A Scanning Electron Microscopic Evaluation of SurfaceDefects of New and Used Retreatment Files

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Abstract:

This study evaluated the surface defects of new and used Retreatment files using scanning electron microscope. Methods: Thirty extracted human mandibular molars with curvature 10^o to 25^o were used in the study. The selected teeth decapitated and distal roots were separated then cut coronally to establish 16 mm length. Root canal preparation was performed using ProTaper Rotary system, Obturation was performed with lateral compaction technique using master cone size F2 with Resin sealer. The obturated teeth were randomly divided into two

main groups of fifteen teeth. In-group I: ten sets of ProTaper retreatment files will be used to remove gutta-percha from thirty obturated canals and in group II: ten sets of D-race retreatment files were used to remove gutta-percha from thirty obturated canals. ProTaper and D-race retreatment files were examined before and after being used. Results: scanning electron microscopic analysis of both the retreatment file systems revealed that, the ProTaper retreatment files were less surface defects than the D-Race retreatment files but, the difference was not statistically significant. Conclusion: ProTaper retreatment files showed less distortion and fracture when compared to D-Race retreatment files.

***Keywords**: Retreatment, defects, fracture, nickel–titanium, rotary instrument, electron microscopic.*

1. Introduction

In recent years, patients increasingly expect to retain their natural teeth and are often reluctant to have their natural teeth extracted. Root canal retreatment might offer patients a second chance to save their teeth(1).

The necessity of endodontic retreatment is being seen with greater frequency. Proper case selection, patient education, and use of recent techniques may reduce the fatigue and frustration experienced during the treatment of such cases (2).

Removal of gutta-percha by conventional methods by using hand files from the root canal system might be difficult and time-consuming. The relative difficulty in removing gutta-percha varies according to the canal length, cross-sectional diameter, and curvature.

For this reason, rotary nickel-titanium files have been proposed for the removal of the root canal filling, and in recent years, a number of retreatment file systems were developed.

ProTaper, D-race retreatment files were designed to facilitate the removal of filling material, such as gutta-percha, pastes and resin-based materials.

The defects or distortions of nickel-titanium endodontic instruments vary from deformation of instruments spirals, scraping, pitting, disruption of the cutting edge and blunt edge. Moreover, Instrument fracture may occur which might be flexural fracture. Such fracture is caused by a defect in the internal surface of the metal alloy and it is not accompanied with a defect on external surface (3).

The major clinical concern with the use of rotary nickel-titanium instruments is the unexpected fracture that occurs without any visible defects of previous permanent deformation (4). The manufacturer states that the only predictable way to prevent failure is to discard rotary instruments regularly after a certain number of uses. However, there is no agreement about the number of use to which an instrument can be submitted before failure. Therefore, this study conducted to **evaluation of surface defects of new and used Retreatment files using scanning electron microscope.**

Materials and methods:

Thirty extracted human mandibular molars with curvature 10^{o} to 25^{o} according to Schneider‘s technique were used in the study. None of the teeth had received restorative or endodontic therapy. Following

extraction, the teeth were stored in containers containing normal saline at room temperature to avoid any effect that fixative might have on the dissolution of organic tissue.

The selected teeth were decapitated and distal roots were separated. They then cut coronally to establish 16 mm length. Blocks were designed to hold root specimens in position.

Root canal preparation was performed using ProTaper Rotary system according to the manufacturer's recommendations using a crown-down technique till F2 finishing file. Obturation was performed with lateral compaction technique using master cone size F2 with Resin sealer. After obturation teeth were stored in 100% relative humidity at 37°C in incubator for 7 days to allow complete setting of the sealer.

The obturated teeth were randomly divided into two main groups of fifteen teeth. In-group I: ten sets of ProTaper retreatment files will be used to remove gutta-percha from thirty obturated canals, each set were used for 3 canals only. In-group II: ten sets of D-race retreatment files were used to remove gutta-percha from thirty obturated canals, each set were used for 3 canals only. Removal of filling material

Group I:The filling material was removed from the coronal third using ProTaper rotary retreatment file D1 (30/.09) with an effective cutting tip to facilitate initial penetration, followed by D2 ProTaper instrument (25/.08) for the middle third of the root canal. Finally, D3 ProTaper instrument (20/.07) was used to full working length. The instruments were activated by an electric motor (E-cube, black, Korea) at500 rpm speed and 3 N/cm torque, in a brushing motion**.**

Group II: Retreatment was performed using D-Race retreatment files, the coronal third of the root filling was removed using DR1 (30/0.10) with an active tip to facilitate its initial penetration. It was activated by an electric engine at 1000 rpm speed and 1.5 N/cm torque. DR2 (25/.04) was used with light apical pressure to full working length, and run at 600 rpm speed and 0.7 N/cm torque**.**

- For the two techniques the canals were irrigated with 2ml sodium hypochlorite (2.5%) between files and at end of procedure then dried with paper points .
- The criteria for complete removal of filling material and the retreatment procedure was considered to be completed when the initial working length was reached and no more gutta-percha remnants were seen on the flutes of the last used instrument or in the irrigating solution inside the canal.(5-6)

Before use new instruments were examined under scanning electron microscope (JEOL JSM-5300 scanning microscope) at 750× magnification, in lateral views.

After use, the instruments were wiped with gauze moistened with alcohol, ultrasonic cleaning was performed, packed, and autoclaved. Instruments were inspected again in lateral view at same magnification.

The data for defects that were detected under scanning electron microscope for ProTaper retreatment files and D-Race retreatment files were entered into a Microsoft Excel spread sheet.

Each system was rated in the following categories according to **Purayil et al**. (7)As follows: The presence of defects (plastic

deformation, blunting of the cutting edges, micro cracks،craters and fracture,) were scored according to the following criteria

1. No defect (No plastic deformation or bending or other deformation of the cutting edge is visible).
2. Minor plastic deformation (The cutting edge or flute of the instrument is a curved or deformed with the disruption of cutting edge).
3. Blunting of cutting edges/micro cracks (The flute or cutting edges of the instrument is blunt with or without micro cracks).
4. Craters (Some part of the flute or cutting edge of the instrument is missing as indicated by a crater on the surface).
5. Fracture.

The scoring of surface defects as observed from scanning electron micrographs was analyzed using T test.

Results:

In ProTaper group, 16 files showed no defects along the shaft, 5 files showed minor plastic deformation, 3 files showed cutting edges/micro cracks, 2 files showed missing part of cutting edge, 4 files had fracture.

In D-Race group 3 files showed no defects along the shaft, 3 files showed minor plastic deformation, 5 files showed cutting edges/microcracks,2 files showed missing part of cutting edge, 7 files had fracture.

Table 1 shows Statistical analysis showed no significant difference in defects and fracture at failure between all instruments tested ($P < .480$). The highest defects and fracture were observed for D-Race retreatment files and the lowest for Pro-Taper retreatment file. Figures 1, 2, 3, 4 and5.

Table (1): Result of the test

Device	N	Mean	Standard Deviation	Test Value	P value
ProTape	5	6.00	5.701	0.740	0.480
D-Race	5	4.00	2.000		

Since P value =0.480 which is greater than 0.05, we conclude that there is no significant difference between the new and used retreatment.

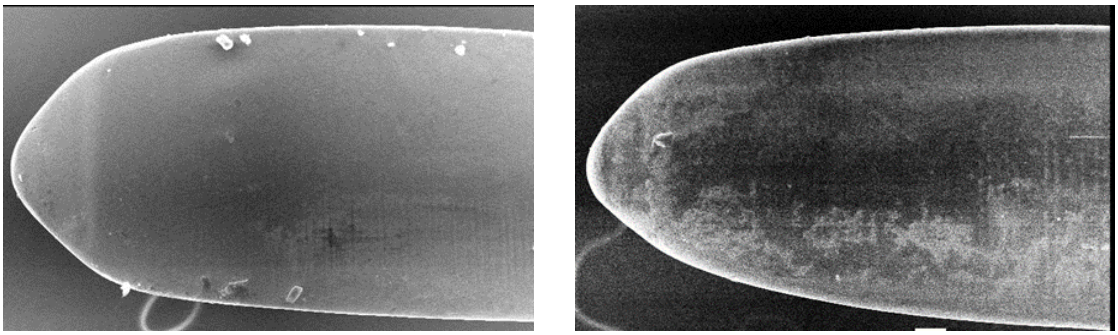

Fig. (1): SEM micrograph of the DR1 file showing the surface debris and after used showing minor plastic deformation.

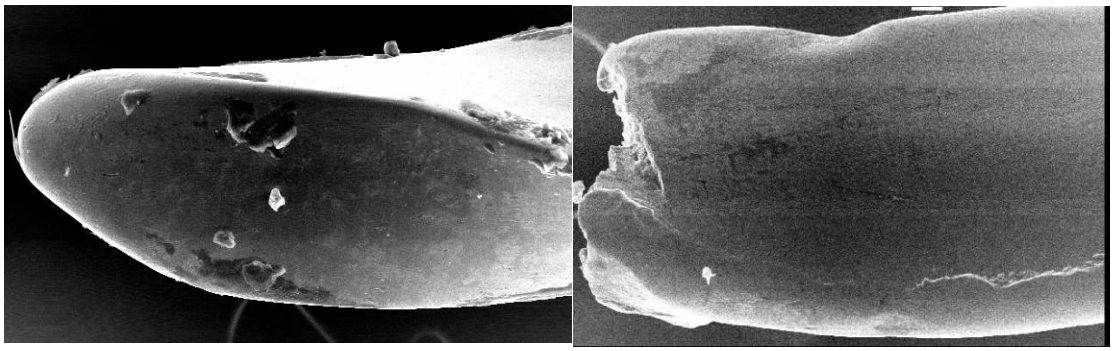

Fig. (2): SEM micrograph of the DR2 file showing the surface debris and after used showing minor fracture.

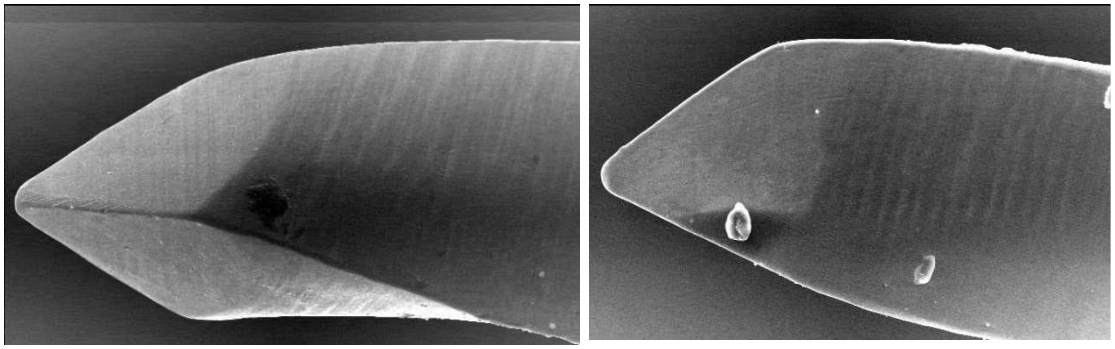

Fig. (3): SEM micrograph of the D1 ProTaper file showing the machining marks and after used showing machining marks and No defect.

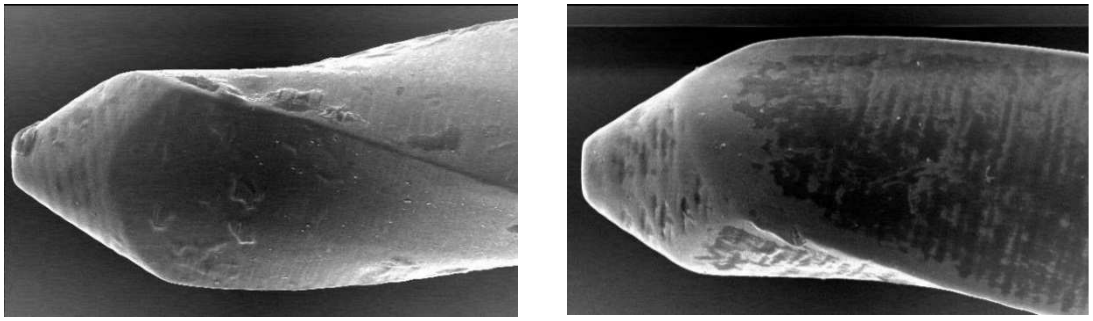

Fig. (4): SEM micrograph of the D2 ProTaper file showing the surface debris and after used showing Blunting cutting edge.

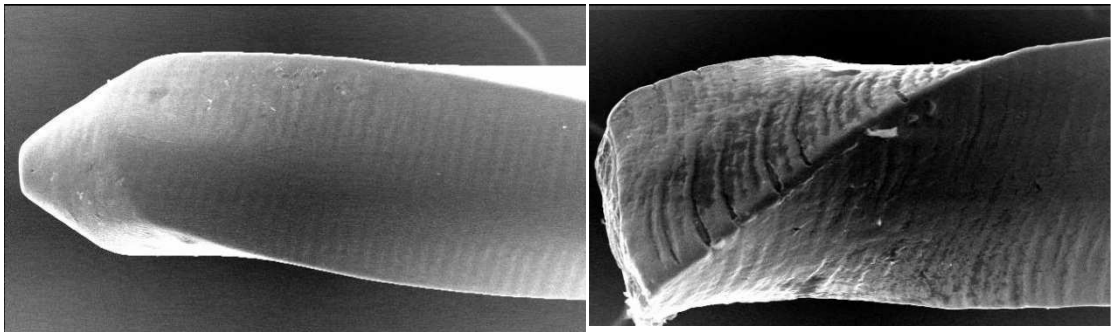

Fig. (5): SEM micrograph of the D3 ProTaper file showing the machining marks and after used showing micro cracks and fracture.

Discussion:

Several techniques such as magnifying loupes, surgical operating

microscope, stereomicroscope and atomic force microscopy have been used for evaluating the surface defects on the instrument.(7,8-9) However, SEM was used in the present study because it has been the accepted method for the accurate evaluation of instruments deformation.(7-10)

Nonsurgical endodontic retreatment gained greater importance against apical surgery for the treatment of endodontic failure cases.(11)Among different retreatment methods, rotary instruments gained popularity as they are faster than hand instruments in removing root filling materials, thus decreasing patient and operator fatigue.(12,13,14,15,16,17,18) However, the high risk of instrument fracture during clinical use poses a major problem to clinicians.(19,20,21) This is related to a number of variables such as: operator skill, root canal anatomy, surface condition of the instruments, design features, speed and frequency instruments are used.

Mesial canals of lower mandibular molars were selected with moderate curvature as they represent difficulty in retreatment, convey a relatively complicated curve and are usually smaller in diameter than distal canals posing a greater challenge to rotary instruments. This is in agreement with Aydin et al (2009)(22) and Beasley et al (2013).(23)

Decoronation allows specimen standardization by eliminating some variables, such as root canal access and dental crown anatomy, thus providing a more credible comparison of the suggested retreatment

techniques.(24) Therefore in this study, the teeth were standardized to 16mm, so that different lengths could not create an impact on the results.(25,26)

The speed at which the instrument operate might affect the efficiency of retreatment by plasticizing gutta-percha through heating that's why instruments rotated at high rotational speeds are more susceptible to distortion and fracture(27). The recommended revolution per minute (RPM) for ProTaper and D-Race retreatment files according to the manufacturer are 500 RPM and 600 to 1000 RPM respectively. This may explain the early deformation and fracture of D-Race retreatment files. This could be attributed to the observations of Yard et al (2002)(28) and Royzenblat and Goodell (2007)(29) who found an increase in file fracture and spiral distortion with higher speed.

In the current study, new instruments were examined under scanning electron microscopic showing structural defects and imperfections such as surface debris, pitting, machining marks. Bhagabati et al (2012)(30) reported that these defects might reduce the cutting efficiency of the instruments and increase the level of stresses which make the files more vulnerable to fracture. Our results are in agreement with Tripi et al (2001),(31) Svec and Powers et al (2002),(10) Alexandrou et al (2006),(32) an Lopeset al (2010)(33) and contradict with the results of Herold et al (2007)(34) and Chianello et al (2008)(35) who found that new files with well-polished surfaces were free of defects. Such difference might be attributed to the low magnifications they used during testing of the new files.

When examining used instruments under scanning electron microscopic examination, they showed surface debris, plastic deformation,blunted edges and microcracks. Despite of ultrasonic cleaning process before SEM examination debris particles adhered tenaciously to the instrument surface which could be as a result of the manufacturing process, gutta-percha or dentine particles adhering from preparation of the canals. Regarding defects, they were observed along the faces of the flutes or at the tips in the form of scrapping or pitting defects and blunting of the cutting edges. This is in agreement with Egger et al (1999),(36) Tripi et al (2001),(31) Svec& Powers (2002),(10) Alapati et al (2003),(37) Torian et al (2006)(38) and Kottoor et al (2013).(39). On the other hand microcracks were present near the separated tip region of the files in the two groups, Fine cracks with irregular path were also noted in D-Race retreatment files while in ProTaper retreatment group, cracks were show running along the machining marks this is in agreement with Kim et al (2010)(40) and Lopes et al (2010) (33). The presence of defects increased the risk of failure with further use because defects acts as local stress-raisers that lead to crack propagation.

Conclusions:

Within the limitations of the present in vitro study, it can beconcluded that ProTaper retreatment files showed less distortion and fracture when compared to D-Race retreatment files in curved root canals.

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