C-shaped canals in mandibular second molars in the Hong Kong population: a computed tomographic study

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ABSTRACT  Objectives. To investigate the frequency and type of C-shaped root canals in mandibular second molars of the Hong Kong Chinese population, using spiral computed tomographic images. Methods. Spiral computed tomographic images belonging to 116 patients were studied. All teeth were examined in axial computed tomographic sections from pulpal floor to the apex to determine the presence of C-shaped canals. The teeth with C-shaped canals were classified using Melton’s classification. A total of 207 mandibular second molars were studied; 66 (57%) of the subjects were females, and subject ages ranged from 15 to 72 years, with a mean of 34 years. Results. Sixty-two teeth had C-shaped root canals. Of these, 17 (27%) teeth were type I (continuous C-shaped root canals), 28 (45%) were type II (semicolon-shaped canals), and the rest (27%) were type III (two separate canals). All were grooved lingually. Fourteen patients had one mandibular second molar with a C-shaped root canal configuration and one normal mandibular second molar, whereas 24 had bilateral mandibular second molars with C-shaped root canals. Conclusion. The frequency of C-shaped root canals in mandibular second molars is high in the Hong Kong Chinese patients.

Key words: Asian continental ancestry group; Hong Kong; Tomography, spiral computed; Tooth abnormalities

Introduction

The study of root anatomy of teeth has an endodontic as well as anthropological significance. Mandibular second molars usually have two roots and three root canals but variations in the number of roots as well as canal morphology are not uncommon. In 1979, Cooke and Cox 1 first described the term C-shaped root canal. They reported three cases where the root canals were like the English capital letter ‘C’, in which canals were connected by a continuous slit. C-shaped canals are commonly found in permanent mandibular second molars but they can also be found in maxillary first molars 2-4, maxillary second molars, and mandibular first 5 and second premolars 6, third molars 5, as well as in mandibular first molars 7. The mandibular second molars with C-shaped root canals vary in their configurations and many methods have been used to classify such canals 8-9.

This study was undertaken to determine the frequency of C-shaped root canals in second permanent mandibular molars in a sample of spiral computed tomographic (CT) images of teeth in a Hong Kong population.

Methods

Spiral CT images of the mandible of Chinese patients taken at the Oral Radiology Unit, the Faculty of Dentistry of the University of Hong Kong during the year 2006 were selected and examined. The CT images were obtained using a helical single slice CT Hispeed scanner (FX/I CT; General Electric, Milwaukee [WI, USA). The exposure settings were between 120-140 kV and 150 mA with an image resolution of 512 x 512 pixels. The slice thickness was 2 mm. All molars were evaluated in axial sections from the pulpal floor to the root apices so as to identify C-shaped canals (Figure). All CT images were examined...
once by the main author. Age and gender of the patients were recorded. C-shaped canals at the sub-pulpal level were classified into the following three categories using Melton’s classification:

I: C-shaped outline without any separation (continuous C-shaped canal);

II: canals separated by dentin into one canal distant from a buccal or lingual C-shaped canal (semicolon-shaped canal); and

III: two or more separated and discrete canals (separate canals).

Results

Of the 116 patients studied, a total of 91 (78%) patients had both mandibular second molars but 25 (22%) had only a single second molar, so 207 mandibular second molars were studied. Sixty-six (57%) of the subjects were females. Subject ages ranged from 15 to 72 years, with a mean of 34 years. Sixty-two (30%) of 207 teeth had C-shaped root canals; 17 (27%) were type I (continuous C-shaped canals), 28 (45%) were type II (semicolon-shaped canals), and the rest (27%) were type III (two separate canals). All were grooved lingually. Fourteen patients had one C-shaped and one normal mandibular second molar, whereas 24 had bilateral C-shaped canal configurations.

Discussion

Although rare in Caucasians, C-shaped canals in mandibular second molars are relatively common in Asians, being present in 10-52% of individuals (Table). In the present study, we observed a 30% prevalence in the Hong Kong population, which was lower than that reported by Walker (52%) and Yang et al. (32%). Most prior studies had used extracted teeth, whereas we used CT images of teeth in vivo. Although Cimmili et al. used spiral CT images in their study, they were of extracted teeth. Jin et al. also used CT images in a Korean population in 2006 and reported a prevalence of 45%.

Studies of the root canal system of mandibular second molars showed that C-shaped canals were more prevalent in Asian populations. The prevalence of C-shaped canals in Hong Kong Chinese was 30%, which is lower than that reported in other studies. The reason for this discrepancy is unclear but may be due to differences in sample size, sample selection, or methodological differences.

Table: Reported prevalence of C-shaped root canals in mandibular second molars

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Ethnic origin</th>
<th>Total no. of mandibular second molars studied (%) with C-shaped canals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walker</td>
<td>1988</td>
<td>Hong Kong Chinese</td>
<td>100 (52%)</td>
</tr>
<tr>
<td>Yang et al.</td>
<td>1988</td>
<td>Hong Kong and Taiwan Chinese</td>
<td>581 (32%)</td>
</tr>
<tr>
<td>Manning 11</td>
<td>1990</td>
<td>Unknown</td>
<td>149 (13%)</td>
</tr>
<tr>
<td>Weine 16</td>
<td>1998</td>
<td>Mixed</td>
<td>811 (8%)</td>
</tr>
<tr>
<td>Haddad et al. 17</td>
<td>1999</td>
<td>Lebanese</td>
<td>94 (19%)</td>
</tr>
<tr>
<td>Gulabivala et al.</td>
<td>2001</td>
<td>Burmese</td>
<td>134 (22%)</td>
</tr>
<tr>
<td>Gulabivala et al.</td>
<td>2002</td>
<td>Thai</td>
<td>60 (10%)</td>
</tr>
<tr>
<td>Lambrianidis et al.</td>
<td>2001</td>
<td>Greek</td>
<td>480 (5%)</td>
</tr>
<tr>
<td>Al-Fouzan 19</td>
<td>2002</td>
<td>Saudi Arabian</td>
<td>151 (11%)</td>
</tr>
</tbody>
</table>
| Seo and Park 20   | 2004 | Korean                      | 272 (clinical; 33%)
             |      |                             | 96 (in vitro; 31%)                                                    |
| Cimmili et al. 14 | 2005 | Turkish                     | 491 (8%)                                                                |
| Jin et al. 15     | 2006 | Korean                      | 220 (45%)                                                               |
| Present study     | 2006 | Hong Kong Chinese           | 207 (30%)                                                               |
Molars have demonstrated variations in numbers as well as distribution of root canals, possibly due to differences in examination methods. Other explanations for differences between studies include: numbers of teeth evaluated, classification systems used, and ethnic background of the patients. For example, the examination methods varied from extracted teeth, clinical observations, radiographs to CT scans.

Most studies on the prevalence and anatomical characteristics of C-shaped canals in mandibular second molars used extracted teeth or teeth that had been treated endodontically. Such teeth may have undergone many aging changes in the pulpo-dentinal complex, and hence in the root canal system. Most of the teeth examined in the present study were relatively young (mean age, 34 years). The value of intraoral periapical radiographs for diagnosing C-shaped canals is debatable. Cooke and Cox reported that they were not helpful, but Haddad et al. found common characteristics in almost all preoperative radiographs. Lambrianidis et al. reported that preoperative and working length periapical radiographs are of little value in identifying C-shaped root canals, whereas simultaneous interpretation of preoperative, working length, and postoperative radiographs could be helpful. In this study and the one by Jin et al., CT images of teeth with C-shaped canals were not verified by other means (clinical observations or microscopic examination), but the accuracy of CT imaging is well documented.

Teeth with single C-shaped canals are exceptions rather than the rule. Canal configuration can vary at the sub-pulpal floor levels. Yang et al. found the category I configuration to be the least common variant. Category II was the most frequent in their study (45%), which was consistent with the findings of Seo and Park (64% for clinical observations and 57% for laboratory analysis), Yang et al. and Haddad et al. but not those of Jin et al. However continuous or semicolon-typed canals have a high tendency to divide into two or three canals in the apical regions. These findings taken collectively illustrate that C-shaped canals can vary in number as well as form, along the length of the root, causing debridement, obturation and restoration difficulties during endodontic treatment. Due to changing canal configurations at different levels of the root, Melton’s classification has been adapted with various modifications.

Inability to detect C-shaped root canals could lead to endodontic treatment failure. It is therefore important to identify the presence of C-shaped root canals in single-rooted mandibular second molars. Conventional radiographs give only a 2-dimensional view of the teeth, whereas spiral CT images can show 3-dimensional images, and therefore much detail. For this reason, CT has been used in many aspects of clinical dentistry including implantology. Computed tomographic images have been used to measure the mesiodistal and buccolingual length of teeth as well as their relationship to vital structures. Such images can also be used to assess root canal filling materials, posts, dental caries, and root fractures, and the morphology of the root canal system can be accurately visualized. Spiral CT imaging can also be used as a useful tool for diagnosing the morphology of mandibular molars, but the radiation risk involved must be considered.

In conclusion, the frequency of C-shaped root canals in second mandibular molars in the Hong Kong population noted in this study was high, but less than previously reported, which might be due to the use of CT imaging rather than examination of extracted teeth or radiographs. The high frequency of C-shaped root canals in the Hong Kong population has important clinical as well as anthropological implications. The findings reported here could be regarded as a pilot project for a larger anthropological study with multiple calibrated assessors. The clinical significance of using CT for the detection of C-shaped canals in different endodontic cases is yet to be evaluated.

References

10. Lambrianidis T, Lyroudia K, Pandelidou O, Nicolaou A. Evaluation of periapical radiographs in the recognition of C-