



Cone Beam Computed Tomography Analysis Of Remaining Dentin Thickness On Instrumenting Extracted Premolars With Different Rotary Niti File Systems- An In-Vitro Study

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ABSTRACT

Aim: The current study aimed at assessing the remaining dentin thickness on instrumenting extracted premolars with various file systems.

Materials And Methods: 30 extracted single rooted mandibular premolars were collected. Access cavity preparation was done and working length determined. Following the pre-cone-beam computed tomography (CBCT) scan, the corresponding file groups were prepared biomechanically. Group I – Protaper Gold, Group II –ProFit S3, and Group III – Neo Endo. Post-CBCT scan was taken and the pre- and post-CBCT scans were compared for remaining dentin thickness. Following the pre-cone-beam computed tomography (CBCT) scan, the corresponding file groups were prepared biomechanically and analyzed with ANOVA (P = 0.001).

Results: Among three different rotary endodontic files, S3 showed minimum reduction in dentin thickness followed by Neo Endo and Protaper Gold and there was a statistical significant difference between intergroups (p=0.01).

Conclusion: ProFit S3 shown to be effective in preserving the remaining dentin thickness as compared to other groups.

Keywords: Cone beam computed tomography, remaining dentin thickness, mandibular premolars, Nickel titanium

INTRODUCTION

Success in endodontic treatment depends on a number of variables, including quality of instrumentation canal cleaning, disinfection, and three-dimensional obturation (Kumar et al. 2022). Efficient root canal debridement and shaping that adheres to the original anatomy are prerequisites for effective endodontic therapy (Jain et al. 2016). Even when the strictest guidelines and most precise treatment techniques are followed, endodontic failures still happen (Kulkarni et al. 2019). A good filling can be achieved by shaping while still maintaining the placement and integrity of the canal and apical anatomy. But overshaping removes too much of the dentin's remaining thickness, weakening the root system (Chaudhary et al. 2018). Stock and Lim indicated that the minimum thickness of the canal walls following preparation should be 0.3 mm of dentin. This enables sufficient resistance to lateral forces and occlusal forces during canal obturation. (Lim and Stock 1987)

Over the years, the field of endodontics has changed and advanced, NiTi rotary instrument designs are constantly being improved to enhance their cutting and shaping qualities (Gagliardi et al. 2015). Because of its high flexibility, improved cutting ability, increased efficiency, predictability, and improved centering ability, rotary nickel-titanium (NiTi) files have improved root canal shaping (Uppin et al. 2016). According to experimental findings, Ni-Ti rotary systems result in a more centred and tapered preparation with less canal transportation. (Tomer et al. 2018). To achieve the best outcome, the instruments used for root canal preparation should always be consistent with and maintain the canal's original shape to maximize cleaning efficiency and reduce needless weakening of the tooth structure (Jain et al. 2016). Following intraradicular operations, the remaining dentin thickness is correlated with the root's resistance to fracture. Choosing the file system that minimizes the canal wall while performing acceptable biomechanical preparation is crucial when the pre instrumentation canal wall thickness is very low (Dhingra and Parimoo 2015).

Variable shapes and systems of engine driven NiTi files are available in the market. Some advantages of Protaper gold system is more effective, adaptable, and safe cutting action

(Yılmaz Çırakoglu and Özbay 2021) which is the gold standard. Profit S3 (PS3), a new heat-treated rotary mechanism with titanium oxide coating, was unveiled in 2019 and is based on Blue Technology. It has a variable taper design with a rectangular cross-section having two point contact (Antony et al. 2020). Neo Endo files have a triangular cross-section with regulated memory, sharp cutting edges, and remarkable flexibility. They are gold-treated NiTi rotary files. (Verma et al. 2017).

Because of its noninvasive nature, three-dimensional (3D) vision, precision, and dependability, cone-beam computed tomography (CBCT) has emerged as a boon since it can measure dentin thickness of root canal walls, making it a vital diagnostic tool to evaluate the RDT. (Mangal et al. 2018). Our team has extensive knowledge and research experience that has translate into high quality publications (Sathish and Karthick 2020; Krishna, Nivesh Krishna, and Yuvaraj Babu 2016; Sriram, Thenmozhi, and Yuvaraj 2015; Subashri and Thenmozhi 2016; Mootha et al. 2016; Marofi et al. 2021; Mohanavel et al. 2020; Vigneshwaran et al. 2020; Suresh et al. 2014; Robert et al. 2010)

Thus, the aim of this study was to evaluate remaining dentin thickness, using CBCT, on instrumenting extracted premolars with various rotary file systems.

MATERIALS AND METHODS

The current in vitro investigation was carried out at Chennai, Saveetha Dental College Department of Conservative Dentistry and Endodontics. The Institutional Ethics Committee gave their approval to the study protocol. We followed the PRILE guidelines for conducting the study.

Based on the assessment a total sample size of 30 was achieved at a power of 95% using G*power software 3.1.0. Thirty single-rooted mandibular premolars cleansed ($1 - \beta = 95\%$, $\alpha = 0.05$) and preserved in saline were taken and the length of the tooth was standardized to 16 mm by flattening the occlusal surface of the tooth, and divided according to the file system used Group I – Protaper Gold, Group II – ProFit S3, and Group III – Neo Endo. Teeth that showed evidence of root canal obstruction, severe decay, two canals, calcification, dentinal cracks, pulp stones, and resorption or fracture were excluded.

To provide a baseline against which we could measure the parameter of remaining dentin thickness following biomechanical preparation, CBCT scans of all the samples were taken prior to instrumentation. The biomechanical preparation was carried out by a single trained operator, and access was acquired using a carbide bur. Working lengths were established using a 15 K file, and working length was kept 1mm short of the radiographic apex. Thirty Based on three distinct rotary file systems, human mandibular incisors were divided into three groups (n=10).

Group 1: Protaper Gold

Coronal enlargement is done using SX rotary file and apical enlargement was done with Protaper Gold rotary file till size F2 and 6% taper was used according to manufacturer's instruction till the working length using crown-down motion with the coronal portion as a stable reference point. The time taken for biomechanical preparation of a sample was about 5–6 min

Group 2: Neo Endo

Coronal enlargement is done using SX rotary file and apical enlargement was done with Neo Endo rotary file till size F2 and 6% taper was used according to manufacturer's instruction till the working length using crown-down motion with the coronal portion as a stable reference point. The time taken for biomechanical preparation of a sample was about 4-5 min

Group 3: Profit S3

Coronal enlargement is done using SX rotary file and apical enlargement was done with Profit S3 rotary file till size PF2 and 6% taper was used according to manufacturer's instruction till the working length using crown-down motion with the coronal portion as a stable reference point. The time taken for biomechanical preparation of a sample was about 4-5 min

All the CBCT images were examined pre and post op and RDT was measured in horizontal sections at three levels of root canals using Carestream 3D imaging software.

- Level 1: 4 mm from the apex
- Level 2: 8 mm from the apex
- Level 3: 12 mm from the apex

Statistical Analysis

SPSS software version 17.0 (Chicago, SPSS Inc.) was used for statistical analysis. Shapiro wilk test was done for normality and Turkeys post hoc test was done for multiple comparison between the groups. In this study, $p < 0.05$ was considered to be the level of significance. Here (table 1) gives the significant difference between quality of obturation between three different rotary files.

RESULTS

After obtaining the values, the mean and standard deviation was calculated in all three groups. There were statistically significant results obtained in all three groups. Group 1 has a mean value of 0.83 g, group 2 has a mean value of 0.585 g, and group 3 has a mean value of 0.350 g of extruded debris

TABLE 1: amount of remaining dentin thickness at 4mm, 8mm and 12 mm both mesiodistally (MD) and buccolingually (BL)

		Groups			
		PROTAPER GOLD	NEO ENDO	PROFIT S3	P value
MD at 4mm	Mean	.8300	.5850	.3500	0.043*
	Std. Deviation	.17029	.20555	.19003	
MD at 8mm	Mean	.7030	.5300	.2400	0.03*
	Std. Deviation	.11176	.10328	.11738	
MD at 12mm	Mean	.5910	.4500	.0670	0.00*
	Std. Deviation	.11949	.13744	.08499	

BL at 4mm	Mean	.9420	.6300	.3900	0.039*
	Std. Deviation	.20943	.09487	.23781	
BL at 8mm	Mean	.8560	.5450	.2560	0.028*
	Std. Deviation	.09559	.15175	.15027	
BL at 12mm	Mean	.7200	.3960	.1876	0.012*
	Std. Deviation	.15492	.08909	.07437	



FIGURE 1: Amount of remaining dentin thickness at mesiodistal and buccolingual dimensions were taken at every 4mm, 8mm and 12mm after using three rotary endodontic files.

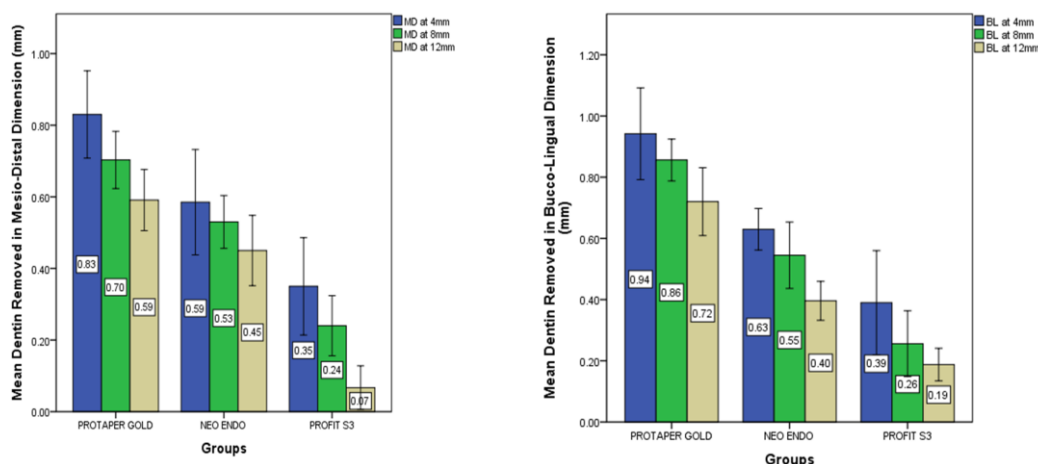


FIGURE 2: Bar graph represents the amount of remaining dentin thickness at 3 levels after using three different rotary endodontic files for canal preparation

DISCUSSION

One of the most crucial phases of a root canal treatment is the biomechanical preparation of the root canals (Shahriari et al. 2009). With root canal therapy, an endodontist's main objectives are to completely disinfect the canal space, stop the spread of periradicular tissue inflammation, and create favorable conditions for periradicular healing (Tomer et al. 2018). In order to prevent severe root structure thinning, the optimum instrumentation should remove the same amount

of dentin from the canal walls (Jain et al. 2016). The three files' shaping abilities were assessed using the CBCT imaging approach because it offers a precise, repeatable, three-dimensional investigation of any potential dentin modifications, such as dentin thickness. (Singh et al. 2019).

According to (Gagliardi et al. 2015) evaluated the shaping characteristics of the ProTaper Gold system with ProTaper Next and ProTaper Universal systems using micro-computed

tomographic imaging found that protaper gold and protaper universal maintained more dentin compared to PTN.

According to (Duque et al. 2017) evaluated the influence of the NiTi wire in Conventional NiTi and Controlled Memory NiTi instrument systems on the quality of root canal preparation came to the conclusion that PTG maintained the dentin thickness and centralisation compared to PTU cervically and no statistical difference apically.

(Antony et al. 2020) did a comparative evaluation of the canal transportation, centering ability, and dentin removal of Profit S3 (PS3), One Curve (OC), and ProTaper Gold (PTG) systems using cone-beam computed tomography (CBCT) and came to an conclusion that PS3 and OC rotary file showed less removal of dentin compared to PTG ($P < 0.00$).

According to (Tomer et al. 2018) compared and evaluated the remaining dentin thickness of root canals with ProTaper Gold, NeoEndo and Revo-S systems using cone beam computed tomography for analysis, concluded that Protaper Gold file system removed more dentine than Revo- S and NeoEndo file system.

When the removal of dentin was compared across the three groups, there was a statistical difference ($P < 0.05$). It's critical to have enough remaining dentin thickness to withstand occlusal loading forces and lateral stresses experienced throughout the obturation process (Shahriari et al. 2009). Stock and Lim indicated that the minimum thickness of the canal walls following preparation should be 0.3 mm of dentin. This enables sufficient resistance to lateral forces and occlusal forces during canal obturation. (Lim and Stock 1987). Under the circumstances of this current in vitro study, it suggests that ProTaper showed maximum removal of dentin at all three levels apically from root canal compared to NeoEndo and ProFit S3 systems which were statistically significant. Its effects on the prognosis stability of the teeth, including canal transportation, uninstrumented surface area, and maintenance of dentin thickness, require further study to confirm and elaborate.

CONCLUSION

Within the limitation of the study, we can conclude that minimum reduction in dentin thickness during biomechanical preparation of

root canal was seen in ProFit S3 file system followed by Neo Endo and maximum was seen in Protaper Gold. There is a substantial difference between all the groups when intergroup comparisons are made in terms of the reduction in dentin thickness during biomechanical preparation of the root canal.

REFERENCES

1. Antony, S. Delphine Priscilla, Aravind Kumar Subramanian, M. S. Nivedhitha, and Pradeep Solete. 2020. "Comparative Evaluation of Canal Transportation, Centering Ability, and Dentin Removal between ProTaper Gold, One Curve, and Profit S3: An in Vitro Study." *Journal of Conservative Dentistry: JCD* 23 (6): 632–36.
2. Chaudhary, Nidhi Rathi, Deepti Jawa Singh, Rani Somani, and Shipra Jaidka. 2018. "Comparative Evaluation of Efficiency of Different File Systems in Terms of Remaining Dentin Thickness Using Cone-Beam Computed Tomography: An In Vitro Study." *Contemporary Clinical Dentistry* 9 (3): 367–71.
3. Dhingra, Annil, and Deepika Parimoo. 2015. "Evaluation of Remaining Dentine Thickness Using Wave One and One Shape File System with Cone Beam Computed Tomography." *Int J Contemp Dent Med Rev* 2014: 3–5.
4. Duque, Jussaro Alves, Rodrigo Ricci Vivan, Bruno Cavalini Cavenago, Pablo Andrés Amoroso-Silva, Ricardo Affonso Bernardes, Bruno Carvalho de Vasconcelos, and Marco Antonio Hungaro Duarte. 2017. "Influence of NiTi Alloy on the Root Canal Shaping Capabilities of the ProTaper Universal and ProTaper Gold Rotary Instrument Systems." *Journal of Applied Oral Science: Revista FOB* 25 (1): 27–33.
5. Gagliardi, Jason, Marco Aurélio Versiani, Manoel Damiano de Sousa-Neto, Andres Plazas-Garzon, and Bettina Basrani. 2015. "Evaluation of the Shaping Characteristics of ProTaper Gold, ProTaper NEXT, and ProTaper Universal in Curved Canals." *Journal of Endodontia* 41 (10): 1718–24.
6. Jain, Aditi, Hemant Asrani, Abhinav Chand Singhal, Taranjeet Kaur Bhatia, Vaibhav Sharma, and Pragya Jaiswal. 2016. "Comparative Evaluation of Canal Transportation, Centering Ability, and Remaining Dentin Thickness between WaveOne and ProTaper Rotary by Using Cone Beam Computed Tomography: An in Vitro Study." *Journal of Conservative Dentistry: JCD* 19 (5): 440–44.
7. Kulkarni, Nishita Rajeev, Sharad Basavraj Kamat, Santosh Irappa Hugar, Girish Shankar Nanjannawar, and Pranav Devendra Patil. 2019. "Evaluation of Remaining Dentin Thickness

- Following Use of Three Different Rotary Nickel-Titanium Retreatment Files: A Cone-Beam Computed Tomography Study.” *Journal of Conservative Dentistry*: JCD 22 (6): 588–92.
8. Kumar, Tarun, Sunandan Mittal, Vanita Keshav, Ramanjot Kaur, and Ena Maakhni. 2022. “A Comparative Evaluation of Remaining Dentin Thickness Following Biomechanical Preparation of Teeth Using Different Rotary File Systems: An in Vitro Study.” *Journal of Conservative Dentistry*: JCD 25 (1): 32–36.
 9. Lim, S. S., and C. J. Stock. 1987. “The Risk of Perforation in the Curved Canal: Anticurvature Filing Compared with the Stepback Technique.” *International Endodontic Journal* 20 (1): 33–39.
 10. Mangal, Shivani, Sylvia Mathew, B. V. Sreenivasa Murthy, Shruthi Nagaraja, K. Dinesh, and Poornima Ramesh. 2018. “Cone-Beam Computed Tomographic Evaluation of Remaining Dentin Thickness in Bifurcated Roots of Maxillary First Premolars after Rotary Instrumentation and Post Space Preparation: An in Vitro Study.” *Journal of Conservative Dentistry*: JCD 21 (1): 63–67.
 11. Shahriari, Shahriar, Hasan Abedi, Mahdi Hashemi, and Seyed Mohsen Jalalzadeh. 2009. “Comparison of Removed Dentin Thickness with Hand and Rotary Instruments.” *Iranian Endodontic Journal* 4 (2): 69–73.
 12. Singh, Shalini, Muqthadir Siddiqui Mohammed Abdul, Utsav Sharma, Shan Sainudeen, Chayan Jain, and Jacob Tony Kalliath. 2019. “An in Vitro Comparative Evaluation of Volume of Removed Dentin, Canal Transportation, and Centering Ratio of 2Shape, WaveOne Gold, and ProTaper Gold Files Using Cone-Beam Computed Tomography.” *Journal of International Society of Preventive & Community Dentistry* 9 (5): 481–85.
 13. Tomer, Anil K., R. Gupta, A. Behera, N. Mittal, A. A. Raina, M. Ramachandran, and Others. 2018. “An in-Vitro Evaluation of Remaining Dentine Thickness through Cbct Using Different Files.” *Int J Appl Dent Sci* 4 (3): 9–13.
 14. Uppin, Veerendra, Vinaya Varghese, Madhu Pujar, Nirmal Kurian, and Hemant Vagarali. 2016. “Comparison of Canaltransportation and Centering Ability of ProTaper Next, Hyflex Cmandwave One System Using Cone - Beam Computed Tomography-an in-Vitro Study.” *Dental Journal of Advance Studies* 04 (02): 088–093.
 15. Verma, Mudita, N. Meena, R. Anitha Kumari, Sudhanva Mallandur, R. Vikram, and Vishwas Gowda. 2017. “Comparison of Apical Debris Extrusion during Root Canal Preparation Using Instrumentation Techniques with Two Operating Principles: An in Vitro Study.” *Journal of Conservative Dentistry*: JCD 20 (2): 96–99.
 16. Yılmaz Çırakoglu, Neslihan, and Yağız Özbay. 2021. “Apically Extruded Debris Associated with ProTaper Next, ProTaper Gold and TruNatomy Systems: An in Vitro Study.” *Journal of Dental Research, Dental Clinics, Dental Prospects* 15 (1): 30–34.