In vitro evaluation of coronal leakage of different sealers in complex cavities

Mauro Henrique **CHAGAS E SILVA**[1]
Luciana Andrea **SALVIO**[2]
Carolina Oliveira de **LIMA**[3]
Mariane Floriano Lopes Santos **LACERDA**[4]
Celso Neiva **CAMPOS**[5]

DOI: http://dx.doi.org/10.14436/2358-2545.6.2.016-020.oar

ABSTRACT

Objective: To evaluate in vitro the microleakage in complex cavities sealed with temporary restorative materials (TRM). **Methods:** The cavities were prepared in 60 maxillary premolars extracted from human beings, and the specimens were divided into 3 groups: 1- Intermediate Restorative Material (IRM); 2- Coltosol; 3- Fill Magic Tempo. Three teeth served as negative control and had no cavities prepared. Before sealing the cavities, a collagen sponge was left within the pulp chamber for evaluation of dye penetration. Ten teeth in each group were not submitted to the action of thermal cycling and occlusal mechanical force, while another 10 teeth were submitted to these actions. The sample was immersed in Rhodamine B dye at 0.5%, 37°C for 7 days. **Results:** All the teeth (100%), except for the negative controls, presented dye infiltration. All teeth sealed with Coltosol (100%) fractured after mechanical testing, while those with IRM and Fill Magic Tempo remained macroscopically intact. The action of thermal and mechanical stresses, or not, with regard to dye penetration. **Conclusion:** None of tested materials prevented dye infiltration. Coltosol should not be used as TRM in complex cavities due to its low resistance to occlusal mechanical force.

Keywords: Dental materials. Mechanical processes. Dental leakage.

How to cite this article: Chagas e Silva MH, Salvio LA, Lima CO, Lacerda MFLS, Campos CN. In vitro evaluation of coronal leakage of different sealers in complex cavities. Dental Press Endod. 2016 May-Aug;6(2):16-20.
DOI: http://dx.doi.org/10.14436/2358-2545.6.2.016-020.oar

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

» Patients displayed in this article previously approved the use of their facial and intraoral photographs.

[1]Specialist in Endodontics, private practice.
[2]Adjunct Professor of the Federal University of Juiz de Fora.
[3]Post Graduation Student in Dental Clinic, Federal University of Juiz de Fora.
[4]Assistant Professor, Federal University of Juiz de Fora.
[5]Associate Professor of the Dental Clinic, Federal University of Juiz de Fora.

Submitted: 14/02/2016. Revised and accepted: 07/06/2016.

Contact address: Celso Neiva Campos
Rua Lindalva de Paula Ribeiro, 240 - Bosque Imperial
CEP: 36.036-466 – Juiz de Fora/MG
E-mail: cncampos@terra.com.br

Introduction

The aim of endodontic treatment is cleaning and shaping the root canal system (RCS), to eliminate bacteria and their by-products in order to control infection and prevent reinfection of the root canal system (RCS). In order to preserve these aims, it is necessary to select a temporary restorative material (TRM) able to keep the endodontic cavity free of oral fluid leakage and provide more effective action of intracanal medication.[1,2]

The temporary restorative materials used inadequately can lead to coronal microleakage[3] and consequently contaminate the RCS and periapical tissues, resulting in endodontic treatment failure.[4] Therefore, it is essential the knowledge of their insertion techniques, in order to satisfy clinical requirements, such as time, occlusal forces, complexity of cavities and absence of tooth structures.[5] However, there are few studies about the use of TRMs in complex cavities, under the action of thermal and mechanical stresses.

The aim of this study was to evaluate in vitro coronal microleakage in complex mesio-occlusal-distal (MOD) cavities sealed with three temporary restorative materials (IRM®, Coltosol® and Fill Magic Tempo®), by using laboratory simulated thermal cycling and mechanical forces.

Materials and Methods

The present study was approved by the Ethical Committee (#151.293). Therefore sixty three human maxillary premolars, extracted due to orthodontic or periodontal indication were used in this study. The inclusion criteria were all teeth should have intact crowns and roots. The mesio-distal measurement of each tooth was made with a caliper, taking as reference the central sulcus and marginal crest. From a mean of the measurements, the teeth selected should equal this measure with a variation of one millimeter more or less, in order to avoid discrepancies.

The teeth were stored in 0.9% saline solution and kept refrigerated until the samples prepared. Thus, the roots were sealed with two coats of red nail varnish (Revlon), up to the amelocement junction, with 30 seconds between applications of the layers. After drying, the teeth were fixed on bases made with PVC connections (Tigre, São Paulo, SP, Brazil), filled with heat activated acrylic resin (VIPI). The teeth were placed in the base, through a metal guide, with the same diameter as the PVC connection (Fig 1).

Then, class II MOD cavities were prepared, by the same operator, specialist in Endodontics. Class II MOD cavities were prepared with a diamond burr #2094 KG Sorensen (Medical Burs Ind. e Com. de Pontas e Brocas Cirúrgicas Ltda., Cotia, SP, Brazil), to a depth of 4 mm, so that a minimum thickness of 3.5 mm of TRM would be placed to prevent dye penetration[1] (Fig 2). As negative control, three healthy teeth without cavity preparation were used.

The access to the pulp chamber was performed with diamond burr #2094 and finishing with a #1557 carbide and an Endo-Z burr KG Sorensen® (Medical Burs Ind. e Com. de Pontas e Brocas Cirúrgicas Ltda., Cotia, SP, Brazil).

Once the cavities were prepared, a layer of nail varnish was used on the tooth surface to seal possible microcracks, preventing dye penetrating into these regions. After drying, pieces of Hemospon (Technew, Biodente Materiais Odontológicos, Chapecó, SC, Brazil) were used to fill the pulp chamber space, simulating the region of intracanal medication.

After this, the teeth were randomly divided into three groups (n=20) according to the restorative material to be applied: Group 1: restoration with IRM (Dentsply, Petrópolis, RJ- Brazil); Group 2: restoration with Coltosol (Vigodent/S.A Ind. e Com.- Rio de Janeiro,RJ- Brazil), and Group 3: restoration with Fill Magic TEMPO (Vigodent/S.A Ind. e Com.- Rio de Janeiro,RJ- Brazil).

The materials were manipulated and inserted into the cavity in accordance with the specifications of manufacturer and afterwards samples were stored in a closed plastic receptacle containing distilled water at 37°C.

Twenty-four hours after inserting the TRMs, ten teeth from each group were submitted to thermal and mechanical forces in a thermal cycler, set to 100 cycles[6] at temperatures from 5°C to 60°C.[7,8] Subsequently, the samples were again stored for 24 hours.

Thus, the specimens were submitted to the incidence of simulated vertical occlusal forces in a mechanical fatigue simulator machine (ERIOS ER-11000, São Paulo, SP, Brazil), with the pistons set to 58 psi - equivalent to 40 N/cm^2, resulting in a force of approximately 4 kgf/cm^2 [9-12] (Fig 3).

At the end of this period, the teeth submitted or not to the action of thermal cycling and mechanical forces

were immersed in Rhodamine B dye 0.5% for 7 days, at 37^0 C. After this, they were washed for 20 minutes to remove excess Rhodamine B.

To evaluate dye penetration, the TRMs were removed and the fibrin sponge in the pulp chamber was evaluated for the presence or absence of dye,[13-15] attributing the following scores: 0-sponge without presence of dye and 1- sponge with presence of dye.

The negative control teeth were sectioned longitudinally with a diamond disc following the vestibular-lingual direction, and after this, in the axial direction, so that specimens could be analyzed for the presence or absence of dye.

Results

All the teeth analyzed, those submitted or not to thermal and mechanical stresses presented Rhodamine 0.5% dye infiltration. Therefore, when the dichotomic data analysis were observed, statistical analysis by the test (Chi-square) was unnecessary, because one of the possible responses had occurred in 100% of the experimental units.

Discussion

Coronal sealing is important between treatment sessions and post endodontic treatment to prevent the microorganisms access into the coronal and

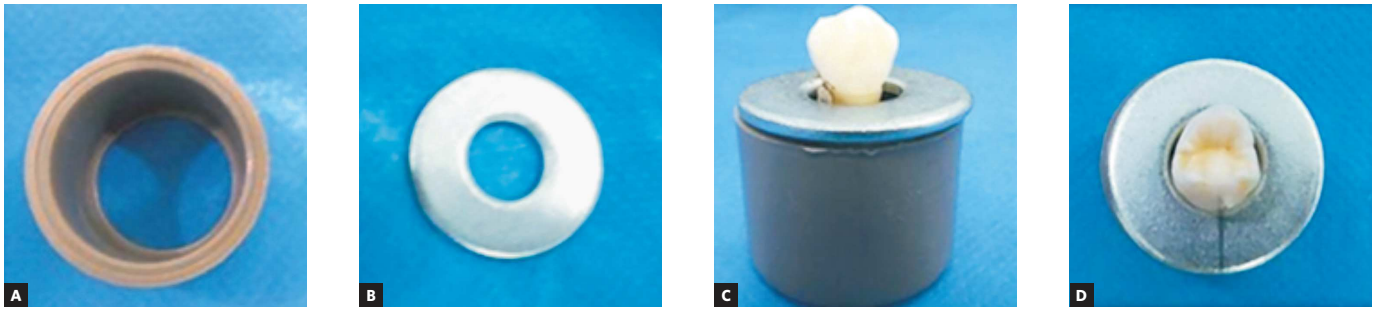

Figure 1. PVC connection and metal washer used for fabricating base and positioning the tooth.

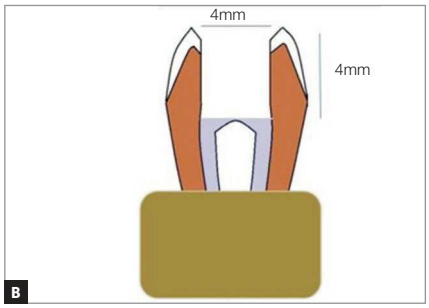

Figure 2. Burrs used for preparation (left) and diagrammatic drawing of aspect of cavity after preparation (right).

Figure 3. Samples in Mechanical Fatigue Machine (ERIOS) submitted to action of vertical forces.

radicular pulp cavity, thereby preventing their infection or re-infection.[1,16]

To attain these objectives, the temporary restoration must have ideal requisites, such as satisfactory working time, support occlusal forces and replaced dental tissue lost due to caries or by deficient restorations.[5]

The markers commonly used in studies about leakage are methylene blue, fuchsin, Rhodamine, Indian ink and radioactive markers,[17,18] being methylene blue most frequently used. Nevertheless, this marker present inconvenient features, such as discoloration in contact with materials containing zinc, silver, calcium hydroxide and copper[19] and their temperature instability.[17,19] In this study, the Rhodamine B was used because it has particles smaller than bacteria. Moreover, it does not discolor in the presence of zinc, a substance present in IRM and Coltosol.[19] To prevent these chemical interactions, the teeth were not filled with root canal sealer or intracanal medication.

As regards to cavity design, several studies have used Class I cavities.[1,3,8-11,20-22] In this study, it was preferred the complex cavity preparation, because in clinical practice, the teeth were usually destroyed or restored.[10]

The influence of thermal cycling on materials was to simulate the temperature changes that occur during the routines of eating, drinking liquids and breathing, and the consequent formation of cracks that propagate at the interfaces.[23]

After the period of thermal cycling and storage of the samples, it was observed, macroscopically, that the samples in the group restored with Coltosol were laced with cracks, as opposed to the samples in the groups restored with IRM and Fill Magic Tempo. Coltosol contains calcium sulfate in its structure, is therefore relatively hydrophilic, and tends to absorb water.[9] The cracks may have arisen due to expansion of the material, because there was no lateral walls to keep the material confined within rigid walls.

During the simulation test of vertical occlusal forces, it was observed that in group 1 (Coltosol) the TRM fractured. This fact could be justified by the presence of cracks after the storage time, which may have resulted in weakening of the teeth. The samples of group 2 and 3 (IRM and Fill Magic TEMPO, respectively) remained intact during the cycles; a fact similar with study of Liberman et al.[9] (2001), in which the samples of calcium sulfate- and zinc oxide-based TRMs suffered deterioration with mechanical fatigue cycles.

The results showed that the sponges inserted in the pulp chamber were stained with Rhodamine B in 100% of the samples, except in those of the negative control group, showing that none of the TRMs used effectively prevented dye infiltration.

Whereas in all teeth were sponges impregnated with a dye, it has been observed that the TRMs evaluated in this study were ineffective as sealants against dye penetration. The data analysis should be made with caution when transferred to clinical practice, because in spite of the dye having penetrated into the pulp chamber, this does not mean that bacteria penetrated. This fact can be verified in Chailertvanitkul et al.[12] (2009) study, in which bacteria and dye were used concomitantly, and in the majority of cases where the dye penetrated, the bacteria did not.

Although all the units in Group 2 were destroyed, they behaved in the same way as the other groups, by allowing dye penetration.

It was not performed an analysis of quantification, since the teeth were open, all sponges, which are the markers of infiltration, were stained, meaning that the infiltration had reached the pulp cavity. Because of this, it has not been possible to identify, in this study, whether the thermal and mechanical fatigue produced a difference in dye leakage or not.

Dye microleakage test in temporary restorations have been frequently used. However, clinically they provide few data, which suggests that in vivo studies should be made with simulating microorganisms penetration, masticatory movements and conditions of temperature variation.

Conclusion

It could be concluded that none of the tested materials prevented the dye from penetrating into the sponge contained in the pulp chamber. Coltosol should not be used as MRT in complex cavities due to its low resistance to occlusal mechanical forces.

References

1. Webber RT, Del Rio CE, Brady JM, Segall RO. Sealing quality of a temporary filling material. Oral Surg Oral Med Oral Pathol. 1978 July;46(1):123-30.
2. Bobotis HG, Anderson RW, Pashley DH, Pantera EA Jr. A microleakage study of temporary restorative materials used in endodontics. J Endod. 1989 Dec;15(12):569-72.
3. Zaia AA, Nakagawa R, Quadros I, Gomes BP, Ferraz CC, Teixeira FB, et al. An in vitro evaluation of four materials as barriers to coronal microleakage in root-filled teeth. Int Endod J. 2002 Sept;35(9):729-34.
4. Malone KH 3rd, Donnelly JC. An in vitro evaluation of coronal microleakage in obturated root canals without coronal restorations. J Endod. 1997 Jan;23(1):35-8.
5. Naoum HJ, Chandler NP. Temporization for endodontics. Int Endod J. 2002 Dec;35(12):964-78.
6. Crim GA, Garcia-Godoy F. Microleakage: the effect of storage and cycling duration. J Prosthet Dent. 1987 May;57(5):574-6.
7. Lai YY, Pai L, Chen CP. Marginal leakage of different temporary restorations in standardized complex endodontic access preparations. J Endod. 2007 July;33(7):875-8. Epub 2007 May 2.
8. Pai SF, Yang SF, Sue WL, Chueh LH, Rivera EM. Microleakage between endodontic temporary restorative materials placed at different times. J Endod. 1999 Jun;25(6):453-6.
9. Liberman R, Ben-Amar A, Frayberg E, Abramovitz I, Metzger Z. Effect of repeated vertical loads on microleakage of IRM and calcium sulfate-based temporary fillings. J Endod. 2001 Dec;27(12):724-9.
10. Mayer T, Eickholz P. Microleakage of temporary restorations after thermocycling and mechanical loading. J Endod. 1997 May;23(5):320-2.
11. Kampfer J, Göhring TN, Attin T, Zehnder M. Leakage of food-borne Enterococcus faecalis through temporary fillings in a simulated oral environment. Int Endod J. 2007 Jun;40(6):471-7. Epub 2007 Apr 24.
12. Chailertvanitkul P, Abbott PV, Riley TV, Sooksuntisakoonchai N. Bacterial and dye penetration through interim restorations used during endodontic treatment of molar teeth. J Endod. 2009 July;35(7):1017-22.
13. Hagemeier MK, Cooley RL, Hicks JL. Microleakage of five temporary endodontic restorative materials. J Esthet Dent. 1990 Nov-Dec;2(6):166-9.
14. Jensen AL, Abbott PV. Experimental model: dye penetration of extensive interim restorations used during endodontic treatment while under load in a multiple axis chewing simulator. J Endod. 2007 Oct;33(10):1243-6.
15. Jensen AL, Abbott PV, Castro Salgado J. Interim and temporary restoration of teeth during endodontic treatment. Aust Dent J. 2007 Mar;52(1 Suppl):S83-99.
16. Hartwell GR, Loucks CA, Reavley BA. Bacterial leakage of provisional restorative materials used in endodontics. Quintessence Int. 2010 Apr;41(4):335-9.
17. Heintze SD. Clinical relevance of tests on bond strength, microleakage and marginal adaptation. Dent Mater. 2013 Jan;29(1):59-84.
18. Srikumar GP, Varma KR, Shetty KH, Kumar P. Coronal microleakage with five different temporary restorative materials following walking bleach technique: an ex-vivo study. Contemp Clin Dent. 2012 Oct;3(4):421-6.
19. Wu MK, Kontakiotis EG, Wesselink PR. Decoloration of 1% methylene blue solution in contact with dental filling materials. J Dent. 1998 Sept;26(7):585-9.
20. Pieper CM, Zanchi CH, Rodrigues-Junior SA, Moraes RR, Pontes LS, Bueno M. Sealing ability, water sorption, solubility and toothbrushing abrasion resistance of temporary filling materials. Int Endod J. 2009 Oct;42(10):893-9.
21. Ciftçi A, Vardarli DA, Sönmez IS. Coronal microleakage of four endodontic temporary restorative materials: an in vitro study. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2009 Oct;108(4):e67-70.
22. Balto H. An assessment of microbial coronal leakage of temporary filling materials in endodontically treated teeth. J Endod. 2002 Nov;28(11):762-4.
23. Gale MS, Darvell BW. Thermal cycling procedures for laboratory testing of dental restorations. J Dent. 1999 Feb;27(2):89-99.