Evaluation of proximity of mandibular molars and second premolar to inferior alveolar nerve canal among central Indians: A cone-beam computed tomographic retrospective study

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ABSTRACT

Context: A study was done to assess the average distances of root apices of mandibular first molar, second molar, and second premolar to inferior alveolar nerve canal (IANC), among males and females in central India.

Materials and Methods: High-resolution full-volume cone-beam computed tomography (CBCT) scans were obtained from the radiology database at the Sri Aurobindo College of Dentistry, Indore. After scrutinizing the database, CBCT of 40 males and 40 females that conformed to the inclusion and exclusion criteria were selected for the study.

Results: All the data were analyzed using SPSS, Version 16. Descriptive statistics of the variables and measurements are presented using Students t-test (paired and unpaired), and correlation between age was tabled by Karl Pearson’s correlation coefficient method.

Conclusion: For the second premolar, the average distance to the IANC was 0.88–13.03 mm for males and 0.00–5.49 mm for females. The average distance of IANC to the mesial root apex of first molar was 1.46–13.23 mm for males and 0.93–8.03 mm for females. For the second molar, the average distance was 1.31–14.71 mm for males and 0.00–6.91 mm for females (values on left side were shorter as compared to right side). In the overall population, only second molar exhibited significant difference in the distance from root apex to IANC when compared bilaterally. In addition to gender differences, age-related differences were found to be significant for the first molar on left side and second molar on the right side of the population (P < 0.05).

Key words: Cone-beam computed tomography, inferior alveolar nerve canal, overfilling, over instrumentation

Various procedures in endodontics may lead to inferior alveolar nerve (IAN) injury, a rare but serious treatment complication. It can result from periapical surgery, over-instrumentation, irritant root canal medicaments, and overfilling by root canal obturation materials. Majority of IAN injury cases reported were in relation to the lower second molars, but the complication may also occur in the first molars and premolars. The accidental extrusion of materials beyond the periapical area are generally well tolerated by the tissues due to the lesser amount of the material. However, sometimes symptoms such as pain, hyperesthesia, hypoesthesia, anesthesia, dysesthesia, and paresthesia have been reported after the extrusion of endodontic materials into the mandibular canal when in contact with alveolar nerves as a result of the neurotoxicity of their components.

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Several studies have underlined the undesired and often avoidable iatrogenic damage to the IAN. It has been reported that in harvesting procedures involving the mandibular ramus, IAN damage may cause sensory deficits in up to 8.3%.\cite{8}

Cadaver findings cannot be translated to patient population owing to the differences in age or disease. Skull-based studies lack demographic data or use clinically inconsistent and anatomically irrelevant landmarks or include edentulous mandibles.\cite{9} Use of two-dimensional imaging modalities and computed tomograms have their own limitations.\cite{8}

A better understanding of the intrabony anatomy of the IAN and its relationship to mandibular molar (MM) anatomical landmarks particularly with emphasis on the tooth may aid to decrease the risk of inadvertent IAN injury associated with various endodontic surgical and nonsurgical intervention in the molar and second premolar region.

Hence, the aim of the study was to assess the distance between the apical tip of the mesial roots of the first and second molar and second premolar to the superior border of IAN and its clinical importance during endodontic surgical and nonsurgical treatment of mandibular region among males and females in central India.

**MATERIALS AND METHODS**

High-resolution full-volume cone beam computed tomography (CBCT) scans were obtained from the radiology database at the Sri Aurobindo College of Dentistry, Indore. After scrutinizing the database, CBCT of 40 males and 40 females that conformed 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 premolar, 1st and 2nd MM or IAN.

All the CBCTs were taken by the same trained personnel between October 2014 and August 2015 in the same machine (Kodak CBCT, CS 9300) 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 OnDemand software (CS 9300 Dental Cone Beam Imaging System, Carestream Dental, a Division of Carestream Health, Inc., Rochester, New York) incorporated with the same machine. Linear measurements were made in sagittal cross sections. Using 200-µm thick sections, the distance from the apex of root to the superior border of the inferior alveolar canal was determined. The measurements were made with respect to the root apices of second premolar and mesial roots of the first and second MM [Figure 1a-d].

Anatomic measurements were made by two observers, and the mean of the values was considered as the measurement for the particular patient. All measurements were measured along the superior border of the IANC from the root apices of second premolar and mesial roots of the first and second molar. Measurements were done bilaterally for every patient.

All the data were analyzed using SPSS, version 16 (SPSS Inc., Chicago, IL, USA). Descriptive statistics of the variables and measurements are presented using Students $t$-test (paired and unpaired) and correlation between age was tabulated by Karl Pearson’s correlation coefficient method. Data were analyzed to determine the effect of age and gender on the position of the IAN with respect to the apex of the second premolar and mesial roots of the mandibular first and second molars $P \leq 0.05$ was taken as significant.

**RESULTS**

Table 1 depicts the mean ages of the study population. One major finding in this study was that regardless of age, females had significantly shorter ($P < 0.05$) vertical distances from the IAN canal (IANC) to the root apices of mandibular teeth [Table 2].

For the second premolar, the average distance to the IAN was 0.88–13.03 mm for males and 0.00–5.49 mm for females.

![Figure 1:](image-url) (a) Axial view of a representative cone beam computed tomography scan, (b) reconstructed thin-slice panoramic image section showing well defined bilateral inferior alveolar nerve canal, (c) nerve tracing along the superior border of the inferior alveolar nerve canal, (d) sagittal slice illustrating measurement of the root apex to the inferior alveolar canal
The average distance of IAN to the mesial root apex of first molar was 1.46–13.23 mm for males and 0.93–8.03 mm for females. For the second molar, the average distance was 1.31–14.71 mm for males and 0.00–6.91 mm for females. In the overall population, only second molar exhibited significant difference in the distance from root apex to IAN when compared bilaterally (Values on left side were shorter as compared to right side) Table 3. Table 4 indicates a significant difference in the vertical distal of root apices to IAN of second premolar and second molar among females when comparing the right and left sides. There was no significant difference among the male population in bilateral comparison. In addition to gender differences, age-related differences were found to be significant for the first molar on left side and second molar on the right side of the population (P < 0.05) [Table 5].

**DISCUSSION**

Various surgical or nonsurgical procedural mishaps in endodontics pose a potential iatrogenic cause of IAN injury. Gutta-percha is traditionally considered an inert root-filling material, and the paresthesia's cases involving Gutta-percha usually results from overfill of thermoplastic Gutta-percha. If the sealer is extruded in the mandibular canal space, it can cause problems that vary from mild inflammatory reactions to severe neurotoxic damage.[10,11]

Damage by accidental extrusion of sealer into the mandibular canal may occur due to mechanical, thermal, or chemical processes.[12,13]

The literature describes four possibilities of endodontic sealer spreading to the periradicular region: Toward the mandibular canal, drainage through lymphatic vessels systemic diffusion through a periapical vein, and progression toward soft tissues between bone and mucosal membrane.[14]

The filling materials most commonly associated with this complication are paraformaldehyde containing pastes (e.g., Sargenti N2 paste [Hager and Werken, GmbH and Co. KG, Duisburg, Germany] and AH26 [Dentsply Maillefer Instruments, Ballaigues, Switzerland]). Paraformaldehyde is a polymeric hydrate of formaldehyde that on contact with water releases formaldehyde gas, which may cause permanent damage to the nerve.[15,16]

Surgical endodontic procedures require precise knowledge of anatomic structures that might be traumatized. Even though there is a high success rate with nonsurgical root canal treatment, root-end surgery might be required in up to 26% of cases presenting with apical periodontitis.[17]

However, the proximity of the IAN to root structures is a critical anatomic issue for surgery on MMs, even with advanced technology. It has been reported that dentoalveolar and root-end surgery can cause persistent neurosensory disturbances including paresthesia, dysesthesia, or anesthesia of the IAN. [18,19]
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**Table 5: Correlation between age with second premolar, first molar, and second molar scores by Karl Pearson’s correlation coefficient method in entire population**

| Sides | Variables               | Correlation between age with |
|-------|-------------------------|------------------------------|
|       |                         | r   | t   | P   |
| Left  | Second premolar         | 0.1425 | 1.0966 | 0.2774 |
|       | First molar             | 0.2579 | 2.0326 | 0.0467* |
|       | Second molar            | 0.2071 | 1.6120 | 0.1124 |
| Right | Second premolar         | 0.1562 | 1.2047 | 0.2332 |
|       | First molar             | 0.1225 | 0.9401 | 0.3511 |
|       | Second molar            | 0.2572 | 2.0274 | 0.0472* |

*P<0.05. Positive r value indicates positive relation.

There are case reports reported were in injury to the IANC occurred either to the extrusion of the endodontic sealer or the Gutta-percha.[12,13,20,21]

Hence, a thorough knowledge of the relative three-dimensional (3D) position of the IAN to the root apices of the MMs and its significance to gender and age is imperative for any procedure to be carried out with minimal risk to the patient. CBCT has made considerable improvements in dental imaging and has proved to be extremely accurate than other radiographic techniques for locating the mandibular canal before surgeries.[22-24]

CBCT allows for 3D reconstruction of the dentomaxillofacial complex in a true 1:1 anatomic representation. In other conventional radiographic techniques, there are distortion and magnification of the anatomic structures ranging from 3.4% for periapical radiographs to more than 14% for panoramic radiographs.[25]

Various studies have been conducted regarding the proximity of IAN to the root apices of the MMs. A study conducted by Simonton et al. concluded that females had significantly more vertical distance from the IAN to the mesial and distal apices; regardless of age and shorter horizontal distances from total width of mandibular bone at mesial and distal apices. The overall width of the mandibular bone decreased in both genders from the third to sixth decade of life. These three major findings in their study suggested that there could be a direct impact on treatment planning for surgical endodontic procedures involving the mandibular first molar.[26]

Another retrospective study conducted by Nair et al. demonstrated that IANC coursed superiorly toward the root apices from the second molar to the first premolar and closer to the buccal cortical plate anteriorly and was closest to the lingual cortical plate at the level of the second molar. It was also noted that in 32.95% of the cases, the canal was seen at the level of the canine. They concluded that caution needs to be exercised during endodontic surgical procedures in the mandible even at the level of the canine.[27]

Various studies have been reported by several authors regarding morphological variations of lingula, incidence of retromolar foramen, and canal and its clinical significance, communication between the lingual nerve and mylohyoid nerves, and mandibular foramen in different age groups of children.[28-30]

A study was conducted by Balaji et al. to assess the clinically relevant position of the IANC to the periapex of first and second molar in south Indian patients among the age group of 20–29 years using cone beam computerized tomograms. They concluded that the maximum and minimum values of first molar was in range of 8–11.3 mm (left and right side) and 4.3–11.4 mm (left and right side) average for second molar. Among the gender, females demonstrated lesser values.[31]

In the study presented (central Indians), the average distance of IAN to the mesial root apex of first molar was 1.46–13.23 mm for males and 0.93–8.03 mm for females. For the second molar, the average distance was 1.31–14.71 mm for males and 0.00–6.91 mm for females. For the second premolar, the average distance to the IAN was 0.88–13.03 mm for males and 0.00–5.49 mm for females.

This study found that the distance between the IAN and the root apices of mandibular first molars, second molars, and second premolars is significantly shorter in females than in males (both right and left side). Positive correlation was observed between the age and the distance of IAN canal and root apices. The probable reason for this finding could be due to the continued development of jaw up to the age of forty which reflects the age group selected for this study. The value in the tables throws light on the precaution to be considered on part of an endodontist to avoid mishaps dealing the periapical area of the roots which are in close proximity to the anatomical structures.

**CONCLUSION**

The result of this in vitro study indicate the potential for iatrogenic nerve damage during both surgical and nonsurgical endodontics. Caution must be exercised during the use of potentially toxic irrigants and intracanal medicaments.

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**Conflicts of interest**
There are no conflicts of interest.

**REFERENCES**

1. Grötz KA, Al-Nawas B, de Aguiar EG, Schulz A, Wagner W. Treatment of injuries to the inferior alveolar nerve after endodontic procedures. Clin Oral Investig 1998;2:73-6.
2. Escoda-Franco J, Canálida-Sahli C, Soler A, Figueiredo R, Gay-Escoda C. Inferior alveolar nerve damage because of overextended endodontic
Inferior alveolar nerve paresthesia in vitro in central Indians Hiremath, et al. 2016. 

1. Tai KW, Huang FM, Huang MS, Chang YC. Assessment of the genotoxicity of resin and zinc-oxide eugenol-based root canal sealers using an in vitro mammalian test system. J Biomed Mater Res 2002;59:73-7.

2. Friedman S, Mor C. The success of endodontic therapy – Healing and functionality. J Calif Dent Assoc 2004;32:493-503.

3. Dempf R, Hausamen JE. Lesions of the inferior alveolar nerve arising from endodontic treatment. Aust Endod J 2000;26:67-71.

4. Libersa P, Savignat M, Tonnell A. Neurosensory disturbances of the inferior alveolar nerve: A retrospective study of complaints in a 10-year period. J Oral Maxillofac Surg 2007;65:1486-9.

5. Alonso-Ezepeleta O, Martín PJ, López-López J, Castellanos-Cosano L, Martín-González J, Segura-Egea JJ. Pregabalin in the treatment of inferior alveolar nerve paraesthesia following overfilling of endodontic sealer. J Clin Exp Dent 2014;6:e197-202.

6. Blanas N, Kienle F, Sándor G. Inferior alveolar nerve injury caused by thermoplastic gutta-percha overextension. J Can Dent Assoc 2004;70:384-7.

7. Agbaje JO, Jacobs R, Maes F, Michiels K, van Steenberghe D. Volumetric analysis of extraction sockets using cone beam computed tomography: A pilot study on ex vivo jaw bone. J Clin Periodontol 2007;34:985-90.

8. Ludlow JB, Laster WS, See M, Bailey LJ, Hershey HG. Accuracy of measurements of mandibular anatomy in cone beam computed tomography images. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007;103:534-42.

9. Klinge B, Petersson A, Maly P. Location of the mandibular canal: Comparison of macroscopic findings, conventional radiography, and computed tomography. Int J Oral Maxillofac Implants 1989;4:327-32.

10. Lazzerini F, Morari D, Nissi R, Gagliani M, Uslenghi CM. The measurement parameters in dental radiography: A comparison between traditional and digital technics. Radiol Med 1998;191:364-9.

11. Simonton JD, Azavedo B, Schindler WG, Hargreaves KM. Age- and gender-related differences in the position of the inferior alveolar nerve by using cone beam computed tomography: J Endod 2009;35:944-9.

12. Potu BK, Pulakunta T, Ray B, Rao MS, Bhat KM, D’Silva SS, et al. Unusual communication between the lingual nerve and mylohyoid nerves in a South Indian male cadaver: Its clinical significance. Rom J Morphol Embryol 2009;50:145-6.

13. Poonacha KS, Shigiri AL, Indushekar KR. Relative position of the mandibular foramen in different age groups of children: A radiographic study. J Indian Soc Pedod Prev Dent 2010;28:173-8.

14. Balaji SM, KrishnaSwamy NR, Kumar SM, Rooban T. Inferior alveolar nerve canal position among South Indians: A cone beam computed tomographic pilot study. Ann Maxillofac Surg 2012;2:51-5.