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Comparative evaluation of microleakage of luting cements used for luting stainless steel bands - An Invitro study

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Abstract

To evaluate the microleakage of various luting cements, Custom made stainless steel bands were adapted on 30 human molars. The molars were randomly and equally divided in three groups of 10 each and stainless steel bands were luted with three different luting agents i.e Zn phosphate, GIC Type I and HY Bond GI CX Smart respectively onto the crown of the sample molars taken for the study. Samples were immersed in 0.2% methylene blue dye and after 48hrs and dye penetration was recorded using stereomicroscopic analysis. Statistical significance revealed that the marginal indignity was found to be best in HY Bond GI CX Smart with statistically significant difference.

Keywords: Luting cements, microleakage, Giomer, HY Bond GI CX Smart, GIC.

Introduction

Natural teeth are believed to be the best space maintainers of oral cavity and that is the main reason that they are important to be saved even when carious, by restorations or endodontic therapy unless the extraction is unavoidable. Despite the best efforts in prevention, premature loss of primary teeth continues to be a common problem in paediatric dentistry due to many reasons like unawareness, resulting in disruption of arch integrity which adversely affects the proper alignment of permanent successors. In that condition, space maintainers are the choice of appliances used for maintaining space created due to premature loss of primary teeth. The fixed space maintainers are usually indicated to maintain the space created by unilateral/bilateral premature loss of primary teeth in either of the arches.

In today's scenario, dentistry uses a wide range of luting cements to retain crowns, bands or FPD etc. to tooth structure. So, there should be good understanding of the properties of luting cements to ensure the long-term clinical success of cemented restorations like stainless steel crown, stainless steel bands, space maintainers etc.

Long-term clinical success of band adaptation is influenced by many factors, one important factor being the selection of an appropriate luting agent. No single luting agent is capable of meeting all the requirements, which is one reason why there is such a wide choice of luting agents currently available from conventional water-based to contemporary adhesive resin cements, but the proper selection of a luting cement is a last most important step that require meticulous execution for long term success of fixed restorations.

However, two factors are of primary importance while choosing a luting agent: retention that defines correct and permanent position of the fixed restoration in situ and marginal seal that enables adaptation of the restoration and surfaces of the prepared teeth. Among numerous determinants responsible for the quality of retention and marginal seal, cement characteristics used for cementing of the fixed restorations enabling intimate contact between the surfaces of prepared teeth and fixed restorations are to be particularly emphasized. Cement disintegration through its decomposition or dissolution in oral fluids, shrinkage on setting, the strength and weakening of the bond between the cement and dentine or cement and restoration are reported as possible causes of microleakage and loss of bonding effect. Mechanical loading to which restoration is exposed after cementing as well as temperature changes are also the factors favouring microleakage.

The degree of microleakage varies significantly between different cements. As very few studies have been conducted to compare the efficacy of self-adhesive luting cements with the conventional luting cements by comparing the longevity of bands due to least microleakage, so the aim of this in vitro study was to determine the microleakage properties of different luting agents used in cementing stainless steel bands on molars.

Objective

This in vitro study investigated the microleakage of different luting agents (HY Bond GI CX-Smart, zinc-phosphate, glass-ionomer cement) used for cementing stainless steel bands on extracted human molars.

Materials and Methods

A total of 30 human molars extracted due to periodontal problems or orthodontic treatment purposes were selected for this present study. All the samples were cleaned and kept in normal saline. Custom-made stainless-steelbands were selected and adapted on to the samples. The cement was mixed according to the manufacturer's recommendation. Cement mixture was then applied in a thin, even layer onto the internal surface of the SS bands. The Stainless-steel bands were then luted onto the sample teeth with 3 different luting agents viz, zinc phosphate, GIC Type I, HY Bond GI CX-Smart respectively.

Three cements of different chemical structure and tooth hard tissue bonding were selected for permanent bonding of the space maintainers. Basic characteristics of the cements used in the experiment are presented in Table 1. The apex of all the teeth were then sealed with blue inlay wax and the rest exposed portion of the root and crown surfaces were coated with finger nail varnish. Samples were then kept in 0.5% methylene blue dye for 24hrs. After being rinsed and dried sectioning of the samples was done with the help of cutting disc and samples were cut mesiodistally into two halves separating buccal and lingual surfaces. Both the sections were observed with stereomicroscope under 10x magnification for dye penetration.The images were captured, and each section was assessed to check the depth of penetration according to the Shivana.S criteria using the following scale:

0-no dye penetration; 1-dye penetration upto 1/3 of axial surface length; 2-dye penetration upto 2/3 of axial surface length; 3-dye penetration along the whole depth.

Results

This present study was conducted in collaboration with the Cosmo research lab, Greater Noida. The data for this study was analysed using the ANOVA and Kruskal-Wallis statistical test. For the purpose of statistical interpretation p-value of 0.05 were considered statistically significant.

It was observed that the microleakage of Group A (HY Bond GI CX Smart) had the lowest mean value of 0.30, followed by group B (Glass Ionomer TypeI) with a mean value of 1.40, while Group C (Zn Phosphate) had the highest mean value of microleakage, i.e, 1.80 as shown in Table 2 & 3.

Discussion

In the present study, 30 extracted molars were collected and were randomly divided into three groups of 10 each. The results from the present study showed that there was a significant differences between the result of the three groups ($p<0.05$). Therefore, out of the three luting cements, lowest statistically significant values of microleakage were evidenced by Self-Adhesive Resin free cement HY Bond GI CX Smart, somewhat higher values were recorded with glass-ionomer type I luting cement, while zinc-phosphate cement had the highest values of the observed parameter.

Methodology and cementing agents used in this study are different from those applied in other studies and thus direct comparison of our results with the results of other authors is not possible. Nevertheless, if the results of microleakage degrees in different types of cements obtained in this study are compared to the results obtained by other authors, the same order of the cements with respect to the capacity of reduction of microleakage may be observed: self-adhesive cement < glass-ionomer < zinc-phosphate cement .

The highest degree of microleakage observed in zinc phosphate cement is consistent with the results of numerous studies dealing with the similar analyses. A possible reason for this unfavourable result related to zinc-phosphate cement lies in the mechanical type of bond with dental tissue. An additional factor that may influence the results is cement solubility caused by keeping of the specimens in water, which is in concurrent with the study done **by Medic V et al** in **2010.**

The second interesting explanation for poor results of zinc-phosphate cement in reduction of microleakage is reported by **Kenny SM, Buggy M**. Zinc-phosphate cement, together with glass-ionomer cement, belongs to the group of acid-base cements. Both of the cements contain acid as a component which is responsible for high acidity of cement mixture during cementation. In accordance with the study done by **by Medic V et al** in **2010**, acidity of the zinc-phosphate cement at the moment of application to the dental tissues is 1.6, which subsequently increases during the cement setting. Acid component of the cement may demineralize smear layer and intact dentine. Exposed collagen fibres surrounded by empty spaces of demineralized dentine undergo hydrolysis over time under the influence of oral fluids and water, which impairs the accomplished bond and leads to the development of micro cracks and microleakage. Another reason might be due to presence of internal stress within the brittle, thin film zinc phosphate cement, that when subjected to the effects of pressure cycling may have produced stresses. These stresses could exceed the cohesive and adhesive strength of the material and result in disruption of the cement layer which causes microleakage. High permeability of the stainless steel bands cemented using zinc phosphate cement indicates low probability of satisfactory marginal sealing with this type of cement.

In the present study, microleakage of GIC type I cement was found to be less than Zn phosphate cement but more than HY Bond GI CX smart, a possible explanation may lie in the fact that GIC being hydrophilic in nature is sensitive to early moisture contamination and desiccation, thus leading to the development of microcracks and microleakage, which is in accordance with the study done by **Ladha K et al** in **2010**.

In the present study, microleakage was found to be least in Hy Bond GI CX Smart cement. The least microleakage of this luting agent is attributed to its composition which contains Fluoroalminosilicate glass and Hy agent in its powder component, while the liquid comprises of Acrylic acid tricarboxylic acid co polymer solution and tartaric acid.

The patented Hy-Agent additive contains tannic acid, zinc fluoride and strontium fluoride, that helps to improve its physical properties and reduce decalcification, generating an effective seal at the interfaces between restorative alloy, cementing agent and dental tissue without requiring pre-treatment of the prepared tooth surfaces which id well explained in a study “Mechanical Properties of Tannic-acid-treated Dentin Matrix” done by **A.K.B. Bedran-Russo et al** in **2009**.

In accordance with the study done by **A.K.B. Bedran-Russo** in 2009, Tannic acid, a commercial form of condensed tannin, is a naturally occurring collagen cross-linking agent polyphenol, consisting of a complex mixture of polygalloylglucose esters with weak acidity that has the ability to modify collagen chemically. Alterations to the collagen, mostly by modification in the number of cross-links, provide the collagen matrix with enhanced mechanical properties and lower rates of enzymatic degradation. Resistance to collagenase digestion is a crucial property of a TA-collagen matrix, since it indicates an increase in stability and possibly a protection mechanism against degradation over a long period of time.

Another reason could be attributed to the Combination of zinc and fluoride complex, which was seen to enhance remineralisation of enamel lesions when compared to fluoride alone, probably by retarding lesion arrestment, which is in accordance with the study done **by Lynch RJ etal** in **2011**.

According to the study done by **Yassen GH et al** in **2012**, another component that makes a difference in decreasing the microleakage content of HY Bond GI CX Smart is Strontium. However, Strontium alone did not improve the remineralization of artificial caries lesions, but a synergistic effect between the combination of fluoride and strontium was found to enhance remineralisation and hence decrease the chance of microcracks and microleakage.

Conclusion

Based on the results of the present study, the following conclusions were drawn:

1. Out of the three luting cements, Self-Adhesive Hy Bond CX smart Cement was found to be the most effective in marginal integrity of stainless steel bands as it provided the minimum microleakage on stereomicroscopic analysis.
2. Zn Ph was found to be least efficacious in maintaining the marginal integrity of the stainless steel bands when used as luting cement.

Legend Figures and Talbes

Figure 1: Least microleakage seen in Group A (HY Bond GI CX Smart)

Cement type	Manufacturer	Code	Chemical composition	Bond with dentine
Zinc-phosphate	Harvard, Richter-Hoffman, Berlin	ZnP	ZnO, MgO, phosphoric acid	Mechanical
Glass-Ionomer Fuji I GC,	FujiI GC, America	GJ	Alumino-silicate glass, polyacrylic and citric acid	Chemical
HY Bond GI CX-Smart	SHOFU INC.	CX	HY agent, tannic acid,zn fluoride and strontium fluoride	Chemical

Table 1: Description of used luting agents.

Group	N	Mean	Std. Deviation	Std. Error Mean
A. HY BOND GI CX SMART	10	0.30	0.483	0.153
B. GLASS IONOMER	10	1.40	0.516	0.163
C. ZINC PHOSPHATE	10	1.80	0.632	0.200

Table 2: Mean values of microleakage in different groups.

Anova						
		Sum of Squares	Df	Mean Square	F	Sig.
Microleakage	Between Groups	12.067	2	6.033	20.111	0.000*
	Within Groups	8.100	27	.300		
	Total	20.167	29			

*p value < 0.05 Significant

Table 3: Comparison of means of microleakage among different groups.

Groups	Mean Difference	Std. Error	Sig.	95% Confidence Interval	
				Lower Bound	Upper Bound
A VS B	-1.100	.245	0.000*	-1.73	-.47
B VS C	-1.500	.245	0.000*	-2.13	-.87
A VS C	-.400	.245	0.3**	-1.03	.23

Table 4: Intergroup comparison of mean value of Microleakage.

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