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FREQUENCY OF CANALS IN PERMANENT MAXILLARY SECOND MOLAR ON THE BASIS OF CLINICAL AND RADIOGRAPHIC PARAMETERS

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ABSTRACT

Endodontic treatment has a major and productive role in teeth conservation and maintenance in modern dentistry. Endodontic treatment also called root canal treatment (RCT), is the procedure in which the diseased or damaged pulp (core) of a tooth is removed and the inside areas (the pulp chamber and root canals) are filled and sealed. Permanent molars including maxillary 2nd molars are the most common teeth requiring root canal treatment. Maxillary 1st and 2nd molars are among the most difficult teeth for endodontic treatment due to their complex root canal system. Shortage of knowledge regarding root canal anatomy and its variations in configuration may result in numerous root canal treatment failures. The objective of this study was to determine the frequency of canals in permanent maxillary second molar on the basis of clinical and radiographic parameters. A total of 120 subjects were examined. Two detection procedures, clinical and radiographical were used in patients scheduled for endodontic treatment in maxillary second molar. Two pre-operative radiographs with different angulations were taken and access cavity was prepared after administration of local anaesthesia and rubber dam isolation. Canals were first located with DG-16 explorer using magnifying dental loupes and then negotiated with size 10 K file. A third periapical radiograph was taken with the files placed in the negotiated root canals to confirm their presence. Out of the 120 teeth 16 (13.3%) teeth had two canals, 101(84.2%) teeth had three canals, and 3(2.5%) teeth had four canals. Age-wise analysis of the frequency of different canals showed that prevalence of molars with three canals was significantly higher in the subjects with age between 31 and 40 years. To summarize, the study noted four morphological variations in the root canal configuration of Maxillary second molar teeth in Pakistani subpopulation. Hence, while executing the endodontic treatment in the

maxillary second molars a thorough assessment of the root canal system should be carried out.

Keywords: *Root Canal, Root canal system, Endodontic treatment, Mesiobuccal root, Second Mesiobuccal canal*

INTRODUCTION

The quality of root canal treatment (RCT) performed by general dental practitioners largely depends on their attitudes, techniques and different approaches toward endodontic treatment.[1] The appropriate root canal therapy is described as cleaning, shaping and disinfection of the root canals and consequently, a three-dimensional obturation can be procured.[2] Endodontic treatment is extensively used for pulpal and periapical diseases.[3]

A rewarding root canal treatment requires a comprehensive knowledge of the tooth anatomy and morphology of the root canal system as there is ample mutability in this regard even within the natural extent. The outer morphology and inner anatomy of the teeth are awfully uncertain in terms of number and structure of roots and root canals.[4] One of the restrictions to the chemo-mechanical preparation of the root canal is anatomical complexities, which results in regions not contacted by instrument, producing failed cases.[5]

Success of endodontic treatment revealed in some studies is as high as 96% while in others it is as low as 60%.[1] The most commonly used method for judging root canal have been periapical radiograph (2D image).[6] But as the root canal system (RCS) differ from tooth to tooth, a 3-Dimensional scan of the root canal structure is essential for ideal cleaning and shaping of canals.[7] A limited field of view (FOV) CBCT can be thought about especially when difficult anatomy is anticipated and for likely missed canals.[8] Endodontic treatment of maxillary second molars can be really challenging. Besides the inner most position of the maxillary second molar in the maxillary arch, the difficulty of instrumentation and the large diversity of its root canal systems are the primary reasons for adversities of endodontic treatment.[3]

The specifics of human tooth morphology were presented by GV Black in 1902. Each human tooth has its particular root anatomy and has been examined in details. For example, mesio-buccal root of maxillary 1st molar has been proclaimed to have two specific root canals since 1925.[9] Starting from the Caucasians to the Africans and Asians root canal anatomy arrangement follow an ethnic characteristic making root canal treatment further demanding for the practitioners.[10]

The maxillary second molars have been repeatedly researched because of their intricate root and root canal morphology and greater occurrence of fluctuations. Most maxillary second molars show mesio-buccal root, disto-buccal root, and palatal root. A frequent anatomic aberration in these teeth is root fusion, with a predominance of 5.09% to 42.25%. Yang et al indicated that the prevalence of root fusion of maxillary second molars in a Chinese population in Taiwan was 40.1%. Fusion of the palatal root with the mesiobuccal root was the most prevalent, followed by fusion of the mesiobuccal root with the distobuccal root; complete fusion of the three roots into a cone-shaped root was the least common.[11]

The results of a study conducted by Abbas Ali khademi et al indicated that the frequency of three roots and three canals was 88.2% in maxillary second molar in Iranian population.[2] There are numerous techniques for assessing the anatomy of the root canal system containing preparation of access cavity and radiography while file is in the root canal both in vivo and in vitro. Additional means involve canal staining and tooth clearing, conventional and digital radiography, computed tomography (CT), cone-beam computed tomography (CBCT), serial sectioning and microscopic interpretation.[12]

There has been a lack of research in our domain on the frequency of root canals in permanent maxillary second molar. The purpose of this study is to investigate the frequency or number of root canals present in permanent maxillary second molars in local population clinically and radiographically. Hence knowledge of variations in root canal anatomy of permanent maxillary second molar will improve the endodontic practice of general dental practitioner by successfully treating the maxillary second molars.

Methodology

A descriptive cross-sectional study was conducted in the department of operative dentistry Peshawar Dental College (PDC), Peshawar. Duration of the study was 6 months from Feb 2021 to Aug 2021. Sample size was

calculated using WHO Sample Size Calculator stating the statistics for Root 1 (i.e. single rooted Max 2nd molar: Table 1 [1]) as 4.7%, margin of error 3.8% and 95% confidence level. The estimated sample size was 120. Samples were decided using non probability consecutive sampling technique. Inclusion criteria for the study was as follows; all the permanent maxillary second molars following the clinical and radiographical diagnosis of irreversible pulpitis and apical periodontitis were included in this study, second maxillary permanent molar with no previous root canal treatment, patients aged 16 to 60 years (irrespective of gender), elective endodontic treatment. Whereas the exclusion criteria being teeth with open apices, Internal root resorption, Intra-canal calcifications, unrestorable teeth.

Approval to carry out the study was obtained from the institutional Ethical Review Committee at Peshawar dental college before start of the study. Patients referred from outpatient department were reexamined in department of endodontics for diagnosis and treatment planning which included thorough history taking, clinical and radiographic examination and performing sensitivity tests. Patients were informed/explained regarding the purpose, procedure, risk and benefits of the study. Verbal and written informed consent were obtained from all the patients regarding his/her participation in the study, and they were assured of maintaining confidentiality of the data collected from them. The data was collected using a customized proforma. Inclusion and Exclusion criteria were strictly followed to control bias and confounders. All the procedures were carried out by the trainee researcher himself under the supervision of the supervisor.

Two detection procedures, clinical and radiographical examination were used in patients scheduled for endodontic treatment in permanent maxillary second molar. Two pre-operative radiographs were taken; one with 90°angulations to the tooth in bucco-lingual direction and a second with mesial shift of 20° to find out the third dimension and were examined for roots and root canals. The patients were administered local anesthesia by infiltration technique in the buccal sulcus adjacent to the upper second molar which was to be treated followed by the rubber dam application. A standard access cavity was made using the no 4 round bur and non-end cutting tapering fissure carbide bur. After deroofing the chamber completely and straightening the walls appropriately, bleeding was controlled using sodium hypochlorite wash and by excavating the coronal portion of the pulp with a spoon excavator. After the hemostasis was achieved the chamber floor was examined with the help of 3.5x magnifying loupes. The identified orifices of mesiobuccal, distobuccal and palatal canals were first located with Endodontic explorer (DG16). After clear visualization and using magnifying dental loupes (3.5 x) the canals were then be negotiated with size 10 K-file. A third periapical radiograph was taken with the files placed in the negotiated root canals to confirm their presence.

The data was entered and analyzed in statistical package for social sciences (SPSS) version 20.0. Mean + standard deviation was calculated for age. Frequencies and percentages were calculated for gender, age, side of root(right/left) and number of canals. Effect modified by age, gender and side of root were addressed through stratification. Post stratification a Chi-square was applied as a test of significance keeping level of significance i.e. p-value <=0.05 as significant. And the results were presented in the form of tables and charts.

Results

A total of 120 patients were included in this study among which 64(53.3%) were male and 56(46.7%) were female with an overall age range of 16-60years. The mean age of the sample was 36.85±11.80 years. Regarding the side of the jaw for canals of second maxillary molar reported was; right side (58), left side (62). The most important finding of this study was to find out the frequencies of canals in maxillary 2nd molar which are as follows; 2 canals were 16 (13.3%) in number, 3 canals were 101 (84.2%) in number, and 4 canals were 3 (2.5%) in number. Summarized in table 1 and figure 1 below.

Number of canals found	Frequency (N)	Percentage (%)
2 canals	16	13.3
3canals	101	84.2
4 canals	3	2.5
Total	120	100

Table 1 Frequency of number of canals found

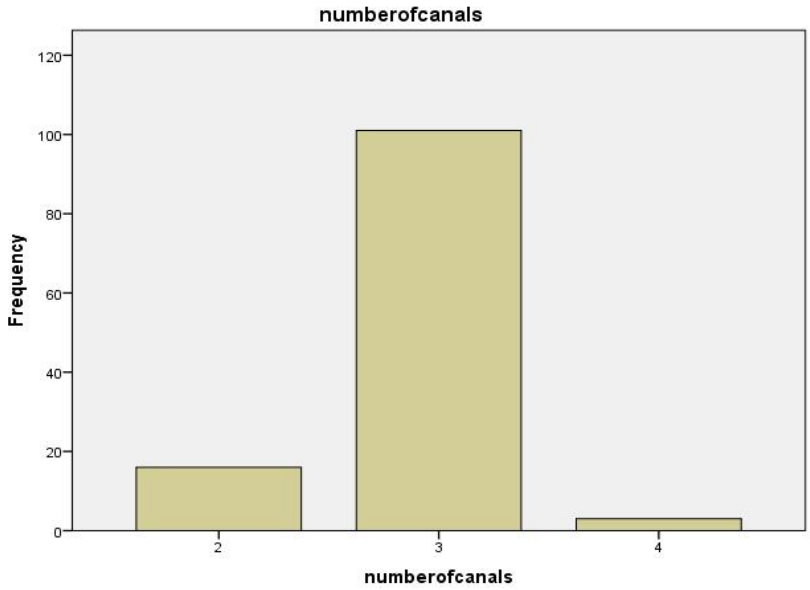

Figure 1 Frequency of number of canals found

Age vs number of canals in maxillary 2nd molar

Among 16-20 years age group total 9 cases were reported which included (2 canals=1 case), (3 canals= 8 cases), (4 canals =0 case)

Age group 21-30 years, total 34 cases were reported which included (2 canals=3 cases),(3 canals= 30cases), (4 canals = 1 case)

Age group 31-40 years, total 39 cases were reported which included (2 canals= 5 cases),(3 canals= 33cases), (4 canals = 1case)

Age group 41-50 years, total 18 cases were reported which included (2 canals= 1 case),(3 canals= 16cases), (4 canals = 1case)

Age group 51-60 years, total 20 cases were reported which included (2 canals= 6 cases),(3 canals= 14cases), (4 canals = 0 case)

Age group (years)	Frequency (N)	Percentage%
16-20	9	7.5
21-30	34	28.3
31-40	39	32.5
41-50	18	15.0
51-60	20	16.7
Total	120	100

Table 2 Stratification of canals with respect to age (Mean age ± SD {36.85 ± 11.80})

Gender vs. number of canals in maxillary 2nd molar

64 cases were reported in males and 56 cases in females out of 120 patients selected for this study.

In males (2 canals = 9), (3canals = 53), (4 canals = 2)

In females (2 canals = 7), (3 canals = 48), (4 canals = 1)

Gender	Frequency(N)	Percentage (%)
Male	64	53.3
Female	56	46.7
Total	120	100

Table 3 Frequencies and Percentages with respect to gender

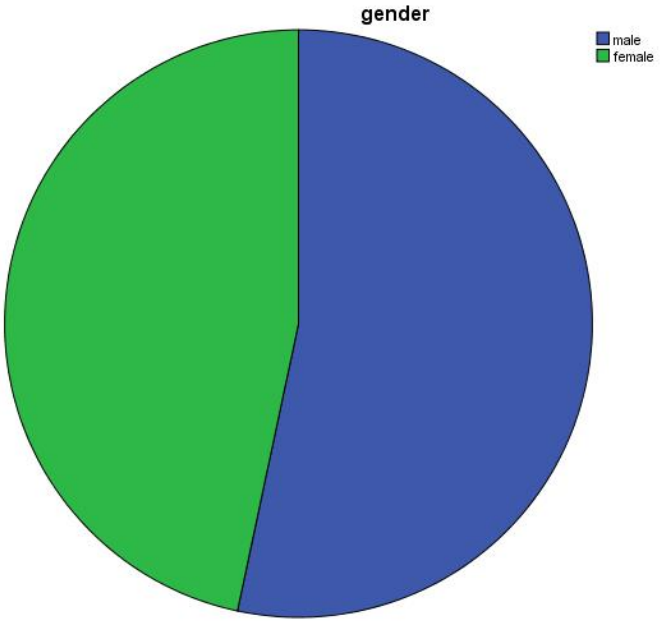

Figure 2 Gender distribution

Side of the jaw vs. frequency of 2nd maxillary molar

right side 58 cases (48.3%) and left side 62cases (51.7%) out of which;
right side maxillary molar had (2canals= 8 cases), (3 canals=47 cases), (4 canals= 3 cases)
left side maxillary 2nd molar (2 canals= 8cases), (3 canals= 54 cases), (4 canals= 0 case)

Side of the jaw	Frequency(N)	Percentage (%)
Right	58	48.3
Left	62	51.7
Total	120	100

Table 4 Frequencies and Percentages of side of the jaw

Number of canals	Gender		Total	P-Value
	Male	Female		
2	9	7	16	
3	53	48	101	
4	2	1	3	***0.86***
Total	64	56	120	

Table 5 Stratification of canals with respect to Gender

Number of canals	Side of jaw		Total	P-Value
	Right	Left		
2	8	8	16	
3	47	54	101	***0.187 right side***
4	3	0	3	***0.187 left side***
Total	58	62	120	

Table 6 Stratification of canals with respect to side of the jaw

Age group	Number of canals			Total	P-value
	2	3	4		
16-20	1	8	0	9	
21-30	3	30	1	34	
31-40	5	33	1	39	***0.475***
41-50	1	16	1	18	
51-60	6	14	0	20	
Total	16	101	3	120	

Table 7 Frequencies/Stratification of canals Decade wise

Discussion

The maxillary second molars have been repeatedly researched because of their intricate root and root canal morphology and greater occurrence of fluctuations. Most maxillary second molars show mesio-buccal root, disto-buccal root, and palatal root. A frequent anatomic aberration in these teeth is root fusion, with a predominance of 5.09% to 42.25%. Yang et al indicated that the prevalence of root fusion of maxillary second molars in a Chinese population in Taiwan was 40.1%. Fusion of the palatal root with the mesiobuccal root was the most prevalent, followed by fusion of the mesiobuccal root with the distobuccal root; complete fusion of the three roots into a cone-shaped root was the least common.

There are numerous techniques for assessing the anatomy of the root canal system containing preparation of access cavity and radiography while file is in the root canal both in vivo and in vitro. Additional means involve canal staining and tooth clearing, conventional and digital radiography, computed tomography(CT), cone-beam computed tomography(CBCT), serial sectioning and microscopic interpretation.

In this study, the root canal configurations of maxillary second molars were assessed clinico-radiographically. In simple cases, when root canal examination is possible from intraoral periapical radiographs or clinical procedures, the use of CBCT is not necessary. When abnormal findings are observed on intraoral periapical images and/or clinical setting, it may be impossible to evaluate the root canal system effectively. In these situations, CBCT imaging is needed for further diagnosis and treatment regarding as low as reasonably achievable principle.

This research included 120 patients among which 53.3% were male and 46.7% were female with an overall age range of 16-60 years. The mean age of the sample was 36.85±11.80 years. The most important finding of this study was to find out the frequencies of canals in maxillary 2nd molar which are as follows; 2 canals were 16 (13.3%) in number, 3 canals were 101 (84.2%) in number, 4 canals were 3 (2.5%) in number.

M.D Peikoff et al[13] conducted a study on 520 root canal treated maxillary second molar teeth. They categorized and described the variations in maxillary second molars from the perspective of number of roots, number of canals and anatomical appearance. They reported six different variations of the morphology of the root canal system and concluded that the most frequent type was the Variant 1(three separate roots with three canals) with 56.9%. Another study conducted by N.Eskoz and F.S Weine[14] on total 73 maxillary second molars showed that 67 molars (91.8%) had three roots. Out of these 67 molars 59.7% had type 1 canals i.e single canal from orifice to apex. The results of these studies are comparable to the present study.

In a study performed by M. Mashyakhy et al[7] on a Saudi subpopulation via CBCT included 294 maxillary second molars. They concluded that 292 (99.3%) teeth had separated three roots and only 2 (0.7%) had an extra palatal root. Among 292 maxillary second molars only 33.6% had three canals while 66.4% had four canals. The results of this study are in contradiction to the present study. These different values may be explained by the different general practice setting and the method of evaluating root morphology and root canal configurations.

Shafqat et al[15] conducted a study on a Pakistani subpopulation and included 80 maxillary second molar teeth with irreversible pulpitis. They found that the most frequently occuring root canal morphology was three canals (50%), followed by an equal frequency of four and two canals (21.25%). In a similar study conducted

on a Pakistani subpopulation Khan M et al[16] included 95 subjects out of which 61.1% had three canals and 25.3% had four canals. The results of these studies are comparable to the present study.

The results of a study conducted by Abbas alikhademi et al[2] on 460 maxillary second molar teeth in an Iranian population indicated that the frequency of three roots was 88.2% while the prevalence of type 1 canal i.e single canal from orifice to apex was 57.6%.

Libfeld H and Rotstein I[17] studied a total of 1200 maxillary second molar teeth and divided them into two groups. They concluded that out of 1000 teeth (group 1) 90.6% had three roots. Of the 200 root treated maxillary second molars (group 2), 169 teeth (84.4%) had three roots with three root canals. The results of this study are in conformity with the present study.

The present study used the clinical and radiographic method of canals detection in maxillary second molars, and shows high prevalence of three roots and three root canals which supports the findings of several other studies. The findings obtained via correlation between age and number of canals were in line with the findings of the previous studies which suggest that in younger individuals the fourth canal (MB2) is not completely calcified and may be negotiable clinically even under 2.5 x magnification.

The presence of lesser number of four canaled molars in groups with individuals of older ages may also be due to the difference in the methodology applied in detecting the number of canals with sensitivity of 2.5x loupes being significantly less than in vivo methods like examination under dental operating microscope. Several studies have shown that the use of higher magnification methods such as the use of dental operating microscopes significantly improve the ability of the operator to locate and negotiate additional canals such as the MB2 canal.

Several in vitro methods have been used to evaluate root canal morphology and the number of root canals. These include clearing of tooth and various ink injections into the canal, pulp floor inspection with scanning electron microscope and examination of teeth with the three dimensional (3D) radiographic methods like CBCT and micro CT. The 3D radiographic methods have reported a higher incidence of a fourth canal (second mesiobuccal canal) as compared to other methodologies. The downside to CBCT is the large radiation dose when used in vivo and lower resolution as compared to the micro CT. This makes micro CT a more attractive tool in finding prevalence of canals. Micro CT is however an in vitro tool only and cannot be employed in vivo to detect the number of canals and root morphology preoperatively, unlike CBCT.

Conclusion

To conclude, the chances of having three canals in both male and female got high with the increase in age and there was no significant difference in prevalence between male and female subjects. The study also highlighted the importance of magnification and other clinical aids in the detection of the canals. Therefore, while preparing the access cavity in the maxillary second molars, the pulp floor should be carefully examined under magnification, supplemented with clinical aids, to detect all present canals.

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