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RESEARCH ARTICLE

CLINICAL PERFORMANCE OF ULTRA-RAPID PHOTO POLYMERIZING BULKFILL COMPOSITE AND NANO COMPOSITE USING SINGLE BOND UNIVERSAL ADHESIVE IN CLASS II CAVITIES

Dr. Renu Bala Sroa, Dr. Baljeet Kumar, *Dr. Parul Chauhan, Dr. Harshveer Kaur and Dr. Mamta Katal

¹Professor and Head, Dept. of Conservative Dentistry and Endodontics, Punjab Government Dental College and Hospital, Amritsar, Punjab, India; ²Associate Professor, Dept. of Conservative Dentistry and Endodontics, Punjab Government Dental College and Hospital, Amritsar, Punjab, India; ^{3,4,5}Post-graduate Student, Dept. of Conservative Dentistry and Endodontics, Punjab Government Dental College and Hospital, Amritsar, Punjab, India

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*Corresponding Author:

Dr. Parul Chauhan

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ABSTRACT

Background: The technological improvements in adhesive dentistry have led to development of ultra-rapid photopolymerizing bulkfill which can be cured in 3 or 5 seconds of intense light irradiation and upto 4 mm increments. **Objectives:** The aim of the present study was to evaluate clinical performance of bulkfill composite (Tetric PowerFill) and nanocomposite (Tetric N Ceram nanohybrid) using Single Bond Universal adhesive in Class II cavities. **Materials and Methods:** Forty permanent maxillary and mandibular molars were selected in patients and divided into two groups: Group I (n=20) restored with incremental-fill Tetric N Ceram nanohybrid and Group II (n=20) restored with bulkfill Tetric PowerFill in Class II followed by evaluation at 3, 6 and 9 months according to Modified USPHS criteria for colour match, marginal discoloration, surface texture, anatomic form, marginal integrity, loss/fracture of restoration and secondary caries. Data was analyzed using Chi-square test. **Results:** Group II as regard color match, marginal discoloration, marginal integrity, surface texture and anatomic contour performed somewhat better than Group I. However, statistically no significant difference was found between Group I and Group II (p> 0.05). **Conclusion:** Within the limitations of this study, clinical performance of ultra-rapid photo polymerized bulk fill composite, Tetric Power Fill at 9 month was comparable to Tetric N Ceram nanohybrid in Class II restorations.

INTRODUCTION

Polymerization shrinkage is the most important factor in restoration failure. This shrinkage results in stresses between the tooth and composite resin, which creates marginal gap in the area, resulting in leakage of saliva, bacterial penetration and secondary caries. For restoration in posterior teeth, the conventional incremental placement technique is a gold standard to apply and cure composite in a limited thickness of 2 mm increments. This placement technique is quite sensitive and requires adequate light curing to ensure a thorough cure. However, there are several disadvantages associated with the use of incremental approach; for example, voids can be trapped between the increments, bonding failure could occur between the increments, it can be difficult to place composite after conservative cavity preparation, and the time taken to complete the procedure is lengthier due to the time required to place and polymerize each increment¹. Bulkfill composites have emerged as alternatives to conventional, incrementally filled resin composites. A more translucent resin matrix led to increased light penetration and depth of cure, enabling cavity filling in single increments of 4-5 mm².

Low shrinkage and high filler content of these materials cause shrinkage stresses to be very low and this allows for application of thicker layers. The other advantages of bulkfill composites include elimination of complicated techniques, reduction of clinical steps, increasing the clinical work speed and reducing fatigue for the operator. A newer bulkfill composite Tetric PowerFill (Ivoclar Vivadent) introduced in the market, is an ultra-rapid photopolymerized bulkfill (URPBF) resin composite for direct restorations in posterior teeth with light-curing times starting from 3 seconds. Its composition consists of -Bis-GMA (bisphenol-A-glycidyl dimethacrylate), UDMA (urethane dimethacrylate), Bis-EMA (ethoxylated bisphenol-A-dimethacrylate), propoxylated bisphenol A dimethacrylate, DCP (tricyclodecanedimethanol dimethacrylate), β -allyl sulfone AFCT (addition-fragmentation chain transfer) agent, Photoinitiators: - CQ/amine (camphorquinone), Ivocerin, Lucirin TPO (2,4,6-trimethylbenzoyldiphenylphosphine oxide)⁸. The irradiance protocols for this composite are 20 s (500-900 mW/cm²), 10 s (900-1400 mW/cm²), 5 s (1800-2200 mW/cm²), 3 s (2700-3300 mW/cm²)⁷. The incorporation of an addition-fragmentation chain transfer (AFCT) agent (β -allyl sulfone) resulted in random radical polymerization reaction to produce more homogeneous networks.

It cures with light in the wavelength range of 400-500 nm and can be applied in layers up to 4 mm. The photoinitiator Ivocerin and the Aessencio technology allows this bulkfill composite to achieve the same high esthetics as with conventional composites. Since the clinical evaluation of PFILL composite has not been done yet, the aim of the present study was to compare the clinical performance of bulkfill composite with an incremental-fill nanocomposite using Single Bond Universal adhesive in Class II cavities for 9 months.

MATERIALS AND METHODOLOGY

Forty permanent maxillary and mandibular molars were selected irrespective of gender and in the age group of 18-50 years were from out-patients visiting department of Conservative Dentistry and Endodontics, Punjab Government Dental College and Hospital Amritsar. Approval for the study protocol was obtained from the ethical committee of the institution, approval no. 275. The patients included in the study had permanent maxillary and mandibular molars with moderate proximal carious defects, normal opposing dentition and proximal contact with adjacent teeth. Patients with history of pain/swelling in relation to the carious tooth, high caries index, wear facets or fractures, bruxism, bruxomania or other parafunctional habits were excluded from the study. The teeth were cleaned using a slurry of pumice and the shade of the composite was selected. Local anesthesia (2% Lignocaine with 1:200,000 adrenaline) was administered. Isolation was done using Rubber dam (Coltene, Switzerland). Proximo-occlusal Class II cavities were prepared and dimensions of cavities were approximated as: The occlusal portion of the cavity was 3.0 mm in width and 2.0-2.5 mm in depth. The occluso-gingival height of the box was kept 4.0 mm, axial depth was 1.5-2.0 mm and the bucco-lingual width was 3.0 mm. Buccal and lingual walls of the preparation were approximately parallel and connected to the gingival wall with rounded line angles. The cavosurface margins were not beveled. A preformed sectional metal matrix with reinforced ring (TVD Unimatrix, Santa Catarina, Brazil) was placed to replace the missing proximal wall. Two consecutive coats of bonding agent, Single Bond Universal adhesive (3M ESPE, Neuss, Germany) were applied in self-etch mode with a micro-brush and rubbed on dentin and enamel margins for 20 seconds. After gentle air spray for 5 seconds, curing was done for 10 seconds using LED curing light (Woodpecker, China).

The teeth were divided into two groups, viz: Group I and Group II, comprising of twenty teeth each.

Group I: The teeth were restored with Tetric N Ceram nanohybrid (TNC).

Group II: The teeth were restored with Tetric Power Fill (PFILL).

In Group I, the composite resin Tetric N Ceram was inserted into the cavity following incremental placement technique (three proximal increments, two occlusal increments). Each increment was cured for 20 seconds with the LED curing light (light intensity >1000 mW/cm² and spectrum range of 440-480 nm).

In Group II, the composite resin PFILL was inserted into the cavity in bulk. It was cured for 5 seconds with the LED curing light (light intensity >2000 mW/cm² and spectrum range of 440-480 nm). The restorations in each group were finished & polished using Shofu finishing and polishing composite kit (Shofu, Kyoto, Japan). The patients were recalled after 3, 6 and 9 months interval for follow-up. However, in case of pain or tenderness, hot and cold sensation, the patient was advised to report immediately. The restorations were rated using modified United States Public Health Service (USPHS) criteria (Ryge & Synder 1973)³. At each follow-up, patients were evaluated clinically in regard to: colour match, marginal discoloration, marginal integrity, change in surface texture, anatomic contour, loss/fracture of restoration and secondary caries.

The loss/fracture of restoration, if any, was noted and the cavity was re-restored. The collected data were subjected to statistical analysis using Chi Square test.

RESULTS

Table No. 1 shows number(percentage) of restorations compared by using Chi-Square test for different criteria at each recall time period in Group I (TNC) & Group II (PFILL). At 3 & 6 months, no change in color match was observed. At 9 months, change in color match was observed for 3 restorations in Group I & 2 restorations in Group II; however, the difference was non-significant (p= 0.972). No marginal discoloration was observed upto 3 months. However, marginal discoloration for two restorations was observed for Group I at 6 & 9 months and for one restoration in Group II at 9 months of observation. The results obtained through statistical analysis showed no difference between the two groups (p= 0.550 for 6 months, p= 0.948 for 9 months). Some differences between the two groups were observed in terms of marginal integrity at 6 & 9 months, however, the difference was non-significant (p=0.948 for 6 months, p= 1.0 for 9 months). In spite that there were changes in anatomic contour for two restorations in Group I at 6 & 9 months of observation period, the results obtained through statistical analysis showed no difference between the two groups (p= 0.550 for 6 & 9 months). Only 1 restoration in Group I showed change in surface texture at 6 and 9 months of recall time period. When put to statistical analysis by using Chi-square test, the results were found to be non-significant (p= 0.794 at 6 & 9 months). None of the restorations fractured or showed secondary caries at 3, 6 & 9 months evaluation period.

DISCUSSION

Despite the great improvements in physical, mechanical, esthetic and handling properties of both adhesives and composites, composite restorations still present some shortcomings such as polymerization contraction and obtaining a tight contact point. This shrinkage results in micro leakage, marginal gap formation, marginal discoloration, secondary caries, and cuspal deflection. To overcome the shortcomings of incremental layering technique of composite restorations, bulk fill composites were introduced that can be inserted into the prepared cavities in layers that are upto 4 or 5 mm thick. In the present study, cavity dimensions were approximated in accordance with Hilton et al. and Thonemann et al. to minimize variations^{4,5}. Single Bond Universal adhesive was applied on cavity walls and floor in self-etch mode. The advantages offered by this adhesive system seems to be related to the unique developed VMS technology. This technology consists of the combination of three important chemical components for the adhesion process: the Vitrebond™ Copolymer, which allows rehydration of the collagen fibers and consequent formation of the hybrid layer, allowing its use even in dry dentin. This adhesive has the MDP (10-methacryloyl oxide decyl hydrogen phosphate), which promotes better adhesion performance to the tooth substrate, improved product stability, increased adhesion in the self-etching technique, and is also used as a metal primer. The added Silane allows the adhesion mechanism to occur in glass-derived (feldspathic and lithium disilicate) ceramics, in the ceramics infiltrated by glass (alumina) and Lava Zirconia, without the need for application of a separate initiating agent⁶.

In Group I, the resin TNC was inserted into the cavity following incremental placement technique. Each increment was cured for 20 seconds. In Group II, the composite resin PFILL was inserted into the cavity and cured for 5 seconds (light intensity >2000 mW/cm² and spectrum range of 440-480 nm)⁷. After completion, the restorations of both the groups were assessed clinically using modified USPHS criteria at 3, 6 & 9 months. Ryge in 1971 introduced the USPHS criteria to evaluate the performance of restorations in clinic and since then have been modified by various authors in their respective studies.

Table 1. Number (Percentage) of Restorations Compared by Chi - Square Test for different criteria at each Recall Time Period in GroupI(TNC) & GroupII(PFILL)

CRITERIA	RATING	3 MONTHS			6 MONTHS			9 MONTHS		
		Group I	Group II	p	Group I	Group II	p	Group I	Group II	p
Color match	Alpha	20(100%)	20(100%)	1.0	20(100%)	20(100%)	1.0	17(85%)	18(90%)	0.550
	Bravo	-	-		-	-		3(15%)	2(10%)	
	Charlie	-	-		-	-		-	-	
	Delta	-	-		-	-		-	-	
Marginal discoloration	Alpha	20(100%)	20(100%)	1.0	18(90%)	20(100%)	2.105	18(90%)	19(95%)	0.948
	Bravo	-	-		2(10%)	-		2(10%)	1(5%)	
	Charlie	-	-		-	-		-	-	
	Delta	-	-		-	-		-	-	
Marginal integrity	Alpha	20(100%)	20(100%)	1.0	18(90%)	19(95%)	0.948	18(90%)	18(90%)	1.000
	Bravo	-	-		2(10%)	1(5%)		1(5%)	1(5%)	
	Charlie	-	-		-	-		1(5%)	1(5%)	
	Delta	-	-		-	-		-	-	
Anatomic contour	Alpha	20(100%)	20(100%)	1.0	18(90%)	20(100%)	2.105	18(90%)	20(100%)	2.105
	Bravo	-	-		2(10%)	-		2(10%)	-	
	Charlie	-	-		-	-		-	-	
	Delta	-	-		-	-		-	-	
Surface texture	Alpha	20(100%)	20(100%)	1.0	19(95%)	20(100%)	0.794	19(95%)	20(100%)	0.794
	Bravo	-	-		1(5%)	-		1(5%)	-	
	Charlie	-	-		-	-		-	-	
	Delta	-	-		-	-		-	-	
Loss of restoration	Alpha	20(100%)	20(100%)	1.0	20(100%)	20(100%)	1.0	20(100%)	20(100%)	1.0
	Bravo	-	-		-	-		-	-	
	Charlie	-	-		-	-		-	-	
	Delta	-	-		-	-		-	-	
Secondary caries	Alpha	20(100%)	20(100%)	1.0	20(100%)	20(100%)	1.0	20(100%)	20(100%)	1.0
	Bravo	-	-		-	-		-	-	
	Charlie	-	-		-	-		-	-	
	Delta	-	-		-	-		-	-	

This method gives a systematic approach for clinical assessment of restorative material by visual inspection and use of an explorer. In addition, it gives a broad assessment of restorations in different categories in a very simplified way³. The results in the present study when assessed for color match showed that the bulkfill (PFILL) performed somewhat better than incremental-fill nanohybrid (TNC) at 9 months. The changes in the color of composites are multifactorial phenomenon. It can be associated with intrinsic discoloration and extrinsic staining that can occur during use. Intrinsic factors involve alterations in the chemical stability of the resin matrix and the matrix-particle interface. Extrinsic factors are related to pigment absorption from exogenous sources in oral fluids, poor oral hygiene, dietary intake, and smoking. Restorations in both the groups showed no marginal discoloration at 3 months recall. It may be attributed to the use of universal bonding agent, Single Bond Universal in self-etch mode. Also, both the composites have more filler content (79 wt% & 80 wt%, respectively) which results in better finishing and polishing of the restorations.

However, some marginal discoloration was observed at 6 & 9 months in Group I and at 9 months in Group II. Marginal discoloration usually results from the defects that exist between the composite restoration and the cavity margins. These defects could be caused by inadequate restoration placement or finishing procedures, unsatisfactory bonding, and/or by subsequent stress fatigue¹⁰. There is an intimate relationship between integrity of restoration margins and polymerization contraction and polymerization shrinkage stress. Marginal integrity of PFILL (bulk fill) restorations may be related to the patented shrinkage stress relievers that are integrated into the filler composition that give the least combination of polymerization shrinkage and stress when compared to competitive incremental fill materials. The composition of the organic matrix of PFILL contains a β -allyl sulfone reagent, which allows the additional fragmentation chain transfer to occur instead of the uncontrolled growth of polymer chains creating short-chain polymers and more homogeneous polymerization¹¹.

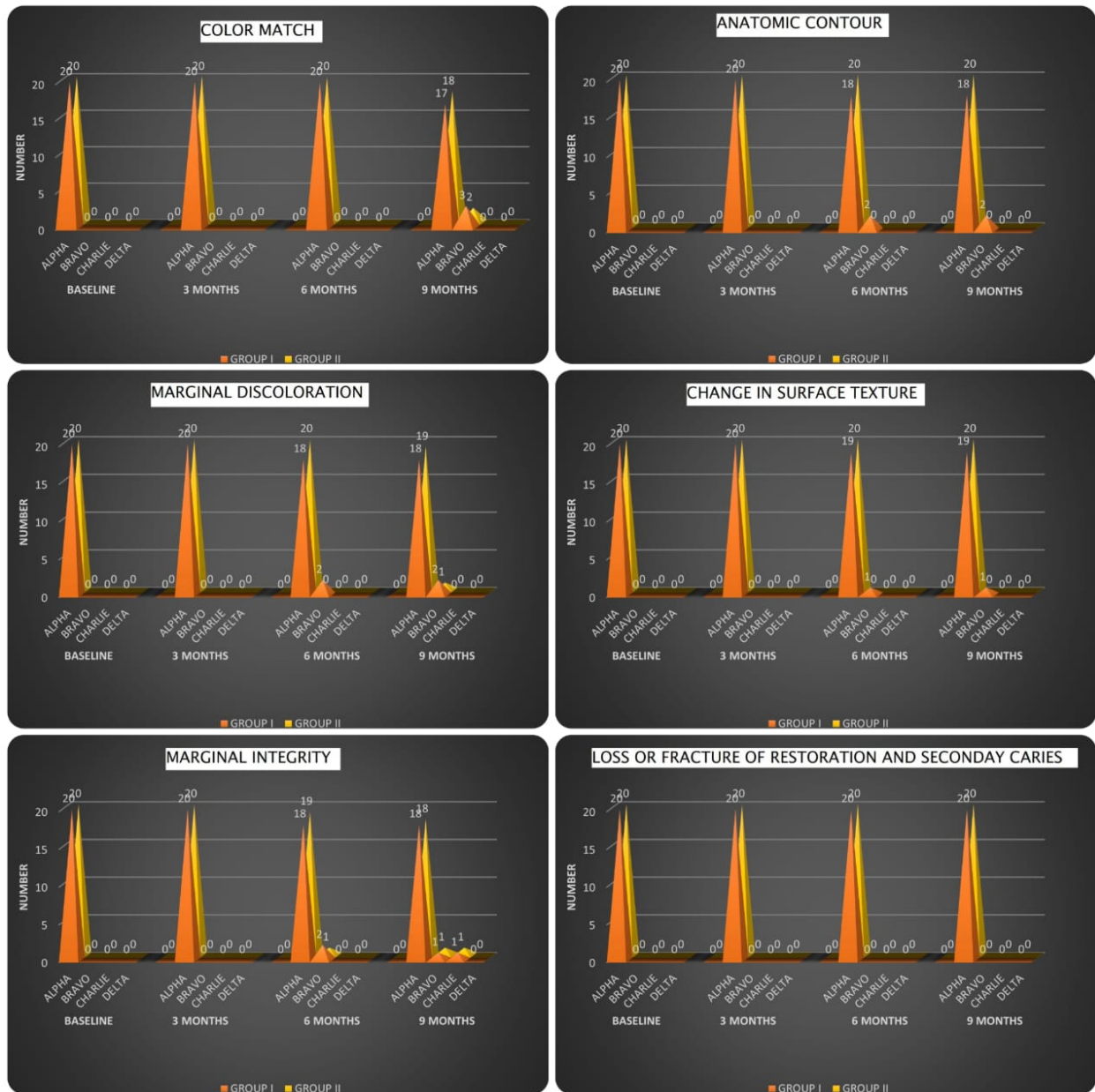


Figure 1. Graphs showing comparison of different criteria using modified USPHS Criteria in Group I (TNC) & Group II (PFILL)

This might have allowed PFILL to achieve better marginal integrity and the results were comparable to the incremental fill composite. Marginal integrity could also be related with the used adhesive system. Although, self-etch mode was used for both restoratives, the promising efficiency of Single Bond Universal which was reflected by higher continuous margins might be another contributing factor for obtaining better results with both the restorations. The observations of the study showed that PFILL has better anatomic form at 6 and 9 months evaluation period than TNC. This fact is likely to be related to incorporation of DCP (tricyclodecane-dimethanol dimethacrylate) in the structural composition of PFILL. DCP has a cyclic aliphatic structure which probably improves mechanical properties by providing rigidity to the polymer network. Besides, the addition-fragmentation chain-transfer mechanism also influences the mechanical properties of PFILL. This results in improved microhardness of the material and therefore improved wear resistance. There was no change in surface texture at 3 months recall period. The size of filler particle is one of the significant factors that determine the smoothness of restorations. Nanohybrid (TNC) and bulkfill (PFILL) include features of nanotechnology. "Nano additives" and nano filler have been included in a targeted fashion which is responsible for better finishing and polishing of the restoration and smooth surface texture.

However, at 6 & 9 months, rough surfaces were more in nanohybrid (TNC) restorations. This may be attributed to incorporation of voids during incremental restoration. Although some differences were found between the Group I and Group II at 6 and 9 months as regard color match, marginal discoloration, marginal integrity, anatomic contour and surface texture, statistically these differences were non-significant. There was no loss of restoration and secondary caries at each recall time period. This may be due to good oral hygiene of the patients, adequate restorative technique, adhesive system used and good marginal seal of the tested groups.

CONCLUSION

- At 6 & 9 months, some differences between the two groups were observed for each criteria, however, when put to statistical analysis by applying Chi-Square test the difference was statistically non-significant.
- Since PFILL performed equally well to the TNC composite, hence, the bulkfill PFILL with 5 seconds of intense light radiation and the ability to be cured upto 4 mm thickness can be

recommended in Class II restoration of posterior teeth using Single Bond Universal adhesive in self-etch mode.

- However, before drawing any definite conclusion, a large number of samples and longer period of observations are required to evaluate the effect of ultra-rapid photopolymerized bulkfill composite in Class II composite restorations.

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LIST OF ABBREVIATIONS USED

AFCT	Addition-fragmentation chain transfer
Bis-GMA	Bisphenol-A-glycidyl dimethacrylate
Bis-EMA	Ethoxylated bisphenol-A-dimethacrylate
CQ	Camphorquinone
C- factor	Configuration factor
DCP	Tricyclodecanedimethanol dimethacrylate
LED	Light emitting diode
MDP	10-methacryloyl oxide decyl hydrogen phosphate
PFILL	Tetric PowerFill
TEGDMA	Triethyleneglycol dimethacrylate
TPO	2,4,6-trimethylbenzoyldiphenylphosphine oxide
TNC	Tetric N Ceram nanohybrid
UDMA	Urethane dimethacrylate
URPBF	Ultra-rapid photopolymerized bulkfill
USPHS	United statespublic health services

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