ORIGINAL ARTICLE

Density and apical sealing ability of lateral compaction using two different spreaders and vertical compaction using BeeFill device

Shiva Sadeghi[1*] DDS, MS, and Haniyeh Haji Sadeghi[2] DDS

1. Assistant Professor of Endodontics, Dental School/Dental Research Center, Guilan University of Medical Sciences, Rasht, Iran.
2. General Dentist.

Abstract

Introduction: Proper apical seal and obturation density are essential to long-term success of root canal therapy (RCT). The apical seal and density of lateral compaction techniques using stainless-steel and nickel-titanium spreaders and vertical compaction with BeeFill device were compared in this *in vitro* study.

Materials and Methods: A total of 66 extracted maxillary central incisors were instrumented. The volume of each canal was determined after preparation**.** The weight of each root was measured before and after obturation. Lateral compaction technique was performed using stainless-steel (groups a) and nickel-titanium spreaders (groups b), filled with AH26 sealer (groups 1a and 1b) and without sealer (groups 2a and 2b). Canals in vertical compaction technique (groups c) were filled with (group 1c) and without (group 2c) sealer using Beefill system. Density was determined as the ratio of weight/volume. Sealing ability was evaluated using dye penetration method. Data was analyzed with ANOVA and T-test.

Results: T-test results showed a significant difference between groups which were filled with/without sealer for their apical sealing ability ($P<0.001$), however there was no significant difference in obturation density ($P=0.397$). ANOVA test showed that there was a significant difference in apical sealing ability among the different experimental groups ($P<0.001$), while there was no significant difference in density ($P=0.456$) of obturation. The mean dye leakage for groups using sealer was significantly different to those obturated without sealer. The sealing ability of obturation techniques using sealers were significantly more than those without sealers.

Conclusion: Under the condition of this *in vitro* study, density and apical sealing ability of these three obturation methods had no difference. However, the quality of apical seal has improved using AH26 sealer. **[Iranian Endodontic Journal 2009;4(1):10-14]**.

Keywords: Density, Instrument, Nickel-titanium, Root canal obturation, Seal, Stainless-steel.

Received June 2008; accepted November 2008

*Correspondence: Dr. Shiva Sadeghi, Dental School, Guilan University of Medical Science, Opp. Pardis Hotel, Rasht, Iran. E-mail: Sadeghi_dds@yahoo.com

Introduction

Three-dimensional obturation of the prepared root canals is essential to long-term clinical success of root canal therapy (1). The root canal system should be sealed apically, coronally, and laterally and the obturation material should be of uniform density (1).

Cold lateral compaction and vertical compaction, each with different variations are the two most commonly used root canal filling techniques employing gutta-percha and sealer. Cold lateral compaction provides controlled placement of gutta-percha, but it is a time consuming technique, lacks homogeneity, poorly adapts to the canal walls, and may induce vertical root fractures (2). To achieve optimal obturation, the flexibility of the spreader is an important factor in lateral compaction technique. Nickel-titanium spreaders have greater flexibility than stainless-steel spreaders; and it has been argued that these spreaders penetrate closer to the working length (3,4). However, the apical seal and density of the root canal obturation following

lateral compaction with these two different spreaders has not been investigated extensively. Vertical compaction uses heat to produce a homogenous obturation that adapts well to the canal walls. This technique may result in the extrusion of gutta-percha into the periapical tissue and may be time consuming (2). Other techniques such as injection molded, thermo-plasticized gutta-percha and thermomechanical compaction have evolved in an attempt to decrease operating time while preserving the benefits of the warm gutta-percha technique. BeeFill system is a new device that has been introduced in the marketplace for back-filling of the root canal but has not been investigated extensively.
The aim of this *in vitro* study was to evaluate the density and apical sealing ability of lateral compaction technique using stainless-steel and nickel-titanium finger spreaders as well as the vertical compaction technique with BeeFill device in extracted human teeth.

Materials and Methods

Sixty-six recently extracted human maxillary central teeth with single, straight canals and mature apexes were used in this *in vitro* study. All teeth were stored in normal saline after extraction and were disinfected by 5.25% sodium hypochlorite solution for 30 minutes before experimental procedures. To eliminate root length as a variable, the crowns were removed, so that the remaining roots' length were about 15±1 mm. Patency and working lengths were determined with K-file size #15 (Mani, Japan) until it passed the foramen, of which 1 mm was subtracted and this was recorded as the working length. All root canals were cleaned and shaped with K-files using step-back technique up to size #40. Flaring was performed by Gates Glidden size #1-3 (Dentsply, Maillefer, Ballaigues, Switzerland). All instruments were used for just five canal preparation. Irrigation with 2.5 mL of 2.6% sodium hypochlorite solution was performed using a 22-gauge needle between each two files.
After instrumentation, the volume of each canal was measured to accurate 1 lambda (µL) by injecting blue brume-phenol solution (Merck, Darmstadt, Germany) using hamilton syringe (AEG, Japan). Finally, the root canals were dried using paper points and were weighted using a digital balance (Unitech, China) to accurate 0.01 gr.
Sixty of the samples were divided into two groups: group 1 utilized AH 26 and group 2 did not use AH 26 (Dentsply, DeTrey, Konstanz, Germany) (n=30). Each of these groups was then divided into subgroups of 10. In group (a) the canals were compacted using stainless-steel spreader; in group (b) nickel-titanium spreaders were used; finally in group (c) BeeFill device was utilized to fill the canals. The samples were divided equally among experimental groups so that the total volume of root canals was equivalent. The remaining six teeth were used as negative or positive controls (n=3)
Lateral compaction technique (groups 1a, 1b, 2a, 2b): Lateral compaction method was used with (groups 1a, 1b) and without using AH26 sealer (groups 2a, 2b). A #40 gutta-percha point (Gapadent, Korea) was selected and gently seated at the working length. The C size stainless-steel (Mani, Japan) (groups 1a, 2a) and nickel-titanium finger spreader (groups 1b, 2b) (FKG Dentaire, La Chaux-de-Fonds, Switzerland) was introduced to within 2 mm of the working length. Condensation was completed using accessory cones until they could not be introduced into the canal to more than 3 mm of their length. Once the excess was cut with a flame-heated hand plugger, gutta-percha was condensed adequately.
Vertical compaction technique (groups 1c, 2c): Vertical compaction method was used with (group 1c) and without using sealer (group 2c). A #40 master cone (Gapadent, Korea) was fitted 0.5 mm short of the working length. After the master cone was seated into the prepared root canal, the coronal portion of the cone was removed with a red-hot heat carrier. The down-packing phase was done by condensing gutta-percha in an apical direction successively with three preselected pluggers (VDW, Munich, Germany) to within 3, 5 and 7 mm from the root apex passively. As needed, additional gutta-percha was inserted, warmed and condensed vertically into the canal until the entire apical third was obturated and the small plugger could condense gutta-percha in 5 mm from the apex. Back-packing phase was done

using BeeFill device (VDW, Munich, Germany). To soften gutta-percha cartridge (VDW, Munich, Germany), the device was set at 180˚C and flow rate 60. Pushing the plunger segment of the device, a few millimeter of softened gutta-percha was injected into the canal. In between the addition of the gutta-percha, cold prefitted pluggers were used for condensation of the gutta-percha to a homogeneous mass. This was continued until the entire root canal was packed. All obturated canals were evaluated radiographically.

After obturation, each canal was weighted again and the difference between post obturation and post instrumentation weights was recorded. Density of filling material was determined as the ratio of mean weight increase/volume.

Control groups: In negative leakage control group, two teeth were obturated by lateral compaction technique using two different spreaders, and the other by vertical compaction using BeeFill device. Their orifices were filled with wax and the total root surfaces were covered by two layers of nail polish. The three positive leakage control teeth were not obturated. Their root surfaces were not covered with nail polish but the orifices were filled with wax in order to prevent the coronal leakage.

Linear leakage evaluation: All root surfaces except for apical 2 mm were covered with two layers of nail polish, so that dye could penetrate only from apical. After keeping the apical part of all roots in Pelikan ink (Pelikan, Hanover, Germany) for 7 days, the roots were washed with water and were left to dry for 24 h. Nail polish was then removed by Acetone.

Two grooves along the long axis of each root were made using a tapered bur in a turbine handpiece and a little water spray. All roots were then split longitudinally using a chisel. All preparations were completed by same operator.

Apical microleakage was assessed blindly by two examiners measuring the most extensive linear dye penetration using a stereomicroscope (Olympus, Tokyo, Japan) and a digital caliper to accurate 0.01 mm. The mean score was calculated. Finally collected data was compared using T-test and analysis of variance (ANOVA) at a significant level of P<0.05.

Table 1. Mean dye leakage and density in all groups

GROUPS	Leakage		Density	
	N	Mean (SD)	N	Mean (SD)
1a	**10**	**1.57 (1.89)**	**10**	**0.0015(0.0004)**
1b	**10**	**1.78 (2.45)**	**10**	**0.0018(0.0004)**
1c	**10**	**0.39 (0.87)**	**10**	**0.0015(0.0002)**
2a	**9**	**10.07 (5.35)**	**10**	**0.0018(0.0004)**
2b	**10**	**7.61 (6.48)**	**10**	**0.0015(0.0005)**
2c	**10**	**7.28 (2.99)**	**10**	**0.0017(0.0003)**
P-value	*P<0.0001*		*P=0.456*	

1a) lateral compaction (S.S spreader with sealer)
1b) lateral compaction (NiTi spreader with sealer)
1c) Vertical compaction (BeeFill with sealer)
2a) lateral compaction (S.S spreader without sealer)
2b) lateral compaction (NiTi spreader without sealer)
2c) Vertical compaction (BeeFill without sealer)

Results

The negative control demonstrated no dye penetration while the positive control showed dye penetration along the entire root length.

The mean linear dye leakage and density for all groups are shown in Table 1. One sample was excluded from lateral compaction group using stainless steel spreader without sealer, because it was broken during sectioning.

T-test results showed that there was a significant difference between groups which were filled with and without using sealer for apical sealing ability (P<0.001), while there was no significant difference for density of obturation (P=0.397).

ANOVA test showed that there was a significant difference for apical sealing ability among different experimental groups (P<0.001), while there was no significant difference for density of obturation (P=0.456). Post hoc test analysis showed that mean dye leakage of each obturation technique with using sealer had significant difference with all obturation techniques without using sealer. There was also significant difference between each obturation technique without using sealer and all obturation techniques using sealer for sealing ability.

In other words, mean dye leakage had no statistically significant difference between the three obturation techniques using sealer and without using sealer. Mean dye leakage showed significant difference for each obturation method with and without using sealer.

Discussion

Apical sealing ability and density are two important criteria of a three dimensional obturation of the root canal system. The purpose of this *in vitro* study was to compare density and apical sealing ability of lateral compaction technique using nickel titanium and stainless steel spreaders and vertical compaction technique using BeeFill device. Furthermore, the effect of using sealer on density and apical seal was investigated.

In this study, extracted maxillary central teeth with large and straight canals were selected and were instrumented up to file size #40 in order to minimize the variables such as anatomical variation, canal size and the diameter of the apical foramen. As it has been reported that longer roots have a potential for greater leakage, roots with 15±1 mm long were used (5). To eliminate the operator variable, all preparations were completed by a single operator.

Longitudinal sectioning of roots and linear measurement of the dye penetration were used to evaluate apical seal. AH26 was selected as a sealer because it provides very good apical sealing and optimal condition for all obturation methods (6,7).

According to the result of the present study, mean dye leakage between groups which were filled with and without using sealer showed significant difference. These findings emphasize on the effect of using sealer for prevention of apical leakage and were supported by the findings of Mielitic and Wu *et al.* (8-10).

Mean dye leakage had no statistically significant difference between the three obturation techniques with/without using sealer. Mean dye leakage had no statistically significant difference for each obturation method with and without using sealer. These findings support previous studies recommended that obturation technique has no effect on the apical seal (7,11-13).

Up to now, the quality of root canal obturation has been evaluated either by the visual inspection of the obturation material with the aid of a microscope or radiographs, or by measuring the density, a more objective quantitative method, using clear plastic blocks (14). In all previous studies, the densities, or weights per volume, were determined by weighting the plastic blocks before and after obturation. An increase in weight of filling material in the same volume (ie, the instrumented canal) implied an increase in density of the obturation.

In this study, we used extracted human teeth instead of acrylic blocks. The advantage of using extracted teeth is that we could examine both the apical seal and the density simultaneously.

The findings showed that there was no significant difference between the densities of obturation in different methods. This was different from those reported by Lea (2), Dietch (15), and Nelson *et al.* (14). Lea *et al.* reported that the obturation density of vertical compaction technique using continuous wave was significantly more than lateral compaction (2). Dietch *et al.* showed that the density of lateral compaction using spreader that energized by ultrasonic was significantly more than cold lateral compaction (15). Nelson reported that density in lateral compaction using system B was significantly more than cold lateral compaction (14).

One possible reason for this difference may be that in all of these three studies, acrylic blocks were used for evaluating density. They assumed that all samples have a constant volume after instrumentation, thus they weighted blocks after preparation and obturation without measuring the volume of samples. One of the disadvantages of this method is that the volume of samples may be different after preparation. In the present study, density of filling material was determined in a more precise manner.

Another disadvantage of using acrylic blocks, especially when one of the warm vertical or lateral compaction techniques applies, is volume expansion of blocks. Undoubtedly, heat makes acrylic blocks expand and thus, the amount of gutta-percha increases.

Conclusion

Under the condition of this study, density and apical sealing ability of obturation methods had no difference. However, the quality of apical seal has improved using AH26 sealer.

References

1. Walton RE, Torabinejad M: Principles and practice of endodontics, 4th Edition. Saunders, Philadelphia, 2009: pp. 306-19.
2. Lea CS, Apicella MJ, Mines P, Yancich PP, Parker MH. Comparison of the obturation density of cold lateral compaction versus warm vertical compaction using the continuous wave of condensation technique. J Endod 2005;31:37-9.
3. Walia HM, Brantley WA, Gerstein H. An initial investigation of the bending and torsional properties of Nitinol root canal files. J Endod 1988;14:346-51.
4. Schmidt KJ, Walker TL, Johnson JD, Nicoll BK. Comparison of nickel-titanium and stainless-steel spreader penetration and accessory cone fit in curved canals. J Endod 2000;26:42-4.
5. Wu MK, Wesselink PR. Endodontic leakage studies reconsidered. Part I. Methodology, application and relevance. Int Endod J 1993;26:37-43.
6. Dalat DM, Spangberg LS. Comparison of apical leakage in root canals obturated with various gutta percha techniques using a dye vacuum tracing method. J Endod 1994;20:315-9.
7. Limkangwalmongkol S, Burtscher P, Abbott PV, Sandler AB, Bishop BM. A comparative study of the apical leakage of four root canal sealers and laterally condensed gutta-percha. J Endod 1991;17:495-9.
8. Miletić I, Ribarić SP, Karlović Z, Jukić S, Bosnjak A, Anić I. Apical leakage of five root canal sealers after one year of storage. J Endod 2002;28:431-2.
9. Miletić I, Anić I, Pezelj-Ribarić S, Jukić S. Leakage of five root canal sealers. Int Endod J 1999;32:415-8.
10. Wu MK, Fan B, Wesselink PR. Diminished leakage along root canals filled with gutta-percha without sealer over time: a laboratory study. Int Endod J 2000;33:121-5.
11. Director RC, Rabinowitz JL, Milne RS. The short-term sealing properties of lateral condensation, vertical condensation, and Hydron using 14C human serum albumin. J Endod 1982;8:149-51.
12. Gharai SR, Thorpe JR, Strother JM, McClanahan SB. Comparison of generated forces and apical microleakage using nickel-titanium and stainless steel finger spreaders in curved canals. J Endod 2005;31:198-200.
13. Pérez Heredia M, Clavero González J, Ferrer Luque CM, González Rodríguez MP. Apical seal comparison of low-temperature thermoplasticized gutta-percha technique and lateral condensation with two different master cones. Med Oral Patol Oral Cir Bucal 2007;12:175-9.
14. Nelson EA, Liewehr FR, West LA. Increased density of gutta-percha using a controlled heat instrument with lateral condensation. J Endod 2000;26:748-50.
15. Deitch AK, Liewehr FR, West LA, Patton WR. A comparison of fill density obtained by supplementing cold lateral condensation with ultrasonic condensation. J Endod 2002;28:665-7.