ORIGINAL ARTICLE

Working length changes following straight-line access and different coronal flaring methods

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Abstract

Introduction: The purpose of this *in vitro* study was to compare working length (WL) changes after straight-line access (SLA) and different coronal flaring (CF) methods.
Materials and Methods: Coronal access preparations were made (without SLA) in molar teeth to allow access to 120 canal orifices with a hand file. The suitable cusp and root tips were then flattened to facilitate reproducible and accurate measurements. WL was determined before and after SLA and after different methods of CF. These methods consisted of: stainless-steel (SS) hand files + NiTi hand files, SS hand files + Gates Glidden burs (GG) (#1 to #3), (#3 to #1), GG in step-back manner and crown-down manner without using SS hand files and NiTi rotary orifice shapers. Data was analyzed by paired T-test and coefficient of variance.
Results: The mean difference in WL changes after SLA was statistically greater than other methods of CF ($P<0.001$). The mean difference of WL after CF, in SS hand files + GG (#3 to #1) group was significantly different with SS hand files + NiTi hand files group ($P<0.004$) and NiTi rotary group ($P<0.04$). Also the mean changes of WL in SS hand files + NiTi hand files group was significantly different with GG (#1 to #3) group ($P<0.01$).
Conclusion: It is better to established working length after SLA. Least changes in WL was occurred with NiTi rotary orifice shapers after coronal flaring. **(Iranian Endodontic Journal 2008;3:57-61)**

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Introduction

The significance of precise working length (WL) estimation and it's maintenance throughout endodontic treatment is well recognized (1-3). In many current preparation techniques, straight line access (SLA) and coronal flaring (CF) are suggested to minimize transportation of the canals (1,2,4-9). SLA involves the use of a tapered fissure diamond bur to remove coronal tooth structure. CF involves the use of hand files, Gates Gliddens (GG), Peeso Reamers, NiTi Rotary and/or other especially designed burs for removing coronal root dentin.

It has been suggested that SLA and CF result in a decrease of canal length (3,10). Caldwell found that the use of stainless steel (SS) hand files resulted in a mean length change of -0.35 mm in the mesiobuccal canals of maxillary molars and a decrease of -0.29 mm in the mesiobuccal canals of mandibular molars after complete instrumentation (11). Davis *et al.* compared pre and post instrumentation WL in curved root canals prepared with: (a) early CF (flaring completed before WL determination) or late CF (flaring completed after WL determination), and (b) SS hand files + GG drills or rotary NiTi files (12). They indicated that WL decreased for all canals as a result of canal preparation. The mean decrease in WL was significantly greater for SS group than NiTi group. Fewer changes in WL occurred in both groups when initial WL was determined after coronal flaring. Schroeder *et al.* showed that there was a measurable, significant change in canal length after SLA and CF (13). They concluded that the mean change was slight and clinically unimportant.

The present *in vitro* study thus aims to compare WL changes after SLA with WL changes after different methods of CF. These methods consisted of: SS hand files + NiTi hand files, SS hand files + GG burs (#1 to #3), (#3 to #1), GG burs in step-back manner and crown-down manner without using SS hand files and NiTi rotary orifice shapers.

Materials and Methods

One hundred and twenty canals of recently extracted permanent human molars were used (mesiobuccal/mesiolingual of mandibular molars and mesiobuccal/distobuccal of maxillary molars). Before experimental procedures, all teeth were stored in normal saline and were disinfected by 5.25% hypochlorite solution for 30 minutes. Following assessment for complete root formation, soft tissue and calculus were removed mechanically. While the teeth were in up-right position in alginate mold, a film (Kodak, Rochester, NY, USA) was aligned so that the long axis of the root canal was parallel to the surface of the film and the x-ray tube. Radiographs of each tooth were exposed using a dental x-ray machine (Planmeca, Helsinki, Finland) which was set at 65 kV and 7.5 mA. The films were exposed at 0.65 sec with a source-object distance of 8 cm and film-object distance of 5 mm. The films were uniformly developed manually for 20 s, fixed for 60 s, and washed with running water for 10 min. Using the technique described by Schneider (14), roots with mesial/distal curvatures between 20 and 45 degree were selected.

Coronal access preparations were made (without SLA) using a high speed handpiece and air/water spray to allow access to the canal orifices with a hand file. Then the appropriate cusp and root tips were flattened with a diamond disk to facilitate reproducible and accurate measurements. A K-file #10 (Dentsply, Maillefer, Ballaigues, Switzerland) was placed inside the canals so that the rubber stop of the file rested on the flattened cusp tip (occlusal reference), and the file tip reached the glass slab against which the root was held. This distance (WL) was measured by a digital caliper (LG, Korea) to the nearest 0.01mm. In each phase, measuring procedures were completed twice for each canal, and a mean value of WL was calculated and recorded. All preparations and WL determination were completed by a single operator experienced in preparation with the different types of instrument.

In the next phase, the access cavities were corrected by SLA using a high speed hand-piece and a 7714 tapered fissure bur (Kerr, Australia) to remove dentin shelves in the chamber and coronal tooth structure. WL was measured as described. Then the teeth were randomly divided into six experimental groups (n=20/group).

Each specimen in groups 1, 2, and 3 was treated as follows: the root canals were flooded with 5.25% NaOCl then a #15 stainless steel K-type file (Dentsply Maillefer, Ballaigues, Switzerland) was placed until moderate resistance was felt. The file was rotated clockwise 1/4 turn without apical pressure and was then removed from the canal. This was continued until a #25 file size had been used. Then CF was finished in group 1 using NiTi hand files 30-45 (FKG Dentaire, La Chaux-de-Fonds, Switzerland) utilizing the balance force technique as described by Roane (15). In group 2, Gates Glidden burs (Dentsply Maillefer, Ballaigues, Switzerland) were used in a step-back manner (#1 to #3) for CF, while in group 3 GG burs were used in crown-down manner (#3 to #1). The GG series were advanced into the canal until slight resistance was felt. Then with slight pressure directed away from the inner canal curvature, the drills were withdrawn; thus the drills were not used to a predetermined depth.

In groups 4 and 5, coronal flaring for each specimen was accomplished by GG burs from (#1 to #3) and (#3 to #1) without using hand files.

Each specimen in group 6 was treated as follows: the root canals were flooded with 5.25% NaOCl. Profile orifice shapers (Dentsply Maillefer, Ballaigues, Switzerland) were used to enlarge the coronal portion of the canals. A crown-down technique was used for canal enlargement using a 16:1 gear reduction handpiece (Anthogyr, Sallanches, France) and gentle pressure. While

Table 1: Mean WL changes in studied groups (millimeters)

Group		Pre SLA/Post SLA		Post SLA/Post CF	
	N	Mean	SD	Mean	SD
1-S.S hand files + NiTi hand files	20	0.2440	0.3670	0.2900	0.2427
2-S.S hand files + GG((#1 to #3)	20	0.3950	0.5687	0.2775	0.3751
3-S.S hand files + GG (#3 to #1)	20	0.5965	0.5079	0.4745	0.5077
4-GG burs (#1 to #3)	20	0.5355	0.5702	0.4110	0.5163
5-GG burs (#3 to #1)	20	0.6795	0.5666	0.2750	0.5838
6-NiTi rotary orifice shapers	20	0.9525	0.9365	0.1570	0.5766
Total	120	0.5672	0.5861	0.3142	0.4670

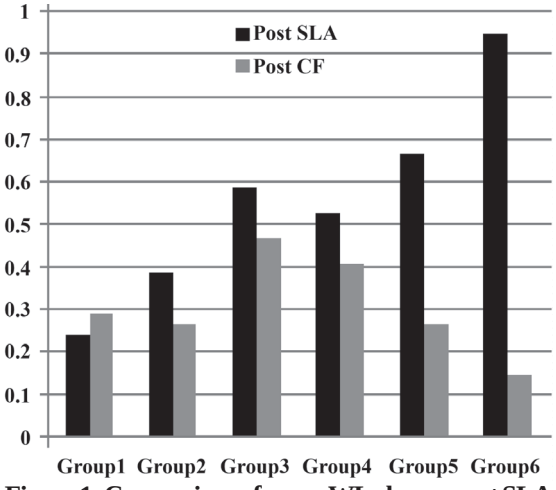

Figure 1: Comparison of mean WL change post SLA and post CF (mm)

rotating at 300 rpm, a #3 NiTi orifice shaper was placed into the canal until it no longer moved apically. After filing with up and down movement for 5-10 seconds, #2 and #1 NiTi orifice shapers were used as previously described. Again WL was measured in all groups post coronal flaring. For all preparations, 1 mL of 5.25% NaOCl was used for irrigation between each file size. Finally, collected data was analyzed by paired T-test and coefficient of variance at a significant level of ($P<0.05$).

Results

The mean difference of WL change are shown in Table-1 and illustrated in Figure 1. Data analysis using paired T-test showed that the average WL change was decreased by 0.56 mm after SLA which was statistically significant ($P<0.001$). There was a statistical significant difference between the average WL change post CF and post SLA ($P<0.001$).

Following CF, there was a little change in WL among different groups, however the mean decrease of WL was greatest for the SS hand files + GG (#3 to #1) group (0.47mm). Least change in WL was observed in NiTi rotary orifice shapers group (0.15mm). An analysis of variance revealed that the mean difference of WL post CF, in group 3 (SS hand files + GG #3 to #1) was significantly different with group 1 (SS hand files + NiTi hand files) ($P<0.004$) and group 6 (NiTi rotary group) ($P<0.04$). Also the mean change of WL in group 1 was significantly different with group 2 (GG #1 to #3 group) ($P<0.01$).

Discussion

The results of the present study showed that the major change in WL occurred after SLA and the mean difference of WL change post SLA was statistically greater than post different methods of CF. The WL in curved canals was decreased on average by 0.56mm following SLA. The WL then further changed but to a lesser extent (on average 0.25mm) following CF, the greatest change observed when SS hand files + GG #3 to #1 (group 3) were used. This is clinically important because it indicates significant potential for over instrumentation, over medication and overfilling of the canals. If instruments and obturating materials are not kept within the canal space, periapical inflammation may occur. This may increase post treatment pain and flare-ups and adversely affect the prognosis of endodontic treatment (16-18).

Comparison of the different experimental groups following CF showed that the mean decrease of WL was significantly greater in SS hand files

+ GG #3 to #1 group (0.47mm) while the least change occurred in NiTi rotary group (0.15mm). Our findings were similar to the results reported by Davis and Marshall (11). In their study, the mean decrease of WL was reported 0.48mm for SS group and 0.22 mm for NiTi rotary group. Coronal flaring with GG drills tends to create a straight-line access to the mid-root of the canal while NiTi rotary files tended to follow the original canal contour and remain centered within the canal during instrumentation, thus minimizing the straightening of the canal. This supposition is also supported by the findings of Thompson and Dummer (19-20) and Bryant *et al.* (16). Our results indicate that NiTi rotary orifice shapers should be used for coronal flaring rather than a regimen of SS hand files + GG (#3 to #1) as less change in WL results following NiTi use. WL can be estimated after SLA when NiTi orifice shapers are used for coronal flaring. If SS hand files + GG (#3 to #1) are used for CF, it is suggested to estimate WL after both SLA and CF or re-evaluate WL by radiography or an apex locator post CF, as greatest change in WL results from their use after coronal flaring.

There was no significant difference after coronal flaring with different methods of GG drills. However, when these drills are used in combination with hand files, less change in WL occurred in step-back manner. Probably, initial coronal flaring with hand files caused drills to penetrate deeper into the canal and step-back manner provide condition to cut dentinal walls relative to original canal contour. Using only GG drills for CF, caused more changes in WL in step-back manner, because the drills penetrate deeper than crown-down manner but can not follow the original canal contour like the combination method as initial CF with hand files was not done. In the present study, despite considering a stratified randomized distribution of samples according to the Schneider method (radiographs were taken using paralleling technique and repeated for SLA), a remarkable difference occurred between groups after SLA. It seems that Schneider method alone is not adequate for sampling selection because it only provides some information regarding the apical geometry of canal curvature and can not describe the geometry of the coronal part of the root canal curvature. In addition, the shape and configuration of the access cavity prior to SLA, such as its location, size and angulations may be different among samples. Thus the degree of divergence of cavity walls that aids the removal of dentinal overhangs over the canal orifices may be different in samples. It is recommended that these variable factors should be considered in future research.

Conclusion

According to the results of this *in vitro* study, straight line access or adequate access cavity design can affect working length more than coronal flaring. It is better to use NiTi rotary orifice shapers for coronal flaring as the least change in working length occurred with these instruments. Working length can be estimated post straight line access when these files are used for coronal flaring. For other methods of coronal flaring, especially when SS hand files and GG are used, it is advocated to estimate working length after both straight line access/ coronal flaring.

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