VOLUME-6 | ISSUE-2 | FEBRUARY-2017 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 78.46

# A SEM EVALUATION OF THE SMEAR LAYER AND DEBRIS RETAINED IN THE ROOT CANAL AFTER USING SELF-ADJUSTING FILE (SAF) AND PROTAPER-NEXT ROTARY FILES- AN INVITRO STUDY.

Dental Science

**KEYWORDS:** Self-adjusting file, ProTaper Next files, Smear layer, Debris

**Foram Mehta** — Post-graduate Student, Department of Conservative Dentistry & Endodontics, A.B Shetty Memorial Institute of Dental Science, Nitte University, Deralakatte, Mangalore.

**Shishir Shetty** — Professor, Department of Conservative Dentistry & Endodontics, A.B Shetty Memorial Institute of Dental Science, Nitte University, Deralakatte, Mangalore.

**Mithra N Hegde** — Vice Dean and Dean of Dental Faculty, Head of the Department, A.B Shetty Memorial Institute of Dental Science, Nitte University, Derlakatte, Mangalore.

## ABSTRACT

To evaluate and compare the amount of smear layer & debris retained in the root canal after using SAF and PTN rotary files using SEM. Fourty-eight human permanent mandibular first molar were divided into two in which SAF system & PTN rotary files were used for instrumentation and subdivided into three groups where first group specimens were irrigated with normal saline, second group with 3% sodium hypochlorite and 17% EDTA & third group with 3% sodium hypochlorite and examined under SEM. Collected data was statistically analyzed. When 3% sodium hypochlorite & 17% EDTA were used as irrigants, SAF had shown significantly less smear layer retained compared to PTN on overall comparison as well as in middle third samples in subgroup comparison. Smear layer and debris retained after the biomechanical preparation with SAF was less compared to PTN rotary files along with different irrigants used.

## INTRODUCTION

The main goal of endodontic treatment relies on complete debridement of the root canal[1]. During biomechanical preparation, all instrumentation techniques generates variable amount of smear layer and debris within the root canal[2] which can get compacted either laterally along the canal wall or apically creating apical plug[3]. Any remaining tissue, debris, bacteria or smear layer can contribute towards the endodontic failure[2]. Hence it is important to remove all of them before initiating root canal obturation[4].

Self-Adjusting file (SAF, ReDent Nova, Ra'anana, Israel) is hollow, compressible and flexible file providing three dimensional adaptation to the natural root canal anatomy[5]. A special irrigation device (VATEA, ReDent Nova) can be connected to irrigation hub of the file to provide continuous irrigation[6]. The metal mesh has a scrubbing action on the dentin wall. Thus the combination of simultaneous scrubbing and continuous irrigation along with vibration of the file creates turbulence and agitation of the irrigant in the canal thereby retaining less debris and smear layer[7].

The ProTaper Next rotary files (PTN, Denstply, Maillefer, Ballaigues, Switzerland) are made from M-wire technology having an off centre rectangular cross-section which provides snake like swaggering movement as it advances into the root canal[8]. This design improves the flexibility of the active portion of the file and has impact on the cleaning ability by removing the debris out of the canal as it advances, thereby retaining less debris within the canal[9].

As both these file systems have common advantage of retaining less smear layer and debris, hence this study was conducted to compare the amount of smear layer and debris retained after the instrumentation along with different root canal irrigants.

## MATERIALS & METHODOLOGY

The study was conducted in Department of Conservative Dentistry & Endodontics, A.B. Shetty Memorial Institute of Dental Sciences in association with the Department of Metallurgy & Material Engineering, National Institute of Technology Karnataka.

Forty-eight human permanent mandibular first molars were decoronated at cemento-enamel junction with the help of diamond disks in order to obtain distal roots. Working length was determined for all the teeth and glide path was established by hand instrumentation upto size no. 20 stainless steel K-file.

48 specimens were divided into two main groups

Group 1: Instrumented with SAF in three subgroups
1A: Normal Saline irrigation
1B: Alternate 3% Sodium Hypochlorite and 17% EDTA irrigation
1C: 3% Sodium Hypochlorite irrigation

Group 2: Instrumented with PTN files in three subgroups
2A: Normal Saline irrigation
2B: Alternate 3% Sodium Hypochlorite and 17% EDTA irrigation
2C: 3% Sodium Hypochlorite irrigation

SEM EXAMINATION

All specimens were carefully split into two halves longitudinally, dehydrated and placed inside the gold sputtering machine. The specimens were then examined under SEM (JEOL, Japan model 5309) at a magnification of X200 for debris and X2000 for smear layer. Three series of photomicrographs were taken for each specimen at coronal, middle and apical third sections. Three evaluators independently gave scores for each of the images for smear layer and debris using Gutmann et al (1994)10 scoring criteria.

Scoring criteria

DEBRIS

Score 1: Little or no superficial debris covering up to 25% of the specimen.

Score 2: Little to moderate debris covering between 25 and 50% of the specimen.

Score 3: Moderate to heavy debris covering between 50 and 75% of the specimen.

Score 4: Heavy amounts of aggregated or scattered debris covering over 75% of the specimen.

SMEAR LAYER

Score 1: Little or no smear layer, covering less than 25% of the specimen; tubules visible and patent.

Score 2: Little to moderate or patchy amounts of smear layer; covering between 25 and 50% of the specimen; many tubules visible and patent.

Score 3: Moderate amounts of scattered or aggregated smear layer; covering between 50 and 75% of the specimen; minimal to no tubule visibility or patency.

Score 4: Heavy smear layer covering over 75% of the specimen; no tubule orifices visible or patent.

**SMEAR LAYER PHOTOMICROGRAPHS (2000X)**

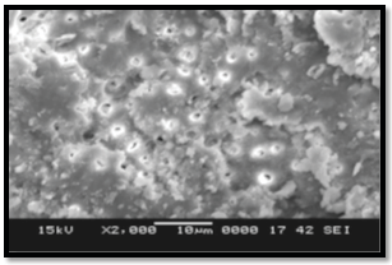


**FIGURE 1: SAF INSTRUMENTATION, NORMAL SALINE IRRIGATION**

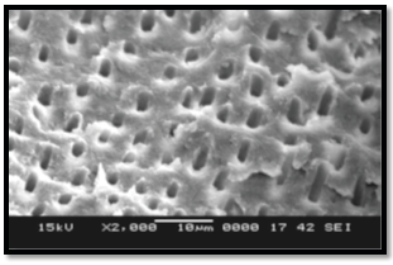


**FIGURE 2: SAF INSTRUMENTATION, SODIUM HYPOCHLORITE & EDTA IRRIGATION**

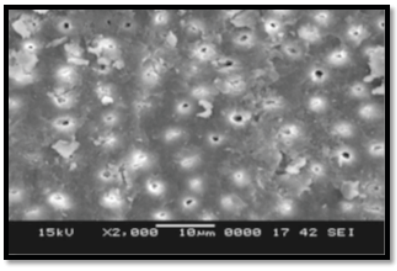


**FIGURE 3: SAF INSTRUMENTATION, SODIUM HYPOCHLORITE IRRIGATION**

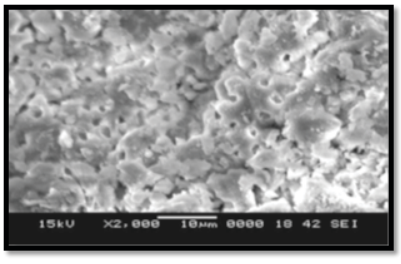


**FIGURE 4: PTN INSTRUMENTATION, NORMAL SALINE IRRIGATION**

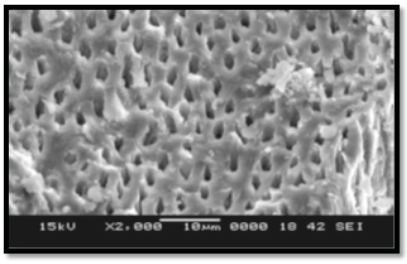


**FIGURE 5: PTN INSTRUMENTATION, SODIUM HYPOCHLORITE & EDTA IRRIGATION**

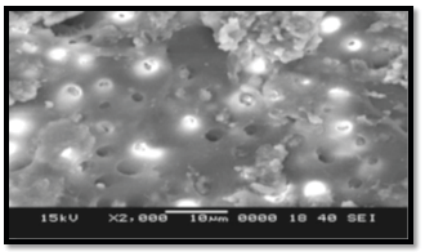


**FIGURE 6: PTN INSTRUMENTATION, SODIUM HYPOCHLORITE IRRIGATION**

**DEBRIS PHOTOMICROGRAPHS (200X)**

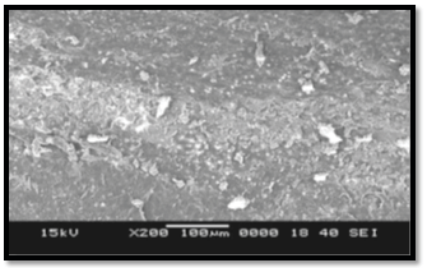


**FIGURE 7: SAF INSTRUMENTATION, NORMAL SALINE IRRIGATION**

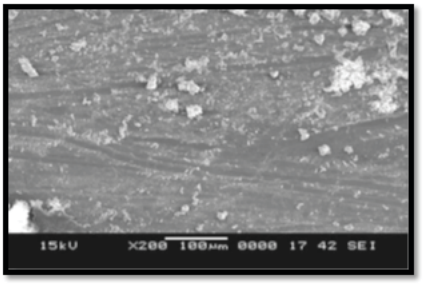


**FIGURE 8: SAF INSTRUMENTATION, SODIUM HYPOCHLORITE & EDTA IRRIGATION**

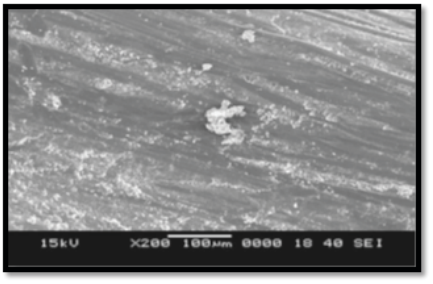


**FIGURE 9: SAF INSTRUMENTATION, SODIUM HYPOCHLORITE IRRIGATION**

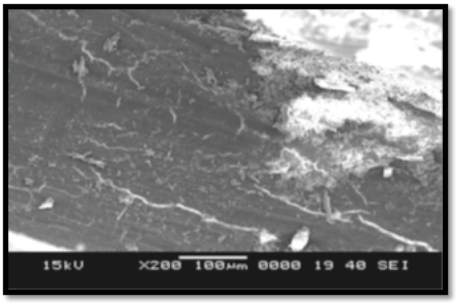


**FIGURE 10: PTN INSTRUMENTATION, NORMAL SALINE IRRIGATION**

VOLUME-6 | ISSUE-2 | FEBRUARY-2017 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 78.46

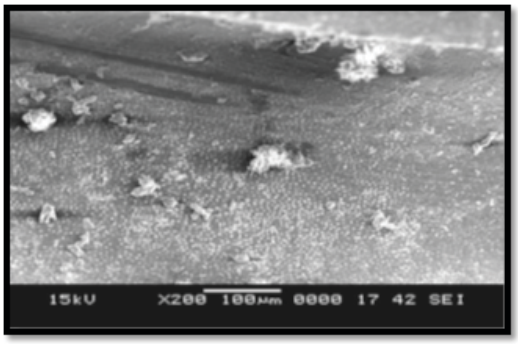


**FIGURE 11: PTN INSTRUMENTATION, SODIUM HYPOCHLORITE & EDTA IRRIGATION**

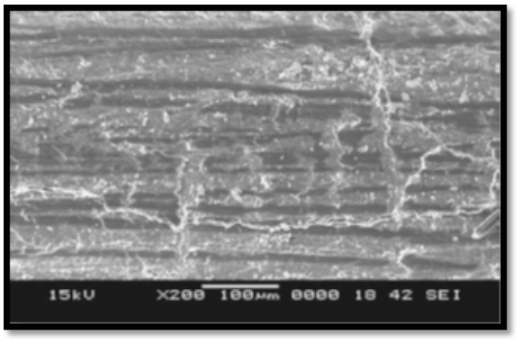


**FIGURE 12: PTN INSTRUMENTATION, SODIUM HYPOCHLORITE IRRIGATION**

**STATISTICAL ANALYSIS:**

Inter-examiner reliability for scoring the SEM images was verified using Fleiss' Kappa test. Data was analysed using Fisher's exact test. P<0.05 was considered to be statistically significant.

**RESULTS:**

**TABLE 1: FLEISS' KAPPA STATISTICS FOR INTER EXAMINER AGREEMENT**

| | VALUE | STANDARD DEVIATION | 95% CONFIDENCE INTERVAL |
|---|---|---|---|
| SMEAR LAYER | 0.45 | 0.03 | 0.3862 – 0.5128 |
| DEBRIS | 0.30 | 0.034 | 0.2394 – 0.3758 |
| Value: 0.21 to 0.4- Fair agreement, 0.41 to 0.6- Moderate agreement | | | |

TABLE 2: OVERALL SCORING OF SMEAR LAYER AFTER SAF & PTN INSTURMENTATION

| Smear layer scoring | Normal saline | | Sodium hypochlorite and EDTA | | Sodium hypochlorite | |
|---|---|---|---|---|---|---|
| | SAF | PTN | SAF | PTN | SAF | PTN |
| Score 1 | 13(54.17%) | 9(37.50%) | 20(83.33%) | 11(45.83%) | 16(66.67%) | 10(41.67%) |
| Score 2 | 6(25.0%) | 7(29.17%) | 4(16.67%) | 10(41.67%) | 4(16.67%) | 7(29.17%) |
| Score 3 | 3(12.50%) | 5(20.8%) | 0 | 3(12.50%) | 4(16.67%) | 6(25.0%) |
| Score 4 | 2(8.3%) | 3(12.50%) | 0 | 0 | 0 | 1(4.2%) |
| P | 0.71(ns) | | 0.01(sig) | | 0.29(ns) | |
| Sig- significant, ns- non significant | | | | | | |

**TABLE 3: OVERALL SCORING OF DEBRIS AFTER SAF & PTN INSTURMENTATION**

| Debris scoring | Normal saline | | Sodium hypochlorite and EDTA | | Sodium hypochlorite | |
|---|---|---|---|---|---|---|
| | SAF | PTN | SAF | PTN | SAF | PTN |
| Score 1 | 16(66.67%) | 13(54.17%) | 21(87.50%) | 17(70.83%) | 18(75.0%) | 16(66.67%) |
| Score 2 | 3(12.50%) | 4(16.67%) | 3(12.50%) | 6(25.0%) | 6(25.0%) | 4(16.67%) |
| Score 3 | 5(20.8%) | 6(25.0%) | 0 | 1(4.2%) | 0 | 4(16.67%) |
| Score 4 | 0 | 1(4.2%) | 0 | 0 | 0 | 0 |
| P | 0.77(ns) | | 0.29(ns) | | 0.14(ns) | |
| ns- non significant | | | | | | |

**TABLE 4: SMEAR LAYER SCORING AT CORONAL, MIDDLE & APICAL THIRD AFTER SAF & PTN INSTRUMENTATION & NORMAL SALINE IRRIGATION**

| | Coronal | | Middle | | Apical | |
|---|---|---|---|---|---|---|
| | SAF | PTN | SAF | PTN | SAF | PTN |
| Score 1 | 7(87.5%) | 6(75.0%) | 3(37.5%) | 2(25.0%) | 3(37.5%) | 1(12.5%) |
| Score 2 | 1(12.5%) | 2(25.0%) | 4(50.0%) | 3(37.5%) | 1(12.5%) | 2(25.0%) |
| Score 3 | 0 | 0 | 1(12.5%) | 3(37.5%) | 2(25.0%) | 2(25.0%) |
| Score 4 | 0 | 0 | 0 | 0 | 2(25.0%) | 3(37.5%) |
| P | 1.00(ns) | | 0.67(ns) | | 0.83(ns) | |
| Fisher's exact test | | | ns- non significant | | | |

TABLE 5: SMEAR LAYER SCORING AT CORONAL, MIDDLE & APICAL THIRD AFTER SAF AND PTN INSTRUMENTATION & SODIUM HYPOCHLORITE & EDTA IRRIGATION

| | Coronal | | Middle | | Apical | |
|---|---|---|---|---|---|---|
| | SAF | PTN | SAF | PTN | SAF | PTN |
| Score 1 | 8(100.0%) | 7(87.5%) | 8(100.0%) | 3(37.5%) | 4(50.0%) | 1(12.5%) |
| Score 2 | 0 | 1(12.5%) | 0 | 4(50.0%) | 4(50.0%) | 5(62.5%) |
| Score 3 | 0 | 0 | 0 | 1(12.5%) | 0 | 2(25.0%) |
| Score 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| P | 1.00(ns) | | 0.03(sig) | | 0.15(ns) | |
| Fisher's exact test | | | sig- significant, ns- non significant | | | |

TABLE 6: SMEAR LAYER SCORING AT CORONAL, MIDDLE & APICAL THIRD AFTER SAF AND PTN INSTRUMENTATION & SODIUM HYPOCHLORITE IRRIGATION

| | Coronal | | Middle | | Apical | |
|---|---|---|---|---|---|---|
| | SAF | PTN | SAF | PTN | SAF | PTN |
| Score 1 | 6(75.0%) | 5(62.5%) | 5(62.5%) | 5(62.5%) | 5(62.5%) | 0.0% |
| Score 2 | 1(12.5%) | 1(12.5%) | 2(25.0%) | 1(12.5%) | 1(12.5%) | 5(62.5%) |
| Score 3 | 1(12.5%) | 2(25.0%) | 1(12.5%) | 2(25.0%) | 2(25.0%) | 2(25.0%) |
| Score 4 | 0 | 0 | 0 | 0 | 0 | 1(12.5%) |
| P | 1.00(ns) | | 1.00(ns) | | 0.02(Sig) | |
| Fisher's exact test | | | sig- significant, ns- non significant | | | |

TABLE 7: DEBRIS SCORING AT CORONAL, MIDDLE & APICAL THIRD AFTER SAF & PTN INSTURMENTATION & NORMAL SALINE IRRIGATION

| | Coronal | | Middle | | Apical | |
|---|---|---|---|---|---|---|
| | SAF | PTN | SAF | PTN | SAF | PTN |
| Score 1 | 6(75.0%) | 5(62.5%) | 5(62.5%) | 4(50.0%) | 5(62.5%) | 4(50.0%) |
| Score 2 | 2(25.0%) | 2(25.0%) | 1(12.5%) | 1(12.5%) | 0 | 1(12.5%) |
| Score 3 | 0 | 1(12.5%) | 2(25.0%) | 3(37.5%) | 3(37.5%) | 2(25.0%) |
| Score 4 | 0 | 0 | 0 | 0 | 0 | 1(12.5%) |
| P | 1.00(ns) | | 1.00(sig) | | 1.00(ns) | |
| Fisher's exact test | | | ns- non significant | | | |

TABLE 8: DEBRIS SCORING AT CORONAL, MIDDLE & APICAL THIRD AFTER SAF AND PTN INSTRUMENTATION & SODIUM HYPOCHLORITE & EDTA IRRIGATION

| | Coronal | | Middle | | Apical | |
|---|---|---|---|---|---|---|
| | SAF | PTN | SAF | PTN | SAF | PTN |
| Score 1 | 8(100.0%) | 7(87.5%) | 7(87.5%) | 5(62.5%) | 6(75.0%) | 5(62.5%) |
| Score 2 | 0 | 1(12.5%) | 1(12.5%) | 3(37.5%) | 2(25.0%) | 2(25.0%) |
| Score 3 | 0 | 0 | 0 | 0 | 0 | 1(12.5%) |
| Score 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| P | 1.00(ns) | | 0.57(ns) | | 1.00(ns) | |
| Fisher's exact test | | | ns- non significant | | | |

TABLE 9: DEBRIS SCORING AT CORONAL, MIDDLE & APICAL THIRD AFTER SAF AND PTN INSTRUMENTATION & SODIUM HYPOCHLORITE IRRIGATION

| | Coronal | | Middle | | Apical | |
|---|---|---|---|---|---|---|
| | SAF | PTN | SAF | PTN | SAF | PTN |
| Score 1 | 7(87.5%) | 6(75.0%) | 6(75.0%) | 5(62.5%) | 5(62.5%) | 5(62.5%) |
| Score 2 | 1(12.5%) | 2(25.0%) | 2(25.0%) | 1(12.5%) | 3(37.5%) | 1(12.5%) |
| Score 3 | 0 | 0 | 0 | 2(25.0%) | 0 | 2(25.0%) |
| Score 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| P | 1.00(ns) | | 0.57(ns) | | 0.31(ns) | |
| Fisher's exact test | | | ns- non significant | | | |

**DISCUSSION:**

This study evaluated amount of smear layer and debris retained within the canal after biomechanical preparation with SAF and PTN file system.

On considering overall scoring of smear layer and debris (Table 2 and 3), SAF along with alternate irrigation of 3% sodium hypochlorite and 17% EDTA showed least amount of smear layer and debris retained compared to all other irrigation groups. Higher scores were seen for both smear layer and debris when only normal saline and sodium hypochlorite were used as irrigants. Results of this study is in accordance to previous studies which stated that alternate irrigation of 3% sodium hypochlorite and 17% EDTA is more effective compared to using only 3% sodium hypochlorite or normal saline[12,13.]

When only normal saline was used as irrigant (Table 4 and 7), there was no significant difference seen between the two file systems for smear layer and debris in any of coronal, middle or apical third but cleaning efficiency decreased from coronal to apical third in both the file groups. Normal saline flushes the debris out of the canal but does not have antimicrobial property, neither does it dissolves organic tissue or remove the smear layer[15].

When alternate 3% sodium hypochlorite and 17% EDTA were used as irrigants (Table 5 and 8), SAF had shown smear-free surfaces at coronal and middle thirds whereas 50% smear layer was retained at apical third. This is in accordance to previous studies where Metzger et al12 had also shown 35% smear layer retained and Adiguzel et al11 had shown 50% smear layer retained at the apical third after SAF instrumentation.

When only sodium hypochlorite was used as irrigant (Table 6 and 9), PTN had shown moderate to heavy scores compared to SAF in the apical third for the smear layer with the difference being significant. This may be attributed to the scrubbing action of SAF in comparison to cutting action of PTN, due to which the amount of smear layer produced by SAF is thinner compared to PTN thereby enhancing the flushing action of NaOCl for the complete removal of the smear layer. The dissolving action of NaOCl is due to release of free chlorine but it gets consumed rapidly during first phase of tissue interaction and needs to be replenished for its complete action & successful debridement[14]. According to Ozer et al, during SAF operation there is continuous irrigation which refreshes NaOCl, thereby providing free chlorine for interaction in root canal to dissolve organic component of debris[2].

SAF file due to its vibration movement creates sonic activation of the irrigants used and the metal mesh of the file produces scrubbing action during in and out movement of the file thus showing better cleaning efficiency[7]. On the other hand, irrigation for PTN group was done with conventional needle and syringe which would be only effective if the needle reaches the end of the prepared canal[11]. Hence further research can be carried out to compare PTN file system with activated irrigation and SAF file with continuous irrigation system.

**Conclusion:**

From this study following conclusion could be drawn

1- The amount of smear layer and debris retained after the biomechanical preparation with the SAF was less compared to PTN rotary files along with different irrigants used.

2- Coronal and middle third sections had retained less debris and smear layer compared to apical third sections in both the file groups.

3- Combination of 3% Sodium hypochlorite and 17% EDTA was found to be more efficient in removal of smear layer and debris compared to irrigation with only normal saline and 3% sodium hypochlorite.

**REFERENCES:**

1. Poggio C, Dagna A, Chiesa M, Beltrami R, Colombo M. Ultrastructural analysis of the root canal walls after preparation with two rotary nickel-titanium endodontic instruments. Contemp Clin Dent 2014; 5:357-60.
2. Ozer S. Y., Adiguzel O, Tacettinoglu E. D., Asci S, Kaya S. Effectiveness of the SAF versus ProTaper systems to remove smear layer in artificially induced internal root resorption cavities. Saudi Endod J 2013; 3:17-23.
3. Foschi F, Nucci C, Montebugnoli L, Marchionni S, Breschi L, Malagnino V.A & Prati C. SEM evaluation of canal wall dentine following use of Mtwo & ProTaper NiTi rotary instruments. Int Endod J 2004; 37:832-839.
4. Jahromi M. Z, Fathi M. H, Zamiran S. Experimental study of smear layer and debris remaining following the use of four root canal preparation systems using scanning electron microscopy. Journal of Islamic Dental Association of IRAN 2013; 25(3):179-185.
5. Adiguzel O. A literature review of SAF. Int Dent Res 2011; 1:18-25.
6. De-Deus G, Souza E M, Barino B, Maia J, Zamolyi R. Q, Reis C and Kfir A. The self-adjusting file optimizes debridement quality in oval shaped root canals. J Endod 2011; 37(5):701-705.
7. Metzger Z. The self-adjusting file (SAF) system: An evidence based update. J Conserv Dent 2014; 17(5):401-419.
8. Burklein S, Mathey D, Schafer E. Shaping ability of ProTaper next & BT Race nickel-titanium instruments in severely curved root canals. Int Endod J 2014:1-8.
9. Ruddle C. J, Machtou P, West JD. The shaping movement, 5th generation technology. Dentistry Today 2013:1-8.
10. Gutmann J. L, Saunders W. P, Nguyen L, Guo I. Y. Ultrasonic root-end preparation Part 1. SEM analysis. International Endodontic Journal 1994; 27:318-324.
11. Adiguzel O, Ozer SY, Kaya S, Uysal J, Ganidagli-Ayaz S and Akkus Z. Effectiveness of ethylenediaminetetraacectic acid (EDTA) and MTAD on debris and smear layer removal using a self-adjusting file. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011; 112:803-808.
12. Metzger Z, Teperovich E, Cohen R, Zary R, Paque F & Hulsmann M. The self-adjusting file (SAF). Part 3: Removal of debris & smear layer- A SEM study. Journal of Endodontics 2010; 36(4):697-702.
13. Shishir Shetty, SureshChandra B. An SEM evaluation of the smear layer produced by newer rotary instruments and effectiveness of different combinations of irrigants. Endodontology 2002: 55-68.
14. Ozer S.Y., Adiguzel O, Kaya S. Removal of debris & smear layer in curved root canals using SAF with different operation times- A SEM study. International Dental Research 2011; 1:1-6.
15. Balaji T. S. Effect of various root canal irrigants on removal of smear layer and debris- An SEM study. Pakistan Oral & Dental Journal 2010; 30(1):205-210.