared the image quality and visibility of anatomical structures in the mandible between five Cone Beam Computed Tomography (CBCT) scanners and one Multi-Slice CT (MSCT) system by scanning one dry mandible with five CBCT scanners (Accuitomo 3D, i-CAT, NewTom 3G, Galileos, Scanora 3D) and one MSCT system (Somatom Sensation 16) using 13 different scan protocols. Visibility of 11 anatomical structures and overall image noise were compared between CBCT and MSCT. Five independent observers reviewed the CBCT and the MSCT images in the three orthographic planes (axial, saggital and coronal) and assessed image quality on a five-point scale and found that CBCT image quality is superior to MSCT even though some variability exists among the different CBCT systems in depicting delicate structures. Considering

the low radiation dose and high-resolution imaging, CBCT could be beneficial for dentomaxillofacial radiology.

30. **Nikos Makris** et al (2010)[33] assessed the visibility and the course of the incisive canal and the visibility and the location of the lingual foramen using cone-beam computed tomography (CBCT) by using 100 CBCT of patients that was taken for preoperative planning The examinations were taken using the NewTom 3G CBCT unit, applying a standardized exposure protocol. Image reconstruction from the raw data was performed using the New Tom software. Three experts were asked to assess the visibility of the incisive canal using a four-point rating scale. The position of the incisive canal was recorded in relation to the lower, buccal and lingual border of the mandible using the application provided by the CBCT software and found in 83.5% of the scans and the mean endpoint was approximately 15 mm anterior to the mental foramen. The mean distance from the lower border of the mandible was 11.5 mm and its course was closer to the buccal border of the mandible in 87% of the scans. The lingual foramen was visible in 81% of the scans and concluded that high detection rate of the incisive canal and the lingual foramen in the anterior region of the mandible using CBCT indicates the potential high preoperative value of CBCT scan for surgical procedures in the anterior mandible.

31. **Carmen Elena Georgescu** et al (2010)[11] proposed that CBCT is necessity in the assessment of jaw bone to effectively evaluate the treatment and measurement in

the CBCT are more accurate when compared with OPG by analysing 51 clinical cases in a total of 700 patients to whom their dental practitioners recommended both OPG and CBCT. After assessment of the incisive canal, conclusion has been made with confirmation of previous results that is the visibility is much lower on panoramic radiographs compared to panoramic sections and saggital sections of CBCT.

32. **Apostalkis** et al (2011)[13] used CBCT to scan 93 patients with a Newtom VG device to identify and measure the variation in the presence and extent of anterior loop of the inferior alveolar nerve. The anterior loop was identified in 48% of cases with a mean length of 0.89 mm. In 95% of cases anterior loop was < 3mm.In absence of CBCT the safety margin would be achieved only with a distance of 6mm between the anterior border of the mental foramen and the most distal interforaminal implant fixture. This information may be used to provide recommendations to the surgeon without access to a 3D scan of the dento-alveolar region.

33. **Fereidoun parnia** et al (2012)[16] conducted a study to assess appearance , visibility , location and course of anatomical landmarks in a mandibular interforaminal region using cone beam computed tomography (CBCT) of 96 patients and concluded that it is not safe to recommend any definite distance mesially from the mental foramen. The diameter of the canals and foramens

should be determined on a case – by –case basis to exploit the appropriate location for each individual.

34. **A. Santini and I.Alayan** (2012)[41] recorded the position of the mental foramen in relation to the mandibular teeth and anatomical landmarks of mandible in 76 Chinese, 46 European and 33 Indian skulls of known or calculated age at death and found that the length of the length of the Indian mandibles is smaller than the European and the Chinese and proposed that the notion that the mental foramen lies between the first and second molars can no longer be accepted. Population differences occur and the preoperative radiographs are mandatory.

35. **Christiano de Oliveria-Santos** et al (2012)[12] examined CBCT from 100 (200 hemimandibles) patients , analyzed and registered following parameters : diameter and corticolization of mandibular canal (MC); trabeculation in submandibular gland fossa (SGF) region; presence of bifid MC;and direction of bifid canals;and measurement of anterior loop by using CBCT and panoramic reconstructions and said that the recommendations of safe fixed distance from anatomical landmarks for endosseus implants are not reliable and pointed out that the valuable contribution of the pre-operative examinations with low-dose CBCT prior to surgical procedure particularly for implant placement is required.

36. **Asha Ragunathan** et al (2013)[4] identified various patterns of entry of mental nerve in a total of 300 panoramic radiographs taken for routine diagnostic purposes and the radiographs were assessed independently by two observers and the position, the entry pattern of mental nerve on the right and left side were recorded and the entry pattern were categorized as straight, looping, or perpendicular. The study revealed the most common pattern of entry of mental nerve was straight one followed by presence of anterior loop on at least one side. The authors said that the Panoramic radiography may not be reliable imaging modality for identifying the presence of anterior loop which needs to be determined for preoperative surgical planning of surgical procedures in the mandibular premolar region. Cone beam computed tomography (CBCT) can be used for better visualization of the area.

37. **Musatafa Gomusak** et al (2013)[30] proposed that correct visualization of anterior loop has important role for planning the implant placement in preventing complications like paraesthesia and bleeding .Cone beam computed tomography is a successful method that provides three dimensional imaging with low ionized radiation to image the anterior loop. So reliability and precision of the images obtained by CBCT is successful than periapical or panoramic imaging.

38. **Marcio Borges Rosa** et al (2013)[29] did a study that included 352 CBCT scans that had been originally been used for preoperative planning of implant placement in the interforaminal region of anterior mandible to quantify the ability of cone

beam computed tomography (CBCT) .For each scan the length of the mental nerve loop and the length , diameter and path of the incisive canal were determined. The inferior alveolar nerve loop and incisive canal had a mean length of 2.40 ± 0.93 mm and 9.11 ± 3.00 mm respectively. The mean incisive canal diameter was 1.48 ± 0.66 mm and concluded that an accurate means to identify critical anatomical features in the anterior mandible and preoperative surgical planning can be done by CBCT.

39. **Xiao Li et al** (2013)[46] used a spiral computed tomography to identify the anterior loop of inferior alveolar nerve and to measure its length and position in 68 Chinese patients who were scanned by 64-slice spiral computed tomography, and the measurements had been made. The authors found anterior loop in 83.1% of the cases, with a mean length of 2.09 mm .The mean distance from the superior border of mental foramen to the alveolar crest was 13.00 mm, and the mean distance from superior border of origin of anterior loop to the alveolar crest was 17.83 mm and concluded that the anterior loop was highly prevalent in Chinese, and the length of the anterior loop was highly variable. So, drilling should be done approximately 5.5 mm mesially from the mental foramen, when installing implants in the most distal interforaminal area.

40. **Mohammed Jasim AL-Jubbori** et al (2014) used different radiographic techniques like Computed tomography, Digital radiograph and panoramic radiograph to detect the importance of mental foramen location and concluded

that 3 dimensional imaging like computed tomography is mandatory when dental implant or oral surgical procedure conducted in mental foramen area will prevent neural complication and patient morbidity.

41. **Aleksander et al** (2014)[32] compared the prevalence and length of mental loop by measuring it with panoramic radiograph (PR) and cone beam computerized tomography (CBCT).In Eighty two PR and Eighty two CBCT the presence and position of mental foramen(MF) , its distance to the lower border of mandible , the anterior length of mental loop (ML) and the bone quality was determined. The authors identified ML in 36.6% of PR and 48.8% of CBCT. The mean of anterior extension of inferior alveolar nerve and the distance to inferior border of the mandible was higher for PR and found that there is magnification in PR images with respect to those of CBCT. The two dimensional imaging provides less accurate and reliable information regarding the anterior loop than CBCT. So, the authors recommended CBCT while planning implant placement in the anterior region.

42. **Dr.Muhammad Ashraf Yoosuf Bobat** et al (2014) dissected 20 cadaveric specimens bilaterally and recorded the position of mental foramen in relation to the lower border of mandible and adjacent teeth. The anterior loop of the mental nerve was identified through anatomical dissection and measured. The study

showed the mental foramen position is located between the 1st and 2nd premolar and approximately 13 mm from the lower border of the mandible.

43. **Katharina Filo , DMD** et al (2014)[27] identified and measured the anterior extension of alveolar loop (aAL) and the caudal extension of (cAL) of the inferior alveolar nerve by using 694 CBCT scans of dentate and partially edentulous patients, performed for further diagnosis before mandibular third molar removal between January 2009 and February 2013, by using multiplanar reconstruction. The frequency of aAL was 69.73% and cAL was 100%.The mean value of aAL was 1.16 mm. The study showed a high frequency and large variations in aAL and cAL. CBCT had been reliable tool for identifying and measuring the anterior loop. So, preoperative diagnosis with CBCT is recommended for implant placement in the vicinity of mental foramen.

44. **Juan Muileno-Lorenzo** et al (2015)[20] analyzed the anatomic characteristics of the mental foramen (MF) and the presence of accessory mental foramen (AMF) using CBCT and compared the capability of CBCT and panoramic radiograph (PAN) in terms of MF and AMF visualization. The study consisted of 357 patients who had both CBCT and PAN examinations. The authors found the MF located predominantly below the second premolar, the presence of AMF influences the size of MF. The mean AMF area in the study was 1.5 to 2 mm.

45. **Sun-Kyong Yu** et al (2015)[39] used 26 hemimandibles from 19 cadavers and with the aid of surgical microscope the location of the anterior loop, diameters of mandibular, mental, incisive canals and their distance from bony landmarks were measured by using digital calipers and their diameters were 2.80±0.49, 2.63±0.64, and 2.22±0.59 mm respectively. The anterior loop of mandibular canal was located at the mean of 3.1 mm anterior and 2.7 mm inferior to the mental foramen and continued upward and backward to the mental canal, and forward to the incisive canal. These detailed morphological features of the anterior loop of mandibular canal represent useful practical anatomical knowledge regarding the interforaminal region.

46. **Arzu Demir et al** (2015)[7] evaluated the frequency and types of mental foramen's anterior loop in 279 (138 females, 141 males, age range 20-69 years) dentate patients (both sides of mandible) in a Turkish population by using CBCT. In Type 1 the mental branch left the inferior alveolar nerve posterior to opening of the mental foramen. In type 2 the mental branch left the inferior alveolar nerve perpendicular to the opening of the mental foramen .In type 3 the mental branch left the inferior alveolar nerve anterior to the mental foramen. The distribution of type 3, type 2 and type 1 were noted 59.5%, 31.9% and 8.6% respectively. There was no significant difference on right and left side between males and females and found that the CBCT can be used to observe three dimensional tracking of the mental nerve from the inferior alveolar nerve to the mental foramen. So,

divergence of the mental nerve and foramen should be evaluated for various surgical procedures involving the interforaminal areas.

47. **Sakdhari S et al** (2016)[43] used CBCT of 200 patients in an Iranian population to evaluated the prevalence of inferior alveolar nerve's anterior loop and mandibular incisive canal in a 200 high resolution CBCT images of the patient, the images were obtained by NewTom Giano unit and were measured in NNT viewer software and found the prevalence of the anterior loop as 19%, with the minimum length of 3 mm and the prevalence of the incisive canal was 87.5%. The maximum diameter of incisive canal was 5.3 mm which was located between the first and second premolars and the measurement of length of the IAN's loop and the incisive canal's diameter are necessary to prevent nerve injuries during surgical procedures in the anterior mandibular region.

48. **Edudara Helena Leandro do Nascimento et al** (2016)[15] evaluated the prevalence and extent of anterior loop in a Brazilian Population by using CBCT of 250 patients (500 hemimandibles) .The length of the anterior loop was compared based on gender ,age, and side of the mandible.

49. **Baratollah Shaban et al** (2017)[8] evaluated different anatomical variants of the anterior loop of the inferior alveolar nerve using CBCT of 71 patients (36 males and 35 females) and classified anterior loop into three variants. Type I – the anatomy is Y-shaped, the incisive branch thickness is similar to the main branch.

Type II – the anatomy is T-shaped, incisive branch is perpendicular to the main branch and the main branch enters the mental foramen in perpendicular direction. Type III the anterior loop is Y-shaped and the incisive branch is thicker than main branch and the mental branch diverges from inferior alveolar nerve to the mental foramen. The authors found Type III as most common variant

50. **Zebasiddiqui et al** (2019)[51] assessed prevalence the anterior loop in 37.3% of North Indian Population and found it was highest in the age group of 36-56 years.

MATERIALS AND METHODS

SOURCE OF DATA

Patients visiting the Out Patient Department of Oral Medicine And Radiology Of Rajas Dental College And Hospital were considered for the study. Out of 535 patients reported to Rajas Dental College and Hospital for CBCT in the time period of 2017-2019, 127 patients (254 Hemimandibles) from the age group of 16-65 years who were fulfilling the inclusive criteria were randomly selected. A prior ethical approval was obtained from the Institutional Ethical Committee before the start of the study.

EQUIPMENT

New Tom Go CBCT machine with New Tom NNT analysis software

INCLUSIVE CRITERIA:

1. Patients from the age group of 16 and 65 years.

2. The anterior aspect of the mandible bilaterally and up to 3cm distal to the mental foramen had to be included in the volume.

3. No pathology that could affect the position of the mandibular canal and mental foramen was present.

4. No evidence of any trauma or surgery that could affect the position of the mandibular canal and mental foramen.

5. The images had to be of adequate quality.

EXCLUSIVE CRITERIA:

1. Presence of systemic diseases.
2. Pregnancy/ Lactating patients.
3. Patients undergoing radiotherapy.
4. Presence of implants or mental artifacts in foramen region.

IMAGING PROCEDURES

CBCT images were obtained with a New Tom Go CBCT machine. All CBCT images were taken using a field of view (FOV: 10x6 cm) and a basic voxel size of 0.08 mm. Operating parameters were set at 4.0 mA and 90 kV, and the exposure time was 5.6 seconds. The datas were reconstructed with slices at an interval of 0.25 mm and sliced in 3 dimensions i.e axial, coronal and saggital.

For evaluation of the CBCT scans, a 32inch LCD monitor's (HP L1910, Hewlett-Packard Development Co., Palo Alto, CA, USA) with 1280 × 1024 pixel was used. The NNT Imaging Software (v4.6) Windows edition (Myray, Italy) was used. Images were selected considering a high level technical standard (i.e., appropriate sharpness, density, and contrast), clearly showing the mandibular teeth, mental foramen and the mandibular canal. Patients having images of anterior mandible and at least 2 cm distal to MF up to the lower cortical border bilaterally were chosen.

METHOD USED

The axial reconstruction image was initially used. The volume was rotated towards the side being analyzed, in order to position the long axis of the mandibular canal parallel to the saggital plane, and to position the coronal reconstruction perpendicular to the region of interest. The coronal reconstruction image was then used, and immediately afterwards, the most mesial point of the mental foramen was obtained in order to identify the presence or absence of an anterior loop. In the coronal sections, it was possible to identify two basic types of images: one with an anterior extension represented by a single round hypodense image and the other characterized by 2 round hypodense images[15].

According to Apostolakis and Brown[13] anterior loop can be differentiated from the incisive canal based on the fact that the incisive canal has a diameter of less than 3 mm. When only a single round hypodense image was visualized, it was interpreted as the incisive canal if it exhibited a diameter smaller than 3 mm. If the diameter was larger than 3 mm, the anterior extension of the mandibular canal was considered to be an anterior loop. An anterior loop was also considered to be present when 2 round hypodense areas were observed, with one corresponding to the lumen of the mandibular canal that traverses the mental foramen anteriorly and inferiorly, and the other reflecting the doubling back (loop) of the mandibular canal, leading to the externalization of the inferior alveolar nerve.

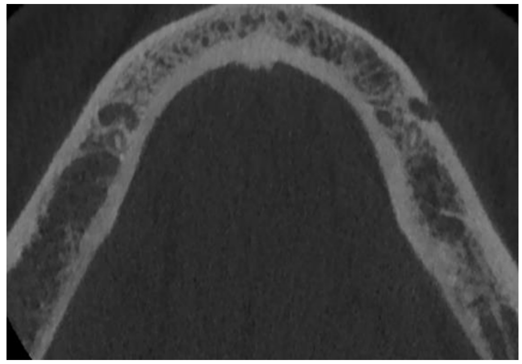
The length of the anterior loop was measured using the amount of consecutive coronal reconstructions situated between the anterior border of the mental foramen and the anterior border of the loop. This number was multiplied by the thickness of the slices (0.25 mm).When the anterior loop appeared as 2 round hypodense areas, its length was measured by counting the number of reconstructions in which the 2 round hypodense images appeared, added to the number of reconstructions in which the canal diameter was at least 3 mm. The number of slices was then multiplied by the thickness of the reconstructions (0.25 mm).

The data were summarized as absolute and relative frequencies. The Pearson chi-square test was used to evaluate the presence of an anterior loop with regard to age, gender, and the side of the hemimandible. The relationships of length with age, gender, and hemimandible side were evaluated using linear regression. P-values<.05 were considered to indicate statistical significance.

CASE REPORTS

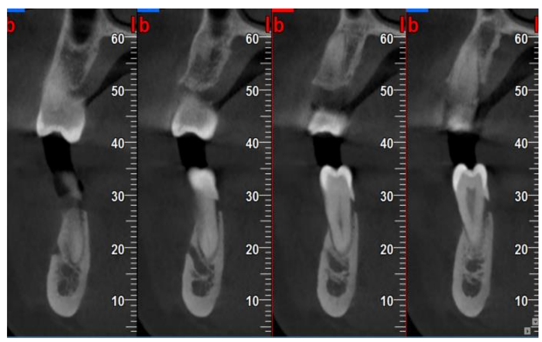
CASE 1

a.



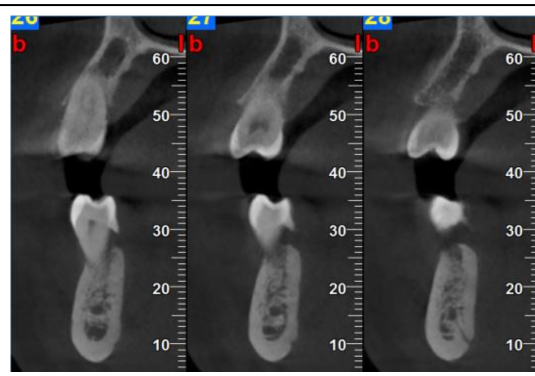
a. Axial reconstruction

b.



b & c- Coronal reconstruction slices showing exit of the IAN through the mental foramen and anterior loop of IAN

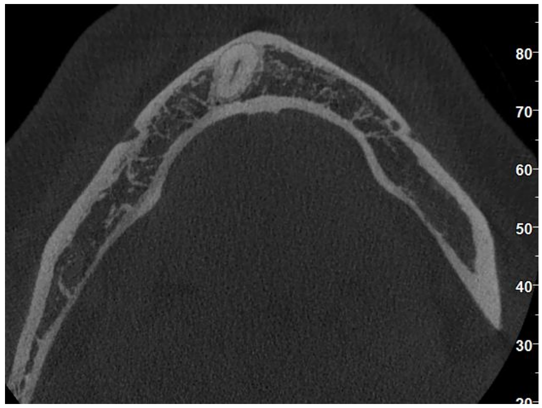
c.



Measurement – 4 x 0.25 = 1mm.

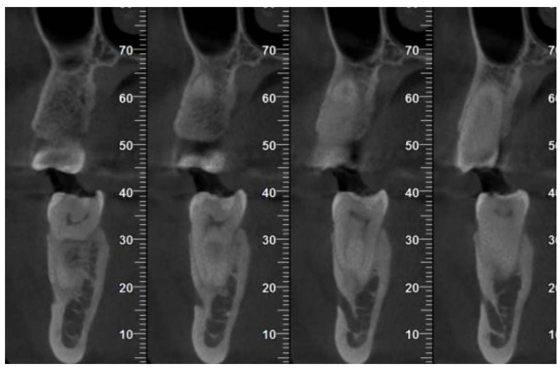
CASE 2

a.

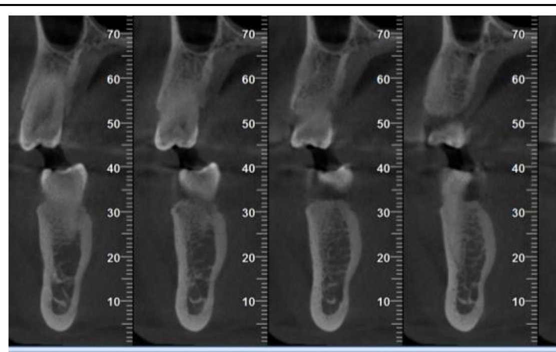


a. Axial reconstruction

b.



c.



b &c. Coronal slices that shows anterior loop of IAN as a single round hypodense image with a diameter ≥ 3mm.

Measurement - 3 x 0.25 = 0.75mm

RESULTS

The CBCT scans of 127 patients were evaluated, among whom 73 (57.4%) were females and 54 (42.6%) were males, with ages ranging between 16 and 65 years (mean age, 51.4±15.3 years). The anterior loop was visualized in 142 (55.9%) of the 254 hemimandibles analyzed, and the mean length was 1.1±0.79 mm (range, 0.25-3.25 mm). These findings were analyzed according to gender, the side of the hemimandible (right and left), and the age of the patient (Table I).

A significantly higher prevalence was found among female (p=0.02) than male (Table X). The highest prevalence was found between the third, fourth, and fifth decades of life (Table VII and VIII) and the greatest variation in length was observed in the fourth and fifth decade. Higher prevalence of anterior loop was seen on the right side (p=0.04) than left side (Table XII).

Of the 142 hemimandibles in which the anterior loop was identified, in 95 cases (66.9%) the length was less 1.00 mm. In 42 cases (29.6%), the length was between 1.50 mm and 2.5 mm, and in only 5 cases (3.5%) the length was between 2.75 mm and 3.25 mm. Thus, the loop was 2.5 mm or shorter in approximately 90% of the cases. The anterior loop was visualized in 84 (66.1%) of the 127 patients evaluated. Table II summarizes our findings according to the unilateral or bilateral presence of an anterior loop.

TABLE I

DISTRIBUTION OF CASES OF WITH AND WITHOUT AN ANTERIOR LOOP OF THE MANDIBULAR CANAL AND STATISTICAL ANALYSES ACCORDING TO THE SIDE OF THE MOUTH AND THE GENDER AND AGE OF THE PATIENT.

Group	Total Number	Presence of anterior loop n(%)	Absence of anterior loop n(%)	Range (mm)	Anterior loop Median	Mean ± SD
Gender						
Male (54)	108	57 (52.8 %)	51 (47.2%)	0.25 - 3.25	0.75	0.94± 0.79
Female (73)	146	85 (58.2%)	61 (41.7 %)	0.25 - 3.25	0.75	0.96 ± 0.75
Hemimandible						
Right	127	84 (66.1%)	43 (33.9%)	0.25-3.25	0.88	1.07±0.79
Left	127	58(45.7%)	69 (54.3%)	0.25-3.25	0.75	0.91±0.77
Age (years)						
16 – 25 (12)	24	10 (41.7 %)	14 (58.3%)	0.25 -2.00	1.75	1.35 ± 0.77
26 – 35 (18)	36	15 (41.7 %)	21(58.3 %)	0.25 – 2.00	1.75	1.27 ± 0.74
36 – 45 (40)	80	51(63.8 %)	29 (36.2 %)	0.25 – 3.25	0.75	0.98 ± 0.81
46 – 55 (43)	86	54(62.8 %)	32 (37.2 %)	0.25 - 3.25	0.75	0.87 ± 0.74
56 – 65 (14)	28	12 (42.9 %)	16(57.1 %)	0.25 – 2.75	1.00	1.03± 0.76
Total	**254**	**142 (55.9%)**	**112(44.1%)**	**0.25 - 3.25**	**0.75**	**1.00 ± 0.79**

TABLE II

RESULTS REGARDING THE UNILATERAL OR BILATERAL PRESENCE OF AN ANTERIOR LOOP OF THE IAN.

Anterior Loop	n (%)
Bilateral	58 (69.0%)
Unilateral Right	15 (13.1%)
Unilateral Left	11 (17.9%)
All	84 (100)

TABLE III

CHI SQUARE FOR PRESENCE AND ABSENCE OF ANTERIOR LOOP FOR MALE

	Frequency	Presence of anterior loop	Absence of anterior loop	Total
Male	Observed	57	51	108
	Expected	54	54	108
	Percentage	52.8 %	47.2 %	100%
	Chi Square = 0.24 p = 0.62 Not Significant			

TABLE IV

CHI SQUARE FOR PRESENCE AND ABSENCE OF ANTERIOR LOOP FOR FEMALE

	Frequency	Presence of anterior loop	Absence of anterior loop	Total
Female	Observed	85	61	146
	Expected	73	73	146
	Percentage	58.3 %	41.7 %	100%
	Chi Square = 3.62 p = 0.06 Not Significant			

TABLE – V

CHI SQUARE FOR PRESENCE AND ABSENCE OF ANTERIOR LOOP FOR 16 TO 25 YEARS

		Presence of anterior loop	Absence of anterior loop	Total
Age 16 to 25	Observed	10	14	24
	Expected	12	12	24
	Percentage	41.7 %	58.3 %	100%
	Chi Square = 0.38 p = 0.54 Not Significant			

TABLE – VI

CHI SQUARE FOR PRESENCE AND ABSENCE OF ANTERIOR LOOP FOR 26 TO 35 YEARS

	Frequency	Presence of anterior loop	Absence of anterior loop	Total
Age 26 to 35	Observed	15	21	36
	Expected	18	18	36
	Percentage	41.7 %	58.3 %	100%
	Chi Square = 0.70 p = 0.40 Not Significant			

TABLE –VII

CHI SQUARE FOR PRESENCE AND ABSENCE OF ANTERIOR LOOP FOR 36 TO 45 YEARS

	Frequency	Presence of anterior loop	Absence of anterior loop	Total
Age 36 to 45	Observed	51	29	80
	Expected	40	40	80
	Percentage	63.8 %	36.2 %	100%
	Chi Square = 5.52 p = 0.02 Significant			

TABLE –VIII

CHI SQUARE FOR PRESENCE AND ABSENCE OF ANTERIOR LOOP FOR 46 TO 55 YEARS

	Frequency	Presence of anterior loop	Absence of anterior loop	Total
Age 46 to 55	Observed	54	32	86
	Expected	43	43	86
	Percentage	62.8 %	37.2 %	100%
	Chi Square = 5.12 p = 0.02 Significant			

TABLE IX

CHI SQUARE FOR PRESENCE AND ABSENCE OF ANTERIOR LOOP FOR 56 TO 65 YEARS

	Frequency	Presence of anterior Loop	Absence of anterior loop	Total
Age 56 to 65	Observed	12	16	28
	Expected	14	14	28
	Percentage	42.9 %	57.1 %	100%
	Chi Square = 0.32 p = 0.57 Not Significant			

TABLE X

CHI SQUARE FOR PRESENCE AND ABSENCE OF BETWEEN MALE AND FEMALE

Presence of Anterior Loop	Frequency	Male	Female	
	Observed	57	85	142
	Expected	71	71	142
	Percentage	40.1 %	59.9 %	100%
	Chi Square = 5.14 p = 0.02 Significant			

TABLE XI

CHI SQUARE FOR PRESENCE OF ANTERIOR LOOP AMONG DIFFERENT AGE CATEGORIES

	Frequency	16 to 25	26 to 35	36 to 45	46 to 55	56 to 65	Total
Presence of Anterior Loop	Count	10	15	51	54	12	142
	Expected	28.4	28.4	28.4	28.4	28.4	142
	Percentage	7.0 %	10.6 %	35.9 %	38.0 %	8.5 %	100%
	Chi Square = 68.8 p < .0001 Significant						

TABLE XII

CHI SQUARE FOR PRESENCE AND ABSENCE OF ANTERIOR LOOP BETWEEN RIGHT AND LEFT SIDE

	Frequency	Right	Left	
Presence of Anterior Loop	Observed	84	58	142
	Expected	16	42	142
	Percentage	59.1%	40.9%	100%
		Chi Square	= 4.4	
		p	= 0.04	Significant

CONCLUSION

CONCLUSION

This study had done to evaluate the extent of Anterior Loop of Inferior Alveolar Nerve at the Mental Foramen by using CBCT. After evaluating 127 CBCT scans reformatted with New Tom NNT analysis software, 55.9% of cases revealed the presence of anterior loop of the IAN.

The wide range of measurements existed for the anterior loop length (ALL) ranging from 0 to 3.75mm with a mean of 1.00 ± 0.79 mm. Statistical significance found between right side, age group of third, fourth, and fifth decades(36-45, 46-55) of life. In addition to that the females had larger anterior loop than males and also in the right side of the mandible.

So, when placing dental implants in close proximity to MF, caution is recommended to avoid injury to the anterior loop of the IAN that becomes critically important surgical reference point during treatment planning. The recommended safety margin of up to 3mm[13] for dental implant placement anterior or mesial to the mental foramen was found in our study.

This study concluded that presurgical evaluation of the mandible by CBCT scans using the method described would be a useful tool to find the anterior loop of inferior alveolar nerve at the mental foramen to avoid anterior mandibular surgical complications especially in implant placements to prevent post surgical morbidity.

DISCUSSION

The study of the anterior loop of the mandibular canal is a relatively new area of research, and most studies have been conducted in the last few years.[12,13,15, 16, 27, 29,46] The increased interest in the subject is directly related to the greater frequency of operations for the placement of dental implants. Several methods have been used to assess this type of anatomical repair, including panoramic radiography, [16] CT,[46] CBCT [12,13, 15,29] anatomical measurements,[48,35]and other related methods.[49]

Our study showed that the anterior loop of the inferior alveolar nerve was present in 55.9% of all cases. This is higher than the prevalence reported by Ngeow et al[44] who conducted their studies using panoramic radiographic images. The relatively low prevalence rates reported in those studies may have reflected the failure of panoramic radiography to detect the presence of the anterior loop, due to the limitations and disadvantages of radiography, such as two-dimensionality, distortion, and the presence of overlapping structures. Moreover, panoramic radiography can overestimate or underestimate the presence and extent of the anterior loop, and is not considered a reliable modality for evaluating this anatomical variant.

At least one anterior loop was visualized in over half of the patients in our sample. Most of the anterior loops were observed bilaterally, followed by the left and right sides, respectively. These findings were similar to those reported by Apostolakis and Brown[13] who observed an anterior loop in approximately 57% of patients, mostly bilaterally. In the survey conducted by Filo et al [27], a loop was identified in 78.84% of patients, with the majority being bilateral, followed by being on the right and left sides, respectively.

The mean length of the anterior loops found in our study was 1 ± 0.79, a value close to those that have been reported in the literature.[13, 27]The largest anterior loop observed was 3.75mm. Despite being clinically relevant in extent,[12] this length was far lower than the maximum lengths of 9 mm reported by Uchida et al[49] and 11 mm reported by Neiva et al [35]. Moreover, our research demonstrated that in 96.5% of cases, the length of the anterior loop was less than or equal to 2.5 mm.

In our study, the anterior limit of the anterior loop was determined both based on the existence of two separate canals beyond the mental foramen and by using its diameter in all cross-sections. For this purpose, a minimum diameter of 3 mm was established, similar to the values used in other studies.[13,15,46] In contrast, de Oliveira-Santos et al[12] did not measure the diameter of the canal and considered the anterior loop to be present only in cross-sections with 2 round hypodense images, with a structure that they referred to as "8-like." This method may have underestimated the real loop length.

We found that the anterior loop was larger and more prevalent in third, fourth and fifth decades of life and in female patients. Anterior loop was predominantly seen on the right side[13] than the left. Other studies have shown the length of the anterior loop to be significantly related to male gender,[1,2,8,9,12] and to the sixth decade of life. [48]

There was significant relationships between these variables (age, gender, and side) or prevalence of anterior loops.

Although anatomical studies on cadavers,[9,39] provide important and accurate information about the prevalence and variation in length of the anterior loop, CT is the method that actually corresponds to clinical practice and adequately satisfies pre-surgical planning requirements. Furthermore, CT images have been proven to exhibit high precision and reliability in the diagnosis of the anterior loop,[29,49] and other anatomical landmarks in the mandible[12]. As previously stated, CT images are very effective exams for the diagnosis of anterior loops of the mandibular canal and can be used with great reliability to identify their presence and measure their length.[21,27,29] However, CBCT is preferable and is most often used in dental practice due to its advantages, including a lower cost and a lower radiation dose, in combination with the fact that CBCT image quality is comparable or even superior to that of multislice CT for evaluating dentomaxillofacial structures.[8,11,16,40,4]

The high prevalence and significant extent of the anterior loop found in this study highlights the importance of knowledge regarding this anatomical variation. For this reason, it is necessary for professionals to identify the presence of anterior loops and to measure them correctly when planning procedures involving the interforaminal region.

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