Radiological Evaluation of the Anatomic Characteristic of Lingual Foramina and Their Vascular Canals in the Anterior Region of the Mandible Using Cone Beam Computed Tomography

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ABSTRACT
Background: presence of lingual vascular foramina and canals in the interforaminal region may increase the risk of surgical complications during implant placement or any surgical procedure in this area. Aim of this study is the radiological evaluation of the anatomic characteristic of the lingual foramina and their vascular canals in the anterior of the mandible using cone beam computed tomography.

Materials and Methods: Prospective study including 72 Iraqi subjects (31 male and 41 female) ranging from 20 to 59 years, all subjects attended Al-Sharaa dental clinic in Al-Najaf AL-Ashraf city, scanned with CBCT from September 2016 to February 2017. Using 3dimentioonal and sagittal cross section to detect lingual foramina and their vascular canals. Their presence, number, diameter, position, orientation were established.

Results: Lingual foramina in the anterior mandible were viewed in whole sample. Number of lingual canals varied from 1-5, the average diameter of the canals was 0.81 mm. The average distance from the foramina to the base of the mandible and to the alveolar crest was 13.78 mm and 16.05mm respectively. There was no significant correlation found between age and gender on all selected measurements. There was significant association of diameter of lingual foramen with the count, situation, extent and direction of lingual canal through the mandible width.

Conclusion: Cone beam computed tomography is an invaluable system in diagnosis and treatment planning of surgical procedures. It help in detection of various anatomic features of mandible like presence of lingual foramen and canals in the anterior mandible.

Keywords: Lingual foramina and their vascular canals, Anterior of the mandible, CBCT. (J Bagh Coll Dentistry 2018: 30(1): 23-27)

INTRODUCTION
The interforaminal region of the mandible (area constricted between the two mental foramina) is deemed as safe region that because anatomical features like submandibular fossa and the inferior alveolar canal are positioned posterior to it(1). In fact there are some serious anatomical features even in this region including lingual foramina (LF) and canals (LC), incisive canal and the lingual shell concavity(2).

The lingual foramen is a small opening situated on the lingual side surface of the anterior mandible through which small blood vessels pass. The lingual foramina is usually situated in the midline of the internal surface of the mandible at the level of or superior to the mental spines (3). The contents of LC have not been clarified and are still debated(4). Many studies submit that a neurovascular bundle pass into the LF (5,6). However, others declared that the LC includes just artery (6,7).

The anterior of mandible (AOM) is supplied by three arteries: sublingual artery, submental artery, chin artery(8).

During surgical operation of dental implant, orthognathic surgery and osteodistraction in AOM, there is a possibility to damage the vital structure in this area resulting in severe bleeding(3). This hemorrhage may not be noticed instantly within the operation results in big hematoma in the floor of the mouth leading to airway obstruction(9). To avoid this complication, the surgeon should have good knowledge about the anatomical structures in AOM and be carefully prepared for the operation by utilizing the valuable 3 dimensional radiography (3-D) and regulating software present in cone-beam computed tomography (CBCT), the more recent scanning contrivance(8,10), that give image with great resolution, comparatively low irradiation dosage and actual size of substantial bony structures of the AOM on various planes of view(11,12).

In this study, the LF and their bony canals at AOM were assessed by utilizing CBCT images of Iraqi adult patients to provide useful preoperative evaluation.

MATERIALS AND METHOD
In this cross-sectional study included 72 Iraqi adult subjects (male and female) ranging from 20 to 59 years, attend Al-Sharaa dental clinic in Al-Najaf Al-Ashraf City, scanned with CBCT image for

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different surgical interventions from September 2016 to February 2017. Images were acquired using GenDex Finland CBCT unit and exposure factors were set ranging from 6.3-8.0 mA and 90 Kv. The acquired images were processed with Anatomage Invivo 5.4 3D imaging dental software and slice thickness 0.1mm. AOM carefully inspected on the midline and around the midline for checking the present of LF and their bony canals. The number of LF as shown in figure 1, diameter (categorized the foramen diameters as <1 and ≥1 mm) and the orientation of LC (descending trajectory, ascending trajectory or horizontal) were analyzed on the 3D and sagittal view, the position of LF was described in relation to genial tubercle(above, below) the distance from the lower cortex border of the foramina to the inferior border of the mandible (main foramina) upper one as shown in figure 2 and the distance from the upper cortex border of the foramina to the alveolar crest as shown in figure 3. The extent of penetration of LC through the width of mandible (lingual, middle, buccal third), as shown in figure 4.

Statistical analyses were done using IBM SPSS version 21 computer software. Compliance of a continuous quantitative random variables with Gaussian curve (normal distribution) was analyzed using the Kolmogorov-Smirnov test. The statistical significance of difference in mean between two groups was assessed using the independent samples t-test, while between more than two groups ANOVA model was used. ANOVA trend was used when the independent (grouping variable) was an ordinal level variable. The accuracy and reproducibility of examiner readings was determined by means of inter-examiner calibration to compare the readings of examiner (10 randomly selected readings) with those performed by professional senior, the comparison appeared no significant difference between the first and second examiners readings when paired t-test was applied. Also all the measurement repeated by the same examiner after 2 weeks from the first reading (intra-examiner calibration) on randomly selected 10 subjects, comparison of two reading showed non-significant difference when paired t-test was applied.

Figure 1: 3D image showing the present of more than one lingual canal in the lingual median region of the mandible (2 canals)

Figure 2: Distance from the lower cortex border of the lingual foramen to the base of the mandible (13.44mm)

Figure 3: Distance from the upper cortex border of the lingual foramen to the crest of alveolar bone (17.44mm)
RESULTS:
The data were analyzed, 160 LC from 72 subjects, LF is observed in 72 (100%) of study sample, and 55 (76.4%) had multiple LC (two canals 38.9%, three canals 31.9%, four canals 2.8%, and five canals 2.8%).

LC traverse the mandibular bone to a variable extent, 40 of total 160 canals extended through only the lingual third of the mandible width, the majority (55.6%) extend to the middle third and only 19.4% reach the buccal third, there was a moderately strong positive (direct) linear correlation between canal diameter of LF and depth of penetration inside the mandible r=0.432, P<0.001 as shown in figure 5.

The orientation of LC was detected in the sagittal plane, 83 of total 160 canals had descending trajectory, 35% of the canals had ascending trajectory and 13% were solely anterior.

In relation to genial tubercle (GT), 87 (54.4%) of total 160 canals were above GT and 45.6% were found below GT, there was statistically significant linear correlation between the diameter of LF and the count of LC per subject with the position of LF in relation to GT as shown in table 1.

The mean distance from LF to the base and alveolar crest of the mandible was 13.78mm and 16.05mm respectively. The correlation between age or gender with the measurement of the distance from LF to the base and alveolar crest of the mandible showed statistical not significant difference as shown in table 2 and 3.

Table 1: Association of the position of lingual canal opening in relation to genial tubercle with the diameter of the canal

<table>
<thead>
<tr>
<th>Diameter of canal (mm)</th>
<th>Position of LC opening - genial tubercle</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Below</td>
<td>Above</td>
</tr>
<tr>
<td>Range</td>
<td>0.31</td>
<td>1.81</td>
</tr>
<tr>
<td>Mean</td>
<td>0.69</td>
<td>0.89</td>
</tr>
<tr>
<td>SD</td>
<td>0.27</td>
<td>0.31</td>
</tr>
<tr>
<td>SE</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>N</td>
<td>73</td>
<td>87</td>
</tr>
</tbody>
</table>

Table 2: Distance from the lingual foramen to the base of the mandible

<table>
<thead>
<tr>
<th>Accurate measurements</th>
<th></th>
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<tbody>
<tr>
<td>Range</td>
<td>4.18 to 18.72</td>
</tr>
<tr>
<td>Mean</td>
<td>13.78</td>
</tr>
<tr>
<td>SD</td>
<td>2.94</td>
</tr>
<tr>
<td>SE</td>
<td>0.35</td>
</tr>
<tr>
<td>Number of subjects</td>
<td>72</td>
</tr>
<tr>
<td>Range of normal values (5th to 95th centile)</td>
<td>7.64 to 18.08</td>
</tr>
</tbody>
</table>

Table 3: The distance from the lingual foramen to the alveolar crest

<table>
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</table>
The range of the diameter of the LC was 0.3mm-1.8mm with mean 0.81mm, about 28.1% of all the subjects had LF with diameter ≥1mm. We categorized the foramen diameters as <1 and ≥1 mm to give an idea about the hazard of haemorrhage severity. There was statistically significant indirect linear correlation between the diameter and count of LC per subject as shown in figure 6.

![Figure 6: Association of the count of lingual canal per subject with the diameter of the canal](image)

**DISCUSSION**

In the AOM there are many anatomical landmarks, such as foramina and vascular canals. Due to neurovascular content of LC, any trauma to this canal may cause haemorrhage or neurosensory complications. Consequently, that very important to do well planning preoperatively by radiological investigation to avoid any neurovascular disturbances. Imaging by CBCT provides perfect visualization of foramina and canals, because there is no superimposition of the anatomical structures (especially in the AOM))13).

In the present study all the CBCT images taken showed the present of LF, and the number of canals ranged from 1 to 5 per patient. These finding come in agreement with Tepper et al.14) Gahleitner et al.9) Park et al.16). The majority of LC extend to the middle third of the mandible width, and these findings agreed with Abesi et al.15). Babiuic et al.2). Most LC had descending direction, the trajectory of the LC described in this study is similar to that described by Babiuic et al.2). Liang et al.15) Tepper et al.14) McDonnell et al.17). The LF were above the GT more than that present below it, that come in accordance with Babiuic et al.2) Bernardi et al.18) and Denny et al.19). The average distance from the LF to the alveolar crest was of 16.05mm, with a minimum of 8.67mm and a maximum of 27.71mm. Previous studies (2,19,20) agreed with the results of the present study and the difference in mean distance value is probably due to anatomical variation and different ethnicity. The relative frequency of subjects with canal diameter ≥ 1 mm is (28.1%) that was agreed with the study made by Babiuic et al.2) Yildirim et al.21). The results of the present study in table 1 showed highly significant correlation between diameter of LF and the position of it (P<0.001). Our results come in agreement with Sheikhi et al.20) Liang et al.15) and Bernardi et al.18) who analyzed the morphology of LF and found that it had mainly an oval shape, the main axis of the superior LF located vertically, while the main axis of the inferior LF located horizontally. These findings can express the exceeding of the superior LF in diameter than the inferior one.

Figure 5 showed that the penetration of the LC through the width of the mandible had direct linear correlation with the diameter of LF. No previous study, however, had described this association as seen in this study.

There is an important relationship between the diameter of LF opening and the size of blood vessels that go through them, and the vessels with a diameter less than 1mm are a potential hemorrhagic index risk (2,18).

Figure 6 showed significant association of the count of LC per subject with the diameter of the canal. No previous reports had described this association. However, Liang et al.15) who reported that the majority of lower jaw having two LF, the larger one with greater dimensions (longer canal and larger diameter) was similar to single canals.

In conclusion, CBCT imaging provides perfect visualization of lingual foramen. There was statistically significant linear correlation between the position, extent, count of LF and its diameter. There was statistically significant linear correlation between the count and the extent of LC diameter. No previous investigations provided a statistical correction for the relationship between the count of LC and the extent of LF to the mandible. The correlation between age or gender with the measurement of the distance from the lingual foramen to the base and alveolar crest of the mandible showed no statistically significant difference.

**REFERENCES**


andibular interforaminal region for
anals with CBCT.


**الخلاصة**

النقطة اللغوية وقوائم الأوعية الدموية في المنطقة المحدودة بين القنوات اللغوية قد يزيد من خطر المضاعفات الجراحية أثناء وضع الغرسة أو أي إجراء جراحي في هذه المنطقة.

الهدف من هذه الدراسة: تقييم الخصائص التشريحية للنقطة اللغوية وقوائم الأوعية الدموية في مقدمة الفك السفلي باستخدام التصوير المقطعي ذو الشعاع المخروطي.

**المواضيع والطرق:** دراسة استطلاعية شملت 131 موتطا عراقياً (62 من الذكور و69 من الإناث) تتناول أعمارهم من 31 من الذكور و41 من الإناث. تم تحديد عدد القنوات اللغوية وقوائم الأوعية الدموية في مقدمة الفك السفلي عن طريق التصوير المقطعي ذو الشعاع المخروطي.

**النتائج:** تم اكتشاف الثقوب اللغوية في مقدمة الفك السفلي في العينة كاملة. وتراوح عدد القنوات اللغوية من (1.5) إلى (6.5). وكان متوسط قطر القنوات (0.13) مم. كان متوسط قطر القنوات من القنوات إلى قاعدة للكلاسي (0.13 مم) و (0.15 مم) على التوالي. وظهرت النتائج أنه لم يكن هناك أي تأثير الاسم على نوع القنوات اللغوية في جميع المراحل المختلفة. كان هناك ارتباك كبير بين قطر القنوات اللغوية من القنوات إلى قاعدة الفك السفلي.

**الاستنتاج:** التصوير المقطعي ذو الشعاع المخروطي هو نظام لا يقدر بثمن في التشخيص وفحص الحالات للعديد للعمليات الجراحية. أنها تساعد في الكشف عن الملحق التشريحي المفصل وقدرة وجود القنوات اللغوية والقوائم في مقدمة الفك السفلي.