ORIGINAL ARTICLE

IN VITRO MICROSCOPIC ANALYSIS OF APICAL 3MM OBTURATION AFTER GT, LIGHTSPEED, AND PROFILE ROOT CANAL PREPARATION

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ABSTRACT

Objective: To compare the quality of continuous wave obturation technique following preparation of the apical third with three different NiTi rotary instrumentation systems.

Methodology: Mesiobuccal canals of 75 extracted human maxillary and mandibular molars were used in study. After instrumentation 25 canals each with GT ProFile .06 and LightSpeed, canals were obturated with continuous wave technique 3-5 mm from the working length. Roots were sectioned at 1mm, 2 mm, and 3 mm from the apex and stained with methylene blue. Two operators evaluated pictures of each section (24X) for obturation quality. Grades of 1- good adaptation, thin sealer film; 2- irregularities with thick film of sealer separating gutta-percha for up to 1/3 from the canal walls; 3- voids or thick film of sealer separating gutta-percha from the canal walls for more than 1/3 were assigned.

Results: The average obturation grade at 1mm was GT= 2.16, ProFile =1.96, LightSpeed =1.80; at 2 mm GT =1.84, ProFile =1.52, LightSpeed =1.52; at 3 mm GT =1.40, ProFile =1.40, LightSpeed =1.20. Overall LightSpeed showed better results but Kruskal-Wallis test showed no differences among groups at all three levels. Statistically significant improvements were revealed in the quality of filling as the distance from the apex increased.

Conclusion: Under the conditions of this study, root canals shaped by GT, LightSpeed and ProFiles revealed similar quality of root canal obturation. The quality of root canal obturation improved in all groups as the distance from the apex increased.

Key words: Apical obturation, root canal preparation, GT, lightspeed, profile curved canals.

INTRODUCTION

The success of a root canal treatment depends on the removal of pulp tissue, bacteria, and necrotic debris combined with adequate canal shaping to facilitate obturation. With cleaning and shaping being the most tedious and demanding phase of endodontic therapy, the practitioner must define certain instrumentation goals. The goals of endodontic instrumentation are to: (1) instrument with control so that there is enlargement without deviation from the original canal; (2) instrument to a size that is consistent with total mechanical and chemical debridment; (3) debride the root canal system from its coronal orifice to its working length, regardless of canal curvature; and (4) create a shape that tapers from the coronal orifice to the apical opening. Techniques for instrumentation to a predetermined size are described. It is agreed that the larger the apical preparation size the better the chance of achieving optimal debridment[1,2]. Whereas most of these criteria are easily achieved in straight canals, fulfilling these goals can be very difficult in curved canals.

In order to alleviate the effects of canal curvature on the apical portion of the instrument, crown down preparation of the root canals is advocated[3]. A number of preparation techniques are described to provide an optimum shape at the end of instrument preparation[4,5]. In a study comparing six different instruments and instrumentation techniques, roots were cross-sectioned at 2, 5, and 9 mm from the apex to determine the quality of canal preparation. In this study, LightSpeed instruments had the largest number of

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round canals at all levels, which are considered most desirable[6]. A round apical preparation is believed more likely to ensure cleaning of all canal walls, subsequently assuring a better apical seal[7].This new generation of NiTi rotary instruments potentially allowed shaping of narrow, curved root canals, without causing significant aberrations[8-10].

In a study comparing LightSpeed and stainless steel K-files using simulated curved canals, the LightSpeed stayed centered in the canals maintaining the central axis, with minimal incidence of transportation, elbow formation and zipping[11]. In another study comparing engine-driven NiTi instrument systems to hand files, again it was not surprising to find that the NiTi systems remained better centered in the canal than the stainless steel hand files[12]. Furthermore, the investigators found no significant difference among NiTi rotary systems at sections taken 1, 3, 5 mm from working length using video imaging.

The purpose of this study was to evaluate the quality of different combinations of instrumentation and obturation techniques based on the centerness and roundness of preparation and the adaptation of gutta-percha to the prepared dentinal wall.

MATERIALS AND METHODS

It was an experimental in-vitro study. Mesiobuccal canals of 75 extracted human molar teeth with completely formed apices were used. All teeth were cleaned and shaped similarly except for the apical 4 mm. Radiographs were taken pre-operatively, working length, mid-op (cone fit), and post-operatively with Reprosil putty impression material from BL and MD angulations for each tooth. Each tooth was accessed with divergent walls, exposing all canal orifices with straight-line access. Coronal flare was employed using Gates Glidden burs (# 4-2) in the coronal 2/3 of the canal or where curvature permitted. Patency was achieved with #8 file passively inserted into the canal until the tip of the file was visible outside the apex. The working length was obtained by subtracting 0.5mm from this measurement. The apical width was gauged using K-file and LightSpeed. The larger of the two was used to prepare the canals to a minimum of four sizes larger except for GT instrumentation where apical size was maintained at ISO size 20. The canals were then instrumented 4 mm short of WL using GT files. The apical 4 mm was prepared using three different techniques i.e. Profiles (.06), GT, and LightSpeed with 25 canals to each technique.

Irrigation was carried out with 17% EDTA solution after each instrument. A final soak of 5.25% NaCL for 6 minutes, coupled with use of patency file. Obturation of

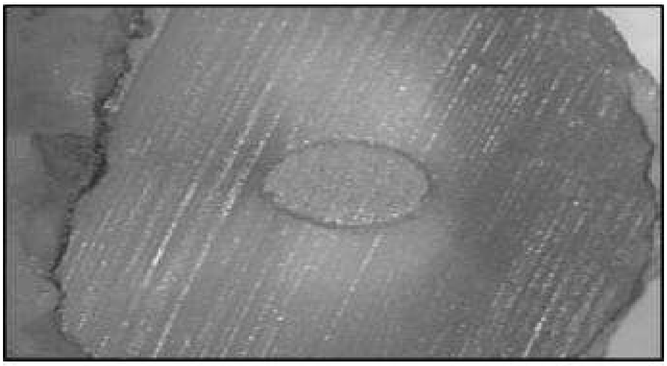

Figure 1 a: Grade (1): well adapted GP with a thin film of sealer with no voids or irregularities.

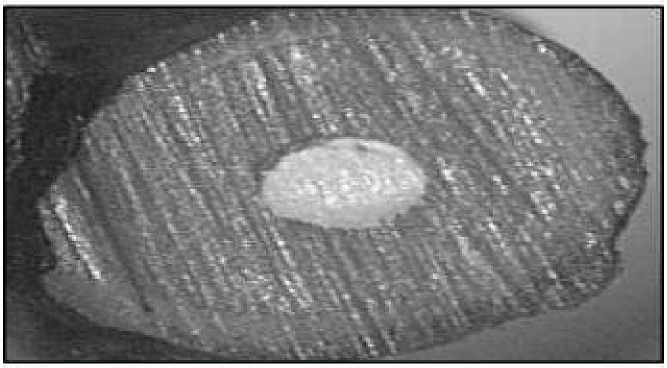

Figure 1 b: Grade (2): voids or irregularities with thick film of sealer separating GP for up to 1/3 of the canal walls.

Figure 1 c: Grade (3): voids or irregularities with thick film of sealer separating GP from the canal walls for more than 1/3.

the 75 canals was carried out using warm vertical technique with System B penetration 3-5 mm from WL with Obtura back-fill. Root section was then done with Isomet slow speed saw perpendicular to the long axis of the canal determined both by visual and radiographic inspection of each root. Each root was sectioned 1mm, 2 mm, 3 mm and 4 mm from the anatomic apex. A Sony digital camera attached to the Moller microscope with X 24 magnification was used to take pictures of the sections. Pictures were numbered without reference to the method of instrumentation. Two different operators viewed the pictures for the quality of instrumentation and obturation. Obturation was assessed on the ratio of GP to sealer, adaptation of GP to canal walls and homogeneity of the

GP (presence of voids or multiple cones surrounded by sealer).

Grades of 1 (good), 2 (acceptable) and 3 (unacceptable) were assigned using the following criteria: Grades of 1-

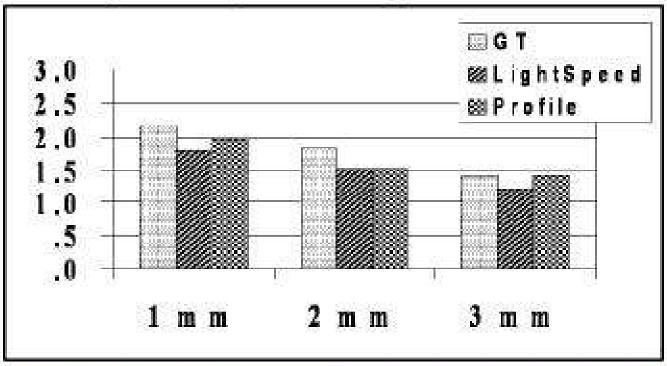

Figure 2: Distance from anatomic apex.

good adaptation, thin sealer film; 2- irregularities with thick film of sealer separating gutta-percha for up to 1/3 in (fig. 1 a-c) from the canal walls; 3- voids or thick film of sealer separating gutta-percha from the canal walls for more than 1/3. The statistical analysis of the obturation grades results were analyzed using the non-parametric Kruskal-Wallis test.

RESULTS

Means and standard deviations of grades obtained by each instrumentation system at three different evaluation levels are shown in Table I. These results are plotted in

Table 1: A Comparison of Obturation Grades among Three NiTi Rotary Systems.

Level	GT	Lightspeed	Profile
	Mean±SD	Mean±SD	Mean±SD
1 mm	2.16± 0.80^{a}	1.80± 0.82^{a}	1.96± 0.84^{a}
2 mm	1.84 ± 0.75^{a}	1.52 ± 0.65^{a}	1.52± 0.77^{ab}
3 mm	1.40 ± 0.58^{b}	1.20 ± 0.50^{b}	1.40± 0.65^{b}
Total	**1.80± 0.77**	**1.51± 0.70**	**1.63± 0.78**

SD = Standard Deviation
Values followed by a similar superscripts across columns are not statistically significant from one another

Figure 2. Canals prepared with GT exhibited the highest average grade at the 1mm and 2 mm levels (i.e. least favorable) while GT and Profile had the same average obturation grades at the 3 mm level. On the other hand, LightSpeed achieved the lowest average grade (i.e. most favorable) at the 1mm and 3 mm levels, while it achieved an equal and average grade with ProFile at the 2 mm level. However, the results of the Kruskal-Wallis test did not show any statistically significant difference among obturation grades obtained by the three instrumentation systems at the three different levels ($p>0.05$). Table I shows that the grades improved as the distance from the apex increased. This is evidenced by the slight decrease in average grades in Figure 2. The results of Kruskal-Wallis test revealed statistically significant differences between 1mm level and 3 mm level for all instrumentation systems. A similar trend was also noticed between 2 mm level and 3 mm level except for the ProFile group in which evaluation grades at these levels were not significantly different from one another.

DISCUSSION

In this study, the ability to produce a round preparation using three NiTi instruments in apical 3 mm and its subsequent effect on apical obturation quality using continuous wave technique was compared. The warm vertical technique used in this investigation is known to replicate the root canal preparations better than the cold lateral condensation technique[15].

Overall, instrumentation shapes produced by LightSpeed NiTi rotary instruments achieved the most favorable scores for obturation but the results were not statistically significant. These results are similar to a recent study that found the distribution of filling materials similar in all combinations of instrumentation and obturation techniques[14]. A statistically significant trend in improvement of evaluation grade was noticed as the distance from the apex increased. The results indicated that at 3 mm from the apex, all the NiTi rotary instruments used in this study shaped the canals adequately for optimal obturation.

The favorable results achieved at 3 mm level can be attributed to a number of factors. Firstly, a continuous wave technique was used which may have achieved better plasticization of gutta-percha at 3mm level[15]. The penetration depth of the plugger has been significantly related to percentage of gutta percha found in root canal[16]. In this study, the depth of penetration of system B tip was 3 to 4 mm short of working length and may have led to optimal filling of root canals at this level. Secondly, the quality of root canal filling in oval shaped canals can be compromised[17, 18]. Due to the tapered nature of the instruments the preparations at 3 mm level were considerably larger than one at 1 mm level. As a result of which the irregular shape of root canals at 3 mm level gained a more rounded shape, which is more amenable to traditional root canal obturation techniques. However, it is realized that apical 1 mm of the root canal remains the most critical area and the instrumentation techniques used in this study were not able to ideally shape it for optimal obturation.

The warm vertical gutta-percha compaction technique requires canals to be sufficiently flared to allow the tip of the plugger to penetrate to the apical third[19]. In this study, the apical 4 mm of the canals was prepared using three different instruments however the differences in taper achieved at the apex did not translate into differences in quality of obturation.

One of the important factors that influenced the results of this study is the original canal morphology, which varies greatly between different teeth groups and even between different roots of the same tooth. It is realized that root canals are not always rounded in shape but may exhibit larger bucco-lingual dimension ranging from an oval to a ribbon shaped configuration[20]. Therefore, theoretically the smallest size of instrument to obtain a rounded preparation can vary greatly within every type of canal[1].

In this study, the samples were randomized rather than categorized by root canals. It is envisaged that a study with larger sample size would have neutralized the effect of root canal morphology, and would have more accurately delineated the effectiveness of different instrumentation techniques. Grading of obturation results were conducted by subjective evaluation of micrographs in the current study. Although consensus of two operators was used to reduce the subjective interpretation of results, more objective evaluation scheme for the micrographs may improve the quality of the data. For example, image analysis software could be utilized in the future to quantify the roundness and regularities of the canal preparation and provide a quantitative evaluation of the ratio of gutta-percha to sealer instead of the subjective ratings used for this study. The ability to achieve an apical seal with contemporary obturation methods primarily depends on the quality of the apical preparations. Round apical preparations will ensure a better obturation.

CONCLUSION

Under the conditions of this study, root canals shaped by GT, LightSpeed and ProFiles revealed similar quality of root canal obturation. The quality of root canal obturation improved in all groups as the distance from the apex increased.

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