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CERVICAL MICROLEAKAGE IN CLASS II SNOWPLOW RESTORATIONS: COMPARISON OF DIFFERENT CURING MODES: AN *IN VITRO* STUDY

Dental Science

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ABSTRACT

The aim of the study was to evaluate the effect of curing modes on the cervical microleakage of snowplow restorations done with two different types of composite.

MATERIALS AND METHODS: Standardized Class II box only cavities were prepared on either of the proximal surfaces of forty intact extracted. All samples were randomly divided into four groups (n = 10). Group 1 Tetric N ceram continuous polymerization (TNC CP): teeth were restored with snowplow procedure using Tetric-N-cerem (Ivoclar–Vivadent) and Tetric-N-flow and cured with continuous polynerization for 15 s; Group 2 (TNC SSP): restorations done same as Group 1 but cured with soft start polymerization for 20 s; Group 3 (Beautifil CP): teeth were restored with snowplow procedure using Beautifil II (Shofu, Kyoto, Japan) and Beautifil II Flow 02 (Shofu, Kyoto, Japan) and cured for 15 s; Group 4 (Beautifil SSP): restorations done same as Group 3 but cured with soft start polymerization for 20 s. After staining with 2% methylene blue solution, each tooth was sectioned mesiodistally with diamond disc and examined under stereomicroscope (Magnification 4 × 40) (Lawrance and Mayo) for the evaluation of dye infiltration. The extent of microleakage was scored using the ISO microleakage scoring system.

RESULTS: TNC SSP group showed significantly less microleakage than TNC CP group. Between Beautifil CP and Beautiful SSPs, there was no significant difference in the microleakage.

CONCLUSION: Soft start polymerization significantly reduced the microleakage in snowplow restorations done with TNC composite, but it is insignificant in the Beautifil II composite

KEYWORDS

Beautifil Ii, Microleakage, Soft Start Polymerization, Tnc Composite

INTRODUCTION:

An ideal restoration should create permanent and perfect seal between the restoration margin and the tooth structure. The clinical success of posterior composite restorations is still limited with respect to leakage, as a result of contraction stress due to polymerization shrinkage.[1]

To reduce shrinkage stress effects different techniques have been suggested like sandwich restorations, different incremental placement techniques of the resin composite and different light-curing regimens.[2]Unfortunately none of these has been able to eliminate micro-gap formation at gingival margin.

However, for class II cavities, the factors primarily responsible for microleakage problems are related to the initial shrinkage stress of the composite resin, the difference between the coefficient of thermal expansion of materials with hard dental tissue, the inaccessibility of the cervical area and in particular, problems of bonding to the cervical substrate, dentin or cementum.[3]

Flowable composite resin was postulated to be able to reduce the microleakage. It has been recommended as the first increment for class II restorations because of its better flow, easy application in areas which are difficult to access and adaptation to irregular surface of the cavity preparation.[4,5]

The use of cured increment of flowable resin composite in conjunction with class II resin composite restorations has shown mixed results in studies of microleakage. Some studies have shown improved marginal seal and others have indicated worsened gingival seal.Because of higher resin content, flowable composites demonstrate up to three times greater polymerization shrinkage than do standard hybrid composite formulations.[6]This adversely impacts the adhesion of composite to the cavity preparation, as higher polymerization shrinkage and polymerization shrinkage stress have been shown to significantly decrease the bond strength.[7]

In *snowplow technique*initially a flowable resin layer was applied on the gingival and axial walls, which was only polymerized together with the initial gingival traditional composite layer applied in the cavity, thus most of the flowable composite is displaced by the composite resin and only a small composite quantity remains in those areas of the cavity where the high viscosity composite resin did not fully adhered to the cavity walls.[8]

Several articles have suggested that modifying curing light output may reduce polymerization shrinkage and improve marginal integrity. Three modes are available. A continuous cure is used when the output is constant for a specified period of time. The step- or ramp-cure begins at low intensity and switches to higher intensity. The pulse-delay cure is a discontinuous curing procedure. It has been suggested that the curing mode and composite resin placement technique may affect the marginal integrity of a composite resin restoration, in vitro results to date have been mixed, with some investigators showing improved resistance to leakage while others have been unable to demonstrate efficacy with these techniques. So this evaluated the effect of curing modes on the cervical microleakage of snowplow restorations done with two different composites.

MATERIALS AND METHOD:

Forty intact extracted molars devoid of caries, restoration and cracks were chosen for the study. Standardized class II box only cavities were prepared on either of the proximal surfaces with rounded internal line angles and a cavosurface margin at 90 to the tooth surface. The dimensions of the cavities were as follows: buccolingual width=3mm;mesiodistal width=2mm; gingival floor=1mm below the cementoenamel junction. The dimensions of the cavities were verified with a periodontal probe. Cavity preprations were performed with a diamond dome shaped fissure bur, in a water cooled high speed air turbine handpiece. The bur was replaced after every tenth cavity preparation.

The forty teeth were randomly divided into five groups (n=10). A universal metal matrix (Tofflemire, KerrHawe SA Bioggio, switerland)band was placed around each prepared tooth and was supported externally by applying a low fusing compound which

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helped to maintain the adaptation of the band to the cavity margins. Each cavity was cleaned with water spray and was air dried for five seconds.

In groups 1 and 2 the self-etching adhesiveTetric N bond is applied to the cavity walls and air thinned and cured for 20 seconds. For Groups 3 and 4 self-etching adhesive Beautibond is applied to the cavity walls and air thinned and cured for 20 seconds.

Group 1(TNC CP): teeth were restored with snowplow procedure using tetric n cerem(Ivoclar –Vivadent) andtetricn flow and cured with continuous polynerization for 15seconds.

Group 2 (TNC SSP): restorations done same as group 1 but cured with soft start polymerization for 20 seconds

Group 3 (Beautifil CP): teeth were restored with snowplow procedure using beautiful II (Shofu, Kyoto, Japan) and beautiful II flow02 (Shofu, Kyoto, Japan) and cured for 15 seconds

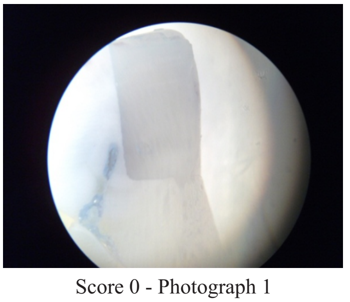
Group 4 (Beautifil SSP): restorations done same as group 3 but cured with soft start polymerization for 20 seconds.

The resin composite in groups 1 and 3 wascured for 15 seconds using the fast curing modeof the LED curing device (light intensity 1100 mW/cm^2).On the other hand, the resin composite ingroups II and IV was cured for 20 seconds, usingsoft-start curing for 10 seconds from 0 to 1100mW/cm2, followed by 1100 mW/cm2 for 10 seconds.The two curing modes resulted in the sameradiation energy of 16.5 J/cm2.

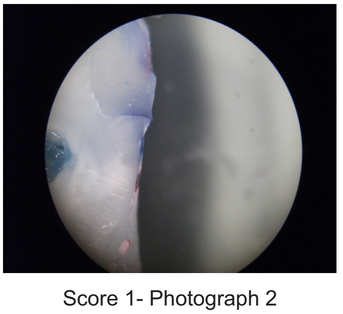
The teeth were stored in distilled water for one week, before the cervical margins were finished with fine diamond bur under water cooling and polished with a sof-lex disc. The restored teeth were subjected to 500 thermo-cycles between 5 C and 55 C in water baths, with a 30 second dwell time. Apical foramina of the teeth were sealed with sticky wax. Two layers of nail varnish was applied 1mm away from the cavity margins.

Samples were then immersed in a 2% methylene blue solution for 24 hours at 37 C.After which teeth were rinsed with tap water for five minutes and then scrubbed to remove the nail varnish. Each tooth was then sectioned mesio-distally with diamond disc. The sections were examined under stereomicroscope ((Magnification 4-40x) (Lawrance& Mayo) for the evaluation of dye infiltration.The extent of microleakage was scored using the ISO microleakage scoring system.[9]

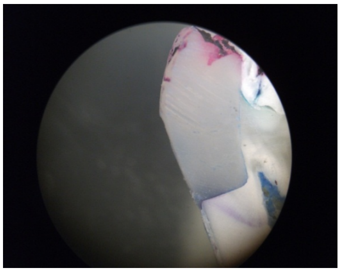
CERVICAL DYE PENETRATION SCORE:
Score 0: No dye penetration (Photograph 1)
Score 1: Dye penetration into ½ of the cervical wall (Photographs2)
Score 2: Dye penetration into all the cervical wall (Photograph 3)
Score 3: Dye penetration into cervical and axial wall (Photograph 4)



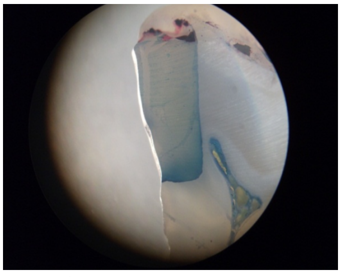
Score 0 - Photograph 1



Score 1- Photograph 2



Score 2 - Photograph 3



Score 3- Photograph 4

RESULTS:
The Mann-Whitney U test shows that TNC SSP group showed significantly less microleakage than TNC CP group. (Table 1 and Graph 1). Table 2 shows the comparison of Beautiful CP with Beautiful SSP groups. Between Beautifil CP and Beautiful SSPs there was no significant difference in the microleakage.

Table 1: Comparison of TNC CP and TNC SSP groups with respect to micro-leakage by Mann Whitney U test
*p<0.05

Micro-leakage	TNC CP group	%	TNC SSP group	%	Total
No leakage	2	10.0	8	40.0	10
Half gingival wall	10	50.0	11	55.0	21
Full gingival wall	7	35.0	1	5.0	8
Till axial wall	1	5.0	0	0.0	1
Total	20	100.0	20	100.0	40
TNC cpvs TNC SSP, Z=-2.6914, p=0.0071*					

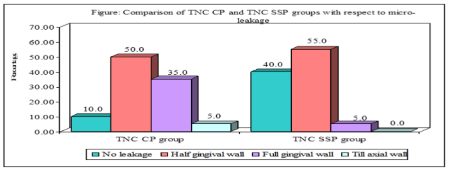
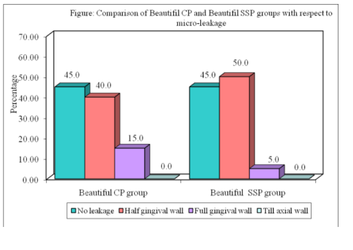


Table 2: Comparison of Beautifil CP and Beautifil SSP groups with respect to micro-leakage by Mann-Whitney U test

Micro-leakage	Beautifil CP group	%	Beautifil SSP group	%	Total
No leakage	9	45.0	9	45.0	18
Half gingival wall	8	40.0	10	50.0	18
Full gingival wall	3	15.0	1	5.0	4
Till axial wall	0	0.0	0	0.0	0
Total	20	100.0	20	100.0	40
Beautifil CP vsBeautifil SSP, Z= -0.2975, p=0.7660					



DISCUSSION:
The interface between the restoration and dental hard tissue is an area of clinical concern as insufficient sealing can result in marginal

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discoloration, secondary caries, restoration failure and pulpitis.[1]

One of the weakest aspects of Class II composite resin restorations is microleakage at the gingival margin of proximal boxes. This is related to the absence of enamel at gingival margins, resulting in a less stable cementum-dentine substrate for bonding.[10] This is sustained by Cagidiaco et al who demonstrated the presence of an outer layer formed partially by cementum located below the cemento-enamel junction that does not allow micromechanical retention by adhesive materials.[11]In addition, the orientation of the dentinal tubules can negatively affect the quality of hybridization and thus favour leakage in resin-based restorations placed in deep interproximal boxes.Restorative composites have relatively high modulus of elasticity and it has been suggested that this high stiffness contributes to their inability to compensate for contraction stress during polymerization. This leads to bond failure and microleakage.

Employing an intermediate layer of low modulus composite can relieve some of the contraction stress during polymerization. So flowable composites have been recommended as liners beneath composite resins due to their low viscosity, increased elasticity and wettability.

Because of higher resin content, flowable composites demonstrate greater polymerization shrinkage than do standard hybrid composite formulations.[12]This adversely impacts the adhesion of composite to the cavity preparation, as higher polymerization shrinkage and polymerization shrinkage stress have been shown to significantly decrease the bond strength.[13]Incremental resin composite application alone is not enough to prevent /reduce the marginal microleakage. It has been suggested that a flexible material intermediary layer will reduce the hardness and will compensate for the polymerization shrinkage stress.[14]However in this study snowplow technique of composite placement is used to so that the flowable composite remains only in inaccessible areas where hybrid composite does not flow. However, it has been demonstrated that even with application of an elastic intermediate material, microleakage is not eliminated.Previous studies demonstrated that softstartcuring delivers low levels of energy initially,allowing the resin composite to flow. This releasesthe stresses of polymerization shrinkage, resultingin reducing microleakage.[15,16]

Between TNC CP and TNC SSP the TNC SSP showed less microleakage. This may be explained by a very short pre gel phase and sudden polymerization of flowable and restorative composites when CP used. The use of low intensity for 10 seconds may delay the gel point giving further possibility for the composite resin to flow.[17]SSP promote a longer pre-gel phase to allow light-cured composite materials to reduce stress more efficiently by internal flow dyamics.[18]

As TNC contains UDMA and dimethacrylates, polymerization stress development would be reduced due to their occurrence of polymer induced phase separation, i.e during the reaction, two physically distinct phases would be formed with different curing kinetics, allowing for more viscous flow during the pre-gel phase. These results of this study are in agreement with previous studies.[19,20]

In the Beautiful II CP and Beautiful II SSP groups there was no significant difference in the microleakage. This could be explained by the fact that beautiful II flow 02 has a low flow and beautibond possess both mechanical and chemical bonding to dentin.If the material–tooth bond remains intact, the final stiff ness of the material may compensate for remaining polymerization contraction stress and lead to a better seal.[21]Theresults of this part of the study are in agreement with the previous studies.[22]

One LED curing light was used in this study, butwith two curing modes. Although the curing timewas different between the two curing modes used,the total energy delivered was the same (16.5 J/cm2). According the Total Energy Concept composite material requires, on average, an energy dose of 12,000 to16,000mJ to properly polymerize on the surface.[23]

The actual light density decreases with increasing distance between the light emission window and the restoration this loss in light intensity is approx. 50% if the distance between the light guide tip and composite surface is 5 mm.[24]As it is impossible to avoid a gap in many situations (e.g.first composite layer in a proximal box), the curing time, which has been determined with the help of the Total Energy Concept, should be prolonged by a factor of 1.5 to 2.

Methylene blue is one of the most common tracers and can be used in different concentrations, from 0.5% up to 5%. It was pointed out that, because of the small surface area of the particles (approximately 0.52 nm^2), methylene blue may lead to an overestimation of leakage at the tooth-restoration interface, particularly with self-etch adhesives in relation to their increased hydrophilicity.

CONCLUSION:

Within the limitations of this study it can be concluded that Soft start polymerization significantly reduced the microleakage in snowplow restorations done with TNC composite but is insignificant in the beautifil II composite.

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