CBCT evaluation of anterior loop length and mental foramen position in Vietnamese Population (CBCT Evaluation of Anterior Loop Length)

Quang H. Nguyen,1 Phimatra J. Putra,2 Hieu Nguyen,3 Hai-Van Giap,3 Florenly4

Abstract

Objective: The purpose of this study was to evaluate the prevalence and length of anterior loop, and determine the accurate position of the mental foramen in Vietnamese population.

Material and Methods: One hundred and twelve CBCT scans taken within July 2017 until February 2020 were used in this study. All images were evaluated using OsiriX DICOM Viewer. The loop length on both side of the mandible was assessed using oblique transverse method by one examiner based on a standardized procedure. The data collected were analyzed using SPSS ver.26.0.

Results: The prevalence of the loop was 92.9% of the sample. The mean of anterior loop length was 1.72 ± 1.00mm. There was no significant difference between genders or sides of the mandible. The most common position of the mental foramen was in line with the axis of the second premolar and below the apices of the premolars.

Conclusion: Cautions should be taken when placing implant in proximity to the mental foramen as anterior loop is present in most of the case. Based on this study, it is considered safer to place implant 5mm anterior to the mental foramen for Vietnamese population.

Keywords: Anterior loop, CBCT, Cone-beam computed tomography, Dental implant, Mental foramen


Introduction

Location of implant placement was divided into four functional zones, in which the one in the mandible is interforaminal zone. This zone often shows horizontal bone deficiency, careful study prior to any treatment is required.1 Another important consideration in anterior mandible implant placement is the surrounding structures i.e., mental foramen (MF), inferior alveolar nerve (IAN) and anterior loop (AnL). MF is funnel-like opening of the IAN to the surface of the mandible, on the lateral side.2 AnL, if present, is defined as the section of the IAN anterior to the MF.1 During the mandibular development, at first the position of MF was displaced anteriorly, then posteriorly after the second deciduous molar erupts. This creates a loop that transverse anteriorly past the MF and turnabouts superiorly, distally and laterally before exiting the MF.4 The anterior loop of the IAN is an anatomical variant that could be observed in a part of population.5 If present, its length (AnLL) was calculated based on the amount of space between the most anterior portion of the loop and the most anterior margin of the MF.4

Diagnostically and clinically, MF and AnL position are important anatomical structures.7 The AnL carrying neurovascular bundle lies inferiorly and anteriorly to the MF; therefore, the AnL should be measured to determine a safe distance for implant placement. Inaccurate detection of the MF and AnL position in lower first and second premolars region led to misplacement of implant, causing paresthesia, dysesthesia, analgesia or anesthesia.3 The presence and length of the AnL cannot be measured with periapical and panoramic radiograph.8,9 Cone beam computed tomography (CBCT) scan on the other hand is an effect tool for preoperative bone assessment and treatment planning.11

This study used CBCT scan to evaluate the anterior loop in terms of prevalence, length and determine the accurate position of the mental foramen. This information is useful in predicting the most distal position for implant placement in interforaminal region.

Material and Methods

One-hundred-and-fifty CBCT scans were collected from specialist dental clinics in Ho Chi Minh city, Vietnam. All the scans were taken with NewTom Giano Cone-Beam 3D Imaging OPG/CBCT unit for various clinical indications between July 2017 and February 2020. The inclusion criteria of this study includes: scans must be of adequate diagnostic quality presence of anterior portion of the mandible on both sides, at least 2cm distal to MF must be include, scan shows absence of skeletal deformities, scan shows absence of trauma, pathology (such as...
cystic or tumor lesions) that could affect the IAN and the position of MF and presence of anterior portion of the mandible on both sides, at least 2cm distal to MF must be included were included. Only one-hundred-and-twelve scans (with a total of 224 hemimandibles) met the inclusion criteria and were evaluated using OsiriX DICOM Viewer software (Pixmeo SARL, Geneva, Swiss).

This study used oblique transverse method to assess AnLL and MF position. Initially, an axial cut (purple line) was adjusted vertically until the largest MF diameter was clearly revealed in axial plane figure 1A and figure 1B. Secondly, the volume was rotated until the coronal cut (blue line) in axial plane was parallel and tangent to the buccal cortical plate at the MF; then, the sagittal cut (yellow line) was adjusted until it pass through the middle of the foramen figure 1C. Thirdly, when the foramen was revealed clearly in the coronal plane figure 2A, an oblique cut (green line) which ran along the canal and passed through the center of MF was made on the coronal plane figure 2B. The image of MF and the anterior loop was then exposed in the oblique plane figure 3A. Next, in the same oblique plane, “Perpendicular lines” tool was used to create line A, that was parallel and tangent to the buccal cortical plate at the opening of the MF. Line B and line C were drawn passing through the most anterior point of the loop and the most anterior point of the MF, respectively figure 3B. Then the prevalence length of the loop was evaluated. Based on the literature, the diameter of the incisive canal is maximum 3mm. Hence, any portion of the canal which had the diameter of ≥ 3mm was considered as part of the mandibular canal including the anterior loop. This characteristic can be used to determine most anterior portion of the loop.

The position of the MF in horizontal plane was classified into five categories as follows figure 4A: Position H1: Anterior to the long axis of the first
premolar, position H2: In line with the long axis of the first premolar, position H3: Between the long axis of the first and second premolars, position H4: In line with the long axis of the second premolar, position H5: Posterior to the long axis of the second premolar.

The position of the MF in vertical plane figure 4B was recorded in relation to the line connecting the apexes of the first and second premolars, as follow: Level V1: Superior to the horizontal line, level V2: At the horizontal line, level V3: Inferior to the horizontal line.

**Statistical analysis**

The difference between genders, left and right side and between age groups in terms of the loop presence, was assessed using Chi-Square test. The AnLL between the right and left side was compared using Paired T-test, and between genders was compared using independent T-test. A P value less than 0.05 were considered statistically significant. A single trained examiner performed all measurements. The intra-examiner reliability of a single trained-examiner was determined within a 2-week interval. Cronbach’s Alpha was used to evaluate the reliability of the measurements, and was equal to 0.962 for the left side and 0.944 for the right side, showing appropriate superimposition and measurement agreement. All statistical analyses were performed using SPSS software version 26.0 (SPSS Inc, Chicago, IL, USA) figure 5.

**Results**

A total of 112 CBCT scans examined in this study included 66 males and 158 females, with a mean age of 44.5 years (range, 17-72 years) table 1. The anterior loop was present (length >0.00mm) in 92.9% of the cases. The mean AnLL of 112 samples (224 hemimandibles) was 1.72 ± 1.00mm, ranging from 0.00mm to 4.91mm. In 208 hemimandibles with the loop present, the percentage of anterior loop with more than 2mm, 3mm and 4mm length were 34.1%, 12% and 4.3%, respectively. The rest of the cases had AnL length less than 2mm figure 9.

The mean length was 1.62 ± 0.87mm on the left side and 1.81 ± 1.10mm on the right side. There is no statistical significance between the left and right-side table 2. The mean AnLL on male patients was 1.83 ± 1.10mm and 1.67 ± 0.95mm on female counterparts and no statistically significant difference was found table 3.

The distribution of the MF position was recorded according to sides (left and right), genders and in relation to horizontal and vertical plane tables 4 and table 5. There was no significant difference between left and right side on both horizontal and vertical plane. H4 was the most prevalent horizontal position of the MF (38% in right and 39% in left side). In regards to gender, females showed highest prevalence of H4 on right and left side; whereas, males showed H5 on both sides table 4. In terms of vertical position of the MF, V3 showed the most prevalence on both right (male = 78%, female = 81%) and left sides (male = 88%, female = 81%).

**Discussion**

In this study, we used oblique transverse method to accurately evaluate multiple anatomical structures in the same view. The presence of the loop in Vietnamese was noticed in 92.9% of the cases. This finding corresponded with previous studies using CBCT and probe on cadavers which showed a high prevalence of 85.2%, 88% and 94%. In contrast, other studies found a low prevalence of the loop from 7% to 53.7%.

The possible reason for this might be different methods of CBCT assessment. Each method has difficulty in determining the most anterior point of the loop; however, transverse oblique method makes the assessment reliable as multiple anatomical structures can be displayed in the same view. A CBCT scan with smaller voxel size
and longer scans time could provide better image quality and minimize the errors of measurements. One disadvantage in the present study is that the scan time was short and the quality of the image was of medium resolution only. However, intra-examiner reliability was tested and the statistic result showed excellent agreement.

This research found that the mean loop length was 1.72mm. This finding corresponded with result from other studies using cadaver dissection,\textsuperscript{17} or CBCT scan.\textsuperscript{12} Uchida et al compared the results of direct method on cadavers and the result from CBCT method, equal result with very small difference were found. On the contrary, studies using panoramic radiographs showed different results from CBCT and cadaveric studies, i.e. 3.75mm and 5mm.\textsuperscript{18,19} This implies that CBCT gives an accurate measurement of the anatomical structures as two-dimensional radiograph posed great difficulty in visualization of structures, and give imprecise result.\textsuperscript{10} A CBCT scan with smaller voxel size and longer scan time could provide better image quality and minimize the errors of measurements. One disadvantage in the present study is that the scan time was short and the quality of the image was of medium resolution only.

In terms of implant placement, this study found that the safest distance would be at least 5mm from MF. Although the measurements of the loop length were 4mm in 95.7\% of the cases where AnL existed. Nonetheless, the longest loop recorded in this study was 4.91mm and in 4.3\% of the cases the loop length was more than 4mm. If implant was placed within 4mm from the MF, there is a risk to damage the IAN. Additionally, various studies recommended the most distal aspect of the implant should be at least 1 to 6mm anterior to the loop.\textsuperscript{3,20,21}

Another important factor contributing to implant placement is the position of MF. This study found the horizontal and vertical position of MF were in line with the axis of the second premolar and below the apex of the premolars, which was consistent with other studies.\textsuperscript{22,23} This finding can be used to locate the position of the MF when CBCT is not available.

### Table 4  
Gender distribution of position of the right-sided and left-sided mental foramen in horizontal plane

<table>
<thead>
<tr>
<th>Horizontal position</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior to 1st premolar’s axis (right-sided)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Anterior to 1st premolar’s axis (left-sided)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>In line with 1st premolar’s axis (right-sided)</td>
<td>1 (3.1%)</td>
<td>0 (0%)</td>
<td>1 (0.9%)</td>
</tr>
<tr>
<td>In line with 1st premolar’s axis (left-sided)</td>
<td>1 (3.1%)</td>
<td>1 (1.2%)</td>
<td>2 (1.8%)</td>
</tr>
<tr>
<td>Between 1st and 2nd premolars’ axis (right-sided)</td>
<td>6 (18.2%)</td>
<td>25 (31.7%)</td>
<td>31 (27.7%)</td>
</tr>
<tr>
<td>Between 1st and 2nd premolars’ axis (left-sided)</td>
<td>6 (18.2%)</td>
<td>24 (30.4%)</td>
<td>30 (26.8%)</td>
</tr>
<tr>
<td>In line with 2nd premolar’s axis (right-sided)</td>
<td>12 (36.3%)</td>
<td>31 (39.2%)</td>
<td>43 (38.4%)</td>
</tr>
<tr>
<td>In line with 2nd premolar’s axis (left-sided)</td>
<td>11 (33.3%)</td>
<td>33 (41.8%)</td>
<td>44 (39.3%)</td>
</tr>
<tr>
<td>Posterior to 2nd premolar’s axis (right-sided)</td>
<td>14 (42.4%)</td>
<td>23 (29.1%)</td>
<td>37 (33.0%)</td>
</tr>
<tr>
<td>Posterior to 2nd premolar’s axis (left-sided)</td>
<td>15 (45.4%)</td>
<td>21 (26.6%)</td>
<td>36 (32.1%)</td>
</tr>
<tr>
<td>Total (right-sided)</td>
<td>33 (100%)</td>
<td>79 (100%)</td>
<td>112 (100%)</td>
</tr>
<tr>
<td>Total (left-sided)</td>
<td>33 (100%)</td>
<td>79 (100%)</td>
<td>112 (100%)</td>
</tr>
</tbody>
</table>

### Table 5  
Gender distribution of position of the right-sided and left-sided mental foramen in vertical plane

<table>
<thead>
<tr>
<th>Vertical position</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior to horizontal line (right-sided)</td>
<td>0 (0%)</td>
<td>2 (2.5%)</td>
<td>2 (1.8%)</td>
</tr>
<tr>
<td>Superior to horizontal line (left-sided)</td>
<td>0 (0%)</td>
<td>2 (2.5%)</td>
<td>2 (1.8%)</td>
</tr>
<tr>
<td>At the horizontal line (right-sided)</td>
<td>7 (21.2%)</td>
<td>13 (16.5%)</td>
<td>20 (17.9%)</td>
</tr>
<tr>
<td>At the horizontal line (left-sided)</td>
<td>4 (12.1%)</td>
<td>13 (16.5%)</td>
<td>17 (15.2%)</td>
</tr>
<tr>
<td>Inferior to the horizontal line (right-sided)</td>
<td>26 (78.8%)</td>
<td>64 (81.0%)</td>
<td>90 (80.3%)</td>
</tr>
<tr>
<td>Inferior to the horizontal line (left-sided)</td>
<td>29 (87.9%)</td>
<td>64 (81.0%)</td>
<td>93 (83%)</td>
</tr>
<tr>
<td>Total (right-sided)</td>
<td>33 (100%)</td>
<td>79 (100%)</td>
<td>112 (100%)</td>
</tr>
<tr>
<td>Total (left-sided)</td>
<td>33 (100%)</td>
<td>79 (100%)</td>
<td>112 (100%)</td>
</tr>
</tbody>
</table>
Conclusion

Anterior loop presented in most of the cases and its length depends on the age of the patient: the older the patient gets, the shorter the loop becomes. When planning for dental implant placement in intermorrainal region, there is a risk of damage to the mental nerve and its neurovascular bundle. These research findings suggested the safest site to place dental implant is at least 5 mm anterior to the mental foramen. When 3D reconstructs of the anterior loop was not available, the reference position is in line with the long axis of the second premolar.

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Conflict of Interest

The authors report no conflict of interest.

References


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