ISSN- O: 2458 - 868X, ISSN–P: 2458 – 8687
National Library of Medicine - ID: 101731606

International Journal of Medical Science and Innovative Research (IJMSIR)
IJMSIR : A Medical Publication Hub
Available Online at: www.ijmsir.com
Volume – 8, Issue – 1, February – 2023 , Page No. : 78 – 85

Comparative evaluation of coronal micro-leakage of different temporary restorative materials used for multi-visit endodontic sessions in primary teeth an in-vitro study.

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Citation this Article: Dr. Neha Kalantri, Dr. Parul Rawat, Dr. Ruchi Arora, Dr. Shruti Jain, Dr. Sakshi Runwal, "Comparative evaluation of coronal micro-leakage of different temporary restorative materials used for multi-visit endodontic sessions in primary teeth an in-vitro study", IJMSIR- February - 2023, Vol – 8, Issue - 1, P. No. 78 – 85.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: Temporary filling materials, which are used during and after endodontic treatment until the final restoration is placed, should provide a tight seal of the access cavity, thus preventing reinfection of the root canal system.

Aim: To evaluate & compare coronal micro-leakage of three temporary restorative materials namely Cavit-G, Coltosol-F and Clip-F used in between endodontic sessions in primary molar teeth.

Materials and method: The present in vitro study consisted of forty-five extracted primary molar teeth. Access cavities were prepared and teeth were randomly divided into three groups of fifteen each (n=15) with

- Group I: Cavit-G
- Group II: Coltosol
- Group III: CLIP

Temporary restorative materials were applied according to manufacturer's instructions. Thermocycling was done followed by immersing the samples in 2% methylene blue dye solution for 24 hours. Samples were sectioned and were viewed under stereomicroscope and micro-leakage was measured using a computer software.

Statistical analysis: For analyzing the data, SPSS 23.0 software was used. Kruskal Wallis test followed by Mann Whitney U test for pairwise post hoc comparison was used for inferential statistics.

Results: Least micro-leakage values were observed with CLIP (0.07mm) whereas Cavit-G (0.2mm) & Coltosol (0.3mm) presented higher micro leakage values.

Conclusion: Amongst three materials i.e Cavit-G, Coltosol and CLIP, CLIP exhibited better sealing ability than other two materials, hence it may be used in between sessions of endodontic treatment in primary teeth.

Keywords: Dye penetration, Micro-leakage, Temporary restorative materials.

Introduction

The purpose of endodontic treatment in primary tooth is multi-fold. [1] Effective pulp therapy in the primary dentition is essential because it not only stabilizes the affected primary tooth but also aids in preserving the deciduous dentition's integrity until normal exfoliation, thereby permitting the eruption of the permanent tooth that will eventually replace it. [2]

The most frequent cause of pulpal and peri-radicular diseases has been identified as bacterial infection. [3] Therefore, the primary objective of endodontic treatment is to completely eradicate bacteria while maintaining the tooth in a healthy environment. This is accomplished by preventing bacterial penetration both during and after the treatment procedure. [4] It is without dispute that pulpectomies requiring numerous visits should be interspersed with effective interim restorations. [4]

The interim temporary restorative material used in inter-appointments, is typically applied for 2-3 days during multiple-visit pulpectomies. Over the course of this time, these temporary filling materials need to seal the teeth, thereby preventing entry of bacteria, fluids and organic materials from the oral cavity entering into root canal system. [5]

Additionally, it should also prevent the escape of medications placed in the pulp chamber and/or root canal system, as well as the deterioration of therapeutic materials.

But, one of the problems in regular dental practise and restorative dentistry is coronary microleakage, [6] which is described as the flow of fluid from the oral cavity through the restorative material into the tooth. [7]

It is characterized by, leakage of microorganisms and toxins through the junction between the restoration and the walls of the cavity. [7] Micro-leakage either may occur within the cement-tooth interface or within the cement, or will ultimately leads to the failure of root canal therapy. The results of endodontic therapy may be significantly impacted by it, and failure typically happens during the temporization period. [6]

In paediatric endodontic treatment, to avoid delay and failure of treatment, which results in physical and psychological stresses for the child. Therefore, greater emphasis needs to be placed on the selection of temporary filling material. Several types of temporary filling materials are available for clinician, each with different composition, setting mechanism, and microstructures. [8] Hence the sub sequent study was contemplated to evaluate and compare the coronal micro-leakage of three different temporary restorative materials i.e Zinc oxide-calcium sulphate based, non-eugenol temporary resto rative material and a light cured-resin based temporary restorative materials used for multi-visit endodontic treatment.

Materials and method

Sample preparation

The current in vitro research was carried out in the Department of Pediatric and Preventive Dentistry, Darshan Dental College and Hospital, Udaipur, Rajasthan, India. The protocol was approved by institutional ethical committee (2020-21/1058). The study was undertaken to compare coronal micro-leakage

of three temporary restorative materials used in-between endodontic sessions in primary molar teeth.

Forty-five extracted human maxillary or mandibular primary molar teeth with intact crowns and at least 2mm of root apical to cement-enamel junction were included in the study whereas restored teeth, fractured teeth, endodontically treated teeth and carious teeth were excluded from the study.

Methodology

The selected teeth were cleaned to remove all debris and soft tissue remnants. They were disinfected with 5.25% sodium hypochlorite for 24 hours and then were stored in normal saline at 37 °C until experimentation. Samples were then cleaned and air-dried and were mounted on modelling wax. 4mm × 4mm uniform endodontic access preparations was made on occlusal surface using a #6 round carbide bur followed by an Endo Z bur (safe end fissure diamond bur) with a high-speed air turbine handpiece with water spray. The pulp chamber was irrigated with normal saline and then dried with cotton pellets.

The teeth were randomly distributed into three groups of fifteen each (n=15)

- Group I: Cavit-G (Table 1)
- Group II: Coltosol (Table 1)
- Group III: CLIP (Table 1)

Table 1: Materials used in the study

Material	Brand	Composition	Available form for use
Cavit-G	3M	Zinc Oxide (30-50%), Calcium Sulfate (1-30%), Barium Sulfate (0-20%), Ethylene Bis (Oxyethylene) Diacetate (10-20%), Talc (0-20%) Zinc Sulfate (5-10%), Poly (Vinyl Acetate) (1-5%)	Ready to use form
Coltosol	Coltene	Zinc oxide, calcium sulphate, zinc sulphate, ethylene vinyl acetate copolymer	Ready to use form
CLIP	VOCO	2-hydroxyethyl methacrylate (5-10%) non-hazardous additions	Light cured flowable form

Temporary restorative materials was manipulated as per instructions of manufacturer. The temporary restorative materials was placed in increments and pressed against walls to ensure complete sealing. The teeth with resin-based group were exposed to an LED curing light for 30 seconds.

After placement of temporary restorative materials into access cavities, the specimens were stored in normal saline at 37 °C for 24 hours to ensure proper setting of materials. Thermocycling was done for 500 cycles in water bath maintained at 5°C and 55°C with a dwell time of 30 seconds in each bath. The apices of teeth were sealed with restorative resin so as to ensure that there will be no retrograde entry of dye, which will further leads to wrong scoring. All the surfaces of teeth were then covered with nail varnish, except for the restoration leaving a margin of 1mm around it.

Now dye penetration technique was used to access presence of any micro-leakage around tooth-restorative material interface. The teeth were then immersed in 2 % Methylene Blue dye solution for 24 hours.

Stereomicroscopic analysis

After removal from dye solution, all the specimens were rinsed properly to remove excess stain from surface and then were air-dried. All the samples were sectioned Bucco-lingually using a diamond disc with a straight handpiece at slow speed. The sectioned specimens were then analysed under a stereomicroscope at 20x magnification (Fig. A, Fig. B, Fig. C) and micro-leakage

was measured in millimetres using a computer software (Image J tool software).

Stastical analysis

Descriptive statistics was performed using Statistical Package for Social Sciences (SPSS) version 23.0. Kruskal Wallis test followed by Mann Whitney U test for pairwise post hoc comparison was used for inferential statistics. Level of statistical significance was set at p-value < 0.05

Table 2: Inter-group comparison of mean micro-leakage

	N	Mean	Std. Deviation	Std. Error	95%confidence interval for mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Group 1	15	0.2293	0.27301	0.0704	0.0781	0.3805	0.10	0.90
Group 2	15	0.3073	0.05338	0.0137	0.2778	0.9969	0.22	0.44
Group 3	15	0.0733	0.09612	0.0248	0.0201	0.1266	0.00	0.20
Total	45	0.2033	0.0287	0.0287	0.1454	0.2613	0.00	0.90
P value							0.002*	

- Overall significant difference was seen in the mean micro-leakage when compared using Kruskal Wallis test.
- It was found to be least in Group III samples and maximum in group II samples.

Discussion

The success of endodontic therapy depends on a through chemo-mechanical preparation for removal of necrotic debris and bacteria from the root canal followed by sealing the root canal to prevent ingress of bacteria and tissue fluid. [9] Therefore, primary aim of root canal treatment is to obtain 'fluid tight seal' coronally as well as apically. [10]

Coronal micro-leakage is a significant contributing cause to unsuccessful root canal therapy, [11] even if endodontic treatment was performed adequately. The most common factor for coronal micro-leakage is salivary micro leakage, which may serve as a reservoir of microorganisms and their toxins that may penetrate into the root canal. [10] This could cause a problem as the apical seal may be affect adversely and cause the root canal to fail. Also the movement of microorganisms and toxins may result in furcation involvement through the accessory canals in the floor of pulp chamber.

Therefore, temporary restorations in teeth undergoing root canal treatment must provide an effective barrier against salivary contamination of root canal. So, before placement of permanent restoration, the use of interim restorations is crucial in preventing contamination of the obturated root canal.

Hence, in present study we evaluated coronal micro-leakage using different temporary restorative materials used in multi-visit endodontic treatment.

In our study, maxillary and mandibular primary molars were selected, as molars have adequate surface area to place temporary filling material, whereas in primary

Results

In the present study the results showed the least amount of micro-leakage with Group III (i.e CLIP) and values ranged from 0.00 mm to 0.2 mm and was maximum with Group II (i.e – Coltosol) with micro-leakage values ranged from 0.22 mm to 0.44 mm. Group I i.e Cavit-G showed average amount of micro-leakage and values ranged from 0.10 mm to 0.17mm.

anterior teeth access cavity is small and is difficulty to restore. [10]

The rmocycling of the samples was done to simulate in-vivo intraoral conditions. The temperature range between 5 ^{0}C and 55 ^{0}C were used as these were the extremes of temperature that could be experienced in the oral environment. [12]

To evaluate this coronal micro-leakage, Dye penetration, radio iso tope penetration, bacterial and endo toxin infiltration, dye diffusion, glucose, fluid filtration, caffeine and protein infiltration, animal studies, and electrochemical or 3D evaluation metho do logies have been used. One of the commonly applied methods to evaluate micro leakage is based on linear measurement of dye penetration.

In present study, we have used 2% methylene blue dye to evaluate micro leakage as molecular size of MB dye is similar to bacterial by-products such as butyric acid which can leak out of infected root canals to irritate periapical tissues, also it is easy to use, pH manipulation and availability add to its advantages. The particle size of this dye (0.1-2 µm) is comparable to the size range of a number of endodontic pathogens and appears to be advantageous in endodontic dye leakage studies. [13]

In present study, samples were viewed under stereo micro scope at 20x magnification. The amount of dye penetrated was measured in mm for each group and Image J software was used to measure micro-leakage. It has been stated by A Fabio et al in 2015 that examination by stereomicroscopy is reliable method and based on the technological developments measurement in millimetres is more accurate by digital method (software) when compared to visual. [14] The stereomicroscopic evaluation of Group I in which Cavit-G was used as temporary restorative material showed less mean micro-leakage values as compared to Group II i.e - Coltosol.

These findings were in accordance with the previous study done by S. Deepak and MS. Nivedhitha in 2017, who compared the micro-leakage rates of three materials: Cavit–G, IRM and ZOE, where least dye penetration was with Cavit-G when compared to IRM and ZOE. [15]

This could be due to Cavit-G showing high linear expansion. This expansion enhances the contact between the material and the access cavity walls by reducing marginal gap, and also produces a better seal. Its linear expansion is nearly two times that of ZOE, and it is assumed that this expansion permits the material to adapt more tightly to dentin walls, resulting in providing a good seal under different conditions, including thermo cycling. [12]

The study done by AR Prabhkar et al (2017), who evaluated and compared the sealing properties, water absorption and solubility of IRM, Cavit G and GC Caviton. The results showed that GC Caviton with least micro leakage and least water absorption followed by IRM and Cavit-G, which is contradictory with our study. This could be due to GC Caviton's immediate hygro scopic expansion property leading to better coronal sealing ability. [16]

In our study Cavit-G showed less micro-leakage than other non-eugenol temporary restorative materials. The difference in results could be attributed to the use of different samples, as the composition and structure may vary in primary and permanent teeth.

Mean micro-leakage in Group II i.e Coltosol is higher than other two materials i.e Cavit-G and CLIP. The results were in accordance with study done by Shah H et al in 2021, where they concluded that Coltosol showed higher micro leakage as compared to Cavit-G. [17]

The samples in Group III i.e CLIP showed least mean micro-leakage values as compared to other temporary filling materials. The results obtained in the present study

were in accordance with study done by Samira Adnan et al (2016), in which they compared mean micro leakage of three temporary filling materials placed in endodontic access cavities and concluded that resin based temporary restorative material i.e CLIP would be a material of choice to decrease chance of micro-leakage.[18]

Another study done by Patel.MC et al (2020) who compared sealing ability of three different interim restorative materials namely Cavit-G, IRM and Temp.it. They concluded that Temp.it which is a light cured temporary restorative material, proved to be more effective and efficient against micro leakage in comparison to other two commercially available materials like IRM and Cavit-G. [19]

The decreased micro-leakage observed at CLIP- tooth interface was because of material's better handling properties and the ability to be compacted and rapidly set on curing, which decreases the chance of dye penetration and provide better sealing. [18]

As coronal sealing ability of material is an important key factor for successful endodontic treatment. Hence, the importance of temporary restorative materials should not be neglected and undervalued. [17]

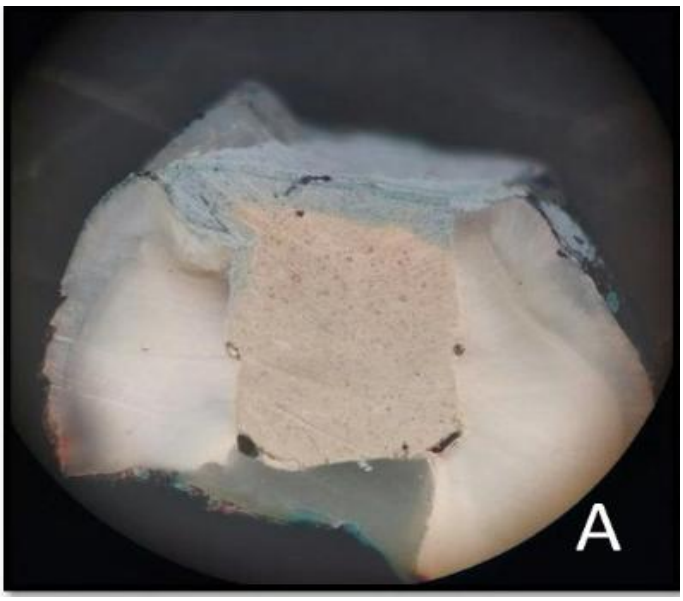

Figure 1 : Group I i.e Cavit-G under Stereomicroscope

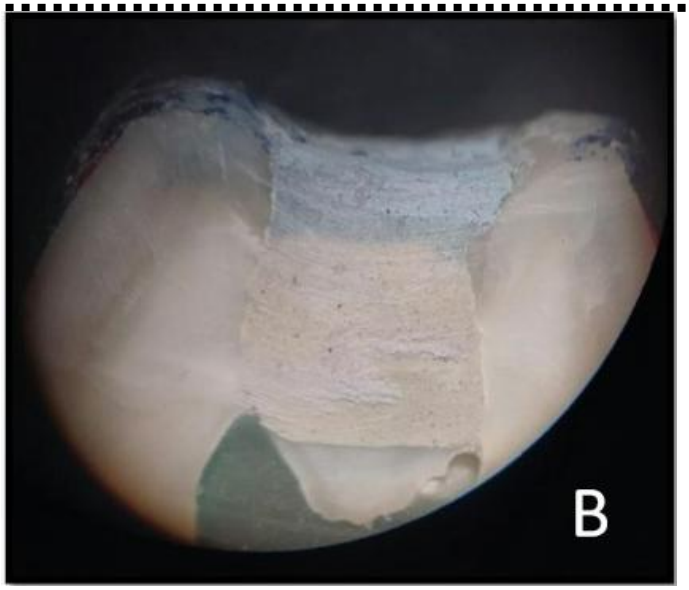

Figure 2: Group II i.e Coltosol under Stereomicroscope

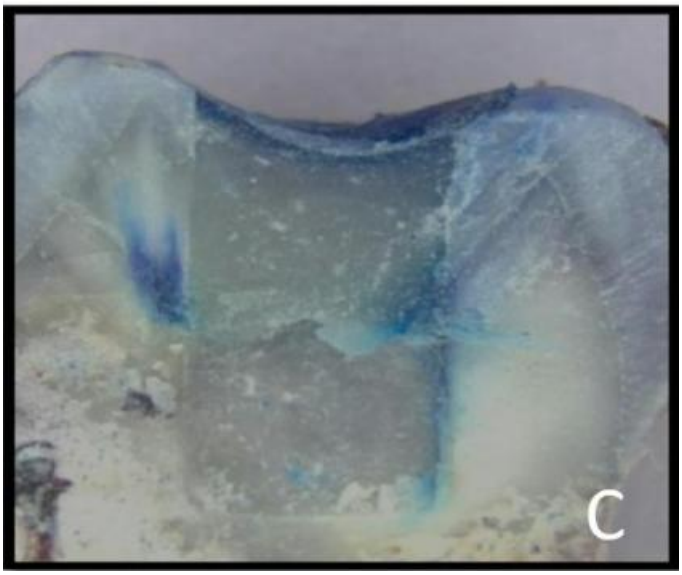

Figure 3: Group III i.e CLIP under Stereomicroscope

Conclusion

Based on the present results, the following conclusions can be drawn: CLIP had better adaptation to tooth interface than other two materials. Light cure temporary restorative material i.e CLIP proved to be more efficient and effective against micro-leakage in comparison to other commercially available materials.

Acknowledgment

I would like to express my heartfelt gratitude to Darshan Dental College and Hospital for their able guidance and support in completing my research work.

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