ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 3, Issue – 6, November - 2020, Page No. : 414 - 419

Comparative Evaluation of Microleakage In Full Veneer Metal Crowns Luted With Various Glass Ionomer Based Cements – An Invitro Study.

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Citation of this Article: Mesari Koteswara Rao, Anche Sampath, G. Phani Krishna, G. Krishnaveni, A.Veena Sravanthi, "Comparative Evaluation of Microleakage In Full Veneer Metal Crowns Luted With Various Glass Ionomer Based Cements – An Invitro Study", IJDSIR- November - 2020, Vol. – 3, Issue - 6, P. No. 414 – 419.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Aim: The aim of the study was to assess, compare and evaluate the microleakage at the margins of full veneer metal crowns cemented with two luting agents.

Materials: (A) Human mandibular third molars, normal saline solution, (B) Medium inlay casting wax, die spacer— die: master gold Renfert Gmbh, Germany, (C) Phosphate-bonded investment material- BEGO, DIN EN ISO 15912, Germany, nickel-chromium base metal alloy, (D) Auto mix glass ionomer cement (GIC) G-CEM Link Ace (G.C. Corporation Tokyo, Japan) Manual mixing luting and lining glass ionomer cement (GIC) (G.C. Corporation Tokyo, Japan),(E) 5% basic fuchsin dye, and (F) Acrylic resin, Cast metal cutting device with diamond disc and external water spray, Stereo microscope with the image analyzing unit.

Methods: A comparative study was done to evaluate the ability of two contemporary luting agents to resist microleakage in cemented nickel-chromium complete metal copings cast on prepared mandibular third molars. The copings were placed back on the respective prepared teeth to check the fit and marginal adaptation was observed under an stereo microscope. The castings were cemented with the two luting agents under study, namely, Manual mixing glass ionomer cement, G-CEM Link Ace under ideal conditions. Cemented specimens were thermocycled after 24hrs between 60° (± 2°) C . After thermocycling, the teeth they were treated with 5% basic fuschin dye solution for 60 minutes, embedded in clear acrylic resin and sectioned buccolingually.

Results: It was concluded from the study that the Auto mix glass ionomer cement showed less microleakage than the manual mixing luting and lining glass ionomer cement.

Keywords: Luting agents, microleakage

Introduction

Dental luting cements form the link between a fixed restoration and the supporting tooth structure. Luting cements play a pivotal role in sealing the margins and prevent marginal leakage. Unfortunately, most of the dental cements available cannot guarantee continual impermeability because of their relatively high solubility in oral fluids. A gap thus created at the restoration margin may become a repository for microorganisms that release toxic products. These toxins may eventually cause gingival and pulpal inflammation, leading to secondary caries.(1)

Microleakage is defined as the seepage of oral fluids containing bacteria and debris between a tooth and its restoration or cement layer. Microleakage is of concern because of the effect bacteria may have on the remaining tooth structures and the pulpal tissues. The process of microleakage can affect the tooth- cement interface associated with a crown restoration as well as the tooth foundation. Different luting agents vary considerably in solubility, strength and ability to adhere to tooth structures, therefore marginal gaps alone may not be the most important cause of microleakage.

Over the last two decades, a lot of interest has been focused on the selection of good adhesive luting agents for the cementation of fixed restorations. Investigators and researchers have advocated different materials and methods to improve the retention of the fixed prosthesis in the oral cavity. Considerable evolution has taken place from ionomer-based luting agents to resin-based adhesive luting agents. With wide acceptance of base metal alloys, numerous luting agents have been used for the cementation of fixed restorations.

Therefore, it is important to assess and evaluate microleakage at the margins of cast metal copings so that it may be prevented.

Materials and Methods

A comparative study was done to evaluate the ability of two contemporary luting agents to compare and evaluate the marginal leakage under cemented nickel- chromium complete metal copings cast on prepared mandibular third molars. Tooth preparation was carried out on the mounted molars by following standardized tooth preparation procedures with help of aerator. An assembly with the airotor mounted on the dental model surveyor was used to achieve a uniform taper of six degrees. The prepared teeth were cleaned with pumice and water. Wax patterns were to be prepared for each prepared tooth. Three coats of the die spacer were applied on the tooth to provide space of 24-25µm for the cement layer. Care was taken to keep it short of the margins by 1 mm. The wax patterns for the copings were fabricated using the dip wax technique to get a close adaptation of the wax to the tooth surface. The casting was carried out in the casting machine with nickel-chromium base metal alloy.

The copings were placed back on the respective prepared teeth to check the fit and the marginal adaptation was observed under an stereo microscope. The castings were cemented with three luting agents, namely, a manual mix glass ionomer cement, a G-CEM LINK-ACE Automix GIC (Figure 1,2). The cemented specimens were thermocycled after 24 hours between 60° (± 2°) C. After thermocycling, the teeth were treated with 5% basic fuschin solution for 60 minutes. The samples were embedded in clear acrylic resin (Figure 3) and allowed to set for 24 hours. After sectioning of the samples the sections were observed under the stereomicroscope(figure 5) and stain penetration was recorded at the tooth-cement interfaces.

The marginal leakage (amount of dye penetration) observed for each sample is scored 0,1,2&3, respectively, based on the following criteria.

Score	Criteria
0	No evidence of stain penetration at the interface of the crown and tooth surface.
1	Evidence of slight stain penetration-less than half the height of the axial wall of the preparation.
2	Evidence of stain penetration equal to half the height of the axial wall of the preparation.
3	Evidence of stain penetration above half the height of the axial wall and extending to the occlusal aspect of the preparation.

Thus obtained score for each sample is noted and then statistically analyzed by the Mann Whitney U test for the comparative evaluation of the microleakage.

Results

It was concluded from the study that the Auto mix glass ionomer cement-GCEM LINK-ACE(figure-1) showed less microleakage than the manual mix glass ionomer cement scores were tabulated from table1-3.

Table 1: Microleakage mean scores, standard deviation (S.D.), standard error (S.E.), and median of the study samples

Statistic	Auto mix GIC		Powder form GIC	
	Buccal	Lingual	Buccal	Lingual
Mean	0.76	0.72	1.44	1.52
SD	0.72	0.45	0.917	0.918
SE	0.145	0.092	0.183	0.184

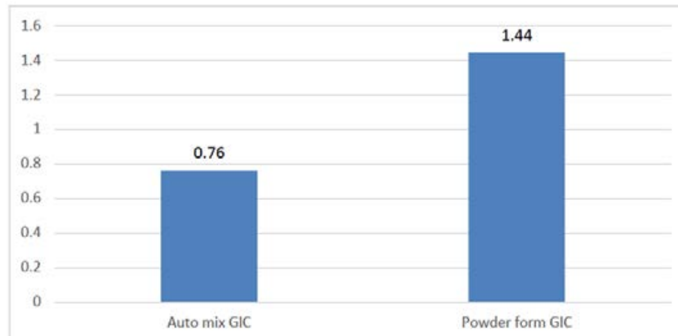
Table 2: Comparison of microleakage between the two groups on the buccal aspect

Group	Mean	SD	Mean Rank	Test statistic	P-value
Auto mix GIC	0.76	0.72	20.42	185.5	0.004*
Powder form GIC	1.44	0.917	30.58		

Table 3: Comparison of microleakage between the two groups on the lingual aspect

Group	Mean	SD	Mean Rank	Test statistic	P-value
Auto mix GIC	0.72	0.45	19.62	165.5	0.001*
Powder form GIC	1.52	0.918	31.38		

Graph 1: Table 2: Comparison of microleakage between the two groups on the buccal aspect



Graph 2: Comparison of microleakage between the two groups on the lingual aspect

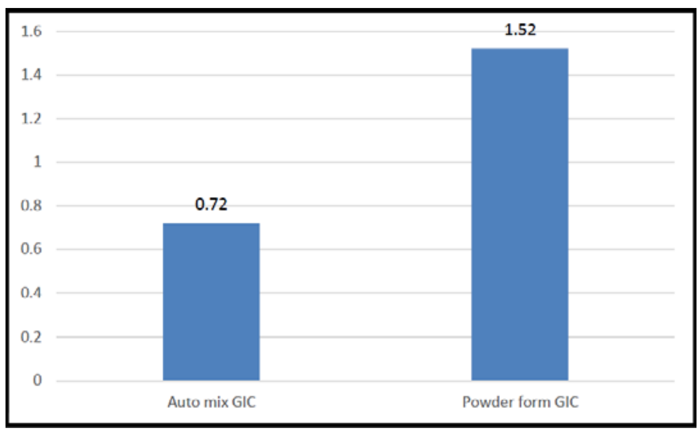


Figure 1: Auto mix GIC

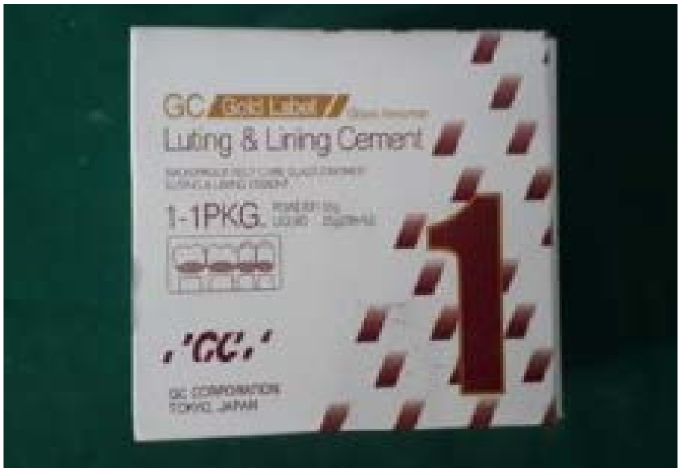


Figure 2: Manual mix GIC

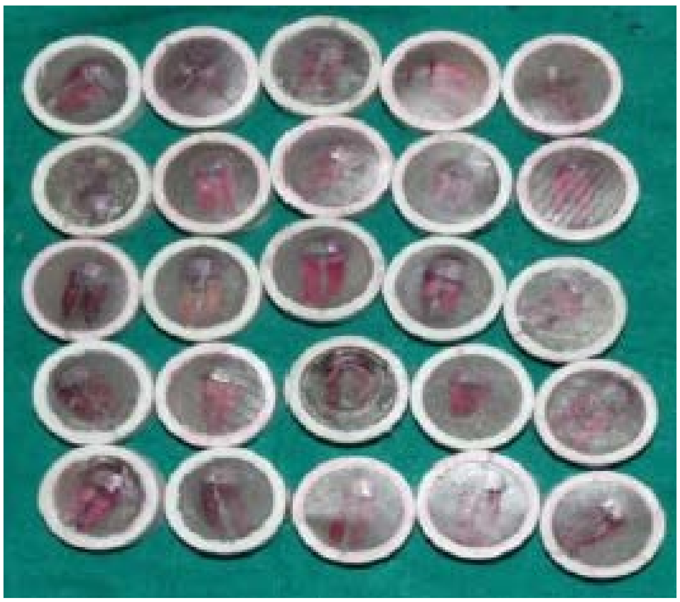


Figure 3: stained samples embedded in clear Acrylic resin

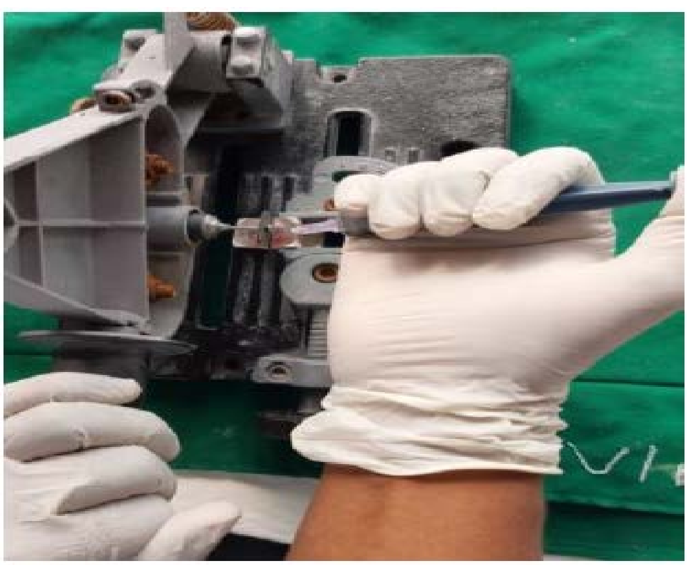


Figure 4: Sectioning of samples with diamond disc

Figure 5: Sectioned samples observed under stereomicroscope

It was found in the present study that the microleakage was significantly higher in manual mix GIC(figure-2) group on the buccal and lingual aspect compared to Auto mix GIC(figure-1) group. Mann Whitney U test was employed as the data violated the assumption of normality as assessed from Kolmogorov Smirnov test and the difference between the groups was found to be statistically significant.

Discussion

Proper selection of a luting agent is an important decision in a series of steps that require meticulous execution and will determine the long-term success of fixed restorations. Previously only one luting agent is available for restoration and luting procedure, i.e. zinc phosphate cement, nowadays plenty of luting agents are available.

The proper cement selection should be based on knowledge of physical properties, biological properties and other attributes of both restorative materials and luting agents.

This study aims at providing an overview of currently available luting agents (cement) and discusses their properties, advantages and disadvantages.

In the search for a material that bonds chemically to the tooth structure, it is essential to investigate its leakage-inhibiting potential. In most of the studies evaluating microleakage beneath full-cast crowns, investigators have used organic dyes, chemical tracers or radioactive isotopes.

The use of organic dyes as tracers has been one of the oldest and perhaps the most commonly used method in microleakage detection. However, it is highly technique-sensitive and the assessment of results requires careful standardization. The choice of whether to use a stain, dye or isotope should be based on the preference of the investigator.(4) All methods require meticulous technique and standardized criteria for evaluating and scoring the degree of marginal leakage. Radioactive isotopes require special handling and authorization for use. The use of a stain or a dye as a tracer may be more convenient for the researcher because no authorization is required for their possession and use. Therefore, 5% basic fuschin dye was used in this study.

This study describes the two different forms of glass ionomer cements Auto mix glass ionomer cement, Manual mixing luting and lining glass ionomer cement (GIC)). Manual maxing GIC cement possesses advantages of Chemical bonding, Sustained fluoride release and ability to absorb fluoride from the oral environment (fluoride recharge) makes it the cement of choice in patients with high caries rate.

Disadvantages include Initial slow setting and sensitivity to early moisture contamination and desiccation, Modulus of elasticity lower than zinc phosphate, so the potential of elastic deformation in areas of high masticatory stress.

Initial low setting pH was assumed to be associated with post cementation sensitivity. Dentin desiccation, thin cement mix together with an excessive hydraulic force, and microleakage may sometimes be responsible for the sensitivity, Insufficient wear-resistance.

The greater leakage of the manual mix GIC compared to the Auto mix glass ionomer cement (G-Cem LINK-ACE) might be thus attributed to the coefficients of thermal expansion of the material involved (*i.e.*, tooth substance, cement, metal crown).

One possible reason for the reduced microleakage with the glass ionomer cement can be its low solubility and disintegration in oral fluids.

To better correlate thermocycle testing in *in vivo* conditions, the system used in this study used a short exposure time to the extremes of temperature with an adequate intervening period for the specimens to return to body temperature. Previous studies have generally used immersion times, which allow both the tooth and the restoration to stabilize at the extreme temperatures, which does not occur *in vivo*. The rationale for the cycling sequence used in this study is that the maximum *in vivo* exposure time of a tooth to an extremely hot or cold material is considered to be two to five seconds after which the tooth returns to the oral temperature.

There is, as yet, no ideal dental cement. Each material is to be used depending upon its merits, demerits and limitations. It has long been recognised that in general, dental materials do not bind or adapt to tooth structure well enough to provide a perfect seal and there is always a pathway for penetration of various solutes and solvents.

Conclusions

Within the limits of this study, the following conclusions can be drawn

1. No strong correlation was found between margin fit parameters and microleakage

2. None of the cementing agents investigated in this study yielded a perfect seal at the bonding interface in enamel or dentin.

3. Auto mix glass ionomer cement (GIC) G-CEM Link Ace revealed the smallest degree of microleakage both in enamel and in dentin when compared to manual mixing luting and lining glass ionomer cement.

4. Under a stereomicroscope, it was observed that the microleakage of basic fuchsin dye was between the cement layer and the tooth surface.

5. Marginal microleakage is only one among the various factors, which influence the success of the cemented restoration.

6. The choice for a particular cement depends entirely on the judgment of the clinician based on the appropriate oral environment, biological and mechanical factors, which the clinical situation demands.

Limitations

1) In this study, only two types of dental luting cements were evaluated.

2) Microleakage was not observed between the crown and the cement interphase.

3) Only the sealing property of the luting cement is evaluated with no relation with the marginal fit of the crown

4) To better correlate thermocycler testing in *in-vivo* conditions. The system used in this study had short exposure time with an adequate intervening period for the specimens to return to body temperature.

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