

# Compare of the Frequency of Instrument Fracture of Endodontic File Using Rotary Pro Tapers and HY Flex Series

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## ABSTRACT

**Objective:** To compare the frequency of instrument fracture of endodontic file using Rotary Pro Tapers and EDM Hy Flex series.

**Study Design & Setting:** This experimental in vitro study was conducted at Institute of Dentistry Liaquat University of Medical and Health Sciences Jamshoro.

**Subjects and Methods:** Data was prospectively collected from extracted human teeth. A total of 66 canals were included. Simple descriptive statistics were used to present demographic data, along with frequency and percentages to present qualitative variables. It was decided to perform a post-stratification chi square test taking a p-value of less than 0.05 as significant.

**Results:** A total of 66 canals (33 each endodontic file using Rotary Pro Tapers and EDM Hy Flex series) were included. Mean endodontic file in group A and B was  $1.28 \pm 0.14$  mm and  $0.58 \pm 0.08$  mm. Comparison of instrument separation in endodontic file using Rotary Pro Tapers and Hy Flex series showed separation of 09 (27.3%) and 02 (6.1%) respectively.

**Conclusion:**

Based on the results of this study, Protaper files generated much more stress than EDM Hy Flex files, but comparisons of instrument separation between the two instruments showed that the latter performed better overall.

**Keywords:** Root canal treatment, Endodontic file, Rotary Pro Tapers and Rotary EDM Hy Flex.

## INTRODUCTION

Root canal treatment involves the treatment of vital or necrotic teeth in order to relieve the pain and retain natural teeth with function and esthetics.<sup>1</sup> Root canal treatment can be unsuccessful due to variety of iatrogenic errors ranging from poor access cavity design, untreated infected canals, mishandling of endodontic instruments that could lead to ledges, perforations, instrument breakage/fracture and over and under obturation of root canals, these must be carefully evaluated and examined.<sup>2</sup> This includes appropriate dental and medical history, detailed clinical examination and radiograph for detecting the reason for failure and formulate treatment plan whether to go for nonsurgical endodontic treatment, surgical endodontic procedure or extraction.<sup>3</sup>

By easing the operator's job in preparation of root canals without changing their centricity, curve or length, nickel titanium NiTi rotary instruments have revolutionized root canal treatment.<sup>4</sup> The increased used to nickel titanium rotary endodontic instruments allowed the manufacturers to produce various designs and systems of endodontic file system.<sup>5</sup> The main disadvantage of these instruments is accidental fracture/instrument separation which may block narrow, curved canals and does not allow proper cleaning and shaping of canal.<sup>6,7</sup>

According to previous studies on the mechanism of instrument fractures/separations, the most important factor is the operator's clinical skills and conscious decision to use the instrument for a specified time period.<sup>8-11</sup> Fractures are also significantly reduced when the angle of curvature of the canal is decreased.<sup>12</sup> There are, however, very few studies on rotary NiTi instrument fractures and the different techniques used to treat them.<sup>13-14</sup> One of the study conducted on Rotary ProTaper concluded that incidence of instrument fracture is 22% using rotary protapera and also more crack formation at dentinal surface.<sup>9,15</sup> Whereas another study on the Hyflex endodontic files system concluded that there is no evidence of instrument separation when Hyflex file was used in three canals.<sup>16</sup> Other study on Hyflex endodontic system concluded that Hyflex system files are more bendable and flexible compared to other endodontic file system.<sup>17</sup> And are more fatigue resistant.<sup>18</sup> The Hyflex endodontic system offers minimum amount of significant errors in canal preparation.<sup>19</sup>

To the best of knowledge, there is limited available data on frequency of instrument separation of Rotary NiTi Hy Flex which claims to be less liable to fracture. This study will compare the frequency of instrument separation of rotary Pro Taper and Hy Flex series and its clinical implications and will eventually help to plan the management strategies to minimize the risk of instrument fracture leading to poor prognosis of tooth.

## MATERIAL AND METHODS

This experimental in vitro study with non-probability consecutive sampling was carried out from January to October 2019. The sample size was calculated by using the WHO software with Power of test=90%. The calculated sample size was 33 in each group and total 66.

➤ **Inclusion Criteria:**

- Extracted human maxillary and mandibular molars molar with completed root formation.

➤ **Exclusion Criteria:**

- Non-consenting.
- Previously Endodontic treated tooth.
- Teeth external and internal root resorption or open apices.
- Teeth with sclerosed or calcified canals.

**Data Collection Procedure:** We obtained approval for this study from the College of Physicians and Surgeons Pakistan. A collection of extracted maxillary and mandibular molars from Liaquat University of Medical and Health Sciences' Department of Oral and Maxillofacial Surgery in Jamshoro was used in this study. A cylindrical diamond bur was used to prepare straight line access for each canal after the teeth were mounted in wax blocks. A stainless steel K File (Mani, Utsunomiya Tochigi, Japan) size 6-20 was used to negotiate the canal orifices with the DG 16. A reference point was taken at the cusp tip of the adjacent cusp tip to determine how far from the apical foramen to establish the working length. Following the digital periapical radiograph, the canal curvature was measured using the Schneider method using 15 ISO file. In this stage, each canal was assigned to one of two random groups.

- 1 Group -A ( Rotary Protaper )
- 2 Group-B ( Rotary Hy Flex series )

**Group A (Rotary Protapers):** After creating glide pathway with ISO stainless steel files number 20, Protaper shaping files S1 & S2 and finishing files F1 & F2 were used to prepare canals in Group A.

**Group B (Rotary EDM Hy Flex):** Following the creation of the glide pathway with ISO stainless steel files number 20, Hy flex series files were used to clean and shape the canals and extend them to full length.

A 2% sodium hypochlorite solution was injected into each canal using disposable syringes. The instruments were operated using a 16:1 gear reduction handpiece with a torque- and speed-controlled electric motor (X-SMART; Dentsply Mallifer, Tulsa, OK, USA). For torque and speed, the manufacturer's recommendations were followed. The file was wiped with alcohol-soaked gauze after each use. A file was used every time it was inserted into a canal and removed from it. An endo measuring scale was used to measure the length of instruments before and after each canal preparation. More than 1 mm change in length was considered as instrument separation (failure).

**Data Analysis Procedure:** An analysis of the data was conducted using SPSS Version 20. Quantitative variables such as endodontic file length will be calculated as mean and standard deviation. Frequencies and percentages was calculated for the qualitative variables like maxillary, mandibular molars molar, number of canals and instrument separation (Yes/No). Through stratification of canal count, effect modifiers were controlled for the outcome variables. It was determined that a chi-square test was statistically significant after stratification when a p-value of less than 0.05 was taken into account.

**RESULT**

Out of 33 extracted human teeth in group A, mean endodontic file of group A in our study was 1.28±0.14 mm, and in Group B was 0.58±0.08 mm. As shown in Table 1.

Frequency distribution of teeth showed that out of 33 extracted human teeth in group A, 13 (39.4%) and 20 (60.69%) had extracted maxillary and mandibular teeth respectively, and in group B, 16 (48.5%) and 17 (51.5%) have extracted maxillary and mandibular teeth respectively. As presented in Figure 1.

Table-1: Descriptive Statistics Of Endodontic File Length In Group A And B n=66

Variable	Mean	Standard Deviation	Min-max
Endodontic file length (mm) group a	1.28	±0.14	0.5-2
Endodontic file length (mm)group b	0.58	±0.08	0.5-1.5

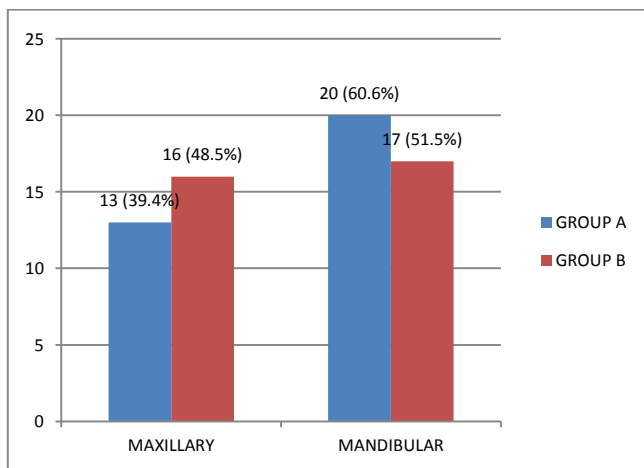


Figure -1: Teeth Distribution In Group A And B n=66

Frequency distribution of number of canal showed that in group A, 16 (48.5%) and 17 (51.5%) had number of canal < 5 and > 5 respectively. Similarly, out of 33 extracted human teeth in group B, 09 (27.3%) and 24 (72.7%) had number of canal < 5 and > 5 respectively. As presented in Figure 2.

Frequency distribution of instrument separation showed that in group A, 09 (27.3%) and 24 (72.7%) patients had and did not have instrument separation respectively. Similarly, in group B, 02 (6.1%) and 31 (93.9%) patients had and did not have instrument separation respectively. P-value was 0.00. As presented in Table 2.

Stratification with respect to instrument separation and number of canals have been documented in table 3 and 4.

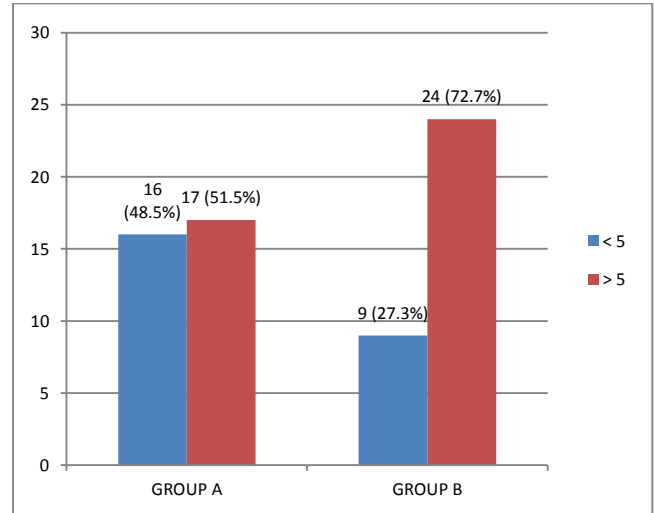


Figure -2: Number Of Canal Distribution In Group A And B n=66

Table -2: Instrument Separation In Group A And B n=66

Instrument separation	Group a	Group b	P-value
Yes	09 (27.3%)	02 (6.1%)	0.00
No	24 (72.7%)	31 (93.9%)	

Table-3: Instrument Separation In Group A And B According To Maxillary & Mandibular Teeth

Teeth	Instrument separation group a		Instrument separation group b		P value
	Yes	No	Yes	No	
Maxillary	06 (46.2%)	07 (53.8%)	01 (6.2%)	15 (93.8%)	0.79
Mandibular	03 (15%)	17 (85%)	01 (5.9%)	16 (94.1%)	0.01

Table-4: Instrument Separation In Group A And B According To Number Of Canal

Number of canal	Instrument separation group a		Instrument separation group b		P value
	Yes	No	Yes	No	
< 5	03 (18.8%)	13 (81.2%)	00 (00%)	09 (100%)	0.00
> 5	06 (35.3%)	11 (64.7%)	02 (8.3%)	22 (91.7%)	0.03

**DISCUSSION**

Root canal treatment is a highly prevalent treatment modality in today's dentistry. Fractures of endodontic instruments are an unwanted occurrence and a major concern when using rotary instruments. In root canal preparation, it is necessary to clean and shape the root canal space without causing any iatrogenic aberrant forms, such as ledges, canal transportation, or perforations. It has become more common for endodontists to use rotary instruments powered by nickel-titanium engines. Nickel-Titanium (NiTi) rotary

instruments are increasingly used for root canal therapy in endodontics, increasing the risk of instrument fracture.

Out of a total of 66 canals (33 each endodontic file using Rotary Pro Tapers and EDM Hy Flex series) that were included. Mean endodontic file in group A and B was  $1.28 \pm 0.14$  mm and  $0.58 \pm 0.08$  mm. Comparison of instrument separation in endodontic file using Rotary Pro Tapers and EDM Hy Flex series showed separation of 09 (27.3%) and 02 (6.1%) respectively.

A wide range of intracanal instrument fractures has been reported, ranging between 0.28% and 16.20%. One five-year retrospective study involving postgraduate students found an overall prevalence of instrument fractures during root canal preparation of 1.83% (40/2180) in 1367 patients (2180 endodontic cases, 4897 root canals).<sup>20</sup> There was 5% fracture prevalence among 1682 instruments collected over 16 months, with 3% fracture prevalence among stainless steel (SS) hand instruments from K3 (SybronEndo, Orange, CA, United States).<sup>21</sup> According to data collected in a student clinic during a 10-year period (1997-2006), the incidence of instrument fracture at the mild stage of 3854 root-filled teeth was 1.0% over the period of time.<sup>22</sup>

In a clinical practice, among 1235 patients (1403 teeth, 3181 canals) over a year, fracture rates were 0.28 %, 0.41%, 0.39%, and 0.52% for ProFile (Dentsply-Maillefer, Ballaigues, Switzerland), ProTaper (Dentsply Maillefer), and K3Endo (SybronEndo) nickel-titanium (NiTi) rotary files.<sup>23</sup>

According to a 4-year retrospective study of 3706 ProFile instruments, 0.3% of them fractured.<sup>24</sup> The incidence of NiTi rotary instrument separation on Mtwo (VDW GmbH, Munich, Germany) rotary instruments was 2.2% based on the number of teeth (11306), and 1.0% based on the number of root canals (24108) in a large retrospective study.<sup>25</sup> Five hundred and ninety-three Mtwo instruments discarded after clinical use were involved in another 1-year study in which fracture incidence was 16.02 percent.<sup>26</sup> The separation rate of LightSpeed (LightSpeed Technology, Inc., San Antonio, TX, United States) NiTi rotary instruments for 3543 canals treated over two years was 1.30%.<sup>27</sup>

The most prevalent procedural fault among NiTi instruments is "intra-canal file fracture", according to a survey from Tehran.<sup>28</sup> In disparate studies with very different designs and populations, the prevalence and incidence of intracanal instrument fractures has been reported in various ways (Table 1). A number of factors contribute to the determination, including the location of the tooth, the difficulty of operative procedures, and the experience of the endodontist. Thus, the occurrence of fractures of intracanal instruments is very variable in the literature.

A rotary instrument fracture is a major concern when using endodontic instruments in clinical practice. There is a possibility that rotary endodontic instruments can fracture due to flexural fatigue, torsional load, or a combination of these factors. It is common for rotary endodontic instruments to undergo composite flexural and torsional stresses during clinical use. A part may be subjected to residual stresses after mechanical loading, which could compromise its durability if repeated loading is required.<sup>29,30</sup>

## CONCLUSIONS

In this study, a lot of stress was generated on the surface of Protaper files, compared to EDM Hyflex, which showed the least stress, while the Protaper showed intermediate stress. Protaper had the highest residual stresses, while EDM Hyflex had the lowest residual stresses. The root canal wall's reaction torque and screw-in tendency will differ between instrument designs. Depending on the instrument design, maximum stress concentrations (in cross section) and residual stress distributions differ. Therefore, the user must analyze the cross-sectional design and taper of files prior to using them, or using them.

In addition, this knowledge would help us set standards and clinical guidelines for patient care. For health care authorities to

plan appropriate strategies, this study can serve as a preliminary study to other large scale studies.

## REFERENCES

- Peters OA. Current challenges and concepts in the preparation of root canal systems: a review. *J Endodont.* 2004;30(8):559-67.
- Ruddle CJ. Nonsurgical retreatment. *J Endodont.* 2004;30(12):827-45.
- Torabinejad M, Corr R, Handysides R, Shabahang S. Outcomes of nonsurgical retreatment and endodontic surgery: a systematic review. *J Endodont.* 2009;35(7):930-7.
- Iqbal MK, Maggiore F, Suh B, Edwards KR, Kang J, Kim S. Comparison of apical transportation in four Ni-Ti rotary instrumentation techniques. *J Endodont.* 2003;29(9):587-91.
- Gutmann J, Gao Y. Alteration in the inherent metallic and surface properties of nickel-titanium root canal instruments to enhance performance, durability and safety: a focused review. *Intern Endodont J.* 2012;45(2):113-28.
- Carotte P. A clinical guide to endodontics—update part 1. *Brit Dent J.* 2009;206(2):79.
- Kesim B, Sagsen B, Aslan T. Evaluation of dentinal defects during root canal preparation using thermomechanically processed nickel-titanium files. *European J Dentist.* 2017;11(2):157.
- Patño PV, Biedma BM, Liébana CR, Cantatore G, Bahillo JG. The influence of a manual glide path on the separation rate of NiTi rotary instruments. *J Endodont.* 2005;31(2):114-6.
- Shen Y, Cheung GS-p, Bian Z, Peng B. Comparison of defects in ProFile and ProTaper systems after clinical use. *J Endodont.* 2006;32(1):61-5.
- Parashos P, Gordon I, Messer HH. Factors influencing defects of rotary nickel-titanium endodontic instruments after clinical use. *J Endodont.* 2004;30(10):722-5.
- McGuigan M, Louca C, Duncan H. Endodontic instrument fracture: causes and prevention. *Brit Dent J.* 2013;214(7):341.
- Martin B, Zelada G, Varela P, Bahillo J, Magán F, Ahn S, et al. Factors influencing the fracture of nickel-titanium rotary instruments. *Intern Endodont J.* 2003;36(4):262-6.
- Bartha T, Kalwizki M, Löst C, Weiger R. Extended apical enlargement with hand files versus rotary NiTi files. Part II. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology.* 2006;102(5):692-7.
- Khongkhunthian P, Tanmukayakul K. Nickel-Titanium Rotary Instrument Separation during Root Canal Preparation by Dental Students: a comparison between a strict crown-down technique and a modified crown-down/step back technique. *Chang Mai Uni J Nat Sci.* 2007;6:241-51.
- Ashraf F, Shankarappa P, Misra A, Sawhney A, Sridevi N, Singh A. A stereomicroscopic evaluation of dentinal cracks at different instrumentation lengths by using different rotary files (ProTaper Universal, ProTaper Next, and HyFlex CM): An ex vivo study. *Scientifica.* 2016;2016.
- Shen Y, Coil J, Zhou H, Zheng Y, Haapasalo M. HyFlex nickel-titanium rotary instruments after clinical use: metallurgical properties. *Intern Endodont J.* 2013;46(8):720-9.
- Ninan E, Berzins DW. Torsion and bending properties of shape memory and superelastic nickel-titanium rotary instruments. *J Endodont.* 2013;39(1):101-4.
- Peters OA, Gluskin A, Weiss R, Han J. An in vitro assessment of the physical properties of novel Hyflex nickel-titanium rotary instruments. *Intern Endodont J.* 2012;45(11):1027-34.
- Zhao D, Shen Y, Peng B, Haapasalo M. Micro-computed tomography evaluation of the preparation of mesiobuccal root canals in maxillary first molars with Hyflex CM, Twisted Files, and K3 instruments. *J Endodont.* 2013;39(3):385-8.
- Tzanetakos GN, Kontakiotis EG, Maurikou DV, Marzelou MP. Prevalence and management of instrument fracture in the postgraduate endodontic program at the Dental School of Athens: a five-year retrospective clinical study. *J Endod.* 2008;34:675-78.
- Shen Y, Haapasalo M, Cheung GS, Peng B. Defects in nickel-titanium instruments after clinical use. Part 1: Relationship between observed imperfections and factors leading to such defects in a cohort study. *J Endod.* 2009;35:129-32.
- Ungerechts C, Bärdsen A, Fristad I. Instrument fracture in root canals - where, why, when and what? A study from a student clinic. *Int Endod J.* 2014;47:183-90.
- Di Fiore PM, Genov KA, Komaroff E, Li Y, Lin L. Nickel-titanium rotary instrument fracture: a clinical practice assessment. *Int Endod J.* 2006;39:700-08.
- Shen Y, Coil JM, Haapasalo M. Defects in nickel-titanium instruments after clinical use. Part 3: a 4-year retrospective study from an undergraduate clinic. *J Endod.* 2009;35:193-96.
- Wang NN, Ge JY, Xie SJ, Chen G, Zhu M. Analysis of Mtwo rotary instrument separation during endodontic therapy: a retrospective clinical study. *Cell Biochem Biophys.* 2014;70:1091-95.
- Inan U, Gonulol N. Deformation and fracture of Mtwo rotary nickel-titanium instruments after clinical use. *J Endod.* 2009;35:1396-99.
- Knowles KI, Hammond NB, Biggs SG, Ibarrola JL. Incidence of instrument separation using LightSpeed rotary instruments. *J Endod.* 2006;32:14-16.
- Mozayeni MA, Golshah A, Nik Kerdar N. A Survey on NiTi Rotary Instruments Usage by Endodontists and General Dentist in Tehran. *Iran Endod J.* 2011;6:168-175.
- Kojima K, Inamoto K, Nagamatsu K, Hara A, Nakata K, Morita I, Nakagaki H, Nakamura H. Success rate of endodontic treatment of teeth with vital and nonvital pulps. A meta-analysis. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2004;97(1):95-9.
- Necchi S, Taschieri S, Petrini L, Migliavacca F. Mechanical behavior of nickel-titanium rotary endodontic instruments in simulated clinical conditions: a computational study. *Int Endod J.* 2008;41:939-949.