ASSESSMENT OF THE ANTERIOR LOOP OF THE INFERIOR ALVEOLAR NERVE IN THE JORDANIAN POPULATION

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ABSTRACT

Objective: To assess the prevalence and length of the anterior loop of the inferior alveolar nerve in the Jordanian population, to aid proper treatment planning before interforaminal surgery.

Methods: 378 hemimandibles (right and left) were analyzed using Cone Beam Computed Tomography (CBCT) scans. Two examiners studied cross-sectional views. The presence and the length of the anterior loop were measured.

Results: Anterior loop was visualized in 59.5% of the examined hemimandibles, the presence of the anterior loop was significantly higher on the right hemimandible than on the left hemimandible (p-value 0.021).

The mean length of the anterior loops, when present, was 1.73mm (±0.84mm). The lengths range from 0.3 to 3.6mm.

Conclusion: Our study showed that the presence of the anterior loop was significantly higher on the right hemimandible than on the left hemimandible. Due to the high variation in the length of the anterior loop in the Jordanian population, a CT scan is necessary to visualize the anterior loop before interforaminal surgery or placing implants in the mental foramen region.

Keywords: inferior alveolar nerve, interforaminal surgery, anterior loop, mental foramen, CBCT,Jordanian population.
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INTRODUCTION:

The inferior alveolar nerve enters the medial aspect of the mandible and runs through the mandibular canal until it branches at the Mental Foramen (MF) to give off the mental branch which leaves the mandible to innervate the soft tissue and the incisal branch which remains within the incisive canal (1,2).

From the departments of: dental department

As the inferior alveolar nerve leaves the mandible via the mental foramen, multiple anatomical variations in the anteroposterior position of the foramen, the presence of accessory foramina, and the presence or absence of an anterior loop (AL) could be encountered (2, 3). The AL is when the inferior alveolar nerve loops within the mandible bone inferior and anterior to the mental foramen before it exits the mental foramen (3). (Fig 1)

Dental and surgical procedures in the anterior mandible are not uncommon; and might be in close proximity to the mental foramina. These procedures include local anesthetic injections, maxillofacial surgeries, endodontic surgeries, and interforaminal dental implant placement.
Consequently, the mental nerve's anatomical variations need to be thoroughly studied and understood, to avoid iatrogenic trauma to the nerve, which might lead to temporary or permanent neurosensory disturbances, or altered sensation (3,4).

Many methods have been used to examine and study the position of the mental foramen itself, such as palpation, inspection during surgery, and different radiographic techniques (5). However, to assess the presence of an AL, clinical methods are useless because, as stated above, it is an intrabony structure therefore, radiographical tools are needed. Radiographs might also help.

differentiate the AL from the incisive canal or any periapical pathology in the premolar area (6,7).

Despite the worldwide acceptance of panoramic x-rays in studying overall dental conditions and pathology, they still have inherent limitations, such as their two-dimensional nature, superimposition, and distortion. On the other hand, the relatively new Cone Beam Computed Tomography (CBCT), solves many of these problems, despite higher costs and relatively higher radiation doses. It has a negligible distortion and an interactive three-dimensional nature that allows clinicians to study anatomy as clean-cut slices regardless of the surrounding structures (8).

Many studies have concluded that significantly fewer loops were detected in panoramic radiographs than in cadaveric jaws or CBCT images. Moreover, the loop measurements were also significantly shorter in panoramic-based research. CBCTs, on the other hand, had the ability to identify the presence and length of the AL accurately (8, 9) Other researchers found that panoramic radiographs have a high incidence of false-negative and false-positive results in identifying the anterior loop and are consequently unreliable (9,10).

Since the presence of the anterior loop is suggested to exhibit a racial trend (11, 12), and because of the lack of studies on the Jordanian population, the present study was conducted to assess the prevalence and length of the anterior loop of the inferior alveolar nerve in the Jordanian cohort.
CBCT was used in our study as it is found to be more accurate as discussed above.

METHODS

After the institutional ethical committee of the Royal Medical Services approval was obtained, this retrospective cross-sectional study took place in the Dentistry and Maxillofacial Department at Queen Alia Military Hospital Amman, between March and December 2020. Images of patients, who had previously undergone CBCT imaging for different clinical reasons, were retrieved from the department's records.

Out of the 252 subjects' images inspected for the study, 189 fulfilled the study's criteria. The

subjects of the study were ethnic Jordanians, an age range

between 23 and 79.

Exclusion criteria were:

- History or evidence of previous trauma or major surgical procedures in the mandible.
- Growth or developmental disorders.

- Generalized or localized maxillofacial pathologies.
- Missing teeth between the canine and first molar on both sides.
- Images with an inadequate field less than the first molar to the first molar.
- Images of inadequate quality due to artifacts or haziness.

Two well-trained highly experienced dentists, a prosthodontist and an endodontist who work in the same department studied the scans. Both read CBCTs regularly either for implant placement or for endodontist treatments. Before starting data collection, the examiners analyzed 20 scans until the intra-examiner and inter-examiner reliability was obtained (Cohen's kappa=0.85).

MACHINE AND PROGRAM

CBCT scans were acquired via the Kodak Carestream CS900 computed tomography machine by a well-trained technologist. The machine settings were as follows: the tube voltage was between 85-95 kv, and the current was 4.0 or 5.0 mA according to the patient's size. The voxel size used was 300 micrometers. Fields of the included images were either 8*8 or 13*11.5 and had to include the mandible. Exposure times ranged from 8-11 seconds according to the selected field and the patient's size. The Carestream 3D imaging software reconstruction program was used to reconstruct and visualize the images.

The examiners then evaluated the reconstructed images in axial, sagittal, and coronal views using the "oblique slicing" view.

ADJUSTING THE CUTS AND DETECTING THE ANTERIOR LOOP

The analysis started by scrolling the axial cuts to view the mental foramina. The selected volume was then rotated towards the side being studied in order to position the mandibular canal's long axis parallel to the sagittal plane, this rotations aim was to set the coronal reconstruction perpendicular to the region of interest (figure- 2). Coronal slices were then used as follows: The section where the mesial end of mental foramen was spotted, and then sections anterior to this one were screened for the presence of the anterior loop by analyzing any radiolucencies. The anterior loop can either show as a single big hypodense area, or as two smaller hypodense areas: one represents the lumen of the mandibular canal that traverses the mental foramen anteriorly; the other reflects the turning back of the mandibular canal (13).

According to Apostolakis and Brown (13), a single round hypodense area is considered as an incisive canal if it measures less than 3 mm in diameter. On the other hand, if the diameter is 3 mm or more the hypodense area is regarded as the anterior extension of the mandibular canal and therefore considered an anterior loop (figure 3).

MEASURING THE ANTERIOR LOOP IF PRESENT

The distance between the mesial edge of the mental foramen and the anterior end of the hypodense area is the anterior loop. To measure this distance, as shown in (figure 4), the number of slices is multiplied by the thickness of each slice which is 0.3 mm in this study. The process of

counting slices and multiplying by 0.3 was completed for each hemi-mandible for the whole sample.

Statistical analysis

The resulting data were analyzed using SPSS (version). Descriptive statistical methods were applied to summarize the anterior loop frequencies, percentages and mean length.

A student t-test was used, to compare gender, face side, and mean differences in length. P-values

of <0.05 were considered significant.

RESULTS

Two hundred and fifty-two subjects were initially screened, 63 of which were excluded as they did not meet the inclusion criteria mentioned above. The CBCT scans of 189 patients met the
criteria and were consequently assessed, of which 109 (58%) were men and 80 (42%) were

women (Table 1).

(Table1) Demographic distribution of the study population

Factor	Categories	Number	Percentage %
Age group	20-40 years	55	29
n=189	41-60 years	75	40
	61-80 years	59	31
Gender	Male	109	58
n=189	female	80	42

Anterior loops were visualized in 225 (59.5%) of the 378 total examined hemimandibles (half of the mandible: right or left) . The presence of anterior loop was significantly higher on the right side, as 124 (65.6 %) of right hemimandibleshad anterior loops, compared to 101 (53.4%) of left hemimandibles, X2 (1, N =378) =5.809, p =

0.021. Males were more likely to have anterior loops, as they were visualized in 137(62.8%) of

males' hemimandibles, compared to 88(55%) of females' hemimandibles, but the relationship was not statistically significant, X2 (1, N =378) =2.357, p= 0.13, (Table 2).

Table 2) the prevalence of anterior loop of the mandibular nerve according to the side of the mouth and the gender of the patient

Group (n)	**Total**	**Absence of anterior loop n (%)**	**Presence of anterior loop n (%)**	**p-value**
Gender				0.13
Male (109)	218	81 (37.2)	137 (62.8)	
Female (80)	160	72 (45)	88 (55)	
Hemimandibles				0,021
Right	189	65 (34.4)	124 (65.6)	
Left	189	88 (46.6)	101 (53.4)	

An anterior loop was not identified in 20.6% of the 189 evaluated CBCT scans as shown in (Table 3)
The AL length in the sample ranged from 0.3 to 3.6mm. The mean length of the anterior loops in the 225 hemimandibles, when present, was 1.73mm (±0.84mm).
The mean length on the right side was 1.69mm (±0.76). On the other hand, the mean length

(Table 3) prevalence of anterior loop in 189 mandible CBCTs

Anterior loop prevalence	**n (%)**
Absent	39 (20.63%)
Bilateral	76 (40.21%)
Right only	49 (25.93%)
Left only	25 (13.23%)
Total	189 (100%)

was 1.76 mm (±0.93) in the left hemimandibles. The mean length in female patients was 1.65mm± (0.88), on the other hand, the mean length in male patients was 1.76mm (±0.88). No significant influence of gender or facial side on the length of the anterior loop was found. With P values of 0.344 and 0.603 respectively (Table 4).

(Table 4) Mean values of anterior loop length according to gender and side of the face)

Factor	**Mean length mm (±SD)**	***P*-value (Student's t-test)**
Side of the mandible Right Left **Gende r** Male Female	 1.69 (±0.76) 1.76 (±0.93) 1.76 (±0.88) 1.65 (±0.88)	 0.603 (221) 0.344 (0.947)

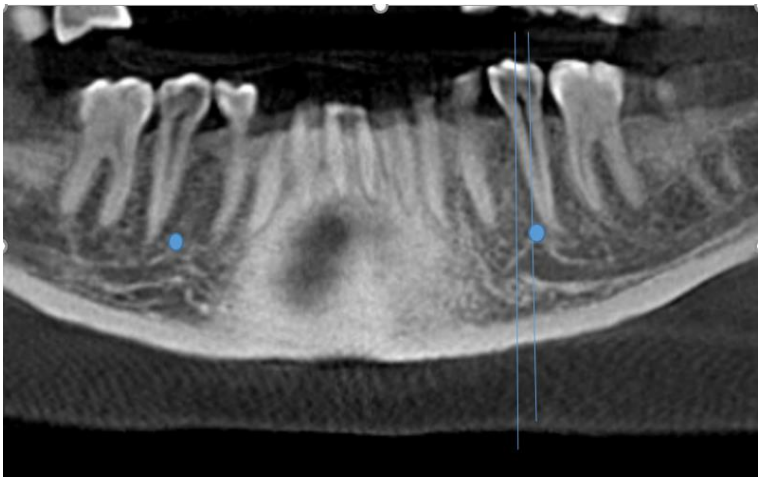

Figure 1: Anterior loop shows as radiolucency anterior to the mesial end of the mental foramen.

Left hemimandible shows an anterior loop (between the two blue lines). While the **right** hemimandible shows no anterior loop.

Figure 2: Rotating the volume to position the long axis of the mandibular canal parallel to sagittal plane (purple line).

The coronal section (green line) passes through the anterior end of the mental foramen; we started looking for the radiolucencies anterior to this section.

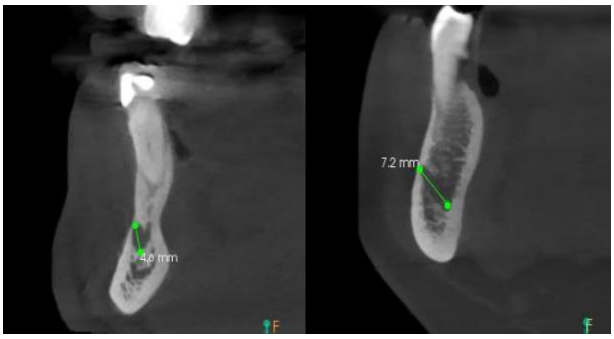

Figure 3: Two examples of anterior loops showing as single radiolucency greater than 3mm anterior to the mental foramina.

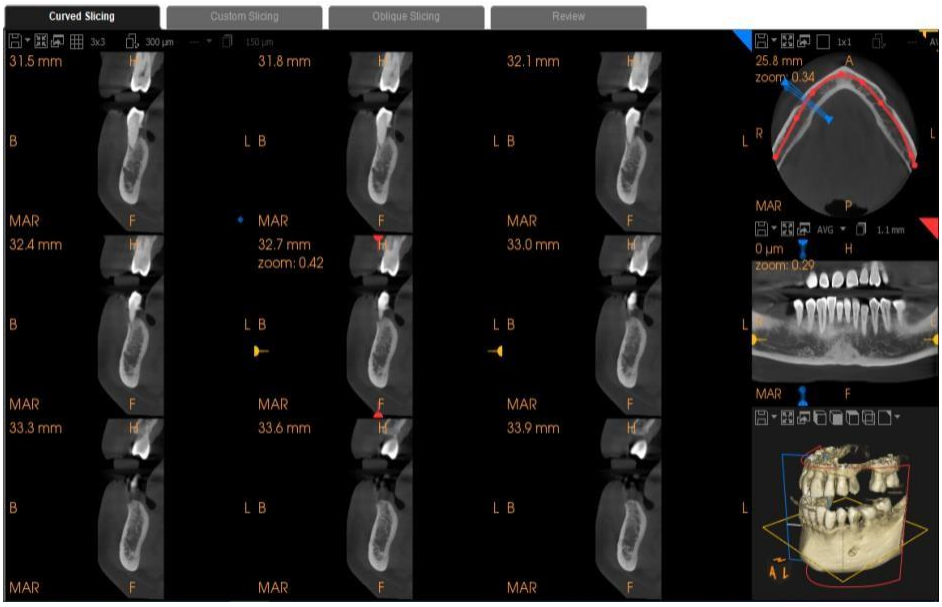

Figure4: An example of measuring the anterior loop length; eight coronal sections (from section 2 to 9) in this case are showing an anterior loop. So as each section thickness is 0.3, and 0.3*8 equals 2.4, the length of the anterior loop is then considered to be 2.4mm.

DISCUSSION

The presence and length of the anterior loop of the mental nerve are highly variable, it is critical to locate the AL in order to avoid iatrogenic trauma during interforaminal surgery or mandibular implant placement. The studies discussed below analyzed the prevalence and length of the anterior loop of mental nerve in different populations using different techniques (10-22).

In our study, out of the 378 studied hemimandibles, 59.5% had shown an anterior looping of the inferior alveolar nerve. These findings are consistent with a 56% prevalence among Indians, a 55% among an Egyptian sample, a 51.7% prevalence between Saudi Arabians, a 40 % prevalence among Egyptians, and a 48.8% prevalence in a Spanish sample. (14-18)

On the other hand, smaller prevalence values were reported in other studies. For example, prevalence values of 15.2% were reported among a Saudi sample, 18,9% among a Brazilian sample, 20% among an Indian sample, 9.7% among an Eastern Indian sample were recorded according to Al-Mahalawy et al., Genu et al., Chappidi et al., Sinha et al., respectively.(19-22)

Other studies, however, presented significantly higher prevalence values of anterior loop presence.

For example, as many as 92.9% of a Vietnamese candidate have an anterior loop, and 94% of a Malaysian sample population had an anterior loop, according to Nguyen et al and Shi Kang Wong et al (23,24).

In the present study, the prevalence of anterior looping among male hemimandibles was 62.8%. in comparison to female hemimandibles where it was 55%, This implies that gender has a statistically insignificant effect on AL presence with a p-value of 0.13. These findings were consistent with the researchresults of many researchers (11,17,20, 23) while Nascimento et al., Gupta et al., and Sinha et al., had reported a significant difference between genders in favor of males (9,14,22).

This study also discovered that the anterior loop was significantly higher on the right side with a p-value of 0.021. This discovery disagreed with the results of Nascimento et al., Srivasta et al., Genu et al., Sinha et al., Nguyen et al., Wong et al. (9, 16, 19, 20,22, 23, 24). In addition, one article (11) found a more common presence of the anterior loop on the left side of the mandible when compared to the right side.

The variety of results from all these global samples might be due to the different racial backgrounds of the patients, differences in the measuring techniques, or the machine's technical properties, which might influence the resolution of the pictures, or the degree of cortication of the mental canal. Further research is also required to study the variation between different ethnicities using standardized technical methods.

CONCLUSION

Our study showed that the presence of the anterior loop was significantly higher on the right hemimandible than the left hemimandible. It also showed a high range of length of the anterior loop in the Jordanian population. These results indicate that a CT scan is necessary to visualize the anterior loop before interforaminal surgery or placing implants in the mental foramen region.

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