Review paper

Anterior Loop of the Mental Nerve- Unlooping its Importance in Dentistry

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Abstract:

In any surgical procedure, proper consideration to anatomical structures along with their precise position is of utmost importance. One such anatomical region in anterior mandible is anterior loop of mental nerve. The dental procedure carried out in anterior mandible can lead to neurosensory disturbances if this loop is injured. The presence of anterior loop have been made using conventional imaging modalities like panoramic and periapical radiography, however, limitations of two-dimensional imaging results in either over- or underestimation of the actual size making its use restricted. Cone Beam Computed Tomography is a gold standard three-dimensional imaging modality that allows generating multi-planar slices of an area of interest; its accuracy for analysis and linear measurements of craniofacial structures have been confirmed by several studies. This paper highlights the role of accurate and thorough assessment of the inter-foraminal region and anterior loop of the mental nerve prior to any surgical procedure especially in anterior mandible to avert any neurological complications.

Keywords: Anterior loop; Implants; Mental foramen; Mandibular nerve; Panoramic radiography.

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Introduction

Scrupulous knowledge of anatomical structures and their precise location is of utmost importance during any surgical procedures. The inferior alveolar nerve (IAN) canal is one such landmark in the mandible which encloses the neurovascular bundle and gives off mental branch via the mental foramen that exit into soft tissue and provides sensation to lip and chin, whereas the incisive branchtraverse anteriorly in the bone to supply anterior teeth.[1]

Various directional paths of mental foramen are proposed like according to Kieser J*et al.* (2002)[2], fivedifferent patterns of the mental nerve emergence are present, *viz*.**(Figure 1)**

Type 1: posterior directed,
Type 2: anterior directed,
Type 3: a right-angled pattern,
Type 4: multiple foramina, and
Type 5: no evaluation possible due to resorbed alveolus.

Whereas, DemirAM *et al.* (2015)[3]broadly classified mental nerve into 3 types based on its exit from the mental foramen, *viz*. **(Figure 2)**

Type 1: mental branch leaving the IAN posterior to the opening of the mental foramen,
Type 2: mental branch leaving the IAN perpendicular to the opening of the mental foramen, and
Type 3: mental branch leaving the IAN anterior to

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the mental foramen.

However, in few cases, IAN can extend beyond mental foramen like an intra-osseous anterior loop, which traverses upwards, outwards and backwards of the IAN originating from the mandibular canal to exit the mental foramen and is called the "Anterior Loop (AL) of the mental nerve".[4]

BavitzJB *et al.*(1993)[5] described that the AL is formed when the mental neurovascular bundle crosses inferior and anterior to the mental foramen then doubles or loops back to exit the mental foramen. JalboutZ and Tabourian G (2004)[6] described AL as "an extension of the inferior alveolar nerve, anterior to the mental foramen, prior to exiting the canal".

The rationale for development of AL of the mental nerve is the change in its position from anterior to posterior after eruption of the second deciduous molar.[7]It has been postulated that with loss of teeth and bone resorption, the mental foramen shifts upward nearer to the alveolar crest. Based on the degree of resorption,the mental nerve may emerge from the mental foramen closer to or at the alveolar crest. Therefore, bone resorption occurs with the loss of teeth, making the mental foramen get nearer to the anterior part of the mental loop, and the AL decreases.[8]

Assessment of AL

Clinically, AL can be assesed with the use of a probe; however, with this method, it is difficult to differentiate between an AL and an incisive canal.[9]Conventional imaging modalities including panoramic and periapical radiography have been used to assess the presence of AL, however, limitations of two dimensional imaging including magnification, distortion and an inability of exact reproduction of projection geometry results in either over- or underestimation of anactual size making its use restricted.[10]Cone Beam Computed Tomography (CBCT) is a gold standard three-dimensional imaging modality that allows generating multi-planar slices of an area of interest; its accuracy for analysis and linear measurements of craniofacial structures have been confirmed by several studies.[11]It also has the ability to establish the presence and length of the AL with accuracy and reliability.[12]The radiographs also helps in differentiating the AL from the incisive canal. Incisive canal presents as a single round hypodense image with a width smaller than 3mm; however, AL has a diameter greater than 3mm or when two round hypodense areas are seen, one casting the lumen of the mandibular canal that traverses the mental foramen anteriorly and inferiorly, and the other showing the loop of the mandibular canal, leading to the externalization of the IAN.[13] **(Figure 3)**

The length of the AL can be measured by a wide array of techniques. One of the most consistentmethods is to count the number of the contiguous vertical cross-sections between the anterior border of the mental foramen and the anterior border of the loop followed by multiplication of this number by the thickness of the slices. The preliminary slice considered for measurement is the first slice just after the anterior margin of the mental foramen disappears.[13]

Literature Review

Many studies have been carried out to evaluate the frequency and extent of AL of the mental foramen among different populations, ethnic groups, age groups and gender.A study was conducted by Moghddam MR *et al.* (2017)[14]to explore the prevalence and length of the AL in Iranians; wherein a total of 452 mandible quadrants of 234 patients (113 males, 121 females) were studied using CBCT. The AL was found in 106 quadrants (23.5% of 451 quadrants) of 95 patients (40.6% of 234 patients), of whom 11 had bilateral AL. The mean anterior loop length was found to be 2.77±1.56mm. It was concluded that the AL might be present in about 40% of patients, regardless of their gender.

Juan del VL*et al.*(2016)[15] conducted a study to measure the ALin a group of 55 Mexican participants wherein 90% of participants showed the AL with the length ranging between 0 and 6.68mm. No significant differences were found between the left and right sides or between genders.

A study was conducted by Yu SK *et al*. (2015)[16]using surgical microscope to study 26 hemi-mandibles from 19 cadavers. The location of the AL, the diameters of the mandibular, mental, and incisive canals, and their distances from bony landmarks were assessed with the help of digital callipers. The AL of the mandibular canal was located 3.05mm anterior to the anterior margin of the mental foramen and 2.72mm inferior to the superior margin of the mental foramen, and was 4.34mm long.

A study was conducted by Apostolakis Dand Brown JE (2012)[13]with the aim to identify and measure variation in the presence and extent of the AL using CBCT wherein 93 patients were scanned. The AL could be recognized in 48% of the patients with a mean length of 0.89mm (0-5.7).

According to NgeowWC*et al.* (2009)[17] anterior loops are most often observed bilaterally, followed by on the right side.KayaY *et al.* (2008)[18] reported that the frequencies of detecting anterior loop were 34% for spiral computed tomography (CT) scans and 28% for panoramic images.

Table 1 shows the various studies for detection of anterior loop and different mental nerve patterns.[19]

Summary

Most common procedures associated with trauma to the IAN include needle induced trauma during anaesthetic infiltration, extractions, endosteal or basal implant placement, alveoloplasty, open reduction of mandibular fractures or orthognathic surgeries.[20]One of the main challenges encountered during any surgical procedure in the inter-foraminal region is the inadvertent injury to the IAN which may manifest as paraesthesia, anesthesia, dysesthesia or pain in the region of lip or chin (reversible or irreversible depending on the duration).[21]This may be attributed to the variable anatomy of IAN canal and the presence of AL.

Since the length of the AL shows a high degree of unpredictability, this gives rise to an area of interest while placing an implant in mandibular anterior region and therefore CTscan must be recommended for every patient being subjected to implant placement especially in the mandible anterior region in order to visualize a safety zone in the proximity of the mental foramen. However, CBCThas advantages of providing images with high diagnostic quality and sub-millimetre resolution with much less radiation dosage when compared to the conventional CT. To avert any injury to the mental nerve, dentists have recommended varying safety margins from the mental foramen, advocating implants being placed at a distance of 1, 4, 5, 6mm from the mental foramen**(Figure 4).** However, 6mm distance from the most anterior point of the mental foramen is considered as most reliable to avoid any neurological complication and injury.[22]Hence precise knowledge is needed to establish the exact location of AL of the mental nerve to avoid any neurological complications.

Conclusion

The mental foramina being an important landmark for the placement of implant is usually oval or round in shape and is situated apical to the second mandibular premolar or between apices of the premolars. The presence of anterior loop and its accurate location are important in preventing injury to the neurovascular bundle. However, it can be found anywhere from the mandibular canine to the first molar. Precise clinical and radiographic assessment of the mandible, including the trajectory of the IAN, incisive canal and mental foramina constitutes an essential pre-operative method while planning for any surgical intervention, such as tooth extraction, implant placement, periodontal surgery, etc. Even though panoramic radiographs are used most commonly for the localization of the mental foramen, there is lack of clarity in identification of its diameter, shape and exit angle owing to the superimposition of anatomical structures, and also magnifying distortions. CBCT provides a more accurate image to recognize essential anatomical characteristics in the anterior mandiblefor pre-operative treatment planning and prevention of post-operative complications.

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Authors' contributions:

Data gathering and idea owner of this study: RI, NP, AP, MKA

Study design:RI, NP, AP, MKA

Data gathering: RI, NP, AP

Writing and submitting manuscript:RI, NP, AP, MKA

Editing and approval of final draft:RI, NP, AP, MKA

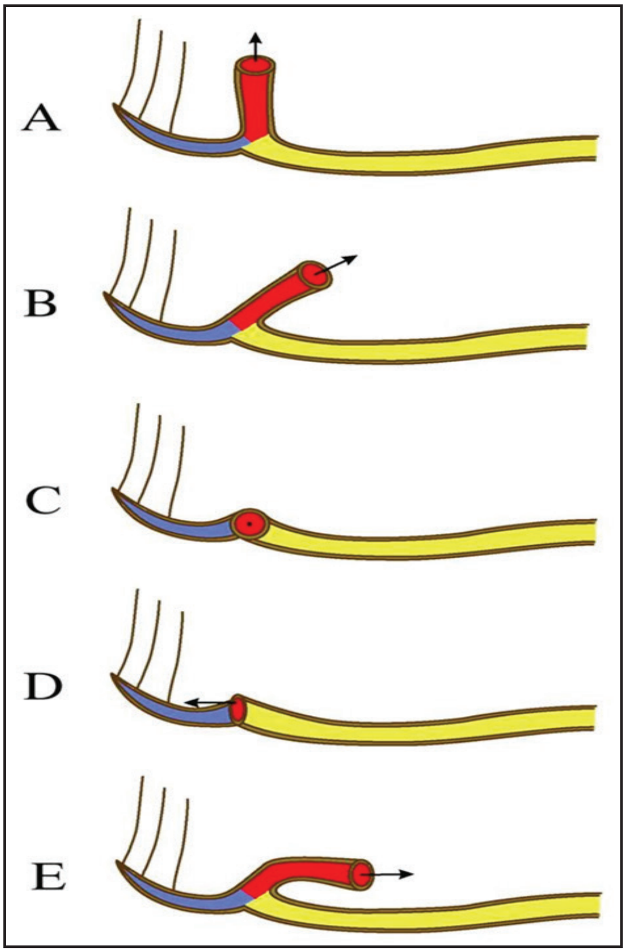

Figure 1: Directional paths of mental foramen as proposed by Kieser J *et al.*

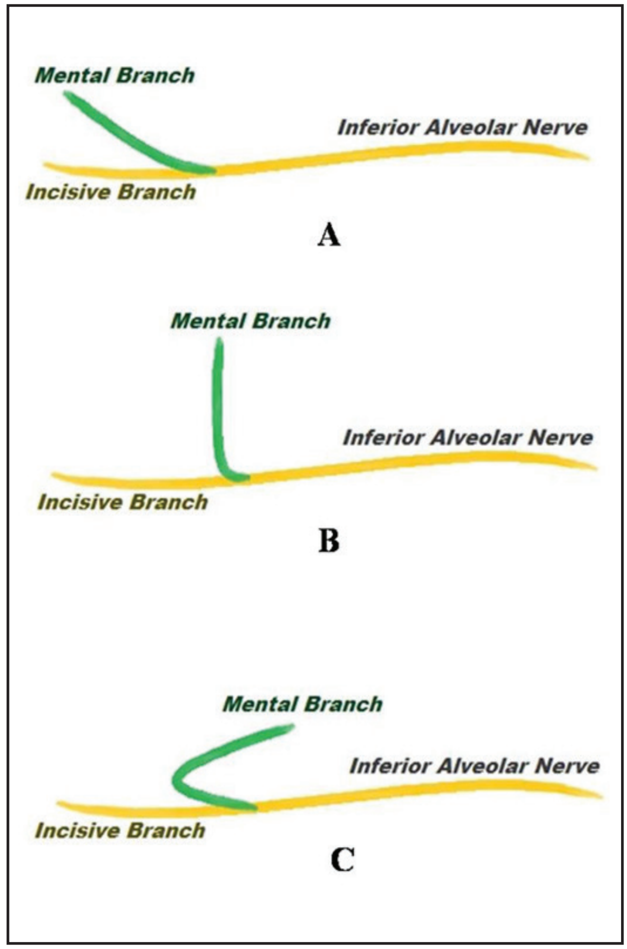

Figure 2: Directional paths of mental foramen as proposed by Demir AM et al.

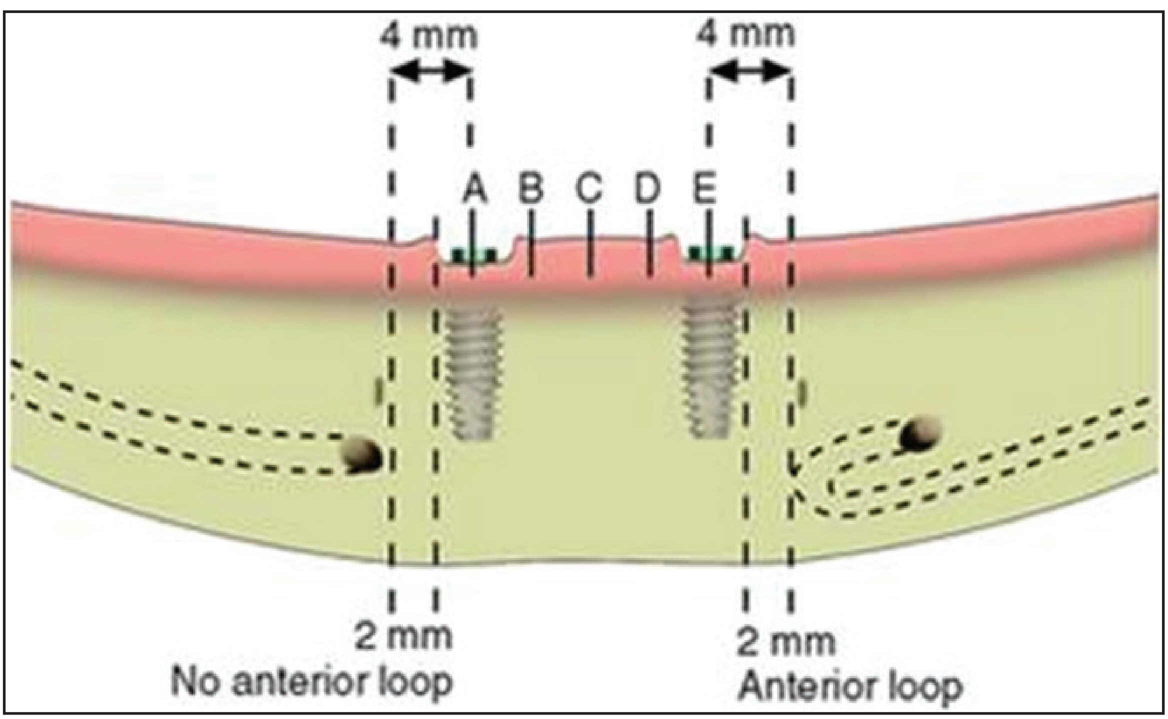

Figure 4: The position of the distal implant between the foramen is affected by the presence of an anterior loop

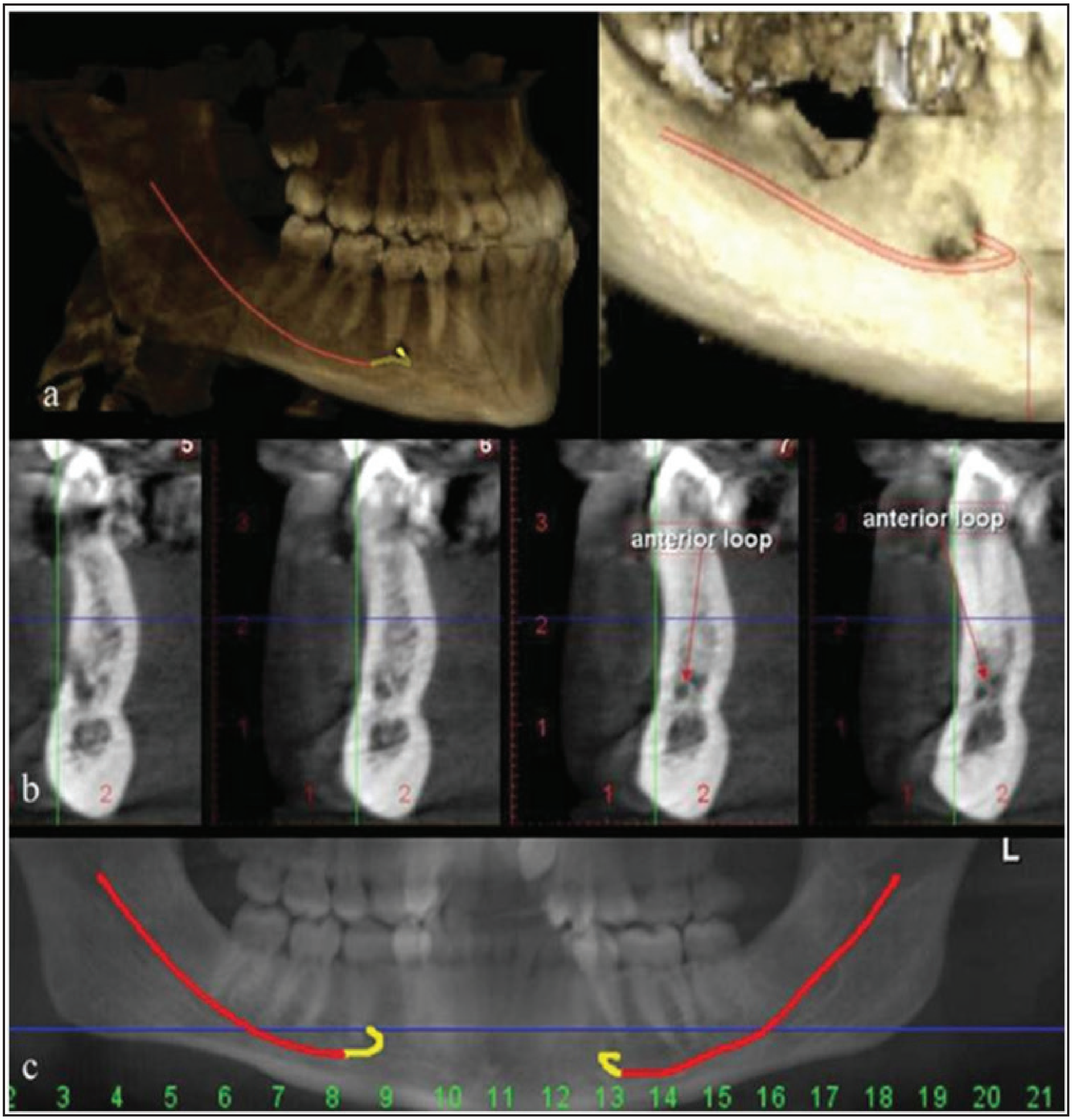

Figure 3: CBCT showing multi-planar slices of aarea of interest

TABLE 1- Various studies for detection of anterior loop and different mental nerve patterns

Author	Type of Study	Result
Kieser*et al.*	For detection of patterns of mental nerve Actual path of emergence of mental nerve human skulls	Most common pattern of emergence in Caucasoid and Maori was a posterior direction. In Black, the most common pattern was a right-angled path of emergence.
Hu *et al.*	The transitional part between inferior alveolar nerve and mental nerve in mandibles	Loop, straight and vertical patterns, constituted 61.5, 23.1, and 15.4%, respectively.
Solar *et al.*	Direct measurements on dissected cadaveric mandibles	60% of total mandibles studied.
Rosenquist	Direct measurements in vivo during surgical exploration	24% of total subjects studied.
Ngeow*et al.*	Panoramic radiographs	40.2% of 240 radiographs studied.
Yosue and Brooks	Panoramic radiographs	21% of 297 radiographs studied.
Misch and Crawford	Panoramic radiographs	12% of 324 radiographs studied.
Jacobs *et al.*	Panoramic radiographs	11% of 545 radiographs studied.
Arzouman*et al.*	Comparison of direct measurements and panoramic radiographs	92 to 96% in direct measurements, only 56% and 76% using different panoramic machines.
Kuzmanovic *et al.*	Comparison of direct measurements and panoramic radiographs	62% of loops that were anatomically present in cadaveric study were not visible on panoramic radiographs.
Mardinger	Comparison of direct measurements and panoramic radiographs	Of radiographically diagnosed loops, 40% were not seen on anatomic examination.
Kaya *et al.*	Comparison of CT and panoramic radiographs	34% loops in CT scans compared to 28% in panoramic radiographs.
Jacobs *et al.*	CT images	7% loops in CT scans (compared to 11% in panoramic radiographs detected by the same author in a previous study).
Apostolakis	Cone beam CT images	Visible loop in 48% of radiographs examined.

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