Comparative Study for the Shaping and Cleaning Ability of Four Rotary Nickel Titanium Instrumentation Systems

(An in vitro study)
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By

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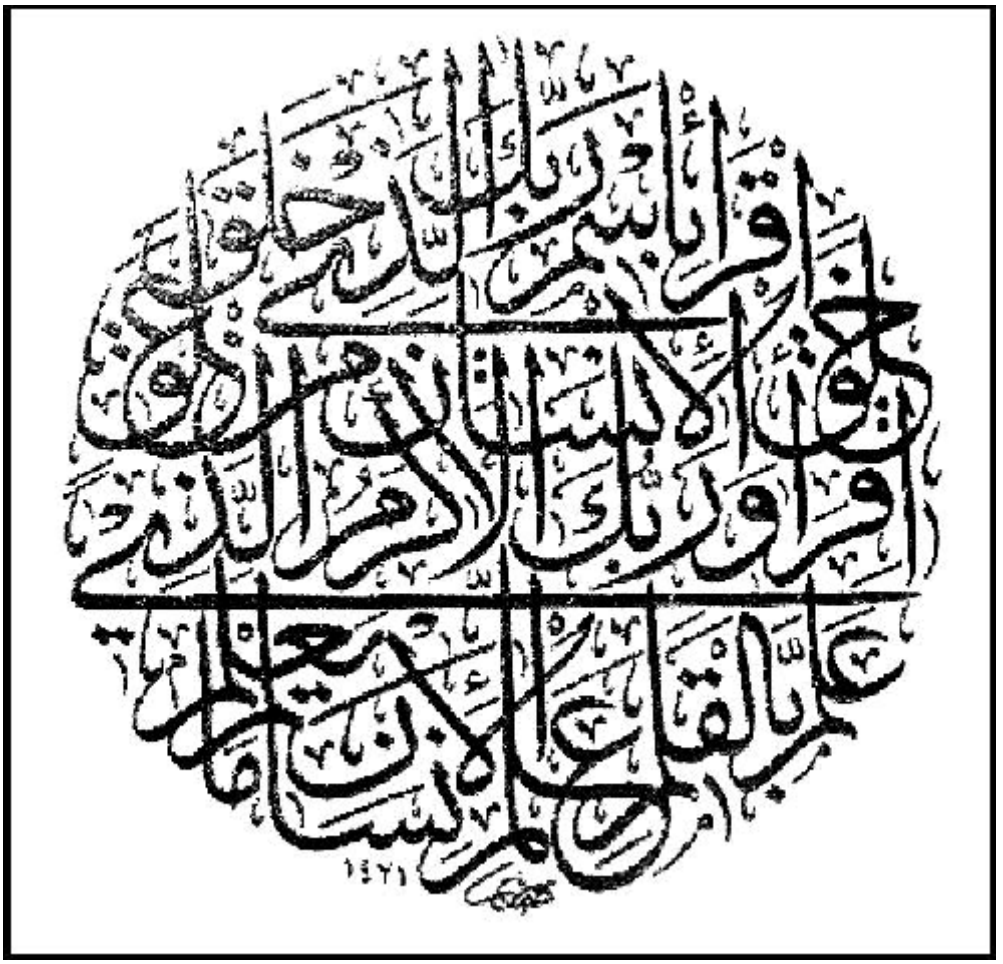
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DEDICATION

TO MY GREAT MOTHER

TO MY DEAREST FATHER

TO MY LOVELY WIFE

TO MY FATHER AND MOTHER IN LAW

AND TO MY BROTHER'S SOUL

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Aim of the Study

The aim of the present study was to evaluate the shaping and cleaning ability of four different rotary NiTi systems in extracted human teeth.

Introduction

Cleaning and shaping is one of the most important steps in the endodontic treatment. It involves removal of the contents of the pulp space and shaping the root canals to receive the filling.

Root canal enlarging instruments were first fabricated from stainless steel; however the main problem with stainless steel instruments was its low flexibility which when used in curved canals leads to transportation, zipping, perforations and/or instrument separation.

These problems led to the development of more flexible instruments that have better ability to maintain the original shape of the canal and the original curve with more uniform and centralized preparation and less procedural errors. These are the NiTi root canal files, that were first introduced as hand instruments. Later, engine driven NiTi files appeared to improve their cutting ability.

Different rotary NiTi files are present on the market with different geometrical designs. These different design features are reflected on the shaping and cleaning ability of those tools.

Shaping ability of nickel titanium files:

One of the objectives of the root canal treatment is the maintenance of canal anatomy and shape and to produce a funnel shaped preparation with the narrowest diameter at the apex to allow hermetic sealing of the canal. Instrumentation of curved canals is always a challenge for the practitioner. The kind of instruments used has a strong influence on the resulting canal shape.

Chan and Cheung [(1)] compared stainless steel and nickel-titanium K-files in curved canals. A total of 24 moderately curved canals in the mesial roots in extracted human mandibular first molars were randomly divided into two groups. These were instrumented manually using either stainless steel or nickel-titanium, K-files with the step-down technique. The results showed that the two file types removed similar amounts of dentine at all three levels examined. The nickel-titanium files left a thicker layer of dentine on both the mesial and furcal aspects than stainless steel files. The NiTi files caused more canal transportation but to the directions which are considered to be safe i.e. the buccolingual directions and the furcal direction in the apical area or away from the danger zone in the coronal and middle thirds of the canal.

Thompson and Dummer [2] evaluated the shaping ability of Quantec Series 2000 rotary nickel-titanium instruments in simulated root canals. A total of 40 canals with four different shapes in terms of angle and position of curve were prepared. It was found that preparation time was less in 40° canals and difference was significant. The instrument failure between 20° canals and the 40° canals was insignificant. The change in working length was better maintained in the 20° curve. As regards to apical stops they were better in 20° group and over half of them were rated poor in the 40° curve. Apical smoothness was better also in the 20° group. All the canals had coronal smoothness and no horizontal or longitudinal grooves. 20° curvature canals exhibited better flow and all canals had good taper. It was concluded that Quantec series 2000 is a reliable instrument in root canal preparation but its quality of preparation decreases with the increase in the degree of curvature.

Bryant et al. [3] evaluated the shaping ability of 0.04 and 0.06 taper profile NiTi instruments on simulated resin canals. Two groups of canals were created using silver points with angles of 20° and 40° and with curves of length 8 mm and 12 mm. Results showed that 83%of the canals retained their working length when prepared to size 35. No aberrations of any kind were found when canals were prepared to size 25 but when canals where prepared to size 35 zips and elbows were found in five (12.5%) canals, all

occurred in the 40°, 12 mm specimens. The difference between canal shapes was significant. As for what is called outer widening of the canal which is similar to the zip but occurs more coronally there was no significant difference concerning canal shapes. No ledges occurred and 2 perforations and 2 danger zones occurred in the 40° canals.

Schäfer [(4)] compared the shaping ability of Hero 642 rotary nickel-titanium instruments with that of stainless steel hand K-Flexofiles. Canals with curvature angles of 28 and 35° were prepared. Results showed that 1 Hero 642 separated in the 28° curve and 2 in the 35° curve while none of the K-Flexofiles separated. In 28° curved canals, working length was maintained significantly better by using Hero 642 instruments than with K-Flexofiles while in 35°the difference was not significant. In the canals with 28° curves, Hero 642 instruments removed material almost regularly on the outer as well as on the inner side of the curvature also canals remained better centered. In the canals with 35° curves K-Flexofiles exhibited material removal mainly in the last 1 to 4 mm of the outer side of the curvature, resulting in moderate bulging of the canal. In general, the Hero 642 instruments had a more centered enlargement than did the K-Flexofiles.

Versümer et al. [5] compared Profile 0.04 and Lightspeed on fifty extracted mandibular molars with root canal curvatures between 20° and 40°.The parameters evaluated were: straightening, postoperative root canal diameter, file fractures, perforations, apical blockages, loss of working length, cleaning ability and working time. Results showed no significant difference in canal straightening. In case of canal cross section the only significant difference which was found was in the coronal third with Lightspeed giving the best results. As for smear layer and debris removal light speed performed better in the coronal third. As for procedural errors both systems were similar with Lightspeed being safer as 3 fractures occurred with profile 0.04.

Tan and Messer [6] evaluated the size of the apical preparation. Thirty freshly extracted mandibular molars were randomly assigned to three equal groups. The mesiobuccal canals were instrumented with K file using step-back technique without coronal flaring (control; group 1), K file using step-back technique after coronal flaring (group 2), and Lightspeed instrumentation (group 3).Final apical size in the first and second group was determined by Grossman criterion where the apical size is the third size after the first file that bounds with the canal walls at the working length while in the third group it was determined according to the manufacturer instructions. Canal cleanliness, canal transportation, and final canal shapes were

determined histological at 1-mm and 3-mm levels short of the working length. Results showed that as regards to canal cleanliness at the apical 1 mm Lightspeed performed better .As for canal transportation the step back technique caused more transportation, also less rounded canal shape than Lightspeed.

Yun and Kim [7] compared four rotary NiTi systems (ProFile, GT Rotary, Quantec, and Protaper files) when used to instrument 48 simulated curved root canals in plastic blocks with the crown-down technique. One operator prepared all the canals until reaching an apical canal size of #30. The instrumentation time, changes of canal dimension and curvature, canal aberration, and instrument deformation. Data were analyzed by using one-way analysis of variance followed by the Duncan multiple range test. The results showed that Protaper took less time in preparation but produced more transportation and more instrument deformation than others.

The cleaning effectiveness and shaping ability of K3 NiTi instruments and K-Flexofiles were evaluated by ***Schäfer and Schlingemann*** [8]**.** A total of 60 root canals of mandibular and maxillary molars with curvatures ranging between 25° and 35° were divided into two groups of 30 canals. Canals were prepared by K3 instruments using a crown-down preparation technique or by K-Flexofile using a reaming motion up to size 35. The degree

of root canal straightening was analyzed using computer image analysis software. The results showed that the K3 instruments resulted in less canal straightening.

Xu et al. [9] compared Protaper NiTi rotary instruments and K-files in management of curved root canals. Results showed no transportations, apical blockages or ledges in the Protaper group. The technique retained the curvature and flow of curved canals. The outcome of this study showed that the Protaper NiTi rotary instruments can prepare curved root canals effectively and safely.

Schäfer and Vlassis [10] compared Protaper versus RaCe as regards to their Cleaning effectiveness and shaping ability in severely curved root canals of extracted teeth. Criteria evaluated were: change in root canal curvature, canal cleanliness which was evaluated with SEM, time needed for preparation and instrument failure. No significant differences were detected between the instruments for the time taken to prepare the canals. Difference in time was insignificant also was the change in working length. As regards to canal straightening the RaCe instruments caused less canal straightening and maintained canal curvature better than Protaper.

Ayar and Love [11] studied the shaping ability of ProFile and K3 rotary NiTi instruments when used in a variable tip sequence in simulated root canals of 20 curvature and 5 mm radius and 30