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Original Article

Evaluation of mandibular premolars root canal morphology by cone beam computed tomography

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Abstract

Introduction: To achieve a successful endodontic treatment, the clinician has to identify the different canal configurations.mandibular premolars have the wide variety of root canal morphology and they are known as the most difficult teeth to treat in endodontics.CBCT provides a non-invasive 3D confirmatory diagnosis as a complement to conventional radiography.The aim of this study was to evaluate the root canal morphology inmandibular premolars using CBCT technology.

Materials & Methods: A total of 114 cone-beam computed tomographic images including 228 mandibular first premolars and 228 mandibular second premolars with fully developed roots, were investigated.The CBCT images were collected from private oral and maxillofacial radiology centers in Isfahan, were examined in axial section and the information of each tooth was recorded by three examiners. Then, the data were analyzed by computer analysis such as; t-test, McNamara, chi-square test.

Results: Of the first premolars 89.56% had a single canal and 10.09% had two canals and 0.44% was C shaped. Of the second premolars 97.37% had one canal and 2.19% had two canals. None of mandibular premolars had three canals and just one C-shaped canal was observed (0.44 %). There was no significant correlation between the prevalence of the diversity of canals and gender.

Conclusion: In this study, most of the mandibular premolars had single canal and first mandibular premolars were five times more likely to have two canals than second premolars.

Keywords: Cone beam computed tomography, Premolar, Root canal

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بررسی مورفولوژی کانال ریشه ی پره مولرهای پایین با استفاده از CBCT

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چکیده

مقدمه: برای موفقیت درمان اندودنتیک ، کلینیسین باید از آناتومی و شکل های مختلف کانال ریشه آگاهی داشته باشد. پره مولرهای مندیبل تنوع گسترده ای از انواع شکل کانال ریشه را دارند و جزو سخت ترین دندانها برای درمان ریشه محسوب میشوند CBCT .روش تصویربرداری سه بعدی غیر تهاجمی است که جهت تشخیص مورفولوژی کانال به کار میرود ومکمل رادیوگرافی معمولی است. هدف از این مطالعه ارزیابی مورفولوژی کانال ریشه پره مولرهای فک پایین با استفاده از CBCT است.

مواد و روش ها: در این مطالعه ۱۱۴ کلیشه ی رادیوگرافی، شامل ۲۲۸ دندان پره مولر اول و ۲۲۸ دندان پره مولر دوم فک پایین با ریشه های کاملا تکامل یافته بررسی شدند. این تصاویر از مراکز خصوصی رادیولوژی دهان و فک و صورت اصفهان بدست آمد و در مقطع آگزیال توسط سه بازدید کننده بررسی و اطلاعات هر دندان ثبت گردید. سپس داده های بدست آمده با استفاده از آنالیزهای کامپیوتری همچون تی تست، مک نامارا و مجذور کای تحلیل گردید.

یافته ها: ۸۹/۵۶٪ از پره مولرهای اول تک کاناله ،۱۰/۰۹ ٪ از آنها دو کاناله و ۰/۴۴ ٪ کانال C شکل داشتند. ۹۷/۳۷ ٪ از پره مولرهای دوم تک کاناله ،۲/۱۹٪ دو کاناله بودند و ۰/۴۴ ٪ از آنها کانال C شکل داشتند.هیچ یک از پره مولرها سه کاناله نبود. ارتباط معناداری میان جنس و شیوع تنوع کانالی یافت نشد.

نتیجه گیری: در مطالعه حاضر اکثر پره مولرهای فک پایین تک کاناله بودند.درصد دو کاناله بودن دندان پره مولر اول فک پایین حدود ۵ برابر بیشتر از پره مولر دوم میباشد.

واژگان کلیدی: توموگرافی کامپیوتری با اشعه مخروطی، پره مولر ، کانال ریشه

Introduction

Knowledge on pulp anatomy is absolutely necessary to achieve success in endodontic treatment. Undetected root canals are the cause of 42% of root canal retreatment.[1]Mandibular first premolars are known as the most difficult teeth to treat in endodontics and have the highest rate of non-surgical endodontic treatment failure(11.45%);the reason is attributed to the wide variety of root canal morphology and difficult access to the second canal.[2,3]Several studies have reported a large variation in the number of roots, root canal type, and apical foramina in mandibular premolars.[4-6]On the other hand, there is a high incidence rate of mandibular premolars with more than one root canal; the prevalence of two canals in the first and second premolars is 27.8% and 8.9%, respectively,and this will affect the outcomes.[2] Unfortunately, the two-canal morphology of mandibular premolars is rarely considered in diagnostic radiography. The lingual inclination of the crown towards the root, especially in the first premolar,and also the separation of the secondary canal with an acute angle,leads to the second canal remaining undiagnosed both in radiography and tactile examinations.[7] Modifying the horizontal angle of radiography,paying attention to disappearance or rapid narrowing of the main canal in radiography(fast break),and meticulous searching with file tip usually facilitate the discovery of the second root canal for clinicians.[8] In a case report, Nallapati declared that in mandibular premolars with more than one canal, the cervical half of the root is often wider than usual with or without a low taper. Therefore, an accurate interpretation of the crown and root morphology of these teeth could be sign of extra root canals.[1] In a similar study, Warren and Laws investigated the relationship between the crown size and the prevalence of two root canals in mandibular incisors by Peck and Peck index of orthodontics.this index describes the numerical expression of the crown shape and is the result of dividing the maximum mesiodistal (MD)diameter by maximum faciolingual (FL) diameter multiplied by 100. Using calipers, they calculated Peck

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and Peck index for teeth determined as two-canal incisors in radiography and evaluated the relationship between the teeth with two canals and the index.[9] Today, some progress has been made in producing three-dimensional images, among which, cone-beam computed tomography (CBCT) technology provides us with some information concerning extra root canals, apical deltas, canal type, accurate measurement potential in all aspects of root canal system, and in total, CBCT images which have been found to be useful in providing accurate three-dimensional anatomic details invivo.[10-13] Considering the high potential of CBCT in the diagnosis of such cases, we evaluated root canal morphology in mandibular premolars by means of CBCT technique in this in vitro study.

Materials and Methods

A total of 114 CBCT images including 228 mandibular first premolars and 228 mandibular second premolars with fully developed roots were evaluated. The CBCT images were collected from private oral and maxillofacial radiology centers from July 2014 to April 2016in Isfahan. CBCT images of men and women, aged 18-65 years were examined. The CBCT images had good quality, and the permanent premolars had no periapical lesions, no root canals with open apices, resorption, or calcification, absence of root canal therapy, posts, and crown restorations, and fully erupted. To evaluate the bilateral occurrence of 2 rooted, three-rooted or C-shaped mandibular first and second premolars, we only evaluated the patients who had bilateral mandibular first or second premolars. All the images were separately assessed twice by three examiners (one endodontist and two maxillofacial radiologist) with a 4-week interval between the assessments. Then, the obtained data were analyzed by computer analysis such as; t-test, McNamara, correlation and chi-square test.

The CBCT images were obtained using a CBCT scanner (Scanora 3D;Sordex, Tulsua, Finland) at 89 kVp, 18.54 mA with an exposure time of 8-9 s .The axial thickness was 0.1 mm and the voxels were isotopic. Serial axial CBCT images were evaluated continuously by moving the toolbar from the orifice of the pulp chamber to the apex to determine the number of canals and their morphology. If there was any doubt regarding the number of root canals during the analysis of axial sections, the number and type of canals were confirmed in the coronal and sagital section. The total numbers of roots, the root canal configuration, and unilateral or bilateral occurrences were analyzed. The incidence and the correlations among right and left side and between females and males were determined. The chi-square test was used to evaluate the statistically significant differences between both genders. Statistical significance was identified at the level of $P < 0.05$.

Results

In the current study, all the teeth were single-rooted teeth. Of the first premolars, 89.47% had a single canal, 10.08% had 2 canals and 0.44% was C-shaped. Of the second premolars 97.37% had one canal, 2.19% had two canals and 0.44% was C-shaped. None of mandibular premolars had three canals and just two C-shaped canals were observed. There was no significant correlation between the prevalence of the diversity of canals and gender (P-value=0.1).The results showed that all the mandibular first premolars in the present study were single-rooted. The numbers and percentages of canals in mandibular first premolars were evaluated in this study as shown in table 1.

Table1. Numbers and percentages of root canals in the investigated mandibular first premolars

Number of Canals	Numbers	Percentages
One Canal	204	89.47
Two Canal	23	10.08
Three Canal	0	0
C-shaped	1	0.44
Total	228	100

The numbers and percentages of mandibular second premolars,evaluated in this study population are illustrated in table 2.

Table2. Numbers and percentages of canals in the investigated mandibular second premolars

Number of Canals	Numbers	Percentages
One Canal	222	97.37
Two Canal	5	2.19
Three Canal	0	0
C-shaped	1	0.44
Total	228	100

There was no significant correlation between the prevalence of diversity of canals and gender. Of the mandibular premolars in female 91.1% had one canal and 9.9 % had two canals. Of mandibular premolars in male 92% had one canal , 7.2% had two canal and 0.8% had c-type configuration. There were no significant differences between females and males regarding the overall occurrence of the canals (P-value=0.1)

Discussion

It is essential to have a thorough knowledge of root canal morphology and configuration for successful endodontic treatment. [14, 15]One of the most commonly missed canals are the second canals in the mandibular premolars. Therefore, to treat or retreat mandibular premolars, dentists need to be aware of the possible existence of two or more root canals before they initiate endodontic treatment.[16] There are differences in the root canal morphologies of different populations.[17]The present study provides a detailed investigation of the

root and canal morphology of mandibular permanent premolars using CBCT in a selected Iranian population.

Many studies have examined root and canal morphologies using various methods. The methods used in analyzing root canal morphology are sectioning, canal staining and tooth clearing techniques, conventional radiography techniques, contrast medium-enhanced radiography, modified canal staining and clearing, and computed tomography (CT) scanning.[18]CBCT has been widely used to evaluate the endodontic applications by clinicians in the past few years, and provides clinicians with three-dimensional information about the external and internal morphology of the root and canal systems. [19-21]There are few studies in this regard, some authors have used CBCT to study variations in dental anatomy in mandibular premolars.[22-26] Reuben et al. reported that CBCT was as accurate as the modified canal staining and clearing technique in identifying root canal morphology.[27] Khademi et al. in 2017 found that CBCT showed a higher accuracy in determining C-shaped root canal morphology than the clearing technique.In the present study,after type I, the most frequent morphologies in both first and second premolars were type V followed by type IV. The prevalence rates of C-shaped morphology in first premolars using clearing and CBCT were 4.4% and 6.6%(28) respectively. This type of canal is more frequent than that in our study.[5]

Salarpour et al. in 2013 indicated that the most common canal type in the mandibular first and second premolars is type I (71% and 76%, respectively), followed by type V (29% and 22%, respectively).[6] The differences between the results of the present study and those of Khademi et al. and Salarpour et al.might be attributed to differences in the sample sizes and the techniques used to evaluate the root canal system morphology.[5,6] Hasheminia and Hashemi in Isfahan in 2007, investigated root canal morphology of second premolars using clearing and cross-section methods. Of 80 samples, 91.25% in clearing method and 88.75% in second method were type I Weines, and these results are close to the results of the present study.[28]

In the study of Burklein etal., on the German population, in the first and second mandibular premolars, 1 root was found predominantly (90.76% and 98.16%, respectively) with 1 canal (77.9% and 96.0%), whereas 2 canals were less common (21.9% and 3.6%). Three roots (0%, <0.11%) and 3 canals (0.2%; 0.4%) were rarely found.[29]The results of their study are somewhat in agreement to those of us, while in their study men represented significantly more roots and root canals compared with women (P<..05), with the exception of the second mandibular premolars that this difference might be attributed to different sample sizes and race.

The most frequent morphology found in our study was one root and one canal, in accordance with the findings of other researchers. Celikten et al.,(2016) studied on the Turkish Cypriot population and found that the most root canal configurations were type I (93%) in both mandibular first and second premolars. [30] Khedmat et al., in 2010 concluded thatout of 217 teeth examined, 192 (88.47%) had a single root canal and the remaining 25 teeth (11.53%) had two root canals.[31] Yu et al., stated that among 178 mandibular first premolars, 87.1% had one canal, 11.2% had two canals in a Chinese population and all mandibular second premolars had one root of which97.2% had one canal and 2.2% had two canals [24] Llena et al. mentioned that all premolars had a single root. One canal was found in 83.3% of the premolars with no gender or tooth type differences. [4]The most prevalent root canal configuration observed in our study was Vertucci type I and there was no significant correlation

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between the prevalence of the diversity of canals and gender.

Conclusion

In the current study, most of the mandibular premolars had single canal and first mandibular premolars were five times more likely to have two canals than second premolars. None of second premolars had three canals and two C-shaped canals were observed in these teeth. It may be suggested that CBCT has potential of evaluating the number and shape of teeth. Data regarding the occurrence and morphology of the roots may provide useful information for dental practitioners to improve the quality of root canal therapy.

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Conflict of interest: The authors declared no conflict of interest.

Authors Contributions

Maryam ZareJahromi developed the original concept, designed and supervised the in vitro procedure and preparation of manuscript. Elmira Poursaeid and Zahra ShiraziZade carried out the in vitro procedures, acquisition of data and writing the manuscript. Mojdeh Mehdizade supervised the procedureand editing of manuscript.

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