Tzu Chi Medical Journal 2020; 32(2): 205–210

Original Article

Assessment of prevalence and position of mandibular incisive canal: A cone beam computed tomography study

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Submission : 28-Mar-2019
Revision : 15-May-2019
Acceptance : 29-May-2019
Web Publication : 19-Sep-2019

Abstract

Objectives: To avoid anatomical and functional damage to mandibular interforaminal region during surgeries, it is necessary to detect the existence of mandibular incisive canal (MIC) and its proximity to adjacent structures. This study was aimed to evaluate the prevalence of MIC and its proximity to adjacent structures among Indian population. **Materials and Methods:** The images of 80 subjects with the age range of 20–60 years who had undergone cone beam computed tomography examination of the mandible were retrieved from the archival records. There was equal distribution of males and females. **Results:** The prevalence of MIC in the current study sample was found to be 43.89% with a slightly higher prevalence on left side as compared to right side, and higher prevalence among females as compared to males. Among different age groups, there was an increased incidence in the age group of >50 years. The distance of MIC from labial and lingual cortical plates and lower border of mandible were 4.338 ± 1.478 mm, 4.34 ± 1.53 mm and 9.417 ± 1.832 mm respectively. **Conclusions:** To conclude, the prevalence of MIC among Indian population was lower as compared to the prevalence among other populations. There were variations in prevalence in terms of age, gender and laterality, which could be used as a reference for further studies conducted on larger sample size. Mapping the incisive nerve canal will enable oral radiologists, to plan safely and negotiate the interforaminal region.

Keywords: *Canal, Cone beam computed tomography, Indian ethnicity, Interforaminal region, Mandibular incisive canal*

Introduction

The anterior region of the mandible is supplied by a plexus of a nerves of which the mandibular incisor nerve is postulated to be one of the terminal branches. The mandibular incisive canal (MIC) is a bilateral canal that houses the mandibular incisive nerve which provides innervation to the mandibular incisors and canines [1]. The canal extends anteriorly and inferiorly and is an extension of the inferior alveolar canal [2].

The mandibular anterior region has usually been considered "a safe region" with minimal morbidity. But this region is prone to several risks that can cause anatomical and functional damage [3]. During procedures such as genioplasty, implant insertion and bone harvesting, the presence of MIC becomes pertinent information [4,5]. Any oversight in detecting the presence of MIC during presurgical planning can cause lack of Osseo integration of implants, pulp sensitivity changes, sensory disturbances postoperatively, oedema and hematoma [1].

Some authors have put forth the possibility that the mandibular incisive nerve does not lie within a bony canal, and runs through the intramedullary spaces, thereby escaping detection by conventional radiography. Two-dimensional (2D) imaging modalities fail to show the buccolingual aspect of the mandible and the cross sectional slices, important for presurgical evaluation. The various disadvantages associated with panoramic radiography such as superimposition of the anatomical structures, patient positioning, magnification, distortion make it difficult to obtain reliable measurements [1,6].

MIC exists mesial to the mental foramen, and this finding has been supported by advanced imaging modalities. Computed tomography (CT) has proved to be an efficient imaging modality to detect MIC as it provides sufficient spatial resolution. But increased radiation exposure (0.96–2.00 mSv), high cost, longer acquisition time are some of the drawbacks of CT imaging. To overcome

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Access this article online

Quick Response Code:

Website: www.tcmjmed.com

DOI: 10.4103/tcmj.tcmj_76_19

How to cite this article: Ayesha RT, Pachipulusu B, Govindaraju P. Assessment of prevalence and position of mandibular incisive canal: A cone beam computed tomography study. Tzu Chi Med J 2020;32(2):205-10.

these drawbacks, cone beam CT (CBCT) has emerged as a preferred 3D imaging modality over tomography in maxillofacial region. CBCT systems provide high resolution images with fine voxel sizes, excellent anatomic resolution, multi planar views and 3D reconstruction in addition to reformatted images. Due to the reproducibility and high degree of reliability of these images, several studies have regarded it as the best method for obtaining precise preoperative incisive canal measurements [2,7].

With the above background, the present study is designed to quantify the prevalence of the MIC, its path and position in relation to the cortical bone and the lower border of mandible by CBCT.

Materials and methods

The study titled was carried out in the Department of Oral Medicine and Radiology in a Dental College and Hospital. The measurements were performed retrospectively on CBCT images obtained randomly from the archives. The study was conducted in accordance with the Declaration of Helsinki and was approved by the local ethics committee of the institute (RRDC and H/PG-151/2016-2017). Informed written consent was waived because the study was a retrospective data analysis.

The images of 80 subjects in the age range of 18–80 years (40 females and 40 males) who had undergone CBCT examination of anterior mandibular region were retrieved randomly from the archives. The inclusion criteria were CBCT images of the interforaminal region of the mandible in cross sectional plane in the age group of 20-60 years. The exclusion criteria were CBCT images of patients with congenital disorders, pathology and trauma to the mandible and images which appear distorted or blurred. The images were also further classified into different age groups i.e., Group I: 20–30 years, Group II: 31–40 years, Group III: 40–50 years and Group IV: >50 years. All the measurements were done, after categorizing the subjects in accordance with the selection criteria.

Imaging procedures

CBCT imaging was performed using a SCANORA® 3D unit. The maximum output of the scanner was 60–90 kVp and 12.5 mA, with field of view of 75 × 145. For imaging, the subject was directed to hold teeth in centric occlusion, and seated in an upright position. The time taken for each scan was 15 s.

Measurements

All images were assessed and measured using ONDEMAND 3D and SCANORA® 3D CBCT (Soredex, Tuusula, Finland) of the CBCT machine. As per Pereira-Maciel *et al*. [1] the MIC initiates its path from the point of closure of mental foramen up to the point where it effaces from the image. Two reference points used for making the measurements were the incisive canal and lower border of mandible. The cross sectional views perpendicular to the lower border of the mandible were selected.

The images were analysed for existence of MIC on both right and left according to the criteria by Pereira-Maciel *et al*. [1]. After confirmed presence of the MIC, the following measurements were made [Figures 1 and 2]:

a. The distance from the MIC to the labial bony surface
b. The distance from MIC to the lingual bony surface
c. The distance from MIC to lower border of mandible.

Statistical analysis

Descriptive and inferential statistical analysis were carried out in this study. Results on categorical variables (such as age, gender, sides) are presented as numbers and percentages. Results on continuous measurements (distance from labial, lingual and inferior surface of mandible) are presented as mean and standard deviation. The level of significance P value was set at $P < 0.05$.

As the data is normally distributed, the following parametric tests were applied:

1. Chi-square test was used to compare the prevalence of MIC among study subjects based on their age and gender
2. Student's paired t-test was used to compare the mean distance of MIC (in mm) to labial, lingual surfaces and lower border of mandible between the right and left sides and also between different surfaces
3. Independent Student's t-test was used to compare the mean distance (in mm) of MIC with respect to different anatomical surfaces between males and females
4. One-way ANOVA test was used to compare the mean distance (in mm) of MIC with respect to different surfaces.

The data was analysed using Statistical Package for Social Sciences (SPSS) for Windows version 22.0 released 2013. IBM Corp., Armonk, NY, USA.

Results

Prevalence of mandibular incisive canal

The prevalence of MIC among study subjects was found to be present in 35 patients (43.8%) of the total subjects and absent in 45 (56.3%) patients. The data showed a decreased prevalence, <50% in the overall subjects studied [Figure 3].

When compared on basis of laterality there was increased prevalence on left side as compared to the right side [Table 1].

The gender wise comparison of the MIC among study subjects showed that the MIC was present in 16 subjects (40%) males and amongst females it was present in 19 subjects (47.5%). The data inferred that an increased prevalence

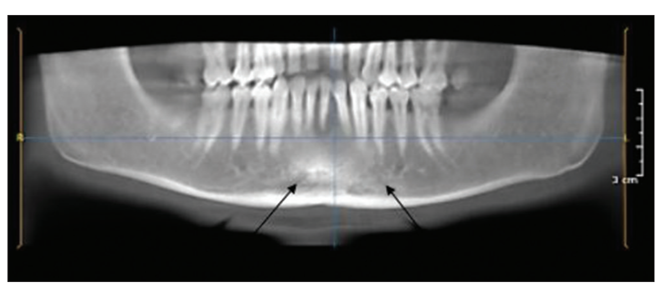

Figure 1: Mandibular incisive canal (cone beam computed tomography – reformatted panoramic view)

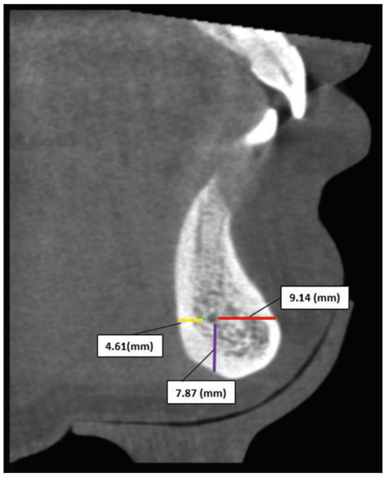

Figure 2: Measurement of distances from mandibular incisive canal to the adjacent surfaces yellow line: Lingual cortical plate; red line: Labial cortical plate; purple line: Lower border of mandible

of MIC was present among females as compared to males [Table 2].

The age wise comparison of the prevalence of MIC among study subjects showed that among different age groups, the incidence was highest in Group IV (66.7%) [Table 3].

Proximity of mandibular incisive canal to adjacent structures

The distance of MIC was measured from labial and lingual cortical plates and the lower border of mandible. The mean values for each were 4.338 ± 1.478 mm, 4.34 ± 1.53 mm and 9.417 ± 1.832 mm respectively reflecting an almost equal distance on the lingual and labial aspect as compared to the lingual border of mandible [Table 4].

The mean distance of MIC to labial, lingual surfaces and lower border of mandible on the right and left sides indicated increased values on left side as compared to right side, except with respect to distance up to lower border of mandible for which the value on right side was more.

The gender wise comparison of mean distance in of MIC with respect to different anatomical surfaces inferred a general increase in the values in males compared to females except in terms of distance from lingual cortical plate. These values were statistically significant ($P \leq 0.05$) [Table 5].

The age wise comparison of mean distance of MIC to different surfaces was also performed which showed the Group I had the maximum mean value with an average distance of 4.754 ± 1.664 mm to the labial surface. The mean distance to the lingual surface was maximum in Group III i.e., 5.523 ± 0.565 mm and up to the lower border of mandible the distance was highest in Group IV i.e., 10.333 ± 1.600 m m [Figure 4].

The data analysing the mean distance (in mm) of MIC based on its proximity to different surface data inferred that the MIC had a slightly lingual course as compared to labial, and was positioned at an average of 9.417 ± 1.832 mm superior to lower border of mandible which was statistically significant [Table 6].

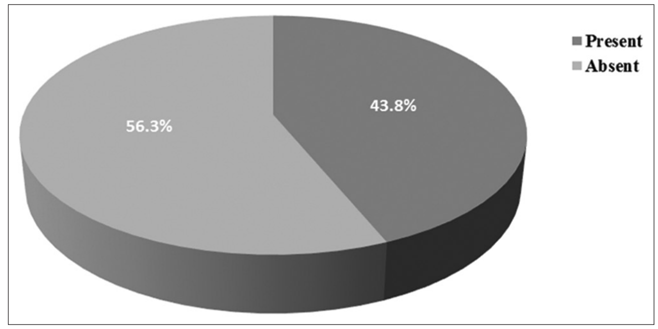

Figure 3: Prevalence of mandibular incisive canal in overall study sample

Table 1: Prevalence of mandibular incisive canal on right and left side

MIC	Category	*n* (%)
Right	Present	29 (36.3)
	Absent	51 (63.7)
Left	Present	32 (40.0)
	Absent	48 (60.0)

MIC: Mandibular incisive canal

Table 2: Prevalence of mandibular incisive canal among different genders using Chi-square test

MIC	Males, *n* (%)	Females, *n* (%)	χ^2	*P*
Present	16 (40.0)	19 (47.5)	0.457	0.50
Absent	24 (60.0)	21 (52.5)		

MIC: Mandibular incisive canal

Table 3: Prevalence of mandibular incisive canal among different age groups using Chi-square test

MIC	Years, *n* (%)				χ^2	*P*
	20-30	31-40	41--50	>50		
Present	13 (38.2)	11 (44.0)	5 (41.7)	6 (66.7)	2.363	0.50
Absent	21 (61.8)	14 (56.0)	7 (58.3)	3 (33.3)		

MIC: Mandibular incisive canal

Table 4: Mean dimensions of mandibular incisive canal for various surfaces

Surfaces	Mean±SD	Minimum	Maximum
Labial	4.338±1.478	1.93	8.03
Lingual	4.340±1.530	1.3	7.74
LBM	9.417±1.832	6.03	14.18

SD: Standard deviation, LBM: Lingual border of mandible

Intra and inter examiner variability

There was no significant differences in the intra examiner as well as inter examiner mean values of parameters and there was excellent correlation between intra and inter examiner values.

Discussion

The MIC has been studied by various authors, but its existence is a point of widespread conjecture even today, especially because many consider it to be an anatomical variation in this mandibular region. This is due to it eluding detection by conventional radiographic modalities [4]. The MIC could

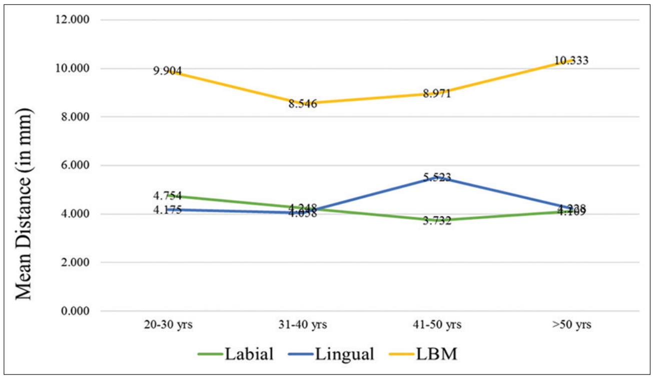

Figure 4: Age wise comparison of mean distance (in mm) of mandibular incisive canal with respect to different surfaces

Table 5: Gender-wise comparison of mandibular incisive canal to different surfaces

Surfaces	Sex	*n*	Mean±SD	Mean difference	*t*	*P*
Labial	Males	16	5.018±1.490	1.252	2.723	0.01*
	Females	19	3.766±1.232			
Lingual	Males	16	3.831±1.596	−0.937	−1.870	0.07
	Females	19	4.768±1.370			
LBM	Males	16	10.114±1.619	1.283	2.174	0.04*
	Females	19	8.831±1.833			

*$P \leq 0.05$ Statistically significant. LBM: Lingual border of mandible, SD: Standard deviation

Table 6: Comparison of mean distance (in mm) of Mandibular incisive canal based on its proximity to different surfaces using student paired *t*-test

Pairs	Proximity	*n*	Mean±SD	Mean Diff	*t*	*P*
La versus	Labial	35	4.338±1.478	−0.001	−0.003	1.00
Li	Lingual	35	4.340±1.530			
La versus	Labial	35	4.338±1.478	−5.079	−13.555	<0.001*
LBM	LBM	35	9.417±1.832			
Li versus	Lingual	35	4.340±1.530	−5.078	−10.538	<0.001*
LBM	LBM	35	9.417±1.832			

*Statistically significant. LBM: Lingual border of mandible, SD: Standard deviation

not be detected with accuracy on 2D imaging modalities like panoramic radiographs owing to its size, corticalization and superposition of images [5-7].

As it is known that treatment planning for mandibular surgical procedures is often complicated by the unknown location and extent of these anatomical structures. The presence of the MIC is of significant interest, for various minor surgeries that are performed in the interforaminal region, which include genioplasty in orthognathic surgery, posttraumatic screw-retained plating, bone harvesting, and insertion of endosseous implants [8-10].

In the current study which examined patients of Indian ethnicity, the incisive canal could be identified in 43.8% of all CBCT scans, and it appeared as a small round radiolucency, surrounded by a radiopaque rim [Figure 3]. Ramesh *et al*. [11] found a prevalence of bilateral canals in 48.33% of their subjects, and these results were comparable with the findings of the current study. But a contrast was noted to studies done by Al-Ani *et al*. [12] who found 100% visibility in the CBCT images. Uchida *et al*. [4] conducted CBCT scans on cadaver specimens and found 100% incidence. Sahman *et al*. [5], Makris *et al*. [7], and Parnia *et al*. [13] and other authors also acclimated to a high prevalence of the canal using CBCT, with a variable visibility of 83%–97.5% [14-17]. The differences observed may be attributed to the difference in the ethnicity of the population and the sample size taken. It may also be due to the tomographic images being obtained from different CBCT systems. The variations seen in terms of slice thickness and sensitivity are due to the voxel size used. An image of greater detail is obtained when a smaller voxel size is used. The current study used a voxel size of 0.5 mm, which is slightly less than other studies [8].

In this study, when compared on the right and left side MIC was present in 36.3% subjects on the right side and 40% on left side. A slight increased prevalence on left side is seen compared to right side. According to our literature search, there are no studies that have compared prevalence on right and left side [Table 1].

In a gender wise comparison of incisive canal in the current study, there was a slightly higher prevalence amongst females as compared to males [Table 2]. There is insufficient literature differentiating the prevalence amongst genders.

In our study among the different age groups classified, the incidence was highest in Group IV [Table 3]. No other studies analysing the prevalence rate among different age groups could be found.

In the present study, the distance of MIC was also measured from labial and lingual cortical plates and up to lower border of mandible. MIC was at a distance of (4.338 ± 1.478 mm) from buccal cortical plate and at a distance of (4.340 ± 1.530 mm) from lingual cortical plate which is almost equidistant [Table 4]. This is in contrast to studies conducted by Apostolakis and Brown [17], Rosa *et al*. [18], Pereira-Maciel *et al*. [1], and Ramesh *et al*. [11] who found it to be in closer proximity to buccal plate. This could be due to the fact that the MIC becomes smaller while progressing mesially from the mental foramen to the mandibular anterior region, where it may become difficult to visualize on CBCT. The current study measured it only at the point of origin and change in ethnicity of population may have contributed to the differences in the findings.

In the current study, when the mean distances of MIC to labial, lingual and lower border of mandible were compared on right and left side, the values on left side were increased as compared to the right side, except in case of distance up to lower border of mandible. This was in contrast to a study done by De Andrade *et al*. [6] on cadavers, in which the position of the incisive nerve was 2.67 ± 0.65 mm from the buccal plate on the right side and 2.64 ± 0.67 mm on the left. This may be due to difference in methodology of the study.

With respect to gender, when comparing the proximity of the MIC to lingual wall the values were higher in females when compared to males which was not statistically significant (P = 0.07) [Table 5]. In contrast Pereira-Maciel *et al*. [1], found no significant difference in terms of proximity of the MIC. This could be due to the differences in the points taken for measurement from MIC to adjacent surfaces, whereas the distance from MIC to the labial surface (P = 0.01) and mandibular border (P = 0.04) was significantly lower for females than for males in the present study. This is similar to the study done by Pereira-Maciel *et al*. [1], Pires *et al*. [19] who found that the distance of MIC to the lower border of mandible was lower for women than for men. According to Al-Ani *et al.* [12] gender was an important factor that affected all median distances. It is postulated that this finding is due to the differences in the bone morphology of men and women. Since, women have a smaller mandible than men in dimension, if the MIC remained at a constant position, it would lie closer to the edge of mandible in women [1].

In the present study, the age wise comparison of mean distances of the canal to the proximity of different surfaces, was also done in different age groups. This showed that the Group I had the maximum mean distance to the labial surface, Group III had maximum distance to lingual surface, and Group IV had maximum distance to lower border of mandible. This could not be compared as there is no sufficient literature discussing the distances in terms of proximity to adjacent surfaces among different age groups.

The current study also compared the proximity of MIC to different surfaces when compared with each other. The data inferred that the MIC had a slightly lingual course with a shorter distance to lingual cortical plate as compared to labial, and was positioned at an average of 9.417 ± 1.832 mm superior to lower border of mandible. This finding was statistically significant. ($P \leq 0.001$) This is contrast to studies conducted by Apostolakis and Brown [17] and Rosa *et al*. [18] who found that MIC was closer to the alveolar process and buccal plate. This can be attributed to difference in ethnicity of study sample.

CBCT imaging provides improved visualization and provides adequate information concerning the mandibular interforaminal region revealing any anatomical variations such as the MIC, and its proximity to adjacent structures [1-3].

In our study, various parameters like the prevalence of MIC, with respect to gender, laterality, and among different age groups were analysed along with the position of MIC relative to its surrounding structures. To the best of our knowledge and literature search, an evaluation inclusive of all the above parameters has not been done in the past. Hence, these findings could be used in further studies with larger sample size for accurate observations.

Conclusions

To conclude, the prevalence of MIC among Indian population was lower as compared to the prevalence among other populations. There were variations in prevalence in terms of age, gender and laterality, which could be used as a reference for further studies conducted on larger sample size. Mapping the incisive nerve canal will enable oral radiologists, to plan safely and negotiate the interforaminal region. This will further enable surgeons to avoid postoperative neurosensory complications. Hence, it is suggested that treatment planning be carried out on a case-by-case basis using a 3D imaging modality to determine the appropriate location of MIC.

Financial support and sponsorship

Nil.

Conflict of interest

There is no conflict of interest.

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