INTRODUCTION

Knowledge of the variations in root and root canal morphology is mandatory for the success of endodontic treatment. Neglecting to probe, prepare and fill all the canals can lead to failure of endodontic treatment. As a group the mandibular premolars are among the most difficult teeth to treat endodontically, because they have high incidence of multiple roots or canals. Moreover their root canal system varies in different ethnic or regional populations.

In large number of population the dimensions of the mandibular premolar, root canal system are wider buccolingually than mesiodistally with, two pulp horns. At the cervix of the tooth, both the root and canal are oval; this shape tends to become flat or round where the canal approaches the middle of the root. Variation to the normal may be two different canals circular in shape; If two canals exist, they are usually circular from the pulp cavity to their apical foramen. A single, broad root canal bifurcating into two separate root canals at the apex of the root. A mandibular first premolar may sometimes have three roots and three canals or one root and four canals. One study reported a C-shaped canal anatomy in the mandibular first premolar.

Traditional radiography, hard tissue section, and root canal staining or micro-CT scanning in vitro are commonly used tools in identifying the configuration of canals. All these studies were either histologic or conventional x-ray studies, thus many of them have their own limitations. Conventional images compress three-dimensional (3D) anatomy into a two-dimensional image, resulting in some important features of the tooth and its surrounding tissues being visualized only in the mesiodistal plane. Thus, features presenting in the buccolingual dimension may not be fully appreciated. Cone beam computed tomography (CBCT) scanning was introduced in the field of endodontics.
in 1990. The application of cone-beam computed tomography (CBCT) provides a non-invasive three-dimensional confirmatory diagnosis as a complement to conventional radiography. Its major advantages are a substantial reduction in radiation exposure and higher quality image rendering for assessment of dental hard tissues. Many studies of root and canal morphology in mandibular premolars have been conducted because these teeth present complex morphology that often complicates treatment. Therefore, present study was undertaken to observe the trend of root and canal morphology of mandibular premolars with CBCT imaging in Indore population.

METHOD

Freshly extracted 1st and 2nd premolars were collected from various clinics from different areas of Indore. All teeth were stored in 1% thymol solution. Premolar teeth having fully developed apices was the inclusion criteria. Teeth having root canal fillings, posts and crown were excluded from the study. The extracted teeth were arranged on a 5x5 cm modeling wax of thickness 1 mm. Side determination i.e. mesial or distal, buccal or lingual were marked on the modeling wax sheet and 9 samples were mounted at a time, the samples were upright and embedded in wax at apex (figure 1) and then placed on a examining platform of CBCT machine (figure 2).

3-D images of premolar teeth were taken using a CS9300 Carestream CBCT machine at Oracle CBCT centre, Indore. Images were captured at the parameters set at 75 kv, 4 mA, exposure time 20 sec, voxel size 90 and FOV 5x5 cm. 40 premolars samples were taken out of which 35 extracted premolars were taken from various regions of Indore city clinics and rest 5 images of intact premolars was obtained from stored data at CBCT centre. Out of total 40 premolars sample, 28 were of 2nd premolars and 12 were of 1st premolars. Axial, coronal, and sagittal two-dimensional sectional images were analysed using CS 3-D imaging software and the best image showing features was selected.

RESULTS

Number of roots and canals: CBCT 3-D image analysis of all 40 mandibular premolars showed single root and most of them had one canal with less variation.

Variations in root canal system morphology: The root canal configuration of mandibular 1st premolars according to vertucci’s classification was as follows: Type-I (91.66%) and Type-V (8.33%) (Table 1), whereas for mandibular 2nd premolars it was: Type-I (89.28%), Type-III (3.57%) and Type-V (7.14%) (Table 2).
Out of 12 mandibular 1\textsuperscript{st} premolars 11 had Type-I canal morphology and 1 premolar had Type –V canal morphology. While in case of 28 mandibular 2\textsuperscript{nd} premolars 25 had Type-I, 1 had Type-III and 2 had Type-V canal morphology respectively (figure 3 & 4).

**Fig. 3** : mandibular right 2\textsuperscript{nd} premolar at oblique sagittal and oblique axial plane. Oblique sagittal section showing vertucci’s Type-III configuration. **& Fig. 4** : mandibular left 2\textsuperscript{nd} premolars oblique sagittal section showing Type-I and Type-V canal configuration.

**DISCUSSION**

Our findings on the number of roots and canals in mandibular first premolars, showing that most had only one root and one canal, are in keeping with the results of previous studies\textsuperscript{9,10,11}. In mandibular second premolars, we also found that all had one root and most had only one canal, in agreement with the findings of miyoshi et al\textsuperscript{12}. Conventional intraoral periapical radiographs are an important clinical diagnostic tool for assessing canal morphology, but these radiographs are not completely reliable because of inherent limitations such as distortion and superimposition of dental structure\textsuperscript{6}. The application of CBCT has been suggested

**Table 1** : Root canal configurations of mandibular 1\textsuperscript{st} premolars

<table>
<thead>
<tr>
<th>Type</th>
<th>Type</th>
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<th>Type</th>
<th>C-shaped canal</th>
</tr>
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<tbody>
<tr>
<td>I (1)</td>
<td>II (2-1)</td>
<td>III (1-2-1)</td>
<td>I (2)</td>
<td>V (1-2)</td>
<td>VI (2-1-2)</td>
<td>VII (1-2-1-2)</td>
<td>(3)</td>
</tr>
<tr>
<td>No.</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>%</td>
<td>91.6</td>
<td>6%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8.33</td>
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**Table 1** : Root canal configurations of mandibular 1\textsuperscript{st} premolars

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<td>I (1)</td>
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<td>IV (2)</td>
<td>V (1-2)</td>
<td>VI (2-1-2)</td>
<td>VII (1-2-1-2)</td>
<td>VIII (3)</td>
</tr>
<tr>
<td>No.</td>
<td>25</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
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</tr>
<tr>
<td>%</td>
<td>89.2</td>
<td>8%</td>
<td>3.57</td>
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<td>7.14</td>
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**Table 2** - Root canal configurations of mandibular 2nd premolars

in these cases to provide a 3D confirmatory diagnosis without causing any tooth damage. It offers high resolution and is well suited for endodontic applications as a complement to conventional radiography\(^{13}\). When uncertainty exists in the diagnosis of canal variations, or a change of shape/direction in the middle apical third of the canal is detected, periapical radiography associated with CBCT can be used to determine or confirm the presence and location of canal bifurcation.

**CONCLUSION**

Within the limitations of our study following conclusion could be drawn:

1) All the samples included in the study collected from various areas of Indore city had single root and most of them had one canal with less variation.

2) CBCT has potential as an auxiliary tool in the evaluation of mandibular premolars with complex canal morphology to improve the quality of root canal therapy.

3) CBCT scanning is of great value in detecting anomalous canal morphology when diagnosis by conventional radiography is inconclusive. Although results indicates towards trends in variation in root canals of premolars, but larger samples needs to be evaluated to set definite statistics in Indore region.

**REFERENCES**


12. Miyoshi S, Fujiwara J, Tsuji YT, Yamamoto K. Bifurcated root canals and


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