|| ISSN(online): 2589-8698 || ISSN(print): 2589-868X ||
International Journal of Medical and Biomedical Studies
Available Online at www.ijmbs.info
NLM (National Library of Medicine ID: 101738825)
Index Copernicus Value 2018: 75.71

Original Research Article Volume 4, Issue 5; May: 2020; Page No. 71-75

COMPARATIVE EVALUATION OF THE MARGINAL ADAPTATION OF FOUR DIFFERENT COMPOSITE RESINS WITH OR WITHOUT PREHEATING – AN IN VITRO STUDY

Dr. Mohanapriya R[1], Dr. Rajesh Gopal. V[2], Dr. A. Arvind Kumar[3], Dr. Benin Paulaian[4], Dr. Joselin[5], Dr. Jai Kolden[6]

[1]PG Student, Dept. Of Cons Dentistry & Endodontics, Rajas Dental College & Hospital, The Tamil Nadu Dr. MGR Medical University, Chennai, Tamil Nadu.

[2]Professor & Head, Rajas Dental College & Hospital, The Tamil Nadu Dr. MGR Medical University, Chennai, Tamil Nadu.

[3]Professor, Rajas Dental College & Hospital, The Tamil Nadu Dr. MGR Medical University, Chennai, Tamil Nadu.

[4]Reader, Rajas Dental College & Hospital, The Tamil Nadu Dr. MGR Medical University, Chennai, Tamil Nadu.

[5,6]Post Graduates, Rajas Dental College & Hospital, The Tamil Nadu Dr. MGR Medical University, Chennai, Tamil Nadu.

Article Info: Received 04 April 2020; Accepted 18 May 2020

DOI: https://doi.org/10.32553/ijmbs.v4i5.1129

Corresponding author: Dr. Mohanapriya R

Conflict of interest: No conflict of interest.

Abstract

Background: Resin composites as direct posterior restorative material was associated with the polymerization contraction and microleakage. Different methods have been introduced to overcome these drawbacks by increasing the degree of monomer conversion and to minimize the polymerization shrinkage. Composite preheating is an innovative method to improve the handling and physical properties. So this study was done to evaluate the effect of prepolymerization warming of different composites on the marginal adaptation.

Materials and Methods: This *in vitro* study was conducted on 80 extracted human maxillary premolars. Class II cavities on the proximal surface were prepared with the dimensions of 4 mm buccolingual width, 2 mm axial depth, and gingival margin at the cementoenamel junction. They were divided into four groups of 20 teeth each and were restored accordingly: Group I – Bulkfill nanohybrid; Group II – Nanofill; Group III – Ormocer; Group IV – microhybrid composites. Each group was further sub - divided into subgroups of 10 teeth, according to the preheated composites and room temperature composites used. After restorative procedures, samples were sectioned in the mesiodistal direction through the centre of the restoration and analysed using Scanning Electron Microscope at 200x magnification and marginal gap width was measured in three areas at the axial wall using Image Processing and Analysis in Java (ImageJ 1.5 2a) software.

Statistical Analysis: Data was entered in Statistical Package for Social Sciences version 21 Software for Windows. The comparisons of four different composite materials with two subgroups were analyzed using Kruskal Wallis test. The level of significance was kept at $p < 0.05$.

Results: Preheating results in more gap formation with the bulk fill nanohybrid and Ormocer showed higher MQ4 scores than the room temperature composites. No statistically significant results were found. But the percentage of gap formation was comparatively higher in preheated composite group.

Conclusion: Within the limitations of the present study, it could be concluded that preheated composites showed poor internal marginal adaptation with increased frequency of gap formation.

Key words: Internal marginal adaptation, Ormocer, Filtek nanofill, Microhybrid, Tetric bulk fill

Introduction

Often clinicians choose composites as an anterior and posterior restorative material, due to its excellent esthetic and mechanical properties. But these materials have its own negative characteristics like polymerization shrinkage and poor marginal adaptation.

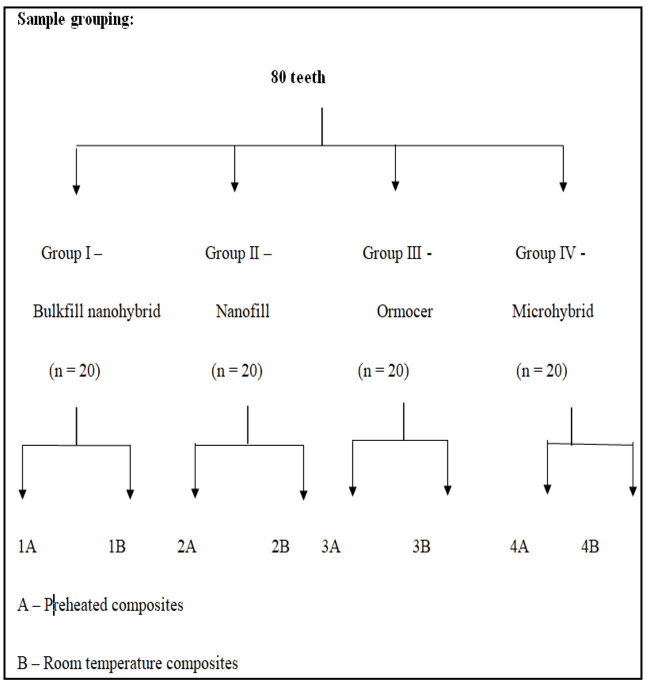
Posterior composite restorations undergo polymerization shrinkage that results in bulk contraction of the material. Dimethacrylate based composites accounts for 2 - 6% volumetric shrinkage [1]. Polymerization contraction stress may cause tooth deformation, adhesive failure and, might cause microcracking of the restorative material [2,3]. Polymerization shrinkage can be minimized by the presence of higher filler loading. It also improves the wear resistance and mechanical properties of the material.

Factors involved to minimize shrinkage stress in direct posterior restorations depends on the choice of the material, choice of the restorative technique and polymerization strategies [4]. Flowable composites usually have reduced filler content with lower elastic modulus. Thus the reduced viscosity in flowable composites associated with inferior mechanical properties and increased shrinkage values. One method to achieve lower viscosity of composites is preheating the composite resin prior to the restorative procedure. Heating the composites reduces its film thickness and viscosity that may partially relieve contraction stress and improve its marginal adaptation without hampering its mechanical properties [5].

AIM

To evaluate the effect of prepolymerization heating on the internal marginal adaptation of four different composites namely bulk fill nanohybrid, nanofill, ormocer and microhybrid composites.

MATERIALS AND METHODS



Cavity preparation:

80 extracted non – carious human maxillary premolars were collected that were extracted for orthodontic purposes (Fig 1.1). Class II cavities were prepared on the proximal surface of all maxillary premolars, with the dimensions of 4 mm buccolingual width, 2 mm axial depth with the gingival margin at the cement-enamel junction (CEJ) (Fig 1.2). Cavosurface margin bevels were not placed. Margins were smoothened using an enamel hatchet. The teeth were randomly divided into four groups of 20 teeth each.

Group I – Bulkfill nanohybrid;

Group II – Nanofill;

Group III – Ormocer;

Group IV – microhybrid composites.

Each group was further divided into two subgroups of 10 teeth each according to the preheated composites and room temperature composites used.

Fig 1.1: 80 human maxillary premolars

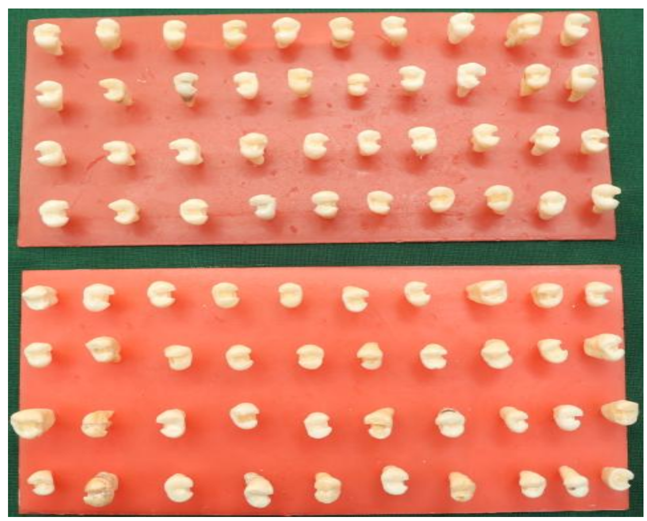


Fig 1.2: Class II cavity preparation in premolars

Restorative procedures:

Using typhodont jaw model, two teeth were mounted together in contact with each other using modelling wax. Sectional matrix was placed between the teeth to provide proper restorative material adaptation.

The class II cavity preparation was etched with 37% phosphoric acid gel for 20 seconds, rinsed with water for 10 seconds and moist dried with cotton pellet for two seconds. Bonding agent (Tetric N - Bond, Ivoclar Vivadent) was applied onto the cavity surface, gently air dried and polymerized for 10 seconds, using LED curing unit with a light intensity of 800 mW/ cm^2 (Bluephase 20i G2 LED curing light, Ivoclar Vivadent AG, Liechtenstein, Western Europe) (Fig 1.3).

The cavities were restored with the respective composite resin. The matrix retainer and the adjacent tooth that were in contact with the restoration were removed after the restorative procedures. The same adjacent tooth was reused for all the samples to maintain contact. Similarly, restorative procedures were performed in four groups using four different composite materials. In preheated composite subgroups, composite materials were subjected to heating using Delta warming device (Delta company, India) at the temperature of 60ºc before insertion of material into cavity preparation (Fig 1.4). Restoration was done in incremental layering technique in 2 mm thickness and light cured for 20 seconds. In group 1, bulk placement technique involve restoration in one increment was used to fill the entire proximal box with 4 mm thickness and light cured for 15 seconds according to manufacturer's instructions (Fig 1.5).

Fig 1.3: Etching with 37% Phosphoric acid gel and bonding agent Application

Fig 1.4: Composite warmer at 61˚ c

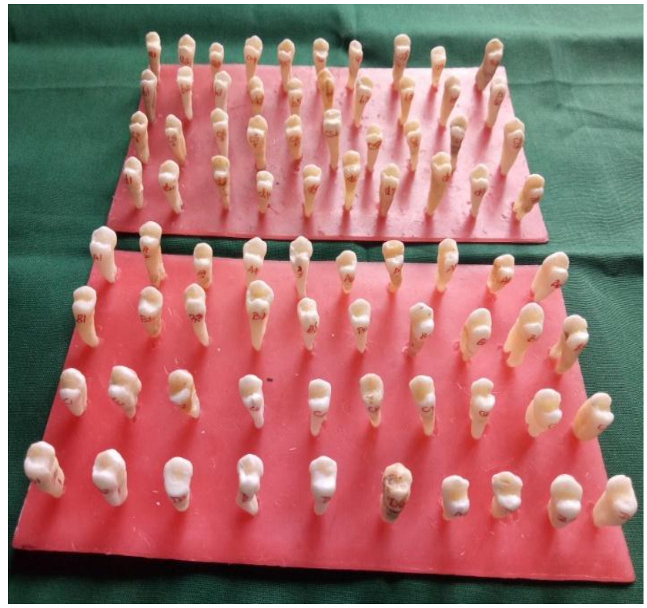


Fig 1.5: Class II composite restorations in 80 premolars based on the respective groups

SEM sample preparation:

Samples were sectioned using diamond disc of 0.10 thickness (Strauss & Co, Israel) longitudinally in the mesiodistal direction through the centre of the restoration. Buccal half of the sectioned teeth were taken uniformly in all the 80 samples. The tooth – restoration interfaces were analysed with Scanning Electron Microscope (SEM) and images were captured at 200x magnification. A criteria by Blunck and Zaslansky was followed to evaluate the micromorphological qualitative assessment of the tooth – restorative interface [6].

MQ1 - Margin hardly visible; No or slight marginal irregularities; No gap

MQ2 - No gap but severe marginal irregularities

MQ3 - Gap visible (hairline crack up to 2 micrometer); No marginal irregularities

MQ4 - Severe gap (>2 micrometer); severe marginal irregularities

Internal margin micromorphology was assessed using Image J software (free license under Public Domain, BSD-2) to trace the complete width of the gap in three areas along the axial wall. Width of the gap was determined for MQ3 and MQ4 criteria (Fig 2.1 and 2.2). Mean average of the gap width in three areas were taken as percentage of scores for each composite in both the groups. Marginal irregularities were evaluated for MQ1 and MQ2 criteria (Fig 2.3 and 2.4). Margins were assessed twice by the same examiner to check reliability.

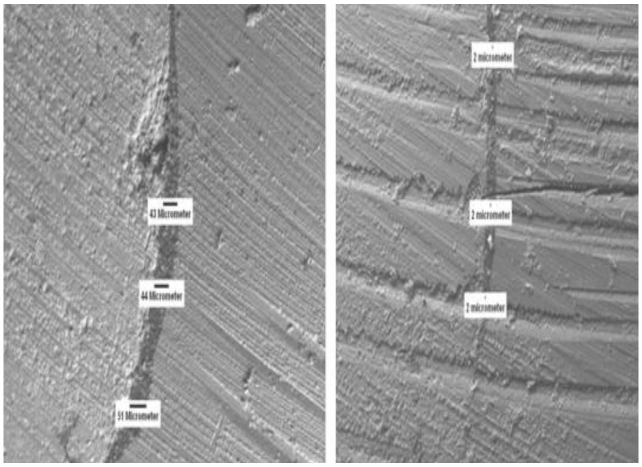


Fig 2.1 & 2.2: SEM image of MQ4 & MQ3 criteria

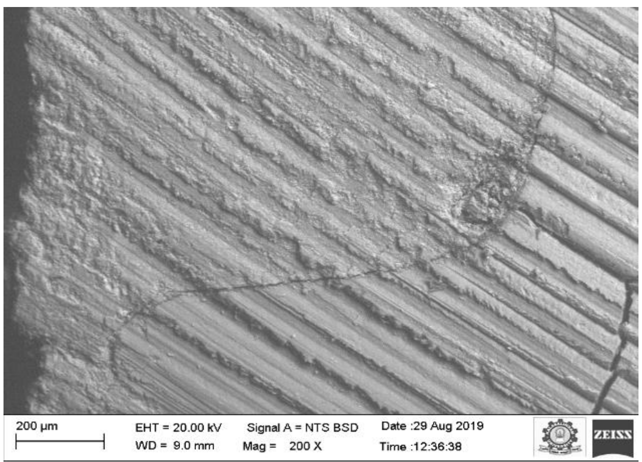


Fig 2.3: SEM image of MQ2 criteria

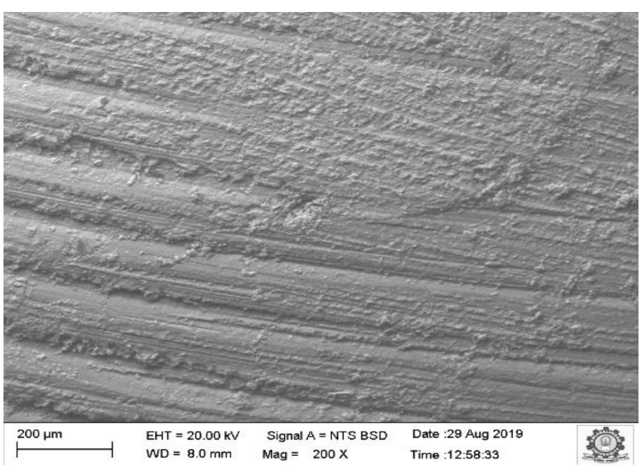


Fig 2.4: SEM image of MQ1 criteria

Statistical Analysis

Margin assessment scores in ordinal data were analyzed using non – parametric Kruskal – Wallis test to check if significant differences in frequency of internal adaptation and gap formation existed between the groups. The measures were considered statistically significant at p < 0.05. Statistical analyses were performed using Statistical Package for Social Sciences (SPSS) version 21.

Results

MQ3 and MQ4 scores were categorized in four groups based on the gap width measurements using Image Processing and Analysis in Java (ImageJ 1.5 2a) software.

Axial adaptation score result of restorative – dentin interface of four different composites in two subgroups were given in the table. Overall, higher percentage of MQ4 and MQ3 scores were observed in preheated composites. None of the samples showed MQ4 score in room temperature nanohybrid and Ormocer composites. Increased MQ1 scores were observed in room temperature nanohybrid and Ormocer composite group.

Overall, no statistically significant results were found in terms of marginal adaptation and percentage of gap formation for the four composites in two subgroups. But room temperature composites showed lesser MQ3 and MQ4 values compared to the preheated group. Bulk fill nanohybrid and Ormocer showed higher percentage of MQ4 values in preheated group.

Table 1: Testing the significance effects of preheated and room temperature composites on the internal marginal adaptation of four composites

		Mq1	Mq2	Mq3	Mq4	Mean rank	P- value
Group i Nanohybrid	1a	10%	20%	30%	40%	12.70	0.082
	1b	30%	20%	50%	0%	8.30	
Group ii Nanofill	2a	30%	30%	30%	10%	10.20	0.813
	2b	30%	20%	40%	10%	10.80	
Group iii Ormocer	3a	30%	20%	20%	30%	12.35	0.143
	3b	50%	30%	20%	0%	8.65	
Group iv Microhybrid	4a	20%	10%	50%	20%	10.30	0.872
	4b	30%	0%	40%	30%	10.70	

* = statistically significant (p < 0.05)
P-value based on kruskal-wallis test

Discussion

The major concern in class II direct composite restorations is to achieve proper adaptation to dentinal wall in axial and gingival margins. Usually, flowable composites was used as stress absorbing layer to minimize contraction shrinkage. In a study conducted by Labella *et al* described the use of flowable composites in two different methods as an intermediate layer light cured either before or simultaneously with the overlying composite [7]. Light curing both the flowable liner and the high viscosity composites simultaneously can provide maximum stress relief than the flowable composites that was polymerized beforehand [8]. But use of flowable composites were associated with lower modulus of elasticity, thus it may result in inferior mechanical properties.

As an innovative technique, low viscosity composites can be achieved with the preheating method. Previous studies stated that the advantage of using preheated composites instead of flowable composites was that resin composite with increased filler loading was used with no restorative compromise [9].

In this study, different preheated composites were used to assess their effect on internal marginal adaptation compared to the use of room temperature composites. The results of the present study showed that there were differences in terms of marginal gap formation in preheated composites than the room temperature composites. Preheated composites showed higher percentage of internal gap formation.

The criteria given by Blunck and Zaslansky where MQ1 and MQ2 was associated with absence of gap. The differences were in terms of marginal irregularities. While MQ3 and MQ4 scores were associated with the presence of gap and the difference was in terms of gap width. The mean average of gap width in three areas were measured using Image J analysis software. Among them, higher percentage of MQ4 values were observed in bulk fill nanohybrid and Ormocer based preheated composites. Microhybrid composites showed higher MQ3 values in preheated group.

The result of the present study was in accordance with the study conducted by C Sabatini *et al* regarding gingival marginal gap formation of preheated composites. The reason behind the increased frequency of gap formation in preheated group can be explained in relation to the cooling curve of the resin composite. Light curing the resin at its higher temperature was associated with the increased degree of monomer conversion into polymer. A higher conversion rate was related to the production of higher shrinkage stresses. Thermal contraction in relation to time also potentially increases the contraction stress that resulted in combined shrinkage stress that adversely hamper the marginal adaptation of hybrid resin [10].

There are certain limitations in this in- vitro study as there are some in- vivo variables that have role in marginal gap formation in posterior composite restorations that cannot be duplicated in – vitro. The room temperature composite temperature was around 23ºC. The temperature of oral cavity was around 35º C, so the preheated composites can be expected to retain the temperature for more time than the room temperature composites. In the present study, cavity margins were placed at the level of CEJ in dentin since dentin possesses greater adhesive challenge than enamel.

In accordance to the results of present study, future studies should be carried out simulating the in – vivo conditions, since the clinician's technique had an influence on the observed results.

Conclusion

Within the limitations of the present study, it could be concluded that

1. Preheated composites exhibited poor internal marginal adaptation than the room temperature composites.
2. Among them, bulk fill nanohybrid and Ormocer composites showed higher frequency of gap formation with more MQ4 scores.

References:

1. Walls AW, McCabe JF, Murray JJ. The polymerization contraction of visible-light activated composite resins. *J Dent 1988;16(4):177-81.*
2. Meredith N, Setchell DJ. In vitro measurement of cuspal strain and displacement in composite restored teeth. *J Dent 1997;25:331-7.*
3. Davidson CL, de Gee AJ, Feilzer A. The competition between the composite-dentin bond strength and the polymerization contraction stress. *J Dent Res 1984;63:1396*
4. Giachetti L, Scaminaci Russo D, Bambi C, Grandini R. A review of polymerization shrinkage stress: Current techniques for posterior direct resin restorations. *J Contemp Dent Pract 2006;4:079 – 088.*
5. Nívea Regina Fróes-Salgadoa, Luciana Maria Silvaa, Yoshio Kawanob, Carlos Franccia,Alessandra Reisc, Alessandro D. Loguercio. Composite pre-heating: Effects on marginal adaptation, degree of conversion and mechanical properties. *Dent mater 2010;26:908–14*
6. Gayatri C, Rambabu T, Sajjan G, Battina P, Priyadarshini MS, Sowjanya BL. Evaluation of marginal adaptation of a self-adhering flowable composite resin liner: A scanning electron microscopic study. *Contemp Clin Dent 2018;9:S240-5.*
7. Labella R, Lambrechts P, Van Meerbeek B & Vanherle G. Polymerization shrinkage and elasticity of flowable composites and filled adhesives. *Dent Mater Journal 1999; 15(2): 128-37.*
8. Kemp-Scholte CM & Davidson CL. Complete marginal seal of Class V resin composite restorations effected by increased flexibility. *J Dent Res 1990; 69(6):1240-43*
9. TrujilloM, Newman SM& Stansbury JW. Use of near- IR tomonitor the influence of external heating on dental composite photopolymerization. *Dent Mater Journal 2004; 20(8):766-77.*
10. C Sabatini, U Blunck, G Denehy, C Munoz. Effects of preheated composites and flowable liners on class II gingival margin gap formation. *Oper Dent 2010; 35(6):663-71*