Influence of Operator's Experience on Root Canal Shaping Ability with a Rotary Nickel-Titanium Single-File Reciprocating Motion System

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Abstract

Introduction: The aim of this study was to evaluate the influence of the operator's experience on the shaping of double-curvature simulated root canals with a nickel-titanium single-file reciprocating motion system. **Methods:** Sixty double-curvature root canals simulated in methacrylate blocks were prepared by 10 students without any experience in endodontics and by 10 professionals who had studied endodontics at the postgraduate level. The Reciproc-VDW system's R25 file was used in the root canal preparation. The blocks were photographed before and after the instrumentation, and the time of instrumentation was also evaluated. Changes in root canal dimensions were analyzed in 6 positions. **Results:** Significant differences ($P < .05$) were found in the apical transport of the first root canal curvature, with a larger percentage of increase of the root canal occurring in the novice group than in the expert one, as well as in the canal deviation at the beginning of the curvatures, whereas no significant results were obtained in the growth rate of the canal area. There was difference in the time of instrumentation, with 3.76 minutes observed in the novice group, as opposed to 2.05 minutes in the expert group. **Conclusions:** The use of the single-file reciprocating motion system Reciproc is not seen to be influenced by the operator's experience regarding the increase of the canal area. Previous training and the need to acquire experience are important in the use of this system, in spite of its apparent simplicity. *(J Endod 2014;40:547–550)*

Key Words

Dental education, endodontics, reciprocating motion, root canal shaping, simulated root canals

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The preparation of root canals is one of the most important stages in endodontic treatment and is directly related to the simultaneous and ensuing disinfection (1). Its aim is to eliminate pulp tissue, bacteria, and other derived products and also provide a suitable shape for the root canal's filling (2), while respecting the original anatomy (3, 4).

Traditionally, root canal shaping has been done by using stainless steel hand files (5). However, during the 1980s nickel-titanium (NiTi) files were introduced. They have 2 or 3 times more flexibility, thereby facilitating curved root canal instrumentation and providing a larger resistance to twisting-induced fractures than steel files do (6). On the arrival of NiTi alloys, the use of rotating instruments was developed. The Giromatic handpiece (MicroMega, Besancon, France), the precursor to the current rotating instrument, made a reciprocating quarter-turn motion (7). New instruments have recently been introduced that use a reciprocating motion instead of spinning around in a continuous motion (5, 8–10), but in this case, these new instruments show an asymmetric reciprocating movement (10).

With the intention to simplify endodontic techniques, reciprocating single-file NiTi systems have recently appeared to reduce twisting-induced fractures (5, 11), which are the main problem encountered by novice operators when using NiTi files (12).

Few articles have evaluated the influence of operator's experience on the preparation of root canals. Some studies found a larger number of fractures in the learning stage than in the practical period (13) and demonstrated that more deformities and fractures occur when rotary NiTi instruments were used by novice operators (14–16).

Despite this fact, there are studies that demonstrate that one of the advantages of rotary systems is that they can be used by either expert or novice operators (17), because many authors affirm that operators with little experience obtain better results when using rotary NiTi instruments as opposed to the manual type (12, 18–21), although experience and practice are indispensable for proper use and improve results (14, 22).

This study's aim was to evaluate the influence of the operator's experience on the shaping of double-curvature simulated root canals with a NiTi single-file reciprocating motion system. Canal enlargement, canal transportation, and the time required to complete the preparation were evaluated.

Materials and Methods

Sixty double-curvature simulated root canals in methacrylate blocks (Dentsply Maillefer, Ballaigues, Switzerland) were prepared by 10 dental students with no experience in root canal treatments and by 10 dentists with postgraduate training in endodontics in the same university. The Reciproc system (VDW, Munich, Germany) was used. Only theoretical information about this canal preparation system was given to undergraduate students, whereas postgraduate students were already familiar and had practical experience with it. Acrylic blocks were used with simulated root canals with the following characteristics: canal length, 16 mm; first curvature, 5-mm radius and 28° angle; second curvature, 4-mm radius and 29° angle (23).

Canal Instrumentation

Initially, canals were irrigated with water (2 mL), and patency was made with a #10 K-file. They were then instrumented with the Reciproc system's R25 file (VDW), a NiTi single-file reciprocating motion system. The established working length was 16 mm. The endodontic motor VDW Silver (VDW) was used with 10 reciprocating cycles per second, which is equivalent to approximately 300 rpm. A new file was used in each canal.

Reciprocating files were used in a crown-down manner by making 3 advancing movements, after which the canals were irrigated with water (2 mL each time), and canal patency was confirmed with a #10 K-file. This procedure was repeated until the operator reached the working length with the file used.

Data Collection

Blocks were photographed before and after the instrumentation with a Nikon D3000 camera (Nikon, Amsterdam, the Netherlands) in a fixed position. The pictures obtained were treated with the Adobe Photoshop CS5 program (Adobe Systems Incorporated, San Jose, CA) by using the "find edges" filter. The pictures were superimposed later.

Concerning the profile of the canal, 6 sections were traced perpendicular to its shaft. The first was at the beginning of the canal, the second was at the middle of the beginning of the canal (before the first curvature), the third was in the first curvature, the fourth was between the first and second curvatures, the fifth was in the second curvature, and the sixth was at the end of the canal (Fig. 1*A*). Size differences between the original canal and the canal after instrumentation were measured in each segment with the Image J software (National Institutes of Health, Bethesda, MD), and likewise the distance from the instrumented canal outline (on both sides) to the original canal outline (Fig. 1*A*, magnified area). Differences between the areas of the original canal and the instrumented canal were also measured.

Operators were timed beginning at canal irrigation and ending when they reached the working length with the reciprocating file.

Statistical Analysis

After checking that data were normally distributed, the analysis of variance test was applied to compare the mean values obtained by the 2 groups of operators (novice and expert). Differences were considered statistically significant if $P < .05$.

Results

Twenty-four methacrylate blocks were analyzed in the novice group and 27 in the expert group because those canals where any instrument was separated were not evaluated (6 instruments were separated in the canal in the novice group and 3 in the expert group).

Increase of the Canal Area after Instrumentation

No significant differences ($P = .32$) were obtained relative to the increase of the canal area between expert and novice operators, 118.62 $\pm$ 29.17 mm^2 in the novice group and 111.48 $\pm$ 22.27 mm^2 in the expert group (Fig. 1*B* and *C*, respectively).

Canal Enlargement

Significant differences ($P = .006$) were obtained in the third segment of the canal transport in the first curvature, where the average increase was 177.17% in the novice group and 135.52% in the expert group. No significant differences were found in any other segment (Table 1).

Canal Transport

Significant differences were obtained between expert and novice operators relative to canal deviation in segments 2 and 4 ($P = .046$ and $P = .006$, respectively), which are the segments before the first and second curvatures. When the third and the fifth segments, which are the first and second curvatures, were analyzed, a greater wear on the internal face was seen (Fig. 1*B* and *C*).

Time of Instrumentation

Expert operators took significantly less time ($P = .00$) to instrument canals, with a mean of 1.62 $\pm$ 0.55 minutes as opposed to 3.80 $\pm$ 1.68 minutes for the novice group.

Discussion

This study's aim was to evaluate operator's experience on canal preparation in simulated root canals by using a single-file NiTi reciprocating motion system.

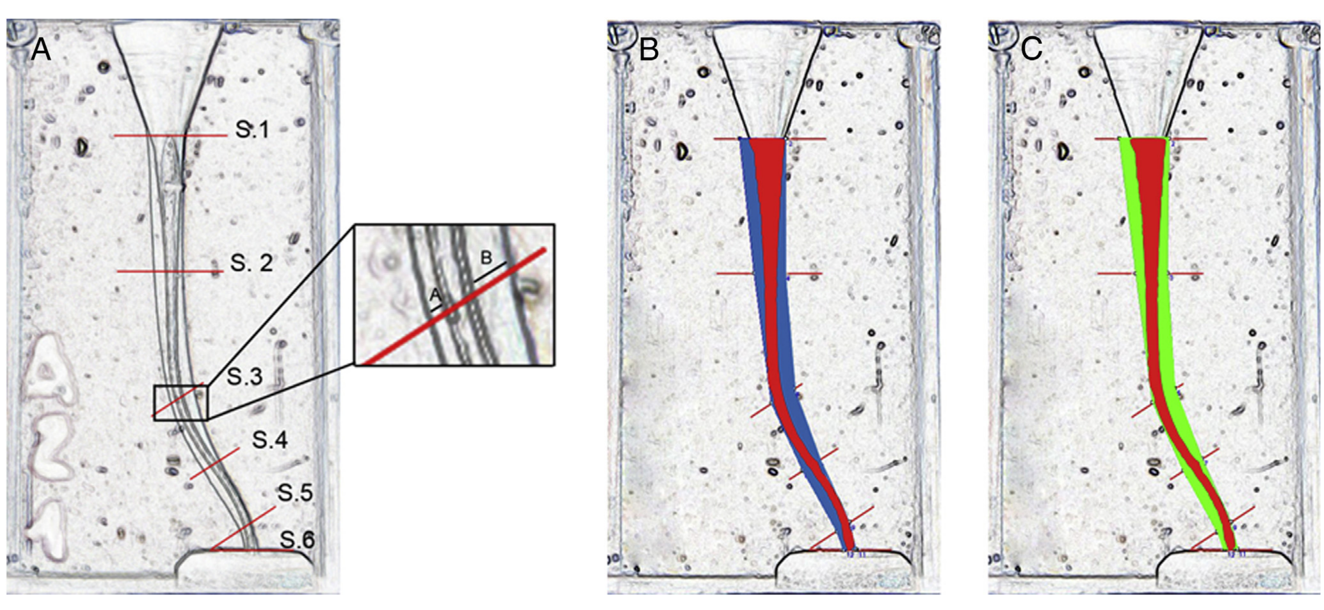

Figure 1. Combination of preoperative and postoperative images with the studied sections. (*A*) The third area has been magnified, showing the measured deviations (*A* and *B*); (*B* and *C*) simulated canals from the average results (*red*, preoperative situation; *green*, after expert shaping; *blue*, after novice shaping).

TABLE 1. Canal Modifications in Novice and Expert Groups (increments and deviations) Shown as Means ± Standard Deviations

		Canal increment		Distance from the instrumented canal outline to the original one			
S	Group	Percentage	*P* value	A (mm)	*P* value	B (mm)	*P* value
1	Novice	64.37 ± 28.14	.45	0.26 ± 0.07	.386	0.09 ± 0.08	.076
	Expert	79.73 ± 25.07		0.28 ± 0.07		0.14 ± 0.09	
2	Novice	151.06 ± 16.55	.77	0.27 ± 0.04	.749	0.22 ± 0.04	.043
	Expert	163.47 ± 29.79		0.27 ± 0.06		0.26 ± 0.07	
3	Novice	177.17 ± 34.81	.006	0.11 ± 0.12	.221	0.40 ± 0.07	.344
	Expert	135.52 ± 62.41		0.08 ± 0.09		0.43 ± 0.12	
4	Novice	138.41 ± 24.87	.45	0.24 ± 0.05	.710	0.10 ± 0.06	.006
	Expert	160.71 ± 47.68		0.25 ± 0.07		0.15 ± 0.08	
5	Novice	86.86 ± 34.37	.57	0.18 ± 0.08	.209	0.03 ± 0.05	.022
	Expert	81.62 ± 31.13		0.21 ± 0.09		0.03 ± 0.08	
6	Novice	61.31 ± 46.14	.883	0.048 ± 0.06	.863	0.081 ± 0.08	.833
	Expert	59.38 ± 46.43		0.045 ± 0.08		0.087 ± 0.11	

A and B, deviation of the canal (Fig. 1*A*, magnified area) in mm; S, canal segment.

P values (analysis of variance test): significant differences when $P < .05$.

The use of simulated root canals in resin blocks has limitations, which must be considered when results are compared with those obtained from real teeth (13), because of differences in texture, hardness, and cross section. However, they allow the direct comparison of shaping capacity, because form, size, taper, and curvature are standardized (22). On the other hand, most errors in root canal preparation occur in curved canals (24), and for that reason this type of canal were chosen for our work.

In this study we have observed significant differences in the canal transport in the first curvature (smaller among expert operators). Nevertheless, in both groups the greater wear occurred on its internal face. Other authors (13) also obtained a larger transport for the novice operator, and in particular, the transport is larger at the beginning of the curvature. The study of Madureira et al (24), conducted with 4 file systems (Profile, ProTaper; K3 hand K-files, and Hero 642) by using double-curvature simulated canals, demonstrated a greater wear on the internal face of both curvatures, just as in our study. However, other studies observed greater wear on the internal face of the first curvature and on the external face of the second one (25–27). Nevertheless, the apical transport is identically performed over the same canal walls in every study, with the difference being that in double-curvature canals the external apical face corresponds with the internal one in our study.

The necessary time to instrument the canal also depends on the operator's experience. Time was significantly shorter among expert operators. Another study in which the time used to prepare simulated canals in acrylic blocks by using ProFile instruments was analyzed (28) concludes that the time necessary to prepare the canal is inversely proportional to the operator's experience. However, in spite of these problems, other authors (29) concluded that novice operators make better canal preparations with rotary files than with hand ones. They also concluded that there are no significant differences in the number of fractures seen in rotary NiTi files and hand NiTi files, but a difference can be seen with regard to stainless steel hand files, which fractured more often than rotary files (12). In our study we found that the number of separated instruments was double in the novice group than in the expert group (6 versus 3 over 30); this could be related to the operator's experience.

Conclusion

The use of the single-file reciprocating motion system Reciproc is not seen to be influenced by the operator's experience regarding the increase of the canal area, although a larger apical transport in the first curvature is observed when the operator has no experience.

The time required for instrumentation is shorter according to how much experience the operator has. The obtained results indicate the importance of previous training and the need to acquire experience, in spite of the system's apparent simplicity.

Acknowledgments

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

References

1. Peters OA, Schönenberger K, Laib A. Effects of four Ni-Ti preparation techniques on root canal geometry assessed by micro computed tomography. Int Endod J 2001;34:221–30.
2. Schilder H. Cleaning and shaping the root canal. Dent Clin North Am 1974;18:269–96.
3. Sonntag D, Stachniss-Carp S, Stachniss C, Stachniss V. Determination of root canal curvatures before and after canal preparation (part II): a method based on numeric calculus. Aust Endod J 2006;32:16–25.
4. Burroughs JR, Bergeron BE, Roberts MD, et al. Shaping ability of three nickel-titanium endodontic file systems in simulated S-shaped root canals. J Endod 2012;38:1618–21.
5. Yared G. Canal preparation using only one Ni-Ti rotatory instrument: preliminary observations. Int Endod J 2008;41:339–44.
6. Walia HM, Brantley WA, Gerstein H. An initial investigation of the bending and torsional properties of Nitinol root canal files. J Endod 1988;14:346–51.
7. Harty FJ, Stock CJ. A comparison of the flexibility of giromatic and hand operated instruments in endodontics. J Br Endod Soc 1974;7:64–71.
8. Berutti E, Chiandussi G, Paolino DS, et al. Canal shaping with WaveOne Primary reciprocating files and ProTaper system: a comparative study. J Endod 2012;38:505–9.
9. Berutti E, Paolino DS, Chiandussi G, et al. Root canal anatomy preservation of WaveOne reciprocating files with or without glide path. J Endod 2012;38:101–4.
10. Bürklein S, Hinschitza K, Dammaschke T, Schäfer E. Shaping ability and cleaning effectiveness of two single-file systems in severely curved root canals of extracted teeth: Reciproc and WaveOne versus Mtwo and ProTaper. Int Endod J 2012;45:449–61.
11. Varela-Patiño P, Ibañez-Párraga A, Rivas-Mundiña B, et al. Alternating versus continuous rotation: a comparative study of the effect on instrument life. J Endod 2010;36:157–9.
12. Sonntag D, Delschen S, Stachniss V. Root-canal shaping with manual and rotatory Ni-Ti files performed by students. Int Endod J 2003;36:715–23.
13. Al-Omari MA, Wirtti S. Shaping canals with ProFiles and K3 instruments: does operator experience matter? Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2010;110:e50–5.
14. Mandel E, Adib-Yazdi M, Benhamou LM, et al. Rotatory Ni-Ti profile systems for preparing curved canals in resin blocks: influence of operator on instrument breakage. Int Endod J 1999;32:436–43.
15. Yared GM, Bou Dagher FE, Machtou P. Influence of rotational speed, torque and operator's proficiency on ProFile failures. Int Endod J 2001;34:47–53.
16. Yared GM, Kulkarni GK. Failure of ProFile Ni-Ti instruments used by an inexperienced operator under access limitations. Int Endod J 2002;35:536–41.

17. Baumann MA, Roth A. Effect of experience on quality of canal preparation with rotatory nickel-titanium files. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1999; 88:714–8.
18. Gluskin AH, Brown DC, Buchanan LS. A reconstructed computerized tomographic comparison of Ni-Ti rotary GT files versus traditional instruments in canals shaped by novice operators. Int Endod J 2011;34:476–84.
19. Peru M, Peru C, Mannocci F, et al. Hand and nickel-titanium root canal instrumentation performed by dental students: a micro-computed tomographic study. Eur J Dent Educ 2006;10:52–9.
20. Tu MG, Chen SY, Huang HL, Tsai CC. Endodontic shaping performance using nickel-titanium hand and motor ProTaper systems by novice dental students. J Formos Med Assoc 2008;107:381–8.
21. Arens FC, Hoen MM, Steiman HR, Dietz GC Jr. Evaluation of single-use rotatory nickel-titanium instruments. J Endod 2003;29:664–6.
22. Ünal GÇ, Maden M, Orhan EO, et al. Root canal shaping using rotary nickel-titanium files in preclinical dental education in Turkey. J Dent Educ 2012;76: 509–13.
23. Pruett JP, Clement DJ, Carnes DL Jr. Cyclic fatigue testing of nickel-titanium endodontic instruments. J Endod 1997;23:77–85.
24. Madureira RG, Forner Navarro L, Llena MC, Costa M. Shaping ability of nickel-titanium rotary instruments in simulated S-shaped root canals. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2010;109:e136–44.
25. Coleman CL, Svec TA. Analysis of Ni-Ti versus stainless steel instrumentation in resin simulated canals. J Endod 1997;23:232–5.
26. Al-Omari MA, Dummer PM, Newcombre RG. Comparison of six files to prepare simulated root canals. Int Endod J 1992;25:67–81.
27. Bishop K, Dummer PM. A comparison of stainless steel Flexofiles and nickel-titanium NiTiFlex files during the shaping of simulated canals. Int Endod J 1997;30:25–34.
28. Mesgouez C, Rilliard F, Matossian L, et al. Influence of operator experience on canal preparation time when using the rotatory Ni-Ti ProFile system in simulated curved canals. Int Endod J 2003;36:161–5.
29. Sonntag D, Guntermann A, Kim SK, Stachniss V. Root canal shaping with manual stainless steel files and rotatory Ni-Ti files performed by students. Int Endod J 2003;36:246–55.