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Assessment of anterior loop of mental foramen with cone beam computed tomography-An institutional based study

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ABSTRACT

Background: Cone beam computed tomography (CBCT) is a specialized imaging technology designed to create accurate 3D images of craniofacial anatomy while using significantly less radiation than traditional CT scans. This advancement allows clinicians to closely examine dental and maxillofacial structures, forensic analysis, and modern therapeutic techniques.
Objective: To evaluate several anatomical variants of the anterior loop of the mental foramen using cone-beam computed tomography (CBCT).
Materials and Methods: The study involved 30 randomly selected patients aged 20-60 year from the departmental OPD, who underwent CBCT of the anterior mandibular region to assess the mental foramen. After obtaining a detailed history, a diagnosis was made and explained to the patients. Data were analyzed according to the classification by Solar et al. (1994).
Results & Conclusion: Type 1 mental nerve loop presence was 6.6% greater on the right side (13.3%) than on the left side (6.7%), while Type 3 mental nerve loop presence was 6.6% higher on the left side (63.3%) than on the right side (56.7%) based on a comparison of the anterior loop of the mental foramen. However, Type 2 was similar on both the right (30.0%) and the left (30.0%) sides. The anterior loop of the mental foramen is an important anatomical feature and was comparable (Type 1/Type 2/Type 3) in patients on the right and left side ($p > 0.05$) ($\chi 2=0.78$, $p = 0.678$), showing no significant difference. Understanding its anatomy and occurrence has a significant impact on therapeutic strategies.

1. Introduction

Cone beam computed tomography (CBCT) was specifically intended to produce undistorted 3D images of craniofacial anatomy with a substantially lower effective radiation dosage than CT. The introduction of this novel technology into the field of dental radiology has enabled clinicians to more correctly examine the architecture of dental and maxillofacial structures for fine and micro studies of facial bone. It is particularly beneficial in both forensic and current therapy techniques.

The anterior loop is an anatomical variant of the mental nerve, a branch of the inferior alveolar nerve which extends anteriorly from the mental foramen.[1,2] In our investigation of the mental foramen and its looping, we discovered that

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the inferior alveolar nerve exits the foramen and forms the mandibular canal's anterior loop before dividing into two nerve branches: mental and incisive. The mental branch innervates the skin and mucous membrane of the lower lip and chin, as well as the adjacent buccal nerve and the vestibular gingival of the mandibular anterior teeth. The incisive branch innervates the anterior teeth, including the first premolar.[3]

Prenatally, the mental foramen is positioned beneath the tips of the primary canine and first molar teeth. Furthermore, when the first deciduous molars do not erupt, the mental foramen forms in an anterior direction; nevertheless, when the second deciduous molars emerge, it shifts to a posterior inclination. As a result, the positional shift in the position of the mental foramen could be attributed to skeletal growth and mesial drift of the dental lamina. The mental canal originates in the mandibular canal. It proceeds inside out, upward and backward, until it reaches the mental foramen, wherein the mental neurovascular bundle emerges anteriorly and doubles back to pass through it. To avoid surgical complications caused by mental nerve injury, the positioning of the foramen and the likelihood of an anterior loop overreaching mesially to the mental foramen must be considered.[4–6]

The inferior alveolar nerve's end branches are crucial for anterior mandible implant surgery, as injury to the mental or incisive branches can cause neurosensory disturbance in the lower lip area. Consequently, the anterior loop's location restricts the placement of dental implants between the mental foramens, commonly known as the inter-foraminal region. This anatomical component is necessary for implant surgery and open reduction of a mandibular fracture and orthognathic surgery. The interforaminal area is often identified as the safest location for dental implant surgery.[7]

The objective of our current research is to evaluate mental foramen placements and examine the anterior loop using CBCT, a three-dimensional dental diagnostic technology that provides precise distance measurements and detailed information for a three-dimensional investigation of the concerned region. CBCT imaging is now being used more frequently, particularly in forensic odontology, dental implant planning, maxillofacial surgeries, and other surgical procedures in the region of mental foramen, because of its low cost, rapid image acquisition, and lower exposure dose when compared to other methods, as well as to prevent adjacent structure or nerve damage or related complications.

2. Aim & Objectives

The purpose of this study is to assess several anatomical variants of the anterior loop of the mental foramen using C.B.C.T.

3. Materials and Methods

The Department of Dentistry at Rajkiya Medical College, Orai Jalaun, collaborated with an outsourced center to carry out this study. After obtaining informed consent from 30 patients, a detailed history was gathered, followed by a diagnosis and an outline of clinical and radiological benefits using a patient information sheet. These patients were randomly selected between the ages of 20 and 70 years old and had undergone CBCT assessment of the anterior mandibular region for mental foramen. Following the clinical tests, the same patients underwent CBCT scans, and data was collected and analyzed as per the classification laid by Solar et al. (1994).

3.1. Interpretation of images

All CBCT images were downloaded to a personal computer and analyzed using i-CAT Vision (2004-08) programme. This software evaluates the mental foramen and anterior loop of the mental nerve on sectional panoramic views, as classified by Solar et al. (1994). The images were analyzed using laptop to identify the anterior loop of the mental foramen. The observer was allowed to employ magnification, change the screen brightness, and scroll through the images. A single observer checked all of the data to guarantee its uniformity. The scans were examined routinely to standardize the method, and then statistically analyzed.

4. Results & Observations

This study uses CBCT to assess and compare the presence, position, and appearance of the anterior loop of the mental foramen. The study included 30 CBCT scans of mandibles (60 hemi-mandibles) from patients with periodontal disease, those who are partially or completely edentulous for implant planning, and patients undergoing impacted tooth assessment and orthodontic evaluation. Continuous data was summarized as Mean ± SD (standard deviation), and categorical data were provided as number (n) and percentage (%). Categorical groups were compared using the chi-square ($\chi 2$) test. A two-tailed p-value of < 0.05 indicated statistical significance.

The baseline demographic data (age and sex) of the enrolled patients are summarized in Table 2. Patients' ages ranged from 22 to 70 years, with a mean (± SD) of 47.53 ± 16.71 years and a median age of 52 years. Specifically, 14 patients (46.7%) were ≤ 50 years old, while 16 patients (53.3%) were > 50 years old, indicating a predominance of older individuals. The study cohort comprised 10 females (33.3%) and 20 males (66.7%), resulting in a male-to-female ratio of 2:1.

In patients, the presence of mental nerve loop Type 1 was 6.6% higher at right side (13.3%) than left side (6.7%) as shown in Table 3 whereas Type 3 was 6.6% higher at

Table 1: Classification of Mental Nerve loop (Solar et al.,1994)

Classification of anterior mental nerve loop	
Type	**Description**
I	a) Type I is distinguished by the absence of an anterior loop. b) Anatomy is Y-shaped, with the incisive branch often wider than the main branch. c) The mental branch exits the inferior alveolar nerve posterior to the entrance of the mental foramen.
II	a) The anatomy is T-shaped and lacks an anterior loop, with the incisive branch typically perpendicular to the main branch. b) The mental branch separates from the inferior alveolar nerve perpendicular to the entrance of the mental foramen.
III	a) Anatomy is Y-shaped and characterized by the presence of an anterior loop, with the incisive branch typically as small as the main branch. b) The inferior alveolar nerve's mental branch emerges before the mental foramen opens.

Table 2: Summarizes the number (n) and percentage (%) of patients with entire anterior mental nerve loop types, and compares them using the $\chi 2$ test ($\chi 2$ value).

Mental nerve loop type	**Total (Right side + Left side) (n=60) (%)**	**χ^2 value**	**p value**
Type 1	6 (10.0)		
Type 2	18 (30.0)	34.20	<0.001
Type 3	36 (60.0)		

Table 3: Summarizes the number (n) and percentage (%) of patients with anterior mental nerve loops on both the right and left sides and compares them using the $\chi 2$ test(χ^2 value).

Mental nerve loop type	**Right side (n=30) (%)**	**Left side (n=30) (%)**	**χ^2 value**	**p value**
Type 1	4 (13.3)	2 (6.7)		
Type 2	9 (30.0)	9 (30.0)	0.78	0.678
Type 3	17 (56.7)	19 (63.3)		

Table 4: Summarizes the number (n) and percentage (%) of patients with anterior left mental nerve loop types by sex and compares them using the $\chi 2$ test ($\chi 2$ value).

Left mental nerve loop type	**Female (n=10) (%)**	**Male (n=20) (%)**	**χ^2 value**	**p value**
Type 1	1 (10.0)	1 (5.0)		
Type 2	3 (30.0)	6 (30.0)	0.28	0.871
Type 3	6 (60.0)	13 (65.0)		
χ^2 value, p value	5.70, 0.058	16.35, <0.001	-	-

left side (63.3%) than right side (56.7%). However, Type 2 was similar on the right (30.0%) and left (30.0%) sides. The existence of the anterior loop of the mental foramen (Type 1/Type 2/Type 3) in patients on the right and left sides was similar ($p > 0.05$) ($\chi 2$=0.78, $p = 0.678$), indicating no significant difference.

In patients, the presence of mental nerve loop Type 1 was 5% higher in female (10.0%) than males (5.0%) as shown in Table 4 whereas Type 3 was 60% in females and 65% in males. However, Type 2 was similar in the females (30.0%) and males (30.0%). The existence of the anterior loop of the mental foramen (Type 1/Type 2/Type 3) in females & male patients was similar ($\chi 2$=0.28, $p = 0.871$), indicating no significant difference.

5. Discussion

The anterior loop has been evaluated by different radiographic methods, including panoramic radiography, CT, and CBCT. Panoramic radiography, a two-dimensional standard approach, has limited ability to detect and track the anterior loop. According to studies, CBCT radiography is more useful for pre-surgical implant planning and other surgical procedures in the mental region. CT and CBCT provide three-dimensional imaging without magnification or distortion. CBCT offers the advantage of producing high-quality images at a lower radiation exposure than CT.[8]

Our study's gender distribution (66.7% male and 33.3% female) indicates that males outnumber females. Uchida et al. conducted a similar study in 2009, and the gender distribution of subjects revealed that the majority of the population tested was male (111, 55.5%), with the remainder being female (89, 44.5%). In our study, on CBCT pictures of the north Indian population, the anterior loop of the mental foramen of patients on the right side was Type 1 in 4 (13.3%), Type 2 in 9 (30.0%), and Type 3 in 17 (56.7%) individuals. On the right side, mental nerve loop Type 3 was the most common, followed by Type 2 and Type 1 (Type 1 < Type 2 < Type 3). Arzu Demir et al. (2015) performed a

study with 279 dentate patients (138 females, 141 males, age range 20-69 years) to examine both sides of the mandible and found The distribution values for types 1, 2, and 3 on the right side were 10.4%, 29.4%, and 60.2%, respectively.

In the current study, the presence of the anterior loop of the mental foramen of patients on the left; the mental nerve loop Type 1 was found in 2 (6.7%) patients, Type 2 in 9 (30.0%) patients, and Type 3 in 19 (63.3%) patients. On the other side, mental nerve loop Type 3 was the most common, followed by Type 2 and Type 1 (Type 1 < Type 2 < Type 3). Our findings are validated by Arzu et al. (2015), who found that the type 1 anterior loop of the mental foramen was 6.8%, the type 2 anterior loops of the mental foramen was 34.4%, and the type 3 anterior loop of the mental foramen was 58.8%, indicating that type 3 was more prevalent than types 2 and 1.

In our investigation, the anterior loop of the mental foramen was shown to be overall or entire. Type 1 occurred in 6 (10.0%) patients, Type 2 in 18 (30.0%), and Type 3 in 36 (60.0%) individuals. The mental nerve loop Type 3 was the most prevalent on both sides, followed by Type 2 and Type 1, which was the least common. The occurrence of an anterior loop is very variable across investigations, as demonstrated by a comparable study conducted in 2015 by Arzu Demir et al. The total rates of type 1, type 2, and type 3 were determined to be 8.6%, 31.9%, and 59.5%, respectively. According to their findings, type 1 anterior loop was less founded than type 2 and type 3. There have been several studies in which the authors attempted to quantify the length of the inferior alveolar nerve's anterior loop using various approaches (anatomical, radiographic, and combination). The majority of researches have demonstrated the inaccuracy of radiography due to the high rate of false-positive and false-negative findings. Bone varies in both quantity and quality as it ages. Researcher observed that the drift of the anterior loop becomes varied as alveolar bone resorption occurs after the loss of posterior teeth.[9] Radiographic interpretation of the interforaminal region has been limited due to inadequate radiographs or bone quality, as well as the inability to distinguish these anatomic markers from the trabecular structure.

In the present study, the anterior loop of the mental foramen was investigated using CBCT, which is the most often utilised imaging modality in implant treatment planning. CBCT has proven to be reliable by allowing for the observation of tissues without superposition, distortions, or magnification. Rober et al used CBCT to obtain more reliable results.[4]

According to Haktanr A et al,[10] utilizing multi-detector CT, there is a potential of finding a loop that originates from the mental nerve. The anterior loop of the mandibular canal was seen in 36.9% of instances in Kajan and Salari's[11] CBCT investigation of seven patients. Kaya et al.,[12] found that spiral CT scans detected anterior loops at a frequency of 34% and panoramic pictures at 28%. Spiral CT scans produced results similar to those of Kajan and Salari's investigation. Ngeow WC et al.,[13] identified the anterior loop in 40.2% of panoramic radiographs. However, in our investigation, the existence of overall or complete (right side + left side) anterior loop of the mental foramen in patients Type 3 was the most prevalent type (60.0%) and Type 1 is the least prevalent type (10.0%). Thus, at both side, the mental nerve loop Type 3 was the most common followed by Type 2 and Type 1, the least (Type 1 < Type 2 < Type 3).

The frequencies of recognizing the presence of an anterior loop in the research by Arzouman et al, Kuzmanovic et al, Jacobs et al, and Yosue & Brooks were found to be 12%, 27%, 11%, and 21%, respectively. The reported frequencies were lower than in our study. Several studies proposed a safety margin of 1-9 mm from the anterior border of the mental foramen. In a study conducted by Wismeijer et al, a technique with a 3 mm safety margin was explored for all patients, and sensory abnormalities caused by anterior loop injury were found in 7% of cases. A standard distance from the mental foramen as a safety buffer is still not recommended. Because of this risk, many practitioners place implants anterior to their ideal position in order to avoid harm to the lower lip's mental nerves and sensory abnormalities.[14]

Anterior loops were more frequently observed bilaterally. Similarly, in our study, the anterior loop on both sides was rated at 45.5%. There was no statistically significant difference between men and women. Similar to this study, Ngeow et al. and Kajan and Salari[7] discovered no correlation between the observed frequency of the anterior loop and gender.

Thus, based on our findings, we may conclude that there are three types of anterior loops of the inferior alveolar nerve, with Type 3 being the most prevalent and Type 1 being the least prevalent. Age and gender were indistinguishable, and no significant difference was detected. And, because the inferior alveolar nerve is so important due to its location and involvement in implant surgery, its assessment is critical.[15]

6. Conclusion

CBCT is a safe method for radiographic examination of the interforaminal area. The anterior loop of the mental foramen is an extremely vital anatomical feature. Understanding its anatomy and occurrence has a significant impact on therapeutic strategies. Although several approaches are utilized to evaluate anterior loop anatomy, CBCT can provide exact information and aid in appropriate management and preparation. Our study is one of the few that used CBCT to examine the occurrence of the various forms of anterior loop mental foramen in the Bundalekhand community, with Type III being the most common variant. However, bigger sample sizes are required

to substantiate the current study's findings and provide a strong recommendation for safety margins.

7. Ethical Approval

The study was approved by the Ethical Committee of Rajkiya Medical College Orai-Jalaun, Uttar Pradesh.

8. Source of Funding

Not applicable

9. Conflict of Interest

The authors disclose no financial or personal interests that may have influenced the work reported in this paper.

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