ISSN print: 1224-5984
ISSN online: 2248-3942

Rom Biotechnol Lett. 2019; 24(2): 280-285
doi: 10.25083/rbl/24.2/280.285

Received for publication, October, 6, 2018
Accepted, December, 28, 2018

Original paper

Comparative analysis of the temporary obturation materials applied to M-O-D cavities in endodontically treated teeth

SINZIANA ADINA SCARLATESCU[1*], IOANA SUCIU[1], IRINA MARIA GHEORGHIU[1], PAULA PERLEA[1], BOGDAN DIMITRIU[1], LACRAMIOARA DANIELA IACOMI[1], DAINA GEORGETA LUCIA[3], GRATIELA G PIRCALABIORU[4], RUXANDRA BARTOK[1], DANIELA SIMINA STEFAN[2]

[1]Faculty of Dental Medicine, "Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania;
[2]Faculty of Applied Chemistry and Materials Science, Polytechnic University of Bucharest, Romania
[3]Department of Psycho-Neuroscience and Rehabilitation, University of Oradea,Bucharest
[4]Research Institute of University of Bucharest (ICUB), Bucharest, Romania

Abstract

The temporary restorative filling protects the endodontically treated teeth against leakeage till the final coronal restauration. The aim of this study was to assess three temporary obturation materials (Coltosol F,Coltene/Whaledent Inc., Switzerland; Kavitan Plus, Spofa Dental, Czech Republic; light-curing composite Herculite Ultra, Kerr), after inserting them in large, mesio-occlusal-distal (M-O-D) type cavities of endodontically treated teeth. The teeth were submerged in water at 37º for 14 days. The number of fracture lines emerged on the surface of the material was noted down each day, the intercuspidal distance (ICD) was measured every 2 days, after that the coronal fillings were studied under the endodontic microscope, at a 8X magnification. All teeth, except those filled with composite, showed cracks within the material. In Coltosol F group 53% showed cracks within the teeth structure, 61,53% showed an increase of the ICD and the crown of a tooth fractured the second day after applying the material into the cavity. 38% of teeth in Kavitan Plus group showed cracks within the tooth structure, but no change in ICD, while 15,38% of teeth in composite group showed cracks within the tooth structure and no change in ICD. It appears that the hygroscopic expansion of the Coltosol F in the MOD cavities produced a degree of deflection of the cuspids, while the masticatory forces may worsen this situation. Kavitan Plus and Herculite Ultra can be considered more suitable temporary restorative filling materials in endodontically treated teeth.

Keywords Endodontic treatment; temporary filling; coltosol; tooth fracture; crack lines

To cite this article: SCARLATESCU SA, SUCIU I, GHEORGHIU IM, PERLEA P, DIMITRIU D, IACOMI LD, DAINA LUCIA L, PIRCALABIORU GG, BARTOK R, STEFA DS. Comparative analysis of the temporary obturation materials applied to M-O-D cavities in endodontically treated teeth. *Rom Biotechnol Lett*. 2019; 24(2): 280-285. DOI: 10.25083/rbl/24.2/280.285

*Corresponding author: SINZIANA ADINA SCARLATESCU, Faculty of Dental Medicine, "Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania;
E-mail: sanzianas@gmail.com

Introduction

The temporary restorative obturation is an important stage within dental treatment, being applied on teeth that will later be permanently restored. Temporary obturations are performed on patients with dental caries, requiring root canal treatment, for the protection against bacterial invasion and to prevent tooth fracturing, due to its low resistance, following infection. Sometimes it is absolutely necessary for teeth to be covered with temporary obturations, preliminary to performing the indirect restoration, represented by inlays or onlays. The temporary obturation may be maintained on the tooth up to approximately one month (E. DEVIKA WARRIER, & al. [1]). There are various temporary obturation materials and each clinician must be capable to select the most efficient one for each particular case. The debates on which is the best temporary restoration material is a highly controversial topic even nowadays.

The temporary obturation material must secure a tight closure against the ingress of bacteria, fluids and organic substances from the oral cavity into the endocanalicular system (HJ. NAOUM & al.[2]). When choosing a temporary obturation material , one must take several factors into account, such as: the space available for the material, the occlusal forces to which the tooth is being subjected and the overall time span until the final restoration(R. KAZEMI & al. [3]). The tooth's proper placement and adequate thickness are essential for providing a fitting marginal closure (G.A. WOLANEK & al. [4]).

The purpose of this study was to comparatively assess three temporary obturation materials after inserting them in large, mesio-occlusal-distal (M-O-D) type cavities of endodontically treated teeth, by means of direct view under the optical microscope.

Three materials were selected for this study, namely: Coltosol F (Coltene/Whaledent Inc., Switzerland), which is a zinc oxide-based cement, Kavitan Plus (Spofa Dental, Czech Republic), a self-curing glass-ionomer cement and light-curing composite Herculite Ultra (Kerr). These materials were evaluated during a two-week period.

This study's objectives were:

1. observing and quantifying the fissure lines emerged on the surface of the temporary obturation materials employed;

2. the occurence and the number of the dental cracks caused by the 3 temporary obturation materials for 14 days;

3. marking out the occurrence of the crown fractures consecutively to applying these materials, demonstrated by an increase in the intercuspidal distance (ICD) during the observation period.

Materials and methods

The study was performed on a batch of 39 lateral teeth, of which 25 molar teeth and 14 premolar teeth, all morphologically intact. After creating the access cavities, the canal scouting was made on the entire working length, by using number 08 and 10 ISO Kerr files. The working length was determined by placing a nr. 10 Kerr file into the root canal, until its point was visible at the apical foramen level, having the occlusal cuspid corresponding to the canal as a crown guiding mark. The final working length was calculated by reducing the previously obtained size by 0,5 mm.

The root canal mechanical treatment was made by means of the Protaper Universal (Dentsply Sirona, Switzerland) rotary system, on an endodontic motor with a 250 rpm rotational speed and a 2 Ncm torque. During preparation, irrigation were performed with a NaOCl 2,5% solution, 2 ml following each file and EDTA 19% (Ultradent, South Jordan, UT). All the teeth have been filled by cold lateral condensation technique, using a gutta percha master cone, ISO standardized, equal or a number higher than the last file employed on the entire working length and Adseal (MetaBiomed) epoxy resin-based sealing cement. After the root canal filling, standard MOD cavities were prepared for each tooth, observing the following rules (C. TENNERT & al. [5]):

- vertical cavities: mesial and distal, created 1 mm above the cementoenamel jonction, 5 mm width and 6 mm depth;
- horizontal cavities: 5 mm width, so that the thickness of the vestibular and oral walls remain 3 mm (Figure 1).

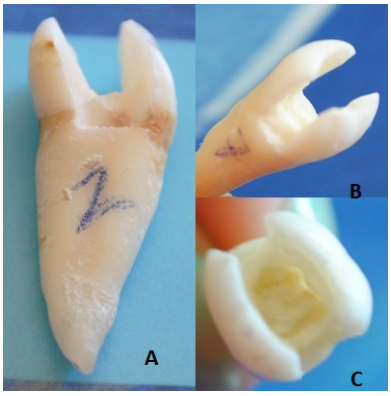

Figure 1. M-O-D cavities.
A, B: MOD cavities on premolars; **C:** MOD cavity on a molar.

In order to measure and monitor the intercuspidal distance, 2 marks were made on the opposite cuspids by means of the flame-shaped diamond dental bur. The intercuspidal distance was measured by electronic caliper (Unior) in the first hour following the obturation of the cavities and afterwards every 2 days, for a 14-day time period.

The teeth were divided into 3 groups of 13 teeth each, according to the crown obturation material employed. Group 1 had a crown restoration with Coltosol F as follows: the material was inserted by spatula, then it was condensed and adapted to the cavity walls by plugger. In group 2 cavities were filled with a cotton pellet of size 0 (Roeko, Coltene/Whaledent Inc., Switzerland) and Kavitan Plus prepared by mixing for 30-45 seconds powder and liquid in a 1/1 ratio. In group 3, after placing the cotton pellet size 0 (Roeko, Coltene/Whaledent Inc., Switzerland), the cavity was adhesively restored with composite, using the successive layers technique, after the acid conditioning of the enamel layer.

In the end, the teeth were submerged in water at 37º for 14 days and each day the number of fracture lines emerged on the surface of the material was recorded. Every 4 days, the water was changed. The coronal fillings were studied on a daily basis under the SmartOptic (Seliga) endodontic microscope, at a 8X magnification, and photo-graphied. After 14 days, they were removed by round diamond bur at a 20 000 rpm speed for examining the pulp-chamber floor. The statistical analysis followed the data assessment by using the Fischer's test with a 5% significance level.

Results

A. <u>Assessment of the cracks within the coronal filling materials</u>

One day after applying Coltosol F, fissures were noticed emerging at the surface and inside the material in 12 teeth (92,3 %) out of 13. The number of cracks emerged on the first day in the Coltosol group stands for 44, 03% of the total number of cracks emerged by the end of the research period (109 cracks). The second day, the number of cracks lines in the filling material substantially increased, by 62 % compared to day 1. On the third day of study, we noticed a much more diminished increase, only by 11% percent compared to the previous day. 7 days after applying Coltosol in the cavity, the fissures integrally involved the 13 teeth.

In group Kavitan Plus, even from the first day of application, all the teeth showed fissures in the obturation material. On the first day the crack lines represent 85,03% of the total number of fissures emerged by the end of the research period (127 cracks). The following day, the number of fissure lines increased by 9% compared to day 1. On the third day, the rate of increase was only 7% , by the end of the study no other fissure lines being detected.

The group Herculite Ultra showed no fissure in the obturation material, all 13 teeth remained undamaged after the application of the composite into the cavity. Compared to the Coltosol group, the Kavitan group harbored diminished cracks, and the total number of fissures remained constant from the third day until the end of the observation period (Figure 2).

B. <u>Assessment of the intercuspidal distance</u>

In case of group Coltosol F, 8 teeth out of 13 (61,53%) The coronal fillings were studied on a daily basis under the SmartOptic (Seliga) endodontic microscope, at a 8X magnification intercuspidal distance, the average increase being of 325 µm (Table I).

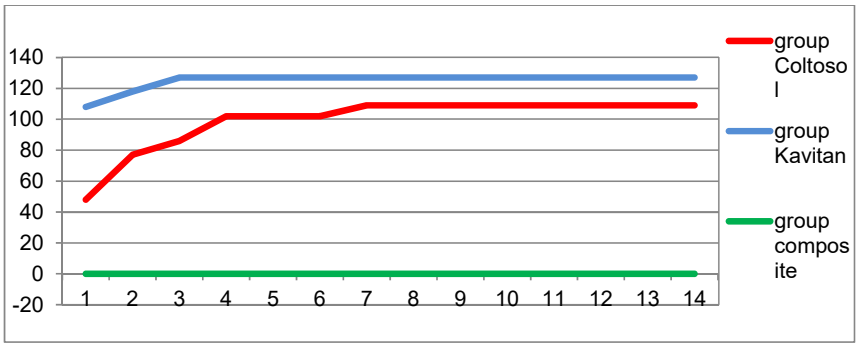

Figure 2. Daily evolution of the number of cracks in the 3 groups observed

Table I. Increase of the ICD, on the teeth composing group Coltosol F

Tooth	Initial value of ICD (mm)	Final value of ICD (mm)
1	5	5
2	5	5
3	5	5
4	6	6
5	6,5	6,5
6	7	7,2
7	6	6,3
8	6	6,2
9	8	8,1
10	6	7
11	6	6,5
12	6	6,2
13	6	6,1

The highest increase of the ICD, with a value of 1 mm, came to a molar tooth in group Coltosol F, which by hygroscopic dilatation, determined also the crown fracture of the entire vestibular wall, the second day after applying the material into the cavity (Figure 3). The teeth filled with Kavitan Plus and composite did not show any modifications of the ICD during the observation period.

Figure 3. Crown fracture determined by the Coltosol F material

C. <u>Assessment of the cracks within the teeth surface</u>

In the Coltosol F group, 7 teeth (53 %) showed cracks in the dental structure. A total number of 16 fissures were noticed in the enamel and in the dentine, of which 11 emerged on the buccal side (68,75%), 2 on the oral side (12,5%), 2 on the pulp-chamber floor and one at the radicular level (6,25%) (Figure 4). In group Kavitan Plus, a total number of 12 cracks ocurred in 5 teeth (38 %). In terms of localization, 8 fissures involved the buccal side (66,66%), 3 the oral side (25%) and one fissure emerged on the radicular level (8,33%) (Figure 5). In group Composite, the cracks involved 2 teeth (15,38%), both being situated only in the enamel and on the buccal side (Figure 6).

Discussions

After completing this study, we were able to evaluate the properties of the materials employed and we drew conclusions regarding the behaviour of temporary obturation materials in a humid environment resembling the oral cavity milieu. MOD cavities were created in the extracted teeth, cavities that are frequently seen in the clinic, in teeth with proximal dental caries and requiring endodontic treatment. Plotino et al, 2008 showed that in these cases there is a decline of up to 63% in the cuspidal resistance and therefore a restoration material is required to not only fill the crown cavity, but also to increase the fracture resistance of the tooth (G. PLOTINO & al. [6]).

Coltosol F is a eugenol-free, zinc oxide-based material, which may be easily applied and then removed in all types of cavities. It hardens quickly in the humid environment but it is associated with a 17-20% hygroscopic expansion, according to the manufacturer's instructions.

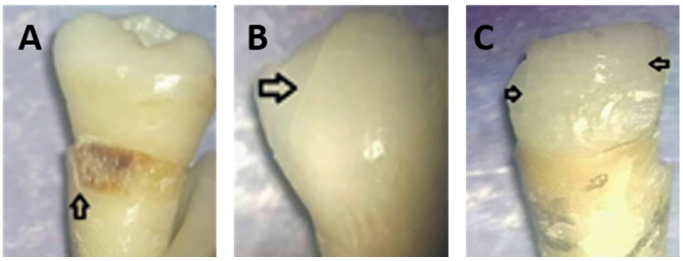

Figure 4. A. Cement crack in the cervical segment buccal side of the root, Coltosol F group, 4X; **B.** Enamel crown crack on the Kavitan group, 8X. **C.** Enamel longitudinal cracks on the buccal surface of a premolar, group Herculite Ultra, 8X

The expansion effect that some dental materials possess is well known. The amalgam expands by 3 vol% in 3 years (S.J. JENSEN & al. [7]) whereas the resin-reinforced glass-ionomer cements may expand by 6 vol% (M.A. CATTANI-LORENTE& al. [8]). A possible explanation for this phenomenon is the water assimilated in time in these materials' structure, which leads to material expansion. The assimilation of the water which also caused the expansion of the materials was complete after 7 days with Coltosol F and after 3 days with Kavitan Plus. The expansion demonstrated by Coltosol F may cause an additional pressure inside the material and on the walls of the cavities. This stress tension may partially dissipate by the expansion of the material outside the cavity, due to walls' deformation. When the tensions reach a limit value, fissures occur both on the internal side of the dentinal walls, as well as between the enamel and the dentine.

The expansion of the filling material in MOD cavities may induce the emergence of lateral internal forces which may cause crown fractures or crown-root fractures. The type of restorative material is an important factor generating longitudinal dental fractures. (M.H. LAUSTEN & al. [9]; F.J. BURKE & al. [10]; S.A. SCARLATESCU & al.[11]). The composites, on the other hand, may increase the fracture resistance in teeth with MOD cavities due to the interaction between the adhesive and the hard dental structure (A.R. DANESHKAZEMI [12]).

In case of Coltosol F , the percentage of teeth with cracks in the obturation material was 92% in the first 6 days and on the seventh day all the teeth showed cracks within the filling material. A similar result, but in a more diminished percentage, namely 85% of the total teeth, was obtained by Tennert et al. (C. TENNERT & al. [5]).

The multitude of cracks emerged in the Coltosol F material, of a spectacular intensity, suggests that the material exhibits the marginal microinfiltration phenomenon, which is a possible means of contamination. As a hygroscopic material, it possesses a high linear expansion coefficient, resulted by water absorption. Although it has many advantages, the material's low wearing resistance and increased water absorption suggest that its use should be limited, since it diminishes the tooth's fracture resistance (P. MONGA & al. [13]; D.G. SEO& al. [14]). For these reasons, Coltosol F should be applied as a temporary obturation material for a short period of time and in small cavities. Similar results have been obtained also by Naoum et al., 2002, the researchers assessing the Cavit material, which, along with Coltosol F, is part of the zinc oxide cements (HJ. NAOUM & al.[2]). The authors concluded that this material is not customarily recommended for temporary obturations in endodontically treated teeth with MOD cavities, but only for those on a very short period of time.

Regarding the Kavitan Plus glass-ionomer cement, it is well known that it releases fluorine and it displays antimicrobial activity. It shows a proper adherence to hard dental structures, it is not hygroscopic, it did not cause deep fissures nor fractures of the crown walls, which is why it might be used as a temporary obturation material, even for a longer period of time. In the Kavitan Plus group, the percentage of fissures in the material was of 100% , even from the first day of application, but their complexity and depth were more diminished compared to group Coltosol F.

The ICD increased in time (from the first day up to the 14th day) in the Coltosol F group. This is in contradiction with the results received in specimens filled with glass-ionomer or composite, where no modification of the ICD was obtained. The assessment of the ICD (325 μm) led to similar results to those obtained by Laustsen et al., 2005: 316 μm. (M.H. LAUSTEN & al. [9]).

During this study, no occlusal forces were applied on the extracted teeth. *In vivo,* the masticatory forces increase the incidence of crack occurrence in restoration materials and of fracture occurrence in the hard dental structure (F.K. COBANKARA & al. [15]; D.G. SEO & al. [14], IM GHEORGHIU &al. [16]). Nevertheless, the highest rate of fracture in the dental structure was displayed in teeth filled with Coltosol F (53%), while the teeth filled with Kavitan Plus led to a lower fracture rate (38%) and the composite produced the smalest number of fractures (15,38%). The total number of cracks in the dental structure observed in

Coltosol group (53%) is higher than the one obtained by Laustsen et al., 2005 (M.H. LAUSTEN & al. [9]), the latter registering cracks in the hard dental structure in 43% of the teeth. The largest amount of cracks was on the buccal side of the crown (68,65% in Coltosol F group, 66,66% in Kavitan Plus respectively). Tennert et al, 2015 have noticed a higher number of root cracks (61%) compared to those obtained in our study (C. TENNERT & al. [5]).

The fact that the smallest number of dental cracks was noticed in teeth with composite materials used for crown obturation suggests that these are restorations which may increase the fracture resistance of the MOD cavities teeth. The occurrence of these fissures may be explained by the fact that these materials shrink during polymerization and the polymerization contraction creates demands in the composite restoration (M.H. LAUSTEN & al. [9]); however, the composites may be employed as crown restoration materials on a longer period of time (G. PLOTINO & al. [6]).

Conclusions

It appears that the hygroscopic expansion of Coltosol F in MOD cavities produced a degree of deflection of the cuspids, which contributed to the occurrence of the crown fracture the second day after the application. Cracks within the filling material have been observed in teeth filled with Coltosol F and Kavitan Plus, while crown-root fissures were noticed in all 3 groups. No crown fractures were detected in endodontically treated teeth in Kavitan Plus or composite filled teeth.

Acknowledgements

For this article all the authors have equal contributions to the first author.

References

1. E. DEVIKA WARRIER, et al. A review on temporary restorative materials. *Int. J. of Pharma. Sci. and Res.*7(8):315-319(2016).
2. H.J. NAOUM, N.P. CHANDLER. Temporization for endodontics. *Int. Endod. J.,* 35(12): 964-970 (2002).
3. R. KAZEMI, K. SAVAFI, L. SPANGBERG. Assessment of marginal stability and permeability of an interim restorative endodontic material. *Oral. Surg. Oral. Med. Oral. Pathol.,* 78(6):788-796 (1994).
4. G.A. WOLANEK, R.J. LOUSHINE, R.N. WELLER, W.F. KIMBROUGH, K.R. VOLKMANN. In vitro bacterial penetration of endodontically treated teeth coronally sealed with a dentin bonding agent. *J. Endod*., 27(5): 354-357 (2001).
5. C. TENNERT, M. EISMANN, F. GOETZ, J.P. WOELBERG, E. HELLWIG, O. POLYDOROU. A temporary filling material used for coronal sealing during endodontic treatment may cause tooth fractures in large Class II cavities in vitro. *Int. Endod. J.,* 48:84-88(2014).
6. G. PLOTINO, L. BUONO, N.M. GRANDE, V. LAMORGESE, V.F. SOMMA. Fracture resistance of endodontically treated molars restored with extensive composite resin restorations. *J. of Prosth. Dent.,* 99:225-232 (2008).
7. S.J. JENSEN, K.D. JORGENSEN. Dimensional and phase changes of dental amalgams. *Scand. J. of Dent. Res.,* 93:351-356 (1985).
8. M.A. CATTANI-LORENTE, V. DUPUIS, J. PAYAN, F. MOYA, J.M. MEYER. Effect of water on the physical properties of resin modified glass ionomer cements. *Dent. Mater.,* 15(1):71-78 (1999).
9. M.H. LAUSTEN, E.C. MUNKSGAARD, C. REIT, L. BJORNDAL. A temporary filling material may cause cusp deflection, infractions and fractures in endodontically treated teeth. *Int. Endod. J.,* 38(9):653–657 (2005).
10. F.J. BURKE, W.M. PALIN, A. JAMES, L. MACKENZIE, P. SANDS. The current status of materials for posterior composite restoration: the advent of low shrink. *Dent. Update* 36:401-409 (2009).
11. S.A. SCARLATESCU, A.C. DIDILESCU, D.C. STEFAN, AL.A. ILIESCU, A. ILIESCU. An in vitro assessment of coronal microlekeage in root-filled teeth. *Int. J. of Med. Dent.,*3(1):27-31 (2013).
12. A.R. DANESHKAZEMI. Resistance of bonded composite restorations to fracture of endodontically treated teeth. *J. of Contemp. Dent. Pract.,* 5:51-58 (2004).
13. P. MONGA, V. SHARMA, S. KUMAR. Comparison of fracture resistance of endodontically treated teeth using different coronal restorative materials. *J. of Conserv. Dent*., 12:154-159 (2009).
14. D.G. SEO, Y.A. YI, S.J. SHIN, J.W. PARK. Analysis of factors associated with cracked teeth. *J. of Endod.,* 38:288-292 (2012).
15. F.K. COBANKARA, N. UNLU, A.R. CETIN, H.B. OZKAN. The effect of different restauration techniques on the fracture resistance of endodontically treated molars. *Op. Dent.*, 33:526-533 (2008).
16. IM GHEORGHIU, V. MARASCU, D. STAICU, D. ZMARANDACHE, P. PERLEA. Comparative ultrastructural analysis of dentin surfaces mechanically prepared using carbon steel conventional burs and polymer burs. *Rom Biotechnol Lett*, 22(4): 12775-84 (2017).