UDC: 611.314:616.314.16]:616.314.6

EVALUATION OF ROOT ANATOMY AND CANAL MORPHOLOGY OF MAXILLARY SECOND PREMOLARS

ЕВАЛУАЦИЈА НА КОРЕНСКАТА АНАТОМИЈА И КАНАЛНА МОРФОЛОГИЈА НА МАКСИЛАРНИТЕ ВТОРИ ПРЕМОЛАРИ

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Abstract

The **aim** of this study was to evaluate the root anatomy and apical canal morphology in maxillary second premolars. For the set task thirty (30) maxillary second premolars were extracted. After thorough rinse, visual assessment of root anatomy was made. Each root was transversally sectioned six millimeters from apex. The apical amputates were decalcificated in 7.5% trichloroacetic acid, then stored in 10% formalin and dyed with hematoxylin-eosin. Apical canal morphology was evaluated with an optical microscope. Most of the maxillary second premolars had a single root with almost equal occurrence of one, two, as well as variable root canal configuration (70.0%; n=21). Equal occurrence of double separated and fused roots with total value of (27.0%; n=8) was noted, with a single canal and two root canals accordingly. A very rare occurrence of maxillary second premolar with three roots (3.0%; n=1) was detected, two vestibular and one palatal, each containing a single canal configuration. Accessory lateral canals were detected in 17.0% of maxillary second premolars. Transversal communications were detected in maxillary second premolars with one root and double fused roots (46.6%; n=14). Two apical foramina were detected in the majority of maxillary second premolars (46.6%; n=14). A single apical foramen (36.6%; n=11), three (10.0%; n=3), four (3.4%; n=1) and five apical foramina (3.4%; n=1) were detected as well. When surgery of maxillary second premolars is to be considered, it is reasonable to expect difficulties because of variable canal configuration, transversal canal communications and numerous apical foramina, that cannot be detected with clinical and radiology examinations. **Keywords:** maxillary second premolar, root anatomy, canal morphology, decalcification, optical microscope

Апстракт

Цел на оваа студија беше да се процени коренската анатомија и каналната морфологија на максиларните втори премолари. За остварување на поставената цел триесет (30) максиларни втори премолари беа екстрахирани. По темелна промивка се направи визуелна проценка на коренската анатомија. Секој корен беше трансверзално пресечен 6мм од коренскиот апекс. Добиените апикални ампутати беа декалцинирани во 7,5% трихлороцетна киселина, фиксирани во 10% формалин и обоени со хематоксилин и еозин. Апикалната канална морфологија беше проследена со оптички микроскоп. Најголем број на вторите премолари имаа еден корен, со скоро еднаква застапеност на една, два и променлива канална стуктура (70.0%; n=21). Еднаков број на двокорени примероци со фузионирани и сепарирани корени беше забележан (27.0%; n=8) со соодветна застапеност на едноканална и двоканална конфигурација. Во оваа студија беше забележена и многу ретка појава на максиларни втори премолари со три корени (3.0%; n=1), два вестибуларни и еден палатинален, секој со по еден канал. Акцесорни канали беа детектирани кај 17,0% од примероците. Трансверзални комуникации беа детектирани кај премоларите со еден корен и со фузионирани корени (46,6%;n=14). Два апикални форамени беа детектирани кај повеќето примероци (46,6%;n=14). Покрај тоа, беа забележани еден форамен (36.6%; n=11), три (10,0%; n=3), четири (3.4%; n=1) и пет форамени. Врз основа на добиените сознанија од оваа студија кога е во прашање хируршка терапија на максиларните втори премолари може да се очекува комплексност поради варијабилната канална конфигурација, трансверзални конекции и мултипни апикални форамени кои клинички и рентгенолошки не можат да се детектираат. **Клучни зборови:** максиларен втор премолар, коренска анатомија, апикална канална морфологија, декалцификација, оптички микроскоп.

Introduction

A thorough knowledge and understanding of root anatomy and canal morphology is a key prerequisite for successful surgical and endodontic treatment.

Apical surgery of maxillary premolars is a delicate surgical procedure that incorporates removal of apical pathology, identification of roots number and location, root resection, examination, identification, instrumentation of the complex apical canal anatomy and placement of hermetic apical seal.

Intraoral and extra oral radiography is an important preoperative diagnostic tool that proffers a two dimensional image of a three dimensional entity. Therefore the

number of roots, their shape, position and complex inner canal morphology remain questionable, even guessable.

Clinical examination and exploration, adjacent to radiographic evaluation, using various probes and canal files enables the surgeon additional information concerning the root canal morphology.

Nevertheless, the apical canal morphology remains uncertain and dubious.

Hence, surgeons and endodontists are forced ad nauseam to follow their own tactile sensitivity rather than trail required preoperative anatomical landmarks with clear accuracy.

It is of paramount importance to be able to identify and verify existing root and apical canal morphology preceding any surgical and endodontic procedure.

There are several published data on the root and canal morphology of maxillary second premolars.

Frequent variation in the number of root canals, the configuration of pulp cavity and insufficient knowledge of the morphology of maxillary first and second premolars can affect the outcome of the endodontic treatment. The upper premolars can have canals that are difficult for treatment because of the proximity of the maxillary sinus and variations of the apical delta[1,2]. The relative simplicity and uniformity of the external surfaces of roots often mask internal complexity[3].

The maxillary premolars are among the most difficult teeth to treat due to their variation in number of roots, canal configuration, the direction and longitudinal depressions of the roots, and various pulp cavity configurations[4,5].

The roots of these teeth are very problematic, especially in the apical third. Thus, the treatment of the canal in the apical portion has to be performed with great caution[6].

The aim of the present study was to evaluate the root anatomy and apical canal morphology of maxillary second premolars.

Material and methods

For the set task thirty (30) maxillary second premolars were extracted. After thorough rinse, visual evaluation of root anatomy was made. Each root was transversally sectioned six millimeters from the apex with a straight hand piece. The apical samples were decalcificated in 7.5% trichloroacetic acid (Merck, UK), exposed in a series of transversal sections starting and numerated from I to VI. The transversal apical sections were stored in 10% formalin and dyed in hematoxylin and eosin {H&E}. Apical canal morphology was evaluated with a Leica DM 2500 optical microscope (Leica Microsystems, Germany).

Results

The majority of second premolars were single rooted (70.0**%**; n=21). Double separated and fused roots with equal occurrence was noted with a total value of27.0%; n=8. Three roots were found **in** 3.0%; n =1. The root anatomy distribution of maxillary second premolars is presented in figure 1.

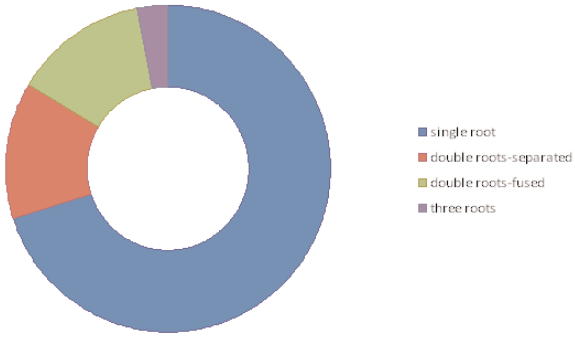

Figure1. *Root anatomy distribution, n=30 (100%)*

Maxillary second premolars with single root (70.0%; n=21) had a single and two apical canal configuration (Fig. 2). Equal occurrence of double separated and fused roots was noted, with a total value of 27.0%; n=8, with a single and two root canal configuration accordingly. A very rare three rooted type of premolar with a single apical canal configuration per root was detected in3.0%; n=1. The distribution of apical canal morphology is presented in Table 1.

Accessory lateral canals were detected in 17.0% of maxillary second premolars.

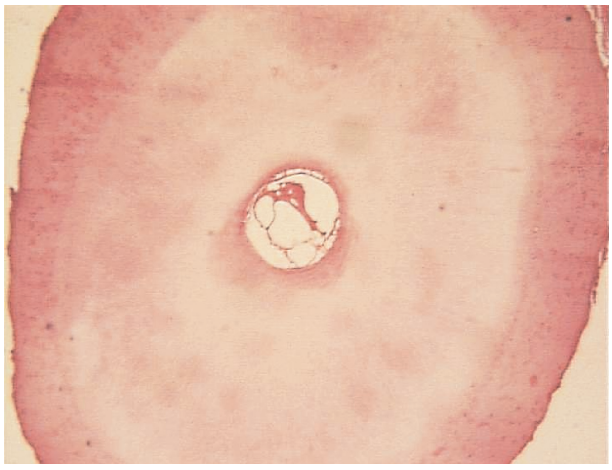

Figure 2. *Single canal (optical microscope, x40 magnification, H&E)*

Table 1. Distribution of apical canal morphology

Apical canal morphology	Single root	Double roots vestibular/palatal		Double roots fused	Three roots vestibular (2) / palatal		
one canal	10	2	2	2	1	1	1
two canals	9	2	2	2	0	0	0
variable canals	2	0	0	0	0	0	0
N=30	21	4		4	1		

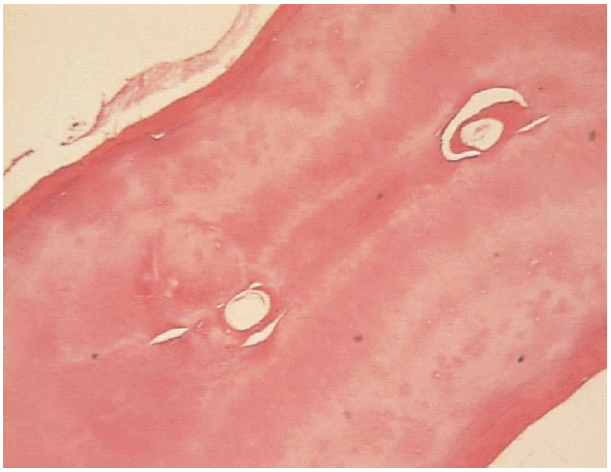

Figura 3. *Two canals (optical microscope, x 40 magnification, H&E)*

Figura 5. *Apical sample with irregular shaped apical foramen (optical microscope, x40 magnification, H&E).*

Transversal communications were detected in maxillary second premolars with one root and double fused roots (46.6%; n=14).

Two apical foramina were evident in the majority of maxillary second premolars (46.6%; n=14). A single apical foramen (36.6%; n=11), three (10.0%; n=3), four (3.4%; n=1) and five apical foramina (3.4%; n=1) were detected as well. The number and location of apical foramina are presented on Figure 4.

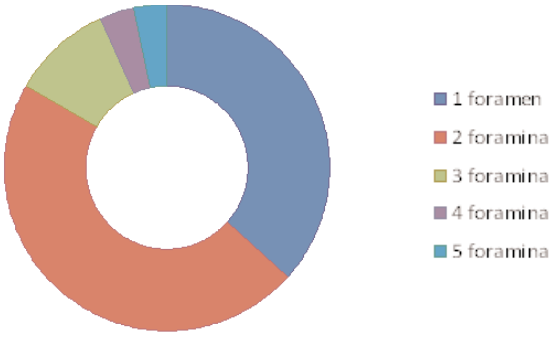

Figura 4. *Incidence of apical foramina*

Discussion

The prime scope of this study was evaluation of the root and apical canal morphology of maxillary second premolars.

In this study, a clear distinction between the root forms was established according to recommendations[7].

The results from our study confirmed a clear predominance of single rooted maxillary second premolars (70%). Far less were double rooted (27%), as demonstrated by other studies. According to Stošić N et al[6] the upper second premolars had one root more often (89.6%). Elkady AM et al.[8] studied the morphology of the root of the second upper premolar using CBCT (cone beam computed tomography). They found that 76.4% of teeth had one root, and the remaining 23.6% of teeth had two roots. A large distribution of one root (in 90% of cases) was also observed in the study conducted on a much larger sample size[2].

Triple rooted maxillary second premolars are a very rare entity. Although the sample size of our study was modest, we encountered three rooted samples, as high as

the reported 0.8-6%[9]. The differences between the results of these morphology studies may be related to variations of examination methods, classification systems, sample sizes, and ethnic background of tooth sources[10].

Morphological canal variations are numerous and are particularly present in the apical root portion.

Unfortunately, the results are difficult to compare, but it's obvious that root canal morphology varies greatly among different populations and even in different individuals within the same population[11].

Because of these differences in the morphology of teeth in patients of different geographic and ethnic groups (on different continents), taking precautions is necessary when relying on the results obtained from studies done in other populations[7].

Numerous studies have been carried out, using different methods such as radiography[12], cleaning and decalcification[13], cutting and microscopic observation[14], and computed tomography for better understanding of the morphology of the canals[15].

It has been reported in the literature that ex vivo demineralization and staining provides the most detailed information, while maintaining the original form and relations of canals[16].

In our study, by implementing the method of decalcification, cutting, staining and microscopic observation, we were able to detect the variation of the apical root canal morphology of the second premolars.

Internal root canal system morphology reflects the external root anatomy. Furthermore, there is correlation between the shape of the outer surface of the root and the shape of the root canal.

Because of unpredictable variations of the apical canal system of maxillary second premolars, the canal evaluation of successive apical transversal sections was performed with stereo microscope and magnification.

The upper second premolars show many variations in the number of canals[17]**.** Predominantly single rooted samples had an equal presence of single and double root canal morphology (70%, n=21). Other study reported upper second premolars with one canal in 79.2% of cases[18] which was much higher than the percentage reported by other authors, despite the fact that even in their research the percentage of one canal was more common[1,2,19]. The frequency of three canals was much lower as only one premolar had three canals (2%), which was also observed in the study of Vertucci F et al[20].

Our results of single canal configuration in maxillary double rooted and three rooted second premolars were in accordance with the published study[21].

Double rooted fused and single rooted samples expressed unpredictable apical canal morphology due to two canal structure as well as a variable one-two–one canal structures.

When two or more canals are present within a single root, chances for transversal communications rise. Literature has reported a high percentage of inter canal communications in teeth with two canals. This communication is of clinical significance as it may be difficult to debride and fill it adequately[22].

The results from our study reported high incidence of transversal communications in maxillary second with two canals (46.6%).

Lower incidence of inter-canal communication or transverse anastomoses/isthmus in 16% of the samples was reported[16].

This was in accordance with the textbook of endodontics, where maximum incidence of intercanal communication was in the middle third of the root[23].

Accessory root canals are predominantly seen in the apical root portion with incidence of 17%[24].

Canal configurations of the maxillary second premolars were categorized at the apex level. Lateral canals were located mainly in the apical region (17%).

The occurrence of lateral canals in our study was consistent with the reported incidence[24].

The number and location of apical foramen is of clinical significance during working length determination, which often depends on the average position of the apical constriction relative to the root apex[22]. The majority of maxillary second premolars in our study had two apical foramina (47.0%). However, the occurrence of a single, three and four foramina with eccentric locations were also detected.

Conclusion

Maxillary second premolars were predominantly single rooted with variable canal morphology, transversal communications and multiple apical foramina. Thus, when surgery is considered it is reasonable to expect complexity.

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