Evaluation of Incidence of Mental Nerve Loop in Central India Population Using Cone Beam Computed Tomography

Abstract

**Context:** Anatomical literature has described the anterior loop being an extension of the mental nerve which is present anterior to the mental foramen while the caudal loop has been described as the distance between the lower border of the mental foramen and the lowest point of the mandibular canal. The knowledge and identification of the anterior and caudal loop of the mental nerve are important in surgical procedures performed around the mental foramen to avoid inadvertent damage to these vital structures resulting in postoperative complications. **Aim:** The present study was conducted to determine the incidence and measurement of mental nerve loop in the mandibular arches using cone beam computed tomography (CBCT). **Settings and Design:** A total of 200 CBCT images were retrieved and inspected for the presence of the mental nerve loop. The length of the anterior loop was measured by counting the number of consecutive contiguous vertical cross sections displaying two round hypodense images. This number was multiplied by the thickness of the slices. The caudal loop was measured as the distance between the lower border of the mental foramen and the lowest point of mandibular canal. **Statistical Analysis Used:** Shapiro–Wilk test and Mann–Whitney U-test were used. **Results:** 57.5% (n = 200 scans) presented with the anterior loop of the mental nerve with a mean length of 0.50 mm and 0.37 mm on the right side and left side, respectively. All the samples of CBCT scans taken were having caudal loop extension with a mean length of 3.53 mm. **Conclusion:** A considerable number of individuals (57.5%) in the present study presented with the anterior loop of the mental nerve. CBCT was found to be an effective imaging modality for the detection of anterior loop of the mental nerve.

**Keywords:** Cone beam computed tomography, mental foramen, mental nerve

Introduction

With evolution, human anatomy has extensively remodeled itself and still continues to do so consisting of various variants of anatomic structures. Because of these variations which are often missed and assumed, the outcome of the surgery ends up unexpectedly different. This especially holds true for the maxillofacial area owing to the various adaptive changes of structures in this region. Hence, a thorough preoperative planning of the maxillofacial region is a prerequisite for a successful treatment outcome.

Anatomical literature has described the anterior loop as an extension of the mental nerve that is anterior to the mental foramen\(^1\) while the caudal loop has been described as the distance between the lower border of the mental foramen and the lowest point of the mandibular canal.\(^2\)

Knowledge of the anatomy and its variations in the region of the mental foramen and the anterior and caudal loop are essential to avoid accidental complication resulting in neurosensory disturbance in the chin and lower lip region that may occur during surgical procedures in the mandibular interforaminal region. To prevent injury to the neurovascular bundle, different diagnostic methods (anatomical, radiographical, and combined) have been attempted to measure the length of the anterior loop of mental nerve,\(^3\) but the actual existence of the loop has been debated,\(^6\) and large variations on the mean length and on the range have been noted.

Although anatomical studies on cadavers provide important and accurate information about the prevalence and variation in length of the anterior loop, cone beam computed tomography (CBCT) is preferable because it actually corresponds to clinical practice and adequately satisfies presurgical needs.

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planning requirements. Furthermore, CBCT images have been proven to exhibit high precision and reliability in the diagnosis of the anterior loop due to its advantages, including a lower cost and a lower radiation dose, in addition to the fact that CBCT image quality is comparable or even superior to that of multislice CT for evaluating the dentomaxillofacial structures.[7-9]

With the above background, the present study was designed to determine the incidence and measurement of mental nerve loop in the mandibular arches using CBCT.

Materials and Methods

The study was carried out in the Department of Oral Medicine and Radiology, Sri Aurobindo College of Dentistry, Indore (Madhya Pradesh).

The images of 200 subjects (who had undergone CBCT examination showing the mandibular premolar/molar region) were retrieved from the archival records and inspected for the presence of the mental nerve loop. The scans obtained for the study were actually recorded for other reasons, for example, assessments of bony pathology, cystic lesions, implant planning, trauma, or level of third molar impactions.

The selection criteria for scans included in our study were as follows:
1. The lower border and the anterior part of the mandible, at least 2 cm distal to the mental foramen, were included in the volume
2. No pathology in the area to be examined that could affect the position of the mental foramen, mandibular canal, or anterior loop
3. Images of adequate diagnostic quality (for instance, no movement or radiation artifacts)
4. To allow for investigation of the proportion of measurements between the right and left sides in a single patient, both sides were available for evaluation in each case.

Image acquisition

The CBCT images were obtained using the three-dimensional (3D) Kodak CS 9300 CBCT machine. The following parameters were used; tube voltage of 90 kV, tube current of 5 mA, exposure time of 11.30 s, and a cylindrical-shaped field of view (FOV) measuring 17 mm × 13 mm with a voxel size of 300 µ. The FOV used was same for all the scans so as to standardize the image selection criteria. All the images had a resolution of 90 µm and a single 360° scan was used. The scans were done according to a pulsed exposure.

The subject was positioned for the CBCT scan as follows: The subject was asked to wear a lead apron and made to stand in an upright position, with the Frankfurt plane parallel and sagittal plane perpendicular to the floor with the help of positioning laser beams. The subject was asked to bite in maximum intercuspation. The head was stabilized with the help of temple rests. The sagittal, coronal, and axial sections of the images were reconstructed from the projection data. The thickness of the image slice was 300 µm and the distance between slices was 1 mm. The contrast and brightness of all the images were kept at a constant value for uniformity during image analyses. All images were assessed under optimal viewing conditions with appropriate image viewing software (Care stream 3D imaging software).

Anterior extension of the mental nerve loop

On each volume, the axial slices were reconstructed parallel to the lower border of the mandible, and on the appropriate selected axial slice, the most anterior part of the mental foramen was marked. Then, again using the axial views, the most anterior part of the inferior alveolar nerve was marked. It was defined as the most mesial area of the mental nerve just before a sudden reduction of the width (constriction) of the nerve as the incisive nerve divided to pass anteriorly in the incisive canal. Based on the available literature of the size of the incisive canal, a cutoff point of 3 mm for the maximum diameter of the incisive canal was taken. A canal of more than 3 mm was always considered part of the mandibular canal (anterior loop) and never of the mandibular incisive canal[10] [Figures 1 and 2].

The length of the loop was measured by counting the number of the consecutive contiguous vertical cross sections displaying two round hypodense images (corresponding to the upper and lower segments of the MC, typically ending in an “8-like” shape anteriorly), 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. The initial slice for measurement was considered to be the first slice just after the anterior margin of the mental foramen disappeared[11] [Figure 3a].

Caudal extension of the mental nerve loop

It is the distance measured between the lower border of the mental foramen and the lowest point of the mandibular

Figure 1: The anterior loop of the mental nerve
canal. This caudal extension was measured in the panoramic reconstruction of CBCT scan\(^2\) [Figure 3b].

The measurements were carried out by two trained and calibrated observers. All the scans were measured and remeasured by the two observers until the desired inter- and intra-examiner reliability was obtained. (Cohen’s Kappa = 0.85).

**Results**

A to 200 CBCT scans \((n = 200)\) was selected for the present study. The scatter of age for all samples was found to be in the range of 8–79 years. The mean age (mean ± standard deviation [SD]) of all samples was 31.27 ± 16.06 years. Of a total of 200 samples, 111 (55.5%) were males and 89 (44.5%) were females.

The presence of mental nerve loop either on the left or right side was recorded and a comparison between gender and various age groups (<20 years, 20–40 years, 40–60 years and 60–80 years) was carried out to identify the incidence and measurement of mental nerve loop in the mandibular arches and their relation with age and gender.

The Shapiro–Wilk test was used to determine the normality of the length of anterior extension and caudal extension and Mann–Whitney U-test was used to identify the significance of difference in the length of anterior extension and caudal extension of the mental nerve, differences between males and females and right and left side, among various age groups. The Spearman’s coefficient of correlation was used to identify the extent of strength and direction of relationship of anterior extension and caudal extension of the mental nerve loop with left and right sides, gender, and various age groups.

Incidence of mental nerve loop in the mandibular arches is reported in Table 1 and highlights the presence of anterior loop of the mental nerve. Bilateral presence was noted among 57.5% of the scans while the presence on the right and left sides was 51.0% and 37.0%, respectively.

Caudal loop extension of mental nerve was found among all (100.0%) samples on the right and left side.

The incidence of anterior loop of the mental nerve in gender is shown in Table 2 and was found to be more common among males in the mandibular arches while the presence of caudal loop extension of mental nerve was noted on the right and left side, among all males (55.5%) and females (44.5%) [Figure 4].

The incidence of anterior and caudal loop extension of the mental nerve in the mandibular arches is shown in Table 3 and was found to be dependent on age because the incidence on the right, left, and both the sides increased as age of the subjects increased [Figure 5].
The mean length of the anterior loop on the right side was 0.46 mm and 0.54 mm among males and females, respectively, which was greater than the left side (0.38 mm and 0.35 mm). The mean length of the caudal loop on the right side was 3.59 mm and 3.46 mm and left side was 3.54 mm and 3.54 mm among males and females, respectively.

The differences in anterior and caudal loop between males and females on the right and left sides based on ranks could not satisfy the limit of statistical significance ($P > 0.05$) [Table 4 and Figure 6].

The statistical agreement showed that sides of anterior and caudal loop of the mental nerve among various age groups (<20 year, 20–40 year, 40–60 year and 60–80 year) were insignificant factor that impacted the dental practices.

**Discussion**

In literature, widely differing values are provided for the incidence of anterior loop. In cadaver studies, they range from 0%\(^{[12]}\) to 88%\(^{[13]}\) in CT studies, values vary between 7%\(^{[14]}\) and 83%\(^{[15]}\) in CBCT studies, the range is between 48%\(^{[10]}\) and 84%\(^{[16]}\). An incidence of 57.5% was found in the present study.

In our study, the incidence of anterior loop of the mental nerve was found to be more common on both the sides among 115 (57.5%) scans, followed by 102 (51.0%) scans on the right side. These findings are similar to those reported by Ngeow and Yuzawati\(^{[12]}\) who observed bilateral occurrence of the anterior loop (34.4%) and also to the findings of Apostolakis and Brown,\(^{[10]}\) who observed an anterior loop in approximately 48% of patients, mostly bilaterally. Besides that in a study conducted by Filo et al.\(^{[2]}\) the anterior loop was identified in 69.7% of patients, with the majority being bilateral, followed by being on the right and left sides, respectively.

Gender distribution of subjects showed that major part of population studied was male (111, 55.5%) while rest were female (89, 44.5%). The incidence of anterior loop of the mental nerve loop in gender was found to be more common among males (58.6%) than females (56.2%). The incidence of anterior loop of the mental nerve on the right side was more (52.3%) as compared to females (49.4%) but on the left side among males (39.6%) was little higher than females (33.7%). Similar to studies by Uchida et al.,\(^{[3]}\) Li et al.,\(^{[15]}\) and Rosa et al.\(^{[17]}\) have shown the anterior loop to be significantly related to males.
Most part of the population (95, 47.5%) was in age group of 20–40 years. The second most common age group had age <20 years and comprised of 51 (25.5%) patients. Thirty-seven (18.5%) subjects found within the age group of 40–60 years. Few (17, 8.5%) patients were recorded in higher age group of 60–80 years. The incidence on the right, left, and both the sides increased as age of subjects increased. The incidence of anterior loop of the mental nerve among elder subjects aged between 60 and 80 years was the highest - 64.7%, 52.9%, and 64.7% on the right and left sides and both the sides, respectively.

Ngeow and Yuzawati[13] and Uchida et al.[5] indicated that the frequency of anterior loops decreases with age whereas studies by Apostolakis and Brown,[10] De Oliveira-Santos,[18] and Filo et al.[2] found no significant difference in the anterior loop when compared with different age intervals.

Perhaps, the variation in our study is due to differences in sample sizes within the age groups with major part of population of patients (95, 47.5%) in age group of 20–40 years and very few (17, 8.5%) patients were recorded in higher age group of 60–80 years. Furthermore, differences in results of our study may be due to different radiographic method used for the assessment of the mental nerve loop.

The mean length of the anterior loop in our study was 0.50 mm and 0.37 mm on the right side and left side, respectively, while various studies[2,10,15,16,18,19] reported a mean length ranging from 0.4 to 6 mm, thus coinciding with the values in the literature. The longest loop in the literature was reported by Neiva et al.[19] in American population being 11 mm, followed by Uchida et al.[5] in Japanese population with a length of 9 mm. Our longest anterior loop measured 3.6 mm.

Length of anterior loop of the mental nerve in the mandibular arches between males and females was approximately same on the right and left sides and the differences between gender and among various age groups (<20 year, 20–40 year, 40–60 year and 60–80 year) were insignificant. Similar to studies by Apostolakis and Brown,[10] De Oliveira-Santos et al.[18] and Filo et al.[2] found no significant relationships between these variables (age, gender, and side) and length of anterior loop. Whereas studies by Uchida et al.,[5] Li et al.,[15] and Rosa et al.[17] have shown the length of the anterior loop to be significantly related to males.

The large variation in incidence and measurement of the anterior loop in the literature probably is due to

| Descriptive statistics                      | Total population | Sex                |
|--------------------------------------------|------------------|-------------------|
|                                            | Right | Left | Right | Left | Right | Left |
| Anterior loop extension                    |       |      |       |      |       |      |
| Mean                                       | 0.50  | 0.37 | 0.46  | 0.38 | 0.54  | 0.35 |
| Median                                     | 0.24  | 0.00 | 0.30  | 0.00 | 0.00  | 0.00 |
| SD                                         | 0.60  | 0.58 | 0.54  | 0.59 | 0.67  | 0.58 |
| Minimum                                    | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 |
| Maximum                                    | 2.70  | 3.60 | 1.80  | 3.60 | 2.70  | 3.00 |
| IR                                         | 0.90  | 0.69 | 0.90  | 0.60 | 0.89  | 0.81 |
| 95.0% CI                                   | 0.41-0.58 | 0.29-0.45 | 0.36-0.57 | 0.27-0.49 | 0.40-0.68 | 0.23-0.47 |
| Caudal loop extension                      |       |      |       |      |       |      |
| Mean                                       | 3.53  | 3.54 | 3.59  | 3.54 | 3.46  | 3.54 |
| Median                                     | 3.30  | 3.30 | 3.50  | 3.30 | 3.30  | 3.30 |
| SD                                         | 1.24  | 1.31 | 1.29  | 1.33 | 1.18  | 1.29 |
| Minimum                                    | 1.20  | 1.00 | 1.20  | 1.00 | 1.40  | 1.50 |
| Maximum                                    | 8.40  | 9.30 | 8.40  | 7.00 | 8.00  | 9.30 |
| IR                                         | 1.78  | 1.80 | 1.90  | 1.90 | 1.65  | 1.75 |
| 95.0% CI                                   | 3.36-3.71 | 3.36-3.72 | 3.35-3.84 | 3.29-3.79 | 3.21-3.71 | 3.27-3.82 |

SD=Standard deviation, IR=Interquartile range, CI=Confidence interval
geographic/ethnic differences as well as to methodological discrepancies. According to De Oliveira-Santos et al.,[18] different radiographic techniques, different methods of measurements, and the absence of a specific definition of AL are recurrent in the literature.

Caudal loop extension of mental nerve

There is little literature dealing with the part of the IAN inferior to the mental foramen although this structure is important in terms of genioplasty or internal fixation of mandibular fractures, and hence, a comparative discussion is difficult.

In our study, we found the presence of caudal loop extension of mental nerve among all (100.0%) samples on the right, left, and both the sides, among males (55.5%) and females (44.5%) and among all age groups with mean (SD) being 3.53 mm (1.27 mm) with a range of 1.1–8.85 mm and length between males and females to be approximately similar on the right and left sides and the differences between gender and among various age groups (<20 year, 20–40 year, 40–60 year and 60–80 year) were not significant, similar to the studies done by Hwang et al.[20] and Filo et al.[2]

A deficient reliability in assessing the anterior loop with panoramic radiography has already been proved.[21] Panoramic radiography is still used in dental surgeries, especially for implant planning in the anterior mandible.

CBCT has gained an increasingly important role in dental diagnosis in recent years. In comparison with classical multidetector CT, CBCT offers the benefits of reduced radiation exposure at comparable resolution and accuracy and has become widely available and affordable over the years. Studies conducted to determine the visibility of anterior loop on 3D cone beam CT have revealed considerably better results.[22,23]

The high prevalence and significant extent of the anterior and caudal loop of the mental nerve found in this study highlight the importance of knowledge regarding this anatomical variation, thereby making it necessary for professionals to identify the presence of the anterior and caudal loop and to measure them correctly when planning procedures involving the preforaminal region. Analyzing CBCT scans using the method described in this paper can be a useful tool in avoiding surgical complications in the anterior mandible.

Further studies with larger samples are needed to assess the variability of the anterior and caudal loop extension of mental nerve using CBCT.

Conclusion

In conclusion, there was a high incidence of the anterior loop of the mental nerve (57.5%, n = 200) in the present study, with the maximum length of 3.6 mm. However, in spite of the wide variation in length, the majority of loops were <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 is done to identify and preserve the neurovascular bundles.

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Conflicts of interest

There are no conflicts of interest.

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