EFFICACY OF 3 DIFFERENT ROTARY FILE SYSTEMS ON CRACK FORMATION IN DENTIN AFTER ROOT CANAL PREPARATION: AN IN-VITRO STUDY

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Abstract:

Aim: The aim of this invitro study was to evaluate and compare the dentinal crack formation after root canal preparation using protaper gold, protaper next and trunatomy file systems.

Material and Methods: The study was conducted on 50 extracted single- rooted mandibular premolar teeth. Access cavity preparation was done and working length was established with 15k type file. Biomechanical preparation was done according to manufacturer's instructions using three file systems, Protaper gold (Dentsply), Protaper next (Dentsply) and Trunatomy (Dentsply) grouped as A, B and C respectively. Teeth in group D were instrumented and serve as a Control group. Canals were irrigated with 12 mL of 1% sodium hypochlorite solution and rinsed with 5mL of distilled water. Then the roots of all teeth will be cut at apical third,middle third and coronal third from apex.The sections were observed under a stereomicroscope for dentinal cracks.

Statistical Analysis: The data was statistically analyzed with chi-square test and one way ANOVA test to compare the appearance of cracks between experimental groups.

Results: In our study, least dentinal cracks were observed in Trunatomy file system followed by Protaper next system and Protaper gold system. No significant difference was seen between Protaper next system and Protaper gold system.

Conclusion: Trunatomy file system showed considerably good results compared to Protaper next and Protaper gold file systems.

KEYWORDS: Dentinal cracks, ProTaper Gold, ProTaper Next, TruNatomy, Stereomicroscope.

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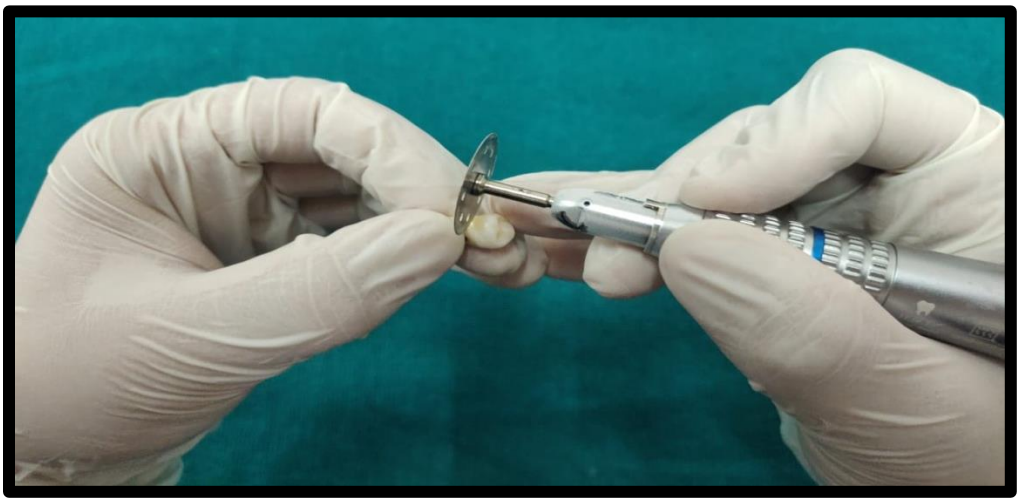
INTRODUCTION: The primary aim of chemo mechanical root canal preparation includes the preservation of original course of the canal and cleaning of the entire root canal system[1].. In the zeal of biomechanical preparation of the canal we inevitably end up damaging the root dentin, which becomes a gateway to dentinal cracks and minute intricate fractures as a result of the development of lateral forces that induce strain on the canal walls; thereby, causing failure of treatment[2]. Vertical root fractures have been reported as a complication following cracks and dentinal defects during and after root canal treatment using Ni-Ti instruments[3]..

Design of file affects strain concentration and apical stress during instrumentation of root canal. Several factors of NiTi files such as different heat treatments, designs, cross-sectional shape, and kinematics may influence the generation of cracks[4]. Recently Ni-Ti instruments had been introduced with their high flexibility and shape memory. . As a result of dentin contact with the files “especially the rotary Ni-Ti” during root canal shaping procedures, momentary stress accumulation may occur and has the potential to induce crack formation. Improving the flexibility of endododontic files increases its ability to conform to the canal lumen thus decreasing stresses imposed on the root canal dentin. This would reduce the potential for microcrack development and other iatrogenic errors like ledging and canal transporataion , which would increase the safety and efficiency of root canal treatment[5].

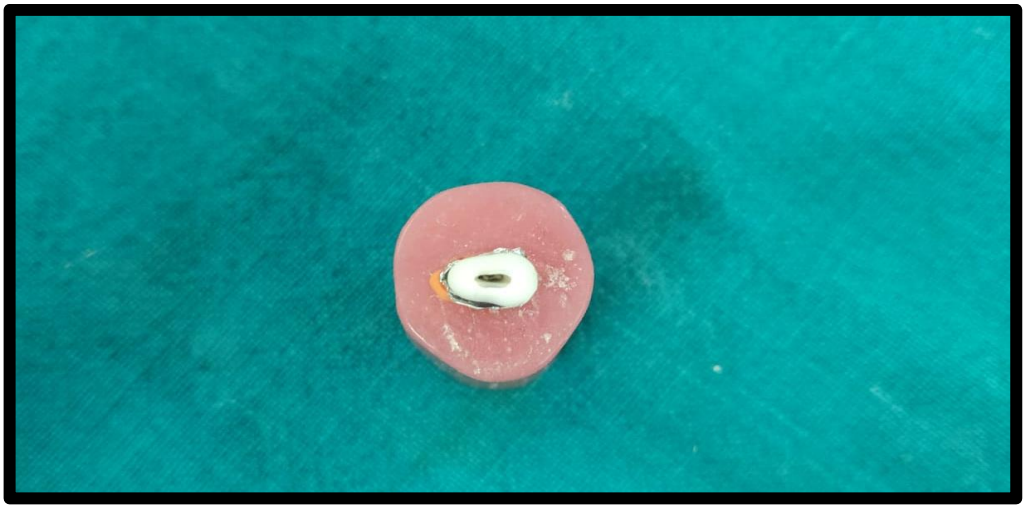
MATERIALS AND METHODS: Fifty freshly extracted single rooted mandibular premolar were used in this invitro study which were collected from the department of Oral and maxillafacial surgery of DeshBhagat Dental College and Hospital, MandiGobindgarh

All collected teeth were rinsed and cleaned from soft tissues and calculus . The teeth were decoronated at the cemento-enamel junction using a diamond disk.



DECORONATION OF TEETH DONE

Periodontal ligament simulation: Aluminium foil was used to cover the root surface of all samples which were then embedded in acrylic resin blocks. The blocks were thereafter filled with a light body silicon impression material in order to create a periodontal ligament mimic layer around the root specimens.



TOOTH EMBEDDED IN ACRYLIC TUBE

Sample grouping and root canal preparation:The teeth were divided into 4 groups, 15 teeth for each group and 05 teeth for control group which were left uninstrumented. Access cavity preparation was done and working length was established.A glide path preparation was done by 10k type file. Apical preparation was completed with size 25 instrument of each system.

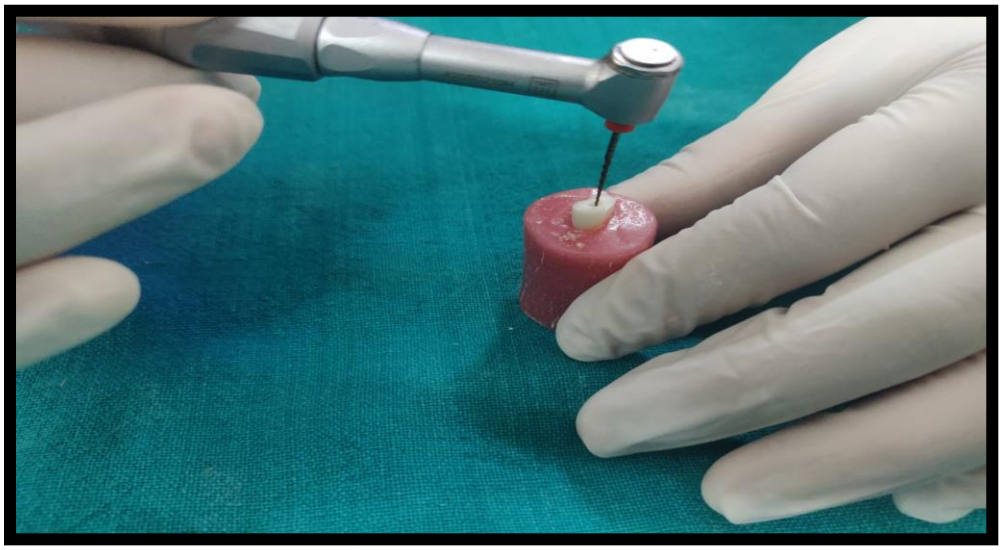
CANAL PREPARATION:

Group A:- Protaper Next Files (n=15): With an estimated working length , size # 10 file was inserted and simply worked within any region of the canal until was completely loose.The root canals were enlarged using the instruments X1 (17/0.04) and X2 (25/0.06) in sequence in a continuous rotary movement until the WL was reached and all the canals were instrumented on the buccolingual and mesiodistal extensions. The endomotorwas used with 300 rpm and 2Ncm of torque.

Group B:-Protaper Gold Files (n=15): The root canals was instrumented using following sequences : Sx file , S1 and S2 files , F1 file and F2 file . All the PTG instruments was used at 300 rpm with a torque of 3 Ncm for Sx and S1 instruments, 1.5 Ncm for F1 instruments and 2 Ncm for F2 instruments.

Group C:- TruNatomy File System (n=15): TruNatomy with the instruments TRN Orifice Modifier OM ,TRN Glider and the shaping file TRN Prime was used at 500 rpm and torque setting of 1.5 Ncm in counter-clockwise direction.

Group D:- Control group(n=05): Teeth left unprepared to serve as control group**.**



ROTARY INSTRUMENTATION

After preparation, the canals were rinsed with 5ml of distilled water and then 17% edta solution was applied for 30 seconds as the final rinse.

Sectioning and Microscopic Examination: All the roots were sectioned at coronal, middle and apical third using a low- speed carborundum disc under water cooling and each section was stained with methylene blue dye for better visualisation..The digital images were taken using a stereomicroscope with the aid of external high definition camera connected to computer to enhance the resolution of the root sections images.

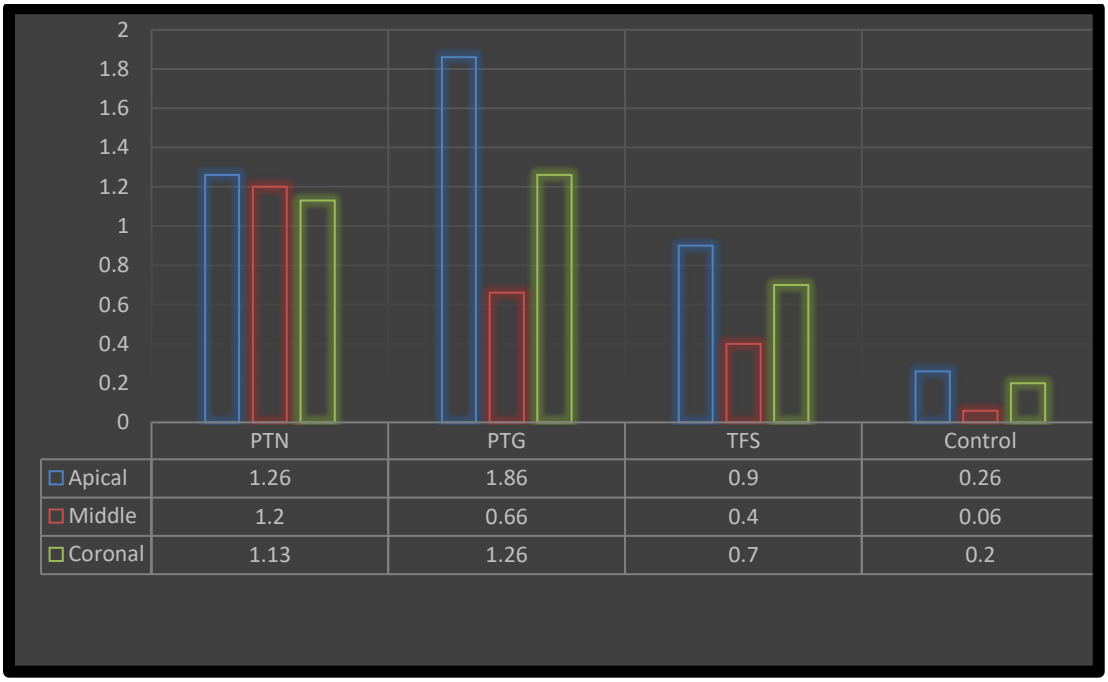
Statistical Analysis: The data obtained was analyzed with descriptive statistics, ANOVA (Analysis of Variance)-one way and post hoc bonferroni test was applied for intergroup comparison. SPSS (Statistical Package for Social Sciences) software was used to perform statistical analysis.

RESULTS: Amongst the rotary systems evaluated, dentinal cracks were observed in all the groups. The specimens prepared with the TruNatomy file system show least amount of cracks followed by ProtaperNext and Protaper Gold file systems.

Comparison of the mean and average number number of cracks in the all groups:

	Data size	Average cracks	Avg Apical	Avg Middle	Avg Coronal
PTG	**15**	**1.26**	**1.86**	**0.66**	**1.26**
PTN	**15**	**1.2**	**1.26**	**1.2**	**1.13**

TFS	**15**	**0.55**	**0.9**	**0.4**	**0.7**
Control	**05**	**0.17**	**0.26**	**0.06**	**0.2**
Total	**50**				



Comparison of number of Cracks at different areas in all study groups

1.Comparison of the mean and average number of cracks in the all groups: The mean scores of dentinal cracks after biomechanical preparation using Protaper gold file system, Protaper Next file system, Trunatomy file system and in the control group which were left unprepared were 1.26, 1.2, 0.55, 0.17 respectively (Table 1). Trunatomy file system has shown least number of cracks followed by protaper nextsystem and protaper gold system.

2. Comparison of the mean percentage of dentinal cracks in the apical region in all groups: The mean scores of percentage of dentinal cracks in the apical region using Protaper gold file system, Protaper next file system, Trunaomy file system and in the apical region of control group were 1.86, 1.26, 0.9, 0.26 (Table 1). Trunatomy has shown least number of cracks in the apical region, followed byProtaper next, then protaper gold file system.

3.Comparison of the mean percentage of dentinal cracks in the middle region in all groups: The mean scores of percentage of dentinal cracks in the middle region using Protaper gold file system, Protaper next file system, Trunaomy file system and in the apical region of control group were 0.66, 1.2, 0.4, 0.06 (Table 1). Trunatomy has shown least number of cracks in the apical region, followed byProtaper gold and protaper next file systems .

4.Comparison of the mean percentage of dentinal cracks in the coronal; region in all groups: The mean scores of percentage of dentinal cracks in the coronal region using Protaper gold file system, Protaper next file system, Trunatomy file system and in the apical region of control group were 1.26, 1.13, 0.7, 0.2 (Table 1). Trunatomy has shown least number of cracks in the apical region, followed byProtaper next and protaper gold file systems.

In our study, least dentinal cracks were observed in TFS followed by PTN and PTG. No significant difference was seen between PTN and PTG.

DISCUSSION: The contemporary endodontic triad for success includes diagnosis, anatomy, and debridement of tooth followed by three- dimensional obturation. Furthermore, the immutable endodontic aim of three- dimensional unblemished seal of root canal system can be achieved by its perfect biomechanical preparation[6]. During root canal preparation , rotational force is applied to the canals by Ni-Ti rotary instruments , during which there is contact between instrument and dentin walls[7].The removal of dentin occurs when the files come into contact with the dentinal wall to produce the canal shape[8].However, the stress created during the root canal instrumentation can potentially damage root dentin.One of the concerns of using rotary instruments is the formation of micocracks within the wall of the root canal due to constant contact by the rotating file inside the canal[9]. In the present study, all the root canal shaping files , produced microcracks in root dentin. These findings are in accordance with Yoldas et al. and Burklein et al., who found cracks in the root canals prepared by rotary NiTi instruments but not in the root canals instrumented with hand K-file[10]. According to our study, incidence of crack

observed in root dentin was greater after instrumentation with protaper gold as compared to protaper next and trunatomy files. Similar results were found by Ozyurek T, reported cracks in 70% of roots instrumented with protaper gold comparing with Hyflex EDM and waveOne gold. In this study, major number of cracks was observed in the apical section for all tested instruments, which is in agreement with previous studies by Kim et al. This may be due to maximum stress in the apical third of the root canals during cleaning and shaping by rotary files[11]**.** The protaper gold has a taper of 0.08 where as protaper next and trunatomy have a taper of 0.06 and 0.04 respectively. Thus, in support of this study, we believe that the larger taper sizes could result in more cracks[12]**.**Also, triangular cross section design decreases the cutting efficiency and provides less space for dentine chips , thus generating stresses on root canal walls[13]**.** The design of file may affect shaping forces on root dentin, these forces may cause root fracture[14]**.** Off- centered rectangular design of ProTaper Next may have contributed to less number of cracks than protaper gold. This design generates a swaggering motion, which decreases screw effect, dangerous taper lock, and torque on the file by minimizing the contact between the file and dentin[15]**.**In support to this study, rotary instrumentation with protaper universal, protaper gold and protaper next show incidence of dentinal defects 37%, 28% and 23% respectively[16]. Our study showed that trunatomy produces least number of cracks because trunatomy files are designed to shape root canal systems to a continuously tapering preparation with maximum preservation of peri-cervical dentine.The instruments are manufactured with a smaller initial wire blank (0.8mm diameter) compared to the 1.1mm diameter of other conventional rotary instruments. TruNatomy instruments are manufactured using a post-manufacturing thermal process that produce a file with super- elastic properties[17] . Furthermore in our study, the TruNatomy system caused significantly less apical cracks than the protaper gold and protaper next systems[18]. Lower dentinal crack incidence in the TRN group may be attributed to the taper differences between TRN and the other groups. It has been argued that TRN instruments are less destructive for root canal system due to regressive tapers and the heat treatment of the NiTi alloy**.** The slenderized pattern might have caused relatively fewer apical cracks in the TruNatomy system. Also, there is at least a one or two-point contact between the instrument and the root canal wall[19]. Peters et al (2014) evaluated that increased rotational speed isassociated with increasing cutting efficiency. According to Capar et al (2014), higher cutting efficiency might be related to less crack formation. Recommended speed for TruNatomy file

system is 500 rpm which is higher than protaper gold (300 rpm) and protaper next (300 rpm) files tested in this study. Thus, TruNatomy file system could result in less cracks than protaper gold and protaper next files[8].

CONCLUSION: Within the limitations of the present study,least dentinal cracks were observed in Trunatomy file system followed by Protaper gold system and Protaper gold system. No significant difference was seen between Protaper next system and Protaper gold system.

Thus, TruNatomy file system showed considerably good results compared to Protaper Next and Protaper gold .Prudent selection of file system for instrumentation is of utmost importance for long term endodontic success

REFERENCES

1. 1.Chole D, Kamble S, Bakle S, Gandhi N, Hatte N, Bawa P. Effects of 3 Single-File System (Protaper Universal, Protaper Next, Protaper Gold) on crack formation in dentin after root canal preparation: An in vitro study. IOSR-JDMS 2019; 18, 47-50.

2. Shori DD, Shenoi PR, Baig AR, Kubde R, Makade C, Pandey S. Stereomicroscopic evaluation of dentinal defects induced by new rotary system: ProTper NEXT. J Conserv Dent 2015:18:210-3
3. Yoldas O, Yilmaz S, Atakan G, et al. Dentinal microcrack formation during root canal preparations by different NiTi rotary instruments and the self-adjusting file. J Endod 2012;38(2):232–5.
4. Vila RM, Biedma BM, De-Deus G et al. Microcomputed Tomographic Evluation of Dentinal Microcracks after Preparation of Curved Root Canals with ProTaper Gold, WaveOne Gold and ProTaper Next Instruments. Journal of Endod 2020:47(2): 309-314
5. Algarni AF et al. Comparative Evaluation of Root Dentin Integrity after Root Canal Preparation with Rotary File Systems of Different Ni-Ti Alloys. Ann Med Health Sci Res. 2019: 9: 614-620
6. Çapar ID, Arslan H, Akcay M, Uysal B. Effects of ProTaper universal, ProTaper next, and HyFlex instruments on crack formation in dentin. J Endod. 2014;40(9):1482–4.
7. Arumugam S, Yew HZ, Baharin SA, Zaman J, Muchtar A, Kanagasingam S. Microcomputedtomomgraphy evaluation of dentinal microcracks following canal

preparation with thermomechanically heat-treated engine driven files. Australian Endod Journal 2021:47(3):520-530.

8. Rose E, Svec T. An evaluation of apical cracks in teeth undergoing orthograde root canal instrumentation. J Endod 2015; 41(12): 2021-4.
9. Burklein S, Tsotsis P, Schafer E. Incidence of dentinal defects after root canal preparation: Reciprocating versus Rotary instrumentation. Journal of Endodontics 2013:39(4):501-4.
10. Kesim B, Sagsen B, Aslan T, Evaluation of dentinal defects during root canal preparation using thermomechanically processed nickel-titanium files. Eur J Dent 2017:11(2), 157-161.
11. Kim HC, Lee MH, Yum J, et al. Potential relationship between design of nickel titanium rotary instruments and vertical root fracture. J Endod 2010;36(7):1195–9.
12. Li SH, Lu Y, Song D, Zhou X, Zheng QH, Gao Y, et al. Occurrence of dentinal microcracks in severely curved root canals with ProTaperuniversal, WaveOne, and ProTaper next file systems. J Endod. 2015;41(11):1875–9.
13. Burklein S, Hinschitza, Dammaschke T, Schafer E. Shaping ability and cleaning effectiveness of two single-file systems in severely curved root canals of extracted teeth:Reciproc and Waveone versus Mtwo and protaper. Int Endod J 2012:45, 449-461
14. Lam PP, Palamara JE, Messer HH. Fracture strength of tooth roots following canal preparation by hand and rotary instrumentation. J Endod 2014:37, 997-1001.
15. Das S, Pradhan PK, Lata S, Sinha SP. Comparative evaluation of dentinal crack formation after root canal preparation using ProTaper Next, OneShape, and Hyflex EDM. J Conserv Dent 2018; 21,153-6.
16. Scarlatescu SA, Preoteasa C, Suciu I, Gheorghiu M, Perlea P, Angelica B, Dimitriu B, Margarit R, Amza O, Andrei M, Didilescu A. Evluation of three different rotary systems on dentinal defects formation in curved canals. Rom BiotechnolLett 2020:25(4), 1716-1723.
17. Vander Vyver PJ, Vorster M, Peters OA. Minimally invasive endodontics using a new single fle rotary system. Int Dent Afr Ed 2020:9, 06-10.

18. Bier CAS, Shemesh H, Tanomaru-Filho M, et al. The ability of different nickel titanium rotary instruments to induce dentinal damage during canal preparation. J Endod 2009;35(2):236–8.
19. Ustun Y, Topcuoglu HS, Duzgun S, Kesim B. The effect of reciprocation versus rotational movement on the incidence of root defects during retreatment procedures.Int Endod J 2015;48(10):952-8.