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A Comparative Evaluation of Marginal Adaptation of Cention N, Zirconomer and Amalgomer CR in Class II Box Preparation - A Scanning Electron Microscopic Study

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Abstract

Background & Objective: The success rate in restoring a class II lesion depends on the type of dental material used for restoration as well the skill of the clinician. Inadequate marginal quality may lead to problems like leakage, recurrent caries and pulpal irritation. Even by considering that an absolute perfect marginal seal is not achievable clinically, a good marginal seal should be the main objective for clinicians. With the advent of newer posterior bulk fill material such as Cention N, Zirconomer and Amalgomer CR there is an imperative need to compare the marginal adaptation of these restorative materials.

Material & methods: A total of 45 mandibular molars were selected for the study. Standardized Class II box preparations were made on the proximal surface of each

specimen by a single operator. Fifteen specimens in each of the three groups using lottery method. Group A was restored using Amalgomer CR (Advanced Health Care, UK); Group B was restored using Zirconomer (Shofu, Japan); Group C was restored using Cention N (Ivoclar, Vivadent). After finishing and polishing, all the specimens were subjected to aging process. The margins of the samples were then observed under scanning electron microscope at 500X magnification.

Results: The Amalgomer CR group, Zirconomer group, Cention N group showed a mean percentage gap free continuous margin of 70.84 ± 1.49, 52.23 ± 4.33 and 92.01 ± 1.58 respectively with statistically significant value of P<0.001.

Interpretation & Conclusion: Regardless of the restorative material used none of the groups provided 100% perfect margins. However, statistically maximum percentage of continuous margins was shown by Cention N while the least was with Zirconomer.

Keywords: Amalgomer CR, Cention N, Marginal Adaptation, Scanning Electron Microscope, Zirconomer

Introduction

Over the past years esthetic dentistry has shown considerable progress leading to the development of a number of restorative materials with improved properties for both anterior teeth and posterior teeth. The main concerns regarding these materials are their durability, marginal adaptability and aesthetics. When marginal quality is not adequate, problems like microleakage, recurrent caries and pulpal irritation may occur.[1,2]

Composites were introduced in 1960s and since then they have been widely used as a restorative material. Despite having good physical properties, the main shortcoming of composite resin materials is polymerization shrinkage resulting in marginal microleakage, post-operative sensitivity and secondary caries.[3]

Cention N is a recently introduced tooth-coloured filling material. It includes special patented is filler which acts as a shrinkage stress reliever and thus reduces polymerization shrinkage and microleakage.[4] Various in vitro studies have demonstrated that Cention N exhibited lesser microleakage when compared with various other restorative materials.[5,6,7,8]

Glass-ionomer cements possess certain unique properties like release of anti-cariogenic fluoride into adjacent tooth structures, chemical bonding to enamel and dentine and a low coefficient of thermal expansion similar to tooth. They are however, susceptible to fracture and exhibit low wear-resistance.[9]

To overcome certain deficiencies ceramic-reinforced glass ionomer (Amalgomer CR) has been introduced to the dental market. The ceramic helps in imparting excellent wear and erosion resistance and also enhances the radio capacity and all round strength of the cement. Studies have demonstrated that its fracture toughness, tensile and flexural strength is much higher than conventional GIC[10]and sometimes close or superior to amalgam.[11]A comparative study on microleakage for Amalgomer, Zirconomer and conventional GIC showed highest microleakage score for Zirconomer followed by Amalgomer and conventional GIC.[12]

Another material introduced is Zirconomer which isa ceramic and zirconia reinforced glass ionomer cements.It was developed as a reliable tooth colored posterior bulk fill restorative comprising of zirconia fillers to enhance aesthetics and handling characteristics.[13]Despite the promises made by the manufacturers, studies have reported that its marginal adaptation was inferior to Sure fill SDR and conventional GIC.[14]The material also presented with highest microleakage when compared with composite and amalgam.[15]

No studies have been done till date comparing marginal adaptation of these newly launched posterior bulk fill restorative material hence there is a need to compare the same, especially at the tooth restorative interphase in the proximal surface of class II.

The null hypothesis states that there is no difference in the marginal adaptation at the tooth restorative interphase in the proximal surface of class II preparations restored with Amalgomer CR, Zirconomer and Cention N respectively under scanning electron microscope.

Material and Methodology

Sample preparation

With the consent from the institution's ethical committee, forty five intact non carious human mandibular molars extracted for therapeutic reasons were collected for the study. Teeth with caries, attrition, cracks or fracture lines, previous restoration and other morphological defects were not included in the study. They were hand scaled and kept in 0.05% thy mol solution at 37°C for no longer than a month before use. Standardized class II box preparations were made on the mesial surface of each specimen with buccolingual width: 3.5mm, axial depth: 2mm, occluso gingival depth: 4mm such that the gingival margin was located 1mm above cement enamel junction.

All preparations were accomplished using high speed hand piece (NSK, JAPAN) and No. 245 tungsten carbide bur under profuse water cooling (one bur used per five preparations).Following the tooth preparation, the specimens were stored in distilled water till thenext procedure. The specimens were randomly allocated into three groups with 15 specimens each using lottery method.

Group A: restored using Amalgomer CR (Advanced Health, Care UK Batch no: 081810-81)

Group B: restored using Zirconomer Reinforced (Shofu, Japan Batch no: 03180980)

Group C: restored using Cention N (Ivoclar, VivadentBatch no:Y19456)

The specimens were restored according to manufacturer's instructions for each material. Tofflemire matrix and retainer were used to facilitate the restoration of the class II preparations and were finished using fine grit finishing diamond bur. For aging purpose the samples were stored for a period of six month in artificial saliva. All the restored specimens were subjected to a the rmocycling regimen of 2500 thermal cycles by alternating immersion in water at +5 ± 8°C and +55 ± 8°C with a dwell time of 2 minutes and transfer time of 5 seconds in each bath. The samples were sectioned buccolingually with the help of diamond disk in a straight air motor hand piece, creating approximately 1 mm thick slab, under copious water irrigation. The one mm section from each sample was sputter coated with a 400 Å gold layer to allow observation under Scanning Electron Microscope (TESCAN-VEGA3 LMU). The gingival margins of the proximal box were evaluated at 500x magnification for marginal adaptation. Results for the marginal adaptation, were expressed as percentages of continuous margins for the total gingival margin length.[16]

Statistical Analysis

The statistical analysis was done using SPSS (Statistical Package for Social Sciences) for Windows Version 22.0 Released 2013. Armonk, NY: IBM Corp. Data were subjected to One-way ANOVA test followed by Tukey's post hoc test to compare the mean percentage of gap free continuous margin between the three study groups. The level of significance was set at $P<0.05$.

*statistically significant

Results

Analysis of variance test showed statistically significant difference in the percentage of gap free continuous margin between the three group ($P<0.001$).Mean percentage of

gap free continuous margins for the three materials are given in the Table no 1.

Table no 1 :Comparison of mean percentage of gap free continuous margin in differentstudy groups using One-way ANOVA Test

Groups	N	Mean	SD	Min	Max	P-Value
A (Amalgomer CR)	15	70.84	1.49	68.2	72.8	<0.001*
B (Zirconomer)	15	52.23	4.33	42.7	59.4	
C (Cention N)	15	92.01	1.58	90.0	94.8	

The inter group comparison with Post hoc test demonstrated that Cention N group showed significantly highest mean percentage of gap free continuous margin, followed by Amalgomer CR group and Zirconomer group. Table 2: illustrates multiple comparison of mean difference in gap free continuous margin between groups.

Table no. 2 Multiple comparison of mean difference in gap free continuous margin between groups using Tukey's Post hoc Analysis

(I) Groups	(J) Groups	Mean Diff. (I-J)	95% CI for the Diff.		P-Value
			Lower	Upper	
Amalgomer CR	Zirconomer	18.61	16.13	21.09	<0.001*
	Cention N	-21.18	-23.66	-18.70	<0.001*
Zirconomer	Cention N	-39.78	-42.27	-37.30	<0.001*

* Statistically significant

Discussion

There is a constant search for a restorative material that warrants firm adherence to the tooth surface with the purpose of reducing the likelihood of microleakage. It is of utmost importance to maintain the marginal seal over an extended period so as to minimize or at least stop potential problems that are encountered clinically such as the marginal discoloration and secondary caries which decides its durability in the oral environment.[17,18]

Mandibular molars were selected for this study and standardized class II cavities were prepared to simulate clinical situation. Cavities were prepared and restored with bulk fill restorative materials - Amalgomer CR, Zirconomer and Cention N respectively strictly according to manufacturer instructions.

Cention N is an “alkasite” restorative which can be used with or without the application of an adhesive. It is urethane dimethacrylate (UDMA) based, self-curing powder/liquid restorative with optional additional light-curing. In this study Cention N was used without adhesive and curing for the purpose of standardization as the other materials used did not require the same.[19]

Dental restoratives are subjected to constant and extreme changes in the oral environment brought about by fluctuations in temperature and ph. artificial saliva was used as an in vitroaging medium to simulate the clinical degradation of restorations. Thermally induced stresses may lead to gap formation and microleakage at the interface which are a result of the mismatch of the coefficients of thermal expansion between the restorative materials and natural tooth structure. Hence, thermo cycling was done to mimic intra-oral temperature variations.

There was statistically significant difference in the percentage of continuous margins at the tooth restoration interface of Amalgomer, Cention N and Zirconomer hence the null hypothesis was rejected.

Amalgomer CR is ceramic reinforced GIC, which not only complies with the international standards of GIC but with the standard for amalgam also. It sets by conventional acid–base reaction of GIC which is indicated for class I and class II cavities. Amalgomer has shown to have superior mechanical properties in relation to conventional GIC.[10]Also it has better shear bond strength when compared with miracle mix and ketac molar.[20]

In the present study Amalgomer CR exhibited statistically significant better marginal adaptation than Group B i.e. Zirconomer (P<0.001).This could be due to significantly higher shear bond strength of Amalgomer CR (6.38 MPa).Smaller filler particle size of Amalgomer could have resulted in better marginal adaptation.

Zirconomer is also a new class of glass ionomer restorative material that professes to combine the strength

and longevity of amalgam with micromechanical bonding and fluoride release associated with GICs without the threats associated with the use of mercury. This is achieved by the addition of zirconia as a filler particle in the glass component of Zirconomer, thereby enhancing the mechanical properties of the material. It has been marketed as an ideal for permanent posterior restorations in high caries-risk patients and in cases where previously amalgam was the restorative material of choice.[21]Studies evaluated and compared the fracture resistance and marginal adaptation of Zirconomer and bulk fill posterior restorative material (Surefil SDR) in non-endodontically and endodontically treated teeth and found that the fracture resistance and marginal adaptation of Zirconomer was significantly lower than Surefil SDR.[15]

In the present study Zirconomer exhibited least continuous margins in comparison with the other two groups. Being a modification of glassionomer cement, its bonding strategy is stated to be a chemical bond, where the carboxylic part of polyacrylic acid bond with the calcium of the tooth structure. The presence of larger size of the filler particles in Zirconomer could have lowered the area for this kind of bonding which reduced the proper adaptation of the restoration to the tooth surface. Addition of zirconia fillers to the glass component of Zirconomer improved its mechanical properties but not its marginal integrity.

Cention N is a direct, tooth-colored restorative material which has special patented filler. The powder of Cention N contains is filler that acts as shrinkage stress reliever thereby reducing the residual stress at interphase. The liquid consists of four different dimethacrylates, initiators and other additives. A combination of UDMA, tricyclodecan-dimethanoldimethacrylate (DCP) and Polyethylene glycol 400 dimethacrylate (PEG-400DMA) cross-links during polymerization to form strong mechanical properties and good long-term stability. The main component of monomer matrix is UDMA that provides moderate viscosity and strong mechanical properties. PGE 400 DMA is a liquid monomer, promotes its ability to wet the tooth substrate and adapts well with smear layer owing to its hydophillic nature there by enhancing good adaptation. Cention N shows a high polymer network density and degree of polymerization over the depth of the restoration as it uses sole crosslinking methacrylate monomer in combination with stable, efficient self-cure initiator.[7]

In the present study Cention N showed better marginal adaptation than Amalgomer CR and Zirconomer owing to the presence of is fillers and complete depth of polymerization. It has shown to have lesser microleakage compared to generally used posterior restorative materials such as GIC and composite restorations, thereby proving to have better sealing ability.[7] Other comparative studies have shown better microleakage scores for Cention N on comparison with Zirconomer, Amalgam and Glass ionomer.[8,22] Inspite of manipulation of Cention N without adhesive and light curing the result was promising for the material. A study had shown that lesser microleakage was observed for Cention N when it was used without an adhesive.[23]

Although in vitro testing of restorations is an important initial screening for the restorative materials, these results cannot be extrapolated in correlating with the clinical performance of restorations. Hence, future in-vitro and ex vivo studies are recommended keeping in mind factors such as masticatory forces and pH fluctuations which were not considered in this study.

Conclusion

Within the limitations of the present study, it can be concluded that 100% perfect margins could not be obtained regardless of the restorative material used. However, best marginal adaptation was seen in Cention N

group followed by Amalgomer CR and Zirconomer group respectively when observed at the gingival tooth restoration interface.

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