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Comparative Analysis of the Properties of Temporary Cement – An In Vitro Study

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ABSTRACT

Introduction: Microbial eradication from the pulpal spaces plays a pivotal role in the success of endodontic treatment. The intricate internal tooth anatomy challenges the clinician at every instance - be it the cleaning, shaping, or complete restoration of the root canal system.

Aim: To assess and compare sealing ability, water sorption and solubility of temporary restorative materials.

Material and Method: Thirty extracted premolars were endodontically treated and restored with temporary restorations, 10 teeth in each group. The groups were - Cavit G, Zinconol, Coltosol F. Teeth were thermocycled and sectioned. Microleakage was tested with Methylene blue dye under stereomicroscope. For solubility and sorption analysis, disc shaped specimens (10 each) were prepared and restored with temporary cements and divided into three groups, depending on the cement used. Specimens were stored in desiccator; dry mass (m1) was obtained. After storing in distilled water, mass after saturation (m2) and thereafter constant dry mass was obtained (m3).Water sorption and solubility was determined by prescribed formulas.

Kruskal Wallis and Dunn's Post-hoc test were used for microleakage. For water sorption and solubility Kolmogorov-Smirnov normality test, ANOVA and Tukey's post hoc test were used.

Result: Coltosol exhibited least microleakage followed by Cavit and Zinconol. Cavit exhibited maximum sorption and solubility, followed by Coltosol and Zinconol .

Conclusion: Coltosol exhibited the least amount of microleakage compared to Cavit and Zinconol. It also demonstrated intermediate level of sorption and solubility. Hence it can be recommended for use as a temporary restorative material during endodontic treatment.

Key Words: Laboratory research, Sealing ability, Solubility, Water sorption, Temporary cement, Restoration

INTRODUCTION

Microbial eradication from the pulpal spaces plays a pivotal role in the success of endodontic treatment. However, making the root canals bacteria-free is like moving the proverbial stone up the hill. The intricate internal tooth anatomy challenges the clinician at every instance - be it the cleaning, shaping, or complete restoration of the root canal system.

Of all the steps in endodontic treatment, one of the steps given least importance is the placement of a temporary restoration. A temporary is required in two situations- as a post endodontic restoration before placing the permanent restoration, or as an inter-appointment dressing in multi visit endodontic treatment. Effective tooth temporization is of paramount importance for successful endodontics.

It is stated that inadequate temporary restoration during an endodontic treatment ranks second amongst all the contributing factors that results in continous pain.[1]

One of the major roles of a temporary is to completely seal the root canal system, thus maintaining sterility, which will avoid postoperative failure .They also help in sustaining the effectiveness of the intracanal medicament.[2]

In presence of moisture the temporary may degrade with resultant spacing between the restoration and the cement; this will ultimately result in failure of the root canal treatment

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as temporary cements will absorb water and there will be dimensional changes.

An inadequate temporary restoration will lead to improper coronal seal, thus jeopardizing the outcome of endodontic treatment.[2,3]

The most desired features in a temporary filling material are adequate sealing ability, decrease in the rate of water absorption (WS) and lower rate of solubility (SL).Thus in our study we performed comparative analysis of the above mentioned properties in three temporary cements, viz. Cavit G, Zinconol and Coltosol F.

Clinical significance

All temporary cements exhibit some amount of microleakage, sorption and solubility, hence should be used for a limited time period in endodontic treatment .

METHODS

Evaluation of sealing ability

30 extracted non carious premolars were taken. Class I endodontic access cavity of specific dimensions was prepared. The teeth were cleaned, shaped and obturated. The teeth were then divided into 3 groups with 10 teeth in each group, where each group of teeth were restored with a specific temporary cement.

Group 1:Cavit G (3M ESPE, Germany)

Group 2:Zinconol (Prevest Den Pro Ltd, India)

Group 3: Coltosol F (Coltene, Alstatten, Switzerland)

The specimens were thermocycled for 500 cycles with 30 seconds dwell time and 3 second interval time after which the root apices were sealed with self cure epoxy resin, which was then followed by coating each tooth with two layers of nail varnish excluding the restoration and 1 mm area around it. This was followed by placing the samples at room temperature in 2% methylene blue dye for 24 hours. A diamond disc was used in the mesiodistal direction to section the tooth along their longitudinal axis .a stereomicroscope was used to view the specimens under 10 x magnification .

The level dye penetration was scored using scoring method.[2]

0 – no dye penetration seen at the tooth/ filling interface

1 – The level of dye penetration is restricted to the dentin enamel junction.

2 – Here dye penetration occurs up to half of the pulp chamber;

3 –dye penetration is seen over half of the pulp chamber.

Evaluation of water sorption and solubility

In each group 10 disc shaped specimens were prepared for each material which were 6 mm in diameter and 3 mm in height. The groups designated were same as mentioned earlier.

Initially all the samples were kept in forced air oven at 37**°C** for 24 hours. Specimen were then stored in a desiccator (Digimatic, Korea) at 24**°C**, weighed daily to verify mass stabilization (dry mass m1). The samples were then stored in distilled water for 7 days at 24 degree celcius to obtain mass after saturation (m2).The specimens were then placed in a dessicator (Digimatic, Korea) at 24**°C** and was reweighed till a constant dry mass value was obtained (m3). Analytical balance (LWL Germany, Model:LB 210S) was used to weigh the specimen with an accuracy of 0.0001g.

Water sorption and solubility was determined by using the formulas

WS=m3-m2/V and SL=m1-m3/V. All the results were duly tabulated.

Statistics

To evaluate sealing ability, the data were subjected to statistical analysis for the calculation of mean .To find the significance of study parameters Kruskal Wallis test followed by Dunn's Post-hoc pair wise comparison test were done in which p-value less than that of 0.05 indicated significance of difference.

Similarly to evaluate water sorption and solubilty Kolmogorov-Smirnov normality test were performed followed by ANOVA test and Tukey's post hoc test ($p< 0.05$=significant) for respective group comparison.

RESULT

Coltosol F (0.60 ±0.5) exhibited the least amount of microleakage followed by Cavit(1.0±0.67), Zinconol(1.90±0.57) exhibited the highest amount of microleakage. There was a remarkable difference in the mean values of microleakage of all cements.(Table 1)

Cavit G (693.12±36.06) exhibited maximum amount of water absorption followed by Coltosol F(342.96±41.17), Zinconol (48.22±9.31) exhibited the least amount of water absorption . There was a remarkable difference in the mean values of sorption of all cements.(Table 2)

Cavit G (633.46±34.32) exhibited highest level of solubility followed by Coltosol F(238.51±47.94), Zinconol(12.38±2.68) showed the least amount of solubility. There was a remarkable difference in the mean values of solubility. (Table 3).

DISCUSSION

In spite of the advent of new restorative materials to improve the clinical success rate of restorative procedures, microleakage poses to be one of the most important factors resulting in failure of the restoration. Microleakage is described as the movement of bacteria, fluid, molecules between the tooth and restoration interface.[4] Ray and Trope demonstrated in their study that there exists a relation between improper coronal restoration and periapical status of the root canal treated tooth.[5] Torabinejad et al. in their study showed that it takes approximately 5 to 73 days for the bacteria to pass from coronal to apical third of tooth.[5]The various adverse effects caused due to microleakage are secondary caries, staining between the tooth and restoration interface, postoperative sensitivity and fracture of restoration or tooth. This may ultimately result in failure of the restoration.[6, 7]

A temporary restorative material is expected to provide adequate seal against the ingress of bacteria. It should also prevent seepage of intracanal medicament.[8] According to recent studies, coronal microleakage plays a pivotal role in determining the prognosis of the root canal treatment.[3, 9]

Comercially there are different temporary cements available with a variety in their compositions, microstructures and setting reactions. So in this study, we selected three materials having different composition viz. Cavit that is a CaSO4 based cement, Zinconol, a zinc oxide eugenol based cement and Coltosol F a zinc sulphate based cement along with fluoride in it .

Methylene blue as a dye has been used in large number of studies and has several advantages as it is inexpensive and demonstrates high degree of staining.[10, 11, 12]

In thermocycling the temperature at which the tooth and restorative materials are exposed is similar to those found in the oral cavity for standardization, this would help to understand the adverse effects seen because of the difference in coefficient of thermal expansion between tooth and restorative material .These cycles could affect the bond strength between the filling material and tooth structure due to the thermal stress induced in this process. A minimum of 500cycles between 5 degree and 55 degree is considered as an appropriate artificial aging test for thermocycling.[13]

Webber et al. stated that at least 3.5 mm thickness of temporary restoration should be used in order to prevent leakage.[14] Hence in our study, we standardized the thickness of all temporary cements used to 4 mm thickness.

The microleakage results of our study were Coltosol F<Cavit G < Zinconol.

Milani et al. in 2017 stated that Coltosol showed good sealing properties due to its hygroscopic expansion; also this material allows expansion on hardening.

Cavit is a premixed temporary filling material that contains zinc oxide, calcium sulphate, zinc sulphate, glycol acetate, polyvinyl acetate resins, polyvinyl chloride acetate, triethanolamine and pigments. As a hygroscopic material, Cavit possesses a high coefficient of linear expansion. The linear expansion seen in Cavit is the main reason for its excellent marginal seal.[14]

The poor sealing ability of Zinconol could be attributed to the instability of zinc oxide when it is subjected to extreme temperature changes.[15]

Another factor to be considered here is whether the cement is hand mixed or pre-mixed. Coltosol and Cavit are pre-mixed cements, whereas Zinconol is a hand mixed cement. There is an added variable in a hand mixed cement, since the dispensing and manipulation has to be performed manually. This may lead to variations and errors. Since Zinconol cement is hand mixed, it may result in lack of homogeneity which will ultimately compromise the seal of the material.

Similar inferences were drawn by a study by Hager et al, this study stated that hand mixed temporary cements exhibited greater microleakage when compared to readymade temporary cements.[16]

There are few microleakage studies of Zinconol cement; however IRM cement, which has similar composition (polymer reinforced ZOE cement) has been tested in many studies.

Zaia AA et al. study showed that Coltosol showed less coronal leakage than IRM in endodontically treated teeth.[17]

However, some studies showed differing results as compared to our study. A study by Odabas et al. showed that there was negligible amount of difference in microleakage between Cavit G, Coltosol and IRM when tested as temporary filling materials in access cavities of primary teeth.[18]

Zmener et al. (2004) also did not find any major difference in the sealing ability of Cavit and IRM.(27) A study conducted by Prabhakar AR et al. (2017) showed that Cavit G. exhibited higher amount of microleakage when compared to IRM.[2]

Water sorption results in volumetric changes in the cement and it ultimately results in softening of the material, this compromises the structural and physical properties of the material.[19]

When the solubility of the material is higher than the estimated value, it will result in dissolution of the cement which will ultimately affect the longetivity of the cement.[20]

Both sorption and solubility lead to loss of marginal integrity, surface properties and aesthetics; this ultimately results in failure of the restoration

In our study, Cavit G. exhibited highest level of solubility and sorption, followed by Coltosol F. Zinconol showed the least amount of solubility and sorption.

Water uptake plays an important role in the setting mechanism of Cavit G.

In Cavit G due to expansion water diffusion occurs which ultimately results in swelling in components of spaces which was occupied by water , this explains its high water sorption as well as its solubility.[2]

Wilson and Batchelor in the year 1970 explained the mechanism of water sorption and solubility in zinc oxide eugenol based cements, microstructural degradation occurs because of aqueous leaching which causes loss of eugenol in the cement matrix .

A study conducted by Pieper CM et al. (2009) showed that Cavit exhibited greater water sorption and solubility as compared to IRM. [19] Similar results were obtained in a study by Prabhakar AR et al.[2]

Our results differed from those of another study by Jani et al., who stated that Cavit G. showed least solubility followed by Coltosol F., amongst all the temporary restorative materials tested.[21]

Our study was not without limitations. This was an invitro study, so the exact condition in the oral cavity such as presence of saliva, masticatory load, food habits etc could not be simulated. Also the sample size and time span used for the study was limited .Hence in order to substantiate the result, more clinical trials with larger sample size for a longer duration are recommended.

STATISTICAL ANALYSIS

Table 1: Comparison of sealing ability (Microleakage):

Kruskal-Wallis Test result:

Test Statistics	
	Value
Chi-Square	14.658
Df	2
p-value	.001

Interpretation: p-value **< 0.05** indicates that the average score of micro-leakage **differ significantly** when compared with each other.

Table 2: Comparison of water sorption

ANOVA test result:

	Sum of Squares	Df	Mean Square	F-test value	p-value
Between Groups	2084572.476	2	1042286.238	1014.412	.000
Within Groups	27741.916	27	1027.478		
Total	2112314.392	29			

Interpretation: p-value < 0.05 indicates that there exists a significance of difference between the average scores of water sorption

Table 3: Comparison of solubility

ANOVA test result:

	Sum of Squares	Df	Mean Square	F-test value	p-value
Between Groups	1976186.334	2	988093.167	851.093	.000
Within Groups	31346.178	27	1160.970		
Total	2007532.512	29			

Interpretation: p-value < 0.05 indicates that there exists a significance of difference between the average scores of solubility

CONCLUSION

Within the limitations of this study it can be concluded that all temporary materials exhibit some amount of marginal leakage, water sorption and water solubility. It is recommended that all temporary restorative materials be used for a short duration and be replaced with a permanent restoration at the earliest.

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