International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

# Comparative Evaluation of Two Different Rotary Systems in the Removal of Debris in Apical Third of the Root Canal: An in Vitro Study

**Dr. Kanchan Hegde[1], Dr. Ashwini Gaikwad[2]**

[1]Post Graduate student, Department of Conservative Dentistry and Endodontics, Bharati Vidyapeeth Deemed University, Dental College and Hospital, Pune, India

[2]Professor and Guide, Department of Conservative Dentistry and Endodontics, Bharati Vidyapeeth Deemed University, Dental College and Hospital, Pune, India

**Abstract:** ***Aim: The aim of the present study is to evaluate and compare the cleaning efficacy of teeth instrumented with ProTaper Next and Self Adjusting File system. Methodology: 45 permanent mandibular premolar teeth with single canal were selected and divided into 3 groups (n=15).One positive control group, one group was instrument with SAF file system while the other with PTN system.The tooth were histologically processed and serial cross-sections were obtained from apical levels. Morphometric evaluation was performed and the percentage of remaining pulp tissue area (PRPT) was calculated for each root canal. Statistical analysis: The non parametric test and Mann Whitney U test were used. Results: No statistical significant difference was found between the two groups (SAF and PTN file system) in their debridement efficacy in the apical third of root canals. Conclusion: Both file systems were efficient in removing the debris from the apical third of the root canals but none of the rotary systems could remove the debris completely.***

**Keywords:** Self Adjusting file, ProTaper Next file, root canal instrumentation, apical third

## 1. Introduction

Endodontic therapy involves treating vital and necrotic dental pulp so that patients can retain their natural teeth in function and aesthetics.The objective of the root canal preparation is to clean and shape the root canal system and also maintain the original configuration.[1]The apical portion of the root canal has known to be a challenge to endodontic treatment. This is because of the complexity of the root canal anatomy and also the limitation of the instrumentation techniques.

Hand files were most commonly used for endodontic instrumentation for many years. Stainless steel files have their limitations as they have been shown to create aberrations.This could probably be due to the inherent stiffness of stainless steel, which is compounded by instrument design and canal shape.

To overcome these drawbacks, several endodontic instrument systems manufactured from nickel-titanium have been introduced into endodontic clinical practice.

ProTaper Next (DentsplyMaillefer, Ballaigues, Switzerland) is manufactured using M-Wire NiTi alloys, and it demonstrates greater flexibility and resistance to cyclic fatigue. This file is designed so its mass of rotation is offset and it also has an off-centered rectangular cross-sectional design which increases the efficiency of the instrumentation.[2]

The Self-Adjusting File system (SAF; ReDent-Nova,Ra'anana, Israel) has a combined shaping and cleaning system designed for minimally invasive endodontic treatment. The system consists of a self-adjusting file which is operated with a special RDT handpiece-head and an irrigation pump (either the VATEA pump or the all-in-one EndoStation unit). This irrigation pump delivers a continuous flow of irrigant through the hollow file.[3]

The purpose of the present study is to evaluate the debridement efficacy of the Self Adjusting File in the apical third of the root canal to compare those results with the performance of the ProTaper NEXT rotary system.

## 2. Materials and Method

Forty-five mandibular premolars extracted for orthodontic reasons were selected. All soft tissue remnants on root surface were cleaned and debris were removed. All the specimens were stored in normal saline until use.

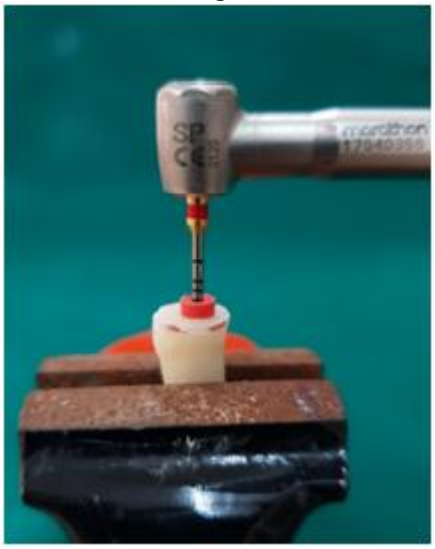
Radiographic examination was used to confirm the presence of single patent root canal. The specimens were decoronated to obtain a standardized root length of 17mm using a diamond disc mounted on a mandrel with micromotor and straight handpiece. Endodontic access cavities were prepared by using air rotor handpiece and sterile diamond burs, and pulp tissue was extripated by using #10K file (DENTSPLY Maillefer, Switzerland). The working length (WL) was established at the apical foramen. The specimens were divided into three groups (n=15).

1) Group A (n=15): control group
2) Group B (n=15): Self adjusting file system
3) Group C (n=15): ProTaper Next file system

Specimens of the other two groups were held in a table mounted vice and root canal were carried out using ProTaper Next system and Self Adjusting File system respectively.

**ProTaper Next File System**

For each specimen a glide path was confirmed using 10K-file. The canal was prepared up to size 20 k file up to the working length.The root canals were prepared using the ProTaper Next system with gentle in and out motion at 300 rpm and 2Ncm torque system with a torque controlled endodontic motor ( Eclass, Marathon). The instrumentation sequences were X1(17/04), X2 (25/06) and X3(30/.075). All instrumentation were prepared till the WL.The specimens were irrigated with 5.25% sodium hypochlorite in between instrumentation with a syringe and an open-end needle. The smear layer was removed using 17% EDTA.

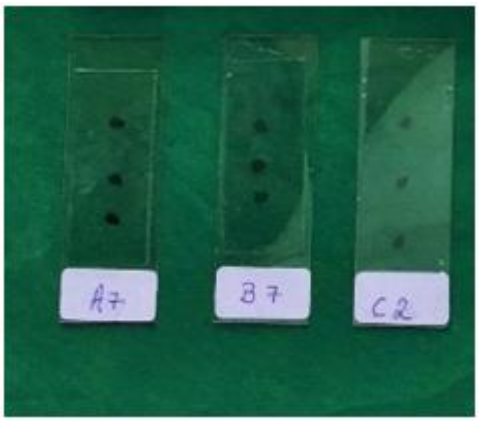


**Self Adjusting File System**

For each specimen a glide path was confirmed using 10K-file. The canal was prepared upto size 20 k file upto the working length.A 1.5-mm diameter SAF (ReDent-Nova) was operated for 4 minutes by using a trans-line (in-and-out) vibrating handpiece (Gentle- Power Lux 20LP, KaVo, Viberach, Germany) adapted with a RDT3 head (ReDent-Nova) at a frequency of 83.3 Hz (50000 rpm) and amplitude of 0.4mm. The instrument was used with a manual in-and-out motion to the WL. Continuous irrigation with 5.25% NaOCl was applied throughout the procedure at 4mL/min by using a special irrigation apparatus (VATEA; ReDent-Nova).The smear layer was removed using 17% EDTA.

**Histological Assessment**

Specimens were immediately immersed in 10% buffered formalin for 48 hours and then demineralized in a 10% (wt. /vol) formal nitric acid solution for a period of 2 to 3 weeks. The end point was monitored radiographically. After rinsing for 24 hours in tap water, the specimens were dehydrated and processed for routine histological examination. Teeth were embedded in paraffin blocks, and serial 0.6-mm-thick cross-sections were obtained from the 1- to 5-mm apical levels. This resulted in a total of 6 slides per tooth. Sections were mounted on glass slabs and stained with haematoxylin-eosin.




**Morphometric Evaluation**

The specimens were visualised using light microscope with Leica DF420 digital microscope camera (Leica Microsystems, Germany). Image analysis and processing were completed using the Leica application suite (Leica microsystems). An outline of the area of the remaining pulp tissue and the cross-sectional area of each root canal was traced. The percentage of remaining pulp tissue area (PRPT) was calculated for each root canal section by dividing the remaining pulp tissue area by the total area of the root canal of the same section.

**Statistical Analysis**

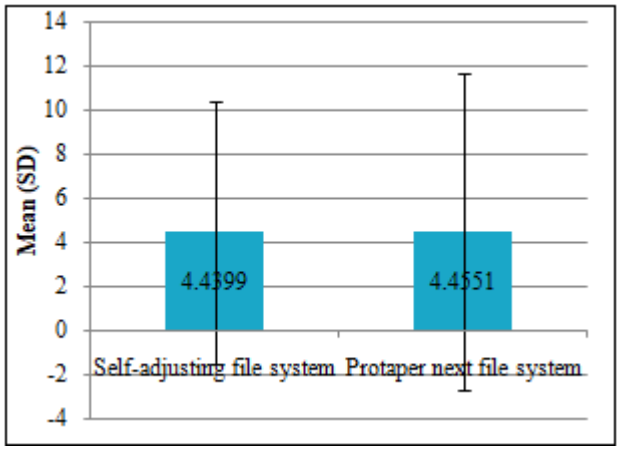
Descriptive and inferential statistical analyses were carried out in the present study. Results on continuous measurements were presented as Mean ± SD. Non parametric test and Mann Whitney U test was used to find the significance of study parameters on continuous scale between two groups. The Statistical software IBM SPSS statistics 20.0 (IBM Corporation, Armonk, NY, USA) was used for the analyses of the data.*P-value was set at P<0.05

## 3. Results

All the microscopic images for the histologic control group displayed a substantial amount of residual pulp tissue (Fig. 1) Both file systems were efficient in removing the debris from the apical third of the root canals. However, no significant difference was found between the two groups i.e. the Self adjusting file system and ProTaper Next file system (p value < 0.98) in their debridement efficacy in the apical third of root canals.(Table 1, Graph 1, Fig. 2 and 3)

**Table 1:** Comparison of remaining debris percentage in terms of {Mean (SD)} among both the groups using Mann Whitney U test

| Group | N | Mean | Std. Deviation | Z value | P value |
|---|---|---|---|---|---|
| Self-Adjusting File System | 15 | 4.4399 | 5.9714 | 0.021 | 0.983 |
| ProTaper Next File System | 15 | 4.4551 | 7.1728 | | |




**Graph 1:** Comparison of remaining debris percentage among both the groups.

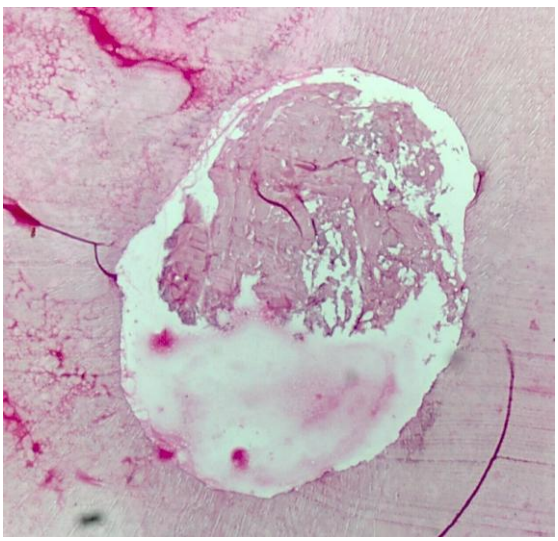


**Figure 1:** A noninstrumented canal from the histological control group. The root canal space is full of pulp tissue

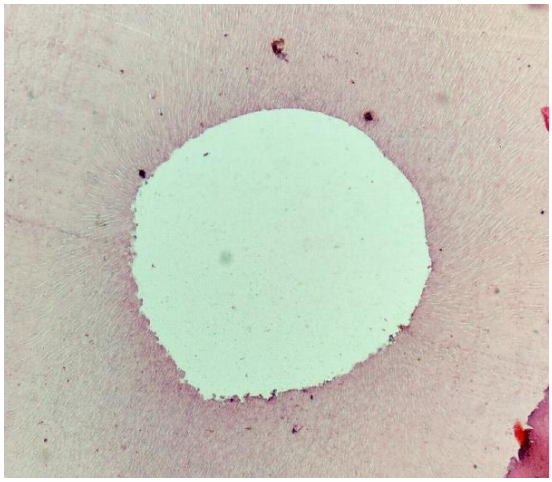


**Figure 2:** A round shaped canal instrumented with the SAF system. The root canal space is free of remaining pulp tissue

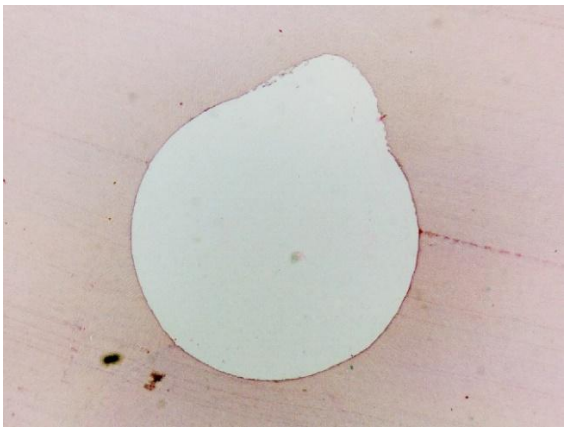


**Figure 3:** A round shaped canal instrumented with the ProTaper Next system. The root canal space is free of remaining pulp tissue

## 4. Discussion

Success of endodontic therapy depends on the elimination of bacteria and their by-products from the root canal system followed by the obturation of the root canal to achieve a hermetic seal.

Most of the Ni-Ti files have the tendency to prepare the main root canal space in circular shape. Due to their rotary action the buccal and lingual extensions are left unprepared. For successful root canal treatment, correct mechanical instrumentation must homogeneously cover the total perimeter of the root canal. The buccal and lingual extensions should also be prepared and inner layers of heavily contaminated dentin should also be removed.

The apical portion is known as the safe heaven for micro-organisms. To effectively clean the apical portion, the instruments should be in contact with every part of the canal wall. As we known it is a big challenge to instrument the apical portion due to its complex anatomy, several modified instrument designs and instrumentation techniques have been proposed..[15]

The Self-Adjusting File system (SAF; ReDent-Nova, Ra'anana, Israel) is a hollow and flexible file which causes vibration and it is known to remove a uniform dentin layer

from the canal walls. It adapts itself three-dimensionally to the shape of the root canal and its cross-section. It attains a round cross-section in a round root canal whereas in an oval or flat it adapts accordingly. It maintains the canal configuration with a slightly larger dimensions and does not machine the central portion of the root canal into a round cross-section.[5]The hollow design of the file has a special irrigation device (VATEA) through which the chosen irrigation fluid enters the file through a free-rotating hub. A fresh, fully active supply of irrigant is continuously replaced throughout the procedure at a flow rate of 5 mL/min. [6]

The ProTaper Next (PTN) is made of M-wire technology and has reduced number of files, including progressive percentage tapers on a single file. It has an offset design with gives major advantages.[7]Firstly, as the file moves through the canal, it gives a snake-like "swaggering" motion and this results in reduced engagement of the file to the canal walls. Only two points of the rectangular cross section touch the canal wall at a time, thus reducing the taper lock and the screw effect on the given file. Secondly, the cross-sectional space is increased and there is a decreased probability for laterally compaction of debris and blockage of the root canal system anatomy.[7,8]

All endodontic instruments create debris and smear layer as a consequence of their action on the root canal walls. These debris may get compacted and prevent complete obturation of the root canal. The combination of instrumentation and irrigation also has a major effect on the debridement of this apical portion of root canal. Irrigation of the cul de sac portion of the root canal presents a distinct challenge.

Even though the SAF group showed better performance than the ProTaper Next group; however there was no significant difference between them regarding the percentage of remaining pulp tissue area (PRPT) in the apical third region (Table 1, Graph 1) ($p < 0.98$).

As mandibular premolars were used, and due to the rounder cross sections in the apical region, SAF and ProTaper Next were effective in removing the debris.

The cleaning efficacy of ProTaper NEXT can also be attributed due to its offset design. It offers improved cutting, loading, and augering debris out of a canal. The PTN system ensures in maintaining the canal patency as there is a reduced probability of lateral compaction of debris and the blockage of the root canal system.[8] Increased file taper has been shown to facilitate root canal debridement. In the present study, size 30/0.75 rotary was compared with the SAF. It is feasible that the larger taper of the rotary files may have contributed to greater debridement.[9] It can be assumed that due to the larger taper, the irrigants could flow better in the apical third and this may have led to removal of the debris.[10,11]

For the SAF system, its special irrigation device provides continuous flow of irrigant at different flow rates and at a low pressure. Due to the vibrating motion of the file, turbulence are created which causes additional activation of the irrigating solution. The combination of the file ability to adapt to the root canal's cross section and the continuous flow of the irrigant through the file may have combined effect on the cleaning ability of the file. This favour's a higher reduction of debris and bacteria than rotary instruments.[5,6]

The SAF and the ProTaper Next group have shown uninstrumented areas. (Fig. 2 & 3). It was observed that some areas were uninstrumented, indicating that complete canal instrumentation was not achieved. [12,13]Despite the SAF's unique ability to expand and adapt to root canal walls, the present study is in agreement with others (9, 12 and 14) that show an inability of this system to debride the crucial apical segment more effectively than the other instrumentation techniques.

However, as this is an in vitro study, the performance of the rotary systems could be affected and could be quite different from clinical biomechanical preparations with variations in tooth morphology. Further studies should be conducted to evaluate its effectiveness in clinical conditions.

## 5. Conclusion

Within the limitations of this study it was found that both file systems were efficient in removing the debris from the apical third but none of the rotary systems could remove the debris completely from the apical third of the root canals.

## References

[1] Schilder H. Cleaning and shaping the root canal. Dent Clin North Am. 1974 Apr;18(2):269-96.
[2] Maia Filho EM, Dos Reis Santos RM, Lima DM, da Silva Pereira SM, Soares JA, de Jesus Tavarez RR, et al. Shaping ability of ProTaper Next, WaveOne, and Reciproc in simulated root Canals. J Contemp Dent Pract. 2016;17(11):902–6.
[3] Metzger Z. The self-adjusting file (SAF) system: An evidence-based update. J Conserv Dent 2014;17:401-19
[4] De-Deus G, Souza EM, Barino B, et al. The self-adjusting file optimizes debridement quality in oval-shaped root canals. J Endod 2011;37:701–5
[5] Metzger Z, Teperovich E, Zary R, et al. The Self Adjusting File (SAF). Part 1: Respecting the root canal anatomy; a new concept of endodontic files and its implementation. J Endod 2010;36:679–90.
[6] Metzger Z, Teperovich E, Cohen R, Zary R, Paqué F, Hülsmann M (2010) The self-adjusting file (SAF). Part 3: removal of debris and smear layer – a scanning electron microscope study. J Endod 36:697–702
[7] Drs. Clifford J. Ruddle, Pierre Machtou and John D. West; The Shaping Movement 5th Generation Technology; Dentistry Today April 2013.
[8] SG Suparna, S Poorvi, D Sandeep, K Shubham; Comparison of Root Canal Cleaning Ability of ProTaper NEXT and WaveOne Rotary filesystems - A Scanning Electron Microscopic (SEM) study; Endodontology, December 2015;27(2):12
[9] Ruckman JE, Whitten B, Sedgley CM, et al. Comparison of the self-adjusting file with rotary and hand instrumentation in long-oval-shaped root canals. J Endod 2013;39: 92–5.

[10] Khademi A, Yazdizadeh M, Feizianfard M. Determination of the minimuminstrumentation size for penetration of irrigants to the apical third of root canal systems. J Endod.2006; 32:417-20.
[11] Huang TY, Gulabivala K, Ng YL: A bio-molecular film ex-vivo model to evaluate the influence of canal dimensions and irrigation variables on the efficacy of irrigation. IntEndod J 2008, 41(1):60–71.
[12] Peters OA, Paque F. Root canal preparation of maxillary molars with the selfadjusting file: a micro-computed tomography study. J Endod 2011;37:517–21.
[13] Paranjpe A, de Gregorio C, Gonzalez A, et al. Efficacy of the self-adjusting file system on cleaning and shaping oval canals: a microbiological and microscopic evaluation. J Endod 2012;38:226–31.
[14] Siqueira JF Jr, Alves FRF, Almeida BM, de Oliveira JCM, Rocas IN. Ability of chemomechanical preparation using either rotary instruments or a self-adjusting file to disinfect oval-shaped root canals. J Endod 2010;36:1850–5.
[15] Ribeiro MVM, Silva-Sousa YT, Versiani MA, et al. Comparison of the cleaning efficacy of self-adjusting file and rotary systems in the apical third of oval-shaped canals. J Endod 2013;39:398–401.