

Comparative evaluation of remaining dentin thickness in furcation area of Mesiobuccal root of permanent mandibular molar after shaping and cleaning in traditional and conservative endodontic access cavity preparations using cone beam computed tomography- an in-vitro study

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Abstract

Aim: To compare the remaining dentinal thickness in furcation area of permanent mandibular molars after shaping and cleaning in traditional and conservative endodontic access cavity preparations using cone beam computed tomography.

Materials and methods: Forty-eight freshly extracted mandibular molar, the mesial roots of which presented a curvature of 20-40 degrees, were selected using the Schneider method. The samples were randomly divided into two groups- Group 1: Traditional Endodontic Access Cavity (TEAC) (n=24) Group 2: Conservative Endodontic Access Cavity (CEAC) (n=24)

All the tooth samples were subjected to pre and post-operative CBCT imaging (Cone Beam Computer Tomography) to determine the remaining dentin thickness of the root canal. Cleaning and shaping of the specimen was carried out for which each group was further divided into three subgroups (subgroup a: Protaper Universal (PTU); subgroup b: Protaper Gold (PTG); and subgroup c: V-Taper 2H). The remaining dentin thickness was measured in millimeters by using CBCT. The distance from the canal walls to the root surface at the first 3 cut surface at coronal level (below the orifice of Mesiobuccal canal) was measured in millimeters using image analysis software. To measure

the dentin thickness two reference points are used: pulpal floor and dome of furcation.

Results: Data suggested that V-Taper 2H files presented the best outcome in retaining the dentin thickness when compared to Protaper Universal and Protaper Gold in both the groups. ($p < 0.05$), There was no significant difference between PTG and PTU systems in the mean amount of removed dentin in both the groups ($p > 0.05$).

Conclusion: The access cavity type did not influence the remaining dentin thickness at the furcation area of the Mesio Buccal root in the mandibular molars. However, V-Taper file revealed better results than Protaper Universal and Protaper Gold in preserving the dentin thickness.

Keywords: Furcation, Remaining Dentin Thickness (RDT), Traditional Endodontic Access Cavity, Conservative Endodontic Access Cavity, Cone Beam Computed Tomography (CBCT), Protaper, V-Taper.

Introduction

Root canal treatment is aimed at removing harmful pathogenic contents, such as pulp tissue, microorganisms, necrotic dentin and attain a uniform taper to facilitate the obliteration of the prepared canal space. [1,2] It is generally accepted that the strength of endodontically treated root is directly dependent on the amount of remaining dentin. Aggressive removal of dentin can potentially weaken the root structure that consequently leads to root fracture or strip perforation especially in high-risk areas such as on the distal walls of mesial roots of mandibular molars

Traditional endodontic access cavity preparation (TEAC) leads to more sacrifice of additional tooth structure which ultimately might lead to decrease fracture resistance of tooth. To overcome the above-mentioned problems a new concept of endodontic access cavity was proposed on dentin preservation by David

Clark and Khademi. The conservative endodontic access cavity (CEAC) represents a contracted form of conventional cavities. [3]

NiTi rotary files have significantly better flexibility and cutting abilities and provide higher quality in the preparation of root canals with low risk of deviations and higher fracture resistance to cyclic and torsional fatigue. [4]

Among the NiTi systems, the Protaper Universal (PTU; Dentsply Maillefer, Switzerland) is a rotary system of conventional NiTi wire that has been widely used and studied. [5,6] It has a variable taper along the length of the instrument, a convex triangular cross-section, and a sharp tip. [4] Another system, the Protaper Gold (PTG; Dentsply, Maillefer, Switzerland) was recently introduced to the market and has characteristics that are generally similar to those of the PTU.

There have been studies which has compared the effect of different powered instruments on the residual dentin thickness from the furcation entrance to the canal orifice during instrumentation in curved Mesio Buccal canals of extracted mandibular molars. [7] Limited literature is available on effects of different types of endodontic access cavity preparation on remaining dentin thickness in the furcation area. Also, role of type of rotary files and its post manufacturing treatment in dentin removal during shaping and cleaning procedures needs to be evaluated. Hence, this study is aimed to compare and evaluate the remaining dentin thickness (RDT) in furcation area of traditional endodontic access preparation and conservative endodontic access cavity preparation after biomechanical preparation with different NiTi rotary files in the molar teeth using CBCT.

Materials and Method

In this in-vitro study was conducted in the Department of Conservative Dentistry and Endodontics with a total sample size of 48 intact human permanent mandibular molar teeth was calculated with 80% power of the study and alpha error at 5% with 95% confidence interval. The teeth obtained were stored in normal saline and then made ready to use.

Sample Preparation

After extraction all soft tissue and calculi was removed and teeth were decontaminated by immersion in 5.25% sodium hypochlorite for 30 minutes and stored in sterile normal saline at room temperature. The storage time of all teeth was less than two months before initiation of the experiment. Teeth were embedded in modelling wax (Fig.1) blocks up to the cemento-enamel junction. (Fig.2) Digital periapical radiographs were taken for each tooth from buccal surface in the anteroposterior position to determine the degree of curvature of the canals. Canals with completely formed apices and severe angles of curvature ($20-40^\circ$) were selected. The degree of the curvature was standardized as described by Schneider. (Fig.3) RVG and CBCT imaging were performed for analyzing the root canal anatomy and preoperative measurements of dentin thickness of the Mesiobuccal canal from the canal orifice to furcation entrance.



Figure 2: Intact tooth embedded in modelling wax



Figure 3: Schneider's method of estimation of canal curvature

Group 1: Traditional endodontic access cavity (TEAC)

Traditional endodontic cavity preparation was done using Endo Access bur or Endo-Z bur gaining straight line access. External outline form was established projecting the internal anatomy of the pulp onto the external surface, by complete deroofting of the pulp chamber to gain straight line access to canals orifices. After the initial drop into the pulp chamber, a DG-16 probe is used to locate the canals by tactile sensation.

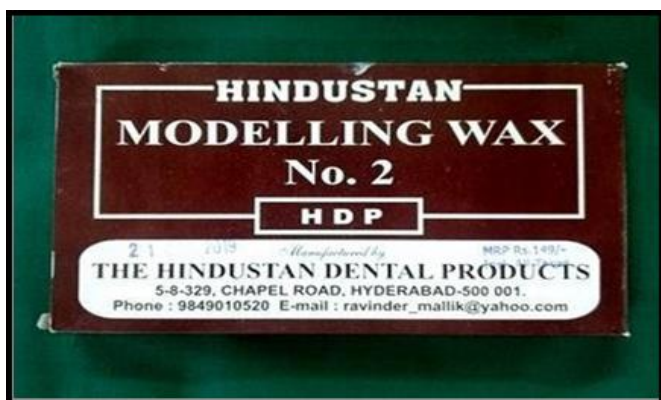


Figure 1: Modelling Wax for model preparation

Flaring of canals orifices that connects the coronal to the apical preparations was kept to minimal to preserve the peri cervical dentine which is defined as an area roughly 4 mm coronal to crestal bone and 6 mm apical to crestal bone.

Group 2: Conservative (soffit) endodontic access cavity (CEAC) (Fig.4)

Clark and Khademi conservative access model was used as a general guide. Coronal access preparation objective used was to remove as little tooth structure as necessary to locate canals orifices and to maintain a soffit which has been defined as a small piece or tiny lip of dentinal roof of 0.5-3.0 mm around the entire pulp chamber. Access was accomplished by cutting near functional cusps, while staying 1-2 mm away from non-functional cusps, and the distal half of the occlusal surface was avoided. Radicular apical preparation was just wide enough to clean canals and remove the biofilm, without aggressive dentine removal for shaping.



Figure 4: Conservative Endodontic Access Cavity (CEAC)

Endodontic Treatment

Root canals were instrumented initially with size 10 K-type files till the major apical foramen, and later the canals were negotiated till working length. The working length (WL) was established 1 mm shorter than the radiographic apex. Chemo mechanical preparation was completed in all the Mesiobuccal canals up to size

25/0.06 of each file system. Sufficient lubrication was done with RC Help (Prime Dental, India) while instrumenting the canals. For each group during and after the use of each file, canals were irrigated with 5ml of 5.25% NaOCl solution and canal patency was checked using number 10K file. (Fig. 5) All the teeth were aligned with the buccal surface in the anteroposterior position and imaged both pre and post operatively by CBCT for remaining dentin thickness in the danger zone.



Figure 5: Determination of working length

Measurement of Remaining Dentin Thickness- (Fig.6)

The remaining dentin thickness is the thickness of a dentin that may be measured in millimetres by using Cone Beam Computed Tomography and 3D IMAGING SOFTWARE. The distance from the canal wall to the root surface at the first 3 cut surface at coronal level (below the orifice of Mesiobuccal canal) was measured in millimeters using image analysis software. The measurements are from: The external surface of the root in line with canal orifice, pulpal floor to dome of furcation and canal orifice to the dome of the furcation.

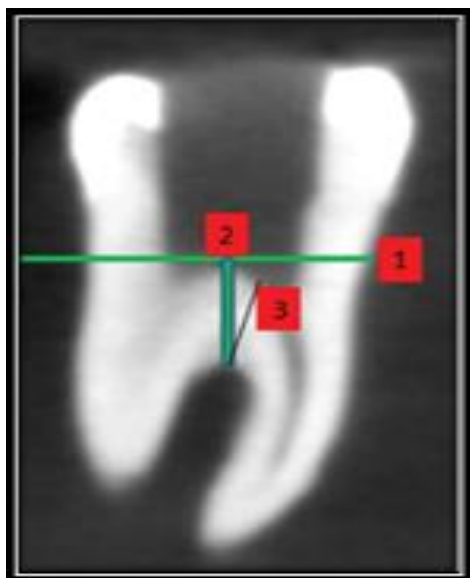


Figure 6: Measurement of Dentin Thickness

Statistical analysis

Statistical analysis using an appropriate package like SPSS (Statistical Package of Social Sciences) software. V.21. inter group comparison (2 groups) was done using t test, else a non-parametric substitute like Mann

Table 1: Intergroup comparison of the pre and post-operative measurement of dentin in Group 1 and Group 2 samples (traditional and conservative access cavity)

Protaper Universal Subgroup A			
	Pre-operative	Post-operative	Mean difference
Group 1 (Traditional access cavity)	2.67 ± 0.44	1.73 ± 0.46	0.94 ± 0.35
Group 2 (Conservative access cavity)	2.52 ± 0.42	1.76 ± 0.36	0.76 ± 0.19
p-value (Student t- test)	0.244		
Protaper Gold (Subgroup B)			
	Pre-operative	Post-operative	Mean difference
Group 1 (Traditional access cavity)	2.37 ± 0.44	1.66 ± 0.45	0.71 ± 0.23
Group 2 (Conservative accesscavity)	2.74 ± 0.37	2.17 ± 0.39	0.57 ± 0.12
p-value (Student t- test)	0.181		
V Taper (Subgroup C)			
	Pre-operative	Post-operative	Mean difference
Group 1 (Traditional access cavity)	2.77 ± 0.36	2.43 ± 0.36	0.34 ± 0.07
Group 2 (Conservative accesscavity)	2.12 ± 0.38	1.83± 0.45	0.29 ± 0.11
p-value (Student t-test)	0.333		

*p ≤ 0.05 is statistically significant

Whitney U test was used. For a numerical continuous data following a normal distribution, inter group comparison (>2 groups) was done using One-way ANOVA test, else a non-parametric substitute like Kruskal Wallis ANOVA test was used. Keeping alpha error at 5% and Beta error at 20%, power at 80%, p<0.05 was considered statistically significant.

Observations and Results

This in-vitro study was carried out on 48 specimens divided into 2 groups and 6 sub- groups, to evaluate and compare the remaining dentin thickness in furcation area of Mesiobuccal root of permanent mandibular molar after shaping and cleaning in traditional and conservative endodontic access cavity preparations using cone beam computed tomography.

There is no statistically significant difference in the amount of dentin reduction in Group 1 and Group 2 using Protaper Universal files. The mean difference of traditional access cavity is (0.94 ± 0.35) and conservative access cavity is (0.76 ± 0.19) . There is no statistically significant difference in the amount of dentin reduction in Group 1 and Group 2 using Protaper

Gold files. The mean difference of traditional access cavity is (0.71 ± 0.23) and conservative access cavity is (0.57 ± 0.12) . There is no statistically significant difference in the amount of dentin reduction in Group 1 and Group 2 using V Taper files. The mean difference of traditional access cavity is (0.34 ± 0.07) and conservative access cavity is (0.29 ± 0.11) .

Table 2: Intragroup comparison of the pre and post-operative measurement of dentin in Group 1 samples (traditional access cavity) using different file systems

	Protaper Universal (1A)	Protaper Gold (1B)	V Taper (1C)	p-value (One-Way ANOVA)
Pre-operative	2.67 ± 0.44	2.37 ± 0.44	2.77 ± 0.36	<0.001*
Post-operative	1.73 ± 0.46	1.66 ± 0.45	2.43 ± 0.36	
Mean Difference	0.94 ± 0.35	0.71 ± 0.23	0.34 ± 0.07	

There is no statistical difference between Protaper Universal and Protaper Gold files in dentin removal. However, V Taper is significantly better than the other two file systems. From Table 2 we can appreciate that V Taper group has significantly higher effectiveness in

retaining dentin thickness (0.34 ± 0.07) when compared to Protaper Gold (0.71 ± 0.23) and Protaper Universal group (0.94 ± 0.35) in the traditional endodontic access cavity.

Table 3: Intragroup comparison of the pre and post-operative measurement of dentin in Group 2 samples (conservative access cavity) using different file systems.

	Protaper Universal (2A)	Protaper Gold (2B)	V Taper (2C)	p-value (One –Way ANOVA)
Pre-operative	2.52 ± 0.42	2.74 ± 0.37	2.12 ± 0.38	<0.001*
Post-operative	1.76 ± 0.36	2.17 ± 0.39	1.83 ± 0.45	
Mean Difference	0.76 ± 0.19	0.57 ± 0.12	0.29 ± 0.11	

There is no statistical difference between Protaper Universal and Protaper Gold files in dentin removal. However, V Taper is significantly better than the other two file systems. From Table 3 we can appreciate that V Taper group has significantly higher effectiveness in retaining dentin thickness (0.29 ± 0.11) when compared to Protaper Gold (0.57 ± 0.12) and Protaper Universal group (0.76 ± 0.19) in the conservative endodontic access cavity.

endodontic access preparation on the remaining thickness at the furcation area after root canal preparation is limited.

Therefore, the purpose of the study was to evaluate and compare remaining dentin thickness in furcation area of Mesio Buccal root of permanent mandibular molar after shaping and cleaning in traditional and conservative endodontic access cavity preparations using cone beam computed tomography.

Discussion

The literature related to the influence of traditional endodontic access preparation and conservative

In the present study human mandibular molars with two separate mesial canals and apical foramina with fully formed root apices were selected to study the remaining

dentin thickness after instrumentation. Extracted human teeth reflect the clinical situation more adequately, although root canal morphology and dentine hardness cannot be standardized, and could differ significantly from one tooth to another. [8] Intact mandibular molars were selected as these teeth are under constant crushing load of mastication and bears maximum load. The mandibular first molars have complex internal anatomy with major variations in the mesial roots. The canals in the mesial root are not located in the center of the root. Hence dentin present between the canal and furcation area is very thin. [1,9]

To determine the canal curvature, the Schneider method, which was the first and still most common method was used in the present study. [10,11] The Mesio Buccal canal was evaluated in this present study as they are more prone to strip perforation when compared to the Mesiolingual canals due to the less amount of dentine present towards their distal surface of the root. [11] Later all the teeth were embedded into the modelling wax rim as they allow X-rays to pass through it and produce a better image quality and also to stabilize the teeth in the same angulation during preoperative and postoperative scanning. [2,9]

In this study intra group comparison was made to identify effectiveness of these instruments in retaining dentin at the furcation area of Mesio Buccal canal and the results showed that Protaper Gold group was equally effective in retaining dentine thickness ($p > 0.05$) but V Taper group has significantly higher effectiveness in retaining dentin thickness at the furcation area ($p = 0.001$) in both the investigated groups. This can be attributed to its reduced shaft diameter and less cross-sectional area. This is in accordance with highlights from various literature that the canal centering ability is better within

NiTi instruments, instruments with less cross-sectional area and instruments with noncutting tips. [12,13]

In this present study the results of the intragroup comparison between Protaper Universal (Subgroup-1) and Protaper Gold (Subgroup-II) file system showed no significant difference in retaining dentine thickness systems. This finding could be attributed to the same geometrical and cross-section design of PG and PU files. Both systems have convex triangular cross-sectional design combined with the flute design with its progressive tapers sequence along the shaft. [14,15] The result of the present study was in accordance with study by Elnaghy AM et al. 37 who stated that there is no significant difference between PTG and Pro Taper Universal NiTi rotary systems in root canal shaping abilities of mesial canals of mandibular first molars at three levels of 3, 5, and 7 mm.

Present study also reveals that Protaper Gold is found to remove more dentin in the furcation area when compared to V Taper ($p < 0.05$). Paqué et al. (2010) [16] in his study confirmed that Protaper Gold has greater cutting ability in the coronal and middle thirds of the root canal system. It was explained that this could probably be related to the sharp cutting edges of the convex triangular cross-sectional design and its flute design that combines multiple tapers within the shaft up to 19%.

Limitations of the study could be that small sample size due to the strict inclusion and exclusion criteria and difficulty in finding sound teeth with standardized curvature was a limitation of this study.

Although minimally invasive interventions have been embraced in some areas of dentistry, the CEACs concept in endodontics has largely been opposed because it poses challenges not encountered with TEACs. Technologies (e.g., operating microscopes and improved nickel

titanium instruments are available that enable treatment with less convenience form. [17,18] Since there is no study in the literature, which examines the effect of access cavity preparation on the remaining dentin thickness at the furcation after cleaning and shaping using different NiTi rotary files, the results of present study cannot be directly compared to those of previous studies.

Conclusion

The current results did not show any benefits associated with the CEAC group compared with the TEAC group in the preserving the dentin at the furcation area of mandibular molars with respect to Mesio Buccal canal. V Taper file has the advantage of retaining dentin thickness significantly in furcation area when compared to Protaper Gold and Protaper Universal file systems. Protaper Gold file system also showed promising results in retaining dentin thickness which was comparable to V Taper file system but not better than V Taper. Protaper Universal file system should be used cautiously as this file system removed more dentin than other two file systems.

References

1. Makati D, Shah N, Brave D, Singh Rathore V, Bhadra D, Dedania M. Evaluation of remaining dentin thickness and fracture resistance of conventional and conservative access and biomechanical preparation in molars using cone-beam computed tomography: An in vitro study. *J Conserv Dent*. 2018;21(3):324.
2. Issac JK, Rao MR, Shameem A, Nair R, Ghanta S, Thankachan RP. Comparison of the Remaining Dentin Thickness in the Root after Hand and Four Rotary Instrumentation Techniques: An in vitro Study. *J Contemp Dent Pract*. 2013 ;14(4):712–7.
3. Shabbir J, Zehra T, Najmi N, Hasan A, Naz M, Piasecki L, et al. Access Cavity Preparations:

Classification and Literature Review of Traditional and Minimally Invasive Endodontic Access Cavity Designs. *J Endod*. 2021;47(8):1229–44.

4. Duque Ja, Vivian Rr, Cavenago Bc, Amoroso-Silva Pa, Bernardes Ra, De Vasconcelos Bc, et al. Influence of NiTi alloy on the root canal shaping capabilities of the Protaper Universal and ProTaper Gold rotary instrument systems. *J Appl Oral Sci*. 2017;25(1):27– 33.
5. Capar ID, Ertas H, Ok E, Arslan H, Ertas ET. Comparative study of different novel nickel- titanium rotary systems for root canal preparation in severely curved root canals. *J Endod*.2014 ;40(6):852–6.
6. Gagliardi J, Versiani MA, de Sousa-Neto MD, Plazas-Garzon A, Basrani B. Evaluation of the Shaping Characteristics of Protaper Gold, Protaper NEXT, and Protaper Universal in Curved Canals. *J Endod*. 2015 ;41(10):1718–24.
7. Zinge P, Patil J. Comparative evaluation of effect of rotary and reciprocating single-file systems on pericervical dentin: A cone-beam computed tomography study. *J Conserv Dent*.2017;20(6):424.
8. Hulsmann M, Gambal A, Bahr R. An improved technique for the evaluation of root canal preparation. *J Endod*. 1999;25(9):599–602.
9. Ambika Sigadam, Kalyan Satish R, Girija. S. Sajjan, Madhu Varma K, Babu KV, Sirisha Ganguru. Comparative Evaluation Of Radicular Dentine Thickness In Danger Zone Of Mandibular First Molar After Instrumentation With Two Different Rotary Systems Using Cbct - An Invitro Study. *Int J Med Sci Diagn Res [Internet]*. 2020 [cited 2022 Feb 1];4(8). Available from: <https://www.ijmsdr.com/index.Php/ijmsdr/article/view/643>
10. Garala M, Kuttler S, Hardigan P, Steiner-Carmi R, Dorn S. A comparison of the minimum canal wall thickness remaining following preparation using two

- nickel-titanium rotary systems. *Int Endod J.* 2003 ;36(9):636–42.
11. Yoo Y-S, Cho Y-B. A comparison of the shaping ability of reciprocating NiTi instruments in simulated curved canals. *Restor Dent Endod.* 2012 ;37(4):220–7.
12. Hulsmann M, Schade M, Schäfers F. A comparative study of root canal preparation with HERO 642 and Quantec SC rotary Ni-Ti instruments. *Int Endod J.* 2001;34(7):538–46.
13. Arora A, Taneja S, Kumar M. Comparative evaluation of shaping ability of different rotary NiTi instruments in curved canals using CBCT. *J Conserv Dent JCD.* 2014;17(1):35–9
14. Hashem AAR, Ghoneim AG, Lutfy RA, Foda MY, Omar GAF. Geometric analysis of root canals prepared by four rotary NiTi shaping systems. *J Endod.* 2012 ;38(7):996–1000.
15. END-ProTaperGold-Brochure-EN-1502.pdf [Internet]. [cited 2022 Feb 22]. Available from: <https://www.dentsplysirona.com/content/dam/master/regions-countries/north-America/product-procedure-brand/endodontics/product-categories/files-motors-lubricants/rotary-and-reciprocating-files/Protaper-gold/documents/END-ProtaperGold-Brochure-EN-1502.pdf>
16. Paqué F, Balmer M, Attin T, Peters OA. Preparation of Oval-shaped Root Canals in Mandibular Molars Using Nickel-Titanium Rotary Instruments: A Micro-computed Tomography Study. *J Endod.* 2010;36(4):703–7.
17. Bóveda C, Kishen A. Contracted endodontic cavities: the foundation for less invasive alternatives in the management of apical periodontitis. *Endod Top.* 2015;33(1):169– 86.
18. Clark D, Khademi J. Modern molar endodontic access and directed dentin conservation. *Dent Clin North Am.* 2010;54(2):249–73.
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