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Evaluation of the Anatomic Variations of Lingual Foramen and its Bony Canals with CBCT in South Indian Sub-population: A Radiographic Observational Study

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aim: To assess prevalence and morphometrics of lingual foramen and lingual canals using Cone Beam Computerised Tomography (CBCT).

Materials and Methods: This was a retrospective observational study, in which 144 CBCT scans were obtained from the archives of Department of Oral radiology, Vishnu dental college, Bhimavaram. Parameters such as number, location, length of the lingual canal, travel path of the lingual canals, distance from the lingual foramen to inferior border, in cases where extra foramen is present an additional criteria involving measurement of the distance between both the foramen was also evaluated. Statistical analysis was done using chi-square test and results were formulated.

Results: Lingual foramen was a common observation in all of the examined CBCT scans and 21% of scans showed two lingual foramen. The average distance from the Inferior Lingual Foramen (ILF) to Inferior Border (IB) was 3.3 ± 1.0 mm. The mean length of the Superior Lingual Canal (SLC) was 4.2 ± 1.3mm and the mean length of the ILC (Inferior lingual canal) was 4.2 ± 1.2mm. The majority of the inferior lingual foramen (76%) were inclined and only 0.1% of foramen were vertical.

Conclusion: Variations in the prevalence of the lingual foramen are observed due to variations in the ethnicity, geographic location. Detailed evaluation of these anatomic structures using CBCT help in prevention of the complications and will improve the treatment outcome.

Keywords: Mandible; lingual nerve; cone beam computed tomography.

1. INTRODUCTION

Among all the teeth present in the oral cavity, the mandibular anterior teeth are the most common teeth to be lost due to various periodontal problems. Recent trends in replacement of missing teeth with dental implants have been increasing since the past few decades. The mandibular anterior region is considered as a relatively efficient area for the placement of implants because of the quality of the bone in this region [1-3] Detailed evaluation of the anatomical structures present in this region is very important before any procedures.

The lingual foramen are small foramen that are present on the lingual surface of the mandible. The sub-lingual artery, sub-mental artery which are branches of the lingual artery exit this foramen and supply the mylohyoid muscle, peripheral muscles, lips, gingiva and mucosa in the floor of the mouth [4]. Knowledge of these lingual foramen is very important especially during procedures such as local anesthesia injections, periapical and orthognathic surgeries, Implant surgeries, treatment of mandibular fractures and removal of cysts and pathologic lesions especially in the anterior region where these foramen with their nerve bundles are located [5]. Once these foramen and the neurovascular bundles are injured, it results in haemorrhage and sensory disturbances. If the haemorrhage occurs in the mandibular anterior region, it may eventually lead to obstruction of airway that will be life threatening to the patient [6-9].

Variations exist in the prevalence, morphology, dimensions and location of these foramen according to ethnicity and geographic locations. Therefore detailed knowledge of these variations in different populations is essential in clinical dentistry to avoid possible complications and increase the treatment outcome. The current study is undertaken to determine the prevalence and morphometric variations of lingual foramen through CBCT.

2. MATERIALS AND METHODS

The present study was carried out in Vishnu dental college, Bhimavaram. This study followed a retrospective design where CBCT scans of 144 patients aging 20-60 years (divided into four groups of 10yrs each) who visited the hospital for routine dental care were analyzed.

A total of 144 CBCT scans were collected from archives of department of radiology and details of age and gender were recorded. All these CBCT scans were taken for various diagnostic and therapeutic needs of the patients. A CRANEX 3D SORDEX machine with SCANORA 5.2 software was used to obtain the image of 6X8 field of view (FOV) with exposure parameters set at 10mA, 90 KVp and 2.3s. The system was then prepared and software launched for exposure. The volumetric image was automatically downloaded

in to the ONDEMAND 3D viewer software. The CBCT scans showing full visibility of mandibular arch from molar to molar region were included in this study, CBCT scans having any artefacts, pathologies or any developmental abnormalities in the region of interest were excluded from the study.

2.1 Evaluation of the Lingual Foramen

The axial plane along with the sagittal planes were assessed to locate the lingual foramen. Any openings on the lingual cortical plate of the mandible in the symphysis region were considered as lingual foramen. A straight arch reference at the point of opening is placed in the axial view using the same reference point, the lingual foramen were observed in the sagittal plane.

In the sagittal plane, the lingual foramen were classified based on the location in relation to the genial tubercles as the foramen located above the genial tubercles-Superior lingual foramen-SLF, the foramen located below the genial tubercles as Inferior lingual foramen-ILF. In the same plane, a long axis was drawn at the widest portion of the ridge. The travel path of the lingual canal was categorized as parallel to the long axis [Vertical] (Fig. 3a), perpendicular to the long axis [Horizontal] (Fig. 3b) and inclined upward/ downward [Inclined] (Fig. 3c).

Considering the same reference point in the coronal plane, the lingual foramen were observed as small dots. The section showing the maximum diameter was considered for evaluating the morphometrics of the lingual foramen. Measurements of the lingual foramen such as the distance from the foramen [SLF and ILF] to the inferior border of the mandible (Fig. 1), distance from the SLF to ILF were analyzed in the coronal view and other parameters such as length of the lingual canals (Fig. 2a) and travel paths of the lingual canals were assessed in the sagittal plane. For canals that are curved, a tape line measurement was done by marking points throughout the length of the canal (Fig. 2b).

2.2 Parameters Measured

1. The location of the lingual foramen in relation to the genial tubercules.
2. Number of lingual foramen
3. Distance from the lingual foramen to the inferior border of the mandible
4. Length of the lingual canals
5. Travel directions of the lingual canals.

All these parameters were compared with age and gender of the patient and were tabulated.

3. RESULTS

3.1 Position and No of Lingual Foramen and Lingual Canals

Of all the examined CBCT scans, the presence of lingual foramen was a common finding. A total of 175 lingual foramen were observed in 144scans. 78% (113) of the sample had a single lingual foramen and 21% were observed to have double lingual foramen.

The cross-sectional images of the CBCT scans were examined to evaluate the position of the lingual foramen. 100 of 144 scans (69.4%) have lingual foramen in the superior position, 13 of 144 scans have inferiorly placed lingual foramen (9%) and 31 of 144 (21.6%) scans have both SLF and ILF.(Graph 1)

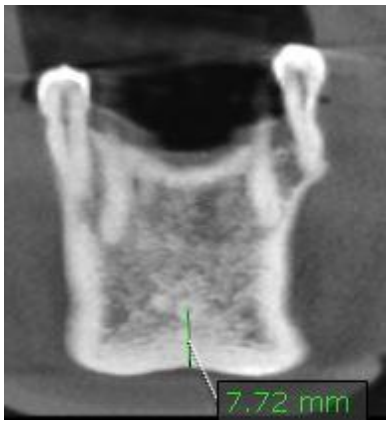


Fig. 1. Distance from accessory lingual foramen to inferior border of mandible

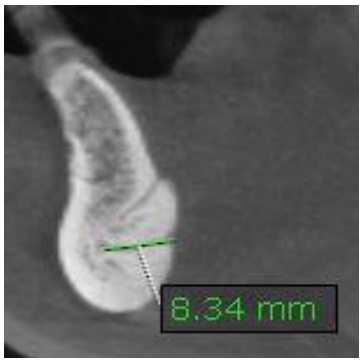


Fig. 2a. Length of the lingual canals

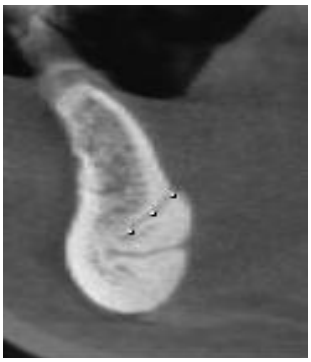


Fig. 2b. Length of lingual canal in case of curved canal

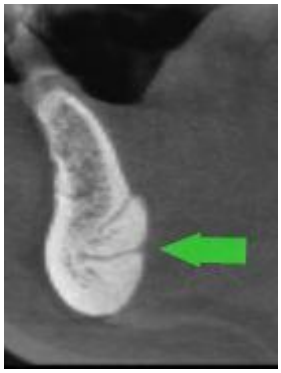


Fig. 3a. Horizontal path

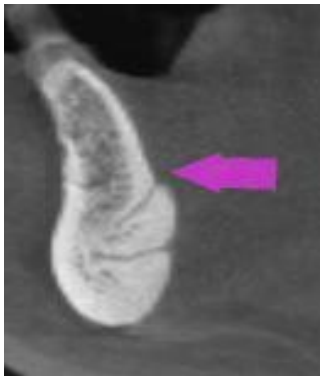


Fig. 3b. Vertical path

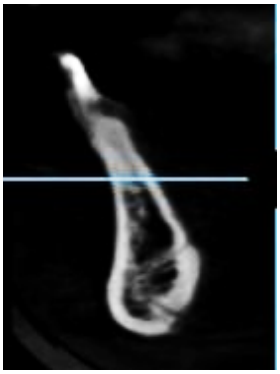


Fig. 3c. Inclined path

Fig. 3. Travel path of the lingual canals

3.2 Distance from Lingual Foramen to Inferior Border of Mandible

The mean distance between the lingual foramen and a stable osseous land mark- the inferior border of the mandible was measured and summarized in Table 1.The inferior lingual foramen was located very close to the inferior border of the mandible. An additional measurement was observed in cases with two foramen (distance from SLF TO ILF) where the superior lingual foramen is located at a distance of approximately 7.2±2.1mm from the ILF which is relatively very close to the root apex of the mandibular central incisor.

3.3 Length of the Lingual Canals

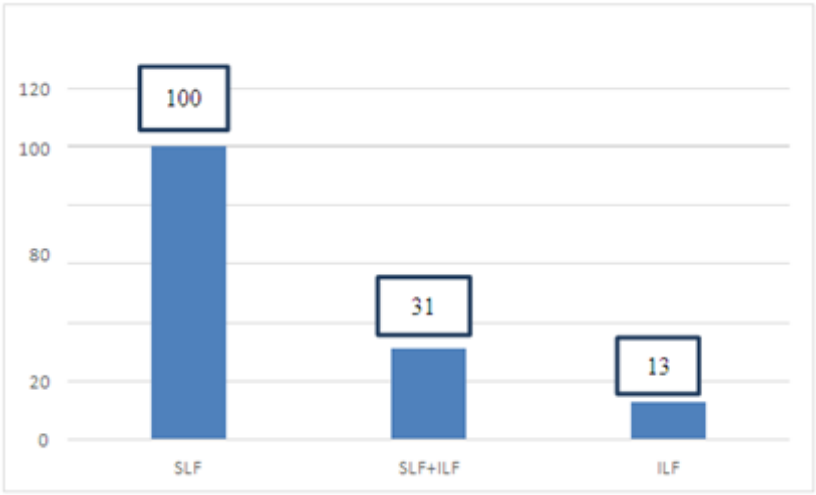
The distance between the openings of the canal on the lingual cortical plate to the end point of the canal was measured with the linear measurement tool in the sagittal plane. For canals that are curved, a tape line measurement was done by marking points throughout the length of the canal. The lengths of the SLC and ILC were summarized in Table 2 which shows the SLC and ILC are approximately of the same length.

3.4 Travel path of Lingual Canals

The travel path of both superior and inferior lingual canals were evaluated separately. Majority of the superior and inferior lingual canals were inclined with the vertical path being the least travelled among both the canals (Table 3).

3.5 Age and Gender Variations of the Various Parameters

The total sample was divided into four groups based on their age, group 1 =20-30yrs, group 2=31-40yrs, group 3 =41-50yrs, group 4 =51-60yrs. The highest number of individuals belonged to group 4(55) while group 3 had 24 individual and group 2 had 44 individuals. Individuals belonging to group 1 constituted the least percentage in the sample (21). The total



Graph 1. Position of the lingual foramen

Table 1. Distance from lingual foramen to inferior border of mandible

Lingual Foramen	Diameter (Mean±SD)
SLF TO IB	9.7mm±2.5mm
ILF TO IB	3.3mm±1.0mm
SLF TO ILF	7.2mm±2.1mm

Table 2. Length of lingual canals

Lingual foramen	Maximum	Minimum	Mean±SD
SLC	7.2 mm	1.2 mm	4.2±1.3 mm
ILC	6.5 mm	2 mm	4.2±1.0 mm

Table 3. Travel path of lingual canals

Foramen	Inclined	%	Horizontal	%	Vertical	%	Total
SLF	91	63.4%	26	19%	14	10%	131
ILF	10	76%	2	15%	1	0.1%	13
Total						144	

sample was also divided based on the gender into males and females. The total sample consists of 69(47.9%) females and 75(52%) males.

Compared to females, males showed a relatively longest distance from both the SLF and ILF to the inferior border of the mandible. Also a longest distance between the SLF and ILF was measured in males compared to females. With advancing age, a decrease in the distance from both the superior and inferior lingual foramen was observed. Most of the SLF and ILF in both the genders showed an inclined path (males-70.8%, females-68.2%) with the vertical path being the least travel path of the lingual foramen.

4. DISCUSSION

An increase in the use of dental implants have been observed in the recent years especially in the mandibular anterior region. Lingual foramen are relatively common anatomic structures in the anterior mandible, failure of detection of these foramen during various surgical procedures results in complications and failure of the treatment [1,7,10]. Variations in the prevalence rates has been observed due to difference in the ethnicity, geographic location and methodology opted for the study. The present study was done to assess the prevalence and morphometrics of lingual foramen using 144 CBCT scans.

The lingual foramen that were present in the midline were divided based on their location [11,12] in to

a) Foramen present above the genial tubercles –Superior lingual foramen (SLF).
b) Foramen present below the genial tubercles-Inferior lingual foramen (ILF).

In this study, all the examined CBCT scans showed at least one lingual foramen. A similar kind of results were also observed in a study done by Demirlap KO et al. [13] where lingual foramen were found to be present in 96.6% of the examined CBCT scans of individuals in Turkish population. Based on the classification system adapted, in the present study 69.4% of the foramen were found to be SLF and 9% of the foramen were ILF. These prevalence rates were found to be less compared to the study done in Iranian population by Shelki M et al. [14] where the superior and inferior lingual foramen occurred with a frequency of 99% and 74.5% respectively. Similar results were also observed in study done by Alqutaibi AY et al in Saudi population [15], Trost M et al. [16] in central European population. The results of the preset study were contrary to the study done in Karnataka population by Kumar AG et al. [17] where majority of the foramen were found to be located below the level of the genial tubercules.

The variation in the prevalence rates of the accessory foramen in this study may be due to variations in the ethnicity and geographic location of the individuals. Various methods employed in the study, the sample size, radiographic technique used might have also influenced the prevalence rates of the study. This variations in the prevalence rates of the lingual foramen according to different geographic locations necessitates a thorough preoperative evaluation of the foramen in various regions to prevent surgical complications and ensure a better treatment outcome.

As the alveolar crest constantly undergoes various resorptive changes with time and the morphology of the ridge varies from individual to individual, the inferior border of the mandible being a stable anatomical landmark that is unaffected by these changes, the inferior border of the mandible was chosen for measurements in this study. The mean distance from SLF to inferior border of the mandible was 9.7±2.5mm**,** mean distance from ILF to inferior border of the mandible was 9.2±2.8mm and the mean distance from SLF to ILF was 7.2±2.1mm. These values were in accordance to the study done by Shelki M et al. [14] with a distance of 10.8mm from the inferior border of the mandible. A Slightly higher values were observed in the study done by Kawai T et al. [18] with a mean distance of 11.4mm from the SLF to inferior border of the mandible and a distance of 4.4mm from ILF to the inferior border of the mandible indicating that the SLF is present at a much higher level above the inferior border and at a level that is close to the apex of the roots of the mandibular central incisors and precautions must be taken while dealing with any procedures involving the periapical regions of these teeth. The morphometrics of the accessory lingual foramen obtained in this study were less compared to the study done in Lebanese population by Aoun G et al. [12] where a mean distance of 14.00±2.32mm was recorded from the SLF to the inferior border of the mandible.

In this study, the length of both the SLC and ILC were measured. The mean length of the SLC measured in this study was 4.2±1.3mm.These values were lower compared to the study done by Aoun G et al. [12] in Lebanon population, where the mean length of the SLC was 5.81±1.6mm. The mean length of the ILC measured was 4.2 ± 1.0mm.These results were accordance to Aoun G et al [12] with a mean length of the ILC being 4.25±1.2mm. These variations in the results may be due to variations in the ethnicity and geographic location of the individuals in the study and methodology used for the study.

Majority of lingual canals observed in this study had an inclined path with an inclination that is directed upwards towards the root apices of the teeth and only few canals were observed to have a vertical path, indicating a need for utmost care to track the path of the foramen so as to prevent any perforation of the lingual nerve that can result in complications that may be life threatening to the patient. Similar results were also observed in a study done by He X et al. [19] in Chinese population.

Potential limitations of the present study is the smaller sample size and inclusion of individuals attending a dental institute. A larger sample size with wider population range to understand the prevalence of the foramen among various ethnic groups may serve as basis for future studies.

5. CONCLUSION

Mandibular anterior region is relatively the most common site for implant placement Inspite of this, it remains commonly neglected region as many surgical procedures are being performed without proper evaluation of the important anatomical structures in that region. Most of the clinicians due to lack of failure of the detection of these lingual foramen perforate them and and land up in failure of treatment performed. Detailed evaluation of these anatomic structures using CBCT help in prevention of the complications and will improve the treatment outcome.

CONSENT

As per international standard or university standard, patients' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

The study was carried out in Vishnu dental college, Bhimavaram after obtaining approval from ethical committee.[IRB NO: IECVD C/2021/PG01/OMR/IVT/26].

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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