

A survey of experience-based preference of Nickel-Titanium rotary files and incidence of fracture among general dentists

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Objectives: The purpose was to investigate the preference and usage technique of NiTi rotary instruments and to retrieve data on the frequency of re-use and the estimated incidence of file separation in the clinical practice among general dentists. **Materials and Methods:** A survey was disseminated via e-mail and on-site to 673 general dentists. The correlation between the operator's experience or preferred technique and frequency of re-use or incidence of file fracture was assessed. **Results:** A total of 348 dentists (51.7%) responded. The most frequently used NiTi instruments was ProFile (39.8%) followed by ProTaper. The most preferred preparation technique was crown-down (44.6%). 54.3% of the respondents re-used NiTi files more than 10 times. There was a significant correlation between experience with NiTi files and the number of re-uses ($p = 0.0025$). 54.6% of the respondents estimated experiencing file separation less than 5 times per year. The frequency of separation was significantly correlated with the instrumentation technique ($p = 0.0003$). **Conclusions:** A large number of general dentists in Korea prefer to re-use NiTi rotary files. As their experience with NiTi files increased, the number of re-uses increased, while the frequency of breakage decreased. Operators who adopt the hybrid technique showed less tendency of separation even with the increased number of re-use. (*Restor Dent Endod* 2012;37(4):201-206)

Key words: Crown-down technique; Fracture incidence; Hybrid technique; Nickel-titanium rotary file; Preference

Introduction

In 1988, root canal instruments manufactured from nickel-titanium (NiTi) alloy were introduced to overcome the rigidity of stainless steel.¹ Since then, various NiTi rotary systems have been constantly released. Continuous improvements have been made to the instruments' design and implementation in the hope of achieving shaping efficiency while reducing the risk of procedural accidents, such as transportation or file separation.²⁻⁵ Nevertheless, each NiTi system has different mechanical properties and clinical performance based on its geometrical characteristics and manufacturing methods.⁶⁻⁹

Since the crown-down technique was introduced for manual instrumentation in 1984, it has proved invaluable for rotary preparation systems using NiTi instruments and has become a fundamental part of rotary preparation.¹⁰ However, various file systems differ in shaping performance, and it has been suggested that the hybrid use of 2 or more systems may achieve better shaping efficacy and reduce file fracture.¹¹ Some NiTi rotary file systems are thought to be effective with sequential use of the instrument for up to

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the total working length.¹²⁻¹⁴

The crown-down technique is the preferred instrumentation technique, and ProFile or ProTaper are the most frequently used NiTi rotary file systems among diplomats and/or active members of the American Board of Endodontists.^{15,16} For clinicians, it is of utmost importance to select proper instruments and techniques to obtain high cutting efficiency and predictable control over the entire instrumentation procedure without aberrations. The latest data on the use of NiTi files can be obtained from web-based publications reporting leaders' opinions and surveys of current trends.¹⁵⁻¹⁷ Many techniques for the use of NiTi rotary files have been recommended by manufacturers and researchers, who report preparation efficiency and cutting safety for reducing file fracture.

There is a general perception that NiTi rotary files have a considerable risk of fracture during use. Clinically, there is a potential for rotary NiTi instruments to separate in the canal, and even new instrument may unexpectedly break on its first use.¹⁸⁻²¹ According to the survey studies, operators recognize file fracture as one of the most prominent issues with NiTi rotary instruments.¹⁶ Further, they consider practitioner's experience, preparation technique, and overuse as factors related to file fracture.^{17,21} However, there is little available information on clinical experience, frequency of reuse, and incidence of file separation among the operators.

Therefore, the purpose of this survey was to investigate the preference and usage technique of the NiTi rotary instrument among general dentists on the basis of their clinical experience. This questionnaire also retrieved data on the frequency of NiTi file re-use and the estimated incidence of file separation in the clinical practice setting.

Materials and Methods

A survey was disseminated via e-mail and on site to 673 general dentists. The on-site questionnaire was distributed to 473 dentists who attended a dental conference in May 2010. An e-mail survey with the same questionnaire was sent during the same time period to 200 general dentists in South Korea who left their e-mail address during the registration period for the conference. The survey consisted of 7 questions regarding the file brands, usage techniques, frequency of re-use, and occurrence of file fracture during canal preparation with NiTi rotary instruments (Table 1). Some participants provided more than one reply to each question, and some did not respond to certain questions. Percentages were calculated based on the number of respondents or responses to each question. The correlation between the operator's experience (NiTi file experience) or preferred technique and frequency of re-use and the correlation between the experience or technique and the incidence of file fracture were assessed using a Pearson χ^2 test at a 5% significance level.

Table 1. Questionnaire form

Please select one answer regarding your personal conditions, file preference, and fracture experience. Thank you for your cooperation.	
1. When did you graduate from Dental School? ① less than 5 years ago ② 5 – 10 years ago ③ 10 – 20 years ago ④ more than 20 years ago	5. If you use hybrid instrumentation, please note the combination files used. _____ + _____ e.g., gate-glidden drill + ProTaper
2. How long have you used the NiTi rotary files? ① less than 6 months ② about 6 months to 2 years ③ more than 2 years	6. How many times do you re-use your NiTi rotary files (discard after _____) ① single use ② 2 uses ③ approximately 5 uses ④ approximately 10 uses ⑤ more than 10 uses
3. What is your primary NiTi instrument for root canal preparation? ① ProFile ② ProTaper ③ TF ④ K3 ⑤ Hero ⑥ Mtwo ⑦ RaCe ⑧ GT ⑨ Lightspeed	7. What is the estimated frequency of NiTi file breakage in the root canal? Breakage frequency: ① once a week ② once a month ③ less than 5 times a year ④ extremely rare
4. What is your main preparation method with NiTi rotary instruments? ① crown-down technique ② shaping up or sequential manner ③ hybrid preparation	

Results

A total of 348 general dentists responded to the questionnaire either on site or by e-mail, representing a 51.7% response rate. More than 42% of the respondents were the dentists who graduated from dental school within the previous 5 years, 23.9% graduated within the previous 5 to 10 years, 16.7% graduated within the previous 11 to 20 years, and 16.7% graduated more than 21 years before. Most general dentists had been using the NiTi rotary files for more than 2 years (49.4%). Beginner users of NiTi rotary files were the second most common population (33.7%), and 16.9% reported they had been using NiTi rotary files for 6 to 24 months. The most frequently used NiTi instruments for root canal treatment was ProFile (39.8%) followed by ProTaper (32.6%) (Figure 1). ProFile was most commonly used among inexperienced operators (43.0%) as well as experienced operators (40.1%) (Table 2). The most preferred preparation technique among the respondents was crown-down (44.6%). However, sequential preparation (29.3%) and hybrid technique (26.0%) were also used (Table 3). The combinations of ProTaper/ProFile (33.6%) and gate-glidden drill/ProFile (29.6%) were the 2

most common combinations among the respondents who reported using a hybrid technique.

The data in Table 4 demonstrate that 54.3% of the respondents re-used NiTi files more than 10 times. Only 6 respondents (1.9%) reported discarding NiTi files after a single use. There was a significant correlation between experience with NiTi files and the number of re-uses. Experienced operators more commonly reported reusing files more than 10 times, while beginners reported discarding NiTi files after less than 5 uses ($p = 0.0025$). However, there was no significant correlation between experience with NiTi files and the frequency of file separation ($p = 0.0583$). There was a significant correlation between the preparation technique and the number of file re-uses ($p = 0.0003$). The operators who used the crown-down technique reported reusing NiTi files less than 5 times, while those using the hybrid technique tended to re-use files more than 10 times.

Regarding the incidence of file fracture, 54.6% of the respondents estimated experiencing NiTi file separation less than 5 times per year (Table 5). The frequency of file fracture was significantly correlated with the instrumentation technique ($p = 0.0003$). The operators who used the sequential total length technique showed a strong tendency toward increased file fractures (more than once per month). On the other hand, users of the hybrid technique commonly reported experiencing file fractures less than 5 times per year or not at all.

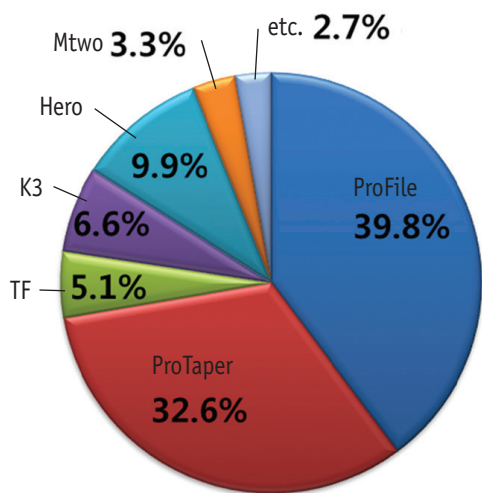


Figure 1. Preference of NiTi rotary instruments.

Table 3. Preference of NiTi rotary file instrumentation technique according to experience

Career	Instrumentation technique (%)		
	Crown-down	Sequential	Hybrid
Less than 6 mon	54.2	27.0	18.8
6 mon to 2 yr	33.3	30.0	36.7
More than 2 yr	40.9	23.2	35.9
Total	44.6	29.3	26.0

Table 2. Most frequently used NiTi instruments according to experience

Career	NiTi instruments (%)						
	ProFile	ProTaper	Hero	K3	TF	Mtwo	Others
Less than 6 mon	43.0	37.7	5.5	6.2	5.1	0.0	1.5
6 mon to 2 yr	37.5	26.0	8.3	8.3	4.9	8.3	4.2
More than 2 yr	40.1	32.4	11.4	6.1	5.3	1.5	2.7
Total	39.8	32.6	9.9	6.6	5.1	3.3	2.7

Table 4. Frequency of NiTi file re-use according to experience

Career	Number of NiTi file re-uses (%)				
	1	2	5	10	>10
Less than 6 mon	4.5	12.5	10.2	22.7	50.0
6 mon to 2 yr	1.9	0.0	3.7	35.2	59.2
More than 2 yr	0.6	1.2	8.4	34.9	54.8
Total	1.9	4.2	8.1	31.5	54.3

Table 5. Estimated frequency of NiTi file breakage according to experience

Career	Frequency of NiTi file breakage (%)			
	Once per wk	Once per mon	≤ 5 times per yr	Extremely rare
Less than 6 mon	8.8	44.1	39.7	7.4
6 mon to 2 yr	9.6	30.8	55.8	3.8
More than 2 yr	3.1	30.2	60.5	6.2
Total	5.7	33.7	54.6	6.0

Discussion

Proper root canal shaping without procedural accidents, such as transportation or file separation, is of the utmost importance for clinicians. To minimize these accidents, practitioners establish their techniques for proper usage of NiTi files based on information acquired from continuing education courses and/or articles reporting survey data.^{15-17,22} As a research tool, surveys provide information on opinions, attitudes, and behaviors of respondents. Surveys should be planned well and conducted to achieve a high response rate, so results will be representative.²³ This study had an overall response rate of 51.7%, which was acceptable for dental surveys (50 - 70%) although it was not high enough.²⁴

Our results revealed that the majority of participants (66.7%) graduated from dental school within the previous 10 years. This might have been because dentists with over 10 years of practical experience were hesitant to use NiTi file systems and adopt new armamentarium. This pattern of usage was confirmed by the survey of Parashos and Messer.²² Almost half of the respondents reported using NiTi files for more than 2 years (49.4%). They may have participated in this survey, because they wanted to achieve better outcomes from root canal treatments by learning and sharing new technical knowledge with the community. Continuing education courses in endodontics enable clinicians to update their knowledge and learn new instrumentation techniques.²⁵ In Korea, NiTi rotary systems have not been made mandatory in the undergraduate

curriculum. As such, further education courses might be necessary. ProFile and ProTaper were the two most frequently used NiTi rotary instruments among general dentists, which is consistent with results of a survey from 2009.¹⁵ In the present survey, 204 respondents (39.8%) choose ProFile as a primary rotary instrument. Among them, 99 respondents (48.5%) selected ProTaper as a second answer. It is presumed that ProFile and ProTaper might be alternatively used as a primary NiTi file by the same operator. This suggests that these two files are complementary by compensating for each other's drawbacks. The results of this survey confirmed that ProTaper/ProFile is the most frequently used combination among the hybrid technique.

It is recommended that NiTi rotary instruments be discarded after a single use.¹⁸ A single use is ideal for reducing the risk of file separation; however, the high operating cost of NiTi files has forced clinicians to re-use them. The incidence of rotary NiTi file separation after repeated clinical use has been reported to be between 1.68% and 2.4%.^{19,20} One *in vitro* study demonstrated that NiTi files can be used up to 10 times without significant reduction of fracture resistance.²⁶ Wolcott *et al.*²⁰ suggested that ProTaper may be re-used at least 4 times, because a greater number of instrument failures occurred during the fifth use. Even though manufacturers often recommend only a single use, it is not unusual for clinicians to use NiTi instruments more than 5 times.²⁷ Previous surveys also revealed no consensus on the reusability of NiTi instruments.^{16,17} According to a UK survey, 32% of general

dentists reported discarding their NiTi instruments after a single use, while 40% reported reusing them 2 - 5 times, and 27.2% reported reusing them more than 6 times.¹⁷ In a US study, Bird *et al.* reported that the majority of respondents used NiTi instruments on 2 - 4 patients before discarding them, whereas 21% used NiTi rotary instruments only a single time before discarding.¹⁶ The present survey results showed that only 1.9% of respondents discarded NiTi instruments after a single use, while 54.3% of the respondents re-used NiTi files more than 10 times. Therefore, multiple uses were more prominent than single uses among the respondents (Table 5). The frequency of reusing NiTi files differed according to experience with NiTi files ($p = 0.0025$). Experienced operators had a strong tendency of reusing NiTi files more than 10 times, while beginners showed a tendency of discarding NiTi files after less than 5 re-uses. This was due to the experience-based opinion that a file can be safely re-used more. It seems that experienced operators do not rush through a procedure or lose feeling for the instruments, so that it could decrease the chance of a torsional failure.^{14,28}

The preparation technique was also correlated with the number of file re-uses. Specifically, the operators who use the crown-down technique re-used NiTi files less than 5 times, while respondents who adopted the hybrid technique showed a strong tendency to re-use files more than 10 times ($p = 0.0003$). Meanwhile, more than 54% of beginners used the crown-down technique, whereas the majority of operators who used the hybrid technique were experienced operators. This suggests that the preparation technique may reflect the NiTi file usage experience. Our survey revealed that beginners showed a higher tendency of file fracture (more than once per month), while experienced NiTi users reported fractures less than 5 times per year. However, we found no correlation between the experience of NiTi file users and the frequency of file separation ($p = 0.0583$). This result is consistent with that of Madarati *et al.*, who did not identify a correlation between the frequency of file fracture and the length of experience with NiTi instruments.¹⁷ Meanwhile, the frequency of file fracture was positively correlated with the number of root canals prepared.

In contrast, the preparation technique was associated with the frequency of file separation ($p = 0.0003$). The majority of respondents reported NiTi file separation less than 5 times per year. However, operators who use the sequential total length technique tended to experience file fracture more than once per month. The crown-down technique for root canal preparation has been used for more effective cleaning and shaping, especially after the development of NiTi rotary files. It minimizes coronal interference, allows minimal engaging surface of each instrument, decreases the torque load of each instrument, and reduces procedural errors. The hybrid

technique does not deviate from the principles of the crown-down preparation. Therefore, experienced operators combine instruments from different file systems and use different instrumentation techniques to achieve the best biomechanical cleaning and shaping results, resulting in the fewest procedural errors.^{11,29-31} The total length technique is designed for using NiTi files in a sequential manner to working length, shaping with progressively larger instruments. This instrumentation technique is also called step-back enlargement of NiTi file or the single length technique, because the full length of the canal is approached at the same time and shaped in a step-back manner.^{12,14,18} It was reported that this technique does not cause apical transportation or aberration in canal morphology.³² However, our survey demonstrated that the operators who use the sequential total length technique reported file fractures more than once per month. Many fractured instrument fragments are 1.5 mm or less in length. Therefore, clinicians may not even be aware of their stress and fracture.⁵ Considered the higher probability of apical contact than other preparation techniques, the sequential total length technique must be used with caution.

Conclusions

A large number of general dentists in Korea prefer to re-use NiTi rotary files. Moreover, as their experience with NiTi files increased, the number of re-uses increased, while the frequency of breakage decreased. Regarding preparation technique, operators who adopt the hybrid technique showed less tendency of NiTi file separation even with the increased number of re-use. Although this survey is not representative of all dentists in Korea, it will help our understanding of current performance and will provide direction for further education and training.

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References

1. Walia HM, Brantley WA, Gerstein H. An initial investigation of the bending and torsional properties of Nitinol root canal files. *J Endod* 1988;14:346-351.
2. Schäfer E, Schulz-Bongert U, Tulus G. Comparison of hand stainless steel and nickel titanium rotary instrumentation: a clinical study. *J Endod* 2004;30:432-435.

3. da Silva FM, Kobayashi C, Suda H. Analysis of forces developed during mechanical preparation of extracted teeth using RaCe rotary instruments and ProFiles. *Int Endod J* 2005;38:17-21.
4. Shen Y, Cheung GS, Bian Z, Peng B. Comparison of defects in Profile and ProTaper systems after clinical use. *J Endod* 2006;32:61-65.
5. Parashos P, Gordon I, Messer HH. Factors influencing defects of rotary nickel-titanium endodontic instruments after clinical use. *J Endod* 2004;30:722-725.
6. Xu X, Eng M, Zheng Y, Eng D. Comparative study of torsional and bending properties for six models of nickel-titanium root canal instruments with different cross-sections. *J Endod* 2006;32:372-375.
7. Kim HC, Kim HJ, Lee CJ, Kim BM, Park JK, Versluis A. Mechanical response of nickel-titanium instruments with different cross-sectional designs during shaping of simulated curved canals. *Int Endod J* 2009;42:593-602.
8. Turpin YL, Chagneau F, Bartier, Cathelineau G, Vulcain JM. Impact of torsional and bending inertia on root canal instruments. *J Endod* 2001;27:333-336.
9. Kim HC, Yum J, Hur B, Cheung GS. Cyclic fatigue and fracture characteristics of ground and twisted nickel-titanium rotary files. *J Endod* 2010;36:147-152.
10. Morgan LF, Montgomery S. An evaluation of the crown-down pressureless technique. *J Endod* 1984;10:491-498.
11. Walsch H. The hybrid concept of nickel-titanium rotary instrumentation. *Dent Clin North Am* 2004;48:183-202.
12. Schäfer E, Erler M, Dammaschke T. Comparative study on the shaping ability and cleaning efficiency of rotary Mtwo instruments. Part 2. Cleaning effectiveness and shaping ability in severely curved root canals of extracted teeth. *Int Endod J* 2006;39:203-212.
13. Grande NM, Plotino G, Pecci R, Bedini R, Malagnino VA, Somma F. Cyclic fatigue resistance and three-dimensional analysis of instruments from two nickel-titanium rotary systems. *Int Endod J* 2006;39:755-763.
14. Roland DD, Andelin WE, Browning DF, Hsu GH, Torabinejad M. The effect of preflaring on the rates of separation for 0.04 taper nickel titanium rotary instruments. *J Endod* 2002;28:543-545.
15. Lee M, Winkler J, Hartwell G, Stewart J, Caine R. Current trends in endodontic practice: emergency treatments and technological armamentarium. *J Endod* 2009;35:35-39.
16. Bird DC, Chambers D, Peters OA. Usage parameters of nickel-titanium rotary instruments: a survey of endodontists in the United States. *J Endod* 2009;35:1193-1197.
17. Madarati AA, Watts DC, Qualtrough AJ. Opinions and attitudes of endodontists and general dental practitioners in the UK towards the intracanal fracture of endodontic instruments: part 1. *Int Endod J* 2008;41:693-701.
18. Arens FC, Hoen MM, Steiman HR, Dietz GC Jr. Evaluation of single-use rotary nickel-titanium instruments. *J Endod* 2003;29:664-666.
19. Iqbal MK, Kohli MR, Kim JS. A retrospective clinical study of incidence of root canal instrument separation in an endodontics graduate program: a PennEndo database study. *J Endod* 2006;32:1048-1052.
20. Wolcott S, Wolcott J, Ishley D, Kennedy W, Johnson S, Minnich S, Meyers J. Separation incidence of protaper rotary instruments: a large cohort clinical evaluation. *J Endod* 2006;32:1139-1141.
21. Wu J, Lei G, Yan M, Yu Y, Yu J, Zhang G. Instrument separation analysis of multi-used ProTaper Universal rotary system during root canal therapy. *J Endod* 2011;37:758-763.
22. Parashos P, Messer HH. Questionnaire survey on the use of rotary nickel-titanium endodontic instruments by Australian dentists. *Int Endod J* 2004;37:249-259.
23. Lydeard S. The questionnaire as a research tool. *Fam Pract* 1991;8:84-91.
24. Hovland EJ, Romberg E, Moreland EF. Nonresponse bias to mail survey questionnaires within a professional population. *J Dent Educ* 1980;44:270-274.
25. Barbakow F, Lutz F. The 'Lightspeed' preparation technique evaluated by Swiss clinicians after attending continuing education courses. *Int Endod J* 1997;30:46-50.
26. Ounsi HF, Salameh Z, Al-Shalan T, Ferrari M, Grandini S, Pashley DH, Tay FR. Effect of clinical use on the cyclic fatigue resistance of ProTaper nickel-titanium rotary instruments. *J Endod* 2007;33:737-741.
27. Yared GM, Bou Dagher FE, Machtou P. Cyclic fatigue of ProFile rotary instruments after clinical use. *Int Endod J* 2000;33:204-207.
28. Sattapan B, Nervo GJ, Palamara JE, Messer HH. Defects in rotary nickel-titanium files after clinical use. *J Endod* 2000;26:161-165.
29. Moore J, Fitz-Walter P, Parashos P. A micro-computed tomographic evaluation of apical root canal preparation using three instrumentation techniques. *Int Endod J* 2009;42:1057-1064.
30. Setzer FC, Kwon TK, Karabucak B. Comparison of apical transportation between two rotary file systems and two hybrid rotary instrumentation sequences. *J Endod* 2010;36:1226-1229.
31. Kim JW, Park JK, Hur B, Kim HC. Comparison of shaping ability using various Nickel-Titanium rotary files and hybrid technique. *J Korean Acad Conserv Dent* 2007;32:530-541.
32. Sonntag D, Ott M, Kook K, Stachniss V. Root canal preparation with the NiTi systems K3, Mtwo and ProTaper. *Aust Endod J* 2007;33:73-81.