Investigation of the endodontic space in maxillary first permanent molars

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Summary
The purpose of the investigation was to establish the exact number of root canals in the maxillary first permanent molar, their direction, type and relation, based upon a large number of random samples.

Randomly chosen 443 maxillary first permanent molars (221 left and 222 right) were investigated with the aim to get more knowledge into the morphology of the endodontic space. One canal in the mesiobuccal root appeared in 366 teeth or 82.62% and three canals in mesiobuccal root were found in 25 teeth or 5.64%. In the distobuccal root two canals were found in 8 teeth or 1.81%. In palatal root two canals were found in 4 teeth or 0.9%. Analyzing the obtained data it has been established that there was not a significant correlation between the appearance of two canals in the mesiobuccal root and the side of the jaw. There is also no relation between the type of the canals and splitting of the mesiobuccal root at the apex.

Key words: pulp, root canals, morphology

INTRODUCTION
A thorough knowledge of the morphology of the endodontic space is a supposition for successful treatment of pulpal affections. Owing to the complexity and variability of the pulpal chamber and root canals endodontia of molars is in general dental practice often avoided. Maxillary first permanent molars being the first teeth to erupt in the childhood are therefore more exposed to caries and dental pathosis more often develops.

Unfortunately many molars are extracted, because of various reasons. There is no doubt that to perform an exact endodontic treatment requires knowledge and practical skill of the dental surgeon combined with patience and appreciation of the person undergoing the complicated endodontic treatment.

It is my opinion that every dental student should become aware of the importance during his special education of endodontia, and to get the best knowledge of the endodontic morphology and become qualified to perform even the complicated endodontic treatment of molar teeth.
For some time the endodontic treatment was not regarded a difficult task, because the dental profession presumed each tooth has one canal only, based on the investigation of Carabelli in 1844.

Numerous investigations have been performed with the aim to throw more light into this problem (Lenhossek, Barrett, Okumura, Hess, Meyer, Skilling, Weine, Wheeler). But in spite of all the efforts of various experts in dental morphology many failures are encountered after endodontic treatment of the molar teeth.

Having in mind the fact that for a successful endodontic treatment it is obligatory to find and negotiate all root canals in the tooth to be treated and afterwards fill hermetically all the empty endodontic space, the task of the present investigation was a direct observation of the root canal in extracted maxillary first permanent molars placing endodontic files in mesiobuccal canals and drilling the root longitudinally until the contact with the file. It was possible in this manner to expose all the existing root canals.

The purpose of this investigations was to established:
1. The number of canals in the mesiobuccal root
2. The number of canals and their types in the distobuccal root
3. The number of canals in the palatal root
4. The relation between root canals and side of jaw

MATERIAL AND METHODS

A random sample of 443 maxillary first permanent molars (221 left and 222 right) was collected following the extraction and stored in glass dishes filled with 5% formaldehyde solution. Afterwards all samples were rinsed with running water and cleaned to remove remaining parodontal tissue and kept in a dish of 3% hydrogen peroxid for 24 hours, and then rinsed with 70% alcohol and dried with warm air.

All teeth were opened on the occlusal surface using high speed air turbine with a cylindrical diamond bur with water spray. The roof of the pulp chamber was removed with a low rotating fissure bur No. 2. After the removal of pulp tissue the entrance of the mesiobuccal, distobuccal and palatal canals were made visible. The entrance to the additional secondary mesiobuccal canal often can not be seen due to the inclination of the mesioaproximal surface of the pulpal wall, which covers the entrance to mesiobuccal additional-secondary canal. In order to expose this canal a part of the mesiobuccal surface of the pulpal wall was removed starting from the primary mesiobuccal canal towards the palatal wall approximately 1 mm wide and 2–4 mm long.

Kerr reamers No 08 and 010 were placed in the exposed canals. This was followed by longitudinal drilling of the mesiobuccal root until the first contact with reamers along the entire length of the root. Root canals were then dyed to make a better observation of relation and directions of root canals possible.
Tables No 1, 2 and 3 show the occurrence of all canals in the mesiobuccal, distobuccal and palatal roots, and the percentage in relation to their total appearance.

### Table 1

<table>
<thead>
<tr>
<th>Mesiobuccal root</th>
<th>Occurrence</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 canal</td>
<td>52</td>
<td>11.74</td>
</tr>
<tr>
<td>2 canals</td>
<td>366</td>
<td>82.62</td>
</tr>
<tr>
<td>3 canals</td>
<td>25</td>
<td>5.64</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>433</td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

Photographs 1, 2, 3 show the mesiobuccal root with various numbers of canals.

![Fig. 1 One canal in the mesiobuccal root](image1)

![Fig. 2 Two canals in the mesiobuccal root](image2)

![Fig. 3 Three canals in the mesiobuccal root](image3)

### Table 2

<table>
<thead>
<tr>
<th>Distobuccal root</th>
<th>Occurrence</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 canal</td>
<td>435</td>
<td>98.19</td>
</tr>
<tr>
<td>2 canals</td>
<td>8</td>
<td>1.81</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>443</td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

### Table 3

<table>
<thead>
<tr>
<th>Palatal root</th>
<th>Occurrence</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 canal</td>
<td>439</td>
<td>99.1</td>
</tr>
<tr>
<td>2 canals</td>
<td>4</td>
<td>0.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>443</td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>
Table 4 show the appearance of various types of canals in the mesiobuccal root.

<table>
<thead>
<tr>
<th>Type of canal in the mesiobuccal root</th>
<th>Occurrence</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two separated canals</td>
<td>172</td>
<td>46.99</td>
</tr>
<tr>
<td>Two partially connected canals</td>
<td>28</td>
<td>7.65</td>
</tr>
<tr>
<td>Two connected canal at the apex region</td>
<td>166</td>
<td>43.35</td>
</tr>
<tr>
<td>Total</td>
<td>366</td>
<td>100.00</td>
</tr>
</tbody>
</table>

The distribution of certain types of canals in the mesiobuccal root in relation to the side of the jaw is shown in table 5.

<table>
<thead>
<tr>
<th>Number and type canals in the mesiobuccal root</th>
<th>Occurrence</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>Two separated canals</td>
<td>91</td>
<td>81</td>
</tr>
<tr>
<td>Two partially connected canals</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Two connected canals in the apex region</td>
<td>75</td>
<td>91</td>
</tr>
</tbody>
</table>

Figure 4 presents the occurrence of two separated canals, two partially connected canals, and two connected canals in the apical region.
Figure 5, 6, 7 presents the section of the mesiobuccal root with different types of their canals.

It was established that the maxillary first permanent molars can have in their mesiobuccal root two separate canals, two partially connected canals and two canals which join in the apex region. This phenomenon does not depend upon the side of the jaw. In all types of canals in the mesiobuccal root a marked splitting on the apex of the root up to 1 mm was observed (Fig. 8).
The obtained and analysed data show that the type of the canals does not depend on splitting of the root apex. This substantiates the hypothesis that in separated additional secondary canals three is the same percentage of teeth with splitting of the apex of the root and teeth without splitting (probability $p_1 = 0.81$, $p_2 = 0.86$).

Three canals were found in the mesiobuccal root in 5.6%. They can be differently orientated:

a. Three canals connected at third of the apex
b. The third canal connected with the primary canal
c. Secondary canal connected with the primary canal, and
d. Three separated canals.

My observation regarding the distobuccal root of the maxillary first permanent molars. Two canals have found in 1.81%. In the palatal root two canals have found in 0.9% of the cases. These canals are also differently orientated.

DISCUSSION

Numerous investigations performed during the past years have revealed that the maxillary first permanent molar has a very complex endodontic morphology. This refers especially to the mesiobuccal root.

Various data on the presence secondary canal in the mesiobuccal root of the maxillary permanent molar have been published. This variety is due to different methods applied in the investigations and to the fact that in the investigations the first and second molars were considered together. According to my clinical experience maxillary first and second permanent molars show a series of morphological differences which lead to different relations within the pulp space. Lenhossek reports that the secondary canal was found in mesiobuccal root of the maxillary first molars in 62%. Hess investigated maxillary first and second molars together, and concluded that the secondary canal was present in 53% of the cases only.

Green reports double canals in the mesiobuccal root in 50%, Okumura in 52%, Weine in 51.5% of the cases. Nosonowitz and Brenner in their in vivo reported 69%, and Pineda and Kuttler in 74.7% of the cases. Acosta and Trugeda reported on the presence of the secondary canal in 68.40%.

The comparison of the above data on occurrence of the secondary canals in the mesiobuccal root with my results shows somewhat a higher appearance of the additional secondary canals, which is due to simplicity of my method used and the objectivity of evaluation based upon direct observation using the described method.

The occurrence of the two separated canals varies from 8.2% (Bence) to 47% (Pineda). In this study two separated canals in mesiobuccal root have been found in 46.99% of the cases. In comparison the shape of the mesiobuccal root with the type of the canal, a regularity in the appearance of a marked splitting on the apex of the root has been observed. However, by analyzing the data it was established that the type of the canal does not depend on the presence of
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a splitting of the root. Kerekes and Tronstad\textsuperscript{17}, on the basis of the investigation carried out on 40 maxillary first permanent molars, have reported about in 10\% two canals in the palatal root. Comparing this result with my own I believe that this percentage is too high, because I could not verify it on 443 maxillary first permanent molars (Šutalo\textsuperscript{18}). My results are identical with results Cecic\textsuperscript{19} and al. being 0.9\%.

Further thoroughly investigations are necessary to clarify the problem of endodontic space in maxillary first permanent molars.

CONCLUSION

Based on results in the investigation of 443 randomly chosen maxillary first permanent molars, the following may be drawn:
1. One canal in the mesiobuccal root was found in 52 samples or 11.74\%.
2. The occurrence two canals in the mesiobuccal root was found in 366 samples or 82.62\%.
3. Three canals in the mesiobuccal root of the maxillary first molars were found in 25 or 5.6\% of the cases.
4. Two canals in the distobuccal root were found in 8 samples or 1.81\%.
5. Two canals in the palatal root were found in 4 specimen or 0.9\%.

Analyzing the obtained data, it has been established that there is no significant difference between the occurrence of two canals and in the respect of the left and the right side of the jaw.. There has not been a relation between the type of the canal and the splitting at apex of the mesiobuccal root.

References


Sažetak

U ovom je radu ispitivana morfologija endodontskih prostora prvih gornjih kutnjaka. Poznata je činjenica da se neuspjesi u endodontskom tretmanu prvog gornjeg kutnjaka osim neadekvatnog tehničkog pristupa mogu pripisati i nedovoljnom poznavanju morfologije endodontskog prostora. Činjenica da se u stomatološkoj literaturi dugi niz godina raspravlja o endodontskoj morfologiji prvog gornjeg kutnjaka nije bila zapreka da se pristupi ovom istraživanju iz razumljivog razloga što su podaci iz literature vrlo različiti, a kadkad i oprečni. U nakani da se ustanovi stvaran broj kanala u korijenvima prvog gornjeg kutnjaka, njihov međusobni odnos kao i moguće morfološke varijacije, nasumče je uzeto 443 ekstrahiranih prvih gornjih kutnjaka (221 lijevih i 223 desnih). Nakon čišćenja i sušenja svi su uzorci otvarani na okluzijskoj plohi turbo-bušilicom i dijamantnim brusnim tijelom do krova pulpne komorice, koji je zatim odstranjivanje čeličnim svrdlom br. 2 do potpunog nestanka rogova pulpe. Ulazi u primarni mezio-bukalni, disto-bukalni i palatinalni kanal su uvijek bili vidljivi, dok se ulaz u sekundarni meziobukalni kanal nije mogao vidjeti bez dodatnog uklanjanja dijela mezioapikalne stijenke pulpne komorice.

U ovako prikazane kanale postavljeni su Kerr proširivači No 008-0010, a zatim je izvršeno uzdužno brušenje mezio-bukalnog i disto-bukalnog korijena do arvor kontakta s površinom proširivača. Nakon uklanjanja proširivača izvršeno je bojenje kanala polikolor bojama.

U raspravi o rezultatima se aovori o broju kanala u pojedinim korijenvima prvog gornjeg kutnjaka. Najveću pažnju je privukao meziobukalni korijen zbog složenosti svoje morfologije. Od sveukupno ispitanih 443 prvih gornjih kutnjaka u meziobukalnom korijenu utvrđeno je 52 zuba s jednim kanalom ili 11.74%, 366 zuba ili 82.62% s dva kanala i 25 zuba ili 5.64% s tri kanala. U distobukalnom korijenu su dva kanala utvrđena u 8 zuba ili 1.81%, dok su u palatinalnom korijenu dva kanala nađena samo u 4 zuba ili 0.9%. Korijenki kanali mogu imati različite međusobne odnose. U meziobukalnom korijenu susreću se potpuno separirana dva kanala u 172 uzorka ili 46.99%, dva dielomično spojena kanala u 28 uzorka ili 7.65% u dva kanala koji se međusobno spajaju u predielu apikalne trećine korijena u 166 uzorka ili 43.35%.

U daljnjem tijeku rada se raspravljalo o povezanosti između pojave separiranih kanala u meziobukalnom korijenu sa znakovima kalanja na apektu korijena, kao i korelaciji između pojave dvostrukih kanala i strane čeljusti. Utvrđeno je da ne postoji signifikantna razlika između ove dvije pojave.

Ključne riječi: pulpa, korijenski kanali, morfologija