Analysis of Tooth Access Opening by Students Who Have Completed a Course in Endodontic Practice (Part I. Molars)

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Abstract
Our dental university has allocated time for endodontic practice to 4th-grade students who have completed a 3rd-grade course in endodontics. In this term, students practice access opening of extracted upper and lower human molars. All the teeth are donated by students themselves, and the effectiveness of this approach for teaching has been analyzed. Students found 3 root canal orifices in 82.1% of upper molars with 3 root canal orifices, and 3 root canal orifices in 87.5% of lower molars with 3 root canal orifices and 2 root canal orifices in 87.1% of lower molars with 2 root canal orifices. No appreciable difference in ease of access opening was observed between upper and lower molars. Perforation occurred about 20% more frequently in upper than in lower molars. Knowledge of tooth anatomy is essential for students studying endodontic practice. Future efforts should be directed at improving endodontic education to ensure that failure does not occur in practice.

Keywords:
Access opening, Tooth morphology, Perforation

Introduction
Graduation from dental school in Japan requires completion of a 6-year course. At Nihon University School of Dentistry at Matsudo, the theory and practice of endodontics is taught to 3rd-grade students. Usually, access opening, root canal treatment and root canal filling of incisors, premolars and molars are done using extracted human teeth or artificial teeth. However, the curriculum was changed in 2005, and time for endodontic practice is now allocated to 4th-grade students who have finished the 3rd-grade student course. At this time, practical experience in access opening is gained using extracted human upper and lower molars. All the teeth are donated by students, and the effectiveness of this approach has been analyzed. Here we discuss the importance of this approach for endodontic teaching and practice.

Materials and Methods
Extracted upper and lower molars were gotten by students, and the teeth were checked by instructors. Severely damaged teeth (C3 and C4) were discarded. X-ray photographs of every extracted tooth were taken from two directions: M-D and B-L. Kodak® X-ray film was used, and the tooth was mounted on the film case as shown in Fig. 1. Students performed tooth access opening by reference to both the tooth and the X-ray photographs. After completion of the procedure, the teeth were donated to us for analysis of the effectiveness of this educational approach. X-ray photographs were taken for two directions (M-D and B-L) using a digital X-ray system (Compuray, Trophy Radiologie, Japan). The donated teeth were checked by instructors, and third molars were excluded from this analysis. A microscope (MANI® IMS22Z) was used for checking the root canal orifice.
had 1 root canal orifice. These data are shown in Table 1.

Access opening

Upper molars: Unsuccessful access opening were observed in 4 root canal orifices teeth. Three root canal orifices, 69/84 (82.1%), 2 root canal orifices, 10/81 (11.9%), and 1 root canal orifice 5/84 (6.0%) were found in 3 root canal orifices teeth. Two root canal orifices, 2/2 (100%), were found in 2 root canal orifices teeth.

Lower molars: Four root canal orifices, 1/2 (50%), and three root canal orifices, 1/2 (50%), were found in 4 root canal orifices teeth. Three root canal orifices, 28/32 (87.5%), 2 root canal orifices, 2/32 (6.3%), 1 root canal orifice, 2/32 (6.3%), were found in 3 root canal orifices teeth. Two root canal orifices, 54/62 (87.1%), 1 root canal orifice, 6/62 (9.7%) were found in 2 root canal orifices teeth, and unsuccessful access opening was 2/62 (3.2%). One root canal orifice, 5/5

Table 2. Discover of root canal orifice in upper molars

<table>
<thead>
<tr>
<th>Number of root canal orifice</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>82.1</td>
<td>11.9</td>
<td>6.0</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
<td>100 (%)</td>
</tr>
</tbody>
</table>

A : adequate disclosure  
B: undiscovered one root canal orifice  
C: undiscovered two root canal orifices

Table 3. Discover of root canal orifice in lower molars

<table>
<thead>
<tr>
<th>Number of root canal orifice</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>87.1</td>
<td>9.7</td>
<td>3.2</td>
</tr>
<tr>
<td>3</td>
<td>87.5</td>
<td>6.3</td>
<td>6.3</td>
</tr>
<tr>
<td>4</td>
<td>50</td>
<td>50</td>
<td>0 (%)</td>
</tr>
</tbody>
</table>

A : adequate disclosure  
B: undiscovered one root canal orifice  
C: undiscovered two root canal orifices

Results

Root canal orifice

Upper molars: 2/90 teeth (2.2%) had 4 root canal orifices, 84/90 (93.4%) had 3 root canal orifices, and 2/90 (2.2%) had 2 root canal orifices. In 2/90 teeth (2.2%), the root canal orifices could not be identified.

Lower molars: 2/101 teeth (2.0%) had 4 root canal orifices, 32/101 (31.7%) had 3 root canal orifices, 62/101 (61.4%) had 2 root canal orifices, and 5/101 (5.0%)
(100%), was found in one root canal teeth. These data were shown in Table 2 and 3. And typical cases were shown in Figs. 2–10.

Perforation
Perforation was observed in both upper and lower molars: in 18/90 upper molars (20.0%) and in 14/104

Fig. 2. Discover of three root canal orifices in four canal orifices tooth

Fig. 3. Discover of three root canal orifices in three canal orifices tooth

Fig. 4. Discover of two root canal orifices in three canal orifices tooth

Fig. 5. Discover of two root canal orifices in two canal orifices tooth

Fig. 6. Discover of four root canal orifices in four canal orifices tooth

Fig. 7. Discover of three root canal orifices in three canal orifices tooth
lower molars (13.9%). Many more perforations were observed on the mesial side than on the distal side in both upper and lower molars; 2/18 (10.1%) perforations including the pulp floor in upper molars and 6/14 (40.3%) in lower molars were observed. These data are shown in Figs. 11 and 12. Typical cases are shown in Figs. 13–16.

*Removal of the pulp horn*

In 42/90 upper molars (46.7%) and 17/101 lower molars (16.8%) the pulp horn was removed completely (Figs. 17 and 18). Appropriate removal was observed more often in upper than in lower molars.

*Overall performance*

Cavities were prepared appropriately in 16/90 upper molars (17.8%) and 14/101 lower molars (13.9%) (Table 4).

Fig. 8. Discover of two root canal orifices in two canal orifices tooth

Fig. 9. Discover of one root canal orifice in two canal orifices tooth

Fig. 10. Discover of one root canal orifices in one canal orifices tooth

Fig. 11. Perforation parts of upper molars

Fig. 12. Perforation parts of lower molars
Fig. 13. Perforation in upper molar

Fig. 16. Perforation containing pulp floor in lower molar

Fig. 14. Perforation in lower molar

Fig. 17. Residual ratio of pulp horn in upper molars. A: pertinency, B: B side, C: all circumferences, D: etc.

Fig. 15. Perforation containing pulp floor in upper molar

Fig. 18. Residual ratio of pulp horn in lower molars. A: pertinency, B: all circumferences, C: BD side, D: D side, E: BLD side, F: etc.

Table 4. Evaluation of outline form

<table>
<thead>
<tr>
<th></th>
<th>pertinency</th>
<th>incongruity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper molar</td>
<td>17.8</td>
<td>82.2</td>
</tr>
<tr>
<td>Lower molar</td>
<td>13.9</td>
<td>86.1 (%)</td>
</tr>
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</table>
Discussion

Access opening is the most important aspect of endodontic therapy because root canal treatment cannot be done without discovery of the root canal orifice. The number of root canal orifices and root canals differs according to tooth type. For example, upper incisors each have one root canal orifice and one root canal, whereas upper premolars have two root canal orifices and two root canals. Knowledge about tooth anatomy is essential for dental treatment, especially endodontic therapy. In the previous research, Nonaka et al. (1) have been reported that knowledge of tooth anatomy is important in endodontic fundamental practice.

Usually, students have learned about tooth anatomy by the time they reach 2nd grade. However, they have no experience in preparing cavities for confirmation of the pulp horn and root canal orifice. Thus, location of the root canal orifice is difficult without a sufficient grasp of the 3-dimensional structure of the tooth.

Upper molars each have 3 root canal orifices (generally, the first molar has 4) and lower molars each have 3 root canal orifices (2, 3). In the present series of teeth, 3 root canal orifices were found in 93.4% of upper molars. However, teeth with 3 root canal orifices accounted for 31.7% of lower molars and teeth with 2 root canal orifices accounted for 61.4%. This result suggested that the majority of the teeth obtained from the students were second molars, especially lower molars.

In practice, students found 3 root canal orifices in 82.1% of upper molars with 3 root canal orifices, 87.5% of lower molars with 3 root canal orifices, and 87.1% of lower molars with 2 root canal orifices. No appreciable difference was observed between upper molars and lower molars in terms of efficiency of access opening. We concluded that most students had a good grasp of the number of orifices in molars.

Perforation was observed in upper molars about 20% more frequently than in lower molars, but many more perforations including the pulp floor were observed in lower molars than in upper molars. As we did not obtain X-ray photographs before access opening, the reason for this is unclear. However, we speculated that perforated teeth had an unusual morphology in the pulp horn and pulp floor area. They may have lacked space due to ageing (3), and it was very difficult to find the position of the canal orifice. Students sought the root canal orifice without, or with insufficient, knowledge of tooth anatomy, and prepared the pulp floor excessively. Finally, gouging and perforation occurred. In future, it will be necessary to give students instruction in anatomical peculiarities of aged teeth to avoid preparation failure in practice. For example, the distance from the cusp to the pulp floor, the size of the root canal orifice, and other features in both aged and young teeth. Poor results were also observed for removal of the pulp horn and outline of the cavity preparation.

We intend to change the approach used for theory and practice of endodontics to improve the results of dental education.

References