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"ASSESSMENT OF 2SHAPE, TRUNATOMY, PROTAPER GOLD, HYFLEX CM, AND HYFLEX EDM ROTARY FILE SYSTEMS FOR SHAPING ABILITY IN ROOT CANALS: A CONE BEAM COMPUTED TOMOGRAPHY STUDY"

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ABSTRACT

Aim and Objectives- This research utilized cone beam computed tomography (CBCT) to assess and compare the performance of five rotary file systems- 2Shape, Trunatomy, ProTaper Gold, Hyflex CM, and Hyflex EDM for centering ability, canal transportation, and total volume of removed dentin at apical third, middle third and coronal third.

Material and Methodology- One hundred freshly extracted mandibular first molars were randomly divided into 5 groups and instrumentation was done according to manufacturer's instructions using the following NiTi files: 2Shape, Trunatomy, ProTaper Gold, Hyflex CM, and Hyflex EDM. Pre and post-instrumentation CBCT imaging was performed and specialized software was used to analyse CBCT scans evaluate the volume of removed dentin, apical transportation, and centering ability at apical third, middle third and coronal third.

Results- No significant variances were observed in the total volume of dentin removed, apical transportation, and centering ability among the 2Shape, Hyflex CM, Hyflex EDM systems at apical third, middle third and coronal third. In contrast, the ProTaper system exhibited a significantly greater difference in these metrics.

Conclusion- At apical third, middle third and coronal third Trunatomy reported significantly less canal transportation, better centering ability and less dentine removal. 2Shape, Hyflex CM and Hyflex EDM maintained the original canal anatomy better and did not remove excess dentin while canal preparation as compared to ProTaper Gold.

Keywords- 2Shape, Trunatomy, ProTaper Gold, Hyflex CM, Hyflex EDM, CBCT, Shaping Ability.

INTRODUCTION

The advent of rotary file systems in endodontics has revolutionized the way root canal treatments are performed, significantly enhancing the efficiency, accuracy, and outcomes of these procedures. These systems consist of nickel-titanium (NiTi) files, which are known for their superior flexibility, strength, and resistance to fatigue when compared to traditional stainless steel files. The use of rotary file systems in endodontics has brought about several key advancements and benefits [1].

Rotary file systems help maintain the root canal's central alignment during the instrumentation process. Achieving a well-centered preparation is essential for an optimal seal and successful healing. Canal transportation occurs when the instrument strays from its intended path within the canal, leading to irregular shapes. Such excessive deviation can undermine the effectiveness of irrigation and the placement of filling materials, potentially leading to treatment failure. A good rotary file system effectively enlarges the canal space while preserving its original anatomy[2].

The 2Shape NiTi rotary file employs a NiTi-alloy known as T-wire and follows a sequence comprising two instruments: TS1 (#25, 0.04) and TS2 (#25, 0.06) [3].
TruNatomy instruments by features a unique mechanical design and enhanced heat treatment of NiTi alloys. It offers three distinct shapes aimed at achieving thin shaping, resulting in increased space within the canal. These shapes exhibit a parallelogram outline when viewed in cross-section and incorporate an off-centered design [4].
ProTaper Gold operates on a rotating motion and is crafted from an NiTi alloy referred to as M-wire, renowned for its progressively tapered design which purportedly enhances cutting efficiency and safety [5].

The HyFlex CM rotary instruments are crafted from a controlled memory (CM) Ni-Ti wire, created through a unique manufacturing process that examines the material's memory [6].
Hyflex EDM distinguished by its innovative manufacturing method utilizing electric discharge machining, commonly referred to as the EDM-based file system [4].

MATERIALAND METHODOLOGY

One hundred mesiobuccal roots of extracted mandibular first molar teeth with fully developed apices were selected and stored in saline solution. Pre-instrumentation cone-beam computed tomography (CBCT) scans were conducted. Roots with curvature between 25° to 30° were selected, and canal curvature was assessed using Schneider's technique. Access preparations were made using Endo-Access burs (Dentsply Maillefer), followed by negotiation of root canals with #10 K-files (Dentsply, Maillefer, Switzerland). Distal roots along with the corresponding crown portion were removed at the furcation level using a low-speed diamond bur submerged in water and discarded. Working length was determined by inserting a #10 K-file to the root canal terminus and subtracting 1 mm, confirmed using an electronic apex locator. The teeth were then randomly divided into five experimental groups, each containing 20 samples.

Group1 – 2Shape- sequence TS1 (25/0.04) and TS2 (25/0.06) were used.
Group2- Trunatomy - small size with 20/0.04 taper and prime size with 26/0.04 taper were used.
Group3- ProTaper Gold- SX file (one half of the working length), S1 file, S2 file, F1 and F2 files with a taper of 25/0.08 were used.
Group4- Hyflex CM- 25/0.8 (orifice opener), followed by 20/0.04. 25/0.04, 20/0.06 were used.
Group5- Hyflex EDM- 25/ (onefile) was used for shaping the root canal up to working length according to the manufacturer’s guidelines.

Prior to root canal instrumentation, CBCT scans of all teeth were performed using a CBCT machine (e.g., NewTom 3 G, QR srl, Verona, Italy) with settings of 90 kVp, 6 mA, 0.125-mm voxel size, and a 360° rotation. Reconstruction of CBCT images into 3D visualization of root canal architecture was achieved using specialized software (e.g., OnDemand3D, CyberMed,

Seoul, South Korea). Each group's root canals were instrumented by a single operator following the instructions specific to each rotary file system, with the operator being calibrated to ensure consistency in instrumentation. Post-instrumentation, CBCT scans were repeated using the same machine and parameters. In vivo Dental software (Anatomage, San Jose, CA, USA) facilitated the analysis of pre- and post-instrumentation CBCT images, accurately measuring and visualizing root canal anatomy.

The dentin volume removed was quantified in mm[3] for each root canal by determining the difference between the volume before and after instrumentation, as depicted in Figure 1[7].

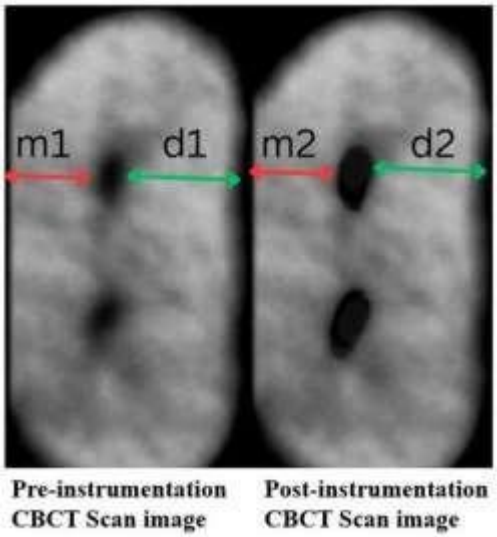

FIGURE 1 Pre and Post- instrumentation CBCT scan image.

Canal transportation and centering ratios were computed across three cross-sectional levels-apical, middle, and coronal thirds of the root utilizing the subsequent equation.
Canal transportation: Mesiodistally = (m1 − m2)− (d1 − d2).
Canal centering ratio = (m1 − m2)/(d1 − d2) or (d1 − d2)/(m1 − m2).
Mesial (m1) is the shortest distance from the mesial edge of the root to the mesial edge of the uninstrumented canal. Distal (d1) is the shortest distance from the distal edge of the root to the distal edge of the uninstrumented canal.
Mesial (m2) is the shortest distance from the mesial edge of the root to the mesial edge of the instrumented canal. Distal (d2) is the shortest distance from the distal edge of the root to the distal edge of the instrumented canal.

Statistical analysis was conducted using IBM SPSS Statistics software (Armonk, NY, USA). A one-way ANOVA followed by post-hoc tests was employed to compare the five groups. The threshold for statistical significance was established at $P < 0.05$.

RESULTS

VOLUME OF DENTIN REMOVED

Table 1 presents the mean ± standard deviation of the volume of dentin removed (in mm) for the examined groups along with the statistical analysis at apical, middle and coronal third. There was no significant difference observed between the 2Shape, Hyflex CM, and Hyflex EDM groups. Trunatomy exhibited a relatively lower volume of dentin removed, while Protaper Gold demonstrated a significantly higher volume of removed dentin.

Table 1- Mean and standard deviation values for volume of removed dentin detected at Apical, Middle and Coronal third.												
Inner Measurements							Outer Measurements					
	2Shape	Trunatomy	Protaper Gold	Hyflex CM	Hyflex EDM	P	2Shape	Trunatomy	Protaper Gold	Hyflex CM	Hyflex EDM	P
Apical third	0.07± 0.01	0.05 ±0.03	0.11± 0.06	0.08 ±0.04	0.08 ±0.03	0.07	0.18 ±0.03	0.13± 0.09	0.30±0.03	0.21±0.05	0.18±0.03	0.064
Middle third	0.22± 0.04	0.17 ±0.05	0.39± 0.04	0.28 ±0.06	0.26 ±0.04	0.04*	0.22 ±0.08	0.19± 0.04	0.39±0.07	0.28±0.06	0.23±0.07	0.03
Coronal third	0.26± 0.06	0.23 ±0.03	0.41± 0.05	0.31 ±0.03	0.29 ±0.05	0.03*	0.26 ±0.03	0.21± 0.07	0.38±0.05	0.29±0.04	0.27±0.05	0.03

CANAL TRANSPORTATION

Table 2 illustrates the degree of mesiodistal canal transportation at the apical, middle, and coronal thirds. Upon assessment at the apical third, the Trunatomy rotary file system displayed the least transportation, whereas PTG exhibited the highest mean transportation. No significant difference was observed among the 2Shape, Hyflex CM, and Hyflex EDM groups.

When assessed at the middle and coronal thirds, a statistically significant difference was noted, with Trunatomy displaying the least transportation and Protaper Gold demonstrating the maximum canal transportation.

Table 2- Mean and standard deviation values for the amount of Canal transportation at Apical, Middle and Coronal third.						
	2Shape	Trunatomy	Protaper Gold	Hyflex CM	Hyflex EDM	P
Apical third	0.011 ± 0.004	0.010 ± 0.005	0.017 ± 0.004	0.014 ± 0.005	0.013 ± 0.006	0.06
Middle third	0.027± 0.005	0.012 ± 0.005	0.051 ± 0.004	0.044± 0.006	0.039 ± 0.007	0.04*
Coronal third	0.081 ± 0.002	0.053 ± 0.001	0.107 ± 0.007	0.104 ± 0.005	0.098 ± 0.005	0.03*

CENTERING ABILITY

Table 3 demonstrates that across all levels-apical, middle, and coronal third—no significant differences were observed between 2Shape, Trunatomy, Hyflex CM, and Hyflex EDM in terms of centring ability. Conversely, Protaper Gold exhibited a reduced ability to stay centered compared to the other Niti rotary files mentioned.

Table 3- Mean and standard deviation values for the amount of Centering ability at Apical, Middle and Coronal third.

	2Shape	Trunatomy	Protaper Gold	Hyflex CM	Hyflex EDM	P
Apical third	1.26±0.13	1.32±0.14	0.61±0.16	1.17±0.13	1.27±0.13	0.05*
Middle third	1.34±0.15	1.49±0.15	0.79±0.13	1.29±0.16	1.33±0.14	0.043*
Coronal third	1.53±0.14	1.56±0.13	0.92±0.14	1.45±0.15	1.50±0.16	0.037*

DISCUSSION

The literature lacks comprehensive comparisons of the shaping abilities of NiTi rotary instruments such as 2Shape, Trunatomy, ProTaper Gold, Hyflex CM, and Hyflex EDM. To address this gap, the study focused on evaluating the following aspects: the volume of dentin removed, apical transportation, and the centering ratio.

In this study, ProTaper Gold was identified as having a more aggressive cutting action and removing a larger volume of dentin in comparison to the 2Shape, Trunatomy, Hyflex CM, and Hyflex EDM rotary file systems. Among these, the Trunatomy rotary file was noted for removing the least volume of dentin. In an in vitro study conducted by Surakanti JR et al. (2018), it was found that Hyflex EDM and WaveOne Gold NiTi files removed less resin compared to Reciproc NiTi files. This outcome aligns with the findings of our study, which also reported a lower volume of dentin removal with Hyflex EDM [8].

In a study by Kim et al. (2021) that evaluated the shaping abilities of ProTaper Gold, WaveOne Gold, and the newly introduced TruNatomy in simulated S-shaped canals, it was found that the TruNatomy group removed less resin across all sections compared to the others. Meanwhile, the ProTaper Gold group showed a significantly higher resin removal[9].

Furthermore, the Trunatomy file system was observed to have the minimal amount of transportation relative to 2Shape, ProTaper Gold, Hyflex CM, and Hyflex EDM. This difference was statistically significant at the middle third and coronal levels, although at the apical level, the difference was not statistically significant. Conversely, ProTaper Gold was associated with significantly greater transportation.

Across all sections-apical, middle, and coronal thirds- 2Shape, Trunatomy, Hyflex CM, and Hyflex EDM rotary file systems demonstrated a significant difference in centering ratio as compared to ProTaper Gold. Protaper Gold exhibited less centered preparation.

Vyver et al. (2019) outlined the benefits, clinical protocols, and uses of the newly introduced Trunatomy system. Their conclusion emphasized that Trunatomy instruments ensure effective preservation of dentin alongside superior debridement, while also maintaining the original anatomy of the root canal. The conclusion aligns in accordance with the present conducted study[10].

Turkistani et al. (2015) reported comparable findings in their study comparing the shaping efficacy of Hyflex EDM and ProTaper Next rotary instruments in curved root canals using micro-CT, noting that Hyflex EDM demonstrated superior shaping ability over the ProTaper Next system[11]. Similarly, Gagliardi et al. (2019) investigated canal transportation in curved canals using Protaper Gold, ProTaper Next, and ProTaper Universal files, finding that both Protaper Gold and ProTaper Next induced less canal transportation compared to ProTaper Universal[12]. Contrarily, in our study, when comparing Protaper Gold with Trunatomy and Hyflex EDM, we observed increased canal transportation with Protaper Gold relative to Trunatomy and Hyflex EDM, indicating divergent results.

Trunatomy is renowned for its ability to preserve the fundamental root canal anatomy and maintain tooth integrity, with minimal risk of procedural defects like canal transportation. It is offered in three distinct sizes: a small-size system with a 20/0.4 taper, a prime-size system with a 26/0.04 taper, and a medium-size system with a 36/0.4 taper. According to the manufacturer, the slender design of the Trunatomy instruments collectively facilitates superior dentin debridement. The unique geometric configuration of the Trunatomy file system features a special parallelogram and off-centered design. Moreover, Trunatomy instruments are crafted using a specially heat-treated NiTi wire, resulting in enhanced flexibility and performance[10].

CONCLUSION

It can be concluded that compared to the 2Shape, Hyflex CM, and Hyflex EDM systems, the Trunatomy system demonstrates minimal canal transportation, reduced volume of dentin removal, and superior centering ability. Conversely, Protaper Gold exhibits significantly higher canal transportation and a greater volume of dentin removal, along with less centered preparations. This property of preserving tooth structure gives Trunatomy an advantage over other rotary file systems. However, further in-vitro and in-vivo studies are necessary to comprehensively analyze additional properties of these file systems.

REFERENCES

1. Glossen CR, Haller RH, Dove SB, del Rio CE. A comparison of root canal preparations using Ni-Ti hand, Ni-Ti Engine-driven, and K-flex endodontic instruments. J Endod 1995;21:146‑51.
2. Peters OA. Current challenges and concepts in the preparation of root canal systems: a review. J Endod 2004;30(8):559-667.
3. Micro Mega, France. 2Shape. Available from: http://www.micromega.com/shaping/2shape?lang=en. [Last accessed on 2017 Sep 17].
4. Kumar M, Paliwal A, Manish K, et al. Comparison of Canal Transportation in TruNatomy, ProTaper Gold, and Hyflex Electric Discharge Machining File Using cone-Beam Computed Tomography. J Contemp Dent Pract 2021;22(2):117-121.

5. Elnaghy AM, Elsaka SE. Shaping ability of ProTaper gold and ProTaper universal files by using cone beam computed tomography. Indian J Dent Res 2016;27:3741.
6. Koçak S, Şahin FF, Özdemir O, Koçak MM, Sağlam BC. A comparative investigation between ProTaper Next, Hyflex CM, 2Shape, and TF-Adaptive file systems concerning cyclic fatigue resistance. J Dent Res Dent Clin Dent Prospects. 2021 Summer;15(3):172-177.
7. Hartmann MS, Barletta FB, Camargo Fontanella VR, Vanni JR. Canal transportation after root canal instrumentation: A comparative study with computed tomography. J Endod 2007;33:9625.
8. Surakanti JR, Punna R, Vanapatla A, Vemisetty H. Comparative evaluation of cleaning ability of Reciproc and WaveOne Gold reciprocating file systems – A scanning electron microscopic study. Indian J Dent Sci 2018;10:98101.
9. Kim H, Jeon SJ, Seo MS. Comparison of the canal transportation of ProTaper GOLD, WaveOne GOLD, and TruNatomy in simulated double-curved canals. BMC Oral Health. 2021 Oct 16;21(1):533.
10. Vyver PJ, Vorster M, Peters OA. Minimally invasive endodontics using a new single-file rotary system. Int Dent Afr 2019;9(4):6-20.
11. Turkistani AK, Gomaa MM, Shafei LA, et al. Shaping ability of HyFlex EDM and ProTaper next rotary instruments in curved root canals: a micro-CT study. J Contemp Dent Pract 2019;20(6):680-685.
12. Gagliardi J, Versiani MA, Neto MD, et al. Evaluation of the shaping characteristics of ProTaper gold, ProTaper NEXT, and ProTaper universal in curved canals. J Endod 2015;41(10):1718-1724.