Root canal morphology of mandibular first premolars in western Indian population: an in vitro study

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INTRODUCTION
Success of the root canal treatment depends upon complete biomechanical preparation of root canal and three dimensional obturation. Hence, in order to achieve this during endodontic therapy, thorough knowledge of root canal morphology and its complexity is essential. Morphologically, variations of root canal systems are commonly encountered and can be considered as normal.1 It is reported that the original geometry of canal, before shaping and cleaning procedures, had more influence on the changes that occurred during preparation, than the instrumentation technique itself. Thus, they emphasized on the importance of root canal anatomy.2 Amongst all the teeth, mandibular first premolar, has high flare up and failure rates, the major contributory factor is attributed to the variations in root canal anatomy.3,4 Several studies have been carried out in different populations which have shown that root canal morphology varies with race, when compared with Caucasian patients, those of African have higher number of extra canals in mandibular first premolar and mandibular second premolar.5 Addition to this, patients of Asian have different percentages of canal configurations than those reported in studies dominated by white and black.6,7 Studies have also been reported gender-specific configurations in almost 2800 teeth which showed 99% were identical to Vertucci’s classification and remaining 1% reported 14 additional canal morphologies in mandibular teeth. Therefore, it can be said that root canal morphology varies according to race and gender.8 Similar studies amongst the western Indian populations are rare. Variety of techniques used to visualize the morphology of pulp chamber include radiographic method, Computed tomography study, cross and longitudinal sectioning of the teeth, amongst this, decalcification and clearing technique has been considered to be effective method in visualizing the pulp cavity in relation to exterior of the tooth more effectively.9 Thus, the purpose of this study was to determine the root canal morphology of
Root canal morphology of mandibular first premolars

mandibular first premolar teeth in Western Indian population using a decalcification and clearing method.

METHODS AND MATERIALS
Two hundred extracted human adult mandibular first premolar teeth with intact crown and root having mature apices were collected randomly from western Indian population. The age and gender of the patients were not known. Teeth with deep caries, metallic restorations, fracture, incompletely formed roots and those which were root filled were not included. The teeth were preserved in 10% formalin until they were studied. All attached soft tissue and calculus were removed using an ultrasonic scaler. Access opening was done using an endo access bur. Since preserving the internal anatomy of the pulp chamber and the radicular portion in an undisturbed state, instrumentation was not preferred. Following this, the teeth were placed in 5.25% sodium hypochlorite solution for 24 hours to remove organic debris from the root canal system. At the end of 24 hour, each tooth was flushed thoroughly with distilled water using hypodermic syringes, to remove the solution or salt accretions of sodium hypochlorite from the canal system, and, to ensure patency of apical openings. This was determined by emergence of water from the apical end of the tooth. The teeth which failed to do so were excluded out of the study since apical stenosis may interfere with the penetration of the dye. The teeth were then placed in 10% nitric acid solution at room temperature for 3-4 days for decalcification. The nitric acid solution was changed every 24 hour and the specimens in the bottle were stirred once every 8 hour. The end-point of decalcification process was determined by ‘needle method’ where the needle was pierced at the unimportant portion i.e. the crown portion of the teeth. After decalcification was completed, the teeth were placed under running water overnight. Then the teeth were dehydrated using ascending grades of isopropyl alcohol solution overnight. The samples were dried with absorbent papers. The dehydrated teeth were then placed into methyl salicylate solution for clearing. It takes around 2 hours to clear the teeth. The demineralized teeth when placed in methyl salicylate turned transparent giving glass like appearance. Commercially available methylene blue dye was injected into pulp chamber using cytoject syringes. The pulp cavity was filled with the dye drop by drop form the coronal portion of the teeth. The anatomy of the root canal was observed and classified based on the Vertucci’s classification.

RESULTS
Amongst 200 mandibular first premolar teeth, 65% had a Type I canal pattern with Type II, Type III, Type IV, Type V, Type VI, Type VII & Type VIII canals being identified in 4%, 15%, 3%, 8%, 2%, 2% & 1% (table I) of the teeth respectively.

Table 1: Percentage distribution of root canal patterns of mandibular first premolars

<table>
<thead>
<tr>
<th>Type of canal pattern</th>
<th>Number of teeth</th>
<th>Percentage of occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>130</td>
<td>65</td>
</tr>
<tr>
<td>Type II</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Type III</td>
<td>50</td>
<td>15</td>
</tr>
<tr>
<td>Type IV</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Type V</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>Type VI</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Type VII</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Type VIII</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>200</td>
<td></td>
</tr>
</tbody>
</table>

Graph 1: Graphical representation of percentage of root canal patterns of mandibular 1st premolars
DISCUSSION
This study analysed the canal morphology of mandibular first premolar teeth amongst western Indian population using decalcification and clearing technique. Many studies on root canal morphology have been carried out using macroscopic sections, radiography,\textsuperscript{10} direct observation with microscope,\textsuperscript{11} Decalcification and clearing, 3D reconstruction,\textsuperscript{12} computed tomography.\textsuperscript{13} It has been found that most detailed information of the root canal morphology can be studied through decalcification and clearing technique. The clearing technique has considerable value in the study of root canal anatomy, for it gives a three dimensional view of the pulp cavity in relation to the exterior of the tooth. In addition, it is not necessary to enter the specimen with instruments, thus the original form and relationship of the canals are maintained. Clearing techniques that render the teeth transparent provide a reliable method for viewing the entire root canal system. Previous studies report a high occurrence of Type I canal pattern.\textsuperscript{14} The most prevalent canal pattern in the present study was Type I occurring in 65\% of the mandibular first premolars. In an earlier study by Vertucci in Caucasian population, the prevalence was 70\%, whereas other studies have reported a Type I canal pattern in 67.2\% to 86.3\% of teeth.\textsuperscript{15} A Type II canal was encountered in 4 \% of the samples and Type V in 8\% of the samples in the present study. Vertucci (1984) in his study did not report any Type II canal patterns, but 24\% of the teeth in his study had a Type V canal pattern. These variations may be attributed to the racial or genetic factors.

Nitric acid is used in the present study as a demineralizing agent as demineralization with nitric acid leads to proper results causing less damage to root canal. Other demineralizing agents that can be used are ethylene diamine tetra acidic acid, hydrochloric acid, urea, chelating agent, electrophoretic decalcification.\textsuperscript{16} Water does not have refractive index that matches human tooth dentin, nor does it match the refractive index of the methyl salicylate oil. Methyl salicylate is the clearing agent of choice in this present study due to its shared refractive index with dentin. Water has to be removed or at least reduced in the sample for the final result to be clear. So, the teeth are dehydrated with ascending grades of isopropyl alcohol i.e. 80\%, 90\% and 100\%. This slow dehydration process can also prevent shrinkage of the specimen which can occur due to rapid removal of water.\textsuperscript{17} The common clearing agent in use are chloroform, benzene, xylene, toluene, carbon tetrachloride, cedar wood oil, methylsalicylate and silicone 710.\textsuperscript{18,19} The methylsalicylate used in present study, was less toxic then xylene, less expensive than cedar wood oil, and silicone 710. Unlike xylene, toluene, chloroform, paraffin and petrol, it is not inflammable. It is moderate in speed of action and causes minimal distortion of tissue when compared with other clearing agents.\textsuperscript{20} Methylene blue dye is used to visualize the internal structure and morphology of the root canal system. It is used due to its differential staining property and dentin permeability. Dye injection into the canal system revealed various canal patterns.
CONCLUSION
A Type I canal pattern was found to be the most prevalent in mandibular first premolar teeth amongst western Indian population. Least prevalence was Type VIII canal pattern.

REFERENCES
17. Dr. Craig Barrington demonstrates the steps behind a new technique that clears a freshly extracted tooth to reveal its internal anatomy, march 16, 2015, endodontic practice.