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Research Article

An In Vitro Evaluation Of Deepest Portion Of Furcal Groove In Maxillary First Premolars Before And After Instrumentation With Stainless Steel Hand Files And Two Niti Rotary File Systems Under CBCT

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ABSTRACT

The objective of this study is to perform a morphometric assessment of the buccal furcation grooves in bifurcated maxillary first premolars and to evaluate anatomical measurements before and after operative procedures using three different file systems: stainless steel K file, Wave One, and NeoEndo file, utilizing CBCT imaging.

Method: 99 extracted human bifurcated maxillary first premolars were selected, and an initial CBCT scan was conducted. Dentin cementum wall thickness at the mid-groove area was measured prior to instrumentation. Subsequently, access cavity preparation was performed. The teeth were then randomly allocated into three groups, with 33 teeth in each group. The first group underwent instrumentation with a stainless steel (SS) K-file up to apical size 25 with a 2% taper, the second group with a Neoendo flex file (NF) up to apical size 25 with a 4% taper, and the third group with a WaveOne (WO) primary file size 25 with an 8% taper. Following instrumentation, a post-operative CBCT scan was conducted, and dentin cementum wall thickness was re-measured at the same location.

RESULT: When compared the dentine removed after instrumentation in the furcal groove is more in WaveOne file (0.24mm) followed by stainless steel file (0.154 mm) and Neoendo file (0.148 mm)

CONCLUSION : Dentin removed at furcal groove region is more in waveone file compared to stainless sttel files and neoendo files

KEY WORDS : dentin thickness , furcal groove, CBCT

INTRODUCTION

The endodontic therapy primarily aims at providing a biologically acceptable environment within the root canal which promotes healing and maintains a healthy periodontium. This is achieved by complete debridement, disinfection and three dimensional filling of the canals. Chemomechanical preparation plays an important role in this process of debridement and disinfection. Shaping and cleaning of canals emphasis on preparing an evenly tapered canals[4]. Schilder suggested a continuous tapering funnel shape from coronal access to the root apex, which can ensure an efficient delivery of irrigants to the apex to flush out the debris[7]. various techniques have been developed for preparation of canals using hand files but due to the inherent inflexibility of files they often results in iatrogenic damage to the natural shape of the canal.).The introduction of nickel titanium rotary instruments in endodontics has evolved a new phase. Structural integrity of the root canal system is impaired by the size and taper of the rotary instruments used to shape the canal.

The bifurcated maxillary first premolar (BMFP) often presents with unique anatomical features that require consideration during endodontic therapy. BMFP has been extensively studied for the presence of a developmental groove on the lingual surface of the buccal root[9]. The developmental groove present was previously reported as "developmental depression", "buccal furcation groove", or "furcal concavity"[1].In a study by Tames et al., it was noted that the groove initiates just apical to the bifurcation, attaining a mean maximal depth of 0.4 mm at an average distance of 1.18 mm from the bifurcation. It then gradually diminishes in depth as it progresses, extending to an average distance of 5.38 mm before disappearing towards the apex[11].

Three-dimensional (3D) radiographic images offer significant potential in the evaluation of anatomical structures and treatment planning. A distinctive feature of CBCT is its capability to measure both initial and post-instrumentation dentin cementum wall (DCW) thickness. This characteristic is particularly valuable as it provides a reliable baseline (initial RDT) against which each successively instrumented canal can be assessed and analysed. A study conducted by Kobayashi et al. suggested that limited CBCT may offer superior accuracy in measuring distances between points compared to Spiral Computerized Tomography[5]. However, to date, no study has examined the comparative performance of different rotary systems regarding dentin removal from the buccal root of bifurcated maxillary first premolars (BMFPs).

The WaveOne (WO) NiTi file system, consisting of a single NiTi file utilizing M-Wire technology, is employed in a reciprocating handpiece for thorough canal preparation, particularly in narrow and curved canals. These files operate with a reverse "balanced force" action, driven by a pre-programmed motor, executing a back-and-forth "reciprocal motion." This motion prioritizes counter clockwise movement over clockwise movement. The Neoendo file (NF), on the other hand, incorporates gold thermal treatment to enhance its cutting efficiency. Featuring a triangular cross-section with sharp cutting edges, it demonstrates improved canal cleanliness compared to instruments with radial lands due to its active cutting blades. Moreover, the non-cutting or safety tips of the NF contribute to reducing procedural errors such as root perforation, zipping, and ledging.
The objective of this investigation was to ascertain the presence of a furcal groove on the palatal aspect of the buccal root of BMFP. Additionally, it aimed to measure the minimum cross-sectional thickness of dentine cementum walls within the groove both before and after instrumentation, utilizing WaveOne, Neoendo files, and stainless steel K-files, with the assistance of limited-field CBCT.

Methodology :

Samples comprising 99 untreated bifurcated maxillary first premolars underwent an initial CBCT scan using a CS 9300 limited field cone beam computed tomography machine (New Tom Vgi - Verona - Italy) to verify the presence of a furcal groove on the palatal aspect of the buccal root. The field of view was set at 5 cm in diameter and 5 cm in height, with scan parameters of 110 kV, 1-20 mA, and a voxel size of 90 micrometers. Point A was marked 0.5 mm apically from the coronal initiation point of the furcation groove on the palatal aspect of the maxillary first premolar (slice level), Point B was marked 0.5 mm coronally from the termination of the furcation groove on the palatal aspect, and Point C was identified as the midpoint between Point A and Point B, representing the deepest point of the groove invagination. The minimum cross-sectional dentin-cementum wall thickness (DCW) at Point C was measured.Access opening was performed using an Endo access bur (Dentsply, Tulsa Dental), and the teeth were randomly allocated into three groups. Group 1 was instrumented with Stainless Steel (SS) K-files (Mani, Inc., Japan) up to size 25, with a 2% taper; Group 2 with Neoendo Flex files (NF) (Orikam, India) up to size 25, with a 4% taper; and Group 3 with WaveOne (WO) (Dentsply Tulsa Dental Specialties Inc., Tulsa, OK) primary files of size 25, with an 8% taper. Canal irrigation was conducted using 5.25% sodium hypochlorite during instrumentation, delivered via a 5 ml syringe with a 27-gauge side-vented needle (Unolok, Hindustan Syringes and Medical Devices LTD, India). A final CBCT scan was performed to assess the remaining DCW thickness at Point C in the furcation groove on the palatal aspect of the maxillary first premolars in all three groups. Statistical analysis was applied to the obtained results.

RESULTS

The study results underwent statistical analysis to assess the significance of instrumentation in the buccal root of bifurcated maxillary premolars and to establish a correlation between palatal root canal wall thickness in the buccal root. Among the three groups, Group III exhibited the lowest mean value after instrumentation (0.61 mm), followed by Group I (0.73 mm) and Group II (0.74 mm). Additionally, Group III demonstrated the thinnest canal wall (0.35 mm). ANOVA analysis between the groups in the pre-test group yielded a statistically insignificant p-value of 0.702 (mean square: 0.009). However, ANOVA between the groups in the post-test group resulted in a p-value of 0.001, indicating significance at a level of one (Highly significant). Pairwise comparisons within the pre-instrumentation groups showed no significant differences. Post-instrumentation comparisons revealed no significant difference between Group I and Group II, but statistically significant differences were observed when comparing Group I with Group III and Group II with Group III. Paired sample tests within each group showed statistically significant differences between pre- and post-instrumentation measurements at a level of one (Highly significant). Group II exhibited the least dentin removal, followed by Group I, while Group III showed the highest dentin removal.

Discussion

Endodontic therapy is crucial for preserving the natural tooth structure, function, and aesthetics by treating the pulp within the tooth. A key aspect of this therapy is achieving a continuous, conical root canal preparation to ensure complete debridement and effective flow of irrigants. While historically stainless steel hand files were

used for root canal instrumentation, their limitations in curved canals led to the introduction of nickel-titanium (NiTi) instruments. Although NiTi instruments reduced complications like elbows and zips, they posed challenges regarding excessive dentine removal and weakened root structure. However, advancements in NiTi instruments, including the introduction of safety tips, have improved outcomes by reducing canal transportation.

The thickness of remaining dentine plays a critical role in preventing vertical root fractures, with the degree of taper of the prepared root canal being a major factor. Higher-tapered NiTi files can weaken the root structure, particularly in curved canals. Studies have shown a direct correlation between dentine cementum wall thickness and the risk of vertical root fractures, with thinner walls being more prone to fracture. This underscores the importance of preserving dentine thickness during root canal procedures.

Maxillary first premolars are commonly treated with root canal therapy and have unique anatomical features, including bifurcation and invaginations. One such feature is the furcal groove, which has been studied extensively. The furcal groove typically starts apical to the furcation and reaches its maximum depth before gradually becoming shallower towards the apex. Studies have shown variations in the depth of the furcal groove, influenced by the location of the bifurcation.

In our study, limited field CBCT evaluation was conducted to measure dentine cementum wall thickness at the deepest portion of the furcal groove in bifurcated maxillary first premolars before and after instrumentation. Three different techniques were employed, including stainless steel hand files, Neoendo NiTi files with changing taper, and WaveOne single-file system. Pre-instrumentation measurements revealed a mean thickness of 0.87 mm. Post-instrumentation, WaveOne demonstrated the most significant dentine removal, followed by stainless steel files and Neoendo files. There was a statistically significant difference in dentine removal between the groups, with WaveOne removing the most dentine.

The study also highlighted the effect of instrument size on dentine removal, challenging conventional assumptions. Interestingly, Neoendo files with a higher taper removed less dentine than stainless steel files with a lower taper. Additionally, post-instrumentation dentine thickness remained above the critical threshold of 0.5 mm, crucial for maintaining root integrity.Variations in dentine thickness across studies may arise from differences in measurement techniques and tooth morphology. However, findings generally align with previous research, emphasizing the importance of preserving dentine thickness, particularly in critical areas like the furcal groove.

In conclusion, preserving dentine thickness is essential for preventing vertical root fractures and ensuring the long-term success of endodontic therapy. Advances in instrumentation techniques, such as the use of NiTi files with safety tips, have improved outcomes by minimizing dentine removal. However, further research is needed to optimize clinical practices and enhance treatment efficacy.

CONCLUSION

Within the scope of investigation the study it was determined that the thickness of dentin removed from the MFP in the furcal groove region post instrumentation is more in waveone(0.24 mm) followed by stainless steel(0.154 mm) and neoendo (0.148 mm) . Neoendo files consistently achieved a more predictable and uniform dentin thickness along the entire length of the bifurcated buccal root of maxillary first premolars, regardless of the initial dentin thickness before instrumentation.

Conflicts of Interest : There are no conflicts of interest

Reference :

1. **Al-Shahrani S M, Al-Sudani D, Almalik M** Microcomputed tomographic analysis of the furcation grooves of maxillary first premolars.
2. **Booker B W 3rd, Loughlin D M.** A morphologic study of the mesial root surface of the adolescent maxillary first bicuspid.*Journal of Periodontology 1985;55:666-70.*
3. **Bramante C M, Berbert A, Borges R P.** A methodology for evaluation of root canal instrumentation. *Journal of Endodontics 1987;13:243-5.Anna Stomatol 2013;4:142–8*
4. **Chow T W** .Mechanical effectiveness of root canal irrigation.*Journal of Endodontics 1983; 9, 475–9.*
5. **Cotton T, Geisler T, Holden D, Schwartz S, Schindler W.** Endodontic applications of cone beam volumetric tomography. *Journal of Endodontics 2007;9:1121-32*
6. **Dowker S. E. P, Davis G. R, Elliott J. C.**X-ray microtomography: nondestructive three-dimensional imaging for in vitro endodontic studies.*Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics, vol. 83, no. 4, pp. 510–516, 1997.*
7. **Fundamental practical dentistry handbook**. Vol. 6 issue 4 april - june 2006. Dr. Siju Jacob
8. **Gutmann J L.**The dentin root complex: anatomic and biologic considerations in restoring endodontically treated teeth. *Journal of Prosthetic Dentistry 1992;67:458-67.*

9. **Li J, Li L, Pan Y**. Anatomic study of the buccal root with furcation groove and associated root canal shape in maxillary first premolars by using micro–computed tomography. *Journal of Endodontics 2013;39:265–8.*
10. **Tamse A.** Iatrogenic vertical root fractures in endodontically treated teeth.*Dental Traumatology 1988;4:190-6.*
11. **Tamse A, Katz A, Pilo R.** Furcation groove of buccal root of maxillary first premolars-a morphometric study.*Journal of Endodontics 2000;26:359-63.*
12. **Zandbiglari T, Davids H, Schafer E** Influence of instrument taper on the resistance to fracture of endodontically treated roots. *Oral Surgery, Oral Medicine, Oral Pathology,Oral Radiology and Endodontology 2006 101, 126-31.*

Table 1 -Shows mean value of canal wall thickness of all groups pre -instrumentation

Group		N	Minimum	Maximum	Mean	Std. Deviation
1	Pre	33	.60	1.20	.8879	.16537
2	Pre	33	.60	1.20	.8909	.15883
3	Pre	33	.60	1.20	.8606	.15799

Table 2 - Shows mean value of canal wall thickness of all groups post instrumentation.

Groups		N	Minimum	Maximum	Mean	Std. Deviation
1	Post	33	.50	1.00	.7333	.14506
2	Post	33	.45	1.00	.7424	.14530
3	Post	33	.35	1.00	.6121	.16299

Table 3 - Pre test ANOVA between groups.

		Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.018	2	.009	.356	.702	Between Groups

Table 4 - Post test ANOVA between groups.

		Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.349	2	.175	7.624	.001**	Between Groups

**p value < 0.010 is considered statistically significant at level 1 (Highly significant)

Table 5 – Pre Test comparison - between groups.

Dependent Variable	(I) groups	(J) groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval
						Lower Bound
Pre	1.00	2.00	-.00303	.03958	1.000	-.0995
		3.00	.02727	.03958	1.000	-.0692
	2.00	1.00	.00303	.03958	1.000	-.0934
		3.00	.03030	.03958	1.000	-.0661
	3.00	1.00	-.02727	.03958	1.000	-.1237
		2.00	-.03030	.03958	1.000	-.1267

Table 6 - Post Test comparison - between groups.

Dependent Variable	(I) groups	(J) groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval
						Lower Bound
Post	1.00	2.00	-.00909	.03726	1.000	-.0999
		3.00	.12121*	.03726	.005	.0304
	2.00	1.00	.00909	.03726	1.000	-.0817
		3.00	.13030*	.03726	.002	.0395
	3.00	1.00	-.12121*	.03726	.005	-.2120
		2.00	-.13030*	.03726	.002	-.2211

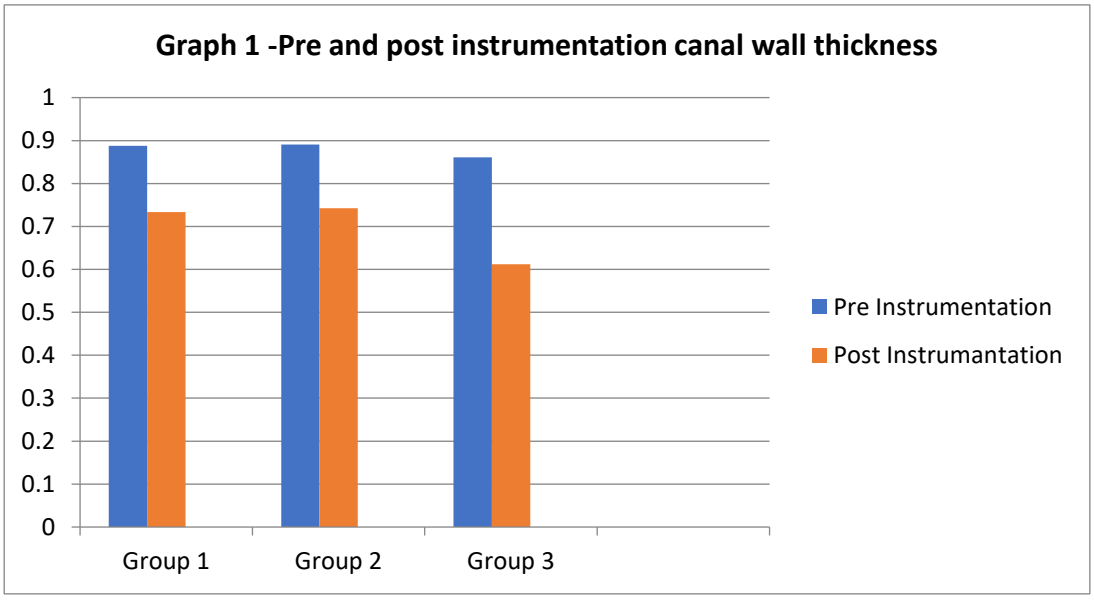
**p value < 0.010 is considered statistically significant at level 1 (Highly significant)
*p value < 0.005 is considered statistically significant at level 5 (Significant)

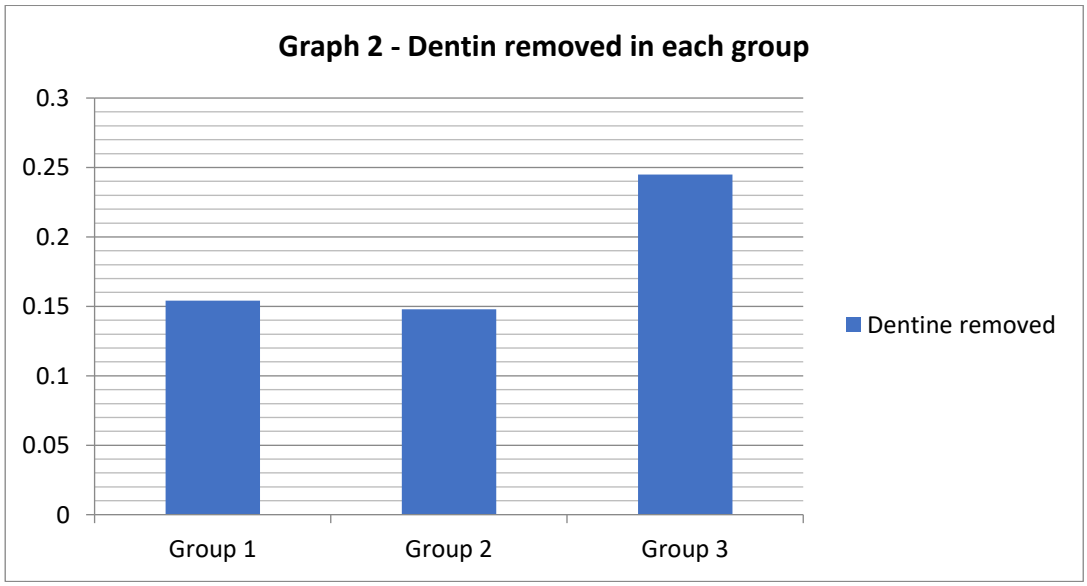
Table 7 - Paired sample test within group comparison

Groups			Paired Differences					t	df	Sig. (2-tailed)
			Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
						Lower	Upper			
1.00	Pair 1	pre - post	.15455	.04395	.00765	.13896	.17013	20.199	32	.000
2.00	Pair 1	pre - post	.14848	.03850	.00670	.13483	.16214	22.157	32	.000
3.00	Pair 1	pre - post	.24848	.04590	.00799	.23221	.26476	31.097	32	.000

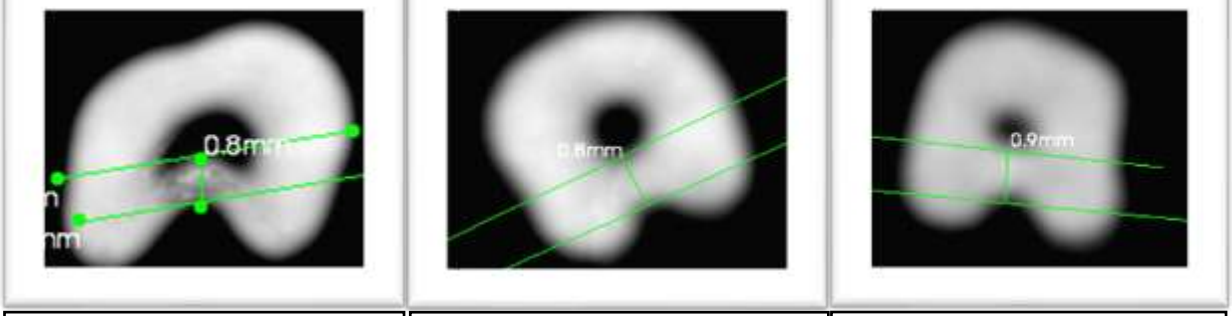
Table 8 - Mean dentine removed by each group

Groups	Mean
Group 1	0.154
Group 2	0.148
Group 3	0.245



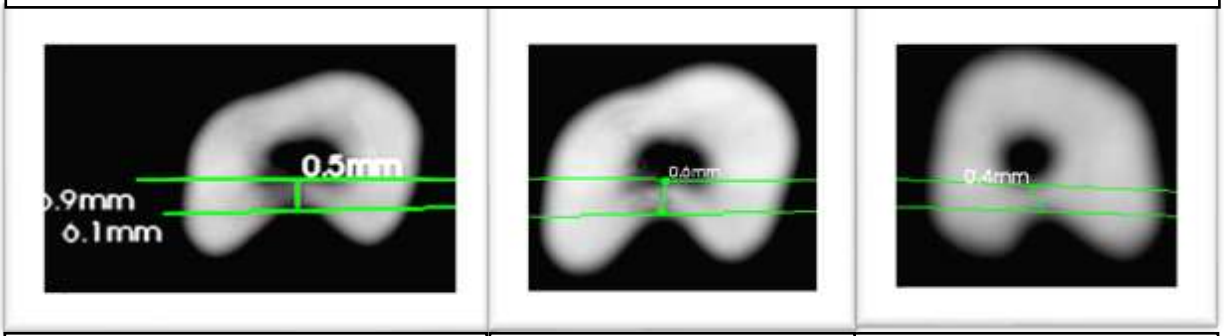


PRE INSTRUMENTATION GROUPS

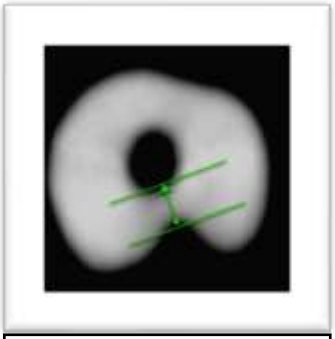


GROUP 1	GROUP 2	GROUP 3

POST INSTRUMENTATION GROUPS



GROUP 1	GROUP 2	GROUP 3



Measurement of the dentine cementum wall thickness