EXAMINATION OF MANDIBULAR LATERAL LINGUAL CANAL WITH CONE BEAM COMPUTED TOMOGRAPHY AND ITS RELATIONSHIP WITH ANATOMICAL STRUCTURES

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ABSTRACT

Background and Aim: The mandible contains many accessory foramina and canals, particularly on the lingual side. The aim of this study was to evaluate the presence of lateral lingual canal (LLC) and the number, diameter and position of lateral lingual foramen (LLF) using cone beam computed tomography (CBCT).

Materials and Methods: CBCT images of 250 patients were retrospectively analyzed. The presence of LLC and the number, diameter and position of LLF were evaluated. The distance between LLF and top of alveolar crest and the distance between LLF and mandibular midline were measured. The effect of gender on numeric values was analyzed by Student's t-test ($p<0.05$).

Results: LLC was present 55.4% in patients, 53.2% were on the right side and 57.6% were on the left side. The mean diameters of LLF were 0.65±0.24 mm and 0.69±0.23 mm for the right and left sides, respectively. LLF was classified as mono 46.8% for the right side and 51.6% for the left side. LLF was observed more frequently in the second premolar region. The mean values of the distances from the LLF to the midline and to the alveolar crest were 14.30±3.73 mm and 21.07±4.13 mm for the right side and 14.61±3.50 mm and 20.65±4.92 mm for the left side, respectively. No effect of gender on numeric values except left LLF-crest distance was detected ($p>0.05$). The left LLF-crest distances were 20.59±3.61 mm in females and 20.70±5.86 mm in males ($p=0.028$).

Conclusion: More than half of the participants had LLC in the present study. CBCT imaging can inform surgeons about the presence, number, dimensions and location of LLC and LLF, as well as the presence of possible arterial and vascular structures.

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INTRODUCTION

The anterior region of the mandible is often considered to be simple and safe for various kinds of oral surgeries. However, the safety recommendations that are relevant to this issue are not based on knowledge of the position or the course of related anatomical landmarks.[1] Over the past 3 decades, several reports have documented life-threatening bleeding and sublingual hematoma in the mouth after surgical operations in the mandible, and further research are needed to understand the causes of these complications.[2-4] This traumatic damage to the vasculature is caused by undesirable perforations in the lingual cortical plate and laceration of the lingual periosteum.[5] The sublingual and submental arteries, which form a rich anastomosing plexus lying close to the mandibular lingual cortical plate, are reported to be easily damaged.[6,7] Recently, researchers have been using cone-beam computed tomography (CBCT) images to assess the course of the mandibular canal and its features, such as the bifurcation, anterior loop, mandibular incisive canal, lateral lingual canal (LLC), and lateral lingual foramen (LLF).[8]

The mandible contains many accessory foramina and canals, particularly on the lingual side. There are two main categories of accessory foramina on the lingual side: medial and lateral lingual foramina. The canal structures of these foramina have been labelled "vascular canals" due to their arterial content, which includes either different arterial branches or anastomoses of the arteries.[9] The LLC contains a neurovascular bundle that originates from the submental artery and the inferior alveolar artery, as well as the inferior alveolar nerve.[6,10]

While orthopantomogram is the go-to for primary data on the oral and maxillofacial region, two-dimensional radiographs do not show the axial and cross-sectional slices that are crucial for pre-surgical assessments.[11] CBCT scan is a common diagnostic tool used in planning dental surgeries, dental implant procedures, and autogenous bone augmentation surgeries.[12-14] Before augmentation and dental operations, CBCT gives the specialists precise information regarding anatomical structures to avoid complications.[15]

A review of the literature reveals that studies evaluating LLC and LLF have been conducted using a variety of radiographic methods. This study aimed to evaluate the presence, diameter, number, and position of lateral lingual canals and foramina by using CBCT.

MATERIALS AND METHODS

Ethical Approval

Ethics committee approval was received for this study from Alanya Alaaddin Keykubat University Faculty of Dentistry Ethics Committee (05-2025/7-1).

Study Design

Two hundred and fifty CBCT images of 250 patients (129 males, 121 females) who visited the Faculty of Dentistry between January 1, 2023, and December 31, 2024 were included the study. Inclusion criteria were as below: 1) no jaw fracture; 2) good visibility in the CBCT scan; 3) no artifacts resulting from movement during image acquisition; and 4) imaging field included the mandibular arch.

CBCT Image Analysis

The CBCT scans were performed using a KaVo OP 3D DVT (KaVo Dental GmbH, Biberach an der Riß, Germany). The operating parameters were 90 kV and 9.23 mA, with a scan time of 8.14 seconds and a field of view of 8 x 15 cm. The CBCT images were evaluated using OnDemand3D® software (version 1.0.9.1451; CyberMed, Seoul, Republic of Korea). The following parameters were observed: 1) presence of LLC, 2) number, diameter and position of LLF, 3) distance between LLF and top of alveolar crest, and 4) distance between LLF and mandibular midline. All images were reviewed, and measurements were performed by an experienced oral and maxillofacial radiologist (T.Ç.) (Figures 1-3).

The position of LLF was categorized into 5 subgroups: 1) canine, 2) canine-first premolar, 3) first premolar, 4) first premolar-second premolar, and 5) second premolar region. In addition, the middle of the LLF to mandibular midline and the middle of the LLF to the top of the alveolar crest distances were measured.

Statistical Analysis

All statistical data were processed using a statistical software (IBM SPSS Statistics for Windows, Version 24.0, Armonk, NY, USA). Categorical variables were reported as frequencies and percentages, while means and standard deviations were used for descriptive statistics of intermittent and continuous numeric variables. The impact of gender on numeric values was assessed using Student's t-test ($p=0.05$). Inter-class correlation coefficients were calculated to evaluate intra-observer reliability for measurements taken from 20 randomly selected CBCT scans.

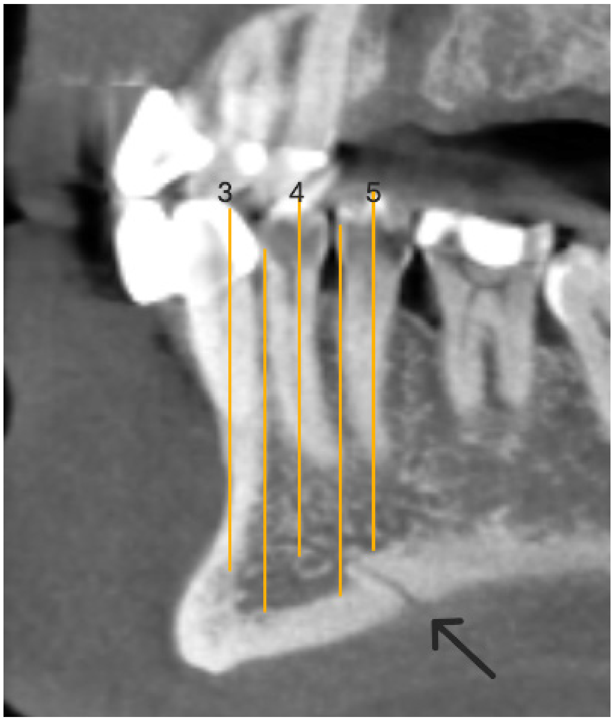

Figure 1. Categorization of LLF by position. The black arrow shows the LLF. The numbers above identify tooth numbers.

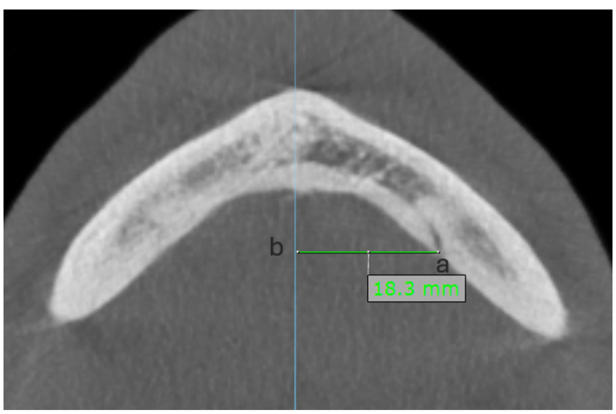

Figure 2. Superior axial slices. a) LLF, b) mandibular midline

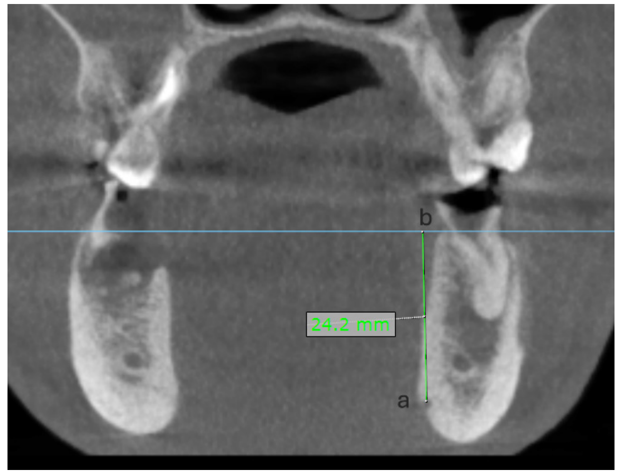

Figure 3. Distance between LLF and alveolar crest. a) LLF, b) alveolar crest

RESULTS

Intra-observer coefficients values were calculated to be >90%. Two-hundred and fifty CBCT images obtained from 250 (129 males, 121 females) patients were evaluated in the present study. The prevalence of LLC was calculated to be 55.4% for all sides (133 were in the right side and 144 were in the left side). While evaluating the location of LLC, it was most commonly observed in the right second premolar region (20.4%). They were 19.2% in the left second premolar, 16% in the left first premolar-second premolar, and 10.4% in the right first premolar-second premolar regions.

The mean diameters of LLF measured for the right and the left sides were 0.65±0.24 mm and 0.69±0.23 mm, respectively. The diameters of the right LLF were 0.61±0.23 mm and 0.69±0.24 mm in females and males, respectively (p=0.784). The diameters of the left LLF were 0.68±0.21 mm and 0.70±0.24 mm in females and males, respectively (p=0.806). The mean values of distances between the LLF and mandibular midline were measured for right and left sides 14.30±3.73 mm and 14.61±3.50 mm, respectively. The average distances between the right LLF and mandibular midline were 14.01±3.91 mm and 14.57±3.57 mm in females and males, respectively (p=0.596). The average distances between the left LLF and mandibular midline were 13.79±2.78 mm and 15.34±3.90 mm in females and males, respectively (p=0.087).

In addition, LLF-crest distances were measured for right and left sides 21.07±4.13 mm and 20.65±4.92 mm, respectively. The right LLF-crest distances were 20.63±4.03 mm and 21.47±4.20 mm in females and males, respectively (p=0.753). The left LLF-crest distances were 20.59±3.61 mm in females and 20.70±5.86 mm in males (p=0.028) (Table 1).

Moreover, LLF was classified as mono-bifid-triple in this study. For the right side 46.8% and for the left side 51.6% mono types were detected. A triple LLF was observed only in the left mandibular region at a rate of 0.4%.

Table 1. Linear measurements of LLF by gender

Parameters	Mean±Standard deviation (mm)		P value
	Females	Males	
Right LLF diameter	0.61±0.23	0.69±0.24	0.784
Left LLF diameter	0.68±0.21	0.70±0.24	0.806
Right LLF-crest distance	20.63±4.03	21.47±4.20	0.753
Left LLF-crest distance	20.59±3.61	20.70±5.86	0.028*
Right LLF-midline distance	14.01±3.91	14.57±3.57	0.596
Left LLF-midline distance	13.79±2.78	15.34±3.90	0.087

*Statistically significant ($p<0.05$).

DISCUSSION

The anatomy and vascular supply of the mandible have been investigated by several cadaver studies.[6,16-18] The floor of the mouth contains two vessels: the sublingual artery and the submental artery. These run anteroposteriorly, one above and one below the mylohyoid muscle. The perforating branches of these vessels enter the inner surface of the mandible through a canal called the "lingual canal". This anatomical structure can be identified on oral radiographs. It can also be identified in anatomical dissections. The different authors have given these canals different names depending on where they are located in the midline of the mandibular symphysis.[16,18,19] In the present study, we used the term "lateral lingual canal" to differentiate the locations of the detected canals, as Gahleitner et al.[20] proposed in a previous report.

Dental surgery operations require complementary radiological examination procedures to locate the inferior alveolar nerve and variations with accuracy, in order to avoid neurovascular bundle lesions.[21,22] Therefore, dentists can rely on the CBCT examination to identify anatomical structures, such as bifid mandibular canals, accessory mental foramina, buccal foramina, or LLC, with relatively low radiation exposure and availability in dental clinics.[23]

The sublingual and submental arteries, which form a rich, interconnecting network close to the mandibular lingual cortical plate, are reported to be easily damaged in the floor of the mouth.[2-7]

The frequency of LLC reported in the literature is quite variable.[24] Moshfeghi et al.[25] found LLC in 11.5% of patients, Sahman et al.[26] in 24.8% of patients, Sanomiya Ikuta et al.[27] in 39% of patients, Yıldırım et al.[28] in 21.1% of patients, and Wei et al.[29] in 69.9% of patients. In the current study, LLC was present 55.4% in patients, 53.2% were on the right side and 57.6% were on the left side. The difference between the studies can be explained by differences between populations. Moreover, variation in the frequency may be attributed to different equipments and settings, the number of participants, imaging resolution and observer training.

In the present study, the position of LLF was classified in 5 subgroups similar to the previous studies.[25,27] Sanomiya Ikuta et al.[27] observed LLF in the second premolar region (26.9%) and Moshfeghi et al.[25] detected LLF most commonly in the second premolar region (55.8%). Sahman et al.[26] observed LLF in the premolar region (83%), and Wei et al.[29] detected LLF most commonly in the premolar region (74.0%). In our study, the position of the LLF on the right and left sides was most commonly found in the second premolar region with rates of 38.9% and 34%, respectively. However, some studies have only classified the premolar region as one region. In our study, the premolar region was divided into 3 regions named the first premolar region, the region between the first and second premolars, and the second premolar region. This may explain the differences between the studies.

The mean diameters of LLF for the right and the left sides were 0.65±0.24 mm and 0.69±0.23 mm, respectively. Similarly, Sahman et al.[26] reported diameters of 0.65±0.18 mm and 0.64 ± 0.17 mm for the right and left sides, respectively. It was concluded by Gahleitner et al.[20] that the diameter of the LLF is important, as it is directly correlated with the diameter of the vessels entering or passing through them. It is important to note that the risk of haemorrhage increases in proportion.[20,30,31] Due to the arterial content of LLC, CBCT imaging of LLC in the interforaminal region is necessary before planning dental surgery operations. In the present study, only LLC diameter values were presented according to subgrouped sides as descriptive data. However, the statistical difference between the sides in the diameters of the LLCs was not evaluated. The diameters of the right LLC were 0.61±0.23 mm and 0.69±0.24 mm in females and males, respectively (p=0.784). The diameters of the left LLC were 0.68±0.21 mm and 0.70±0.24 mm in females and males, respectively (p=0.806). Similar to the literature, no significant difference was found for right and left side LLC diameters in males and females.

In the present study, the middle of the LLF to mandibular midline and crest distances were measured. No relevant study was found in the literature that presents linear measurements. No statistical difference was detected for LLF to mandibular midline distance according to gender (p>0.05). The distances between right LLF and crest were 14.01±3.91 mm in females and 14.57±3.57 in males (p=0.596). However, only left LLF-crest distance was statistically higher in male subjects than females (p=0.028). Therefore, this study contributes to the existing literature by determining LLC and LLF with CBCT and the evaluating their relationship with anatomical structures. There are few limitations of this study. We planned to assess the linear measurements according to the number of LLC (mono, bifid, and triple). However, having lack of sufficient subjects limits the ability to perform statistical analysis. Multi-center studies with larger sample sizes are necessary to examine this issue more comprehensively.

CONCLUSION

More than half of the participants had LLC in the present study. CBCT imaging can inform surgeons about the presence, number, dimensions and location of LLC and LLF, as well as the presence of possible arterial and vascular structures.

ETHICAL APPROVAL

Ethics committee approval was received for this study from Alanya Alaaddin Keykubat University Faculty of Dentistry Ethics Committee (05-2025/7-1).

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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