ORIGINAL RESEARCH PAPER
Volume-9 | Issue-4 | April-2020 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

EVALUATION OF MESIAL DEVELOPMENTAL GROOVE DEPTH AND ITS CORRELATION WITH ROOT CANAL ANATOMY IN MAXILLARY PREMOLARS – A CBCT ANALYSIS.

Dental Science

Dr. Harleen Kaur Bajaj* M.D.S Student, Department of Conservative and Endodontics, Subharti Dental College & Hospital, Meerut, Swami Vivekanand Subharti University. *Corresponding Author

Dr. Padmanabh Jha M.D.S., Professor, Department of Conservative and Endodontics, Subharti Dental College & Hospital, Meerut, Swami Vivekanand Subharti University.

Dr. Vineeta Nikhil M.D.S., Dean Clinical Affairs, Department of Conservative and Endodontics, Subharti Dental College & Hospital, Meerut, Swami Vivekanand Subharti University.

ABSTRACT

Aim: The objective of this study was to evaluate the mesial developmental groove depth and to correlate it with the root canal anatomy in maxillary premolars using CBCT.

Methods: Hundred extracted maxillary premolars were included in the study. Samples were stored in saline with 0.2% thymol until use. Each sample was examined for number of canals, canal configuration, maximum depth of mesial developmental groove with its position coronal to apex and minimum dentin thickness at the position of maximum mesial developmental groove depth using CBCT.

Statistical Analysis: One-way ANOVA-F and Pearson's correlation tests were performed for analysis.

Results: Majority of the maxillary premolars exhibited two canals. The incidence of Type IV canal configuration (most prevalent) for the maxillary first and second premolars were 57.6% and 41.6% respectively. The mean maximum groove depth was found to be 0.86 (±0.42) mm and was located at a mean distance of 7.13 (±2.17) mm coronal to the apex. The mean value for minimum dentin thickness at the position of maximum groove depth was 1.05 (±0.23) mm.

Conclusion: The depth of mesial developmental groove, the minimum dentin thickness and the position of maximum depth of groove varied with the number of canals and canal configuration.

KEYWORDS

Canal morphology, Maxillary premolars, Maximum mesial developmental groove depth, Minimum dentin thickness.

INTRODUCTION

To achieve three dimensional obturation following endodontic therapy, adequate cleaning, shaping and disinfection of the root canal systems is of utmost importance. Performing endodontic therapy in maxillary premolars often present with serious complications owing to its complex and variable anatomy. Inadequate knowledge of the root canal anatomy can thus, predispose maxillary premolars to procedural accidents leading to endodontic failure.

Although various techniques including tooth decalcification followed by dye injection, tooth sectioning and radiographic studies *in vitro*, alternative radiographic techniques with contrast media and others have been used in various studies[1-3] , reports show that Cone Beam Computed Tomography (CBCT) can reveal information more accurately. CBCT is a non-invasive method, more reliable and involves less radiation dose than the conventional CT. Since canal instrumentation is not required for analysis, CBCT provides a three-dimensional view of root canals in their original form[4].

Lately, root canal anatomy of maxillary premolars has not been reported much. Studies only specify that the canal morphologies in maxillary premolars are highly complex and changeable based on the internal anatomical features which include number of root canals, canal configuration, their location, diameter, shapes and curvatures. Also, they are the only teeth to show all eight possible configurations of Vertucci's classification[5]. So far, the mesial developmental groove in maxillary premolars has not been discussed. The mesial developmental groove is a continuation of the mesial concavity on the coronal aspect as it runs the root length to disappear into the furcation area. The important characteristics include the groove depth, its location and the minimum dentin thickness available in that crucial area. Mattuella *et al.*[6] conducted a study on the longitudinal sulcus of buccal root of maxillary premolars and reported that, teeth with larger number of external sulci, present with deeper and more extensive grooves and exhibit more internal variations. However, no literature is available to correlate the presence of mesial developmental groove with the number of root canals and canal configuration. This is of significance because anatomic characteristics like external root morphology and root canal shape predispose roots to perforation during root canal preparation and post placement owing to lesser amount of dentin thickness. Also, these factors in association with local stresses have been proposed as the cause of vertical root fractures.[7]

To sum up, careful inspection of various factors like the presence of radicular grooves and variations in dentin width are crucial for the treatment of maxillary premolars. Therefore, the aim of the present study was to visualize the root canal anatomy and morphology of maxillary premolars using Cone Beam Computed Tomography.

MATERIALS AND METHODS

Extracted human permanent maxillary first and second premolars were collected from the exodontia section of Department of Oral and Maxillofacial Surgery, Subharti Dental College and Hospital, Meerut. The extractions were conducted due to trauma, periodontal and orthodontic reasons. Teeth that were carious, fractured, restored, or had incompletely formed roots were excluded. The maxillary first premolars were distinguished from maxillary second premolars based on the Wheeler's criteria. Stains and calculus were removed using an ultrasonic scaler. Hundred selected teeth were placed in 3% sodium hypochlorite (Pyrax Polymers, Roorkee, India) for 15 minutes for disinfection and then stored in normal saline with 0.2% thymol (Alpha chemicals, Maharasthra, India) to inhibit microbial growth until use. The storage period did not exceed three months.

For CBCT evaluation, specimens were arranged in a template. Cone beam computed tomography scans of the teeth were taken using SICAT Sirona ORTHOPHOS SL 3D machine and the scans were assessed by two investigators using Galileos Imaging Software. The analysis was done for-

Number of root canals and canal configuration: Sections of 1mm thickness were evaluated from the orifice to apex in the axial plane. The canal morphology was determined based on Vertucci's classification.

Maximum depth of groove: Sections of 1mm thickness were evaluated from orifice to apex in the axial plane. The slice with maximum depth of groove was selected for analysis. For this, first a tangent was drawn to the external mesial root surface. Then another line starting from the deepest part of the groove and perpendicular to this tangent was designed to measure the maximum depth (Fig.1a).

Minimum dentin thickness at maximum depth of groove: For this, first a tangent was drawn from the most convex point on the root canal wall on the mesial side; then another tangent was designed at the point of maximum depth of groove. The distance between these two tangents was recorded (Fig.1b).

Position of maximum depth of groove: For this, two lines were drawn; one at the apex and other at the point of maximum groove depth in the sagittal plane. The distance between these two lines was recorded (Fig.1c).

For statistical analysis, data was entered into Microsoft Excel and later analysed using SPSS version 20 (IBM Corp, Armonk, NY, USA). Descriptive analysis was done to calculate the mean and standard deviation for continuous data. One-way ANOVA-F and Pearson's correlation tests were performed to analyse the intergroup and intragroup comparisons respectively.

RESULTS

Majority of the maxillary premolars exhibited two canals (87%), followed by one canal (9%) and three canals (4%). Among the 52 maxillary first premolars, two canals (86.53%) were most prevalent, followed by three canals (7.69%). Only 5.76% of the samples exhibited one canal. Whereas, among the 48 maxillary second premolars, two canals (87.5%) were most prevalent, followed by one canal (12.5%) and none of them exhibited three canals (0%).

Table 1 (a and b) depicts that majority of the maxillary premolars exhibited Vertucci Type IV canal configuration (57.6%) followed by Type V (13.46%) and Type III (11.53%). Four teeth showed an additional configuration; Sert and Bayirli's Type IX (1-3-3) and other three exhibited Peiris *et al*. Type XVIII (1-2-3). Among the 48 maxillary second premolars, Vertucci Type IV canal configuration (41.66%) were most prevalent followed by Type III (18.75%) and Type V (16.66%). Figure 2 (a and b) depict these canal configurations.

The mean values of maximum groove depth, minimum dentin thickness at the position of maximum groove depth and location of maximum groove depth coronal to the apex for maxillary first and second premolars are listed in Table 2.

Pearson's correlation coefficient revealed a significant and positive correlation between the maximum groove depth and the minimum dentin thickness at the position of maximum groove depth. When the comparisons were made between canal configuration and various other parameters using one way ANOVA, it was observed that, samples exhibiting Vertucci's Type IV canal configuration had the highest mean values(S.D) of maximum groove depth which were 1.03 (±0.40) mm. The mean values for minimum dentin thickness at the position of maximum groove depth (1.29 mm) and the position of maximum groove depth coronal to the apex (11 mm) were highest for samples exhibiting Vertucci's Type VI canal configuration (Table 3).

DISCUSSION

Due to its anatomical variation, endodontic treatment of maxillary premolars is highly complicated. In depth knowledge of root canal morphology and its potential for variations may be important for endodontic therapy. In the literature, various techniques have been presented to evaluate root canal morphology. In this study, the CBCT analysis was preferred over other methods as it provides a three-dimensional view of the root canal system and all morphological details can be observed[8].

When the root canal morphology of maxillary first premolars was observed in the present study, out of the total 100 samples, majority of the maxillary premolars exhibited two canals (87%), followed by one canal (9%) and three canals (4%). Out of the total 52 maxillary first premolars, two canals (86.53%) were most prevalent, followed by three canals (7.69%). Only 5.76% of the samples exhibited one canal. Similarly, out of the total 48 maxillary second premolars, two canals (87.5%) were most prevalent, followed by one canal (12.5%). This is in accordance with previous studies[9-15] which have reported varying prevalence rates for maxillary first premolars ranging between 0-26.2% for one canal, 73.3-97% for two canals and 0.5-9.2% for three canals; and prevalence rates ranging between 30-67% for single canal, 32-72% for two canals and 0.3 to 5% for three canals in maxillary second premolars.

In the present study, Vertucci's Type IV canal configuration (62.5%) was found to be most prevalent in maxillary first premolars, followed by Type V (13.46%) and Type III (11.53%). For maxillary second premolars, Vertucci Type IV (41.66%) was prevalent, followed by Type III (18.76%) and Type V (16.66%). Two additional canal configurations were also found which were classified according to Sert and Bayirli's[16] canal configuration (Type IX) and Peiris *et al.*[16] (Type XVIII). This is in accordance with the study done by Gupta *et al.*[1] who reported all eight types of canal configurations as well as two rare Sert and Bayirli's canal configurations.

In the present study the depth of mesial developmental groove was accessed along with the minimum dentin thickness and the position of maximum groove depth in relation to the apex. The mean of maximum depth of mesial developmental groove, minimum dentin thickness and the position of maximum depth of groove coronal to apex were 0.86 ±0.42 mm, 1.05 ±0.23 mm and 7.13 ±2.17 mm respectively. This is in accordance with the study done by Joseph *et al.*[17] who reported that the value of mean of maximum groove depth at the middle third was 0.89 ±0.37 mm. Since we could not find any previous study done on maxillary premolars which evaluated the position of maximum depth of groove from the apex and the minimum dentin thickness in that area, so the findings of the present study cannot be compared.

The results of the present study show that the samples exhibiting more number of canals had greater dimensions of maximum groove depth. Previous anatomic research on maxillary first premolars concluded that the specimen exhibiting deeper maximum depth of the groove, exhibited more internal variations[7]. Another interesting finding of the present study is that, the samples having more number of canals exhibited higher mean values of minimum dentin thickness at the position of maximum groove depth. These findings could not be compared because of the lack of similar studies. However, one valid explanation could be that on looking at the cross sections, in the samples with a single canal at the position of maximum groove depth, the minimum dentin thickness is less because the maximum invagination is present at the centre in a bucco-lingual direction. Also in such cases, the canal is located in the centre and is generally oval in shape which leads to the distance of the exterior of the canal to the point of maximum depth of groove to be less. On the contrary, the samples having multiple canals, the canals are either buccally or palatally placed and the maximum invagination is present at the centre of the groove, so the distance from the exterior of the canal to the exterior of the root will be more, leading to the minimum dentin thickness to be more in such cases.

When the comparisons were made between the canal configuration and various other parameters it was observed that,

a) The specimen exhibiting Vertucci's Type IV canal configuration had deeper and more extensive maximum groove depth and the least values were obtained for Vertucci Type I.
b) The specimen exhibiting Vertucci's Type VI canal configuration had the highest mean values for minimum dentin thickness at position of maximum groove depth. The least dentin thickness was seen in specimen with Type I canal configuration.
c) In the specimen exhibiting Vertucci's Type VI canal configuration, the position of maximum groove depth is more coronally placed than in specimen exhibiting Type VII canal configuration.

CONCLUSION

Within the limitations of this study, the maxillary premolars showed an increased propensity to demonstrate Vertucci Type IV, followed by Type III and Type V canal configurations. Also, the depth of mesial developmental groove, the minimum dentin thickness and the position of maximum depth of groove varied with the number of canals and canal configuration. The samples exhibiting two canals showed greater dimensions of maximum groove depth than samples having one canal. On the contrary, the minimum dentin thickness at the position of maximum groove depth was less in samples exhibiting single canal. Also, samples exhibiting Type IV canal configuration showed greater dimensions of groove depth. However, samples exhibiting Type VI canal configuration showed higher mean values of minimum dentin thickness at the position of maximum groove depth. These anatomic variations need to be considered to prevent iatrogenic errors leading to endodontic therapy.

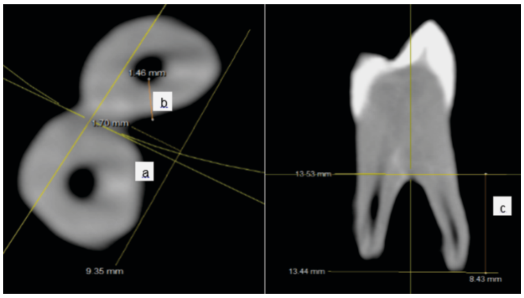

Figure 1: Measurements done for (a) maximum groove depth for a sample and the (b) minimum dentin thickness at the position of maximum groove depth with its (c) location coronal to the apex.

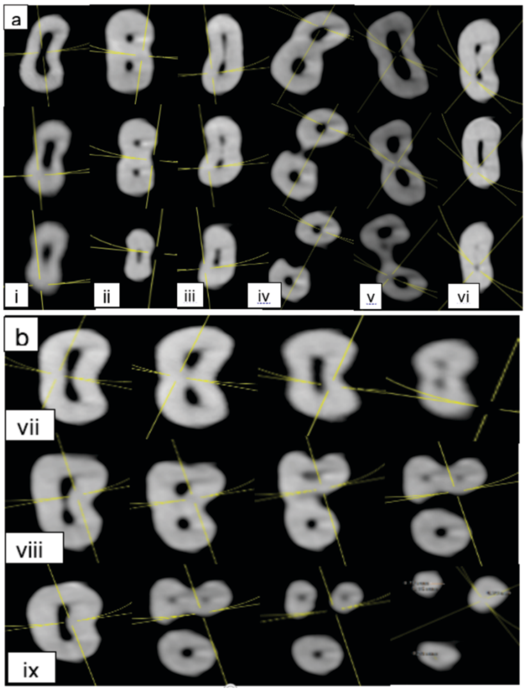

Figure 2a and b : Vertucci's classification of canal configuration (i-vii), Sert and Bayirli's Type IX (viii) and Peiris et al. Type XVIII (ix).

Table 1a and b: Classification of root canal forms of maxillary premolars.

Canal Configuration	Canal Type	First Premolar Number (%)	Second Premolar Number (%)	Total
TYPE I	1-1	3 (5.76%)	6 (12.5 %)	9 (9%)
TYPE II	2-1	0 (0%)	4 (8.33%)	4 (4%)
TYPE III	1-2-1	6 (11.53%)	9 (18.75%)	15 (15%)
TYPE IV	2-2	30 (57.69%)	20 (41.66%)	50 (50%)
TYPE V	1-2	7 (13.46%)	8 (16.66%)	15 (15%)
TYPE VI	2-1-2	0 (0%)	1 (2.08%)	1 (1%)
TYPEVII	1-2-1-2	2 (3.84%)	1 (2.08%)	3 (3%)
TYPE VIII	3-3	0 (0%)	0 (0%)	0 (0%)
TOTAL	-	48	48	96*

* Four out of 100 specimen were trifurcated and did not fall into any of the above mentioned canal configuration as classified by Vertucci. These were classified as under-

Table 2: The minimum, maximum, mean and standard deviation of maximum groove depth and minimum dentin thickness along with the position of the maximum groove depth coronal to the apex.

Canal Configuration	**Canal Type**	**First Premolar Number (%)**	**Second Premolar Number (%)**	**Total**
TYPE IX (Sert *et al.* 2004)	**1-3-3**	**1 (1.92%)**	**0 (0%)**	**4 (4%)**
TYPE XVII (Peiris *et al.* 2007)	**1-2-3**	**3 (5.76%)**	**0 (0 %)**	**3 (3%)**
TOTAL	**-**	**4**	**0**	**100**

S. No	**Parameters**	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Maxillary First Premolars						
1.	Maximum Groove Depth	52	0.25	1.93	0.805	0.4339
2.	Minimum Dentin Thickness	52	0.50	1.61	0.895	0.2389
3.	Position of the maximum groove depth coronal to the apex	52	2.60	11.73	7.53	1.9372
Maxillary Second Premolars						
S. No	**Parameters**	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
1.	Maximum Groove Depth	48	0.16	1.27	0.633	0.2703
2.	Minimum Dentin Thickness	48	0.61	1.44	1.017	0.2064
3.	Position of the maximum groove depth coronal to the apex	48	1.49	11.00	7.010	2.4167
Total (Hundred samples)						
S. No	**Parameters**	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
1.	Maximum Groove Depth	100	0.16	1.93	0.858	0.4231
2.	Minimum Dentin Thickness	100	0.50	1.61	1.052	0.2253
3.	Position of the maximum groove depth coronal to the apex	100	1.49	11.73	7.133	2.1726

REFERENCES

1. Gupta S, Sinha DJ, Gowhar O, Tyagi SP, Singh N, Gupta S. Root and canal morphology of maxillary first premolar teeth in North Indian population using clearing technique: An in vitro study. J Conserv Dent 2015;18:232-6.
2. Patel S, Dawood A, Whaites E, Pitt Ford T. New dimensions in endodontic imaging: Part 1. Conventional and alternative radiographic systems. Int Endod J 2009;42:447-62.
3. Scarfe WC, Fana CR, Farman AG. Radiographic detection of accessory/lateral canals: Use of radiovisiography and hypaque. J Endod 1995;21:185-90.
4. Rameya M, Singh VP. Cone beam computed tomography a novel innovation for assessing the canal morphology of maxillary first bicuspid. Conserve Dent and Endod J 2017;2(1):4-7.
5. Bulut DG, Kose E, Ozcan G, Sekerci AE, Canger EM, Sisman Y. Evaluation of root morphology and root canal configuration of premolars in the Turkish individuals using cone beam computed tomography. Eur J Dent 2015;9(4):551–7.
6. Mattuella LG, Mazzoccato G, Vier FV, So´ MV. Root canals and apical foramina of the buccal root of maxillary first premolars with longitudinal sulcus. Braz Dent J 2005;16:23–9.
7. Lammertyn AP, Rodrigo S, Brunotto M, Crosa M. Furcation groove of maxillary first premolar, thickness and dentin structures. J Endod 2009;35:814–17.
8. Tamse A, Pilo R, Corcino G. Furcation groove of buccal root of maxillary first premolars-a morphometric study. J Endod 2000;26(6):359-63.
9. Pineda F, Kuttler Y. Mesiodistal and buccolingual roentogenic investigations of 7,275 root canals. Oral Surg 1972;33:101-10.
10. Green D. Double canals in single roots. Oral Surg Oral Med Oral Pathol 1973;35:689-96.
11. Pecora JD, Saquy PC, Sousa Neto ND, Woelfel JB. Root form and canal anatomy of maxillary second premolars. External anatomy. Braz Dent J 1992;3(2):81–5.
12. Abella F et al. Cone-beam computed tomography analysis of the root canal morphology of maxillary first and second premolars in Spanish population. J Endod 2015;41:1241–47.
13. Raj J, Mylswamy S. Root canal morphology of maxillary second premolars in an Indian population. J Conserv Dent 2010;13:148–51.
14. Vertucci FJ. Root canal morphology and its relationship to endodontic procedures. Endodontic Topics 2005;10:3–29.
15. Dinakar C, Shetty A, Salian V, Shetty P. Root canal morphology of maxillary first premolars using the clearing technique in a South Indian population: An in vitro study. Int J App Basic Med Res 2018;8:143-7.
16. Bansal R, Hegde S, Astekar M. Classification of root canal configurations: A review and a new proposal of nomenclature system for root canal configuration. J Clin Dent Res 2018;12(5):1-5.
17. Joseph I, Varma B, Bhat K. Clinical significance of furcation anatomy of the maxillary first premolar: A biometric study on extracted teeth. J Periodontol 1996;67:386-9.