Prevalence of Middle Mesial Canals in Mandibular Molars after Guided Troughing under High Magnification: An In Vivo Investigation

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Abstract

Introduction: A limited number of in vivo studies have discussed the prevalence of middle mesial canals in root canal systems of mandibular molars. The reported results have varied between 1% and 25%, with no detailed description of the depth and direction of troughing needed to identify such small canal orifices. The objective of the present study was to determine (1) the prevalence of a middle mesial canal before and after troughing by using a standardized troughing technique, (2) the pathway of the middle mesial canal in relation to the mesiobuccal (MB) and mesiolingual (ML) canals, and (3) its correlation with the patient’s age. Methods: Ninety-one mandibular molars from 87 patients were included in this study. The patient’s age and tooth number were recorded. After access cavity preparation, a standardized troughing technique was performed between MB and ML canals to search for a middle mesial canal by using a dental operating microscope. If a middle mesial canal was located, it was recorded as separate or as joining the MB or the ML canals. Results were statistically analyzed by using Z test and logistic regression. Results: A middle mesial canal was found in 42 of 91 mandibular molars (46.2%). Six middle mesial canals were located after conventional access preparation (6.6%). The other 36 were located after standardized troughing (39.6%). The results were statistically significant (P < .001). There was a higher tendency to locate the middle mesial canal in second molars (60%) versus first molars (37.5%). Younger patients had a significantly higher incidence of a middle mesial canal (P = .004). Conclusions: The middle mesial canal was present in 46.2% of mandibular molars. High magnification, troughing, and patient’s age appeared to be determining factors in accessing the middle mesial canal. (J Endod 2015;41:164–168)

Key Words

Accessory canals, anatomy, dental operating microscope, mandibular molars, mesial root, middle mesial canal, troughing

Root canal system (RCS) disinfection is of paramount importance in endodontic treatment (1). Efforts are made during instrumentation to remove infected pulp tissues and debris from the RCS spaces. However, achieving a sterile environment is impossible because of presence of lateral canals, ramifications, and intercanal communications (2). Complex anatomy is often seen in the mesial root of mandibular molars (1, 3, 4). Few clinical studies have investigated the incidence of middle mesial canals in mandibular molars (5–8). Pomeranz et al (7) classified the middle mesial canal into 3 possible canal configurations: fin, confluent, or independent. Despite reports of a high prevalence of intercanal communications in mandibular molars, reaching 83% (9, 10), success in locating and accessing a middle mesial canal has been very low, ranging between 1% and 25% (5, 6, 11). Failure to locate, clean, and shape these RCSs may result in persistent apical periodontitis (12).

Troughing in the floor of the pulp chamber, with visualization via dental operating microscope, has been proposed by several authors to locate accessory RCSs (5, 6, 8, 13–16). However, the technique describing the depth and direction of troughing, particularly to identify middle mesial canals, has not been thoroughly explained. Lack of such information may result in iatrogenic mishaps while attempting to locate accessory RCS orifices (13). Therefore, the aim of the present study was to do the following:

1. Record the incidence of middle mesial canals in mandibular molars before and after troughing by using a standardized troughing approach
2. Characterize the pathway of the middle mesial canal
3. Determine whether a correlation exists between the prevalence of a middle mesial canal and the patient’s age

Materials and Methods

Patient Selection

The study was approved by the institutional review board of Columbia University, New York, NY. Eighty-seven consecutive patients from a mixed ethnic population, with 91 teeth referred for root canal therapy of their mandibular first (56 teeth) and/or second (35 teeth) molars, were included in this study. The age of patients ranged between...
9 and 71 years, with a mean age of 34 years. All teeth had complete root formation and closed apices.

**Clinical Procedure**

All treatments were performed by the first author by using the dental operating microscope (OPMI pico; Carl Zeiss Meditec, Inc, Dublin, CA) at magnifications ranging between ×6 and ×11. Anesthesia and rubber dam isolation were achieved before initiating treatment. Conventional access cavity was prepared to remove the pulp chamber ceiling (Fig. 1A). Canals were identified, and the number of RCS orifices was recorded at the time. If a middle mesial canal was not located after access cavity preparation, the orifices of the mesiobuccal (MB) and mesiolingual (ML) canals were enlarged up to size 25/04 by using rotary files (Endo Sequence; Brasseler USA, Savannah, GA) (Fig. 1B). Troughing was then initiated in the isthmus area between the MB and ML canals by using size #2 Munce Discovery Bur (CJM Engineering, Santa Barbara, CA). Troughing was performed at the expense of the mesio-axial wall, away from the furcation area, moving the entire isthmus mesially and apically (Fig. 1C). Dentin between the MB and ML canals was removed no more than 2 mm apical to the pulpal chamber floor. The depth of troughing was controlled by using the diameter of the bur head (1 mm in diameter) as a guide. After troughing, a fine explorer was used to check for a negotiable middle mesial canal in the isthmus line between MB and ML canals. If it was found, the orifice was coronally

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Cases with MM</th>
<th>Total no. of cases</th>
<th>MM %</th>
<th>P value</th>
</tr>
</thead>
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<td>&lt;.001</td>
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<tr>
<td>Before</td>
<td>6</td>
<td>91</td>
<td>6.6</td>
<td></td>
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<tr>
<td>After</td>
<td>36</td>
<td>91</td>
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<td></td>
</tr>
<tr>
<td>Mandibular molar</td>
<td></td>
<td></td>
<td></td>
<td>.06</td>
</tr>
<tr>
<td>First molar</td>
<td>21</td>
<td>56</td>
<td>37.5</td>
<td></td>
</tr>
<tr>
<td>Second molar</td>
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<td>Total</td>
<td>42</td>
<td>91</td>
<td>46.2</td>
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MM, middle mesial.

Bold text indicates significance.
flared with rotary files, Shaper X (SX) or Shaper 1 (S1) (Dentsply Tulsa Dental Specialties, Tulsa, OK). Size #15 files (Dentsply Maillefer, Bal-laigues, Switzerland) were placed in the 3 mesial canals, and periapical radiographs were taken to determine whether the middle mesial canal was separate or joining with any of the other RCSs (Fig. 1D). To be recorded as a middle mesial canal, the canal had to be negotiable to within 5 mm of the radiographic apex. All mesial canals were enlarged to a minimum size of 35/04 (Endo Sequence) by using standard needle

Figure 2. Preoperative and postoperative radiographs of 4 possible scenarios of middle mesial canal in mandibular molars. (A and B) Independent middle mesial canal with separate orifice and apical foramen. (C and D) Middle mesial canal with apical fin connecting MB, middle mesial, and ML canals. (E and F) Confluent middle mesial canal joining with ML canal. (G and H) Confluent middle mesial canal joining with both MB and ML canals. (B) was performed by the same clinician in the same manner described but was not part of the study. The image is placed for demonstration purposes.
irrigation of sodium hypochlorite throughout instrumentation. After RCS obturation, a cotton pellet was placed in the access cavity, followed by Cavit (3M ESPE, St Paul, MN), or the tooth was restored with a definitive restoration. Multiple postoperative angulated radiographs were taken to determine the configuration of the middle mesial canal by using the classification by Pomeranz et al (7).

**Statistical Analysis**

A Z test was used to determine the impact of troughing on locating the middle mesial canal and the prevalence of middle mesial canal in mandibular first and second molars. Logistic regression analysis was used to correlate between the patient’s age and presence of a middle mesial canal. This analysis was performed for the following:

1. First molars only
2. Second molars only
3. First and second molars combined

**Results**

Of the 91 mandibular molars treated, 42 (46.2%) had negotiable middle mesial canals. Six of those (6.6%) were located after conventional access cavity preparation. The other 36 (39.6%) were located after troughing between MB and ML canals. The Z test showed troughing to be a significant factor in locating a middle mesial canal (P < .001). There was a trend in locating middle mesial canals more often in mandibular second molars. However, results were not statistically significant (P = .06). There were 21 middle mesial canals (60%) detected in mandibular second molars (n = 35) and 21 (37.5%) in mandibular first molars (n = 56). Results are shown in Table 1.

Of the 42 located middle mesial canals, 4 were independent with separate orifices and apical foramina (9.5%) (Fig. 2C and D). In 5 teeth, the middle mesial canal was a fin that apically communicated with both MB and ML canals (12%) (Fig. 2G and H). In the other 33 teeth, the middle mesial canal was confluent, joining with either MB or ML (Fig. 2E and F), or all 3 canals were joining into 1 RCS (78.5%) (Fig. 2G and H).

Regression analysis showed a significant effect of age on the incidence of middle mesial canal, with decreased prevalence as age increased. That applied in all 3 analyses: mandibular first molar (P = .01), mandibular second molar (P = .02), and all molars combined (P = .004).

**Discussion**

This study highlights the importance of access modification in addressing potential communications present in the mesial root of mandibular molars. Establishing a troughing technique to access the middle mesial canal will assist clinicians in achieving better disinfection of the RCS and possibly better outcome, without excessive damage to the remaining tooth structure. In this study, each tooth served as its own control. This allowed validation of the troughing approach and its impact in locating negotiable middle mesial canal orifices. The troughing procedure (13, 16) requires minimal dentin removal between the MB and ML canals in a mesio-apical direction away from the furcal danger zone (13, 16, 17). Troughing at that level requires clear visibility, specialized instruments, and caution to avoid perforation and its subsequent complications (18). In this study, no perforations occurred in any of the treated teeth. Troughing was controlled to within 2-mm depth by using a 1-mm-diameter round bur head as a depth guide. Further apical extension may jeopardize the visibility and access to the site and possibly lead to root perforation (13). The rationale for using long shank round burs for access modification instead of the commonly used ultrasonic tips (13, 16, 19) was based on the first author’s personal preference. Using such burs for troughing allows controlled cutting, with larger debris particles formation that can be easily removed by using standard needle irrigation.

In this study, troughing was a significant factor in accessing a middle mesial canal (P < .001). Before troughing, the incidence was 6.6%, which coincides with the results presented by Baugh and Wallace (11). After troughing, the prevalence increased by almost 40%. The patient’s age also appears to significantly affect the incidence of locating a middle mesial canal (P = .004). The results are in agreement with previous reports (7, 20, 21). This may be due to the ongoing calcification process that occurs in the pulp chamber and RCS with age (22–24). Such high incidence of middle mesial canal reported in this study cannot be readily explained but may stem from using high magnification, the troughing technique used, and the relatively young patient population. Previous studies were mostly performed on extracted teeth (5, 6, 8), with no reference to the age of the teeth at the time of extraction. It is conceivable that the lower incidence in previous reports (5, 6, 8) is related to using teeth from an older patient population.

It has been proposed by Hess (25) that the mesial roots of mandibular molars develop as 1 RCS, which tend to compress at the middle portion, forming 2 RCSs that are often communicating. In this study, 1 of 8 patients younger than the age of 15 had a single large mesial RCS. This finding disagrees with the results of Peiris et al (21), who reported that in their patient population between the age of 11 and 15, one large mesial canal was common. The incidence of a middle mesial canal in mandibular second molars was higher than in first molars. However, the results were not statistically significant (P = .06). These results are similar to the findings of Karapinar-Kazandag et al (6). This may result from the later eruption of mandibular second molars, allowing better access to intercanal communications before compression and calcification (22–24). This finding is not in agreement with the findings of de Carvalho and Zuolo (8) that first molars had a higher incidence of middle mesial canal compared with second molars.

When communication between the MB and ML RCSs is present, the middle mesial canal may not always be a true separate RCS but rather spaces that still require debridement and disinfection. Regardless of what form these spaces may take, accessing and debriding accessory canals will improve the mechanical efficiency of irrigation and will attenuate the microbial population within the RCS (25). Leaving these spaces untreated may lead to infection and treatment failure (12, 13, 26). It can be argued that mechanical instrumentation of such spaces may weaken the remaining tooth structure. However, previous studies have shown that standard mechanical instrumentation has no significant effect on reducing tooth stiffness (27). Further studies are required to determine the effect of instrumenting the middle mesial canal on the strength of the remaining tooth structure. This study has demonstrated that troughing in the mesial root within a 2-mm depth appears to be an effective and safe approach to examine the mesial roots for potential middle mesial canals. This procedure should be considered as an accessory step when accessing mandibular molars.

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The authors deny any conflicts of interest related to this study.

**References**