



Research Article

# Evaluation of the Separation Length of ProTaper Universal Rotary Files

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## Abstract

**Research Motivation:** This study aims to analyze the correlation between the size of ProTaper® Universal rotary files and the length at which separation occurs. **Design/Methodology:** 120 separated ProTaper® Universal rotary files that broke during root canal treatment were collected from different clinics. The files were divided into the following six groups: Sx, S1, S2, F1, F2, and F3. The length of the separated file was measured, and the length at which separation occurred was determined by subtracting this length from the nonseparated file length. Statistical analysis was performed by ANOVA and Tukey's post-hoc test using SPSS software. **Main Findings:** The statistical analysis revealed significant differences between different sizes of ProTaper® Universal rotary files on account of the length at which separation occurred ( $p < 0.05$ ). **Implications:** Within the limitations of the materials and methods of this study, a correlation was found to exist between different sizes of ProTaper® Universal rotary files on account of the length at which separation occurred. The Sx files were the longest separated files. This means that if they break and cannot be removed, they could cause more complications than would the other ProTaper® Universal files because of unfinished chemomechanical preparation at the unreached rest of the root canal system.

**Keywords:** Endodontics; fracture; instrument separation; ProTaper universal; root canal.

## Introduction

In recent times, nickel-titanium (NiTi) alloys, which were first reported in the 1960s by W.E. Buehler, have been popularly used in root canal treatment (Buehler *et al.* 1968). They are increasingly being used by general dentists and endodontists for cleaning and shaping procedures (Parashos *et al.* 2004, Madarati *et al.* 2008a, Madarati *et al.* 2008b, Er *et al.* 2011). NiTi rotary files show high elasticity and resistance to plastic deformation. These files are faster than hand

files (Short *et al.* 1997), and in terms of centering ratio and amount of transportation, NiTi rotary files show good results (Ersev *et al.* 2010).

Despite their advantages, NiTi instruments also have a high risk of unexpected fracture (Pruett *et al.* 1997, Ankrum *et al.* 2004, Gencoglu *et al.* 2009). Instrument fracture often results from incorrect use or overuse (Gambarini 2001). NiTi instruments tend to separate seven times more frequently than do hand instruments, and they are more

likely to separate in the apical third of narrow canals such as those of maxillary and mandibular molars (Spili *et al.* 2005, Iqbal *et al.* 2006).

Among NiTi rotary files, ProTaper® Universal rotary files (Dentsply Maillefer, Ballaigues, Switzerland) were designed with increasing tapers. The ProTaper® Universal system consists of three shaping files and three finishing files (Wu *et al.* 2011). However, the design of these ProTaper® files reduces the torsional loads, instrument fatigue, and separation possibility. The separation of these files has been investigated *in vitro*, but few studies have reported what actually happens in clinics (Blum *et al.* 2003, Simon *et al.* 2008).

### Materials and Methods

The protocol of this study was approved by the Research Ethics Committee of Izmir Katip

Celebi University. First, numerous clinics in Izmir, Turkey, were identified, and containers were placed at these clinics for collecting broken files. The clinicians were instructed to discard files used with an electric motor (X-Smart; Dentsply Maillefer) in very complex and severely curved or calcified canals but in accordance with manufacturer's recommendations. 120 files that separated during routine clinical endodontic procedures were classified into the following six groups according to their type: Sx, S1, S2, F1, F2, and F3 (Figs. 1). The classified instruments were cleaned ultrasonically and autoclaved. The length of the separated file was measured using an electronic digital caliper, and then, the separation length of each file was determined by subtracting the length at which separation occurred from the nonseparated file length. The obtained data was analyzed statistically by analysis of variance (ANOVA) and Tukey's post-hoc test using SPSS software.



**Figure 1: Separated files collected from different clinics.**

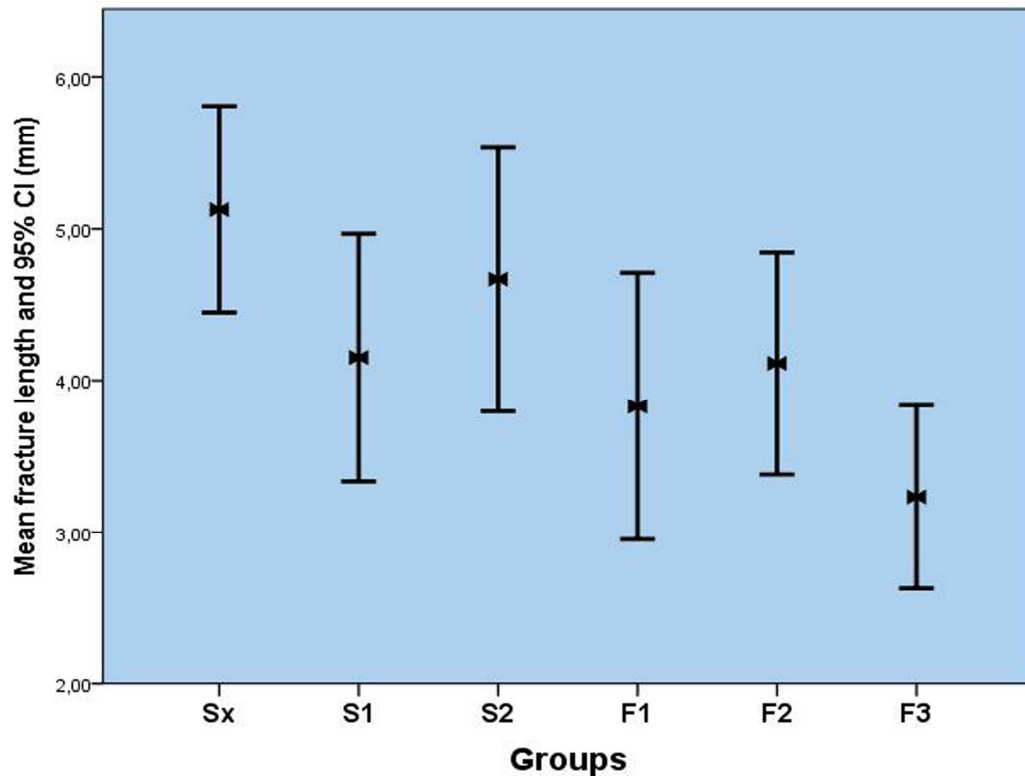
### Results

Table 1 shows the means and standard deviations of the separation lengths of the instruments. The statistical analysis result showed significant differences between different sizes of ProTaper® Universal rotary

files on account of the separation length ( $p < 0.05$ ). The mean separation lengths for Sx, S1, S2, F1, F2, and F3 files were 5.13, 4.15, 4.67, 3.83, 4.11, and 3.23 mm, respectively (Fig. 2). Statistical difference was determined between Sx and F3 ( $p = 0.005$ ).

**Table 1: The means and standard deviations of the separation lengths of the instruments**

Groups	N	Separated Fragment Length	Standard Deviation	File Length	D0	D3
Sx	20	5.13	1.45	19	0.19	0.30
S1	20	4.15	1.74	25	0.17	0.23
S2	20	4.67	1.85	25	0.20	0.32
F1	20	3.83	1.87	25	0.20	0.41
F2	20	4.11	1.56	25	0.25	0.49
F3	20	3.23	1.29	25	0.30	0.57

**Figure 2: Mean fracture lengths of each group.****Discussion**

Most previous studies evaluated such files using controlled and standardized approaches. However, no studies have investigated the outcomes in non-controllable clinics. Wu et al. (2011) evaluated whether relevant factors influence the fracture of ProTaper® Universal rotary files. Their results showed that multiple

factors contributed to the separation of ProTaper® Universal rotary files. However, in the present study, the relevant factors were not analyzed using a standardized in vitro approach; instead, this study focused on the outcome of clinically used ProTaper® Universal rotary files.

If a fractured NiTi fragment is not removed successfully, as in the case of high standards

root canal treatment, it would hinder the control of microbial growth in the root canal beyond the obstruction (Spili *et al.* 2005). On the other hand, in the apical third, fragments are left behind because of the risk of perforation during removal attempts (Fors *et al.* 1986). Therefore, instrument separation should be considered from different viewpoints.

First, the evaluation of separated Sx files showed that the Sx rotary file separated at a higher point compared to the other files. This result is interesting because Sx rotary files are used more coronally than are others. The S2 file showed the second-highest separation length. This was attributed to the tapering design of the file. Both Sx and S2 files exhibit nine increasingly larger tapers that respectively range from 0.035 to 0.19 and from 0.04 to 0.115. However, S1 files exhibit 12 increasingly larger tapers that range from 0.02 to 0.11, and F1, F2, and F3 files have fixed tapers of 0.07, 0.08, and 0.09 from D1 to D3. After D3, the taper of these files decreases and the remainder of the file experiences relatively less force. D3 corresponds to 4-mm length from the tip of the file, and our results showed that fractures generally occurred at this length owing to the high taper and high force.

Second, S1, S2, F1, F2, and F3 files, all of which reach the apical part, were separated with lesser fragments. This was attributed to the larger diameter of the coronal third, which prevents these instruments from tightening in this third small diameter and in complex canal divisions in the apical thirds where tightening could occur (Iqbal *et al.* 2006).

In the present study Sx rotary file separated at a higher point compared to the other files. This result could be important because Sx rotary files are used more coronally than others. When the separation length increases, the unfilled area will be increased between the flute of the file and the root canal wall. Thus, this could result in failure of the root canal treatment.

Because of the limitations of the materials and the methods of this study, it could not be estimated where or when a file will be separated in a clinical setting. Having said that, a correlation was found to exist

between different sizes of ProTaper® Universal rotary files with regard to of the length at which separation occurred. The Sx files were the longest separated files. This means that if they break and cannot be removed, they could cause more complications than would the other ProTaper® Universal files, because of unfinished chemomechanical preparation at the unreached part of the root canal system.

#### **Acknowledgement:**

The authors deny any conflict of interest related to this study.

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