

Morphology of root canals in lower human premolars

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ABSTRACT

Background The knowledge of the root canal morphology and the possible anatomical variations of mandibular premolars are important for the successful endodontic treatment of such cases. The aim of this study was to investigate the presence of two or three root canals in extracted first and second mandibular premolars which were collected from health centers in Syria. **Materials and Methods:** One hundred and ten human mandibular premolars (70 first premolars and 40 second premolars) with fully developed roots were investigated. After access the cavity of the teeth, the root canals were explored and radiographs were taken. **Results:** Premolars with one canal were found in 87% of cases (53% first premolar and 34% second premolar) and premolars with two canals were found in 12% of cases (10% first premolar and 2% second premolar). There was just one case (1%) where a first premolar had three canals. These differences were statistically significant with $P < 0.05$. **Conclusion:** Clinicians should be aware of the anatomical variation in the mandibular premolars and be able to apply this knowledge in radiographical and clinical interpretation.

Key words: Morphology, endodontic, premolars

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INTRODUCTION

To achieve a successful endodontic treatment, the clinician has to identify the different canal configurations. The clinician should be aware of the multiple and complex variations that can occur during root formation.¹

The main objectives of root canal treatment are thorough shaping and cleaning of all pulp spaces and its complete obturation with an inert filling material. The presence of untreated canals may be a reason for failure of endodontic therapy. To achieve satisfactory root canal therapy, a proper and in-depth knowledge of complex root canal morphology is more than essential.²

Diagnosing the correct root canal morphology is critical to the success of endodontic treatment. There are a number of methods that can be used to determine or confirm the morphology of the root canal system. Multiple preoperative parallel radiographs, as well as a mesial or distal shift radiographs, can help to determine the type of canal system

present. A sudden change in radiographic density of a root canal space may suggest a second canal and the level of canal bifurcation.³ If a working length file appears off center on the radiograph, there is a possibility of a second canal. Indistinct definition of root anatomy on several radiographs probably indicates a second root or even possibly a third. A third canal can also be suspected clinically when the pulp chamber does not appear to be aligned in its classic buccolingual relationship.⁴

The dimensions of the mandibular premolar root canal system are wider buccolingually than mesiodistally. Two pulp horns are easily detected: A large, pointed buccal horn and a small, rounded lingual horn. At the cervix of the tooth, both the root and canal are oval; this shape tends to become flat or round where the canal approaches the middle of the root. If two canals exist, they are usually circular from the pulp cavity to their apical foramen. In another anatomical variation, a single, broad root canal may bifurcate into two separate root canals at the apex of the root.⁴ The mandibular first premolar with dual canals dividing at various levels of the root can generate complex mechanical problems. The canals may divide almost anywhere down the root. Because of the absence of direct access, cleaning, shaping, and filling of these teeth can be extremely difficult.⁵

The mandibular second premolar presents less radical problem. A sagittal section of the mandibular first premolar reveals one of the truly difficult situations facing the clinician.

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Instead of distinct individual canals, this tooth presents a fine ribbon-shaped canal system that is almost impossible to clean and shape thoroughly, much less to obturate.⁶

In the study of Prakash *et al.*, 2008 two-rooted mandibular second premolars were found.⁷ In the study of Trope *et al.*, 2008 the radiographs of mandibular premolars of 400 black patients and 400 white patients were examined. The number of first premolars with more than one canal in black patients was significantly higher than in white patients (32.8% versus 13.7%). In the second premolar the difference in the number of root canals between black and white patients failed to reach significance (7.8% versus 2.8%).⁸

In the study of Khedmat *et al.*, 2010 on the Iranian population radiographs of two hundred and seventeen extracted human mandibular first premolars were taken in both mesiodistal and buccolingual directions for each premolar. The results showed that 88.47% had a single root canal. The remaining teeth (11.53%) showed two canals in at least one cross-section of their roots with five root canal configurations. In the mesiodistal (MD) radiographs, only 5.99% of premolars showed two canals with three root canal configurations.⁹

A study by Vertucci and Francois 1986 revealed that the mandibular first premolar had one canal at the apex in 74.0% of the teeth studied, two canals at the apex in 25.5%, and three canals at the apex in the remaining 0.5% of the teeth. Only 12% of mandibular second premolars studied had a second or third canal. They also showed that the second premolar had one canal at the apex in 97.5% and two canals at the apex in only 2.5% of the teeth studied.¹⁰

Dental operating microscope was used for easy endodontic treatment of a mandibular second premolar with three root canals.¹¹ The use of micro-CT scanner 3D analysis was also used for the study of dental and root canal morphology.¹² Another study reported the identification of root canals in molars by tuned-aperture computed tomography.¹³

In a study of Lotfi *et al.*, 2008 a mandibular second premolar with three canals and atypical orifices was investigated. They found one distolingual and one distobuccal at the same level and one mesiolingual on the wall of the second premolar.¹⁴ In 1991, Bram and Fleisher reported a mandibular second premolar with four canals.¹⁵ Mandibular premolars with three canals were reported in previous studies.¹⁶⁻¹⁹

This study aimed to investigate the difference in the number of root canals in both first and second mandibular premolars.

MATERIALS AND METHODS

One hundred and ten extracted human mandibular premolars (70 first and 40 second) with fully developed roots without any root fractures were investigated. These

teeth were extracted for orthodontic reasons. Age, sex and ethnic group of the patients from whom the teeth were extracted were not taken into consideration in this study.

The teeth were collected from health centers and dental offices in the countryside in Syria. The teeth were kept in saline inside labeled plastic containers. All teeth had been numbered and the cavity access of the teeth was made with a round bur. The roof of the pulp chamber was completely removed and access to the root canals was obtained without touching the floor of the chamber with abundant cooling water and using Z bur.

Root canals were explored with #06, #08, and #10 endodontic files (Dentsply-Maillefer, Ballaigues, Switzerland) after being irrigated with 1% sodium hypochlorite using a Luer-Lock syringe.

Once apical patency was obtained—that is, the tip of the endodontic instrument was visualized exiting the apical foramen/foramina—radiographs were taken [Figure 1]. A radiograph unit (Gnatus, Ribeirão Preto, SP, Brazil) operating at a 0.8 s exposition time was used. Ektaspeed plus EP-21P films (Kodak, Rochester, NY, USA) were processed in a portable film processor. This study was approved by the ethical committee of Kalamoon University (No. 1413/56).

Statistical analysis

One-way analysis of variance ANOVA followed by tukey *post hoc* test at the confidence level of 95% was used for comparison in the number of root canals in both first and second premolars. Independent *t*-test was used to compare the number of root canals between first and second premolars.

RESULTS

There were great differences in the shape of the canals and in the number of these canals of the mandibular premolars investigated. Premolars with one canal were found in 87%

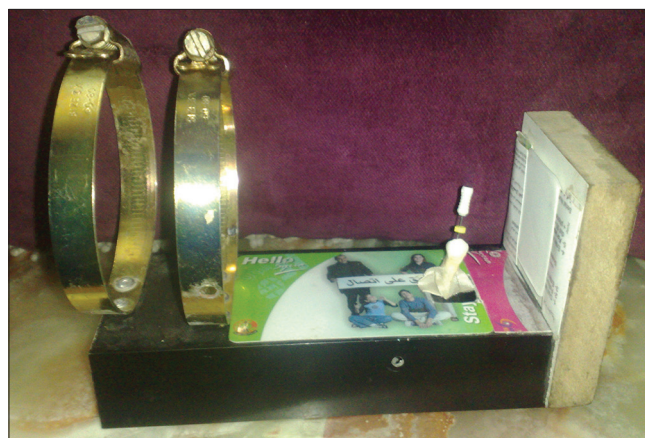


Figure 1: Radiographs taken after the apical patency was obtained

of cases (53% first premolar and 34% second premolar) and premolars with two canals were found in 12% of cases (10% first premolar and 2% second premolar). There was just one case (1%) where a first premolar had three canals [Table 1]. These differences were statistically significant with $P=0.01$.

Premolars with one canal and one apex opening were observed. Other premolars had two canals and one apex. Premolars with three canals and malformation shape were also observed.

The morphology of the premolar roots was also investigated. Some roots were complex giving the feeling that they would have more than one canal but they were not.

The percentages of the first mandibular premolars that had one canal, two canals and three canals were 84.2, 14.2 and 1.4% respectively. Furthermore, the percentages of the second mandibular premolars that had one canal, two canals and three canals were 95, 5 and 0%, respectively [Figure 2]. These differences were statistically significant with $P=0.002$.

DISCUSSION

The root canal system is a part of the tooth that cannot be directly visualized by the dentist. Radiographs are helpful for the visualization of root anatomy, but are limited because they provide two-dimensional images of a three-dimensional object.²⁰ Therefore, accurate knowledge of root anatomy is an important ally to radiographic resources, tactile sense and operator's clinical experience, thus contributing to the success of endodontic treatment. Incomplete disinfection of the root canal system is frequently a cause of failure of endodontic treatment.²¹

Mandibular premolars may be the most difficult teeth in the mouth to treat. The most probable reason is the failure of clinicians to recognize the numerous variations in canal morphology that may exist in these teeth. If the entire root canal system is not located and properly treated, a disproportionate number of cases could result in flare-ups and/or failures.^{22,23} A thorough knowledge of root canal anatomy, careful interpretation of radiographs and proper modification of the conventional access opening appear to be essential for recognition and adequate treatment of teeth with different anatomical variations. The possibility of variations in root canal morphology must be considered before root canal treatment is undertaken.²⁴

The result of this study is in agreement with the study of the study of Khedmat *et al.*, 2010 who found 11.53% of the investigated premolars had two canals.⁹

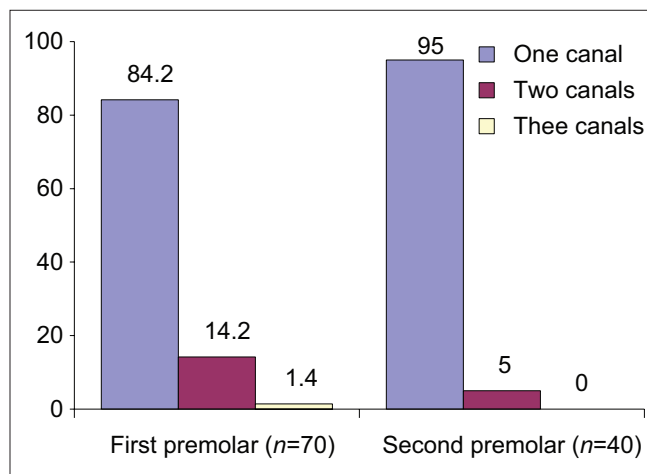


Figure 2: The percentage of root canals in both first and second mandibular premolars

Table 1: Number of canals in the investigated premolars

Number of canals	First premolar (n=70)	Second premolar (n=40)
One canal	59	38
Two canals	11	2
Three canals	1	0

Furthermore, Vertucci 2005 found that the mandibular first premolars had one canal at the apex in 74.0% of the teeth studied, two canals in 25.5%, and three canals in the remaining 0.5%.²

The results of our study are somewhat in agreement to those reported in other studies. One study of a western Chinese population found that of 178 mandibular first premolars, 87.1% had one canal, 11.2% had two canals, and 0.6% had three canals. All mandibular second premolars had one root. Of these, 97.2% had one canal and 2.2% had two canals.²⁵

However, these results are in contrast with the study of Różyło *et al.*, 2008 who found 20% of premolars had two canals because they investigated only 50 teeth of first and second lower premolars.²⁶

Also, the result of this study is in contrast with the study of Dummer *et al.*, 1984 who found in first premolars 69-76% of cases with one canal, 25.5-30% with two canals and 0.5-1% with three canals. In second premolars they found 84.5-99% of cases with one canal, 1-11% with two canals and 0.5-1% with three canals.²⁷

CONCLUSION

Clinicians should be aware of anatomical variation in mandibular premolars and be able to apply this knowledge in radiographic and clinical interpretation. Access cavity refinements may be required for stress-free entry to

complex anatomy. Complex premolar anatomy may be predictably managed following its identification and negotiation. This is very important, and may play a critical role in the success of root canal treatment.

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