Article published online: 2021-11-01

ORIGINAL ARTICLE

Effect of radiotherapy on the sealing ability of temporary filling materials

Ebru Hazar Bodrumlu, Emre Bodrumlu[1], Aysun Avşar[2], Ahmet Deniz Meydan[3]

Department of Pediatric Dentistry, [1]Department of Endodontics, Faculty of Dentistry, Bulent Ecevit University, Zonguldak, [2]Department of Pediatric Dentistry, Faculty of Dentistry, [3]Department of Radiation Oncology, Faculty of Medicine, Ondokuz Mayis University, Samsun, Turkey

Address for correspondence:
Assist. Prof. Ebru Hazar Bodrumlu, Department of Pediatric Dentistry, Faculty of Dentistry, Bulent Ecevit University, Zonguldak, Turkey.
E-mail: hazarebru@yahoo.com

ABSTRACT

Objective: The purpose of this study was to assess the sealing ability of three different temporary restorative materials on endodontic access cavities as compared to radiated and nonirradiated teeth. **Materials and Methods:** All teeth were randomly divided into two main groups according to the presence or absence of the radiotherapy. The specimens in these groups were then divided into three subgroups of 12 teeth each, and into two control groups of eight teeth each as negative and positive control groups. In radiotherapy groups, radiotherapy (1.8 Gy) was applied daily over 35 days resulting in a total application of 63 Gy. Standardized occlusal endodontic access cavities were prepared in all groups. A cotton pellet was placed on the pulp chamber. The access cavities were restored with three temporary filling materials; first fill, Cavit-G and Cavisol. The specimens were immersed in 2% methylene blue solution and centrifuged at 3000 rpm for 5 min. **Results:** Although there was no statistical difference among the three materials for the groups in which radiotherapy was not applied ($P > 0.05$), it was found that the sealing abilities of Cavit-G and Cavisol were not affected by radiotherapy ($P > 0.05$). However, the leakage values of the light-cured polymerized temporary filling material, first fill, were increased when radiotherapy was performed ($P < 0.05$). **Conclusion:** The radiotherapy application reduces the sealing ability of the light-cured temporary filling material, first fill.

Key words
Dental leakage, dental restoration, radiotherapy, temporary

INTRODUCTION

The use of a temporary filling is an indispensable part of medicament application between root canal treatments. These restorative materials act as a barrier against microorganisms, exogenous liquids, and medicines in abutting pulp chambers.[1]

A wide variety of temporary filling materials is currently in use. Among them, hydroscopic materials are preferred by clinicians. Hydroscopic-filling materials provide sufficient coverage by adhering to the dentin wall after it has expanded due to moisture.

The number of cancerous patients have been increasing daily. Ionizing irradiation causes damage in normal tissues located in the field of radiation. Radiotherapy plays an important role in the management of head and neck cancer. Radiotherapy is a treatment commonly used in head-neck cancer alone or in combination with surgery.[2] Many studies[2-6] have revealed that many complications related to mouth and teeth health arise in response to radiotherapy applied to the head-neck region, and their severity is dependent upon localization and the stage of the illness. However, it appears that there are some negative effects on the bone, salivary glands and dental tissues.[2] Therefore, dental clinicians have to be aware of the effects of radiation therapy on dental tissues. In studies of the effects of radiotherapy on dental tissues, it appears that there is high demineralization in the enamel as both physical and chemical changes occurred following the treatment. These effects are accompanied by a reduced stability of the amelodentinal junction after radiotherapy.[3] Moreover, such changes appear to have completely or partially affected the connection of enamel and dentin by adhesives materials.[3-6] Cheung *et al.*[5] stated that the irradiation damage of collagen fibers could result in impaired bond strength between composite and dentin. Hence, adhesive restorative material may be important for radiotherapy irradiated patients.

Access this article online	
Quick Response Code:	Website: www.ejgd.org
	DOI: 10.4103/2278-9626.149675

The effects of radiotherapy applications on the adhesion properties of restorative materials[3-6] and root canal sealers[7] have been previously investigated. However, the sealing ability of the temporary restorative materials on radiated cases has not yet been reported. Many methods[8-12] are used in the assessment of the level of leaking of endodontic materials. One of the most common measurements used is the dye penetration method, owing to its simplicity and reliability. The method is based on the supposition that the depth of dye penetration represents the gap between the root filling and the canal walls.

The aim of this study was to assess the sealing ability of three different temporary restorative materials on endodontic access cavities as compared to radiated and nonirradiated teeth.

MATERIALS AND METHODS

A total of 88 extracted maxillar premolars was collected from the oral surgery clinic and used in this study. Ethical approval for use of the extracted teeth was obtained from Ondokuz Mayis University Ethical Community (OMU. ETIK.2008/206). The teeth were stored in 0.9% sodium chloride solution until use.

All teeth were randomly divided into two main groups according to the presence or absence of the radiotherapy. The specimens in these groups were then divided into three subgroups of 12 teeth each, and into two control groups of eight teeth each as negative and positive control groups. The teeth were carefully cleaned with curettes to remove soft tissue remnants and were stored in saline solution prior to instrumentation. Half of the teeth were applied radiotherapy application stated as below. Another half of the teeth were stored in a 0.9% sodium chloride solution (Wizard-Rehber Chemistry, Istanbul, Turkey).

Radiotherapy application

Radiotherapy application was conducted in the Radiation Oncology Department in Ondokuz Mayis University Medical Faculty in Turkey. The teeth were embedded in resin blocks and placed in a plastic plate. To achieve homogeneity of a given radiation treatment, the specimens were fully immersed in saline solution, which was renewed daily. Radiotherapy was applied to the surface of the liquid with Co-60 photons at a distance of 80 cm.[3] Radiotherapy (1.8 Gy) was applied daily over 35 days resulting in a total application of 63 Gy. All teeth were placed in saline solution, regardless of whether they had received radiotherapy or not.

Standard endodontic entrance occlusal cavities (3 mm × 2.5 mm) were created 1 mm above the cemento-gingival junction. All entrance cavities were opened by a clinician using a diamond fissure bur (Diatech Dental Ag, Heerbrug, Switzerland) and cooling water and measured with a milimetric ruler. The root canal ingredients and pulp were removed with a barbed broach (Dentsply-Maillefer, Ballaigues, Switzerland) using the step-back preparation technique. The root canals were washed with 5.25% NaOCl (Wizard-Rehber Chemistry, Istanbul, Turkey) and then dried with paper points (Gapadent Co., Ltd., Tianjin city, China). Cotton pellets were placed into the pulp chambers to prevent temporary filling material from closing the canal entrances. A periodontal probe was used to measure the depth of the opening to be sure that it could accommodate at least 4 mm of temporary filling material.

Teeth were restored with a temporary restorative material setting either with light-cured temporary material, first fill (Pentron, CT, USA) or a calcium sulfate-based temporary resin material, Cavit-G (3M Espe GmbH, Seefeld, Germany) and a filling material containing ZnO eugenol, Cavisol (Jovident BV, Duisburg, Litrak).

After placing temporary restorative materials into the cavities based on the manufacturer's directions, all teeth were placed in distilled water at a temperature of 37°C for 48 h to ensure that the materials set. The restored teeth were closed with nail polish, except for 1 mm around the restored portion.

Additionally, the pulps were removed with a barbed broach in the eight teeth of the negative and positive control groups. The eight teeth in the negative control group were prepared by placing temporary filling materials and covering them with nail polish. The eight teeth in the positive control group were prepared without placing temporary filling material and with no nail polish. The control groups were divided into two groups according to the presence or absence of radiotherapy.

All teeth were immersed in 5% methylene blue dye and centrifuged at 30 g for 5 min. Finally, the specimens were washed with water.

The prepared specimens were separated into two as bucco-lingual with a diamond disc (Le Blond, A and M Institute, Texas, USA) to produce mesio-distal halves. Penetration degree of the marginal dye was measured with a stereomicroscope (Olympus, Tokyo, Japan). The amount of leakage was measured in the each half of each specimen, from the above to the bottom part of the crown, to which the dye had penetrated. The mean leakage value was calculated for each group.

Two-way analysis of variance was used to seek statistically significant differences in apical leakage values among the groups. Multiple comparisons were performed using the *t*-test to isolate and compare statistically significant differences. The data were processed by the statistical software program (SAS Institute, North Carolina, USA). The statistical analyses were made 95% reliance interval.

RESULTS

First fill showed less leakage than Cavisol and Cavit-G in the nonirradiated group ($P > 0.05$), but first fill showed more leakage than the other temporary fillings in the irradiated group ($P < 0.05$).

Although there was no statistical difference among the three materials for the groups in which radiotherapy was not applied ($P > 0.05$), it was found that the sealing abilities of Cavit-G and Cavisol were not affected by radiotherapy ($P > 0.05$). However, the leakage values of the light-cured polymerized temporary filling material, first fill, were increased when radiotherapy was performed ($P < 0.05$) [Table 1].

DISCUSSION

The application of radiation is a well-known consequence of radiotherapy of malignant tumors in the head and neck region and are related to cumulative doses that vary from 50 to 70 Gy delivered over a 5–7 weeks timescale. In the present study, 44 specimens were irradiated with 63 Gy fractionally applied over a period of 5 weeks. This corresponds to a common clinical procedure[3] for radiotherapy patients.

Many *in vitro* methods[9-12] have been used to evaluate the sealing quality of endodontic filling materials. The dye penetration method with methylene blue was preferred, because it has a low molecular weight and penetrates more deeply along root canal filling.[13] Air trapped inside the root canal system may inhibit the penetration of dyes.[14] Thus, dye penetration tests under negative or high pressure are recommended.[15] Oliver and Abbott[14] stated that after centrifugation at 3000 rpm for 5 min, dye penetration was 91.7%, and dye penetration by passive immersion was 20.7%. For this reason, active dye penetration tests, where trapped air is removed under a vacuum, or the dye penetration test is performed under high pressure, are recommended.[13,14] Moreover, Pommel *et al.*[16] found no correlation between dye penetration, electrochemical, and fluid filtration methods. Hence, centrifugation was used in the current study.

Temporary filling materials provide a tight seal in endodontic access cavities, thereby preventing seepage of bacteria, oral fluids, and other debris into the pulp chamber, which is essential for the success of root canal treatment.[1] However, the thickness of the temporary filling material is an important factor, which contributes to its sealing ability. It has been reported that a minimum of 4 mm of restorative material is necessary to prevent microleakage.[1,17] Hence, a 4 mm thick temporary filling material has been preferred in this study.

Radiation damage and crystalline restructuring of the mineralized tissues of teeth may account for the postradiation changes of the dentition. The irradiated dental tissue reduced the microhardness[3,4,18] after the irradiation. Bodrumlu *et al.*[7] indicated that apical sealing ability of the resin-based root canal sealers decreased slightly when radiotherapy was applied, although there is no significant statistical difference.

Cavit-G and Cavisol provided an adequate seal in irradiated and nonirradiated groups in the present study. Similar results have been reported by Jacquot *et al.*[19] in terms of the nonirradiated results of this study. Since there is no study to compare the sealing ability of the temporary restorative materials on radiated cases, no comparison has been done. Besides, the studies[3-6] exhibited that the demineralization in the enamel occurred after the radiotherapy application. Correspondingly, the reason of the sealing ability reduction in the light-cured temporary filling material, first fill can be explained with the weakened bond due to enamel demineralization after radiation.

Table 1: Mean leakage values for the experimental groups (mm)

Temporary filling material	Mean apical leakage values		*P*
	Nonradiotherapy application groups	Radiotherapy application groups	
Cavisol	3.25±0.62	3.48±0.57	>0.05
Cavit-G	3.05±0.59	3.29±0.62	>0.05
First fill	2.78±0.54	5.15±0.65	<0.05

CONCLUSION

This study was carried out *in vitro,* which limits the clinical validity of the results. Cavit-G and Cavisol showed similar leakage levels, whether or not radiotherapy was applied. However, the sealing ability of the light-cured temporary filling material was decreased with radiotherapy. Based on the results of this *in vitro* study, it may be concluded that the radiotherapy application reduces the sealing ability of the light-cured temporary filling material, first fill.

REFERENCES

1. Rhodes JS, editor. Advanced Endodontics Clinical Retreatment and Surgery. 1st ed. London: Taylor and Francis Inc.; 2006. p. 129-49.
2. Glass BJ, Van Dis ML, Langlais RP, Miles DA. Xerostomia: Diagnosis and treatment planning considerations. Oral Surg Oral Med Oral Pathol 1984;58:248-52.
3. Pioch T, Golfels D, Staehle HJ. An experimental study of the stability of irradiated teeth in the region of the dentinoenamel junction. Endod Dent Traumatol 1992;8:241-4.
4. Kielbassa AM, Beetz I, Schendera A, Hellwig E. Irradiation effects on microhardness of fluoridated and non-fluoridated bovine dentin. Eur J Oral Sci 1997;105:444-7.
5. Cheung DT, Perelman N, Tong D, Nimni ME. The effect of gamma-irradiation on collagen molecules, isolated alpha-chains, and crosslinked native fibers. J Biomed Mater Res 1990;24:581-9.
6. al-Nawas B, Grötz KA, Rose E, Duschner H, Kann P, Wagner W.

Using ultrasound transmission velocity to analyse the mechanical properties of teeth after *in vitro*, *in situ*, and *in vivo* irradiation. Clin Oral Investig 2000;4:168-72.
7. Bodrumlu E, Avsar A, Meydan AD, Tuloglu N. Can radiotherapy affect the apical sealing ability of resin-based root canal sealers? J Am Dent Assoc 2009;140:326-30.
8. Wu MK, De Gee AJ, Wesselink PR, Moorer WR. Fluid transport and bacterial penetration along root canal fillings. Int Endod J 1993;26:203-8.
9. Martell B, Chandler NP. Electrical and dye leakage comparison of three root-end restorative materials. Quintessence Int 2002;33:30-4.
10. Bodrumlu E, Tunga U. Coronal sealing ability of a new root canal filling material. J Can Dent Assoc 2007;73:623.
11. Xu Q, Fan MW, Fan B, Cheung GS, Hu HL. A new quantitative method using glucose for analysis of endodontic leakage. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2005;99:107-11.
12. Mayer T, Eickholz P. Microleakage of temporary restorations after thermocycling and mechanical loading. J Endod 1997;23:320-2.
13. Ahlberg KM, Assavanop P, Tay WM. A comparison of the apical dye penetration patterns shown by methylene blue and India ink in root-filled teeth. Int Endod J 1995;28:30-4.
14. Oliver CM, Abbott PV. Entrapped air and its effects on dye penetration of voids. Endod Dent Traumatol 1991;7:135-8.
15. Spångberg LS, Acierno TG, Yongbum Cha B. Influence of entrapped air on the accuracy of leakage studies using dye penetration methods. J Endod 1989;15:548-51.
16. Pommel L, Jacquot B, Camps J. Lack of correlation among three methods for evaluation of apical leakage. J Endod 2001;27:347-50.
17. Weston CH, Barfield RD, Ruby JD, Litaker MS, McNeal SF, Eleazer PD. Comparison of preparation design and material thickness on microbial leakage through Cavit using a tooth model system. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2008;105:530-5.
18. Kielbassa AM, Wrbas KT, Schulte-Mönting J, Hellwig E. Correlation of transversal microradiography and microhardness on *in situ*-induced demineralization in irradiated and nonirradiated human dental enamel. Arch Oral Biol 1999;44:243-51.
19. Jacquot BM, Panighi MM, Steinmetz P, G'Sell C. Microleakage of Cavit, CavitW, CavitG and IRM by impedance spectroscopy. Int Endod J 1996;29:256-61.

How to cite this article: Bodrumlu EH, Bodrumlu E, Avşar A, Meydan AD. Effect of radiotherapy on the sealing ability of temporary filling materials. Eur J Gen Dent 2015;4:8-11.

Source of Support: Nil, **Conflict of Interest:** None declared.