Journal of Oral Science, Vol. 50, No. 4, 435-439, 2008

Original

In vitro comparison of three different lengths of remaining gutta-percha for establishment of apical seal after post-space preparation

Saeed Rahimi[1)], Shahriar Shahi[1)], Saeed Nezafati[2)], Mohammad F. Reyhani[1)], Sahar Shakouie[1)] and Leila Jalili[3)]

[1)]Department of Endodontics, Tabriz Dental School, Tabriz University (Medical Sciences), Tabriz, Iran
2)Department of Oral and Maxillofacial Surgery, Tabriz Dental School, Tabriz University (Medical Sciences), Tabriz, Iran
[3)]Private Practice, Tabriz, Iran

(Received 13 May and accepted 16 October 2008)

Abstract: The quality of apical seal with regard to the length of remaining gutta-percha following post-space preparation is still controversial. The purpose of this *in vitro* study was to compare three different lengths of remaining gutta-percha for apical seal after post-space preparation. A total of 126 single-rooted extracted maxillary human anterior teeth with intact apices, straight roots, and without resorption were used in this study. The root canals were prepared and filled with gutta-percha and AH26 sealer. The post-space preparation was accomplished. Ninety-six teeth were randomly divided into three groups (4, 5 and 6 mm of gutta-percha was retained in group 1, 2 and 3, respectively).Thirty teeth were considered for the control groups in which 5 teeth served as positive and 5 teeth served as negative controls. The specimens were placed in India ink for 48 hours and then divided into two halves. The amount of leakage was observed and measured with a stereomicroscope at ×16 magnification and 0.1 mm accuracy. The results showed that there were significant differences among the three experimental groups ($P < 0.05$). The best apical seal after post-space preparation was associated with the maximum length of remaining gutta-percha in the apical portion of the treated teeth. (J. Oral Sci. 50, 435-439, 2008)

Keywords: apical seal; gutta-percha; microleakage; post-space preparation.

Correspondence to Dr. Shahriar Shahi, Department of Endodontics, Tabriz Dental School, Tabriz University (Medical Sciences), Golgasht Street, 5166614713, Tabriz, Iran
Tel: +98-914-314-2971
Fax: +98-411-334-6977
E-mail: shahriar_shahi@hotmail.com

Introduction

Endodontically-treated teeth should be restored properly to replace missing tooth structure, maintain function and esthetics, and protect against fracture and infection. Successful endodontic debridement and apical sealing are essential underpinnings for the restoration of non-vital teeth. Long-term clinical success of these teeth requires integration of both the endodontic and restorative disciplines.

The post is a restorative dental material placed in the root of a structurally damaged tooth in which additional retention is needed for the core and coronal restoration. The post is bonded or cemented inside the root and extends coronally to anchor the core. The purpose of the post is to hold on to the core and consequently the crown. It also helps protect the apical seal from bacterial contamination caused by coronal leakage. Post-space preparation should allow placement of a remaining root canal filling material that provides an adequate seal.

Maintenance of adequate obturation is critical to resist bacterial microleakage. The integrity of the apical seal is

proportional to the amount of endodontic filling material. Leakage is significantly higher with post-space and 3, 4, 5, or 7 mm of apical filling material than in a completely filled canal (1-3). It has been shown that after preparation of the post space, roots with residual apical gutta-percha of less than 3 mm are associated with a higher incidence of periapical radiolucency, compared with roots with longer residual root canal filling (4). Nixon et al showed that the best apical seal was obtained when a maximum of 6 mm of gutta-percha was retained (5). Galen and Muller stated that retention of the last 4 to 5 mm of filling material at the apex is the minimum requirement for an endodontic seal (6). It is commonly accepted that a remaining root canal filling of 3 to 5 mm provides an adequate seal (1, 7, and 8). However, this recommendation was based mainly on apical percolation studies and should be re-evaluated. Since it is impossible to retain greater length of gutta-percha after preparation of the post space in a majority of cases, the results of studies on the quality of apical seal with various lengths of remaining gutta-percha following post-space preparation differ. Therefore, the purpose of this in vitro study was to compare three different lengths of remaining gutta-percha for establishment of apical seal after post-space preparation.

Materials and Methods

One hundred twenty six single rooted extracted human teeth without caries, cracks, resorption, or dilaceration, and with intact apices were selected and stored in buffered 10% formalin solution (pH 7.0).The teeth were immersed in 5% sodium hypochlorite for 20 min to remove organic tissues from the root surfaces. The remaining materials on the root surface were mechanically removed with hand curettes. The crown portions of the teeth were removed with diamond disk (D&Z, Darmstadt, Germany). The roots were prepared to a length of 16 mm from the coronal part to the root apices. The teeth were checked for cracks using an operating microscope (Zeiss, Munich, Germany) at ×10 magnification.

The working length was established with a #15 K-File (Maillefer, Balaiggues, Switzerland) 1 mm short of the apex. The patency was checked using the #15 K-File which passed through the apical foramen during instrumentation. The canals were prepared with a #40 K-File to the working length and shaped with a #70 K-File, subtracting 0.5 mm for each number of files after #40 K- File. 2.5% Sodium hypochlorite was used as the irrigant followed by a saline rinse. After one week, the teeth were randomly divided into three experimental groups containing 32 teeth each and three positive and three negative control groups containing 5 teeth each. The canals of the teeth except positive controls were obturated with gutta-percha (Aria Dent, Tehran, Iran) and AH26 sealer (Dentsply, Konstanz, Germany) with lateral condensation technique. In this technique, gutta-percha No. 40 was selected as "master cone" and it was checked for resistance to displacement or "Tug back". The fit was confirmed with a radiograph. The AH26 sealer was applied to the canal wall and a NiTi finger spreader (Maillefer) was selected which matched the taper of the canal. The "master cone" was placed into the canal to the prepared working length. The spreader was inserted till 1 to 2 mm of the prepared length and was then removed by rotating it back and forth as it was withdrawn. Accessory cones were placed in the space created by the instrument until complete obturation and the filling was confirmed with a radiograph. The teeth were kept in an incubator at 37°C in 100% humidity for one week. The post-spaces were prepared with #4 Gates-Glidden drills at 4,000 rpm to a depth that left 4 mm, 5 mm and 6 mm gutta-percha apically in groups 1, 2 and 3, respectively. Radiographic images were taken to confirm the predetermined length of root canal filling in apical parts of the canals. A cotton pellet was placed in the coronal parts of the canals and sealed with glass ionomer cement (Fuji II, GC, Tokyo, Japan). The specimens were kept for 7 days at 37°C in 100% humidity. In all experimental and positive control groups, the entire surface of the roots except the apical 2 mm were covered with one layer of sticky wax and two layers of nail polish. In the negative control groups, the whole surface of the root was covered with one layer of sticky wax and two layers of nail polish. The teeth were then placed in India ink for 72 h.

The specimens were retrieved from the ink and rinsed for 10 minutes in running water and then dried. After cutting off the crowns of the teeth, the roots were longitudinally divided into two halves by creating two facial and lingual fissures along the long axis of the roots, using a diamond disc (D&Z). The filling materials were removed from the canals and the maximum amount of linear penetration of dye was observed with stereomicroscope (Zeiss) at ×16 magnification and measured with electronic digital caliper (0-150mm, Guangulu, China) to 0.1 mm accuracy. The data were analyzed using one-way analysis of variance (ANOVA) and post hoc Tukey tests.

Results

In this study, apical microleakage was seen in all experimental groups (4, 5 and 6 mm of remaining gutta-percha) and positive control group teeth (entire surface of the canals). Microleakage was not seen in the negative control group (Fig. 1). The highest apical microleakage was seen in group 1 (Mean = 0.93 mm, SD = ± 0.62),

4 mm 5 mm 6 mm

Fig. 1 Apical microleakage (dye penetration) was seen in all experimental groups at ×16 magnification (4, 5 and 6 mm remaining gutta-percha).

moderate apical microleakage was seen in group 2 (Mean = 0.78 mm, SD = ± 0.55) and the least apical microleakage was seen in group 3 (Mean = 0.6 mm, SD = ± 0.3) (Fig. 2). There were significant differences in the amount of apical microleakage among the three experimental groups as indicated by ANOVA ($P < 0.05$). The two by two comparison of groups was performed using post-hoc Tukey tests and the difference in mean apical microleakage between group 1 (4 mm) and group 2 (5 mm) was not statistically significant ($P = 0.49$). The difference in average apical microleakage (dye penetration) between group 2 (5 mm) and group 3 (6 mm) was not statistically significant ($P = 0.33$). However, the difference in mean apical microleakage between group 1 (4 mm) and group 3 (6 mm) was statistically significant ($P = 0.03$). Based on the results of Tukey tests, the least amount of apical microleakage was seen when the remaining length of gutta-percha was maximum after post-space preparation.

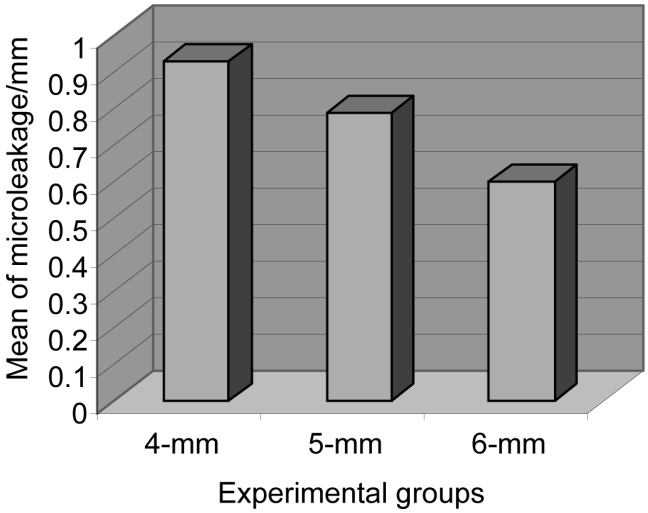

Fig. 2 The mean microleakage in the experimental groups.

Discussion

Root canal treatment will ultimately fail if the obturating material is exposed to oral fluids. Coronal leakage is a major cause of failure (9,10). Even a well-obturated canal with appropriate use of sealer cement does not provide an enduring barrier to bacterial penetration; the restoration (both temporary and permanent) provides the coronal seal (11).

Exposure of obturating materials to oral fluids through a lost restoration, marginal discrepancy, or recurrent caries eventually leads to sealer disintegration and bacterial contamination of the canal system (9). The restoration must provide the coronal seal either as a separate step (for example, placing a barrier over canal orifices) or more commonly as an integral part of the restoration by virtue of its marginal sealing ability (10,12). Posts (particularly prefabricated posts) and cores do not create a seal until the crown is placed (13,14). Lack of an intact sealing restoration is an important factor in assessing the cause of a persistent or developing periapical lesion. Fortunately, this is usually correctable by endodontic and restorative retreatment. Another concern is an inadequate temporary seal, both during treatment and after treatment is complete but before the final restoration. There is not sufficient information to know how much exposure time to oral fluids mandates retreatment, although a maximum of 3 months' exposure has been suggested as a general guideline (11).

The dye penetration technique was used to evaluate the leakage in different studies (5,15-19). We also used dye penetration technique and stereomicroscope to evaluate the leakage of specimens (20,21). The AH-26 sealer was used as a sealer for obturation of teeth with gutta-percha because of good sealing ability (20). The originality of our research can be justified by many existing contradictions about the quality of apical seal as it relates to the length of remaining gutta-percha after post- space preparation in the literature and also the majority of studies in this field discuss the comparison of the gutta-percha removing instruments

(heat, peeso reamer and Gates Glidden drills) and the time of removing gutta-percha (immediate or delayed post-space preparation) rather than the remaining length of gutta-percha after post-space preparation (2,7,19,22).

Abramovitz et al have emphasized that post-space preparation could increase the amount of microleakage (22). In the present study, the amount of microleakage increased when the space for post was prepared. Zemner (23) has shown that when more than 4 mm gutta-percha was retained after post-space preparation, the amount of apical microleakage significantly decreased in comparison with less than 4 mm of remaining gutta-percha. Raiden et al. demonstrated that the least amount of leakage was seen when 4 mm of gutta-percha remained after post-space preparation when compared with 1, 2, 3 mm which was in accordance with this study, confirming that the best apical seal is established with the maximum amount of remained gutta-percha after post-space preparation (24). Nixon et al. compared the amount of apical microleakage between 3, 4, 5, 6 and 7 mm of retained gutta-percha after post-space preparation and showed that the least amount of apical microleakage occurred in the 6-7 mm group (5). This finding was similar to the results of our study to some extent.

Regarding the results of this study and the lack of enough data on the agreement in length of remaining gutta-percha after post-space preparation to prevent apical microleakage, further studies using different techniques with a larger number of cases is recommended.

From the results of the present study, we conclude that microleakage occurred in all experimental groups; however, there was an association between the amount of apical microleakage and the length of remaining gutta-percha after post-space preparation. The least amount of apical microleakage was seen with 6 mm and the maximum apical microleakage was seen with 3 mm of remaining gutta-percha, the difference between the three lengths of remaining gutta-percha was significant. It is suggested that, whenever possible, maximum length of gutta-percha should be retained after post-space preparation to provide an adequate apical seal.

References

1. Abramovitz L, Lev R, Fuss Z, Metzger Z (2001) The unpredictability of seal after post space preparation: a fluid transport study. J Endod 27, 292-295
2. Metzger Z, Abramovitz R, Abramovitz L, Tagger M (2000) Correlation between remaining length of root canal fillings after immediate post space preparation and coronal leakage. J Endod 26, 724-728
3. Zalkind M, Shkury S, Stern N, Heling I (2000) Effect of prefabricated metal post-head design on the retention of various core materials. J Oral Rehabil 27, 483-487
4. Kvist T, Rydin E, Reit C (1989) The relative frequency of periapical lesions in teeth with root canal–retained posts. J Endod 15, 578-580
5. Nixon C, Vertucci FJ, Swindle R (1991) The effect of post space preparation on the apical seal of root canal obturated teeth. Todays FDA 3, 1C, 6C
6. Galen WW, Muller KI (2006) Restoration of endodontically treated teeth. In Pathways of the pulp, 9th ed, Cohen S, Hargreaves KM eds, St Louis, Mosby, 786-821
7. Dickey DJ, Harris GZ, Lemon RR, Lubeke RG (1982) Effect of post space preparation on apical seal using solvent techniques and Peeso reamers. J Endod 8, 351-354
8. Madison S, Zakariasen KL (1984) Linear and volumetric analysis of apical leakage in teeth prepared for posts. J Endod 10, 422-427
9. Saunders WP, Saunders EM (1994) Coronal leakage as a cause of failure in root-canal therapy: a review. Endod Dent Traumatol 10, 105-108
10. Ray HA, Trope M (1995) Periapical status of endodontically treated teeth in relation to the technical quality of the root filling and the coronal restoration. Int Endod J 28, 12-18
11. Magura ME, Kafrawy AH, Brown CE Jr, Newton CW (1991) Human saliva coronal microleakage in obturated root canals: an *in vitro* study. J Endod 17, 324-331
12. Wolcott JF, Hicks ML, Himel VT (1999) Evaluation of pigmented intraorifice barriers in endodontically treated teeth. J Endod 25, 589-592
13. Fogel HM (1995) Microleakage of posts used to restore endodontically treated teeth. J Endod 21, 376-379
14. Fox K, Gutteridge DL (1997) An *in vitro* study of coronal microleakage in root-canal-treated teeth restored by the post and core technique. Int Endod J 30, 361-368
15. Saunders EM, Saunders WP, Rashid MY (1991) The effect of post space preparation on the apical seal of root fillings using chemically adhesive materials. Int Endod J 24, 51-57
16. Shillingburg HT, Hobo S, Whitsett LD, Jacobi R, Brackett SE (1997) Fundamentals of fixed prosthodontics. 3rd ed, Quintessence, Chicago 181-209
17. Limhaugwalmongkol S, Aboott PV, Sandler AB (1992) Apical dye penetration with four root canal

sealers and gutta-percha using longitudinal sectioning. J Endod 18, 535-539
18. Kim SK, Kim YO (2002) Influnce of calcium hydroxide intracanal medication on apical seal. J Endod J 35, 623-628
19. Karapanou V, Vera J, Cabrera P, white RR, Goldman M (1996) Effect of immediate and delayed post prepration on apical dye leakage using two different sealers. J Endod 22, 583-585
20. Miletić I, Ribarić SP, Karlović Z, Jukić S, Bosnjak A, Anić I (2002) Apical leakage of five root canal sealers after one year of storage. J Endod 28, 431-432
21. Tamse A, katz A, Kablan F (1998) Comparison of apical leakage shown by four different dyes with two evaluating methods. Int Endod J 31, 333-337
22. Abramovitz I, Tagger M, Tamse A, Metzger Z (2000) The effect of immediate vs. delayed post space preparation on the apical seal of a root canal filling: a study in an increased-sensitivity pressure-driven system. J Endod 26, 435-439
23. Zemener O (1980) Effect of dowel preparation on the apical seal of endodontically treated tooth. J Endod 6, 687-690
24. Raiden GC, Gendelman H (1994) Effect of dowel space preparation on the apical seal of root canal fillings. Endod Dent Troumatol 10, 109-112