

Measurement of Anterior Loop of Inferior Alveolar Nerve Using Cone Beam Computed Tomography (CBCT)

Patcharee Phraisukwisarn, Pattapon Asvanund, Kornkamol Kretapirom

Department of Prosthodontics, Faculty of Dentistry, Mahidol University, 6 Yothi Street, Rajthevi, Bangkok 10400, Thailand

Objective: The objective of this study was to use CBCT to observe the prevalence of the anterior loop of the inferior alveolar nerve, and to measure its horizontal and vertical distance from the mental foramen.

Materials and Methods: 250 CBCT were reviewed retrospectively due to implant planning in lower premolar-molar area. For each scan, the length of anterior loop in both vertical and horizontal distance from mental foramen was measured and compared data between groups base on gender and age.

Results: The prevalence of anterior loop of inferior alveolar nerve was 64.4%. The mean of vertical and horizontal length was 3.88 ± 1.52 and 2.16 ± 1.2 , respectively. No significant difference in all groups except the horizontal length was significant difference between genders.

Conclusions: More than half of the samples presented the anterior loop. There was variation of anterior loop in horizontal and vertical length from mental foramen. That should be considered before implant placement, due to the possibility of damaging the anterior loop of inferior alveolar nerve.

Keyword: anterior loop, anatomical variation, inferior alveolar nerve, CBCT, dental implant, prevalence

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Introduction

Anatomical variations in the path of the mandibular canal such as anterior loop of the mental nerve are common. In Thai population, the finding of anterior loop from panoramic radiographic was about 43% [1]. This consideration becomes important when planning surgical procedures of the anterior mandible, such as osteotomy, bone harvesting, and the placement of dental implants. Sensory disturbance has been reported as a complication in up to 37% of patients in the first 2 weeks following surgery, with 10 to 15% of patients continuing to complain of problems after 15 months [2]. Sensory disturbance occurs mostly often after placement of a mandibular fixed prosthesis between the mental foramina [3-5]. This is because biomechanical considerations dictate

that the distal margin of the implants should be as close as possible to the mental foramen so as to reduce the length of the distal cantilever, which increases the risk of injury, particularly in cases where a loop of the inferior alveolar nerve is present. In view of these potential complications, preoperative radiographic examination is essential prior to surgical procedures involving the mandible [6]. In particular, the potential presence of an anterior loop of the inferior alveolar nerve should be carefully assessed, and if present, its length should be measured. Periapical or panoramic radiographs are commonly used for diagnosis and for planning in oral surgeries [7]. However, some studies [8-10] have suggested that the length of the anterior loop of the mental nerve cannot be measured with panoramic radiograph. Cone beam computed tomography (CBCT) scans have

significantly improved the precision of preoperative oral surgery planning, primarily because they are effective in any type of bone [11-14].

This study used cone beam computed tomography to observed the prevalence of the anterior loop of the inferior alveolar nerve, and to measure its horizontal and vertical distance from the mental foramen. Compared the measured values between groups based on gender and age. This information would be benefit to safely install endosseous implants in the most distal area of the inter-mental foramen region.

Materials and methods

This research is descriptive retrospective study. The Faculty of Dentistry/Faculty of Pharmacy, Mahidol University Institutional Review Board with protocol no. COA.No.MU-DT/PY-IRB 2015/026.3006, approved the ethic.

The patients, who were obtained CBCT scan (3D Accuitomo, J Morita MFG Corp., Japan,

i-Dixel software Ver. 1.8) for implant planning from Faculty of Dentistry of Mahidol University in year 2014, were selected. 3D Accuitomo operated at 90 kv, 5mA, 17.5 seconds experiment time, field of view of 6x6 cm, and voxel size of 0.125 mm. The inclusion criteria be as follows: (1) CBCT scan in premolar-molar area in mandible; (2) no pathology that could affect the position of the mental foramen and anterior loop of inferior alveolar nerve; (3) no history of trauma; and (4) the images are adequate diagnostic quality. The axial images were reconstructed parallel to the inferior border of the mandible. The cross-sectional images of the mandible were created through the axial image. The identification of all patients was eliminated.

The identification of the anterior loop based on the existence of two separate canals beyond the anterior border and/or an oval or elongated shape of the canal and its size (Figure 1). The canal of greater than 3 mm was considered part of the anterior loop and not part of the mandibular incisive canal of the origin of the anterior loop [15].



Figure 1a: In cross sectional reconstruction, the anterior loop can be demonstrated as two-separated canal

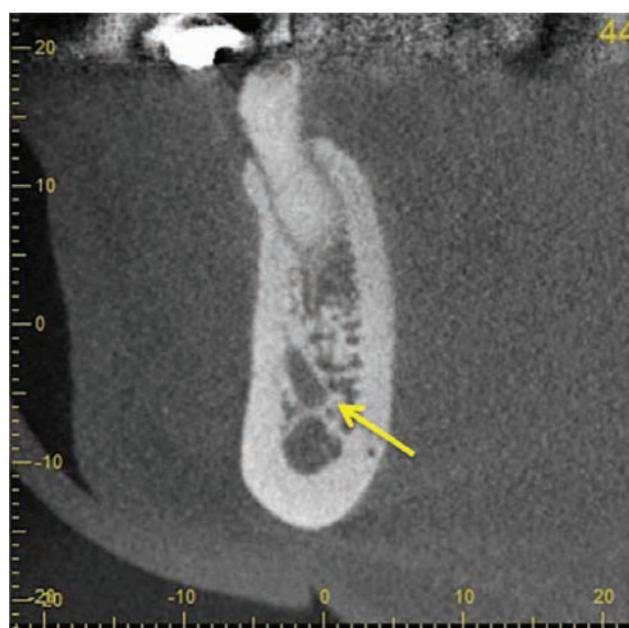


Figure 1b: The anterior loop can be demonstrated as oval or elongated shape of the canal

The length of the anterior loop was defined as both the horizontal and vertical distance from the mental foramen. The vertical distance (MFAL) is the distance from the inner side of the lower cortical border of the mental foramen to the origin of the anterior loop. In cross sectional slice, measured the distance from the inner side of the lower cortical border of the mental foramen to the outer side of the lowest of mandible border (MF) (Figure 2) and measured the distance from the origin of the anterior loop to the outer side of the lowest of mandible border (AL) (Figure 3).

MFAL was calculated by follows:

$$\text{MFAL} = \text{MF} - \text{AL}$$

In horizontal distance was measured from the inner side of the anterior cortical bone of the mental foramen to the inner side of the origin of the anterior loop. The anterior-most margin of the mental foramen was defined in axial view. Vertical cross sections to the mandible were reconstructed with the thickness 0.125 mm and interval thickness

of 0.125 mm. The first slice is the anterior-most margin of mental foramen. The last slice is the origin of anterior loop (Figure 4).

The horizontal distance of anterior loop was measured by counting the number of slices and calculated by follows:

$$\text{Horizontal distance} = \text{Number of slices} \times 0.125$$

The mean values, SD, median and interquartile were calculated

The data were categorized based on gender (male and female group) and age (adult and elderly). Adult age is the age between 21 to 59 years old, while elderly age is the age over 60 years old. The prevalence of the anterior loop was calculated. The prevalence in each gender or age groups was compared using Pearson Chi-Square test. The vertical and horizontal length between groups was compared using Mann-Whitney U test.

Well-trained dentist who was calibrated by an oral radiologist performed all measurements.

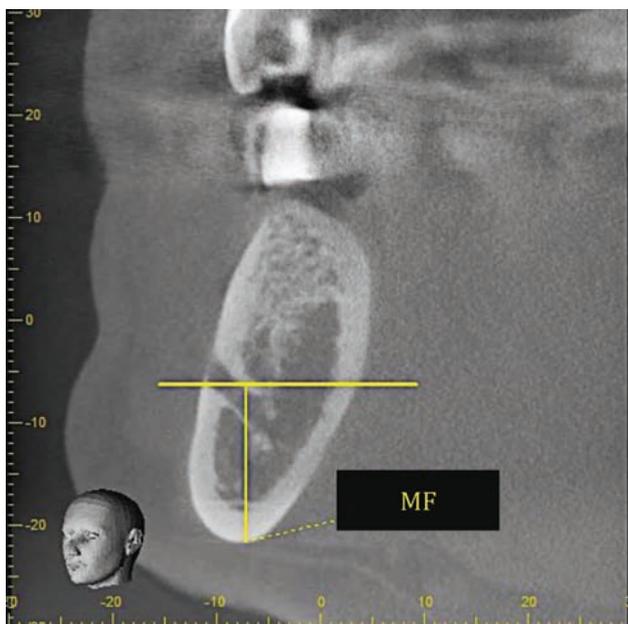


Figure 2: MF distance measure from the inner side of the lower cortical border of the mental foramen to the outer side of the lowest of mandible border

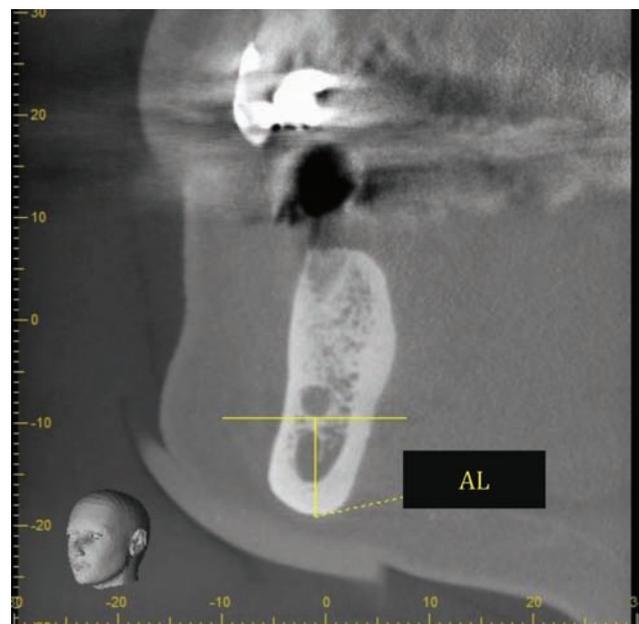


Figure 3: AL distance measure from the origin of the anterior loop to the outer side of the lowest of mandible border

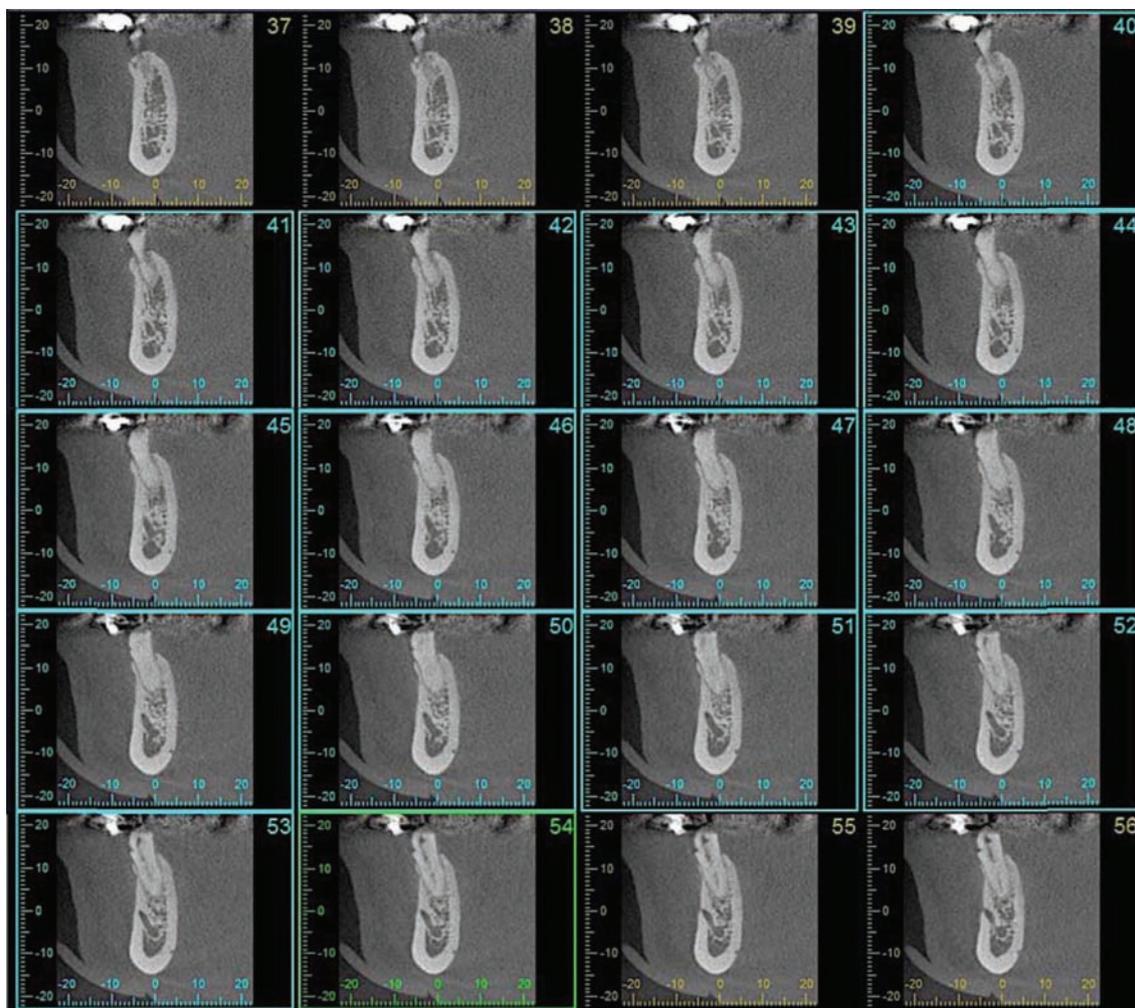


Figure 4: Cross-sectional reconstructions through the body of mandible. The first slice for the measurement is No.54 (anterior-most margin of mental foramen) and the last is No.40 (the origin of anterior loop). The horizontal length; $15 \times 0.125 = 1.875$ mm

Results

A total of 250 sites in 219 patients were evaluated. There were 94 site for males and 156 sites for female. The prevalence of anterior loop was 64.4% (164 sites). Pearson Chi-Square demonstrated that no significant differences between gender and age. All summarize was shown in Table 1. 31 patients were measured in both left and right side; with 7 patients (22.58%) have anterior loop only one side.

Vertical length:

The mean and median of vertical length was 3.88 ± 1.52 and $3.77(2.71-4.83)$ mm, respectively. The shortest vertical length from the mental foramen was 0.36 mm conversely the longest vertical length was 8.83 mm. All summarizes as shown in Table 2.

No significant differences in vertical length were found between male and female or between age groups.

Table 1a: The prevalence of anterior loop categorized by gender

	Anterior loop (Sites)	No anterior loop (Sites)	Total
Male	64 (68.1%)	30 (31.9%)	94 (100%)
Female	97 (62.2%)	59 (37.8%)	156 (100%)
Total	161 (64.4%)	89 (35.6%)	250 (100%)

Table 1b: The prevalence of anterior loop categorized by age

	Anterior loop (Sites)	No anterior loop (Sites)	Total
Working age (21-59)	106 (65%)	57 (35%)	163 (100%)
Elderly age (60+)	55 (63.2%)	32 (36.8%)	87 (100%)
Total	161 (64.4%)	89 (35.6%)	250 (100%)

Table 2: The vertical length of anterior loop of inferior alveolar nerve

	Vertical length (mm)	
	Mean \pm SD	Median (Percentile)
All (n = 161)	3.88 \pm 1.52	3.77 (2.71-4.83)
Gender		
Male	4.15 \pm 1.64	4.24 (3.06-5.15)
Female	3.70 \pm 1.41	3.76 (2.65-4.65)
Age		
Working age (21-59)	3.97 \pm 1.59	3.88 (2.71-4.83)
Elderly age (60+)	3.72 \pm 1.37	3.53 (2.7-4.83)

Horizontal length:

The mean and median of horizontal length was 2.16 \pm 1.2 and 2(1.375-2.81) mm, respectively. This study found 45.34% of the cases had the horizontal length of anterior loop more than 2 mm. The longest horizontal length was 7.125 mm. All measurement were shown in Table 3.

Mann-Whitney U test demonstrated the horizontal length in male was significantly longer than in female ($P < .05$). However, there were no significant differences of the horizontal length when compared by age groups.

Discussion

Radiographic examination is necessary to evaluate the surrounding structure before implant placement in the inter-mental foramen region [16]. In this study CBCT found the present of anterior loop more than half (64.4%) of the samples. While, the other study shown panoramic radiography found only 48.8% [1] of Thai population. Some study [8] demonstrated spiral CT has a higher prevalence of anterior loop than panoramic radiographs. In

contrast, some study [17] shown the prevalence of anterior loop between panoramic radiographs and CBCT was no significant differences.

There was no significant difference in the prevalence and vertical length when compared between gender and age, also no significant difference in the horizontal length for age group. However, there was a statistical difference for gender, with the length significant greater in male ($p < .05$), that was similar to the other studies [18, 19].

The mean of horizontal length of anterior loop in this study was 2.16 mm. In 45.34% of the cases in this study had the horizontal length of anterior loop more than 2 mm and the longest of horizontal length was 7.125 mm. According to the clinical guidelines, the proper implant placement should be away from mental foramen at least 2 mm [16]. It can be imply that there is possibility to damage the anterior loop of inferior alveolar nerve, resulting in hypoesthesia or paraesthesia [20]. Also in complete edentulous case which implant-retained denture was planned without the available CBCT, our study suggested to place the implant anteriorly from the mental foramen more than 2.16 mm to avoid injury to the nerve. However, CBCT suggested before planning implant placement due to the variation of anatomy.

The mean vertical length of anterior loop in this study was 3.88 mm below the mental foramen. The shortest of vertical length was 0.36 mm. This information is benefit for considering the implant length at inter-mental foramen region. In the limited vertical bone height with partial edentulism especially in premolar region, the length and the position of the implant was limited to avoid anterior loop, CBCT scan was suggested.

Due to the voxel size for this study is 0.125 mm, the CBCT cannot identified the structure that less than 0.125 mm. The other error for this study was the limited contrast resolution and pointing device sensitivity.

More than half of the samples presented the anterior loop. There was variation of anterior loop in horizontal and vertical length from mental foramen. Our study recommends the use of CBCT for implant planning, even in the inter-mental foramen region, for all of cases to achieve the success of implant placement.

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Table 3: The horizontal length of anterior loop of inferior alveolar nerve

	Horizontal length (mm)	
	Mean \pm SD	Median (Percentile)
All (n = 161)	2.16 \pm 1.2	2 (1.375-2.813)
Gender		
Male	2.48 \pm 1.29	2.5 (1.50-3.09)
Female	1.95 \pm 1.09	1.75 (1.25-2.38)
Age		
Working age (21-59)	2.15 \pm 1.29	1.88 (1.34-2.75)
Elderly age (60+)	2.19 \pm 0.1	2.125 (1.38-3.00)

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