Characterization Of Lingual Foramina Using Cone-Beam Computed Tomography

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Abstract:

Objective: To assess the location and anatomical character of lingual foramina using CBCT. **Materials and Methods:** CBCT records of 108 patients were evaluated to detect the presence, location, size, and number of lingual foramina using axial, and cross sectional images. **Results:** A total of 463 lingual foramina (representing 100% of all patients) were found. Individuals had between one and eight lingual foraminaon their jaw, with the majority of cases having four (24.1%). Regarding the size; 336 (72.7%) were ≤1 mm and 127 (27.3%) were >1 mm. Regarding the location, only 162 (35%) were LLF, while most of the lingual foramina were MLF (65%). Moreover 23 (21.3%) had lingual foramina on only one side of the mandible, and 85(78.7%) had them on both sides of the mandible. **Conclusions:** CBCT can be used to detect the presence, size, number, and location of mandibular lingual foramina. It is very crucial to recognize characters of these foramina prior to any surgical treatment to avoid operative complications.

Introduction:

The lingual surface of the mandible contain little openings called Lingual foramina, which are much of the time seen in the areas of the incisors and premolars. Lingual foramina are grouped into two sorts as per their position: the lingual foramina situated in the midline of the mandible are called median lingual foramina (MLF), and those situated between canine and premolar teeth are called lateral lingual foramina (LLF).[1]

In light of the amazing bone density of the anterior area of the mandible and the nonappearance of essential neurovascular structures, it was considered a generally protected region for implant surgery.[2,3] Nonetheless, several reports have shown that risky bleeding and haematoma development on the floor of the mouth was brought about by trauma to the blood vessels of the lingual foramen during an implant procedure.[3-8] Surgery in this region can likewise influence the parts of the mylohyoid nerve, leading to paraesthesia or hypoesthesia.[9]

Neurosensory disturbances and haemorrhage may occur once the items of the lingual foramen and canal are injured. Injury to these blood vessel branches during tooth extraction and implant placement has been detected.[10] The risk of arterial injury is higher in the incisors, canine, premolars, and first molar regions during implant surgery. This damage can cause bleeding. Once in a while, the hematoma that leads to a rise of the floor of the mouth after bleeding can lead to obstruction of the upper respiratory tract.[11]

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Previous examinations have demonstrated that lingual foramina show significant anatomical varieties in specimens of human mandibles from various geographical areas; for instance, remarkably in the lateral lingual canal (LLC)
more foramina have been seen in Greenland Eskimo and Indonesian samples, also these significant variations in appearance make these structures unique for a particular individual and may be considered as a forensic fingerprint.[12] So to stay away from neurovascular confusions on the floor of the mouth, it is fundamental to lay out the presence, course, shape, area, and capability of lingual foramina.[13]

Bidimensional imaging such as periapical radiographs can be used to locate lingual foramina but they are rarely seen in panoramic radiographs. The best method to detect these foramina is tridimensional imaging such as Computed Tomography and Cone Beam Computed Tomography which allow precise evaluation of bony structures in the maxillofacial area.[14]

Materials and methods:

This retrospective cross-sectional study was conducted on consecutive CBCT images of the mandible that were obtained from the Radiology Unit database at the Faculty of Dentistry, Mansoura University, Egypt. These scans were performed between 2017 and 2021. These CBCT scans were taken for the purpose of radiological diagnostic purpose and/or surgical treatment. Retained or impacted wisdoms and periapical lesions were the main causes for referrals.

Ethical approval was obtained from the Human Research Ethics Committee of the University of Mansoura for this study No. (M10160321). To ensure patient confidentiality, all images were de-identified. Sample size calculation was based on lingual Foramina

Table 1: Regional frequency of lingual foramina

	MLF n (%)	LLF n (%)	Bilateral n (%)	Unilateral n (%)
Male	147 (31.7%)	87 (18.8%)	42 (38.9%)	14 (13%)
Female	154 (33.3%)	75 (16.2%)	43 (39.8%)	9 (8.3%)
Total	301 (65%)	162 (35%)	85 (78.7%)	23 (21.3%)

LLF (lateral lingual foramina), MLF (median lingual foramina).

measurements between males and females at LIC retrieved from previous research (He al., 2016). Using G*power version 3.0.10 to calculate sample size based on effect size of 0.547, 2-tailed test, α error =0.05 and power 80.0% then total sample size will be 108 at least. A total of 300 CBCT scans of the mandible were collected during the study period. All scans were screened for possible inclusion in the study.

The exclusion criteria were as follows; Mandibular serious pathological lesions, impacted mandibular teeth in the area of interest, mandibular CBCT image of poor quality, missing mandibular teeth in the area of interest, previous history of fracture in the region of interest, and scan that didn't reveal the inferior border of the mandible.

One hundred ninety-two cases were excluded. The remaining 108 scans were further evaluated irrespective of the region of interest. CBCT scans are collected from the computer database Using Cranex® 3DX (SOREDEX, Finland) machine. A single 360° scan was used to gather the projection data for reconstruction. With the use of On- Demand 3D imaging software, each image was carefully scrutinized under standardized viewing circumstances.

Size, position, and numberof lingual foramina per tooth region (third molar to third molar) were determined, also the vertical distance from the superior margin of the lingual foramina to the alveolar ridge crest (L1). In addition, the vertical distance between the lower border of the mandible and inferior margin of the lingual foramina (L2).

Statistical analysis and data interpretation: SPSS v.25 statistical software was used to conduct all statistical analyses (SPSS, Chicago, IL, USA). Quantitative data were described using mean and standard deviation for normally distributed data after testing normality using Shapiro-Wilk test. The significance of the obtained results was judged at the (0.05) level. Student t-test was used to compare 2 independent groups.

Results:

In 108 CBCT scans, a total of 463 lingual foramina (representing 100% of all patients) were found.

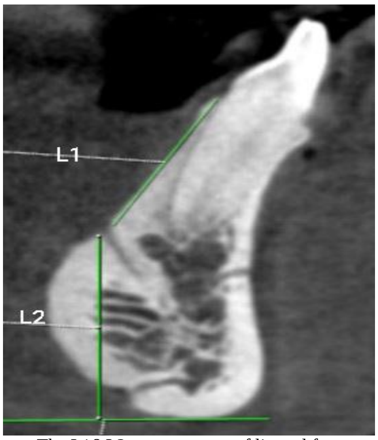

Figure: The L1&L2 measurement of lingual foramen.

Individuals had between one and eight lingul foramina in their jaw, with the higher percentage of patients lingual foramina are categorized as ≤1 mm and>1 mm in the literature to identify the risk of serious haemorrhage. 336 (72.7%) were under or equal to1 mm and 127 (27.3%) were over 1 mm.having four (24.1%) or five (23.1%). The sizes of lingual foramina are categorized as ≤1 mm and>1 mm in the literature to identify the risk of serious haemorrhage. 336 (72.7%) were under or equal to1 mm and 127 (27.3%) were over 1 mm.

Distribution of lingual foramina to different mandibular aspects : Only 162 (35%) of the total number of lingual foramina seen were LLFs. The majority of the lingual foramina (65%) were MLF. 23 (21.3%) of the 108 patients with lingual foramina in only one side of the mandible, whereas 85(78.7%) had them on both sides of the mandible.The MLF and LLF data were comparable by gender (Table 1).In CBCT scans, the mean distance from the lingual Foramina to the crest of the alveolar ridge (L) and the Mean distance from the lingual foramina to the inferior border of the mandibile (L2) was measured for both medial and lateral lingual foramina in the following Table.

Regarding the tooth apex, (72.8%) of lingual foramina were discovered below the tooth apex and (27.2%) were found above.

Discussion:

Lingual foramina have been noted in 100% of cases, which is a high frequency, these results agreed with several studies done by Sekerci et al and Scaravilli et al which found that Lingual foramina have been detected in 58.8– 99.0% of mandibles.[15-18], He et al.[8] reported that 99.5% of all patients had lingual foramina.

In the current study, 1.9 % had just one lingual foramen, 8.3 % had two foramina and 89.8 % had greater than two foramina. Each person had lingual foramina ranging from 1 to 8 in the lower jaw, and the majority of patients had four (24.1%) or five (23.1%).

Table2: Comparison of Measurements between males and females according to location

	LLF		P value	MLF		P value	total		P value
	Male mean± SD	Female mean± SD		Male mean± SD	Female mean± SD		Male mean± SD	Female mean± SD	
L1	19.58(9.21)	18.48(6.69)	0.392	20.84(8.62)	16.79(8.06)	<0.001*	20.37(8.85)	17.35(7.66)	<0.001*
L2	12.69(9.79)	10.27(7.42)	0.08	13.75(8.51)	14.74(8.23)	0.306	13.36(9.01)	13.27(8.23)	0.918

* P ≤0.05 statistically significant. L1, the vertical distance from the lingual foramen to the crest of the alveolar ridge; L2, the vertical distance between lingual foramen and the lower mandibular border; LLF, lateral lingual foramina; MLF, median lingual foramina

In a study of 500 patients done by Sekerci et al.[16] A lingual foramen was present in 85 cases (17%), 141 cases (28.2%) had two foramina, 265 cases (53%) had greater than two foramina, and nine cases (1.8%) had none. According to Liang et al.[19], 72% of patients had only one foramen, 22% had two, and only 4% had three. Furthermore, one canal was found in 71.9% of patients, two canals in 9.4%, three canals in 15.6%, and four canals in 3.1%, according to Babiuc et al.[20].
These findings imply that lingual foramina are very common in the Egyptian population. Additionally, while other research found slightly lower frequencies, our findings might be explained by variations in study design and examination techniques. It has been proposed that CBCT provides highly accurate data on the mandibular anatomy.[21,22] Another reason for the difference in frequency noted may be anatomical variations in human mandibles from different geographical regions.[19]

Previous studies used the diameter of the lingual foramina to categorize the risk of serious haemorrhage as ≤1 mm and >1 mm. Severe bleeding on the mouth floor after implant surgery may be caused by lingual foramina with enormous diameters. According to some studies such as those performed by Yildirim et al.[23] the lingual foramen's diameter and the entering artery's diameter are proportionate. A significant haematoma and a potentially fatal haemorrhage in the bone or soft tissue are likely to result from arteries that are wider than 1 mm.

In an ongoing study, 27.4% of foramina had diameters more than 1 mm, whereas 72.6% had smaller foramina. Male and female patients did not have similar outcomes, the number of foramina more than1 mm diameter was greater in men, also distances from the crest of the alveolar bone to the foramen, and the distance from the inferior border of the mandible to the foramen were greater in men. This agrees with a previous study performed by Yildirim et al.[23] The osseointegration of implants may be negatively impacted by lingual foramina with large dimensions, which can lead to postoperative sensory problems and haemorrhage that could be fatal. Due to these findings, careful implant-prosthetic treatment planning is even more essential for male patients. According to the position of lingual foramina, they were divided into two categories: either in or near the midline Median Lingual Foramin (MLF)); or laterally (Lateral Lingual Foramina (LLF)). 35% were LLF, and 65% were MLF, as we found. The majority of studies stated that the occurrence of LLC was minimal[23,24], however; the study by Tagaya et al.[25] discovered an LLC frequency of 80% utilizing CT imaging.

Based on whether lingual foramina were above or below the tooth apex, they were divided into two categories. The lingual foramina above the tooth apex are more susceptible to injury during implant surgery, periodontal surgery, and endodontic surgery due to the changes in anatomical placement. This study showed that nearly three quarters (72.8%) of lingual foramina were located below the tooth apex. The lingual foramina above the tooth apex had substantially smaller dimensions. These findings imply that even though the lingual foramina above the tooth apex were smaller, care should be taken to avoid surgical complications by paying close attention to them during implant surgery, bone-grafting procedures, and osteodistraction.

Conclusions:

CBCT can be used to detect the presence, size, shape, and position of lingual foramina. It is very essential to recognize characters of these foramina prior to any surgical process to avoid operative complications.

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