



Research Article

## INCIDENCE OF MICRO-CRACKS IN THE ROOT DENTINE DURING VARIOUS RE-TREATMENT TECHNIQUES AN IN-VITRO STUDY

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### ARTICLE INFO

#### Article History:

Received 6<sup>th</sup> December, 2017

Received in revised form 21<sup>st</sup>

January, 2018 Accepted 05<sup>th</sup> February, 2018

Published online 28<sup>th</sup> March, 2018

#### Key words:

Micro cracks, Re-treatment, Wave-one, Protaper universal re-treatment files.

### ABSTRACT

**Introduction:** ProTaper Universal retreatment system is a Ni-Ti rotary instrument that is used for removal of filling material from the root canal. Wave One is a reciprocating instrument used for the preparation of root canals. Although Wave One is fundamentally used for the preparation of root canals, studies have evaluated their use in removal of root filling material. Root fractures may occur as a result of retreatment procedures resulting in dentinal defects (i.e. craze lines or micro-cracks) that propagate with repeated stress application through occlusal forces.

**Aim:** To compare the incidence of dentinal defects caused by reciprocating and rotary techniques during retreatment procedures.

**Methodology:** 53 extracted single-rooted teeth were selected. The biomechanical preparation was done followed by obturation with cold lateral compaction technique. Five canals received no further treatment (control group). Forty-Eight teeth were divided into Six groups (n=8) to undergo the removal of root filling. In Groups 1,2 and 3, the root filling was removed using ProTaper Retreatment files, Wave One files and Gates Glidden drills respectively and canals were not refilled. In groups 4,5 and 6, the root filling was removed using ProTaper Retreatment files, Wave one file, and Gates Glidden drills, the canals were then refilled using a conventional cold lateral compaction technique. Roots were sectioned horizontally at 3mm, 6mm and 9 mm from the root apex and observed under a stereomicroscope at 20 X magnification. Defects were categorized as no defect, incomplete defect, and fracture. The difference between the groups was analyzed using the statistical analysis.

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### INTRODUCTION

The main goal of cleaning and shaping the root canal system is to create adequate space for copious irrigation and three-dimensional obturation. Use of inflexible stainless steel instruments in curved canals can cause iatrogenic damage to the original shape of the root canal.<sup>3</sup> Coronal and radicular tooth structure loss predisposes endodontically treated teeth to fracture, due to prior pathology or endodontic and/or restorative treatment procedures.<sup>2</sup> Perforation, canal transportation, ledge or zip formation, and fracture of files are some of the complications that may occur during the root canal preparation.<sup>7</sup> Furthermore, instrumentation procedures can also cause localized dentinal defects such as craze lines or incomplete cracks with subsequent root fracture when the tooth is subjected to repeated stress by occlusal forces.<sup>7</sup>

Recently, many nickel-titanium (NiTi) rotary systems have been introduced and despite of their various clinical advantages over hand instrumentation such as saving the time and better cutting efficiency, they can generate higher stresses within the root canal.<sup>7</sup> The Protaper Universal Retreatment System (Dentsply Maillefer, Ballaigues, Switzerland) is a NiTi

rotary instrument that is used for removal of filling material from the root canal. It comprises three retreatment files, one for each third of root canal. The instruments have a convex triangular cross section similar to the Protaper Universal shaping and finishing files.<sup>8</sup>

Wave-One (Dentsply Maillefer, Ballaigues, Switzerland) is a single instrument NiTi file system to shape the root canal completely from start to finish. These specially designed NiTi files work in a reverse “balanced force” action using a pre-programmed motor to move the files in a back and forth reciprocating motion. As Wave-One utilizes CCW (counter clockwise) movement greater than CW (clockwise) movement, it is claimed that it requires less apical pressure for its advancement into the canal. It was also thought that reciprocation might decrease the incidence of dentinal crack formation. But this speculation is not supported by literature.<sup>3</sup>

Lateral compaction of gutta-percha is widely used to fill the root canal system and was reported previously to be associated with an increased risk of vertical root fracture (Meister *et al.* 1980, Wilcox *et al.* 1997). Spreader design and applied forces were suggested as contributing factors to the appearance of vertical root fracture during lateral compaction (Pitts *et al.* 1983, Dang & Walton 1989). However, laboratory stress distribution studies consistently conclude that the pressure applied during lateral compaction is insufficient to cause VRF

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(Dalat & Spngberg 1994).<sup>1</sup> Endodontic failures can be attributable to inadequacies in shaping, cleaning and obturation, iatrogenic events, or re-infection of the root canal system when the coronal seal is lost after completion of root canal treatment. Regardless of the etiology, the sum of all causes is leakage and bacterial contamination, thus leading to the need of endodontic retreatment.

The purpose of this study is to compare the incidence of Dentinal micro-cracks caused by Pro-taper Universal retreatment files, Wave One files, Gates Glidden drills during retreatment procedures.

## MATERIALS & METHODOLOGY

### Preparation and obturation of samples

Fifty three freshly extracted mandibular anterior teeth with single, straight roots and intact root apices were obtained from the Department of Oral and Maxillofacial Surgery, CKS Theja Institute of dental sciences and research, Tirupati. The teeth had been extracted for periodontal and orthodontic reasons.

All the teeth were measured 15 mm from the apex with the help of vernier calipers and all the teeth were decoronated with slow speed diamond disk under water coolant. For each decoronated tooth, canal patency was checked with size 15-K file. Biomechanical preparation was done till size 35-K file. Then the canals were irrigated with 3% NaOCl and 17% EDTA solution followed by saline solution. Obturation was done using cold lateral compaction technique with master cone of size 35.02 guttapercha. All the samples were stored in incubator for 7 days at 100% humidity at 37°C.<sup>9</sup>

All the samples were randomly divided into 4 groups, n= (3 experimental & 1 Control group). Experimental groups were again subdivided into 2 subgroups. The divided groups are as follows, based on instruments used for removal of gutta-percha and Reobturation after removal of gutta-percha

### Group 1

- Group 1A - Pro-taper universal re-treatment files **without** Re-obturation.
- Group 1B - Pro-taper universal re-treatment files group **with** Re-obturation.

### Group 2

- Group 2A – Wave-one files **without** Re-obturation.
- Group 2B – Wave-one files **with** Re-obturation.

### Group 3

- Group 3A – Gates Glidden drills **without** Re-obturation.
- Group 3B – Gates Glidden drills **with** Re-obturation.

### Group 4

Control group.

### Retreatment procedure

#### Group 1A & 1B

In group 1A and 1B gutta-percha was removed with The Protaper Universal Retreatment System (Dentsply Maillefer, Ballaigues, Switzerland) with D1 at 500 rpm and D2, D3 at 400 rpm. In group 1A the treatment procedure was concluded with F4 Pro-taper file at 300 rpm and samples were left unfilled.



Fig 1 picture showing prepared tooth divided randomly into groups.

In Group 1B procedure was concluded with F4 Pro-taper file at 300 rpm and re-obturation was done with 40.06 size master cone and accessory cones placed till no 15 size GP can be placed with AH plus sealer.

### Group 2A & 2B

In group 2A and 2B gutta-percha was removed with Wave one Primary file. In group 2A all the samples were left unfilled. In group 2B re-obturation was done with 25 .08 master cone and accessory cones placed till no 15 size GP can be placed with AH plus sealer.

### Group 3A & 3B

In group 3A and 3B gutta-percha was removed with gates-glidden and H-files. In group 3A all the samples were left unfilled. In group 3B Obturation was done with 35 .02 size master cone and accessory cones placed till no 15 .02 size GP can be placed with AH plus sealer.

### Group 4

No procedure was done in this group.

All the samples were sectioned at 3mm, 6mm and 9 mm from apex and subjected to stereomicroscopic evaluation at 20 X magnification to evaluate microcracks of root dentin.

Microcracks were categorized and defined into four distinct categories:

“0” – No Defect

“1” – Craze lines

“2” – Incomplete fractures (a line extending from the outer surface into the dentin but that did not reach the canal lumen; or a partial crack, a line extending from the canal wall into the dentin without reaching the outer surface).

“3” – Complete fracture (a line extending from the root canal space to the outer surface of the root).

After stereomicroscopic evaluation a Chi-square test was performed to explore the difference between the groups and the influence of root level (apical, middle and coronal) on the appearance of defects. The significance level was set at  $P < 0.05$ .

## RESULTS

- The data collected was statistically analyzed to compare the presence of microcracks between various experimental groups.

- Results were expressed as the number and percentage of defective roots in each group.
- The obturated but no retreatment group (Control group) had no microcracks, but microcracks were found in all experimental groups.
- When all the groups with the overall appearance of microcracks were considered, the 9 mm, 6mm level presented significantly more microcracks than the 3 mm level. However, there was no significant difference between the other levels.

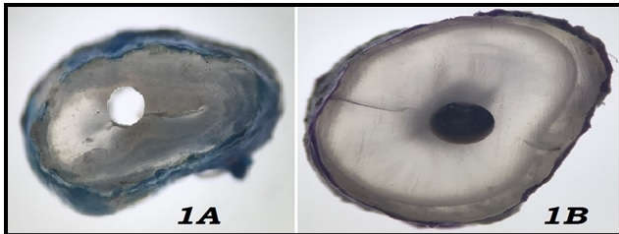


Fig 2 Dentinal defects of group 1A and 1B.

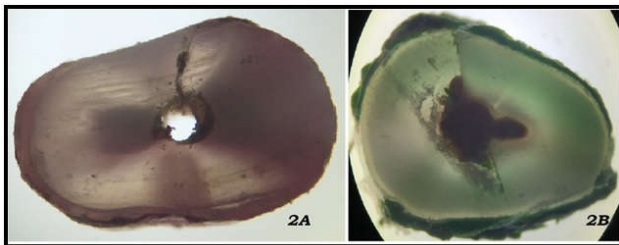


Fig 3 Dentinal defects of group 2A and 2B.

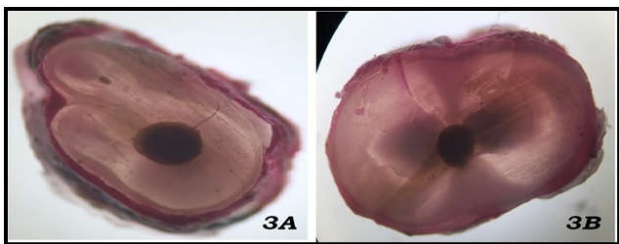


Fig 4 Dentinal defects of group 3A and 3B.

- All instruments caused dentinal defects, with no significant differences between the instrument systems.

Table 1

	Group 1A		Group 1B		Group 2A		Group 2B		Group 3A		Group 3B		Group 4	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
0	11	45.8%	13	54.2%	12	50.0%	9	37.5%	18	75.0%	15	62.5%	12	80.0%
1	7	29.2%	7	29.2%	1	4.2%	7	29.2%	4	16.7%	5	20.8%	3	20.0%
2	5	20.8%	4	16.7%	5	20.8%	6	25.0%	2	8.3%	2	8.3%	0	.0%
3	1	4.2%	0	.0%	6	25.0%	2	8.3%	0	.0%	2	8.3%	0	.0%

- Each group was compared with control groups and it was found that Group 2A, 2B (Wave One) & Group 3A, 4B (Gates Glidden drills) did not produce any significant dentinal cracks. Group 1A, 1B (Pro-Taper universal retreatment) produced significant dentinal cracks as compared to control groups but when compared with each other no significant difference was found.

Table 2

	Group 1A		Group 1B		Group 2A		Group 2B		Group 3A		Group 3B		Group 4		p-value
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	
3 mm	0	6 75.0%	4	50.0%	5	62.5%	2	25.0%	7	87.5%	6	75.0%	4	80.0%	0.404;
	1	0 .0%	3	37.5%	1	12.5%	2	25.0%	1	12.5%	2	25.0%	1	20.0%	NS
	2	2 25.0%	1	12.5%	1	12.5%	3	37.5%	0	.0%	0	.0%	0	.0%	
	3	0 .0%	0	.0%	1	12.5%	1	12.5%	0	.0%	0	.0%	0	.0%	
6 mm	0	2 25.0%	3	37.5%	3	37.5%	4	50.0%	7	87.5%	5	62.5%	4	80.0%	0.148;
	1	3 37.5%	4	50.0%	0	.0%	2	25.0%	0	.0%	1	12.5%	1	20.0%	NS
	2	2 25.0%	1	12.5%	2	25.0%	2	25.0%	1	12.5%	1	12.5%	0	.0%	
	3	1 12.5%	0	.0%	3	37.5%	0	.0%	0	.0%	1	12.5%	0	.0%	
9 mm	0	3 37.5%	6	75.0%	4	50.0%	3	37.5%	4	50.0%	4	50.0%	4	80.0%	0.506;
	1	4 50.0%	0	.0%	0	.0%	3	37.5%	3	37.5%	2	25.0%	1	20.0%	NS
	2	1 12.5%	2	25.0%	2	25.0%	1	12.5%	1	12.5%	1	12.5%	0	.0%	
	3	0 .0%	0	.0%	2	25.0%	1	12.5%	0	.0%	1	12.5%	0	.0%	

- In the coronal root thirds of the samples there were significant difference among all the groups in which group 1 showed highest dentinal defects.
- When inter group comparison is done Group 1 showed more significant level difference than the other groups. When obtained values of 3mm, 6mm, 9mm of groups 1, 2 and 3 are compared, group 1 showed more number of dentinal defects at 6 and 9 mm.
- There was no significant difference between the rest of experimental groups.

## DISCUSSION

- The sectioning method used in the current study allowed the evaluation of the effect of root canal treatment procedures on the root dentine by direct inspection of the root canal wall, observing dentinal defects such as craze lines and incomplete cracks.
- When considering all the defects, protaper universal retreatment group had significantly more defects than all other groups
- Group 1A & 1B samples prepared with Pro-Taper files showed higher incidence of root dentinal crack formation among all the groups. This was in accordance with some of the previous studies, *Bier et al(J. Endod. 2009)*, found cracks in horizontal section of 16% of roots instrumented with the Pro-Taper system.
- The ProTaper universal files have active rotating movement resulting in high levels of stress concentration in root canal walls. Furthermore progressively greater taper of ProTaper files resulted in more coronal dentin removal and resulted in significantly more cracks than Waveone files and gates-gliddendrills.
- In a study conducted by *Liu et al(J. Endod. 2013)*, observed cracks at apical root surface in 25%of roots instrumented with the Pro-Taper system.
- Present study found that the single file (Wave-One) system caused less damage as compared to multiple files used by the Pro-Taper.
- Group 3A & 3B (Gates-Glidden) showed least crack formation, even after using Gates Glidden drills for coronal flaring as their use was limited to coronal one-third only. This was in accordance with the earlier studies which concluded that, use of Gates Glidden drills for coronal flaring does not induce cracks in the root dentinal wall, *R.Liu et al(J. Endod. 2013)*.

- Less crack formation with hand filing can be because of the slower speed, better tactile sensation and less stress generated as compared to rotary instruments.
- In the present study, initial root canal preparation was performed with hand files to determine with more precision the number of defects that occurred during retreatment.
- It was said that initial root canal preparation performed with hand files did not show any dentinal defects (Bier *et al.* 2009, Yoldaset *al.*2012, Ashwinkumar *et al.* 2013).
- Other reasons that can contribute to the root dentinal crack formation beside different type of systems are operator skill, storage conditions and the absence of periodontal cushioning in prepared samples.
- Clinical procedures that can further lead to propagation of these cracks are stresses induced by obturation methods or post space preparation techniques.
- Micro-CT imaging has a much higher definition than stereomicroscopy and a large number of sections can be analyzed per tooth without creating defects
- However, the clinical situation is more complex because of the presence of the periodontal ligament that could further influence the distribution of forces. While some studies did not attempt to imitate bone or periodontal ligament (Onnink *et al.* 1994, Ribeiro *et al.* 2008), others have made various attempts to do so.

#### Limitations of the study

There are a number of limitations present in previous studies evaluating dentinal defect formations: (i) it is possible that the defects occurred during the extraction of teeth (shemesh *et al.*2009), (ii) it is possible that the defects occurred during the sectioning procedure (Bier *et al.* 2009), (iii) it was not possible to evaluate at which point during the instrumentation procedures the cracks were produced, (iv) it is possible that the same defects extend to different levels of the root and were counted as separate defects (onnink *et al.*1994), and (V) it is not possible with the current methodology (root sectioning and direct observation by optical microscopy) to detect pre-existing defects.

#### CONCLUSION

Though the exact duplication of *in vivo* conditions is difficult within the limitations of this investigation, it could be concluded that dentinal micro cracks are produced irrespective of motion kinematics and such an incidence is less with instruments working in reciprocating motion compared with those working in continuous rotation.

Within the limitations of this *in vitro* study, it was observed that the use of Hand, Rotational or Reciprocating instruments could induce the formation of dentinal defects during root canal preparation. It was concluded that the instrumentation of root canals with ProTaper universal retreatment files, WaveOne and Gates-glidden drills could cause damage to root canal dentin. ProTaper universal retreatment have tendency to cause more microcracks compared to other files.

#### References

1. Shemesh H, Bier CA, Wu MK, Tanomaru-Filho M, Wesselink PR. The effects of canal preparation and filling on the incidence of dentinal defects. *IntEndod J.* 2009 Mar;42(3):208-13.
2. DilekHelvacioğlu-Yigit, SedaAydemir, Ayca Yilmaz. Evaluation of dentinal defect formation after root canal preparation with two reciprocating systems and hand instruments: an *in vitro* study. *BiotechnolBiotechnol Equip.* 2015 Mar 4; 29(2): 368–373.
3. Monga P, Bajaj N, Mahajan P, Garg S. Comparison of incidence of dentinal defects after root canal preparation with continuous rotation and reciprocating instrumentation. *Singapore Dent J.* 2015 Dec;36:29-33.
4. Mavani P, Pujar M, Uppin. V, Vagarali H, Patil C, Yalagi V. Comparative Evaluation of root micro cracks by different rotary and reciprocating endodontic file systems. *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS).*2015 SEP:p-ISSN: 2279-0861. Volume 14, Issue 9.
5. Ravi A B, Prabath Singh V P, Sreeram SR, Hariharan M, Razdan TR. Comparison of root microcrack formation after root canal preparation using two continuous rotational file systems and two reciprocating systems –An *In vitro* study. *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS).*2015 NOV: p-ISSN: 2279-0861. Volume 14, Issue 11.
6. DilekHelvacioğlu-Yigit, SedaAydemir, Ayca Yilmaz. Evaluation of dentinal defect formation after root canal preparation with two reciprocating systems and hand instruments: an *in vitro* study. *BiotechnolBiotechnol Equip.* 2015 Mar 4; 29(2): 368–373.
7. Abdel Aziz Mohamed El-Sayed M, Omar Al amoud, Rashid M'gharfaoui M, Radicular dentinal defects incidence after using EDTA gel with different root canal instrumentation techniques. *Journal of Restorative Dentistry* Jan 2015. Vol 3, Issue 1.
8. UstunY, topcuoglu S, DUzgun S, Kesim B. The effect of reciprocation versus rotational movement on the incidence of root defects during retreatment procedure. *IntEndod J.*2015.
9. Silva EJ, Orłowsky NB, Herrera DR, Machado R, Krebs RL, Coutinho-Filho Tde S. Effectiveness of rotatory and reciprocating movements in root canal filling material removal. *Braz Oral Res.* 2015;29:1-6. 2014 Dec.

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