

# Evaluation of the anterior loop of the mental nerve incidence and extension in different age groups in Sulaimania city using digital panoramic imaging system

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## ABSTRACT

**Background:** The anterior loop of mental nerve is commonly described as that part of the neurovascular bundle that transverses anterior and inferior to the mental foramen only to loop back to exit the mental foramen. The aim of the study is to evaluate the incidence and extension of anterior loop of mental nerve by using digital panoramic imaging system to avoid nerve damage during different surgical procedures in dentistry.

**Materials and Method:** Panoramic image was taken for all 400 patients and stored in the computer. Then Horizontal and Vertical for the anterior loop extension when exist was measured and recorded in a special case sheet prepared for each subject.

**Results:** Results indicated that out of 400 patients there were only 25 patients (6.25%) having anterior of the inferior alveolar nerve, 14 cases (56%) of them were males and 11 cases (44%) were females. The extension of the anterior loop of mental nerve was with wide range, for horizontal extension it was 1.3-6.36mm with significant difference between right and left sides, and with vertical extension was between 1.44 -5.98mm with no significant difference between the right and left sides.

**Conclusion:** No significant difference among subjects according to sex and the pattern of visualization of the anterior loop was shown. The anterior loop was visible in 6.25% of the dental panoramic radiographs with 3.5% for males and 2.75% for females.

**Keywords:** Anterior loop, Inferior alveolar nerve, Panoramic image. (J Bagh Coll Dentistry 2013; 25(1):99-104).

## INTRODUCTION

Jalbout and Tabourian <sup>(1)</sup> described anterior loop as "an extension of the inferior alveolar nerve, anterior to the mental foramen, prior to exiting the canal." This means that the mental nerve, however, may extend beyond the mental foramen boundary as an intraosseous anterior loop.

Larger terminal branch of inferior alveolar nerve emerges from the mental foramen as the mental nerve. Usually three nerve branches of approximately 1 mm in diameter come out of the mental foramen <sup>(2)</sup>.

Hu and co-workers <sup>(3)</sup> investigated the topography of the mental nerve by dissecting 31 hemifaces of Korean cadavers and divided this nerve based on the distribution area of the mental nerve as follows: angular, medial inferior labial, lateral inferior labial and mental branches. In most cases lateral inferior labial branch is separating from the angular branch.

Pogrel *et al.* <sup>(4)</sup> tested the hypothesis that some sensory innervations to the lower incisor teeth come from re-entry of the terminal branches of the mental nerve through the labial plate of the anterior mandible.

They investigated 10 cadaver's heads and concluded: three of 20 (15%) specimens showed unequivocal evidence of nerve re-entry into the labial plate. Five specimens displayed strong evidence of nerve fibers re-entering the plate, but these were too fragile to be dissected through the periosteum without breaking. In 12 of 20 (60%) specimens, there were no branches identified that re-entered the bone plate. Of the 8 specimens showing evidence of re-entry, 4 had substantial midline crossover. The finding indicates that branches of the mental nerve may re-enter the labial plate to supply the innervations from the contra lateral mental nerve.

When inferior alveolar nerve arises from the mandibular canal and runs outward, upward and backward to open at the MF it is referred to as anterior loop <sup>(5)</sup>, Figures (1&2)

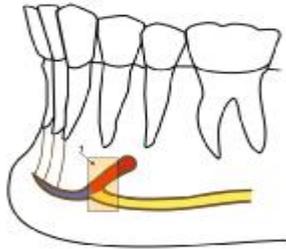
Several studies have shown wide variations in anterior loop length <sup>(5,7-9)</sup>, because of this, it is not advisable to assume that a fixed distance mesially from the mental foramen will be safe for the placement of an endosseous implant, even with the current recommendation of a safety margin of 4-6 mm <sup>(8,10)</sup>.

The anterior loop cannot be seen clinically but can be detected in radiographs, which include dental panoramic radiographs, magnetic resonance imaging and computed tomography. Dental panoramic radiographs are widely used to locate anatomic landmarks in planning for the placement of endosseous implant in the jaw bones. The mental foramen is commonly used as

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the boundary of the inferior alveolar nerve in the mandible when planning for the placement of



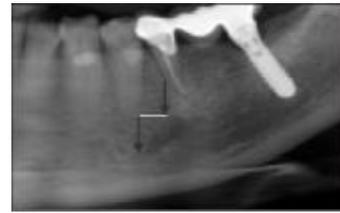
**Figure 1: The anterior loop (AL) of the mental nerve: length variations from the most anterior loop point to mental foramen. Colours: blue = MIC, red = mental canal (the anterior opening of the mandibular canal) . yellow = mandibular canal. 1 = length of the AL (0.00 to 10 mm).<sup>(6)</sup>**

Yosue and Brooks<sup>(13)</sup> noted that an anterior loop (termed continuous type mental foramen in their study) was present in 21% of the 297 radiographs studied, while Jacobs et al.<sup>(14)</sup> noted that it was present in 11% of panoramic radiographs, but was well visualized in only 3%. Similarly, Arzouman et al.<sup>(5)</sup> reported the structure in 12% of dental panoramic radiographs.

Solar et al.<sup>(12)</sup> detected AL in 60% (22 of 37) of dissected cadaver mandibles, ranging in length from 0.5 to 5 mm (mean 1 mm). Neiva et al.<sup>(15)</sup> were probing the mesial cortical wall of the mental canal in 22 cadavers and reported that AL was present in 88% of the time and its length ranged from 1 to 11 mm (mean = 4.13 mm). Rosenquist<sup>(11)</sup> detected anterior loop in 24% (15 of 58) of cadaveric mandibles with loop length variations from 0 to 1 mm. In 13 cadavers, the loop was 0.5 mm long, and two patients had a 1 mm length loop (mean = 0.15 mm). Similarly, Keiser et al.<sup>(16)</sup> found that there was no measurable AL after exposing 1 cm of the nerve on both sides of the MF in 56 cadaveric mandibles.

Arzouman et al.<sup>(5)</sup> assessed 25 adult skulls using two panoramic machines both with and without radiopaque markers placed into the mandibular canal and anterior loop. The anterior loop was also measured directly using flexible tubing (2 mm in diameter). Significantly fewer loops were detected in radiographs as compared with anatomic assessment ( $P < 0.001$ ). A significant loop ( $> 2$  mm) was identified in 92% to 96% of the direct measurements, whereas radiographs identified only 56% and 76% using different panoramic machines. The average length of the anterior loop based on direct measurements was 6.95 mm, whereas radiographic

dental implants in the anterior mandible<sup>(11,12)</sup>.



**Figure 2: Panoramic radiograph showing extension of the mental nerve beyond the mental foramen boundary as an intraosseous anterior loop (arrows).<sup>(5)</sup>**

measurements were 3.18 mm and 3.45 mm using different panoramic machines.

Jacobs et al.<sup>(17)</sup> examined 230 spiral CT scans taken for preoperative planning of implant placement in the posterior mandible where the AL appeared in 7% of the cases. Later Jacobs with co-workers<sup>(14)</sup> examined 545 patients' panoramic radiographs and found anterior loop in 11% of the cases, but was well visualized in only 3% of the detected loops.

A study was undertaken by Ngeow et al.<sup>(18)</sup> to determine AL visibility on 97 dental panoramic radiographs in dentate subjects of various age groups. The anterior loop was visible in 39 (40.2%) dental panoramic radiographs encompassing 66 sites (34.4%). Anterior loops were most often observed bilaterally, followed by on the right side only. The visibility of anterior loop reduced as the age of the subjects increased. No relationship was found between subject gender and the pattern of visualization of the anterior loop. Authors then concluded that panoramic radiography is not sufficient for presurgical implant planning in the mental region and may need to be supplemented with other modalities such as CT for better visualization of the area.

Investigations that compared radiographic and cadaveric dissection data with respect to identifying the anterior loop reported that radiographic assessments result in a high percentage of false positive and false-negative findings.<sup>(5,8,9,19)</sup>

Varied results may be attributed to different criteria used to define the anterior loop, dissimilar diagnostic techniques, and diverse findings in patients Greenstein and Tarnow<sup>(20)</sup>. For example, in above mentioned study of Arzouman et al.<sup>(5)</sup>, a significant loop ( $> 2$  mm) was identified in 92%

to 96% of the direct measurements, whereas radiographs identified only 56% and 76% using different panoramic machines. This can be explained by the finding that distance bone markers or tubing that penetrates the mandibular foramen (on dry skulls) cannot reliably be used to indicate the length of the anterior loop because these devices may penetrate into the mandibular inferior cortex.<sup>(8,11)</sup>

Bavitz et al.<sup>(19)</sup> reported that the anterior loop was present in 54% (17 of 35) of periapical radiographs taken of hemi mandibles. However, this finding was only confirmed by dissection in 11% (4 of 35) of the corresponding cadaver specimens. Loop sizes ranged from 0.0 to 7.5 mm on periapical radiographs and from 0 to 1.0 mm among cadaver specimens. They concluded that damage to the mandibular nerve can be avoided if the distal surface of the most posterior implant is 1 mm anterior to the anterior border of the mandibular foramen.

Mardinger et al.<sup>(9)</sup> assessed 46 hemimandibles using periapical films and dissection with physical evaluation. Anatomically, an anterior loop of the MN was observed in only 13 hemimandibles (28%). No correlation was found between the radiographic image and the anatomical shape of the loop. Furthermore, in 70% of the radiographically diagnosed loops, 40% were not seen in anatomical examination. Anatomically, 8 of 13 anterior loop were 0.4 to 1 mm long, 4 of 13 AL were 1.1 to 2 mm, and one anterior loop was 2.19 mm. Thus, 11% (5 of 46) of AL were > 1 mm.

Kuzmanovic et al.<sup>(8)</sup> studied correlation between the visual interpretation of the panoramic radiographs and the anatomical dissection findings in a 22 cadaveric sample. The anterior loop of the mental canal was only identified in 6 panoramic radiographs (27%) (range: 0.5-3 mm) and 8 (35%) anatomical measurements. Authors then concluded that clinicians should not rely on panoramic radiographs for identifying the anterior loop of the MN during implant treatment planning. However, a safe guideline of 4 mm, from the most anterior point of the MF, is recommended for implant treatment planning based upon the anatomical findings.

More accurate anterior loop assessments were obtained by Uchida et al.<sup>(21)</sup> who used cone beam computed tomography in 4 cadavers and dissected 71 cadavers. The anatomic measurements revealed mean anterior loop size of  $1.9 \pm 1.7$  mm and range 0.0 to 9.0 mm. The average discrepancies between CBCT and anatomic measurements were 0.06 mm or less.

## MATERIALS AND METHOD

The sample consisted of retrospective and prospective study of 400 male and female dentate patients' panoramic images collected from panoramic images saved in the archives and new patients attending the Radiologic Department of the School of Dentistry and Piramerd Dental Hospital. The patients were subdivided according to age as the following:

1. 20-29 years
2. 30-39 years
3. 40-49 years
4. 50 & more

Panoramic image was done for all 400 patients and stored in the computer. They were subjected to contrast and density enhancement and restored for further evaluation by AutoCAD program. All the information and measurements were recorded in a special form prepared for each subject, selected images were clear to be investigated and without any jaw fracture or other pathological conditions affecting the area of interest.

The Horizontal Extension was done by measuring the distance between the tangent to the anterior border of mental foramen to the parallel tangent to the posterior border of the anterior loop was measured for the right side (D1) and for the left side (D2). (Figure 3).

While the Vertical Extension was done by measuring the distance between the tangent to the inferior border of the mental foramen and the parallel line which is tangent the upper border of the anterior loop of mental nerve was measured for the right side (D3) and for the left side (D4) as seen in figure 4.

## RESULTS AND DISCUSSION

The current study used Panoramic image modality as it is the most routinely used tool in implant treatment planning. Moreover, no similar study has been performed on a Sulaimani population. The loop was present in 6.25% of all subjects (400 subjects). This is lower than the incidence reported by Arzourman et al.<sup>(5)</sup> which was 12%, Yosue and Brooks<sup>(8)</sup> 21%, and Kuzmanovic et al.<sup>(8)</sup> 27%. Their higher incidence of visualization may be related to the use of newer panoramic machines providing higher resolution radiographs, while Jacobs et al.<sup>(14)</sup> noted that the anterior loop of mental nerve was well visualized in only 3%. One possible explanation for the underestimation of the anterior loop is because it is an intermedullary structure that is located in an area with relatively thick cortical plates, hence making it difficult to distinguish in plain films<sup>(5)</sup>.

The difficulty in identifying the mental foramen and anterior loop has been attributed to poor radiographs or bone quality, and the inability to distinguish these structures from the trabecular pattern<sup>(8,13)</sup>. Patient position and technician errors affect the quality of the radiograph. Objects that are outside the section or plane of focus (in the focal trough) will result in distorted or obscured images<sup>(22)</sup>.

The incidence of the anterior loop was noted as 56% in males and 44% in females as shown in table1. The anterior loop was more commonly identified in males than in female, while Wei et al.<sup>(23)</sup> showed that no anterior loop was visible in the majority (79%) of female subjects aged  $\geq 50$ , and in all male subjects aged  $\geq 50$  of Malay patients.

In female and male subjects aged 20 – 29, there was no anterior loop of mental nerve (table1), while Wei et al.<sup>(23)</sup> showed that In female subjects the anterior loop was most commonly visible bilaterally (in 43% of radiographs) for the same age group. In contrast, for the male subjects of the same age, the anterior loop was most commonly visible on the right side (in 29% of radiographs). Another 24% of male subjects in this age group exhibited an anterior loop on both sides.

In the subjects aged 30 – 39 (second age-group), the anterior loop was more commonly identified in male than in female. Only one subject (12.5%) of male and female subjects of this age group presented with an anterior loop on both sides and confined to the right side in 3 (37.5%) subjects in males and 2 (25%) subjects in females while on the left side of the second age-group there were 4(50%)subjects in males and 2 (25%) subjects in female having anterior loop of mental nerve (table1), however Wei et al.<sup>(23)</sup> showed that there was Three-quarters (75%) of male subjects of this age group presented with an anterior loop on both sides. In comparison, only a quarter (25%) of female subjects showed an anterior loop of mental nerve, this was bilateral in 2 (16.7%) subjects, and confined to the right side in 1 (8.3%) subject.

In the subjects aged 40-49 (third age-group) , the anterior loop was more commonly identified in males than in females , on both sides there was only 1 (12.5%) subject in both sexes having anterior loop of mental nerve, on the right side 3 (37.5%) subjects in males and 2 (25%) subjects in females having anterior loop of mental nerve, on the left side there were 4(50%) subjects in males and 3 (37.5%) subjects in females having anterior loop of mental nerve, while Wei et al.<sup>(23)</sup> showed that the percentage of subjects with at least one visible anterior loop was almost equal between

genders in subjects aged 40 – 49 years. In subjects aged 50 and more (forth age-group) the anterior loop was more commonly identified in males than in females. There was increased percentage of the incidence of anterior loop of mental nerve as the age of subjects increased (table1). While Wei et al.<sup>(23)</sup> showed that as the age of subjects increased, it became more difficult to identify an anterior loop in the radiographs. They were unable to determine the presence of an anterior loop in almost three-quarters of radiographs in both men and women aged 40 – 49 years. Similarly, no anterior loop was visible in the majority (79%) of female subjects aged  $\geq 50$ , and in all male subjects aged  $\geq 50$ .

With this study, while unable to confirm the presence of the anterior loop in young subjects (first age-group), it cannot be definitively show that these subjects do not have anterior loops. Only a larger study using a superior imaging modality such as computed tomography may be able to improve the findings of this study.

The horizontal extension of anterior loop of mental nerve was noted as (mean=3.07 mm) ranging from 1.3mm to 6.36mm and the vertical extension of anterior loop of mental nerve was noted as (mean=3.27) ranging from 1.44mm to 5.98mm (table2). This agrees with several studies which have shown wide variations in anterior loop length.<sup>(5,7-9)</sup>

It is not advisable to assume that a fixed distance mesially from the mental foramen will be safe for the placement of an endosseous implant, even with the current recommendation of a safety margin of 4-6 mm.<sup>(8,10)</sup>

More accurate of anterior loop assessments were obtained by Uchida et al.<sup>(21)</sup> who used cone beam computed tomography in 4 cadavers and dissected 71 cadavers. The anatomic measurements revealed mean anterior loop size of  $1.9 \pm 1.7$  mm and range 0.0 to 9.0 mm.



**Figure 3: The horizontal extension of anterior loop of mental nerve**



**Figure 4: The vertical extension of anterior loop of mental nerve**

**Table 1: The frequency distribution and percentage of the total cases with anterior loop of mental nerve and its vertical and horizontal dimensions.**

		No.	%of positive cases	% of population
Sex	Total	25	100	6.25
	Male	14	56	
	Female	11	44	
Age-groups	20-29 years old	0	0	
	30-39 years old	5	20	
	40-49 years old	10	40	
	50 years old & more	10	40	
Sides	Right	14	56	3.5
	Left	19	76	4.75
	Both	8	32	2
	Total	33	100	

**Table 2: Horizontal and vertical measurements of anterior loop of mental nerve with minimum and maximum values**

	Horizontal and Vertical measurement	N o.	Mini mum	Maxi mum	Mean ±sd	Test ed gro ups	P
Horizo ntal	D1	14	1.3	4.8	2.77±0.97	D1 vs D2	0.12
	D2	19	1.73	6.36	3.37±1.15		
Vertic al	D3	14	1.44	5.25	3.17±1.12	D3 vs D4	0.58
	D4	19	2.02	5.98	3.36±1.02		

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