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Evaluation Of Gingival Adaptation In Class II Composite Resin Restoration With Different Lining Techniques- A Sem Study

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Abstract

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Introduction

Dental caries is one of the most prevalent chronic diseases of the oral cavity. According to Shafer's, dental caries is an irreversible microbial disease of the calcified tissues of the teeth, characterized by demineralization of the inorganic portion and destruction of the organic substance of the teeth[1]. Based on the extent of caries, the various treatment options can initially begin with prevention of caries, restoring the lesion or a non surgical endodontic treatment. In the case of dental treatment, diseased tissue is removed and teeth restored with appropriate material. Different restorative materials have been used over the years. Silver amalgam has served excellent for centuries and they are very long lasting in nature. But its use has reduced in the recent times, not as much because of public perception on mercury toxicity or environmental issues but due to increased demand for esthetic restorations[2]. Since the invention of Bis-GMA by Bowen in the year 1962,composites allow the possibility of preserving sound tooth structure during cavity preparation and represent a significant esthetic treatment option,enabling the fabrication of restorations with a natural appearance[3].

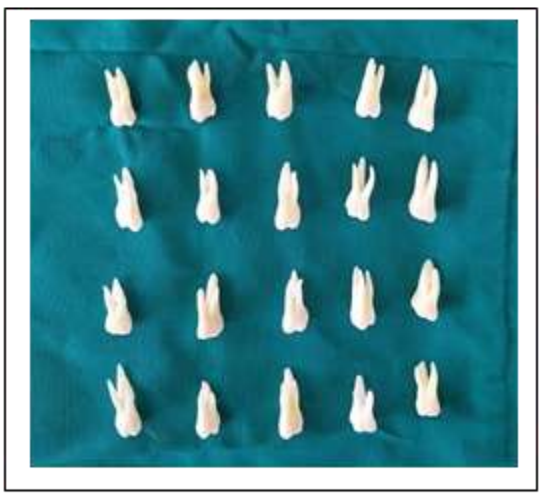
The biggest problem in composite resin is the volumetric shrinkage during pre gel and post gelation phase, which is referred to as the polymerization shrinkage. It is in the range of 2.9-7.1 volume %. The marginal adaptation of a restoration is of utmost importance to prevent microleakage, and hence secondary caries[4]. Microleakage at the tooth/restoration interface is considered to be a major factor influencing the longevity of dental restorations.So materials which provide a nice marginal adaptation is required in clinical practice. The absence of enamel at the gingival cavosurface margin leads to the less adhesion of composite to dentin/cementum , thus increasing the risk of microleakage at the gingival margins in class II composite resin restorations[5]. For this purpose, recently liners are used where they are highly beneficial in achieving adequate marginal seal[6]. A flexible intermediate resin layer like flowable composite resin, glass ionomer cement can dissipate the polymerization shrinkage stress developed at the tooth-restoration interface. Liners can be precured or cocured. Precured liners are cured separately before the application of composite resin whereas cocured liners are cured along with the composite resin[7]. For evaluation of gingival microleakage, Scanning Electron microscope is widely used. The gap at the interface of the tooth and restoration at the gingival cavosurface margin was examined under the scanning electron microscope 1000X.

The purpose of this study was to evaluate the gingival adaptation in class II composite resin restoration with different lining techniques (precure and cocure) using scanning electron microscopy.The null hypothesis of the study was that there will be no variation of adaptation in gingival cavosurface margin using self adhering flowable composite resin or conventional flowable composite resin under scanning electron microscope

Methodology

A total of twenty maxillary first molars were collected, cleaned with 2.5% sodium hypochlorite for 10 minutes and were stored in 0.9% normal saline according to OSHA guidelines. Permanent maxillary first molars which were not restored,non carious, with no resorptive defects, no fracture line, no attrition and had normal morphoplogy were included in the study. Class II MO and DO cavity was prepared on each tooth whose occlusal and buccolingual width was 4mm, axial depth – 2mm and gingival seat was kept 1mm apical to the cement-enamel junction. They were divided into two groups based on the liner used- group 1 (conventional flowable composite resin liner) and group 2 (self adhering flowable composite resin liner).tTetric Flow was the conventional flowable composie resin used and Dyad Flow was the self adhering flowable composite resin used as liner and each group was further divided into two subgroups-precure of liner and cocure of liner subgroups, where in precure subgroup the liner was cured for 20 seconds first followed by placement of bulk fill composite resin. Then the bulk fill composite resin (Tetric N Ceram Bulk Fill) was applied and was cured for 40 seconds. Both the liners were applied in thickness of 0.5-1mm. For placement of the conventional flowable composite resin liner, the separate steps of etching with 37 % phosphoric acid and application of bonding agent followed by curing for 10 seconds were needed but these steps were not needed for placement of self adhering flowable composite resin liner. After restoration, the teeth were stored in distilled water and the teeth were passed through thermocycling for 500 cycles between 5-55°C for 30 seconds. Each teeth were to be decoronated at cemento-enamel junction with diamond discs and then sectioned vertically and mesiodistally into 2 halves along longitudinal axis through center of restoration. Then each section was mounted on stub, coated with platinum and and tooth-restoration interface was examined under scanning electron microscope at 1000X and the gap at the interface was recorded for each sample at the gingival cavosurface margin to axio pulpal line angle.

TWENTY HUMAN MAXILLARY FIRST MOLARS



Steps

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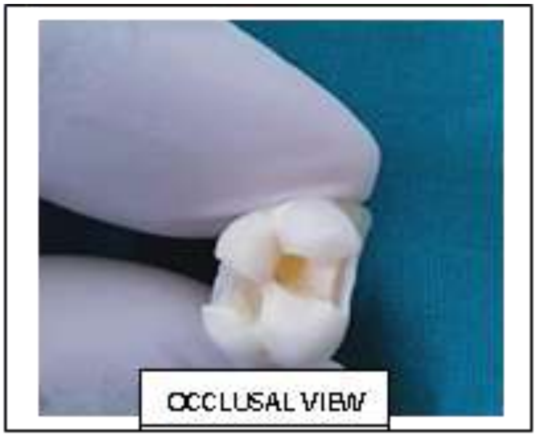
CLASS II MESIO-OCCLUSAL AND DISTO-OCCLUSAL CAVITIES PREPARED ON MAXILLARY FIRST MOLAR



Tooth restored with bulk fill composite resin

SECTIONED SAMPLES

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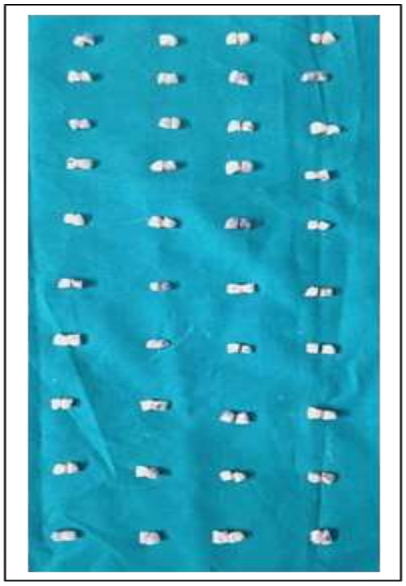

In group 1 a (precure subgroup of convetional flowable composite resin liner group), after application of etchant and application of bonding agent, conventional flowable composite resin was applied as liner and was cured for 20 seconds, followed by the placement of bulk fill composite resin. In group 1 b (cocure subgroup of convetional flowable composite resin liner group),the conventional flowable composite resin liner and bulk fill composite were cured together. In group 2a (precure subgroup of self adhering flowable composite resin liner group), self adhering composite resin was applied as liner without etching and applying the bonding agent, and was cured, followed by the application of bulk fill composite resin. In the group 2b (cocure subgroup of self adhering flowable composite resin liner group), the self adhering flowabe composite resin liner and bulk fill composite resin were cured together.

Statistical Analysis

The intragroup and intergroup comparison of precure and cocure subgroups in Conventional flowable composite resin liner group and self adhering flowable composite resin liner group were done by Independent t test. A two way ANOVA was conducted that examined the effect of material (conventional v/s self-adhering flowable composites) and curing (pre-cure v/s co-cure) on gap at the tooth-restoration interface. In all analyses, the level of significance was set to $p < 0.05$.

Results

The mean value of gap at the tooth-restoration interface in conventional composite resin liner group for the precure subgroup of the is 3.93140 um while the mean value of the gap for the cocure subgroup is 3.3901um. So although both the subgroups do not show any statistically significant difference in the mean value of microleakage, but the cocure subgroup shows more gingival adaptation than the precure subgroup of conventional flowable composite resin liner group.

The mean value of the gap at the tooth restoration interface in self adhering flowable composite resin liner group for precure subgroup is 6.03990 um while the gap at the tooth restoration interface in cocure subgroup is 4.00570 um. So the cocure subgroup shows better gingival adaptation than the precure subgroup in self adhering flowable composite resin liner group.

The cocure subgroup of conventional flowable composite resin liner group shows the best gingival adaptation in class II cavities followed by the precure subgroup of conventional flowable composite resin liner group, then the cocure subgroup of self adhering flowable composite resin liner group and least gingival adaptation was shown by the precure subgroup of self adhering flowable composite resin liner group.

Gap in Conventional flowable composite resin group (in µm)				
subgroup	N	Mean	Std. Deviation	P value
Pre-cure	10	3.93140	1.180490	0.226, NS
Co-cure	10	3.39010	.688602	

Gap in Self-adhering flowable composite resin group (in µm)				
subgroup	N	Mean	Std. Deviation	P value
Pre-cure	10	6.03990	1.634078	0.003, S
Co-cure	10	4.00570	.927712	

Gap in Pre-cure subgroup (in µm)				
material	N	Mean	Std. Deviation	P value
Conventional	10	3.93140	1.180490	0.004, S
Self-adhering	10	6.03990	1.634078	

Gap in Co-cure subgroup (in µm)				
material	N	Mean	Std. Deviation	P value
Conventional	10	3.39010	.688602	0.109, NS
Self-adhering	10	4.00570	.927712	

SEM image (1000X) showing the gap at the tooth restoration interface in the precure subgroup of Group 2(self adhering flowable composite resin liner group)

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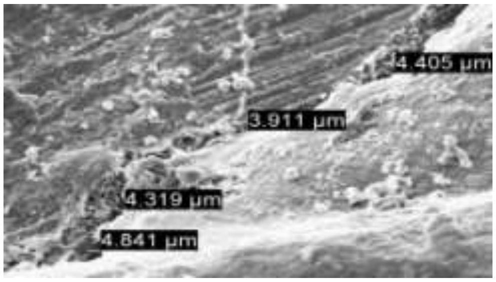
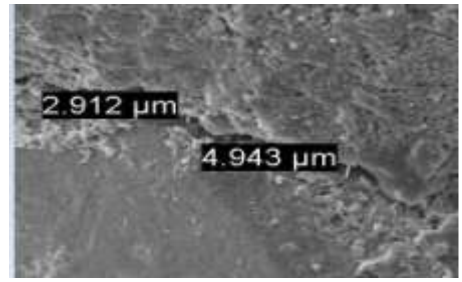
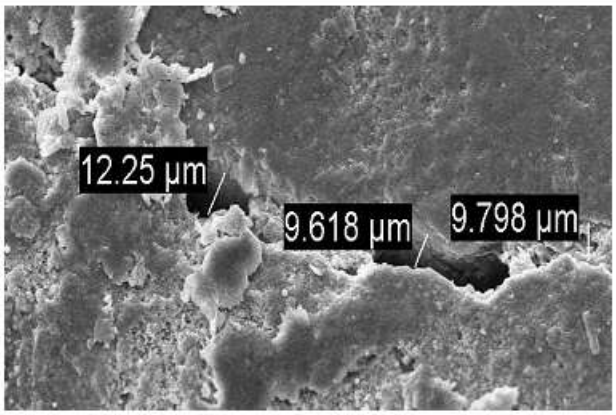


SEM image (1000X) showing the gap at the tooth restoration interface in the precure subgroup of Group 1(conventional flowable composite resin liner group)

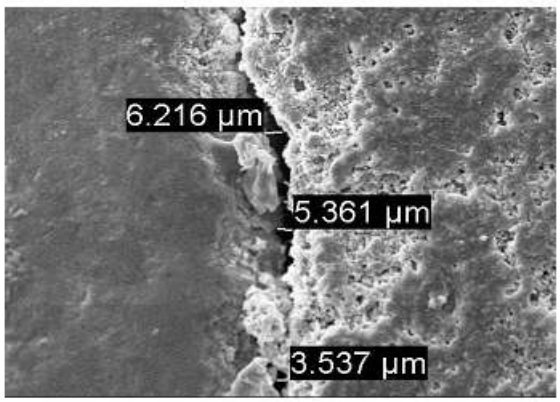


SEM image (1000X) showing the gap at the tooth restoration interface in the cocure subgroup of Group 1(conventional flowable composite resin liner group)

SEM image (1000X) showing the gap at the tooth restoration interface in the precure subgroup of Group 2(self adhering flowable composite resin liner group)



SEM image (1000X) showing the gap at the tooth restoration interface in the cocure subgroup of Group 2(self adhering flowable composite resin liner group)



Discussion

Due to the increased demand for the esthetic restorative materials, the use of composite resin restoration is increasing nowadays as an alternative to amalgam. A study done to evaluate gingival microleakage in class II resin composite restorations by Basavanna et al (2012) suggests that the composite resin restorations gives excellent esthetic results to the patient and at the same time exhibits acceptable longevity[8]. According to a review on bond failure and its prevention in composite resin restoration by J.Sarvesh Kumar et al (2016),it is said that the main disadvantage of composite resin restorations is their poor bonding with the dentin of teeth which in combination with polymerization shrinkage results in microleakage[9]. According to the Principles of polymerization by Odian G et al (1991),it is said that during polymerization, the resultant polymer occupies less space than the monomers resulting in polymerization shrinkage. Another thing of concern while using composite resin is its the high coefficient of thermal expansion[10]. According to a study done by Alaa Turkstani et al (2020) on evaluation of microleakage in class II bulk fill composite resin, the coefficient of thermal expansion of composite resin restorations is 3-4 times greater than the tooth structure. This difference causes different volumetric changes at variable temperature and thus exacerbating the marginal leakage or microleakage[11]. Kidd in 1976 has defined microleakage as clinically undetectable passage of bacteria, fluids, molecules or ions between the cavity wall and applied restorative material[12]. Clinically, microleakage can lead to staining around the margins of the restorations, post- operative sensitivity, secondary caries, restoration failure, pulpal pathology or pulpal death, partial or total loss of restoration[13]. According to a two year follow up study on restorative approach for class II composite resin restorations by MJMC Santos (2015),one of the major disadvantages of class II composite resin restorations is its ineffective bonding at the gingival margins of the tooth due to presence of less or no enamel, thus increasing the risk of microleakage[14]. To reduce this microleakage low elastic modulus liners and various lining techniques have been introduced. An in vitro study done by Kemp Scholte et al (1990) to test the marginal sealing capacity of some adhesive restorative systems and combinations of these systems with various lining materials, it was concluded that the lower elastic modulus of the flowable composite resin liners (1-5GPa) indicates a greater ability to flex with the teeth to accommodate the inherent modulus of the tooth, which will eliminate gap formation and subsequent microleakage[15]. A cavity liner acts as a stress breaker, , has good flow due to low viscosity, and decreases the bulk of the overlying packable composite. Liners with low modulus of elasticity , low surface tension and increased flexibility ameliorate the stresses of polymerization shrinkage and preserve the integrity of bond to tooth structure[16].

In this study, flowable composite resin, Tetric N Flow and self adhering composite resin, Dyad Flow were used as lining materials. The final restoration was done by bulk fill composite resin, Tetric N Ceram Bulk Fill. Many studies like the one done by S.Nagalakshmi Reddy et al (2013), recommends the use of ultrathin lining of 0.5- 1mm thickness and thin lining of 1-1.5 mm thickness of flowable composite resin which reduces the microleakage considerably. The flowable composite resin has less filler loading and shrink more when used in greater thickness. The use of self-adhering composite resin allows for a simpler, less time-consuming (does not require the steps of etching and bonding), and less technique-sensitive clinical procedure[17]. Ozden Okel Bektas et al (2013) performed a study to evaluate the self adhering flowable composite in terms of micro-shear bond strength and microleakage. They suggested that the Dyad-flow contains an adhesive monomer called glycerol phosphate dimethacrylate "GPDM" having an acidic phosphate functional group which could etch the teeth and claiming that it could also bond chemically with their calcium content. However, it was reported previously that the chemical bonding potential of GPDM was not available. This might explain the lower bond strength of self-adhering flowable resin composite. The liners used were either precured or cocured. In precure subgroup, the lining material was cured separately for 20 seconds before application of bulk fill composite resin. In the cocure subgroup, the lining material was not cured separately like the precure subgroup[18].

In this study the cocured flowable composite resin liner group showed best result which was statistically significant..F.D Atika et al (2018) suggested that there is intimate adaptation of the packable bulk fill composite resin with the underlying flowable composite resin liner and hence diminishes the risk of development of voids seen in the precure subgroup[19]. Another study by S.Nagalakshmi et al (2013) mentioned that in the cocure subgroup, the underlying flowable composite resin liner relieves the

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stress as the overlying packable bulk fill composite resin undergoes polymerization shrinkage. Some studies like the one by done Vedavathi Bore Gowda et al (2015) and Rachna Shishodia et al (2022) who evaluated gingival microleakage using different lining techniques showed contrasting results to this study. This may be attributed to the fact that polymerization shrinkage of overlying packable composite would have created contraction forces that may have disrupted the bond of uncured flowable composite liner from the cavity walls[20]. On the other hand, many composites are sticky and have a tendency to pull back as the instruments used to place them are being removed. Also there is an increase in polymerization stresses created due to large volume of polymerizing material .

The precure subgroup of conventional flowable composite resin liner has shown better gingival adaptation than the precure subgroup of self adhering composite resin liner, which was statistically significant. The cocure subgroups of conventional flowable composite resin liner

group and self adhering flowable composite resin liner group have not shown any statistically significant difference in the gap at the gingival cavosurface margin, though the gap was less in the cocure subgroup of conventional flowable composite resin liner group. So, the null hypotheis was partially rejected.

There are few limitations of this study. Since, it is an in vitro study, the results may vary if the study is performed by in vivo technique. The effect of intraoral variables like normal masticatory force, presence of moisture could not be taken into consideration .During the section of the samples for examination under Scanning Electron Microscope (SEM), there may be inadvertent fracture of the composite resin restoration, preventing the proper evaluation of gingival adaptation .

Conclusion

Within the limitations of the study, on evaluation of gingival adaptation in class II composite resin restorations under Scanning Electron Microscope (SEM), it can be concluded that

1. When conventional flowable composite resin was used as a liner under the bulk fill composite resin, it showed statistically significant reduced gap at the gingival cavosurface margin region in comparison to self adhering flowable composite resin as liner. So, conventional flowable composite resin liner showed better gingival adaptation than the self adhering flowable composite resin liner.
2. Among the two lining techniques used, precure lining technique showed more gap at the gingival cavosurface margin region than the cocure lining technique when self adhering composite resin was used as liner which was statistically significant.
3. Although the precure lining technique showed more gap at the gingival cavosurface margin than the cocure lining technique when conventional flowable composite resin was used as liner, it was not statistically significant.

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