The number of roots and canals in the maxillary first premolars in a group of Jordanian population

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ABSTRACT

Objectives: To investigate clinically and radiographically the number of roots and root canals in the maxillary first premolars in a group of Jordanian population using magnifying loupes while carrying out routine endodontic practice.

Methods: A total of 176 patients 87 female (49.4%) and 89 male (50.6%) received root canal treatment of maxillary first premolar at King Hussein Medical Centre from January 2012 till January 2015. The age of the patients was ranging from 18 to 60 years. The teeth included in the study were both clinically and radiographically examined for the number of root canals using sharp endodontic explorer and magnifying loupes. Diagnostic preoperative radiographs were taken for evaluation. Two radiographs in two planes (parallel and 20^{o}- 40^{o} horizontal angle cone shift) were taken during routine endodontic treatment for these teeth. The number of roots and root canals in the maxillary first premolars was recorded.

Results: Out of the total of 176 maxillary first premolars 56 teeth had one root (31.8%), 118 teeth had two roots (67.0%) and two teeth had three roots (1.1%) . Based on Vertucci's classification of root canal morphology: one tooth (0.6%) had type I canal configuration (one canal), 17 teeth (9.7%) had type II (two canals with shared apical foramen), 156 teeth (88.6%) had type IV (two canals with separate apical foramen) and two teeth (1.1%) had type VIII (three canals with separate apical foramina). The percentage of two canals (type II and IV) is 98.3%.

Conclusion: The percentage of two canals (either with shared or separate apical foramina) is very high in the maxillary first premolars in Jordanian population. Inspection should be done for the presence of second canal whenever endodontic treatment is planned for this tooth.

Key words: Anatomic variation, Cone shift, Maxillary first premolars, Root canals, Vertucci's classification.

JRMS Dec 2017; 24(3): 19-24 / DOI:10.12816/0042333

Introduction

A good knowledge of the anatomy of the tooth and its root canal system is essential for the success of root canal treatment.[1] The main goal of root canal treatment is a good cleaning and shaping of all root canals and filling of these canals with an inert filling material.[1,2] The inadequate knowledge of the anatomy of the root canal system can lead to incomplete biomechanical instrumentation and failure of endodontic treatment. [3] It is well known that tooth anatomy varies according to racial origin. .[2,3,4] Therefore it is very important to

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Manuscript Received Sep 18,2016, Accepted Aug 1,2017.

be familiar with characteristic features of the tooth anatomy and its variations in different racial groups since such knowledge can enhance the success of endodontic treatment. [4] Review of the literature showed a high variability in the anatomy of the root canal system of the maxillary first premolar. [5-26] The incidence of one root ranges from 17.9% - 66%; while the incidence of two roots ranges from 33.3% - 80.9%. The occurrence of three roots is scarce and ranges from 0 to 4% .The occurrence of one canal varies between 1.3% - 48.8% while that of two canals ranges from 50.6% to 96.1%. [5-26] The external and internal anatomy of maxillary first premolars of Jordanian population has only been studied by Awawdeh et al. [5] They examined 600 extracted first maxillary premolars from North Jordan clinics using clearing technique. The aim of our study was to investigate clinically and radiographically the number of roots and root canals in the maxillary first premolars in a group of Jordanian population in routine endodontic practice.

Methods

A total of 176 patients 87 females (49.4%) and 89 males (50.6%) received root canal treatment of maxillary first premolars in the endodontic clinic at King Hussein Medical Centre from January 2012 till January 2015. The age of the patients was ranging from 18 to 60 years. The teeth included in the study were both clinically and radiographically examined for the number of root canals. Diagnostic preoperative radiographs were taken for evaluation. The teeth included in the study were those that required nonsurgical endodontic treatment. The included teeth were free of root resorption, had no calcifications or open apices. No retreatment cases were included in the study. Routine endodontic procedures were undertaken: Local anesthesia administration, rubber dam isolation, adequate oval access cavity was opened between the cusp tips, being wider bucco-palatally. 2.5% sodium hypochlorite irrigation was used. Examination of the floor of the pulp chamber to locate canals orifices is done using sharp endodontic explorer and 3.5 high resolution magnification loupes (Keeler Inc. UK). Two periapical radiographs in two angles were taken (parallel and 20^{o}- 40^{o} horizontal angle cone shift) for evaluation of the number of roots and root canals as well as for confirmation of the working length after inserting size 15,20 or 25 K files in the canals. These radiographs were evaluated using x ray viewer. The teeth included were both clinically and radiographically examined by two specialists with more than 10 years of experience in endodontics. The number of roots and root canals in the maxillary first premolars was recorded. The number of roots was recorded as one root, two roots (whether they are completely or partially separate or they are fused) or three roots. The number of canals was classified according to Vertucci classification [7] as shown in Figure 1.

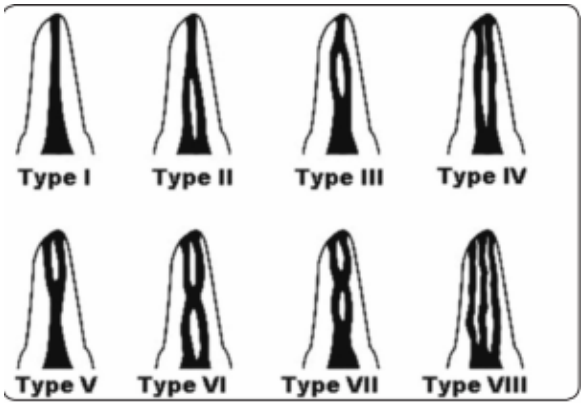

Figure 1: Vertucci classification of the root canal system [7].

Results

Out of the total of 176 maxillary first premolars 56 teeth had one root (31.8%), 118 teeth had two fused or separate roots (67.0%) and two teeth had three roots (1.1%) . Based on Vertucci's classification of root canal morphology: one tooth (0.6%) had type I canal configuration (one canal), 17 teeth (9.7%) had type II (two canals with shared apical foramen), 156 teeth (88.6%) had type IV (two canals with separate apical foramen) and two teeth (1.1%) had type VIII (three canals with separate apical foramina). The incidence of two canals (type II and IV) is 98.3%. Out of the 87 females 32.1% of the maxillary first premolar had one root, 66,7% had two roots and 1.2% had three roots. Regarding root canal morphology 1.2% of the female's maxillary first premolar had type I,

12.6% had type II, 85.1% had type IV and 1.2% had type VIII. Out of the 89 males 31.5% of the maxillary first premolar had one root, 67.4% had two roots and 1.1% had three roots. Regarding root canal morphology none of the male's maxillary first premolars had type I, 6.7% had type II, 92.1% had type IV and 1.1% had type VIII.

Discussion

Knowledge of root canal morphology and its frequent variations is a basic requirement for endodontic success. [1,2] Failure of the dentist to detect all the canals present in the tooth may lead to failure of root canal treatment. [3] The number of roots and canals of the maxillary first premolar in the literature shows a wide variation. [5-26] The differences may be due to the study design (clinical versus laboratory) method of canal identification (radiographic examination, root sectioning, canal staining and root clearing, examination with SEM or CBCT cone-beam computed tomography techniques), classification method, sample size or due to racial variation. [1,2] Clinically, diagnostic preoperative radiograph and its careful examination is necessary before starting root canal treatment. [27] Additional periapical radiographs with cone shift angulations will show more adequate information about root canal system. Martinez-Lozano et al. [28] found that by varying the horizontal angle of x-ray tube 20°- 40°, the number of root canals observed in maxillary first and second premolars coincided with the actual number of canals present. Sardar et al reported that the second canal of maxillary second premolars became obvious in 78% of cases when cone shift radiographic technique was used. [29] In the present study one preoperative radiograph was taken . Another two radiographs (one at right angle and the other with 20°- 40° horizontal angle cone shift) were taken to explore the number of roots and root canals and to take the working length of the canals during root canal treatment. Other diagnostic measures that help in locating root canal orifices include adequate access and modification of the outline of the access cavity, exploration of the tooth's interior and appropriate magnification and illumination. [2,3] In this study adequate oval access cavity was opened between the cusp tips, being wider bucco-palatally. Endodontic explorer and magnifying loupes were used to help in examination of the pulp chamber floor and to identify and locate the orifices of the root canals. Using dental loupes and dental operating microscope (DOM) provides the endodontist with good lighting and magnification which improves the ability to locate extra canals. [30] Ahmad et al [31] reviewed 92 studies done on the maxillary first premolars for different populations and calculated the averages for certain internal and external morphologic features. They reported that the majority of maxillary first premolars had two roots (56.6%) or one root (41.7%) and the majority had two root canals (86.6%) with type IV being the most common canal type (64.8%). Table I compares the results of Jordanian population with other populations for the number of roots of maxillary first premolars. In the present study the classification of the number of roots was challenging as it was difficult to distinguish radiographically between single wide root and two fused roots. In spite of this, the percentage of the number of roots in maxillary first premolar was close to that of Awwawdeh et al in vitro study that was done on extracted teeth of Jordanian population. [5] In our study 31.8% of the maxillary first premolar had one root. This is lower than those reported for Mexicans, [6] North Americans, [7] Chinese, [8] Kuwaiti, [10] and Indian population. [19] An interesting observation in our study is that the majority of maxillary first premolars had two roots and one canal in each root (67%). This percentage is higher than most earlier studies that were done around the world ; its higher than those reported for Mexicans, [6] North Americans, [7] Chinese, [8] Brazilians, [9] Kuwaiti, [10] Singaporeans, [11] and Indians. [19] The incidence of three roots in the present study was only 1.1%. This low percentage is in consistent with previous studies where the incidence varies between 0- 4%. [5- 20] Although the presence of three roots is rare in maxillary first premolar, this must be kept in mind during negotiation of canals during root canal treatment. Premolars with three roots will also cause difficulty in tooth extraction or

movement during orthodontic treatment. Beside the number of roots, the number of root canals in the maxillary first premolars is also studied which is of more clinical significance for endodontists. Table II compares the results of Jordanian population with other populations for the number of root canals in maxillary first premolars. In our study only 0.6% of teeth had one root canal type I. A surprising observation is that our results are much lower than most studies for other populations all over the world. [6-12,14-23] The most common root canal configuration in our study was type IV (88.6%), followed by type II (9.7%). In the present study on Jordanian population the incidence of two canals whether they are completely separate or fused apically is very high (98.3%). This percentage is slightly higher than those of Turkish,[16, 21] Saudi [18, 25] and Spanish population [13] but much higher than those for Mexicans, [6] North Americans, [7] Chinese, [8] Brazilians, [9] Kuwaiti, [10] Singaporeans, [11] and Indians. [19] Our results for the number of roots and root canals are very close to Awwawdeh et al, results. Therefore, the observed variation noted in our studies could be a true variation in Jordanian population. The incidence of three canals (type VIII) in the present study was only 1.1%. This low percentage lies in the range of previous studies where the incidence varies between 0-5%. [5-20] Although the incidence of three canals is rare, it should be kept in mind during root canal treatment of this tooth. Three canals should be suspected clinically when the pulp chamber appears to deviate from normal configuration and does not aligned in its expected bucco-palatal relationship. [32,33] If the pulp chamber seems to be either triangular in shape or too large in a mesiodistal direction, more than one root canal should be suspected. [32,33]

Table 1: Percentages of number of roots in maxillary first premolars of different population.

Study	Population	Number of teeth	1 Root	2 Roots	3 Roots
Pineda and Kuttler (1972) [6]	Mexican	259	43.0	54.6	2.4
Vertucci (1984) [7]	American	400	39.5	56.5	4.0
Walker (1987) [8]	Chinese	100	60.0	40.0	0
Pécora et al (1991) [9]	Brazilian	240	55.8	41.7	2.5
Zaatar et al (1997) [10]	Kuwaiti	79	43.0	53.2	3.8
Loh (1998) [11]	Singaporean	957	49.4	50.6	0
Kartal et al (1998) [12]	Turkish	300	37.3	61.3	1.3
Chaparro, et al (1999) [13]	Spanish	150	40.0	56.7	3.3
Lipski et al (2005) [14]	Polish	142	15.5	75.3	9.2
Atieh (2008) [15]	Saudi	246	17.9	80.9	1.2
Awawdeh et al (2008) [5]	Jordanian	600	30.8	68.4	0.8
Ozcan et al (2012) [16]	Turkish	653	45.2	55.7	1.1
Tian et al (2012) [17]	Chinese	300	66.0	33.3	0.7
Elkady and Allouba (2013) [18]	Saudi	120	28.3	71.7	0
Gupta et al (2015) [19]	Indian	250	53.6	46.0	0.4
Bulut et al (2015) [20]	Turkish	511	28.2	70.8	1
Present study	Jordanian	176	31.8	67.0	1.1

Table 2: Percentages of number of root canals in maxillary first premolars of different population

Study	Population	Type of study	No of teeth	% one canal	% two canals	% three canals
Pineda,Kuttler(1972)[6]	Mexican	In vitro Radiograph	259	26.2	73.3	0.5
Vertucci (1984)[7]	American	In vitro (Clearing)	400	8.0	87.0	5.0
Walker (1987)[8]	Chinese	In vitro (Radiograph and clearing)	100	13	87	0.0
Pécora et al (1991)[9]	Brazilian	In vitro (Clearing)	240	17.1	80.4	2.5
Caliskan et al (1995)[21]	Turkish	In vitro (Clearing)	100	3.9	96.1	0.0
Zaatar et al (1997)[10]	Kuwaiti	In vivo Radiograph	79	11.4	84.8	3.8
Kartal et al (1998)[12]	Turkish	In vitro (Clearing)	300	8.7	89.6	1.7
Chaparroet al (1999)[13]	Spanish	In vitro (CS)	150	1.3	95.3	3.3
Deng et al (2004)[22]	Chinese	In vitro (Clearing)	326	48.8	50.6	0.6
Oginni (2004)[23]	Nigerian	In vivo Radiograph	122	14.8	85.2	0.0
Lipski et al (2005)[14]	Polish	In vitro Radiograph	142	2.1	88.7	9.2
Cheng, Weng (2008)[24]	Chinese	In vitro (Clearing)	422	10.1	87.8	1.9
Atieh (2008)[15]	Saudi	In vitro (Clearing)	246	8.9	89.9	1.2
Awawdeh et al (2008)[5]	Jordanian	In vitro (Clearing)	600	3.3	95.2	1.5
Ozcan et al (2012)[16]	Turkish	In vitro (Radiograph and (CS)	653	7.8	90.7	1.5
Tian et al (2012)[17]	Chinese	In vivo (CBCT)	300	14.3	85.0	0.7
Al-Nazhan et al (2012)[25]	Saudi	In vivo Radiograph	463	3.6	93.6	2.4
Elkady, Allouba(2013)[18]	Saudi	In vivo (CBCT)	120	5.0	95.0	0.0
Ok et al (2014)[26]	Turkish	In vivo (CBCT)	1379	9.6	89.4	1.0
Gupta et al (2015)[19]	Indian	In vitro(Clearing)	250	23.2	75.6	1.2
Bulut et al (2015)[20]	Turkish	In vitro (CBCT)	511	62.6	37.4	0.0
Present study	Jordanian	In vivo Radiograph	176	0.6	98.3	1.1

CS: cross sectioning
CBCT: cone beam computed tomography

Conclusion

Inspection should be done for the presence of second canal whenever endodontic treatment is planned for maxillary first premolars as the incidence of two canals (either with shared or separate apical foramina) is very high in this tooth among Jordanian population. The most common anatomic variation of this tooth is the presence of three roots and three root canals which must be kept in mind while planning and performing endodontic, restorative or surgical treatment of this tooth.

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