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ORIGINAL ARTICLE/ARTICOLO ORIGINALE

Comparison of shaping ability of ProTaper Next and 2Shape nickel—titanium files in simulated severe curved canals

Analisi sperimentale della preparazione endodontica in canali artrificiali con curvature complesse: ProTaper Next Vs. 2Shape

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Centering ability;
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Abstract
Aim: To evaluate the centering ability of ProTaper Next (PTN) and 2Shape (TS) nickel—titanium (NiTi) instruments in terms of maintaining the original root canal configuration in a simulated tooth with severe curvature.
Methodology: Twenty standardized simulated curved root canals were prepared to an apical size of 0.25 mm using PTN and TS (*n* = 10 canal/group) nickel-titanium files. A gig was constructed to enable reproducible image acquisition using a photographic camera. Pre- and post-instrumented images were recorded and superimposed using a computer software. The ability of the instruments to remain centered in the canal was determined by calculating a centering ratio at three independent points of the simulated canal: coronal, middle and apical third of the curvature,

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using a computer software. Statistical analysis was performed using one-way analysis of variance (ANOVA) followed by independent sample *t*-test at 5% significance level.
Results: No significant difference was found between the two systems ($p > 0.05$). At the apical third, the mean centering ratio was significantly higher than the centering ratio of the coronal and the middle thirds in both TS and PTN ($p < 0.05$).
Conclusions: There were no significant differences in the centering ability of the ProTaper Next and 2Shape systems in simulated severe curved canals. Both systems exhibited some degree of transportation, especially in the apical third.

PAROLE CHIAVE
NichelTitanio;
Capacità di centratura;
Trattamento termico;
2Shape;
Protaper Next.

Riassunto
OBIETTIVI: L'obiettivo è confrontare la centratura di preparazione tra Protaper Next e 2Shape in canali artificiali con curvature complesse.
MATERIALI E METODI: 20 molari inferiori artificiali con canali colorati sono stati divisi random per I due tipi di strumenti testate.
Le immagini prima e dopo la strumentazione sono state rilevate mediante un software (Adobe Photoshop 7.0.1; Adobe Systems, Inc., Mountain View, California, USA). La capacita di centratura degli strumenti è stata calcolata misurando i canali in tre differenti porzioni: Coronale, Media ed Apicale.
ANOVA test è stato successivamente eseguito per determinare I valori ottenuti.
RISULTATI: Non sono risultate differenze significativamente tra la capacità di centratura di preparazione tra I due strumenti testati.
CONCLUSIONI: No differenze significative tra I due strumenti testati, entrambi hanno evidenziato un certo trasporto della centratura della pereparazione sopratutto nel terzo apicale.

Introduction

The purpose of instrumentation is mechanical debridement, the creation of space for the delivery of irrigation and optimized canal geometries for adequate obturation,[1] while maintaining the original canal anatomy.[2] In the curved canal, large stainless-steel files (SS) are less flexible and tend to straighten and transport the canal with creating of apical zips and ledges.[3] In danger zone areas, such straightening may lead to strip perforations.[4]

Nickel-titanium (NiTi) instruments have been reported to have a decreased tendency for canal transportation and better centering ability than)SS)[5] due to their greater elasticity.[6] Manufacturers strive to improve NiTi instruments by changing their design and enhancing the structural alloy in an attempt to improve their mechanical performance.[4,7,8]

ProTaper Next (PTN; Dentsply Sirona, Ballaigues, Switzerland) is made of M-wire heat-treated alloy with an asymmetric square cross-section. The PTN system is consist of X1 (17/.04), X2 (25/.06), X3 (30/.07), X4 (40/.06), and X5 (50/.06) files. 2Shape (TS; MicroMega, Besancon, France) is made of T-wire heat-treated alloy with an asymmetric triangular cross-section. The 2S system is composed of TS1 (25/.04), TS2 (25/.06), F35 (36/.06), and F40 (40/.04) files.

To our knowledge, no research investigated the centering ability of TS instruments. Thus the purpose of the present study was to evaluate the centering ability of PTN and TS instruments in terms of maintaining the original root canal configuration in a simulated tooth with severe curvature. The null hypothesis was that there would be no significant difference between the PTN and TS in terms of shaping abilities.

Materials and methods

In order to standardize the root canal curvature, 20 artificial molar tooth models (MM tooth; Micro-Mega) that having severely MB and ML canals (>60°)[9] were selected. The working length (WL) of the ML and MB canals were 23.5 mm and 23 mm respectively. An apical foramen size of 0.1 mm was confirmed by a #10 K-file (Dentsply Sirona). Each simulated canal was colored with blue ink injected using a 27-G closed-end tip and side-vented needle (Ultradent Products, Inc., South Jordan, UT). The canals were randomly assigned to two groups ($n = 10$) according to the system that was used for canal instrumentation.

In Group 1, MB and ML canals were prepared using One G (Micro-Mega), 2Shape TS1 (25/.04) and TS2 (25/.06) files at 300 rpm and 1.2 Ncm torque values using VDW Gold (VDW, Munich, Germany) endodontic motor.

In Group 2, MB and ML canals were prepared using PathFile 1 and 2 (Dentsply Sirona), ProTaper X1 (17/.04) and X2 (25/.06) files at 300 rpm and 2 Ncm torque values using VDW Gold endodontic motor.

A single operator with experience in rotary systems performed all instrumentation procedures according to the manufacturer's instructions. Each new instrument was used to prepare only two canals. Between each preparation step, apical patency was confirmed by using a #10 K-file until the tip of the file could be seen protruding through the apical foramen. The canal was irrigated with 1.0 mL sterile water using a 27-gauge needle after each file and as a final rinse. Each tooth was embedded in a putty base without obscuring the canals. A gig was constructed to enable reproducible image acquisition using a photographic camera (EOS 70D; Canon, Tokyo, Japan). Three reference points were marked around the tooth position to allow for exact superimposition of the images. Pre- and post-instrumented images were recorded. Then, the images were superimposed using a computer software (Adobe Photoshop 7.0.1; Adobe Systems, Inc., Mountain View, CA, USA). The ability of the instruments to remain centered in the canal was determined by calculating a centering ratio at three independent points (coronal, middle, and apical) of the simulated canal.

The calculation of the centering ratio was used the following formula: (X1−X2)/Y (X1 − the maximum extent of canal movement in one direction, X2- the movement in the opposite direction, Y − the wideness of the final canal preparation). The calculation was made using a computer software (ImageJ; NIH, Bethesda, MD).

Statistical analysis was performed using SPSS 22.0 (IBM-SPSS Inc., Chicago, IL, USA) using one-way analysis of variance (ANOVA) followed by independent sample *t*-test at 5% significance level.

Results

The mean centering ratio for TS and PTN were 0.42 and 0.43, respectively. No significant difference was found between the different systems ($p > 0.05$) as shown in Fig. 1. At the apical third, the mean centering ratio was significantly higher than the centering ratio of the coronal and the middle thirds in both TS and PTN ($p < 0.05$) (Fig. 2). There was no difference between the coronal third and the middle third with the different systems.

Discussion

In the past, files and reamers were manufactured from either carbon-steel or SS. The relatively high modulus of elasticity of these materials made it difficult for the larger file sizes to negotiate curved canals.[10] NiTi rotary files are manufactured from a NiTi alloy that is significantly more elastic than SS[11] and was developed by William Buehler in 1962.[11] In 1988, Walia et al. introduced NiTi for the manufacturing of endodontic instruments.[12]

Since the introduction of this alloy, a number of different files have been developed from NiTi. Many studies demonstrate that NiTi instruments remain better centered in the canal compared to SS. Esposito and Cunningham[13] compared NiTi hand and engine-driven files to SS hand files in curved canals. They found that for instruments larger than ISO size 30, both hand and rotary NiTi files were significantly more effective than SS in maintaining the original path of the canal. Glossen et al. reported similar findings with instruments larger than size 45.[14]

However, transportation of the canal can still occur with NiTi instruments in the apical, middle, and coronal thirds. Over the years, many NiTi instruments have been developed to improve root canal preparation. Hand and rotary instruments are available in various designs that differ in tip and taper design, rake angles, helical angles, pitch and different types of alloys.[15]

Numerous studies compared the ability of several new rotary NiTi systems to maintain original canal shape and therefore remain better centered.[7,16–18] The present study focused on two relatively new rotary NiTi systems with asymmetrical cross-section and with a different type of heat treated NiTi alloy. PTN is a M-wire alloy and TS is a T-wire

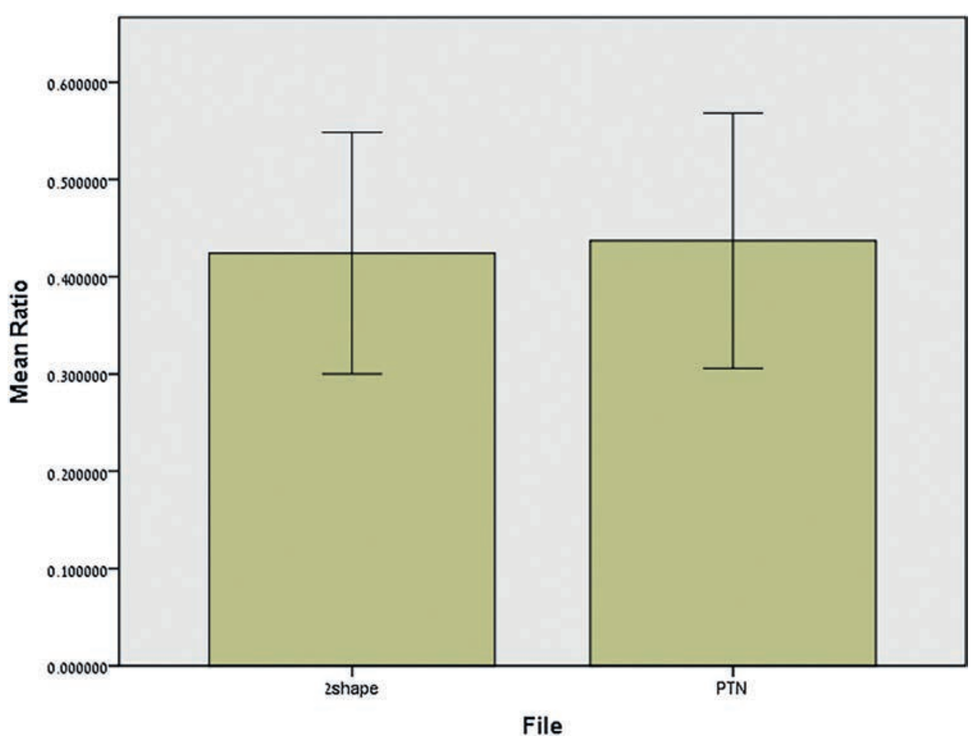

Figure 1 Total mean centering ratio of 2Shape and ProTaper Next.

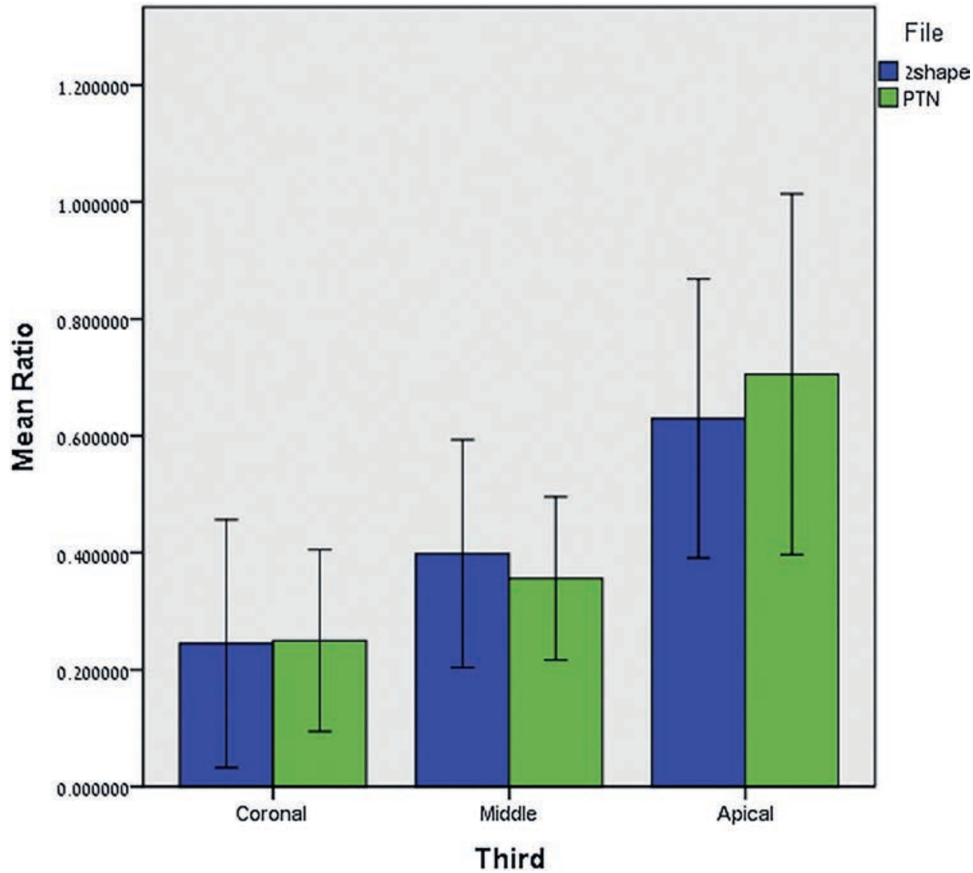

Figure 2 Mean centering ratio of 2Shape and ProTaper Next at the coronal, middle and apical third of the c.

alloy. Both M-wire and T-wire are nitinol after a proprietary thermomechanical processing procedure that increased the flexibility and the fatigue resistance.

In the present study, both PTN and TS exhibit some degree of deflection of the original canal axis. There were no significant differences between the tested file systems. Both systems showed significantly more deflection at the apical third of the simulated canal.

It would be of clinical interest to investigate the performances and centering abilities of these systems in severely curved canals in human teeth.

Conclusion

Based on the parameters examined in this study and within its limitations, it can be concluded that there were no significant differences in the centering ability of the PTN and 2Shape systems in simulated severe curved canals. Both systems exhibited some degree of transportation, especially in the apical third.

Clinical relevance

The respect of the original anatomy is one on the goals of modern endodontics.

Investigation may help the clinical expectation of the instruments tested and help clinicians.

Conflict of interest

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

Acknowledgement

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