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ORIGINAL ARTICLE

Anterior loop of the mental nerve in Saudi sample in Riyadh, KSA. A cone beam computerized tomography study

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Abstract *Background:* The portion of inferior alveolar nerve (IAN) existent anterior to the mental foramen, before parting the canal, is referred to as the anterior loop (AL) of the IAN. The presence of AL is important when placing the implant interforaminal area of the mandible. These anatomical discrepancies can be assessed by cone-beam CT (CBCT), for evaluating its position and exact location. The AL is classified into Types I, II and III. In Type I, Y-shaped anatomy; in Type II, anatomy is T-shaped; and in Type III, Y-shaped anatomy is seen, and the incisive branch is thicker as compared to the main branch.

Aim: In this study, we aim to analyse the prevalence of different types of AL of the IAN in Saudi sample population.

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Materials and Methods: The present study is a retrospective analysis of 149 (86 female & 63 male) CBCT images of patients records from 2018 June to 2018 September in the department of implant dentistry, KSMC, Riyadh. The age range of the patients who participated in the study was 30–60 years. The mean age of female participants is 42.5 ± 5.8, for the male participants is 48.6 ± 11.4 years respectively.

Results: The most frequent type of AL of mental nerve noticed on the right side was of type I (59.1%), followed by type II (27.5%) and type III (13.4%). The most frequent type of AL of mental nerve noticed on the left side was type I (61.7%), followed by type II (26.8%) and type III (11.4%).

Conclusion: The results of the study encourage the usage of CBCT for planning implant treatment. We also suggest that it is obligatory for professionals to categorise the presence of AL and to measure them appropriately when planning for the procedures in the interforaminal region.

1. Introduction

Awareness of anatomical landmarks is vital for effective dental treatment, particularly in surgical procedures. In the mandible, the most vital anatomical landmark is the mandibular canal through which the inferior alveolar nerve (IAN) and vessels pass. The mental nerve is a branch of the IAN, which exits through the mental foramen and supplies sensory branches to the chin and lip. Interforaminal implant surgery necessitates awareness regarding the anatomy and significance of different landmarks such as the anterior loop (AL) of the IAN. Although the interforaminal zone is deliberated as a safe zone for implant surgery, several dentists tend to overlook the AL of the IAN.

Although injuries during implant surgery are not frequent, their severity determines exquisite care for prevention. Consequently, understanding the IAN anatomy is crucial for dentists to avoid any nerve damage during the surgery. Accurate radiographic examination helps to determine the IAN anatomy for accurate dental implant placement. The mental nerve may possess an AL that cannot be detected clinically.

In many patients, the IAN passes downward and then follows an upward and posterior path to exit the canal from the mental foramen as a mental nerve (Nair et al., 2013). This deviation is referred to as the AL of the IAN and might be attributed to the posterior shift of the mental foramen from the deciduous canine region to the deciduous molar region during mandibular development.

The IAN passes anteriorly in the mandibular canal as the incisive branch, which may or may not be noticeable due to numerous branching of the nerve to the anterior teeth and bone. Specific assessment of these anatomical landmarks can be performed using cone beam computed tomography (CBCT). It is an appropriate method for distinguishing the AL of the mental nerve, as CBCT provides a three-dimensional image revealing comprehensive maxillofacial anatomical landmarks and allows the assessment of their position and exact location.

In most instances, the radiation dose used in CBCT is lower than that used in conventional medical CT. CBCT is advantageous compared with panoramic radiography in detecting the AL of the mental nerve and provides more alternatives for measuring the appropriate implant size and angulations to avoid accidental structural injury. Moreover, it provides an image without overlapping and distortion.

According to Solar et al. (1994), the AL can be categorized into three dissimilar types: Type I, Type II, and Type III. According to this classification, in Type I, the AL is not noticeable, and the anatomy is Y-shaped, and no loop is found. The mental branch leaves the IAN posterior to the opening of the mental foramen. In Type II, the AL is absent, and the anatomy is T-shaped. The incisive branch is perpendicular to the main branch, and the mental branch passes into the mental foramen in a perpendicular course. In Type III, the AL is noticeable, and the anatomy is Y-shaped [Fig. 1]

AL occurrence and types vary in different populations. Because common radiographic methods and clinical approaches cannot precisely categorize the AL, evaluating AL prevalence and delineating an accurate, safe distance from the mental foramen in diverse ethnic groups is of greater clinical implication. The present study determined the presence and type of AL of the mental nerve variants in a representative Saudi Arabian population by using CBCT.

2. Materials and methods

2.1. Sample size

In the present retrospective cross-sectional study, 149 CBCT images of the patients were studied based on the records of patients available from June 2018 to September 2018 in the Department of Implant Dentistry, King Saud Medical City, Riyadh, KSA. Among these patients, 86 were women and 63 were men. The age range of the study participants was 30–60 years. The mean ages of the female and male participants were 42.5 ± 5.8 and 48.6 ± 11.4 years, respectively.

Exclusion criteria were as follows: a history of some previous mandibular surgery, such as orthognathic surgery; developmental disorders; operation for cysts and tumors in the mandible; and previous trauma to the mandible. All CBCT images were captured and processed using the Kodak 9500 Cone Beam 3D System; the scan parameters were adjusted to 90 kVp and 10 mA, depending on patient size. The exposure time was 10.8 s, the effective exposure time was 2–5 s, and the voxel size was 0.2 mm × 0.2 mm × 0.2 mm; all CBCT scans were obtained by the same operator and using the same protocol. All images were processed through the DICOM-compatible 3D visualization software to visualize the images. In each case, the type of AL of the mental nerve was analyzed. Three observers were calibrated using 15 randomly selected

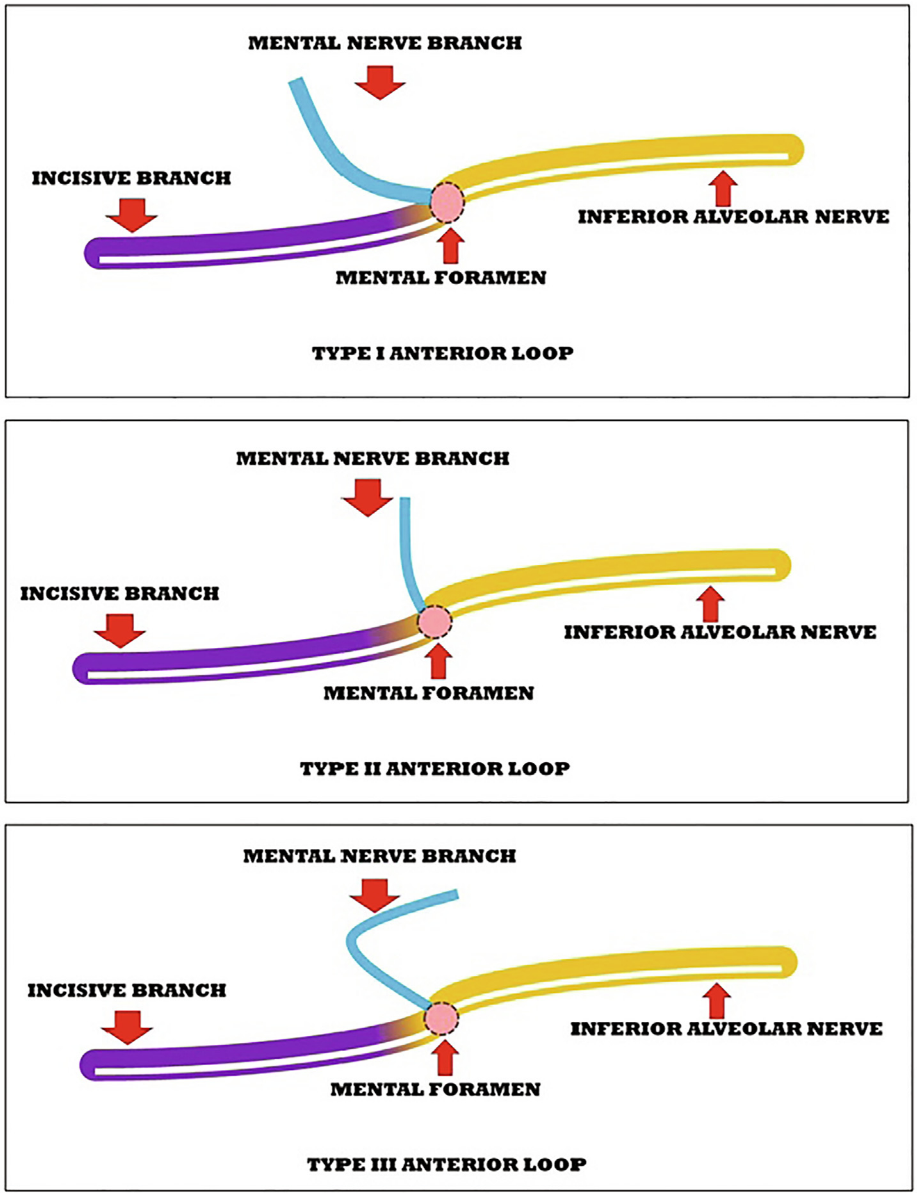

Fig. 1 Classification of anterior loop of mental nerve (Solar et al, 1994).

scans. The reproducibility of measurement amongst observers assessing the same extent to 1/10th of a millimeter was calculated at a correlation of 0.95 for the 15 scans. CBCT scans of the patients were scrutinized, and a special data collection form was completed consequently.

2.2. Inclusion criteria

The sample comprised ethnic Saudi individuals only; the presence of permanent dentition was mandatory. The study participants were aged between 30 and 60 years. The presence of all teeth contiguous to the mental foramen, from the canine to first molar, was required on both sides.

2.3. Exclusion criteria

Patients presenting mixed dentition, of any radiolucent or radio-opaque lesion, obscuring the mental foramen region were excluded. Patients with a history of trauma and/or surgery involving the maxillofacial region and systemic diseases affecting growth and development, particularly around the mental foramen region and anterior area of the mandible, were also excluded. Patients in whom radiography substantiated developmental anomalies/pathologies affecting the maxillofacial region were also excluded. Patients with supernumeraries and unerupted teeth on radiographs were excluded, as the impacted/unerupted teeth might obscure the appearance of the mental foramen. Radiographs were expected to lack any radiographical exposure or processing artifacts.

2.4. Statistical analysis

All statistical analyses were performed using Statistical Package for the Social Sciences version 21. Descriptive statistics were applied for acquiring data about the frequency and percentage of the AL type of the mental nerve noticed.

3. Results

The total number of study participants was 149, of which 86 were women (58%) and 63 (42%) were men. Type I (59.1%) was the most frequent AL of the mental nerve noticed in the female participants, followed by Type II (27.5%) and Type III (13.4%) on the right side. Similarly, Type I (61.7%) was the most frequent AL of the mental nerve noticed in the male participants, followed by Type II (26.8%) and Type III (11.4%) on the left side. Panoramic views were utilized for generating sections [Figs. 2, 3].

4. Discussion

The implication of proximal anatomical landmarks cannot be disregarded, and comprehensive knowledge of these landmarks is a requisite. Failure to identify these landmarks can cause irremediable iatrogenic damage. Injuries to the AL of the IAN can occur in the course of surgical procedures such as implant placement. Such injuries can result in paraesthesia of the part of the jaw and lips, along with neuropathic acute/chronic pain, in turn, instigating difficulty in routine activities such as eating and talking. Other than neural injury, inferior alveolar vessels can be damaged resulting in vascular injury complications. To avoid these complications, few clinicians have attempted to orthodontically move the teeth toward an adjacent atrophic edentulous alveolar ridge to eliminate the need for implant placement by closing the space (Borzabadi-Farahani and Zadeh, 2015; Borzabadi-Farahani A, 2012).

Several studies have appraised the anatomy and prevalence of the AL by using different methods such as cadaver dissection; radiographs such as orthopantomograms, 3D CT, and CBCT; or a combination of anatomical and radiographic evaluation (Apostolakis and Brown, 2012; Greenstein and Tarnow, 2006; Jacobs et al., 2004; Kuzmanovic et al., 2003; Misch and Crawford (1990) Misch and Crawford, 1990; Shaban et al., 2017; Uchida et al., 2009).

Panoramic radiography (OPG) is used for observing the mandibular canal and AL. However, the precision of OPG for evaluating the nerve loop morphology is questionable due to the probable errors reported in 2D views. Moreover, processing errors and incorrect patient positions can strongly affect image quality. CBCT, a rather recent radiographic tool, is beneficial for precisely evaluating anatomical landmarks. CBCT enables viewing of the anatomy three-dimensionally as well as in multiple sections in axial, sagittal, and coronal planes. CBCT also helps in determining AL location (Baratollah S et al., 2017; Rosa et al., 2013). A retrospective comparative analysis of CBCT and OPG established and recommended the use of CBCT analysis for interforaminal implant surgeries (Vujanovic-Eskenazi A et al., 2015).

In a study conducted on the Iranian population, among 180 projections, 32.8% images had the AL (Kheir and Sheikhi, 2017). A study conducted in Malaysia reported the AL in 34.4% of panoramic images (Ngeow et al., 2009). In a study with Indian population, Type III AL was observed in 50% of the participants (Prakash et al., 2018). A Belgian study reported an AL prevalence of 22%–28% (De Oliveira-Santos et al., 2012). A Brazilian study revealed that the AL of the mandibular canal was present in 41.6% of the study population (Nascimento et al., 2016).

The morphology and prevalence of the type of AL vary in different populations (Table 1) (Apostolakis and Brown, 2012; Benninger et al., 2011; Kaya et al., 2008; Kuzmanovic et al.,

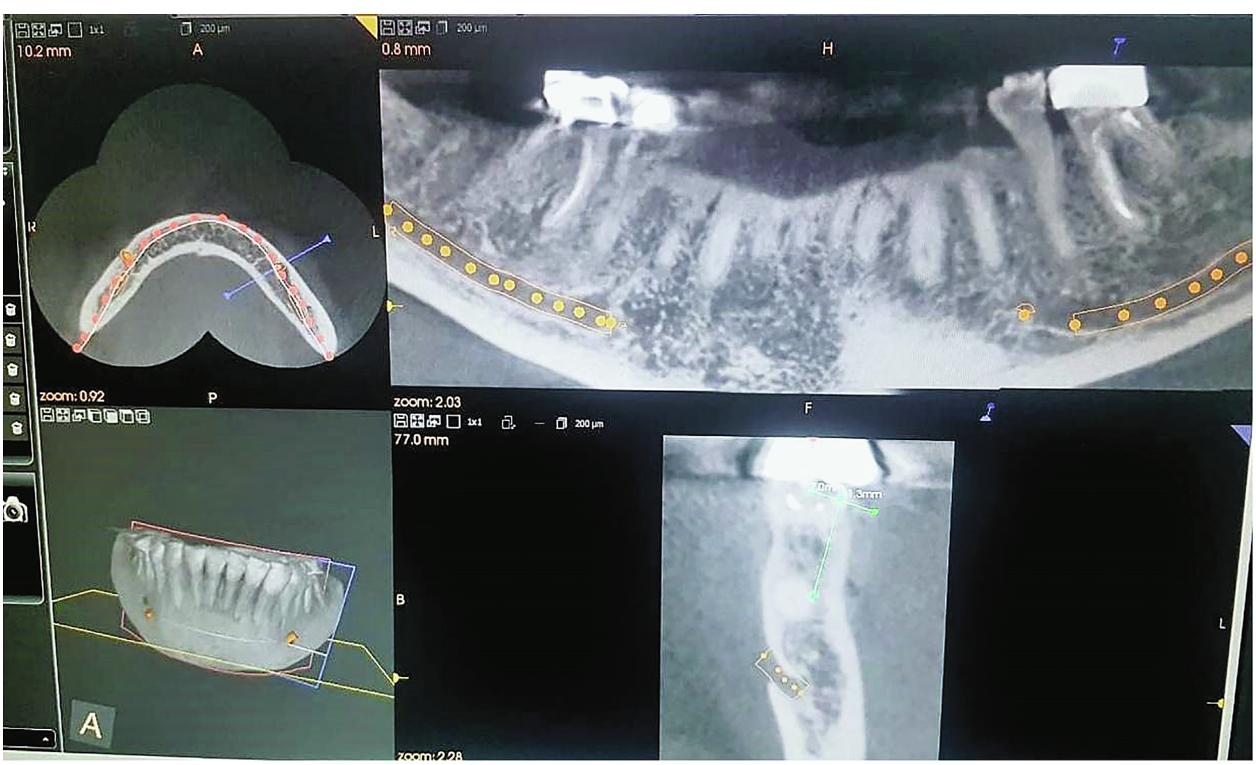

Fig. 2 CBCT image showing anterior loop in a Female patient in different axis.

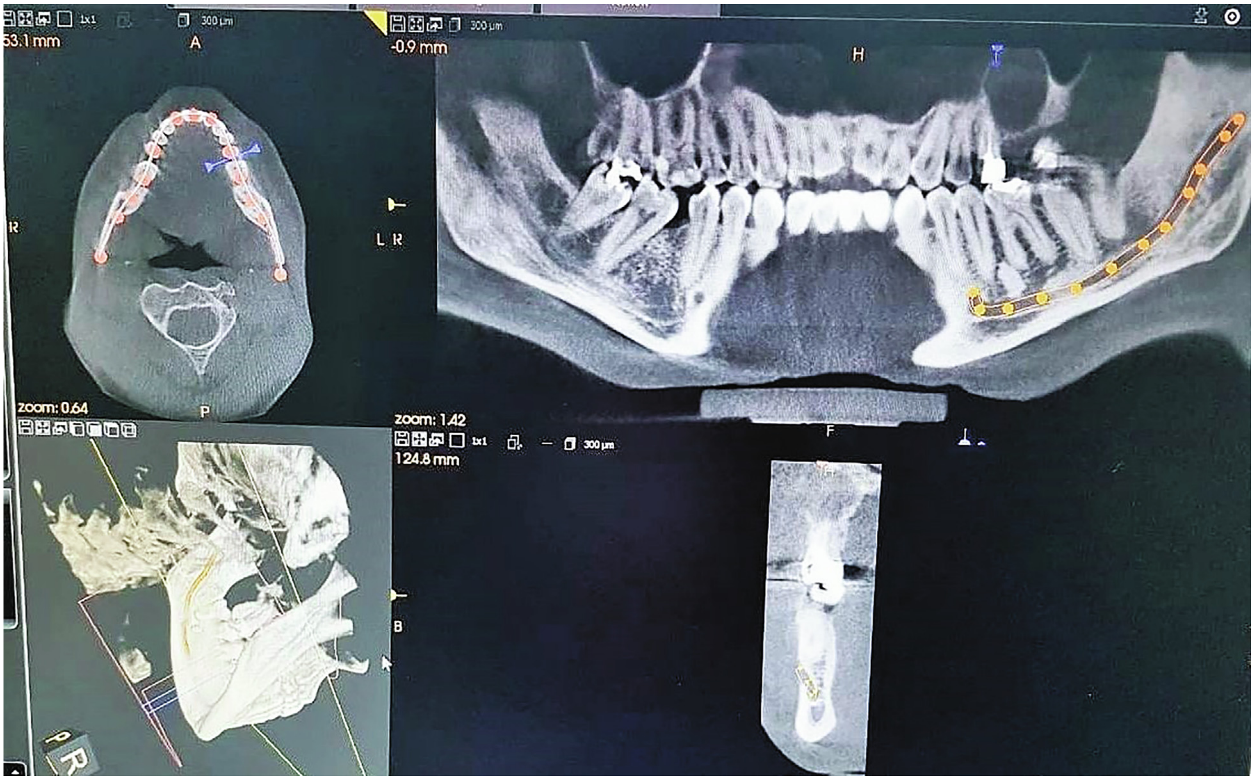

Fig. 3 CBCT image showing anterior loop in a Male patient in different axis.

2003; Li et al., 2013; Moghddam et al., 2017; Parnia et al., 2012; Prados-Frutos et al., 2017; Gupta et al., 2015; Uchida et al., 2007; Uchida et al., 2009; Watanabe et al., 2010; Wong and Patil, 2018; Xie et al., 2019). The AL was observed in 15.2% of 302 CBCT scans in a study with a Saudi population (Al-Mahalawy et al., 2012). Lu et al. (2015) assessed 366 CBCT scans and identified the AL in 85.2% of the cases.

In the present study, Type I (59.1%) was the most frequent AL of the mental nerve noticed in the female participants, followed by Type II (27.5%) and Type III (13.4%) on the right side. Similarly, Type I (61.7%) was the most frequent AL of the mental nerve noticed in the male participants, followed by Type II (26.8%) and Type III (11.4%) on the left side. Type III was the least common type of AL in both the female and male participants, indicating that majority of the participants did not present the conspicuous upward and posterior looping of the IAN. This could be attributed to normal anatomical disparities amongst populations or a delay in the posterior shift of the mental foramen during mandibular development. Our study results were not like those of a study involving a Turkish patient population that reported Type III to be the most prevalent and Type I to be the least prevalent type of AL (Demir et al., 2015).

Table 1 Showing the prevalence of anterior loop in different population.

Author	Year	Country	Prevalence
Ngeow WC et al.	2009	Malaysia	34.4%
De Oliveira–Santos et al.	2012	Belgium	22–28%
Li et al.	2013	China	83.1%
Swati Gupta et al.	2015	North India	19%
Lu et al.	2015	USA	85.2%
Nascimento et al.	2016	Brazil	41.6%
Moghddam et al.	2017	Iran	40%
Kheir et al.	2017	Iran	32.8%
Al-Mahalaway et al.	2017	Saudi Arabia	15.2%
Prados-Frutos et al.	2017	Spain	53.7%
Wong et al.	2018	Malaysia	90%
Prakash et al.	2018	India	50%
Xie et al.	2019	China	14.6%

Based on the results of numerous studies, safety margins for the placement of anterior implants have been suggested. The safety margin is the recommended safe distance from the anterior border of the mental foramen while engaging implants to avoid nerve injury. Wismeijer et al. (1997) considered a protocol with a 3-mm safety margin for all patients, and sensory disorders due to damage to the AL were observed in 7% of the patients.

In another study, a 4-mm safety margin was recommended (Kuzmanovic et al., 2003). However, in the absence of CBCT, a 6-mm safety margin was also recommended (Apostolakis and Brown, 2012). Several clinicians place implants anterior to their ideal position to avoid injury to the mental nerve and sensory disorders in the lower lip (Shaban et al., 2017).

5. Conclusion

The AL of the IAN is a critically significant anatomical landmark. Awareness regarding its anatomy and prevalence distinctly influences the treatment strategy. Although different methods are used to study the AL anatomy, CBCT can precisely provide evidence about the landmark and aid in effective treatment planning. Our study is one of the very few studies focusing on the prevalence of the various types of AL of the IAN by using CBCT in the Saudi Arabian population, and Type I was the most common variant in both the male and female participants. Hence, dentists should categorize the presence of the AL and measure them appropriately when planning for procedures in the interforaminal region. However, studies with a larger sample size are required to substantiate the results of the present study and provide a strong recommendation regarding safety margins.

6. Author statement

Osama saeed alyami, Mazen saeed Alotaibi, Pradeep Koppolu designed the study. Abdulrahman alosaimy, Ashraf abdulghani, Lingam Amara Swapna, Dalal H Alotaibi. Ali Alqerban, Kizhakke Veetil Sheethi wrote the manuscript. All authors provided critical feedback and helped shape the research, analysis and manuscript.

7. Ethics statement

The consent of the patient was sought prior to study. The approval was obtained from the Ethics Committee from King Saud Medical City, Riyadh, KSA.

Declaration of Competing Interest

The authors declared that there is no conflict of interest.

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