Original Research Article

Evaluation of mandibular lingual canal in North Indian population by cone beam computed tomography

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A R T I C L E   I N F O

A B S T R A C T

Background: A numerous unnamed accessory canals and foramina have been reported in maxilla and mandible, especially on the lingual aspect, at the midline, lateral to the lingual and mental foramina as well as in the canine–premolar region of the mandible. Given all the potential complications that could arise from an undetected accessory canal, pre-operative radiographs are the standard diagnostic means to rule out such variations. Out of many radiographic techniques, cone beam computed tomography (CBCT) is a suitable diagnostic method for accessory canals of the jaw due to good image quality, excellent geometric accuracy and low radiation exposure to patient.

Aim: The purpose of this study is to evaluate the frequency and distribution of median lingual canal (MLC) in North Indian population by the use of CBCT.

Materials and Methods: A retrospective analysis of 100 CBCT scans of mandible showing anterior region (51 males and 49 females) of patients from North India; ages ranging from 20- 60 years who visited a diagnostic centre were randomly selected for this study. The CBCT scan evaluation was carried with Carestream 3D software. The frequency and distribution of median lingual canal in anterior region of mandible were evaluated. Two oral and maxillofacial radiologists examined all images to analyze the location median lingual canal with respect to gender and age.
Statistical analysis was performed using SPSS software to determine the frequency and distribution of median lingual canal.

Results: About 100 patients (male = 51 and female = 49) shows the presence of median lingual canal with prevalence rate of 100%.Only one patient shows three canals. MLC was observed in all 100 cases with prevalence rate of 100%. The study shows the maximum prevalence of two MLC i.e. 60.0% among all. The maximum number of one MLC was present in female cases and maximum number of two MLC was present in male cases. 1MLC was maximum in the age group of 51–60 years, while the 2 MLC and 3 MLC canal was maximum in the age group of 41–50 years of total 100 scans respectively. Statistically, no significant differences were observed in the presence of MLC between gender and among various age groups.

Conclusion: The prevalence of MLC near to 100% mandates a thorough radiographic analysis prior to any surgical procedure especially for implant placement in the anterior region of the mandible. A vigilant examination is required using CBCT to avoid post-operative complications.

1. Introduction

Preoperative assessment of bone density, volume, alveolar bone shape are a critically a important parameters for success of mandibular bone surgeries and especially implant placements. Usually Panoramic and periapical radiographs have been used to evaluate implant sites.[1] Limitations of these radiographic modalities are magnification (about 10% to 30%), distortion and no information on third dimension of bone volume.[2] The introduction of cone beam computed tomography (CBCT) revolutionized our ability to virtually dissect maxillofacial structures. A finely detailed visualization of the osseous architecture without distortion, without burn out and without data loss can be done. Further a greater contrast and the ability to create tomographic slices down to .08 mm gives us a true volumetric representation of the alveolar arch play a ideal role for surgical site evaluation for any surgery.[3]

A long past years a region located anterior of mental foramen i.e the intraforaminal region of the mandibular arch has been considered as safe zone. This term has been used because of absence of the neurovascular deficits in important anatomical structures of mandibular anterior region like lip and chin sites after surgical manipulation as compared with the region posterior to the mental foramen respectively.[4,5]

Numerous unnamed accessory foramina and canals have been described in maxilla and mandible, especially on the lingual aspect of the mandible, midline of the mandible, lateral to the

lingual foramina and in the canine–premolar region.[6] The lingual mandibular foramina are accessory foramina on the anterior lingual surface of the mandible, where the median lingual canal (MLC) pierces the lingual cortex at the region of the central incisors.[7,8] The median lingual canal can be detected above (supra-spinosum), below (infra-spinosum), or in the genial tubercle (intra-spinosum).[9] Besides, tremendous variations have been noted in the size and morphology of various foramen and neurovascular canals in these area So a detailed knowledge of the distribution and occurrence of these accessory canals is clinically important for good prognosis of surgery like implant surgery.

Nowadays the demand for replacement of missing teeth by osseointegrated dental implants and grafting procedures in the rehabilitation of edentulous areas of the jaws are increasing at a alarming rate so it is important that pre-operative evaluation of anatomical variations, with respect to both the distribution and morphology of these canals should be done to avoid any hemorrhagic episode following implant surgery. So we performed a radiological study to evaluate the frequency and distribution of (MLC) in North Indian population by the use of CBCT.

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2. Materials and Methods

A study was conducted on 100 CBCT scans of mandible showing anterior region including 51 males and 49 females. The CBCT data was obtained by means of CS 3D imaging system from archievial records at a diagnostic centre Manglam Diagnostic Center Hissar, Haryana. The patient ages ranging from 20- 60 years who visited a diagnostic centre were randomly selected for this study. All the CBCT examinations were performed due to clinical indications prescribed and not for the purpose of this study. The present study was carried out after obtaining ethical clearance number IECJNMC/623 from the institutional ethical committee of Aligarh Muslim University, Aligarh, Uttar Pradesh.

The inclusion criteria include absence of any pathological conditions or deformities in the jaws. The exclusion criteria were Scans with poor image quality, scan showing severe ridge resorption, presence of pathologic bone disease or unerupted teeth in related region. The CBCT scan evaluation was carried with Carestream 3D software. Scans were carefully examined for the presence of any variation in terms of number of MLC in anterior region of the mandible. The slices showing cross-sectional view was analyzed for 1MLC (Figure 1), 2 MLC (Figure 2) and 3 MLC (Figure 3) in relation to the gender and age respectively.

2.1. Sample size estimation

The sample size estimation is done by using formula

$$n = Z^2 \frac{p(1-p)}{d^2}$$

n= Sample size
Z= Statistic corresponding to level of confidence
p= Expected prevalence a
d= precision
Considering the Z value as 1.96 and precision as 0.1 the sample size derived was 95.

2.2. Statistical methods

Descriptive statistics of the resulting data was performed and the percentages of the observed canals were calculated manually. Association of gender with presence of MLC was carried out by using chi-square test. P value <0.05 was considered as statistically significant. The data obtained were tabulated and subjected to statistical analysis. For statistical analysis, SPPS Version 16 was used (SPSS Inc released 2007. SPSS for Windows, Version 16.0, Chicago, USA).

3. Results

The results shows the prevalence of the MLC in Total 100 studies cases in relation to the gender and age. MLC was observed in all 100 cases with prevalence rate of 100%.
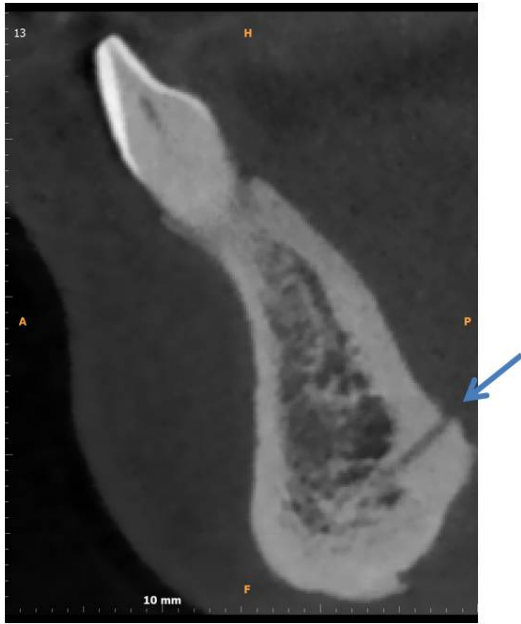
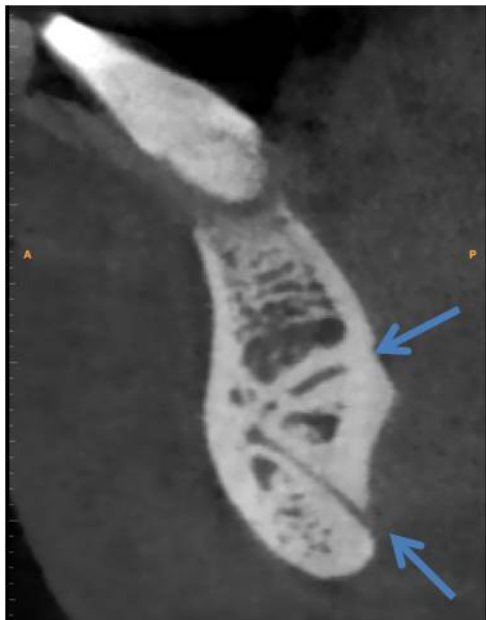**Fig. 1:** Cross-sectional image of CBCT showing 1 MLC

Fig. 3: Cross-sectional image of CBCT showing 3 MLC

Fig. 2: Cross-sectional image of CBCT showing 2 MLC

25 cases respectively. No three MLC was seen in females cases. So the maximum number of one MLC was present in female cases and maximum number of Two MLC was present in male cases. While only one male case of 3MLC was reported in all scans. (Table 1)

The presence of 1, 2, 3 MLC among study cases was also studied. According to age groups, it was observed that 1MLC was maximum in the age group of 51–60 years, while the 2 MLC and 3 MLC canal was maximum in the age group of 41–50 years of total 100 scans respectively (Table 2).

Table 1: Variation in number of MLC according to gender

No of MLC	Distribution in Male (n=51)	Distribution in Female (n=49)	Total (n=100)
1 canal	15(29.41%)	24(48.97%)	39(39.0%)
2 canal	35 (68.62%)	25(51.02%)	60(60.0%)
3 canal	1 (0.01%)	0(0.0%)	1(1.0%)

According to the gender, the study included 51 males and 49 females. The percentage distribution of numbers of canal observed for one MLC is 39.0%, for two MLC is 60.0% and for three MLC is 1.0% only. The study shows the maximum prevalence of two MLC i.e 60.0% among all. Among males, it was observed that one MLC were present in 15 cases, two MLC were present in 25 cases and three MLC were present in only 1 case respectively. While in females one MLC were present in 24 cases, two MLC were present in

Table 2: Variation in number of MLC according to age group

Age (years)	1MLC	2MLC	3MLC	Total(n)
20-30	2	4	0	6
31-40	6	15	0	21
41-50	14	23	1	38
51-60	17	18	0	35
Total	39	60	1	100

4. Discussion

Detailed Knowledge of the anatomical landmarks like canals and the foramens particularly in the anterior region of the mandible is essential important particularly in the field of implant surgery. Although the anterior mandibular region especially between the mental foramens is considered to be safe zone with low risk but literature documents that surgeries in this region may be accompanied by life threatening conditions such as hemorrhage, which may lead to airway obstruction and suffocation ending in death.[9,10] Hence there is need of meticulous preoperative radiographic evaluation of implant site in terms of available bone volume, density, anatomical variation and adjacent vital landmarks present in that specific region to prevent complications. Due to advanced lifestyles, implant placement has been regarded as a better option for the prosthetic rehabilitation, especially in the anterior region. Cone beam computed tomography provides a better visualization of the canals, foramens, and the structures as compare to 2 dimensional radiographs as there is no superimposition of the anatomical structures, especially in the anterior region.[11] Hence, a study was done with regard to the number of MLC in mandibular anterior region and a comparison was done between both genders and among different age groups.

In this study, CBCT scans were used due to low radiation exposure in comparison with conventional computed tomography and highly perceptive in determining three-dimensional accuracy of vital anatomical structures.[10,12,13] The present study showed near to 100% of MLCs in the sample size basically presenting the prevalence of MLC, the fact which is supported by the study done by Wang et al and Zhang et al. who showed a percentage of 97.0%, and 99.3% respectively using CBCT scans respectively.[10,14] Donal Mcdonnell et al in canada conducted a survey of 314 dried mandibles to evaluate the incidence of occurrence and contents of lingual foramen. It was found that the foramen was present in 311 specimens (99.04%).[15] These results suggests that MLC IS a common finding at the midline of mandible.

Regarding the number of MLC in each examined case, the present study shows the maximum prevalence of two MLC (60.0%) followed by 1 MLC (39%) and least 3MLC (1%) respectively. The current findings were consistent with Rosano et al. who recorded that the majority of cases with MLC in a sample of 60 dry mandibles were two canals, followed by the single canals, three canals, and cases with no canals.[8]

A study done by Juodzbalys G showed that 103 patients (90.35%) had at least one lingual vascular canal and 52 (45.61%) had multiple (two or three) canals.[16] These results were similar to our study. As compared to our study, a marked difference was seen in gender distribution. Single vascular canal was found in 8% of males and 7% of females and double lingual vascular canal was found in 5% of males

and 10% of females, which was much lower as compared to our study.

Similarly, in another study by Mathew et al. showed the presence of only single vascular channel emerging through the lingual mandible in most population (84%) and only a few cases showed the presence of multiple channels (16%).[17] In all the studies, there was no significant difference noticed.

The study subjects were of the age group 20-60 and were included after applying the exclusion criteria (male subjects 51; female subjects 49). The maximum number of one MLC was present in female cases and maximum number of Two MLC was present in male cases. While only one male case of 3MLC was reported in all scans.

The statistical analysis showed no association of accessory canals with gender which remains consistent with the previous studies. However, further studies are recommended in this domain for identifying and tracing all the anatomic complexities and diversities of the jaws precisely.

In our study, we found that the presence of single, double, and triple lingual vascular canals among study participants in different ages and genders. It was observed that single MLC was maximum in the age group of 51–60 years, double MLC and triple MLC was maximum in the age group of 41–50 years. Statistically, no significant differences were observed in the presence of MLC among various age groups.

The numerous accessory foramen and canals make a complex anatomy especially in anterior jaw bones. The anterior jaw bones are often considered as safe sites for surgical procedures, but chances of hemorrhages and other neurosensory complications are common during surgical interventions in this region. Therefore, a careful documentation of the anatomic variations in the neurovascularization of the jaws is mandatory.[18] Hence preoperative radiographic examination is crucial for the identification of these complex anatomical structures. The results of the present study clearly prove that accessory canals in the jaws are a common occurrence and thereby the it shows the importance of preoperative radiographic evaluation.

With age related changes and osteoporotic factors, ossification surrounding the canal can decrease, thereby reducing the visibility of canal IN CBCT scans.[19] In^{a}ddition, visibility of such structures is heavily dependent on image quality (resolution, contrast, etc.). As CBCT provide a similar geometry in all three dimensions as it make use of small, isotropic voxels (voxel resolution about 0.076mm) which provides an outstanding high contrast sub millimetre resolution. The Feldkamp algorithm provide a high quality image in the central plane of CBCT examination and hence is considered as one of the standard algorithm for image reconstruction.[20] Literature supports that, cone beam computed tomography have proven to be

indispensible in tracing the morphology and distribution of the accessory canals in the jaws.

The difference between studies in the literature and this study may be due to different scanners, different imaging protocols, and observer detection variability. A limiting factor in the present study was the small sample size, and we suggest that further studies to be performed on a larger group of subjects of different age and ethnicity

5. Conclusion

The examined scan showed considerable variability in the MLC anatomy and location which may increase the risk of life-threatening situations. The prevalence of MLC near to 100% mandates a thorough radiographic analysis prior to any surgical procedure especially for implant placement in the anterior region of the mandible which helps in more accurate planning and contributes to successful treatment. Since conventional radiographs may fail in the identification of variations, CBCT is of fundamental importance in this process. The results of this report demonstrate that special consideration should be given to CBCT before surgeries in anterior region of mandible as to avoid post-operative complications.

6. Source of Funding

7. Conflict of Interest

The authors declare no conflict of interest.

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