ISSN- O: 2458 - 868X, ISSN –P: 2458 - 8687

International Journal of Medical Science and Innovative Research (IJMSIR)

IJMSIR : A Medical Publication Hub

Available Online at: www.ijmsir.com

Volume – 2, Issue –6, November – December - 2017, Page No. : 499 - 505

"Coronal Flaring and Biomechanical Preparation Affecting the Working Length of the Curved Canals" – An In Vitro Study

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Type of publication: Original Research Paper

Conflicts of Interest: Nil

Abstract

Root canal anatomy varies greatly, and the curvature may begin at any level in the canal.[1] During instrumentation care has to be taken to prevent any under or over instrumentation to prevent, or straightening of a curved canal due to over instrumentation, or transporting of the apical foramen because canals can curve at any an level, even straight canals may curve at the apical third.[2] It has been found that the stainless steel instrument tend to straighten the curved canals more than any Ni-Ti instrument due to the stiffness of the stainless steel files.[3] Further development taken in the field has led to development of various Ni-Ti instruments that allows better shaping of the curved canals.[4]

Clinical trials comparing the use of Stainless steel instrumentation with that of Ni-Ti instruments reveal that Stainless steel instrument showed more failures than Ni-Ti on one year post-operative radiographic evaluation. Post-obturation inspite of all the latest developments in the material, design, length and the cutting edge of the blades, still there remains a chance of obtaining procedural errors. **Weine et al** had mentioned that more flared preparations may reduce the chances of elbow formation at the apical third.[5] Various techniques have been recommended for flaring of the canals, but most commonly used are the Crown Down and Step Back Technique. Hence, this in-vitro study was conducted with the following objectives:

- To evaluate the loss of working length after coronal flare with hand stainless steel K files and Nickel-Titanium rotary files (Protaper rotary and RACE system)

- To evaluate the loss of working length after complete canal preparation with hand stainless steel K –files and Nickel-Titanium rotary files (Protaper rotary and RACE system)

Materials and Methods

A total of 60 freshly extracted human Mandibular first molars with moderately curved mesiobuccal canals (20^0-45^0) were selected for this study. They were stored in normal saline at room temperature. The teeth were randomly assigned into three experimental groups of 20 teeth each.

Group1: Hand Stainless Steel K-files + Gates Glidden drills

Group2: Rotary Protaper series (DENTSPLY)

Group3: RACE (FKG Dentaire, La-Chaux-de-Fonds, Switzerland)

Procedure of Preparation : All the teeth were individually mounted in a chemically cured clear acrylic (DPI-PR) using a split metallic mould. Coronal access was made with regular length no.4 round bur and EX-24 safe end bur in a high speed handpiece with coolant.

Digital radiographs of each sample were taken at 3 different stages during canal preparation:

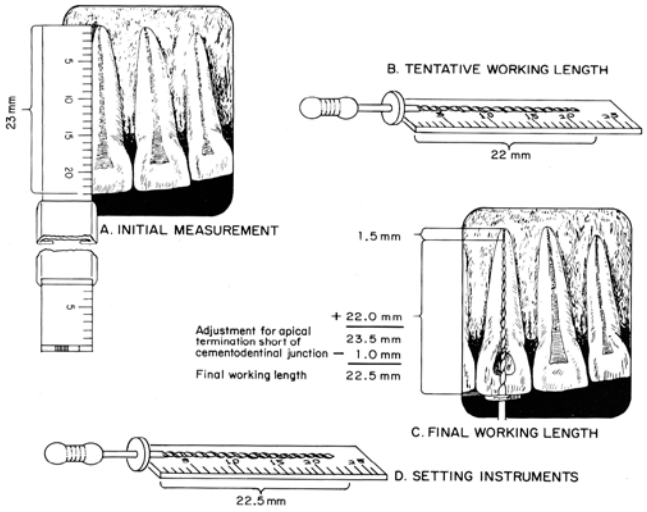
1. Working length digital radiograph after access opening
2. Working length digital radiograph after coronal flaring
3. Working length digital radiograph after final canal preparation.

For Standardization a radiographic paralleling device with a slot to hold the sensor was used to take digital radiographs at different stages so that accurate images could be captured at fixed angulations of 0^0 vertical and 0^0 horizontal for an exposure time of 0.40 seconds. For obtaining working length, Ingle's method (1957)[6] was followed as this method has proved to be superior to other methods and is the most commonly used.

Steps:

1. Root length was measured using a preoperative digital radiograph.
2. 1mm safety allowance for possible image distortion or magnification was subtracted from this measurement.
3. A no.10 Stainless steel file with its rubber stoppers at this tentative working length was selected.
4. The instrument was placed into the root canal until the rubber stopper was at the plane of reference.
5. Working length digital radiograph was taken.
6. On the radiograph difference between end of the instrument and the end of the root was measured and this amount was subtracted or added to the original measured length.
7. From the adjusted length, 1mm (safety allowance) was subtracted to confirm to the apical termination of the root canal at the apical constriction.

These digital images were then used for digital assessment of working length for coronal flaring.



Radicular Preparation

Group 1: Hand Stainless steel K Files: Passive step back technique of root canal preparation was used which was proposed by Mohmoud Torabinejad (1994)[7]

1. Starting with a no.10 K file which is inserted to the radiographic apex with a very light , 1/8th to 1/4th turn and push- pull strokes to establish apical patency with little or no resistance.
2. With the same motion, no.15, 20, 25, 30 K files were carried into the canal as far as they could be inserted passively.
3. Gates Glidden drill no. 1 was introduced slowly to shape the orifice opening of the canal.
4. Gates Glidden drill no. 2 was inserted into the mildly flared canal to a point where it binds slightly. It was then pulled back about 1 to 1.5 mm and the slow speed hand piece was activated. With an up and down motion and slight pressure, the desired canal wall was planned and flared.
5. Similar technique was also used to plane and flare the higher portions of the coronal region of the root canal with the use of Gates Glidden drill no.3.
6. After placing a file no. 15 in the canal the working length was reestablished.
7. Step 4 and 5 were repeated. A file no.30 was inserted to the full working length and the root canal was then prepared.
8. With a Master apical file size no. 30 inserted till the definite working length, another digital radiograph image was taken for the digital assessment of the final loss of working length.

Group 2: Rotary Protaper Series: In this group Crown Down technique was adopted using an endodontic 16:1 reduction gear hand piece powered by electronic motor (Anthrogyr France). All the preparations were carried out at a constant speed of 250 rpm.

Before starting the rotary protaper sequence, canals were passively negotiated with file no. 10 and 15 until a smooth reproducible glide was confirmed. Then rotary protaper series were used in the following sequence after a preoperative radiograph:

1. Negotiations with Stainless steel K file no.10 and 15 each up to 4mm short of radiographic working length.
2. Coronal flaring with S1 up to 4mm short of radiographic length.
3. Coronal Flaring with SX to gain proper straight line access.
4. Working length determination with Stainless steel K files no.10.
5. Enlarging with Stainless steel K file no 15 up to designated working length.
6. Canal preparation with S1 and S2 up to designated working length.
7. Canal Preparation with F1and F2 up to designated working length.

Finally file no. 30 was inserted till the definite working length and another digital radiographic image was taken for digital assessment of the final loss of working length.

Group 3: RACE (Reamer with alternate cutting edge): In this group again Crown Down technique of the root canal preparation was adopted using an endodontic 16:1 reduction gear hand piece powered by electronic motor (Anthrogyr France). All the preparations were carried out on the constant speed of 300-600 rpm.

Before starting the rotary RACE sequence, canals were passively negotiated with file no. 10 and 15 until a smooth reproducible glide was confirmed.The canal was then prepared at the coronal and middle portions using a RACE 40, followed by RACE 35.

- A Digital radiograph was then taken to measure the working length.
- Further enlargement was then carried out using RACE (20/.04 > 25/.04 > 30/.04).
- After final preparation a digital radiograph was taken and a final loss of working length was assessed.

- For all the groups 3% Sodium hypochlorite (NaOCl) and normal saline were used as irrigants and R C HELP as a lubricating agent.

Assessment of Loss Of Working Length

All the digital images:-

- Pre-instrumentation working length images.
- Working length images after coronal flaring.
- Working length images after complete canal preparation were stored and analyzed on a computer (Compaq Presario- Intel Pentium M using Cygnus media ,Cygnus technologies, US).
- The loss of working length after coronal flaring was measured by subtracting WL2 from WL1 (WL2-WL1).
- Final loss of working length was measured by subtracting WL3 from WL1 (WL3-WL1).

Statistical Analysis : The loss of working length was calculated for 20 teeth each in three groups, the mean and the standard deviation for the loss of working length in the instruments was calculated. The comparison of each parameter for pair wise groups was done through students unpaired‘t’ test. The values of‘t’ and ‘p’ were recorded for each pair on the bases of p value. The inference was drawn.

Results

Teeth were randomly assigned into three experimental groups of 20 teeth each, which were divided into following three groups: **Group 1**: Gates Glidden drill plus hand Stainless steel files. **Group2:** Protaper Rotary series. **Group 3**: RACE.

Teeth were mounted in clear acrylic and access opening was done, digital images were taken of each sample at 3 different stages of canal preparation.

- Working length images after access opening.
- Working length images after coronal flaring.
- Working length images after final canal preparation.

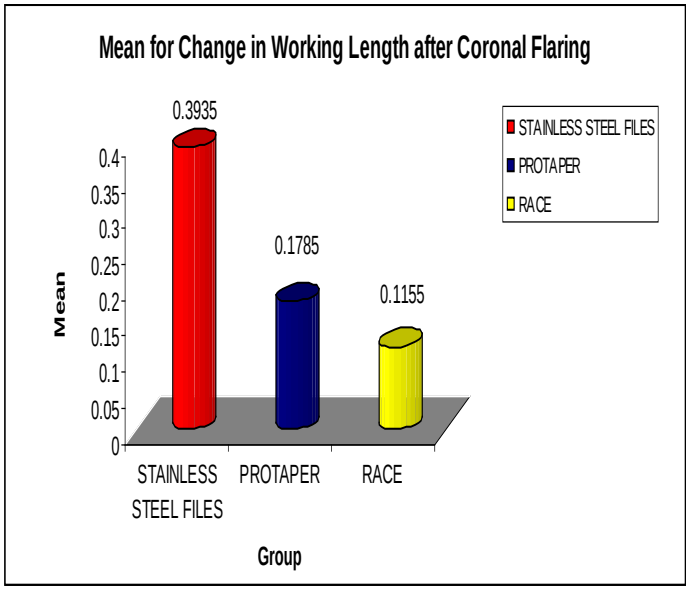


Figure 1: showing mean change in working length in three groups after coronal flaring.

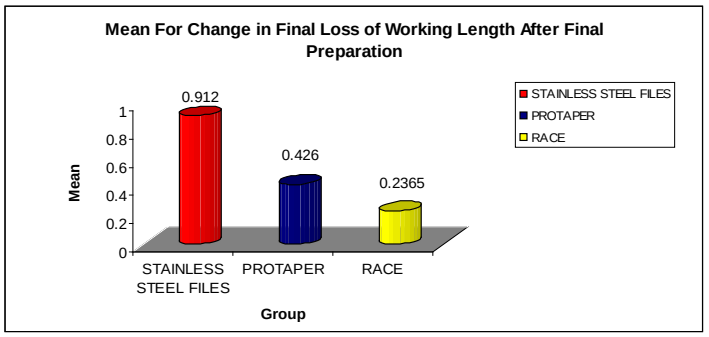


Figure 2: showing mean change in final loss of working length in three groups after final canal preparation.

In group 1 , initial coronal flaring was the factor with the greatest influence on the length change. Of the overall 0.9120 mm mean length decrease that was seen in group 1, 0.3935mm occurred during canal flaring. Of the overall 0.4260mm mean length decrease that was found in group 2, 0.1785mm occurred during initial flaring. On group 3, overall mean decrease in length was 0.2365mm and during coronal flaring the loss was 0.1155mm. So we conclude that the relatively large length change produced by Gates Glidden drills in group 1 was due to the removal of the cervical buldge of the canal. Coronal flaring with

Gates Glidden drills tends to create straight line access to the middle root canal. Flaring in group2 and group3 with the files tended to follow the original canal contour and it did not produce the same type of straight line access to the mid root canal.

Table 1: Change in mean values between Stainless Steel and Gates / Race.

Stainless steel and gates / RACE	T value	P value	Significance
After coronal flaring	6.5653	0.0001	HS
After final preparation	6.4428	0.0001	HS

Table 2: Change in mean values between Protaper/ Race.

Protaper /RACE	T value	P value	Significance
After coronal flaring	3.1300	0.0034	V.SIG
After final preparation	4.9759	0.0001	HS

Table 3: Change in mean values between Stainless steel and gates/ Protaper.

Stainless steel and gates / Protaper	T value	P value	Significance
After coronal flaring	5.0665	0.0001	HS
After final preparation	4.8297	0.0001	HS

A significant difference was appreciated, when the non-flared working lengths were compared with final working length in all the three groups.

Discussion

The most desirable shape of the prepared canal is a progressive taper with the largest diameter at the coronal end and the narrowest at the apical constriction. The tapered preparation is particularly advantageous in situations where the canal is filled with gutta-percha point for an improved apical seal, and a diffuse distribution of stresses. Therefore, when the 'ideal' shape is achieved, both cleaning and obturation of root canal are facilitated.[8] During endodontic instrumentation of a curved canal, the flutes of the enlarging instruments remove more dentin from the inner wall of the curve. This affect tends to "straighten" the canal and thus, may significantly shorten the working length of the canal.[9]

Due to development of advanced instruments designs and in order to overcome the procedural errors a number of authors suggested a return to the crowndown technique. This technique was generally shown to produce rounder preparation in cross-section which was cleaner and also maintained the original curve of the canal. Almost all rotary Nickel-Titanium systems follow the same technique.[10] Flaring the coronal portion of the root canal during endodontic therapy has several advantages and functions (**Baumgartner et al., 1995**). It allows the removal of interferences in the coronal and middle-third and gives the operator better control of the instruments in the apical third. **Lim and Webber (1985)** recommended coronal preflaring because it enables the apical preparation to be performed more efficiently and also reduces the incidence of hourglass shape canals

Thus this study was performed to evaluate changes in the loss of working length and after coronal flaring and after complete canal preparation, using Gates Glidden drill in conjugation with hand stainless steel K files and Ni-Ti rotary files (Protaper and RACE).

Protaper system provides a tapered and adequate canal shape to allow for effective irrigation & obturation .The well planned file design allows for an ideally prepared root canal of easy or difficult shape. This file design allows for ideal & efficient shaping of the coronal aspects of the root canal & the relocation of canal orifices, resulting in straight line access. This also reduces the torsional strain and ease of the pressure to achieve widening of the root canal. Varying helical angle and pitches – improves the cutting action, allow for better removal of debris out of the root canal, and prevent the instrument from screwing into the canal.

On the other hand RACE helps in preventing the screwing on blocking effect and has the advantage of an extremely low operating torque, because the helix angles of the instrument alternate, they cut constantly and remove debris from the canal walls without the screw-in effect found in other instruments. The result is a rotary endodontic file with the lowest working torque, optimum operator control, reduced risk of metal fatigue and improved resistance to instrument fracture. Due to its super flexibility and its ability to withstand high torsional forces, it shapes as well as maintains the canal curvatures better.

Loss of working length was evaluated using digital radiographs interpreted using Cygnus media software (Cygnus technologies, USA) which make working length estimation easier by taking reliable readings over canal curvatures [37.]

Since the advent of Ni-Ti instruments over a decade ago numerous in vitro investigations have assessed various properties of these instruments. However, only limited information is available regarding clinical outcomes following root canal treatment that had been completed with the aid of Ni-Ti rotary instruments.

In the present study, it was observed that the three groups differed in the relative amounts of working length change that occurred as the result of coronal flaring. The Gates glidden drills used in the teeth of group 1 caused, a significantly greater decrease in length during initial canal flaring than did Nickel-titanium rotary file used in the teeth of group 2 and group3.

A comparison within each group of non- flared working minus flared working length indicated that the difference was significant for group 1 but not for group 2 and group 3. The Gates glidden drill showed a very significant difference, when compared to rotary Protaper and RACE. RACE showed the least difference in working length among the three groups.

There are no direct studies found in literature comparing Gates Glidden drills to rotary Protaper and RACE for the loss of working length after coronal flaring which needs to be further investigated.

Ni-Ti rotary instrument show better centering, less straightening and transportation of canals when compared to hand stainless steel K files. This confirms the finding in the general studies of Ni-Ti rotary instruments. **(Luiten D .J et al 1995; Glossan et al 1995)**

From clinical stand point, this study suggests that when using either hand stainless steel instrument (K file) or rotary instruments (Protaper and RACE) in curved canals, it would be better to recalculate the working length during the instrumentation sequence. The recalculation of working length Can be accomplished either after coronal flaring or prior to the completion of apical preparation. Also, the most stable and predictable working length determination would be accomplished after coronal flaring has been completed.

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