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Research Article

Locating the Anterior Loop of the Inferior Alveolar Nerve on CBCT

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Abstract

Purpose: The aim of this study was to determine the variations of anterior loop of mandibular canal in the inter-foraminal region. Presence or absence of anterior loop and the length of the same when present were determined using cone-beam computed tomography (CBCT).

Materials and Methods: CBCT images from 32 patients were acquired randomly using Newtom Giano Mid-Field CBCT Machine and evaluated for the presence and length of the anterior loop. The prevalence and length of the anterior loop was then compared based on the side of the mandible, gender and age. The data were analyzed using the Pearson chi-square test.

Results: An anterior loop was identified in 41% of the cases, and its average length was 2.90 ± 2.79 mm. 62.5% of anterior loops on right side and 40% on left side were longer than 2 mm in length. Prevalence of anterior loop in relation to age groups and gender was statistically non-significant (p value = 0.7725). There were more number of the loops present on left side rather than the right side of mandible, when occurred unilaterally.

Conclusions: The prevalence of important landmarks in inter-foraminal region was under estimated on two dimensional imaging modalities. Three dimensional modality like CBCT, can reveal the true prevalence, location and length of these landmarks like an anterior loop. Every clinician/surgeon must take a note and necessary precautions related to these landmarks when planning for any surgical procedure in this region.

Keywords: *Anterior Loop; Inferior Alveolar Nerve; CBCT*

Introduction

In the head and neck region, anatomical landmarks are standard reference points. They are very important for Oral Surgeons and Radiologists, to aid in diagnosis and planning of surgical procedure [1].

Human mandible has a number of landmarks, the mandibular canal being the most important. It is an anatomical structure that is present bilaterally in mandible sheltering the inferior alveolar artery, vein and nerve. During its course the inferior alveolar nerve usually divides into the mental and incisive nerves, in the molar region. Further mental nerve continues upward and emerges from the mental foramen in conjunction with blood vessels [2]. This canal may occur in different anatomical configurations, in vertical as well as horizontal planes [3].

The precise knowledge of anatomical landmarks of inter-foraminal region (region between mental foramina) and its variations are important for clinicians for avoiding injuries to the neurovascular bundles. One such variation was seen on dissected hemi-mandibles as anterior loop of the mandibular canal [4]. It refers to "an extension of the inferior alveolar nerve, anterior to the mental foramen, prior to exiting the canal" [2].

Though implant placement and other surgical procedures in this inter-foraminal region are usually considered relatively safe, without risks of damaging vital structures. However, cases have been reported of hemorrhagic episodes and post implant paresthesia in this region for which the anterior loop of mandibular canal has been held responsible [1,5].

CBCT, the latest state-of-the art equipment in the field of maxillofacial imaging provides the iso-volumetric data, which allows us to measure and view minute details of the images by reconstructing the data up to 300 microns. CBCT can be a relevant tool in determining the presence, number, diameter, and morphology of these landmarks, including anterior loop of the canal [6].

Aim of the Study

The present cross-sectional study aimed at determining the presence or absence of anterior loop and its length when present, employing CBCT.

Materials and Methods

This cross sectional randomized, single blinded study included 32 subjects (15 males and 17 females) of age group 20 - 70 years, which were randomly selected who underwent CBCT examination of anterior mandible for implant placement.

Scans were acquired using Newtom Giano [Mid-Field FOV (11 cms × 9 cms)] CBCT Machine with a standard exposure protocol (7 mA and 85 kVp with 8 × 6 cms FOV). Slice thickness of the CBCT images were reconstructed upto 300 microns and then all the linear and angular measurements were done by a single radiologist, with the help of the tools available in the NNT viewer.

The CBCT panoramic reconstruction was used to trace the mandibular canal. The mental foramina region was carefully examined for the presence of anterior loop on both sides. It was considered to be present when there was anterior continuation of mandibular canal in the form of an arch, seen on thin slices of panoramic reconstruction. The finding was then confirmed on the cross sectional images (Figure 1a and 1b).

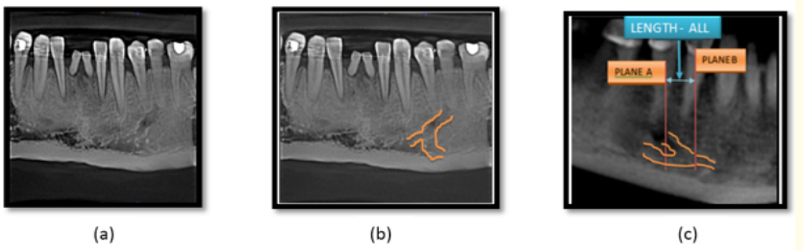

Figure 1: *a. Presence or absence of anterior loop was identified on panoramic reconstruction done on CBCT dicom images. As seen in the image; b. Panoramic reconstruction in CBCT, showing anterior loop and incisive branch; c. CBCT image showing the plane A and B, as well as length of anterior loop*

The length of anterior loop (ALL; if present) was measured. Planes i.e. A and B were defined.

- **Plane A:** It was the plane perpendicular to the inferior border of mandible that passes through the anterior-most margin of the mental foramen.
- **Plane B:** It was the plane perpendicular to the inferior border of mandible that passes through the anterior-most margin of the mandibular anterior loop.

The ALL was considered as the shortest straight-line distance measured between plane A and plane B (Figure 1c). These planes coincided in the absence of an anterior loop.

Result

The 32 subjects (15 males and 17 females)included in the study were divided into 3 age groups, i.e. 20 - 40 years, 41 - 60 years, and more than 60 years. The least number of subjects were of more than 60 years of age. Maximum percentage of male and female subjects (50%) belonged to the age group of 41 - 60 years of age.

The data on frequency of occurrence of anterior loop of mandibular canal on right and left side (Table 1) depicted that right anterior loop was present in only 8 (25%) of subjects whereas left anterior loop was present in only 9 (28.1%) subjects. 13 (40.6%) out of 32 subjects showed at least one anterior loop on either side of the mandible, out of which in 4 (12.5%) patients the presence of the loop was

bilateral. Comparison of the presence/absence of anterior loop of mandibular canal on the right and left side was done using Pearson Chi Square test. The statistical interpretation of which was nearly comparable (p value = 0.777).

	Right		Left	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Present	8	25.0	10	31.3
Absent	24	75.0	22	68.7
Total	32	100.0	32	100.0

Table 1: *Frequency of occurrence of anterior loop of mandibular canal on right and left side.*

The average length of right anterior loop was 2.79 mm (SD ± 2.96 mm). The shortest length was 0.8 mm and maximum length being 9 mm. The average length of left anterior loop was 3 mm (S.D ± 2.80 mm). Minimum was found to be 0.8 mm and longest loop was 10.5 mm (Table 2). The average length of the anterior loop was found to be 2.90 mm (SD ± 2.79 mm).

Right/Left	Mean ± SD (mm)	Range (mm)
Right Anterior Loop (N = 8)	2.79 ± 2.96	0.8 - 9.0
Left Anterior Loop (N = 10)	3.00 ± 2.80	0.8 - 10.5

Table 2: *Average length of anterior loop of mandibular canal of right and left side.*

The anterior loops which were of 2 mm or more in length were considered to be significantly longer. 5 (62.5%) out of 8 on right side and 4 (40%) out of 10 anterior loops on left side were found to be longer than 2 mm. Comparison between right and left side was found to be statistically non-significant. (p value = 0.343) (Table 3). Therefore, the statistical interpretation was drawn that the frequency of occurrence/presence of significantly longer (≥ 2 mm) anterior loop on right and left side of mandible was nearly comparable

Right/Left	≥ 2 mm (significant)		< 2 mm (non-significant)	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Right Anterior Loop (N = 8)	5	62.5	3	37.5
Left Anterior Loop (N = 10)	4	40.0	6	60.0

Table 3: *Frequency of occurrence of significantly longer anterior loops of mandibular canal on right and left.*

Discussion

The number of implants inserted in the inter-foraminal region of the anterior mandible is 1.4 million per year worldwide [7]. Other common surgical procedures performed in this region include bone harvesting from the chin, genioplasty in orthognathic surgery, and screwing with or without plating after trauma of the anterior mandible. Though, inter-foraminal region of mandible is usually considered as safe zone [8,9], still cases have been reported of hemorrhagic episodes and post implant paresthesia in this region [1,5].

A number of cadaveric studies have reported the presence of an anterior extension of mandibular canal as an anterior loop, which has been described as "the mental canal which rises from the mandibular canal and runs outward, upward and backward to open at the mental foramen" [9-11].

Many studies have been performed to visualize the anterior loop on panoramic radiographs but the results were not consistent, due to the superimposition of the cervical vertebrae and to the orientation of the X-ray beam in relation to the trajectory of the canals. Whereas, there are less number of studies to determine this parameter on the CT scan and further less on CBCT [9,10].

The present study shows the appearance of anterior loop on the CBCT scans. The presence of anterior loop was calculated on right and left side of the mandible. 41% of total subjects were showing at least one anterior loop on either side of the mandible. 12.5% of subjects were showing the presence of the loop bilaterally. This finding was in accordance with the study done by Wei Cheong., *et al.* [11] and Solar., *et al* [12]. However, this is higher than the prevalence reported by some other studies [13] which were conducted using panoramic radiographs. This could be due to the inherent limitations of the conventional radiographs which failed to view canal accurately because of its intra-medullary position [8,9].

The average mean length of anterior loop was 2.90 ± 2.79 mm. This finding was in accordance with the study done by Neiva., *et al*. [14] and Uchida., *et al* [15].

Arzouman MJ., *et al*. [9] reported the mean length of anterior loop to be longer than the measurements obtained in our study. The length reported by them was 6.95 mm.

In our study, anterior loops which were longer than 2mm in length were 62.5% and 40% on right and left sides respectively. Arzouman., *et al*. [9] have considered the 2 mm of length of anterior loop to be more significantly important from implant point of view. Because the most common/favorable site for implant placement in anterior mandible is just anterior to mental foramen or canine region. Thus, any neurovascular containing loop if extends for more than 2 mm beyond mental foramen, could be impinged or injured by placement of endosseous implant producing the complications related to either hemorrhage or post implant paresthesia [11]. Moreover, the loops showing the length of 1 mm, is considered to be just a slight change in morphology of mandibular canal, rather than the true looping.

Prevalence of anterior loop in relation to age groups and gender was statistically non-significant. (p value = 0.7725). This finding is contradictory with the results of study done by Wei cheong., *et al* [11]. In our study, the number of subjects showing the presence of anterior looping of mandibular canal did not decreased with the increasing age. The probable reason for this could be the prevalence of loops being studies on panoramic radiographs by Wei Cheong., *et al* [11]. Though, the explanation given by them will not affect the visibility of anterior loop on CBCT.

According to our observations there were more number of the loops present on left side rather than the right side of mandible, when occurred unilaterally. Though, it was not proven statistically. Since this was an additional parameter being studied, no comparison with other studies could be done.

Conclusion

The prevalence of important landmarks in inter-foraminal region was under estimated on two dimensional imaging modalities. Three dimensional modality like CBCT, can reveal the true prevalence, location and length of these landmarks such as, an anterior loop. Every clinician/surgeon must take a note and necessary precautions related to these landmarks when planning for any surgical procedure in this region.

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