Prevalence of second canal in mandibular first premolar of north Malabar population-a cone beam computed tomographic study

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Abstract

Background: Mandibular premolars demonstrate high variability in root canal morphology, especially mandibular first premolars. The purposes of this study were to determine the prevalence of second canal in mandibular first premolar of north Malabar population

Methods

223 extracted permanent mandibular first premolar of north Malabar population (kozhikode, Kannur, Kasaragod, mananthavadi thaluk of Wayanad) were collected from various clinics. After tooth sectioning and mounting on template of modelling wax, cone beam computed tomographic analysis was done to find out second canal.

Results: prevalence of second canal in mandibular first premolar of North Malabar population obtained using CBCT is about 17 %

Conclusion: As per the results obtained and discussed in this in vitro study, it can be concluded that Prevalence of second canal in mandibular first premolar of North Malabar population obtained using CBCT is about 17 %

CBCT is an imaging modality aid that helps clinicians to assess complex root canal morphology in a reliable manner. It is considered as an excellent method for identifying presence of second canal in mandibular first premolars

Keywords: Mandibular premolars, second canal, CBCT, complex root canal morphology

Introduction

An in-depth knowledge of root canal morphology is crucial for the success of endodontic treatment[1.] The morphologies of the roots and canals of the first and second mandibular premolars can be complex and variable. Due to this varied morphology, the endodontic treatment of mandibular premolars is an exacting task[2]. The distribution of the numbers of roots and canals vary greatly in the literature[3.] As per the ideal root anatomy, mandibular premolar is anticipated to have single canal exiting in a single apical foramen. However, in clinical scenario, they may have the most complex anatomical configuration with high prevalence of curvatures, fins, and isthmuses, and may branch, divide, and reunite taking various pathways to the apex.[4]

Vertucci found that the mandibular first premolar has one canal in 74.0% of teeth, two canals in 25.5%, and three canals in 0.5% of teeth. The mandibular second premolar has one canal in 97.5% and two canals in 2.5% of teeth[5]

Advancements in the field of radiology have drawn upon the use of computed tomography (CT) to image teeth. Cone-beam CT (CBCT) scanning has been used in the field of endodontics since 1990[6]. CBCT uses a cone-shaped beam of radiation to acquire data in a single 360° rotation, which reveals the internal structure of an object. When CBCT is compared with conventional CT, it provides improved accuracy, higher resolution, lower scan time, and radiation doses[7] A cone-beam computed tomography has also been used to study root canal morphologies because this non-destructive technique provides three-dimensional pictures[8]

Currently there is very limited data on the prevalence and details of root canal in mandibular premolars, especially in North Malabar population. therefore, the purposes of this study were to determine the prevalence of second canal in mandibular first premolar of North Malabar population

Materials and methods

223 Extracted permanent mandibular first premolar of north Malabar population (Kozhikode, Kannur, Kasaragod, Mananthavadi Thaluk of Wayanad) were collected from various clinics. Teeth were cleaned of any adherent soft tissue, bone fragment and calculus by scaling and polishing. These teeth were placed in a container with 5% Sodium hypochlorite solution which were changed daily for four days.

The inclusion criterion was the existence of at least one mandibular first or second premolar with fully developed roots. Exclusion criteria included unclear or distorted CBCT images, previous endodontically treated or initiated teeth, posts or crowns, periapical lesions, and the presence of physiological or pathological process such as root resorption

The study basically consisted of three procedures.

1. tooth sectioning
2. mounting on template of modelling wax
3. cone beam computed tomographic analysis

1. Sectioning

All collected samples were sectioned at cemento enamel junction (CEJ) using carborundum disc of 0.5 mm thickness.

2. Mounting on template of modelling wax
A rectangle shaped template were made with modelling wax. 10 teeth were embedded in each template with the

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roots inside the wax and occlusal surface exposed. 22 samples were prepared to be mounted on extra-oral imaging system (CBCT). The base of the wax encasing was formed into a flat surface enabling the plate to sit stationary on top of the flat plastic bite plate. After placing on the bite plate the mounted teeth were roughly centered in the focal trough area and a preview picture were taken.

3. Cone Beam Computed Tomographic Analysis The prepared sample plates were placed on to the biteplate of ICAT 17-19 NextGen Extra-Oral Imaging System. To confirm the internal anatomy, axial, coronal and sagittal section CBCT images were taken with of ICAT 17-19 NextGen Extra-oral Imaging System with tube voltage of 90 KV and tube current of 10 mA. Details of the CBCT view of CBCT in the form of digital image were read through the In vivo anatomage software.

Number of canals per root was recorded.

Statistical analysis

Sampling procedure: Cluster sampling

Sample size: 223 Statistical analysis were done using N master software and calculated using following formula
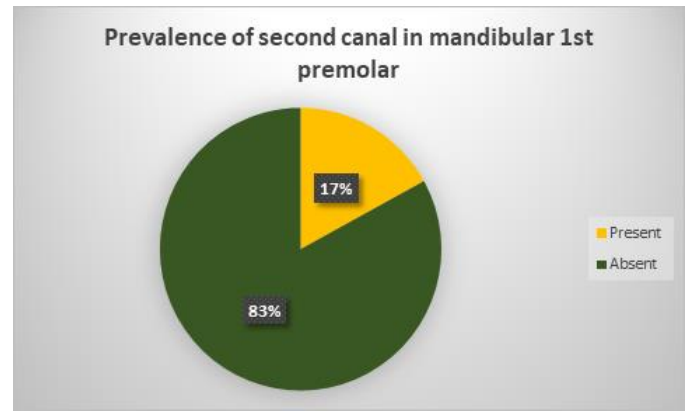
• Formula- N = Z2 α/2 × p× (1- p) ×D E2

Z α/2 = Normal deviate for two tailed hypotheses = 1.96

Results

Prevalence of second canal in mandibular first premolar

	N	%
Present	38	17
Absent	185	83
Total	223	100

Graph 1:

Discussion

Successful root canal therapy consists of meticulous biomechanical preparation and chemical debridement, followed by 3-dimensional (3D) obturation of the root canal system. To ensure these goals, an assimilation of fundamental root canal anatomy is mandatory before performing endodontic therapy[9]

Mandibular first premolars can present with an extremely complex internal root canal morphology.[10,11]

A study by the University of Washington showed mandibular first premolars to have the highest failure rate when evaluating non-surgical root canal therapy, with a reported failure rate of 11.4%.[11]

Vertucci[5] has shown that in mandibular 1st premolar, a single canal is found in 70% of cases; in 4% of cases there could be two canals joining at a common apical foramen; in 24% of cases one root canal bifurcates at the apical third of the root into two branches; and in 1.5% of cases there could be two independent canals.

Earlier studies performed by Miyoshi et al.,[12] using radiographic technique, reported that about 13.8% of Japanese population had two canals, whereas Walker[13] found that 34% Southern Chinese had two canals and 2% had three canals in mandibular premolars. In this study 17 % of mandibular first premolar cases presented second canal.

Our study is in agreement with study by Adnan A. Habib et al[14] who has shown that 82.1% of first mandibular premolars had a single canal and 17.9% contained two canals. Eighty three percent of second mandibular premolars had a single canal, 15.3% two canals, and 1.5% three canals

When multiple root canals exist in a single root, root canals can be missed due to the difficulty in identifying the extra canal on the periapical radiograph. In 2018, the American Association of Endodontists recommended using CBCT imaging for the initial treatment of teeth with the potential for extra canals and suspected complex root canal morphology, including mandibular premolars[15]. CBCT imaging should be used only when a two-dimensional periapical radiograph cannot provide sufficient information for adequate root canal treatment. Moreover, a limited field of view CBCT that is slightly larger than the area of interest should be used to reduce the radiation dose and obtain a higher spatial resolution CBCT image[16]. A CBCT image provides important information about tooth morphology, number and location of the root canals, details of the root canal, such as calcification, curvature, and other complex root canal morphology, and external root morphology, such as a root concavity. This information can alert the dentist that these teeth will be challenging to debride and obturate.

Studies have shown that mandibular first premolars have more anatomical variations compared with mandibular second premolars in terms of the number of roots and the root canal configuration.[17,5]

Another study indicated that there is a high probability of finding an extra canal branching from the main root canal in the middle third level of the mandibular first and second premolar at 75.5% and 50%[18]

In this study the prevalence for 2 canals in mandibular first premolar was 17% agreeing with a previous study by Lu et al. who observed that only 54% of mandibular first premolars exhibited a single canal, whereas 22% contained two canals [19]

The method traditionally used to locate root canals is direct visual inspection[20]. However, the efficacy of this method is closely related to the examiner's skill and knowledge of root canal anatomy[21,22]. In an attempt to facilitate location of accessory canals and reduce treatment failure rates, technological resources such as loupes, microscopes and cone-beam computed tomography (CBCT) have been introduced into endodontic practice

Vertucci used hematoxylin dye injection to examine canal configuration of mandibular premolar[5]

In another study premolar tooth sections was polished with sand paper under running water, dried and stained with methylene blue. Digital photographs of root surfaces at 3, 6, 9, and 12 mm were made at 24X magnification using the mounted digital camera.[19]

Studies have also used CBCT images of premolars obtained from patients to examine its canal anatomy[8]

CBCT is a non-invasive radiographic method that produces three-dimensional, high-resolution. Present study has used CBCT for the identification of extra canals in mandibular first premolars.

The intricate root canal anatomy of mandibular premolars may be difficult to comprehend in routine intraoral periapical radiographs in clinical situations. The advantages of CBCT over periapical radiographs have been high resolution, elimination of chemical processing, rapid image acquisition and a number of image processing tools such as magnification[23]. CBCT is well suited for endodontic applications as a complement to conventional radiography since images can be rotated in any spatial plane without superimposition of the anatomic structures.

In the present study prevalence of second canal of mandibular first premolar is detected by the axial sections and coronal sections of CBCT images. After reading the CBCT images of all the 223 sample and data analysis, it was found that 38(17%) teeth out of 223 sample showed second canal in mandibular first premolar.

Conclusions

As per the results obtained and discussed in this in vitro study, it can be concluded that Prevalence of second canal in mandibular first premolar of North Malabar population obtained using CBCT is about 17 %

CBCT is an imaging modality aid that helps clinicians to assess complex root canal morphology in a reliable manner. It is considered as an excellent method for identifying presence of second canal in mandibular first premolars

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Legend Figures

Figure 1: CBCT ICAT 17-19 NextGen Extra-Oral Imaging System
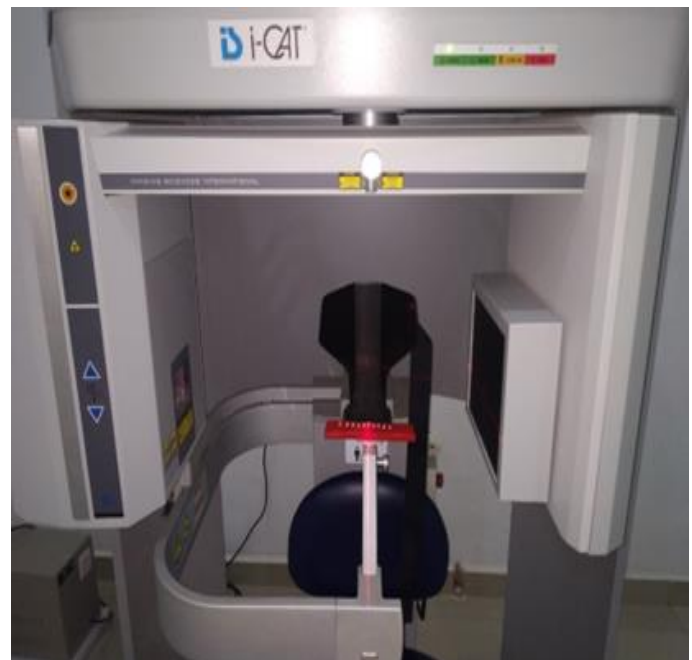

Figure 2: Rectangular template placed on base plate of CBCT

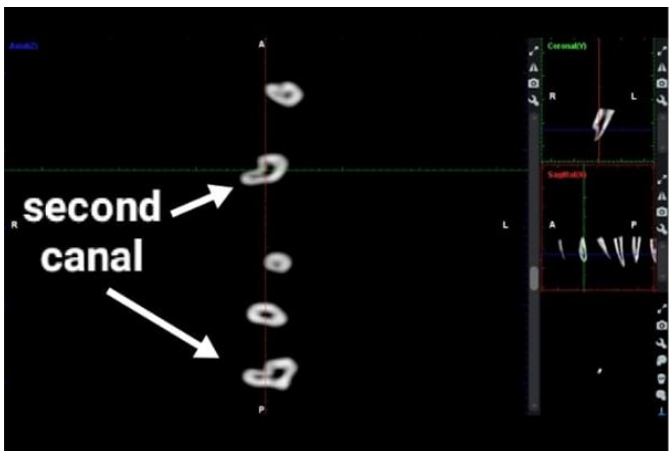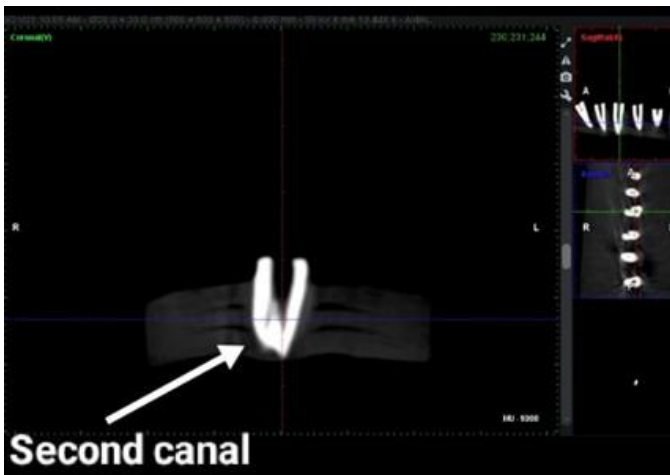Figure 3: Sectioning of permanent mandibular first premolar at CEJ level

Figure 4: Axial, coronal, sagittal sections of CBCT images viewed by in vivo anatomage software