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EVALUATION OF PROXIMITY BETWEEN THE ROOT APICES OF MANDIBULAR SECOND MOLARS AND THE INFERIOR ALVEOLAR NERVE USING CONE-BEAM COMPUTED TOMOGRAPHY: A HOSPITAL-BASED STUDY.

Dental Science

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ABSTRACT

Aim: The purpose of this study was to measure the distance of the inferior alveolar nerve canal from the mesial and distal root apices of the mandibular second molar using CBCT and evaluate the side of the mandible and gender-related changes.

Materials and Method: 200 high-resolution bilateral cone beam computed tomography (CBCT) scans of 200 patients were obtained from the radiology database of Government Dental College and Hospital, Mumbai. The scans were analysed to establish the mean distance of the mesial and distal root apices from the mandibular canal using the manufacturer's software. The obtained data was statistically analysed using Student's t-test. Concerning the left or right side and the gender of the patients, Chi-square test and Parson correlation coefficient were used.

Result: The average distance of the distal root from the inferior alveolar nerve canal was 2.14mm and the distance of mesial root was 2.88mm. The distance between the root apices and mandibular canal was shorter in females than males. There was a positive and moderate correlation with substantial relationship between the left and right mesial and distal root apices in both males and females.

Conclusion: The proximity of the inferior alveolar canal to the root apices of the mandibular second molar must be acknowledged by clinicians and necessary precautions taken during the treatment for the benefit of the patient. Additionally, informed consent should be formulated appropriately to avoid any possible medico-legal implications for the dentist.

KEYWORDS

Cone beam computed tomography, endodontic mishaps, inferior alveolar nerve, mandibular second molar

INTRODUCTION

Thorough knowledge of the anatomy and respecting the tissues are cardinal principles of surgery. Nevertheless, all surgical procedures carry a risk of operative and post-operative complications and endodontics is no exception to it. To minimize the complications, the risk factors should be understood and necessary modifications in the resulting intervention be made. A careful and accurate pre-operative assessment helps prevent mishaps and increase the preparedness of the clinician for management of the same.

The most significant complications from dental surgical interventions are iatrogenic trigeminal nerve injuries, which can result in permanent altered sensation and pain.[1] This causes functional and psychological disability to the patient and possible medico-legal implications for the clinician.

Inferior alveolar nerve (IAN) injury is a rare but serious treatment complication during root canal therapy. This nerve is located in the mandibular canal, which runs horizontally through the body of the mandible till its exit from the mental foramen between the first and second premolar. Endodontic interventions performed on teeth posterior to the mental foramen increase the chances of damaging the inferior alveolar nerve due to the anatomical proximity of their root apices. Breaching the apical seal can take place even in the most experienced hands leading to violation of Schilder's first biological objective, which states “procedures should be confined to the roots themselves.”[2]

This places the nerve at risk of mechanical trauma (overinstrumentation), chemical exposure to the invariably caustic root canal irrigants and intracanal medicaments or thermal injury (e.g. heat for warm root canal filling techniques).[1,3-5] Such injuries have been reported with an incidence of 1-10% in mandibular posterior teeth.[6,7]

The mandibular second molar apices have been reported to be the closest to the mandibular canal when compared with the premolars and the first molar.[8,9] Therefore, the dental procedures involving the mandibular second molar may have the highest risk to have IAN injury. Accurate determination of the location of the mandibular canal before dental procedures is crucial to avoid IAN injury.

Most of the information regarding mandibular second molar and the IAN are usually obtained from conventional periapical or panoramic radiographs. These 2- dimensional radiographs limit the ability to accurately perceive the relationship of the teeth and the neurovascular structures due to superimposition of surrounding structures and distortions.[10,11] With the advent of cone-beam computed tomography (CBCT), exact linear measurements with high accuracy and high reliability are possible because of the isotropy of the voxels.[12,13]

Therefore, the purpose of this study was to measure the distance of the inferior alveolar nerve canal from the mesial and distal root apices of the mandibular second molar using CBCT images and evaluate the side of the mandible and gender-related changes.

MATERIALS AND METHOD

High-resolution mandibular cone-beam computed tomography (CBCT) scans were obtained from the radiology database at Government Dental College and Hospital, Mumbai. After scrutinizing the database, CBCT scans of 100 males and 100 females conforming to the following inclusion and exclusion criteria were selected for the study:

(i) Age between 20 and 40 years;
(ii) Absence of any developmental disturbance or pathology or previous treatment that could influence the IAN or canal or position of mandibular posterior teeth including impactions;
(iii) Complete set of 28 teeth excluding third molars;
(iv) Radiographically completely corticized IANC bilaterally; and

(v) Absence of radiological evidence of skeletal/dental malocclusion that could have altered the position of second molar or IAN.

All the CBCTs were taken in the same machine (Planmeca version 2.0, Finland) at the same settings. Manufacturer's instructions regarding the positioning and placement were followed. Calibration of the linear measurements had been performed using known dimensions in millimeters. Using the coronal and sagittal sections, the exact location of the IANC and tooth apex was identified for the study. The linear measurements were performed using the Romelix software incorporated within the same machine using 500-micron thick coronal sections according to the following method.[7]

- IAN was identified and, a horizontal line, a tangent with the most superior aspect of the IAN, formed the horizontal axis (Figure 1-a);

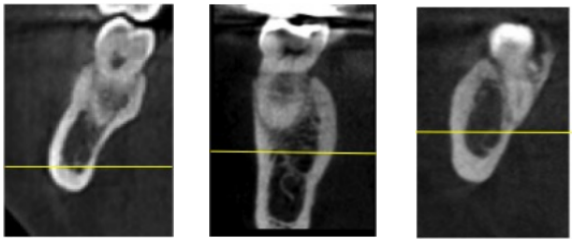


Figure 1-a: Tangent with the most superior aspect of the inferior alveolar nerve forming the horizontal axis.

- root apex was identified, and a vertical line formed the vertical axis (Figure 1-b);

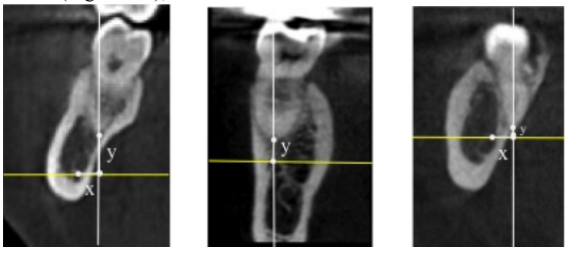


Figure 1-b: Vertical line through the root apex forming the horizontal axis.

- vertical distance (y) was the measurement from the root apex to where the vertical axis and the horizontal axis bisected;
- horizontal distance (x) was the measurement from where the vertical axis and the horizontal axis bisected to the mid-point of the superior aspect of the IAN;
- actual distance of each root apex to the IAN (z) was then calculated mathematically using Pythagoras' theorem applied to the x and y values for each root (Figure 1-c).

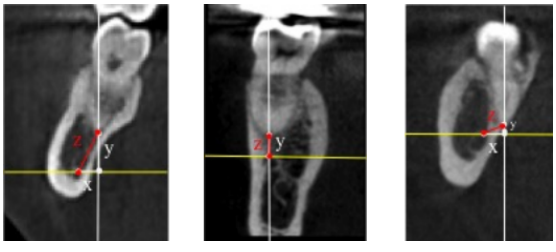


Figure 1-c: Actual linear distance calculated using Pythagoras' Theorem.

Measurements were done bilaterally for every patient.

Statistical analysis

All the data were analyzed using Statistical Package for Social Sciences (SPSS v 21.0, IBM). Inter group comparison of all variables was done using Students t-test for 2 groups.

Comparison of frequencies across the groups was done using Chi-square test. Also for numerical variables, a bivariate Pearson Correlation was calculated.

Data were analyzed to determine the effect of gender on the position of the IAN with respect to the apices of the second molars. $P \leq 0.05$ was taken as significant.

RESULTS

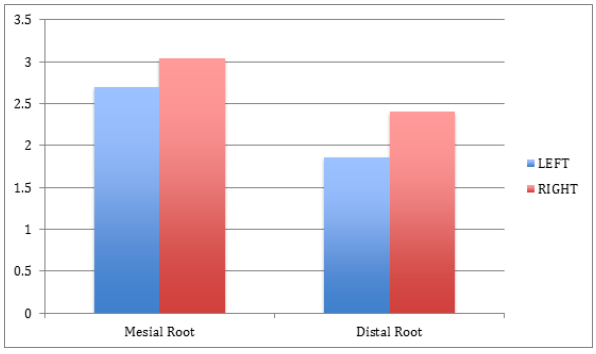
A total of 800 sections were taken from the left and right mesial and distal roots of 200 scans. The measurements determined in the study are described below.

Overall Averages: Upon compilation of all the measurements, the distal root was closer to the mandibular canal with an average distance of 2.14 mm and the mesial root was farther with an average distance of 2.88 mm (Table 1, Graph 1).

Table 1: Distance of the Inferior Alveolar Nerve from the Mandibular Second Molar Root Tips

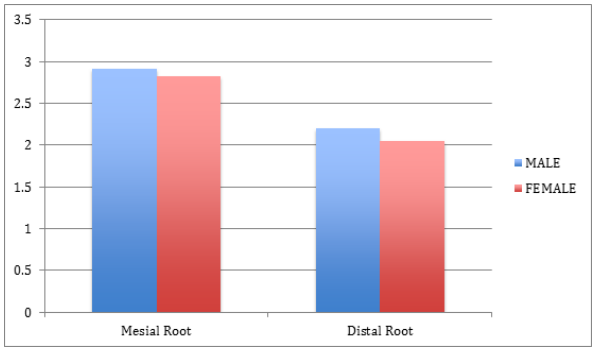
	Mean (mm)	Males (mm)				Females (mm)			
		Mean	Left	Right	Mean Difference	Mean	Left	Right	Mean Difference
Mesial Root	2.88	2.91	2.78	3.06	0.28*	2.82	2.59	3.03	0.44*
Distal Root	2.14	2.20	1.94	2.47	0.53*	2.05	1.77	2.33	0.56*

* Statistically non-significant difference ($p > 0.05$) using t-test.



Graph 1: Mean distance of the mesial and distal root from the inferior alveolar nerve on the left and right sides.

Gender Related: The distance between the root apices and mandibular canal was shorter in females than males. Females had the distal root 2.05 mm away and the mesial root 2.82 mm away from the inferior alveolar canal. Males had corresponding values of 2.20 mm and 2.91 mm respectively. The difference between the genders was not statistically significant (Table 1, Graph 2).



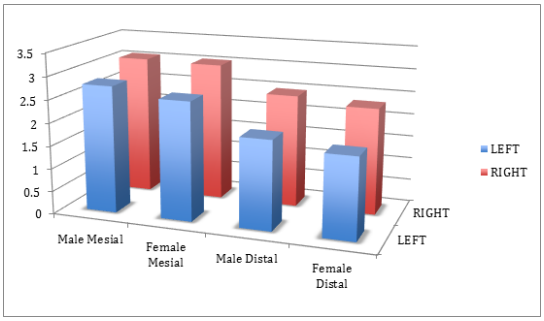
Graph 2: Mean distance of the mesial and distal root from the inferior alveolar nerve in males and females.

Side of the Mandible Related: The apices were farther away on the right than the left side. However, there was a positive and moderate correlation with substantial relationship between the left and right mesial and distal root apices in both males and females, i.e. as the distance increased on one side, the other side also increased. Therefore, the difference was statististically non-significant with the mean difference being 0.55 mm for the distal and 0.36 mm for the mesial root (Table 2, Graph 3).

Table 2: Inter-Group Comparison of Left and Right Side Using t-test

	Groups	Mean	Std. Deviation	t value	p value
Mesial	Right	3.04	2.00	1.238	0.217*
	Left	2.69	2.05		
Distal	Right	2.40	1.97	1.070	0.140*
	Left	1.85	1.74		

* Statistically non-significant difference (p > 0.05) using t-test



Graph 3: Mean distance of the left and right, mesial and distal roots from the inferior alveolar nerve in males and females.

DISCUSSION

The results of this study show that the distal root apex of the mandibular second molar was 2.14 mm away from the mandibular canal while its mesial counterpart was 2.88 mm away. This is in agreement with the recent works of Kovisto et al [9] and Burklein et al [14] who found similar results in their studies using CBCT.

Our findings are in conflict with the earlier works of Denio et al [15] and Littner et al [8] who found mandibular second molars at a secure distance of 3.7 mm and 5.4 mm from the mandibular canal respectively in human dried mandibles. These higher values could be attributed to the fact that dried mandibles do not have distinct canals. [16,17] Besides, difference in the populations studied may also account for the variation in metric values obtained.

On the contrary, Sato et al [18] based on their cadaveric study using panoramic radiographs measured the average distance from the mesial root of the second molar to the superior border of the mandibular canal as 0.79 mm, and that from the distal root as 0.70 mm. The low values could be due to the fact that the lingual mandibular canal is projected higher by the negative angulation of the x-ray tube in a panoramic image. Even though the findings were not statistically significant, a trend could be noticed that the distance is shorter in women than men- a finding similar to the present study. This may be attributed to the fact that because men generally have a larger body size, they show greater distances between the mandibular canal and the root apices. [T4] This also explains why clinically, females have a greater incidence of post-operative pain after dental procedures in the mandibular molar region. [19]

In the present study, the distal root apex was closer to the IANC with a mean distance of 2.14 mm with males having a mean distance of 2.20 mm and females 2.05 mm. This is in line with the existing published scientific literature, which unanimously states the distal root to lie in greater proximity to the mandibular canal than the mesial, more so in females. In bilateral comparison, there was a positive and moderate correlation with substantial relationship (r=0.477 in males, 0.356 in females) between the left and right side, which is in agreement with the works of Hiremath et al [20] and Kovisto et al.[9] The difference between the two sides was however, statistically non significant (p=0.140).

The mesial root was farther at a mean distance of 2.88 mm with males having a distance of 2.91mm and females 2.82 mm. Similar to the distal root, the left and right sides showed a positive and moderate correlation with substantial relationship (r=0.650 in males and 0.447 in females). Statistically, the difference between the two sides was non-significant (p=0.217).

Correlating clinically, the distal root being closer to the IANC warrants caution especially because the distal canals are usually wider with greater diameter of the apical foramen leading to greater chances of slippage of fine instruments past them and extrusion of irrigants, medicaments and obturating materials.

CONCLUSION

The proximity of the inferior alveolar canal to the root apices of the mandibular second molar must be acknowledged by clinicians and necessary precautions taken during the treatment for the benefit of the patient. Additionally, informed consent should be formulated appropriately to avoid any possible medico-legal implications for the dentist. Incorporating these into practice would help achieve harmonious dentist-patient relationship.

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Nil

CONFLICTS OF INTEREST

There were no conflicts of interest.

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