Original Article

Radicular Dentin Thickness Of Maxillary First Premolar As A Critical measurement. A Cone Beam Computed Tomography Study

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Doi: 10.47750/pnr.2022.13. S05.182

Abstract

Introduction: Maxillary first premolar (MFP) has a complex anatomy and great, furcational groove on the palatal side of the buccal root of the MFP represents one of its distinguishing features. Successful root canal therapy and post placement necessitate a good understanding of the radicular dentine thickness (RDT) on the buccal root of the MFP.

Aims & objectives: The present study was to examine the radicular dentin thickness and incidence of furcation groove on the buccal root in two-rooted maxillary first premolar among the genders by using CBCT.

Material and methods: At the dental clinics of Qassim University, a cross-sectional study was conducted using an electronic database that included CBCT images of 400 maxillary first premolars. All the scans were analyzed for furcation groove seen on the buccal root's palatal side in the axial plane. The following measurements were made 1-The most coronal portion of the furcation groove, when present in the buccal root, 2-the palatal root at the level of CEJ and 3-the palatal root 5 mm apical to the CEJ.

Result: Total of 183 CBCT scan of two rooted maxillary first premolars were matching the inclusion criteria,92 (50.27%) were males and 91 (49.73%) were females. The furcation groove was detected in 88 teeth out of 183 MFP's. The prevalence of furcation groove on the palatal aspect of buccal root was 48%. The Radicular dentine thickness of the most coronal part of the furcation groove in the buccal root was higher in the males than females and differences between gender was statistically significant. No statistical difference found for radicular dentine thickness between male and female at level of CEJ in palatal root and the palatal root 5 mm apical to the CEJ ($p<0.05$).

Conclusion: MFPs revealed a comparatively greater incidence of the furcation groove on the palatal side of the buccal root. Gender differences was statistically significant in the thickness of the dentin in the furcation groove of the maxillary first premolar at the most coronal part of the buccal root.

Keywords: CBCT, Furcation groove, maxillary first premolars, Post, Root canal treatment, Radicular dentin thickness.

INTRODUCTION:

Ideal root canal treatment requires a broad understanding of the inner anatomy of teeth, which permits excellent biomechanical preparation, root canal shaping, obturation and well-sealed coronal restorations [1]. Lack of understanding of the internal tooth anatomy is the main cause of root canal treatment failure [2]. Maxillary first premolars (MFP's) have a complex anatomy due to great variation such as bifurcation, deep mesial grooves, furcation with a slender entrance, and a variety of canal configurations [3,4]. These morphological changes make root canal treatment of MFP more challenging. One of the unique features of MFP is the presence of a furcation groove (furcal concavity) in the buccal root in bifurcated MFP [5]. The majority of MFPs have a furcation groove on the palatal side of the buccal root.Several studies have found the presence of a furcation groove ranging between 58% and 100% [5-9]. For the long-term prognosis of RCT, awareness of the radicular dentine thickness on the roots of the MFP is required. The dentine wall on the furcation groove in an unprepared root of the MFP is on average less than 1mm [6]. When a post is required in the MFP, 1 mm of radicular dentine thickness (RDT) must be present around the post [10]. Teeth with less than 1 mm of remaining dental thickness have a great risk of vertical root fracture due to the weakening of the dental structure [11]. A complete or incomplete longitudinal fracture that extends through the long axis of the root toward the apex is referred to as a vertical root fracture (VRF) [12]. Vertical root fractures (VRF) take the third place among the causes of loss of the tooth after dental caries and periodontal lesions MFP with root canal treatment and\or post has a great potential for vertical root fractures [13]. The root canal morphology affects the pattern of stress distribution. The

presence of irregularities in the canal wall like the furcation groove may lead to increased stresses that will eventually cause VRF [14]. Using conventional radiographs for root canal treatment gives limited details, because of the use of 2D images of 3D objects. Cone Beam Computed Tomography (CBCT) produces more effective images that have a 3D nature and overcome the majority of the issues with 2D x-ray images. CBCT was discovered in the 1990s to produce 3D imaging of the maxillofacial region [15]. CBCT is considered an acceptable approach for measuring the dimensions of variable morphological features [16]. Recently, CBCT is considered the first step for diagnosis before root canal treatment that will provide valuable information in three dimensions of teeth that have complex anatomies like the maxillary first premolar [17]. In addition, CBCT provides higher resolution and prevents superposition of anatomical structures [18]. The null hypothesis of the present study is "MFP's with furcation groove in buccal root will have less dentin thickness which may result in negative effects in Root canal treatment or post preparation. The goal of this study is to use CBCT to compare how often the furcation groove is found on the buccal root of two-rooted maxillary first premolars in men and women.

MATERIALS AND METHODS:

The present study was approved and authorized by the ethics committee of the dental research center at Qassim University. CBCT images of maxillary first premolars were collected from 400 consecutive patient examinations performed between January 2019 to December 2021 in the Oral Radiology Department of the College of Dentistry at Qassim University, Kingdom of Saudi Arabia. All the images have been taken for the treatment needs of the patients. Double rooted fully matured maxillary first premolars with closed apices were included in this study. MFPs with a single root, root canal treatment, posts, crowns, periapical pathology, periodontal lesion, trauma, artifacts, unclear images, and any other pathology Out of 400 CBCT scans of maxillary first premolars, 183 matched the inclusion criteria, 92 (50.27%) were males and 91 (49.73%) were females. CBCT scans of patients were captured by Galileos (Sirona Dental Systems, Beinshem, Germany). Scanning parameters were 85KvP, 6mA, 14.1 sec. exposure time, 0.16mm3 voxel size, and field of view of 15X8cm. The images were analyzed by the proprietary software Sidexis 4. All the images were analyzed for the presence of a furcational groove on the palatal side of the buccal root in the axial plane. The following measurements were made: 1-the most coronal portion of the furcation groove, when appeared in the buccal root, 2-the palatal root at the CEJ level and 3-the palatal root 5 mm apical to the CEJ. (Fig 1) Examinations were accomplished by two observers independently blinded to the patient's data and repeated after a 3 week interval. The two observers' readings were compared, and in the event of disagreement, the case was discussed until an acceptance was reached. Statistical analysis was done using IMB SPSS Statistics Version 25 predictive analytics software to determine descriptive statistics, The chi square test was applied to investigate the difference between genders. The Cohen's Kappa test was performed to determine interobserver reliability. The level of significance of all statistical tests was set at $p< 0.05$).

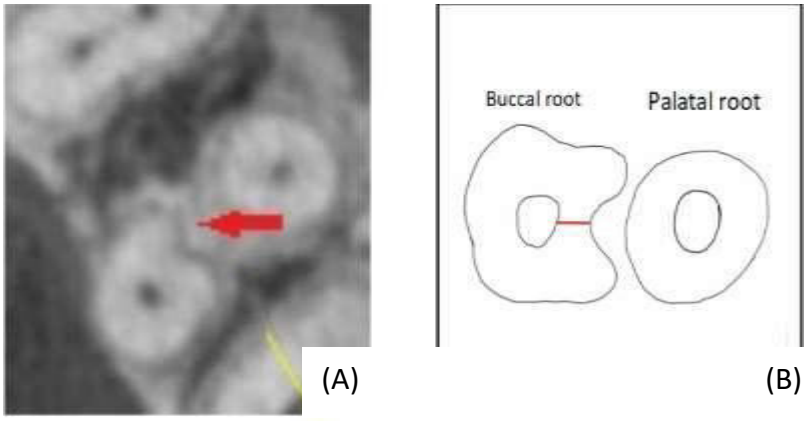

Fig 1.

(A) Axial section of CBCT image of the furcational groove in the buccal root of MFP's (B) Magnified tracking of measurement. The red line pointed to the RDT of the furcation groove at the palatal side of the buccal root.

RESULTS:

A total of 183 double-rooted MFP's were examined and the furcation groove was detected in 88 teeth. The prevalence of a furcational groove on the palatal side of the buccal root was 48%. The chi-square test revealed no statistical significance for RDT between genders at the CEJ level of the palatal root and 5 mm apical to the CEJ ($p = 0.7$) and ($P = 0.39$), respectively. The radicular dentine thickness of the most coronal portion of the furcation groove in the buccal root was higher in the males than in the females, and the differences between the genders were statistically significant ($p = 0.00$). (Table 1). The prevalence of RDT < 1mm was 100% in roots with furcation groove. The CohenKappa test for inter-examiner reliability was excellent (0.8).

Table 1. Shows the dentin canal wall thickness at the three mentioned locations of two rooted maxillary first premolar.

Location of radicular dentine	Gender	N	Mean	Standard deviation	t- value	P-value
The palatal root at the CEJ level.	Male	92	2.32	0.34	0.39	0.7
	Female	91	2.30	0.36		
	Total	183	2.31	0.35		
The palatal root 5 mm apical to the CEJ.	Male	92	1.38	0.27	0.86	0.39
	Female	91	1.33	0.32		
	Total	183	1.35	0.29		
The most coronal portion of the furcation groove in the buccal root.	Male	44	1.16	0.4	4.46	.000
	Female	44	0.8	0.35		
	Total	88	0.98	0.42		

DISCUSSION:

Endodontic canal shaping and post preparation in MFPs are predominately combined with serious complications. Inadequate understanding of MFP's anatomy might lead to procedural errors. Hence, knowledge of anatomical variations must be considered for endodontic treatment of MFP's. The incidence of furcational grooves on the palatal side of the buccal root is believed to be high in multiple populations, ranging from 58% to 100% [7]. The study of Al-Shahrani et al. showed that the Arabian population, had 100% of the 23 MFP's with furcation groove [8]. Kfir et. al. reported that the Israeli population had a prevalence of 58% of 245 MFP's [19]. Another study by Liu et al. revealed that the Chinese population had 95.83% of 48 MFP's detected with furcation groove [20]. Yanik et al. reported in their study about the Turkish population, that 82.05% of 312 MFP's have a furcational groove on the palatal side of the buccal root using CBCT [7]. In our literature, we found the prevalence of the furcation groove was 48% of 183 MFP's. The differences in prevalence can be attributed to the method of investigation used, such as section analysis, CBCT, or micro-CT. RDT was measured at three critical locations. The mean thickness of the most coronal portion in the presence of a furcational groove on the palatal side of the buccal root was 1.025 mm, which is slightly higher than recorded at the same location in the study of Kfir et. al. at 0.98 (±0.2) mm [19]. The mean RDT of the canal wall in the palatal root at the level of the CEJ was 2.31, which appears to be equal or slightly less than revealed in the previously mentioned CBCT study: 2.3 (±0.4) mm [19]. The mean of RDT in the palatal canal wall 5mm apical to the CEJ was 1.36mm, which is almost equal or higher than reported in the previously mentioned CBCT study: 1.35 (±0.2) mm [19].The dentin thickness at most coronal portion of the furcation groove in the buccal root was statistically significant between male and female. It was detected that dentin thickness was higher in this location for males compared to less dentin thickness in females, which should be considered with caution when having endodontic treatment for female patients, indicating that any intra-radicular procedure should be done with additional care and delicacy, especially in female patients. Roots with narrower mesiodistal dimensions, including maxillary and mandibular premolars, are most vulnerable to VRF [3,22]. Cautious post-space preparation, especially in VRF vulnerable teeth, is extremely crucial due to anatomical variation [3, 21]. Redundant removal of radicular dentin weakens the root, RDT after root canal and post preparation is equally critical. There is a clear correlation between the RDT and root strength [3,23,24]. Post preparation weakens teeth, and the tooth capability to resist lateral forces is directly proportional to the tooth RDT [25,26]. As a result, maintaining healthy dentin and avoiding white spot lesions are essential for reducing dentinal hypersensitivity [27,28,29]. A minimum of 1 mm of RDT throughout the canal's circumference. Canal wall was originally 1.0 mm thick, it may be lowered to 0.67 mm during intra-radicular procedures. Accordingly, the RDT after the endodontic canal cleaning and shaping will be remarkably less than the required level of 1.0mm remaining RDT. The RDT in these teeth may be further reduced during post-preparation, severely impairing the tooth structure [19]. Ghoddusi et al. did a different CBCT study and found that the minimum RDT on the palatal side of the buccal roots before and after surgery was less than 1mm [30]. Likewise, our study showed that MFP's with a furcational groove on the palatal side of the buccal root have a RDT of less than 1 mm before any intra-radicular procedure was done. Our study suggests that having CBCT that includes the MFP's, one should concentrate not only on the number of roots, canals, and configuration, but also consider the RDT at the sensible points, to perform more preservative methods in cases with thin walls. In our literature, the null hypothesis of " MFP's with a furcation groove in the buccal root will have less dentin thickness, which may result in negative effects in root canal treatment or post preparation" is accepted. The limitations of the study were the low sample size and the lack of details of the furcational groove (the extent and starting point) were not recorded. Nevertheless, the strength of the present study is that it is the first study to detect a difference in RDT in the furcation groove in MFP's between genders. Further studies are needed to strengthen the current findings.

CONCLUSION:

The presence of a furcational groove on the palatal side of the buccal root of MFPs was found to be relatively common. Hence, conservative endodontic instrumentation and post preparation should be considered, especially in MFP's. There was statistical significance between genders in dentin thickness in the most coronal portion of the furcation groove. have less dentin thickness, indicating additional caution for root canal treatment and post preparation in female patients.

External morphological features such as concavities and grooves have their effects on internal features such as dentinal wall thickness. It is prudent to pay special attention to root morphology before any intra-radicular treatment.

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Source(s) of support: Nil
Presentation at a meeting: Nil

ACKNOWLEDGMENTS

Special thanks to Dr. Faraj Alotaibi for editorial assistance and Dr. Rahul Gaikwad for statistical assistance.

Conflict of interest

The authors deny any conflicts of interest.

Funding

Nil