



Assessment of Coronal Leakage of Temporary Restorations in Root Canal-treated Teeth: An *in vitro* Study

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ABSTRACT

Introduction: Coronal leakage is one of the constant concerns in routine dental practice. It is one of the factors responsible for the failure of root canal therapy. Permanent restorations should be given as soon as possible after the completion of root canal therapy. If unavoidable, provisional restoration should be given in such a way that it maximally reduced the leakage of micro-organisms and fluids from the external environment into the canal space. Hence, we evaluated the effect of saliva on the coronal leakage of temporary restorations.

Materials and methods: Biomechanical preparation of the root canals of 204 fresh mandibular first premolar teeth was done using endodontic files with intermittent irrigation of sodium hypochlorite solution and ethylenediaminetetraacetic acid. Alternate irrigation with normal saline was done periodically. After preparation, drying of the canals was done using paper points followed by sealing of the apical foramen. For the assessment of the microleakage, Siqueira et al apparatus and method was used. All the specimens were divided into four groups based on the provisional restorative material used. All the groups were further divided into three subgroups based on the presence and absence of intracanal medicaments. Verissimo et al's criteria were used to check the turbidity at 1-, 2-, 3-, and 4-week interval respectively. All the results were analyzed by

Statistical Package for the Social Sciences (SPSS) software. Chi-square test was used to measure the level of significance, and $p < 0.05$ was considered to be significant.

Results: In group I, all the subgroups' specimens showed significant difference at 1 week's time. Only the subgroup with no intracanal medicaments in Cavit-containing provisional restoration showed nonsignificant alterations. Statistically significant alterations were seen at 1, 2, and 3 weeks' interval in all the subgroups except for one with intracanal medicaments.

Conclusion: All the temporary restorative materials were not able to prevent microleakage after 1 week's time, with worst bacterial resistance shown by Ketac Molar and ionomer restorative material. Future studies are advocated for better prognosis of root canal therapy.

Keywords: Leakage, Provisional, Restoration.

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INTRODUCTION

One of the constant concerns in routine dental practice in restorative dentistry is coronal leakage. Failure of root canal treatment is one of the common outcomes of such complication.¹ Failure usually occurs in the time period in which tooth is in between the stage of endodontic session and final restoration, i.e., in the phase of temporization. Pathway of the fluid from the oral cavity into the tooth through the restorative material is known as microleakage.² It is of great significance for dentists since it occurs around provisional temporary restorations.^{2,3} Therefore, treated teeth should be restored with permanent restorations as soon as possible to avoid coronal leakage.⁴ If

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permanent restoration is not possible in the immediate future, temporary filling should be done in such a way that it seals the coronal portion of the teeth hermetically and should have marginal sealing properties.⁵ Choice of temporary restorative material should be done with great care. It should have properties of abrasion resistance and dimensional stability. At the same time, it should prevent the contact of intracanal medicaments with the oral environment.⁶ There is still lack of evidence in the literature regarding the effect of saliva on temporary restorations.⁷ Hence, we evaluated the effect of saliva on the coronal leakage of temporary restorations.

MATERIALS AND METHODS

In this *in vitro* study, a total of 204 mandibular first premolar teeth were included for the study. Only fresh caries-free teeth were extracted for the study. Biomechanical preparation of the root canals was done using endodontic files. Intermittent irrigation by sodium hypochlorite and ethylenediaminetetraacetic acid was done in between the filing procedure with a syringe. Alternate irrigation with normal saline was done periodically. After the completion of biomechanical preparation, drying of the root canals was done with paper points. Sealing of the apical foramina was done using cyanoacrylate followed by insertion of the root portion into an Eppendorf tube, leaving the crown portion of the tooth outside exposing the crown to external environment (Fig. 1). Siqueira et al apparatus and method were used for assessment of leakage.⁸ The specimens were then autoclaved for 20 min at 121°C. Depending on the type of coronal seal used, all the study specimens were randomly divided into four groups with 51 teeth in each group as shown in Table 1.

Based on the type of medicament (intracanal) used, all the groups were further divided into three subgroups as shown in Table 2.



Fig. 1: Isolated crown portion of the tooth with root immersed in study solution in Eppendorf tube

Positive controls were the samples in which neither any medicament was used nor were any coronal restoration placed. Cavity depth was approximately 3.5 mm from the base of pulp chamber to the cavosurface margin.⁹ After placement of the medicaments and cotton pellets in the pulp canals and pulp chamber respectively, the teeth samples were filled with provisional restorations depending on their respective groups. Before microleakage test, the teeth specimens were left for about 1 hour. Vial tube was filled with brain heart infusion (BHI) agar using sterile pipettes. To stop the penetration of saliva into the BHI broth, cyanoacrylate was placed between the flask and the stopper. Collection of human saliva was done from volunteers and both the saliva and broth were maintained at a ratio of 25:75 and placed on the crown two times daily. Incubation of the apparatus was done at 37°C following the criteria of Verissimo et al to check the turbidity.¹⁰ Periodic checking of turbidity was done at 1-, 2-, 3-, and 4-week intervals respectively. All the results were analyzed by Statistical Package for the Social Sciences (SPSS) software. Chi-square test was used to measure the level of significance, and $p < 0.05$ was considered to be significant.

RESULTS

Graph 1 shows percentage of leakage in different groups. Significant results were obtained while comparing the negative controls at 1 week, 2 week and 3 week time (Table 3). Table 4 highlights the p-value for percentage of leakage for different subgroups of Group 1. All the subgroups in the group 1 specimens showed significant

Table 1: Division of specimens depending on the type of coronal seal

Groups	Type of coronal seal used
I	Coltosol F (ColteneWhalident)
II	Cavit (3M ESPE)
III	Ketac Molar (3M ESPE)
IV	IRM (Dentsply)

Table 2: Division of each group into various subgroups depending on the type of medicament used

Subgroups	Type of medicament used
i	No medication
ii	CaOH
iii	CHX

Table 3: p-value for percentage of leakage for negative control

Group	p-value (percentage of leakage)		
	After 1 week	After 2 weeks	After 3 weeks
Negative control	0.00018 S	0.00018 S	0.00018 S

S: Significant

Table 4: p-value for percentage of leakage for different subgroups of group I

Groups	p-value (percentage of leakage)		
	After 1 week	After 2 weeks	After 3 weeks
I (i)	0.02018 S	0.21022 NS	0.25125 NS
I (ii)	0.00125 S	0.00412 S	0.00381 S
I (iii)	0.00715 S	0.00842 S	0.00152 S

S: Significant; NS: Nonsignificant

Table 6: p-value for percentage of leakage for different subgroups of group III

Groups	p-value (Percentage of leakage)		
	After 1 week	After 2 weeks	After 3 weeks
III (i)	0.71823 S	0.84586 NS	0.74445 NS
III (ii)	0.00415 S	0.00211 S	0.00415 S
III (iii)	0.00682 S	0.00811 S	0.00222 S

S: Significant; NS: Nonsignificant

Table 5: p-value for percentage of leakage for different subgroups of group II

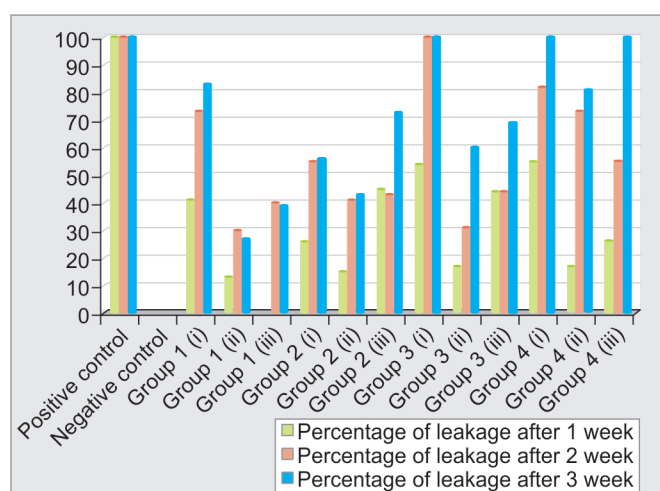
Groups	p-value (Percentage of leakage)		
	After 1 week	After 2 weeks	After 3 weeks
II (i)	0.00125 S	0.42512 NS	0.94852 NS
II (ii)	0.00415 S	0.01242 S	0.00149 S
II (iii)	0.00718 S	0.00145 S	0.00748 S

S: Significant; NS: Nonsignificant

Table 7: p-value for percentage of leakage for different subgroups of group IV

Groups	p-value (percentage of leakage)		
	After 1 week	After 2 weeks	After 3 weeks
IV (i)	0.33451 NS	0.41211 NS	0.74111 NS
IV (ii)	0.00125 S	0.33112 NS	0.31852 NS
IV (iii)	0.00136 S	0.94152 NS	0.31125 NS

S: Significant; NS: Nonsignificant

**Graph 1:** Percentage of leakage in all the groups

difference at one week's time (p -value < 0.05). At two and three weeks' time, all the subgroups in Group 1 specimens showed significant results except for subgroup containing no medications. In group with Cavit as provisional restoration, only the subgroup with no intracanal medicaments showed nonsignificant alterations as shown in Table 5. Table 6 shows p -value for percentage of leakage in groups containing Ketac Molar. Statistically significant alterations were seen at 1, 2, and 3 weeks' interval in all the subgroups except for one with intracanal medicaments. In groups containing ionomer restorative material (IRM), significant results were seen only at 1 week's time, as shown in Table 7.

DISCUSSION

One of the deciding factors in predicting the prognosis of endodontic therapy is the provisional restorative material. The main role of provisional restoration is to temporarily seal the tooth and stop the seepage of fluids, microorganisms,

and other materials from the oral cavity. This results in periapical pathologies once these factors have invaded the periradicular areas.¹¹⁻¹⁴ To prevent this, immediate permanent restorations are advocated as soon as possible after completion of the treatment.^{15,16} Data from the past studies indicate that even poorly root canal-treated teeth can have significantly favorable prognosis if provisional restoration placed coronally is well adapted to the margins, thereby preventing penetration of bacteria and other microorganisms.¹⁷ Hence, we evaluated the effect of saliva on coronal leakage in temporary restorations. In this study, we found that no single temporary restorative material was found to completely prevent bacterial microleakage. Approximately, two-thirds of all the samples showed presence of leakage after 2 weeks' time except for the group with intrapulpal medicaments. In this study, no provisional restorative material was completely resistant to bacterial leakage, with 60 to 70% of the specimens in all experimental groups demonstrating leakage after 14 days, except with intracanal medicaments (Graph 1 and Tables 4 to 7). Hagemeyer et al¹⁷ and Jensen and Abbott¹⁸ have shown that sealing properties of Ketac Molar are less than that of Cavit despite the fact that it performs well under loading pressure.¹⁶ Even in complex cavities, cavity is still shown to have more efficient sealing abilities. In comparison to Ketac Molar, less leakage was observed after 1, 2, 3, and 4 weeks in this study. However, Liberman et al¹⁹ showed that less resistance to load pressure limits the seal ability of Cavit.

Bobotis et al²⁰ showed poor leakage properties of IRM which were in correlation to the results of our study in which we observed presence of high amount of microleakage in samples with IRM as compared with other groups. Time-dependent hygroscopic expansion of Cavit and Coltosol may be responsible for their minimal leakage. However, in Coltosol-subjected groups, fracture

of the teeth can occur due to expansion occurring in cuspal regions.²¹ To decrease the amount of leakage and bacterial contaminations, medicaments are added in the pulp canal space.²² Except for subgroups containing Cavit with chlorhexidine (CHX) and specimens in subgroups CHX with IRM, all other samples showed a comparatively higher leakage in group without intrapulp medicaments as compared with other groups (Tables 4 to 7). We also observed that subgroups containing calcium hydroxide (CaOH) with Coltosol and CaOH with Cavit showed the presence of minimal microleakage up to 3 weeks' time. Similar results were obtained by Gomes et al and Udayakumar et al who also saw minimal leakage in CaOH-containing subgroups in their respective studies. Symanski et al assessed various temporary restorative materials in Brazilian dental schools, during and after endodontic treatment completion. They prepared a questionnaire and distributed it to 191 schools and found that most of the schools recommend a minimum thickness of 3 mm for temporary restorations. They further concluded that choice of dental schools regarding coronal restorative materials is subjected to remaining dental conditions.²⁴ Veloso et al investigated microbial microleakage through Coltosol, IRM, and Vidrion R after post space preparation. They examined 42 maxillary anterior teeth and observed microleakage daily for 3 months. From the results, they concluded that all provisional fillings and intrapulpal medications did not prevent the accumulation of microorganisms to the root apex.²⁵ Cunha et al evaluated the microleakage of temporary sealers and endodontic sealers in 30 bovine teeth. All the teeth were cut at a level of 4 mm below the cemento-enamel junction, and sealing of root canals was done with acrylic resin. From the results, they concluded that microleakage was higher in group containing Sealerplex filling material and Bioplic cap.²⁶ Siqueira et al assessed the sealing capacity of CaOH-based sealers and from the results concluded that sealers containing CaOH show higher physical properties as compared with zinc oxide eugenol-containing sealers.²⁷ Nelida et al evaluated the sealing ability of X-Temp LC and compared it with Coltosol and Vitro Fill with the help of dye penetration test. From the results, they concluded that all temporary restorative materials show some amount of marginal leakage. However, sealing capacity of X-Temp LC and Coltosol was somewhat better than Vitro Fill glass ionomer cement.²⁸ Therefore, for better prognosis and outcome of the endodontic therapy, root canal-treated teeth should be restored with final restoration as soon as possible. Hence, one of the very important aspects which should be stressed on after completion of endodontic therapy is the quality and type of provisional restoration material.²³

CONCLUSION

From the above results, it can be concluded that after 1 week's time, all the temporary restorations were not able to stop microleakage, with worst bacterial resistance showed by Ketac Molar and IRM. After 3 weeks' time, no single temporary restorative material could stop leakage to happen coronally. Future studies are advocated to further improve the prognosis of endodontic therapy.

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