Original Article

Comparative Evaluation of Twisted and ProTaper Files in Pediatric Endodontics – *In-vitro* Study

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Abstract

Aim: The aim of the present *in-vitro* study was to evaluate the cutting efficiency of two nickel-titanium (NiTi) file systems, Twisted File (TF) and ProTaper file. **Materials and Methods:** Thirty extracted human primary tooth root canals were randomly divided into two groups with 15 root canals each. All the root canals after injected with Indian ink were instrumented with ProTaper Rotary NiTi files and Rotary NiTi TFs. All the root canals were then cleared to make them transparent. After the teeth appeared clear, they were observed under a stereomicroscope to check for residual Indian ink in the canals and scored. The data thus obtained were statistically analyzed with Chi-square test and Mann–Whitney test. **Results:** The mean of scoring of Group I, i.e., Rotary TF system, was 1.0. The mean of scoring of Group II, i.e., ProTaper Rotary file system, was 1.40. **Conclusions:** Root canal instrumentation of primary teeth showed nonsignificant differences in the cutting ability between the two systems of ProTaper and TF Rotary which were investigated, but signified a more even and uniform removal of dentin with the TF system.

Keywords: Cutting efficiency, ProTaper rotary, stereomicroscope, twisted rotary

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Introduction

The aim of the present *in-vitro* study was to evaluate the cutting efficiency of two nickel-titanium (NiTi) file systems, Twisted File (TF) and ProTaper files. ProTaper is a well-known instrument designed based on the traditional NiTi grinding process, which has a convex triangular cross-section which is claimed to reduce the contact area between the file and dentin.

The TF has three new design methods of manufacturing, namely R-phase heat treatment, twisting of the metal, and special surface conditioning (deoxidation). These processes significantly increase the instrument's cutting efficiency and resistance to fracture, provide greater flexibility, and maintain the sharpness of the flutes.[1]

Aims and objectives

The aim of this *in-vitro* study was to compare the cutting efficiency of two rotary NiTi file systems, TF and ProTaper, using a stereomicroscope.

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Materials and Methods

The present *in-vitro* study was conducted in the Department of Pediatric and Preventive Dentistry, Guru Nanak Dev Dental College and Research Institute, Sunam. The sample consisted of thirty human primary tooth root canals which were collected from the Department of Pediatric and Preventive Dentistry, Sunam.

Inclusion criteria

Teeth were included in the study based on the following criteria:

- Infected primary teeth with considerable bone loss
- Infected primary teeth with unrestorable crown
- Overretained primary teeth with altered root resorption pattern
- Primary molars with one root resorbed considerably

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more than the other, due to altered path of eruption of its successor.

Exclusion criteria

- Teeth already pulp treated
- Presence of internal resorption and external resorption causing perforation.

Collection of teeth and their storage

Freshly extracted teeth were washed under running water and were immersed in 1% sodium hypochlorite for 15 min for disinfection. All the soft tissues were scrapped off with a hand scaler to remove the tissue remnants attached to it, and the teeth were then stored in isotonic saline solution until use.

Method of root canal preparation

Coronal access cavity was prepared with a large round diamond point. All the overlying dentin were removed with a straight fissure bur to achieve a straight-line access into the root canals. The pulp chamber and root canals were irrigated profusely with saline to remove the debris. #10 sized 21-mm K-file (Mani, Japan) was introduced into each root canal through the apex to determine the patency of the root canal. Final working length was determined by subtracting 1 mm from that length. The root canals were further prepared with no. 15 and 20 sized 21-mm K files. 1% sodium hypochlorite was used after each change of instrument. Indian ink dye was then injected in each root canal by using a 27G needle after drying the canals with absorbent paper points and left to dry for 30 min. The teeth were then mounted in dental plaster till the cementoenamel junction. The root canals were then randomly divided into two groups each containing 15 root canals.

The experimental groups were:

- Group I –Rotary NiTi TFs (SybronEndo, Orange, CA, USA)
- Group II – ProTaper Rotary NiTi files (Dentsply Maillefer, Switzerland).

Group I (Twisted rotary nickel-titanium files)

Rotary TFs were used in a crown-down manner according to the manufacturer's instructions using gentle in-and-out motion. The instrumentation sequence was as follows:

1. 0.08 taper size 25 instrument used to one-third of the working length
2. 0.06 taper size 25 instrument at working length
3. 0.06 taper size 30 instrument at working length.

Group II (ProTaper Rotary nickel-titanium files)

Rotary ProTaper files were used in a crown-down manner according to the manufacturer's instructions using brushing motion. The instrumentation sequence was as follows:

1. S_x used to one-half of the working length
2. S_1 till resistance felt
3. S_2 till resistance felt
4. F_1 till working length
5. F_2 till working length.

Tooth preparation for stereomicroscope observation

The teeth were decalcified by keeping in 5% nitric acid solution for 72 h. The teeth were observed timely and the acid was renewed every 24 h to maintain its efficiency in decalcifying the teeth. Once teeth were completely decalcified, they were washed under running water for 8 h, till the acid completely got washed away from the tooth surface. Then, the teeth were dehydrated by keeping in freshly prepared 70% alcohol for 16 h, and the solution was changed after 8 h. Then, they were kept in 90% alcohol for 3 h, and the solution was changed after every 1 h. After that, the teeth were kept in absolute alcohol for 3 h, and the solution was changed after every 1 h. After decalcification and dehydration, the teeth appeared more opaque or whitish in color. Then, they were kept in methyl salicylate, till they started appearing transparent and clear. It took nearly 2–3 h for the teeth to get completely cleared.

After the teeth appeared clear, they were observed under a stereomicroscope (Lieca) at × 8 magnification. Each root canal was inspected carefully by three blinded examiners for the removal of Indian ink and scored according to the criteria given by Azar and Mokhtare.[2] The mode of scores of the three examiners was analyzed, and higher score was considered during incongruity.

Scores given to each root canal are as follows:

- Score 0: Total cleaning (no ink remaining in any part of the root canal)
- Score 1: Almost complete ink removal (traces of ink found in some areas)
- Score 2: Partial ink removal (ink found on some walls in some areas)
- Score 3: No ink removal (appreciable amount of ink present) [Figure 1].

Results

The residual Indian ink scores of both the groups are shown in Graph 1.

The mean scores for residual Indian ink were less (1.00) for TF rotary than ProTaper rotary instruments (1.40). Therefore, in the present study, scores for residual ink remaining were higher for ProTaper rotary instrumentation, but the difference was not statistically significant (P = 0.477). There was no

Table 1: Chi-square tests

	Value	df	Asymptotic significance (two sided) *P*
Pearson's Chi-square	2.492	3	0.477
Likelihood ratio	2.626	3	0.453
Linear-by-linear association	1.130	1	0.288
Number of valid cases	30		

P<0.05 significant

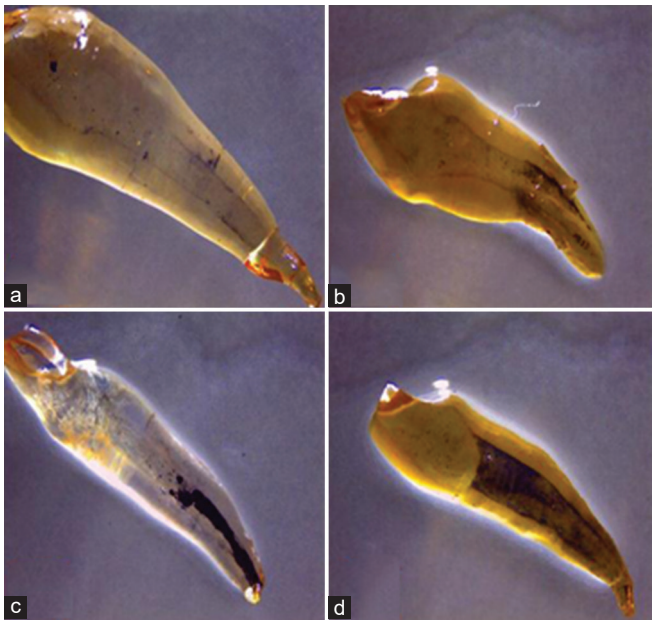


Figure 1: Stereomicroscopic images of sample: (a) Score 0, (b) Score 1, (c) Score 2, (d) Score 3

statistically significant difference between the two groups with respect to cutting efficiency.

Statistical analysis

Statistical analysis was done by Chi-square test and Mann–Whitney U-test.

Table 1 depicts the significance value (*P*) on comparing residual ink scores of both groups (TF and ProTaper) by applying Chi-square test.

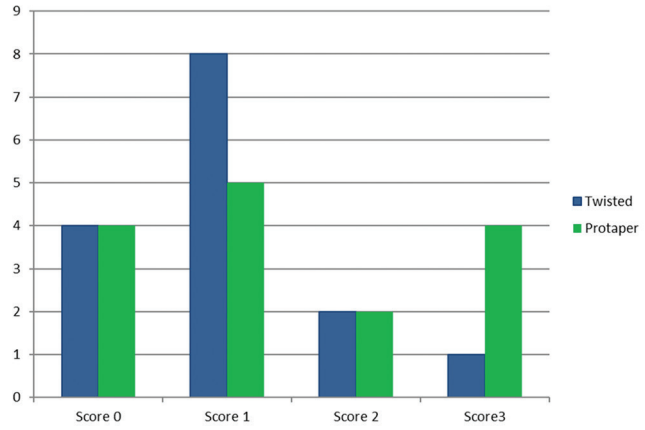
Discussion

Pulpectomy procedure is the preferred treatment of infected pulpal tissue.[3] Successful root canal treatment of deciduous teeth contributes to the healthy development of permanent dentition and of the stomatognathic system as a whole.[4]

When the pulp vitality of a tooth is affected by caries, traumatic injury, or other conditions, pulp therapy may be necessary. Successful pulpectomy procedure depends on effective cleaning, shaping, and three-dimensional obturation of the root canal system.

Biomechanical preparation is one of the main steps of endodontic therapy. It includes bacterial elimination, removal of debris, and shaping with an instrument without causing any straightening and deviation of the canal walls and facilitates three-dimensional obturation of the root canal.[5]

Stainless steel instruments have proved to be very valuable and have provided an improved quality of instruments. They provide satisfactory results in straight canals but create aberrations such as zips, elbows, perforations, and ledges and increase the incidence of transportation and straightening when used in curved canals.[6] Nitinol, a NiTi alloy with a very



Graph 1: Bar graph representing the comparison of residual Indian ink in samples of Twisted and ProTaper Rotary file system

low modulus of elasticity (55% nickel and 45% titanium) by weight owing to its substantially increased flexibility compared with stainless steel instruments, is being used nowadays.[7]

Advanced blade designs have improved the cleaning efficacy during root canal preparation. Several studies show that NiTi rotary instruments enhance the shaping quality, decrease working time, and form a canal shape with adequate conicity.[8]

The most noteworthy advancements were the development of NiTi rotary instruments, new blade design, greater instrument taper, and introduction of full rotary motion for cleaning and shaping of root canals.

The introduction of NiTi rotary instrumentation to pediatric dentistry by Barr *et al.* in 2000[2] has made endodontics easier and faster than manual instrumentation, resulting in consistent and predictable root canal shaping.[9]

Various systems of rotary instruments are available, i.e., ProTaper, Hyflex file systems, Mtwo, RaCe, WaveOne, etc.

The rotary instrumentation is faster in deciduous teeth, probably due to the smaller root canal length.[10] ProTaper a well-known instrument produced with the traditional NiTi grinding process, has a convex triangular cross-section which is claimed to reduce the contact area between the file and dentin. ProTaper system consists of one file as an orifice opener (SX), two shaping files (S1 and S2), and three finishing files (F1–F3).

TFs have been evolved to introduce the third generation of Rotary NiTi instruments into the endodontic market: the TF with R-phase technology with three new design methods of manufacturing, namely R-phase heat treatment, twisting of the metal, and special surface conditioning (deoxidation). These processes significantly increase the instrument's cutting efficiency and resistance to fracture, provide greater flexibility, and maintain the sharpness of the flutes.

TF cutting flutes are created by twisting the file, thus eliminating microfractures for greater strength.

The stereomicroscope technique produces images of high resolution and magnification. It has proven to be a valuable method for the assessment of cutting efficiency of endodontic instruments, thus enabling comparison of instruments and techniques.

The mean of scores of remaining ink was higher for ProTaper group in comparison to the TF group. From the stereomicroscopic images of prepared teeth, it was found that the ink removal was more in the coronal third in comparison to the middle and apical thirds in the ProTaper group. This could probably be related to the sharp cutting edges of the convex triangular cross-sectional design of ProTaper instruments and a flute design that combine multiple tapers within the shaft up to 19%, whereas TF instruments used in this study had a constant taper of a maximum of 8%. This has been confirmed by other investigations.[11] In both groups, apical third showed more presence of ink in comparison to the middle and coronal thirds. This could be attributed to the noncutting modified safety tip of the ProTaper and TF instruments and the decreasing taper of ProTaper finishing files. This finding is consistent with the results of the study conducted by Fayyad and Elhakim Elgendy[1] on permanent teeth.

There is absence of a statistically significant difference between both groups with regard to cutting efficiency. However, the TF system cuts dentin efficiently with more even and uniform cutting all over the length of the root canal. The reason might be attributed to the three proprietary processes to deliver unsurpassed strength and flexibility and cleaning efficiency.

Conclusions

From the present study, it can be concluded that ProTaper File system had shown cutting ability with selective areas of cutting. The TF system removed dentin more evenly all over the length of the root canal, which clarifies the nonstatistically significant difference in cutting efficiency for the two NiTi rotary systems evaluated.

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Conflicts of interest

There are no conflicts of interest.

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