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COMPARATIVE EVALUATION OF MARGINAL SEALING ABILITY OF POSTERIOR PACKABLE COMPOSITE WITH OR WITHOUT LINERS USING DYE PENETRATION METHOD- AN INVITRO STUDY.

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ABSTRACT Condensable" or "packable" composites (Surefil) were introduced as an alternative to dental amalgam. However, concerns have been raised related to the ability of these stiffer materials to adequately adapt to internal surfaces. To offset this problem, low viscosity flowable liners walls are recommended under packable composites. This study aimed at evaluating the effect of SDR and Ketac N100 liners on marginal sealing ability of High Density Surefil posterior packable composite.

Methodology: Sixty permanent extracted molars were mounted in a modelling wax and box only Class II cavities were prepared on the mesial side with gingival seat 1mm above CEJ. Teeth were divided into 3 groups: Group (i) Surefil with SDR; Group (ii) Surefil with Ketac N 100; and Group (iii) Surefil without liner. After restoration, the teeth were immersed in Methylene blue dye, sectioned mesiodistally and then evaluated for leakage under Stereomicroscope.

Results: None of the groups were free of microleakage. Surefil without liner (1.2±0.696) exhibited maximum microleakage followed by Ketac N100 group (0.9±0.718) and SDR group (0.8±0.523) showed least microleakage.

Conclusion: Posterior packable composites should be lined by a resin based liner at the gingival margin to allow better seal.

KEYWORDS : Surefil, SDR, Ketac N100, Microleakage, Stereomicroscope, dye leakage.

INTRODUCTION

The ultimate goal of dental restorative material is to replace the biological, functional and esthetic properties of tooth. Dental amalgam and gold alloys have a long record of clinical success, however, these materials are unesthetic.[1] One of the significant development has been the introduction of resin-based composite technology which has limited the size and shape of tooth preparation to minimal. [2,3] Polymerisation shrinkage may be considered the major disadvantage of the current composite materials. "Condensable" or "packable" composites (Surefil) were introduced as an alternative to dental amalgam to have better physical and mechanical properties in order to uptake high masticatory stresses. [2,4] However, concerns have been raised related to the ability of these stiffer materials to adequately adapt to internal surfaces and cavosurface margins. To offset this problem, materials with low viscosity and better adaption to the cavity walls are recommended under packable composites. [4,5] A nanotechnology based resin-modified photo-polymerizable glass ionomer Ketac™ N100 was introduced in 2007 as a liner. [6,7] Stress Decreasing Resin (SDR), was developed specially for dentine replacement. It is based on changes in monomer chemistry by modifying the Bowen monomer to create monomers with lower viscosity.[8,9,10]

An adequate seal must be obtained for any restorative system in order to maintain good pulpal health and to increase the longevity of the restoration.[11]

This study aimed to evaluate, the effectiveness of flowable resin materials i.e. SDR and Ketac N100, as liner, beneath posterior packable composite (Surefil), for reducing the microleakage in class II restoration.

METHODOLOGY:

Sixty non-carious sound permanent molars free of any defects, cracks and restorations were collected. The teeth were cleaned of soft tissues and debris, and stored in distilled water till use at room temperature.

Each tooth was mounted in a modelling wax block to mimic the posterior teeth alignment. Standardized Class II box-only preparation without retention features, was prepared on the mesial surface of each tooth with buccolingual width of 2.0 mm, an axial depth of 2 mm at the cervical floor and the gingival seat was prepared 1mm coronal to the CEJ. The prepared teeth were randomly divided into three groups (n=20) on the basis of flowable liner used as Group (i) Surefil with SDR; Group (ii) Surefil with Ketac N 100; and Group (iii) Surefil without liner. Before restoring, each prepared tooth was wrapped with Toffelmire matrix and wooden wedges were inserted in order to tightly seal the cervical margins. The prepared cavities were washed and blot moist with a sterilized endodontic paper cone to leave a glistening surface followed by application of bonding agent as per manufacturer's instructions.

For SDR subgroups, Xeno V (Dentsply, DeTrey, Germany) selfetch bonding agent was applied on the prepared cavity walls in two coats, left undisturbed for 20 seconds, dried for 5 seconds, and light cured using LED curing light (Satelec India Pvt. Ltd.) for 20 seconds. This was followed by application of SDR in thickness of 1mm at the gingival seat and light cured for 20 seconds.

For Ketac N100 subgroups, Ketac N100 nanoionomer primer was applied to the prepared tooth surface for 15 seconds, followed by gentle air drying and light cured for 10 seconds. This was followed by application of Ketac N100 in thickness of 1mm to the primed surface at the gingival seat and light cured for 20 seconds.

Each cavity was then restored with Surefil composite using the oblique incremental technique in 2mm increments. Each layer was cured for 40 seconds using a LED light-curing unit with a light intensity of 1250 mW/cm^2. After restoration the teeth were stored in incubator at 37^{0}C 100% humidity for 24 hrs.

The matrix was removed and the restoration was cured using LED Curing light. Cervical overhangs were removed with a #12 BP blade. The restorations were finished using flame-shaped fine diamond burs (MANI). Proximal margins that would be accessible clinically were finished with Diatech SwissFlex discs (Coltene/Whaledent, Switzerland).

The finished and polished specimens were subjected to thermocycling to simulate clinical conditions before testing. All specimens were subjected to thermocycling for 500 cycles by alternatively storing in water reservoirs at 5°C and 55°C, respectively, with a dwell time of 30 seconds and transfer time of 15 seconds.

Teeth were then sealed using sticky wax at the apices. All tooth surfaces were covered with two coats of finger nailpaint, with the exception of 1 mm around the restoration. The teeth were then immersed in 2% methylene blue solution for 30 min. After removal from dye, the teeth were washed under running tap water and sectioned mesio-distally using a water cooled diamond disc. Dye penetration was evaluated under a stereomicroscope (Lawrence and Mayo India Pvt. Ltd.) at x40 magnification.

The depth of the dye penetration was analysed according to a zero to three score scale:

0= No dye penetration
1= Dye penetration upto half of gingival wall
2=Dye penetration more than half of wall but not extending to axial wall
3= Dye penetration involving complete gingival wall including axial wall.

The scores obtained were subjected to statistical analysis to determine the marginal sealing ability of flowable liner-composite combinations.

RESULTS

The data obtained was tabulated and analyzed using SPSS software V.22. Descriptive (Mean ± SD) and comparative statistics were used to compare and illustrate the results. The results of microleakage were analyzed using one-way analysis of variance (ANOVA) followed by Independent 't' test. p value was set for 0.05.

Table 1.: One way ANOVA for the test groups showing mean and standard deviation for each group.

Intergroup comparison	N	Mean	Std. Deviation	Std. Error Mean
GROUP (i) – SUREFIL WITH SDR	20	0.800	0.523	0.117
GROUP (ii) – SUREFIL WITH KETAC N 100	20	0.900	0.718	0.161
GROUP (iii) – SUREFIL WITHOUT LINER	20	1.200	0.696	0.156

Surefil without liner exhibited the maximum microleakage.

Table 2: Multiple Comparisons for microleakage evaluation using independent 't' test

Intergroup comparison	N	Mean	Std. Deviation	Std. Error Mean	Mean Difference	't'	p value
GROUP (i) – SUREFIL WITH SDR	20	0.800	0.523	0.117	0.100	0.503	0.618
GROUP (ii) – SUREFIL WITH KETAC N 100	20	0.900	0.718	0.161			
GROUP (i) – SUREFIL WITH SDR	20	0.800	0.523	0.117	0.400	2.055	0.047
GROUP (iii) – SUREFIL WITHOUT LINER	20	1.200	0.696	0.156			
GROUP (ii) – SUREFIL WITH KETAC N 100	20	0.900	0.718	0.161	0.300	1.342	0.188
GROUP (iii) – SUREFIL WITHOUT LINER	20	1.200	0.696	0.156			

All the groups exhibited significant difference in microleakage. Surefil exhibited maximum microleakage without liner and least microleakage was seen when SDR was used as a liner.

DISCUSSION

Dental composites, though are highly esthetic and provide an excellent bond to the tooth structure, still are undergoing enormous amount of research and lot of developments. It is due to one of its major limitation-Polymerization shrinkage. During photopolymerization, monomers form a polymer network and resin-based composites become solid and shrink as the monomers get converted into polymers and result in development of stresses.[12] These stresses affect the resin–dentine bond integrity and try to pull the resin from the tooth substrate, resulting in marginal gap formation. The marginal gaps causes bacterial penetration, secondary caries and eventual bond failure, interfacial defects, enamel fracture, cuspal movements, and microcracks.[2,13] It is believed that the low stiffness of flowable composites might compensate for the polymerization contraction of the higher modulus restorative resin composites.[14] This study aimed at evaluating the effect of placement of flowable resin liner and resin modified glass ionomer liner on the integrity of restoration–tooth substrate margin.

This study was performed according to the recommendation of the International Standards Organization (ISO) technical specification no 11405. Only caries free teeth were used in this study.[15] The teeth were stored in distilled water as recommended by Strawn et al.[16] to avoid changes in the dentin substrate. This study was done on Class II box only restoration due to increased demand for posterior composite resin restoration. The surface area for bonding was kept standard by standardizing the dimensions of the cavity. In the present study, a flowable resin composite was placed in an increment of 1 mm, which was in agreement with Malmstrom et al.[17,18] Layering techniques was used as advocated by Abbas et al. and Federlin et al.[19] Ciamponi & others, 1994, revealed poor transmission of light through the reflecting wedge. Kays, Sneed & Nuckles, 1991, showed excellent polymerization against a highly polished metal matrix.[18,11,20,21] Hence, metal matrix and wooden wedges were used for this study. Dye penetration technique is a commonly used, simple, and comparable method for microleakage evaluation; hence, it was utilized in the present study.[2] Methylene blue dye has molecule size of 1.2 nm^2 and thus can readily penetrate microgaps. Dye immersion period of 30 min allows only penetration due to capillary action and prevents diffusion of the dye into the adhesive.[22]

Microleakage occurring along the restoration-tooth interface is possibly the greatest determinant to the development of an 'ideal' restorative material. Kidd defined microleakage as "the clinically undetectable passage of bacteria, fluids, molecules or ions between a cavity wall and the restorative material".[23,24]

Low viscosity flowable resin materials have been used as liners under composites due to their good wettability, low viscosity, and high elasticity. Due to its low viscosity, flowable composite is expected to adhere well with the more viscous resin composite.[25]

None of the restorations tested in this study were able to completely eliminated microleakage. This might be because of the difference in coefficient of thermal expansion, cavity configuration, polymerization shrinkage, light polymerization concepts and units, lack of adaptation of the restoration to the cavity wall, lack of adhesion between the restorative material and dentin, and improper manipulation of materials.[19]

In this study, Unlined High Density Surefil posterior packable composite (1.2±0.696) exhibited higher microleakage compared to liner groups. It could be due to the increase in the amount of filler particles in packable composites that results in reduction in viscosity of the resin composite, leading to an inadequate adaptation to the enamel walls.[26] The high filler loading also causes increased stiffness, which can lead to high shrinkage stress; hence, increases in amount of filler do not cause reduction in shrinkage.[9] Additionally, though packable resins do not stick to dental instruments, the packable composites do not have sufficient matrix available for wetting the cavity wall and bonding of the subsequent layers leading to formation of voids. Voids in the restoration can result in postoperative sensitivity and bacterial microleakage. These voids may cause the restoration to fail and lead to caries and possible pulp involvement.[26] Leevailoj et al have suggested that the stiffness of the material is an important factor to explain microleakage results.[27] In this study, Flowable composites with lower stiffness when added beneath Surefil resulted in significantly reduced microleakage which is similar to the results obtained by M Sadeghi and CD Lynch.[28]

Amongst both the liners tested in the present study, the nano-ionomer material (Ketac N100) exhibited more microleakage. The possible reason could be the use of primer without any intermediary bonding material, which might have resulted in relatively low bond strengths obtained.[17] The study conducted by E.A. Shebl et al revealed that the shear bond strength of Ketac N100 increased after three months compared to the base line data.[29] In the present study, microleakage evaluation was done after 24-48 hours of Ketac N100 restoration, so the material didn't get sufficient time to establish strong bond with the tooth structure.

SDR gave better marginal seal as a liner, which can be because of "polymerization modulator" (Urethane-based dimethacrylates) in SDR which synergistically interacts with the camphorquinone photoinitiator[30] to delay the gel point. A study by Burgess et al. showed that SDR shows slow polymerization rate, thus reducing polymerization shrinkage stress.[31]

Further studies should be conducted to evaluate the effect of flowable resin liner on the marginal sealing ability of composite restorations lined by different liners.

CONCLUSION:

Within the limitations of this study it can be concluded that:

1. None of the restorative combinations were free of microleakage.
2. Surefil without liner exhibited more microleakage.
3. SDR is better than Ketac N100 when used as liner beneath Surefil.

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