Journal of Applied Dental and Medical Sciences
NLM ID: 101671413 ISSN:2454-2288
Volume 7 Issue 4 Oct-Dec 2021
https://www.ncbi.nlm.nih.gov/nlmcatalog/101671413
www.joadms.org

Original Research

A comparative evaluation of microleakage around a class v cavity preparation restored with four different tooth coloured materials: an in vitro study

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ARTICLE INFO

Keywords: Microleakage, dental caries, class V cavity, restorative material.

ABSTRACT

Cavities affecting the cervical regions of the teeth (class V) are of a common occurrence and may require restorations; if associated with caries, to alleviate sensitivity, improve appearance and prevent the enlargement of the lesion. A variety of dental materials and adhesives are suggested for restoring class V carious lesions but selecting which will perform best in each situation may present a challenge for the clinician. Therefore, the aim of this in vitro study is to compare and evaluate the amount of microleakage around a class V cavity preparation with four different tooth coloured materials.

Introduction

Dental caries is an infectious microbiological disease of the teeth that results in the destruction of the localized calcified tissues and dissolution of the organic matrix.[1] According to G. V. Black, caries affecting the gingival one-third of the facial and/or lingual surfaces of anterior or posterior teeth have been accurately classified as class V caries.[2] Cavities affecting the cervical regions of the teeth (class V) are a common occurrence and may require restorations; if associated with caries, to alleviate sensitivity, improve the appearance and prevent the enlargement of the lesion.[3]A variety of dental materials and adhesives are suggested for restoring class V carious lesions but selecting which will perform best in each situation may present a challenge for the clinician.

The objective of restorative dentistry is to eliminate carious tissue and bacteria and to fill the cavity with a suitable restorative material. It helps to re-establish the esthetics, functionality of tooth, occlusal stability, and prevent future oral health issues.[4,5]

The inability of the restorative materials to attain the complete marginal seal leads to the occurrence of micro gaps, in which the seepage of fluids, ions, and bacteria occur, which causes secondary caries, hypersensitivity, and pulpal infections. Microleakage is one of the major factors responsible for the failure of class V restorations because gingival margins of such restorations are generally in cementum/dentin. Microleakage is an important property that has been assessing the success of any restorative material used in restoring the tooth.[6]

Nowadays, various materials such as resin-modified glass ionomer cement, flowable composite, Giomer, SDR Plus are commonly used for the restoration of class V cavities.

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Resin Modified Glass Ionomer Cements contain components similar to the conventional Glass Ionomer. In addition, it also contains polymerizable resin monomers in liquid HEMA i.e (2-hydroxyethyl methacrylate) along with initiators and activators. HEMA (2-hydroxyethyl methacrylate) improves dentin bond strength due to its wetting enhancement effect and promotes the diffusion of co-monomers by expanding the demineralized collagen.[7]

Flowable resin-based composites are conventional composites with the filler loading reduced to 37%-53% (volume) compared to 50%-70% (volume) for conventional minifilled hybrids. This altered filler loading modifies the viscosity of these materials. It shows high flexibility, so less likely to be displaced in stress concentration areas cervical wear processes, and cavitated dentine areas. But as every coin has two faces they show high polymerization shrinkage due to low filler content and have weaker mechanical properties too.[8]

Giomer has been introduced as the true hybridization of Glass Ionomer and Composite Resin; containing surface pre-reacted Glass Ionomer (S-PRG) filler particles within a resin matrix. Giomer combines the property of fluoride release of Glass Ionomer Cement with the esthetics, physical, and handling properties of composite resins. [9]

The above-stated materials i.e Resin Modified Glass Ionomer Cement, Flowable Composite, and Giomer show polymerization shrinkage which is responsible for microleakage. To overcome this disadvantage, SDR (Smart Dentin Replacement) Plus Bulk Fill Flowable Composite has been introduced. The SDR technology is a patented urethane dimethacrylate structure that is responsible for the reduction in polymerization shrinkage and stress. It contains fillers like barium aluminofluoroborosilicate glass and strontium aluminofluorosilicate glass. Its resin matrix contains modified urethane dimethacrylate resin, ethoxylated bisphenol-A-dimethacrylate (EBPADMA), triethyleneglycol dimethacrylate (TEGDMA) camphoroquinone (photoinitiator), ethyl-4(dimethylamino) benzoate (photoaccelerator), butylated hydroxyl toluene(BHT), UV stabilizer, titanium dioxide, and iron oxide pigments. It has handling characteristics typical of a flowable composite but can be placed in 4mm increments with minimal polymerization stress. SDR Plus Bulk Fill Flowable has a self-leveling feature that allows intimate adaptation to the prepared cavity walls. [10]

The aim of this in vitro study is to compare and evaluate the amount of microleakage using Resin Modified Glass Ionomer Cement, Flowable Composite, Giomer, and SDR Plus Bulk Fill Flowable Composite around a class V cavity preparation.

Fifty extracted premolar teeth were collected. Superficial debris and calculus were removed from the teeth with an ultrasonic scaler and then stored in saline till further use. Modified class V cavity preparation was done using carbide bur #245 in a high-speed handpiece with air/water spray. Fifty extracted human premolars taken for the study were randomly divided into 2 groups, the experimental group (n=40) and the control group (n=10). Class V cavity preparation was done in all the teeth except for the negative control (n=5) which was the intact teeth. The positive control (n=5) was taken as the teeth on which class V cavity was prepared but not restored. Cavity preparation was standardized in the following dimensions mesiodistal width - 4mm, occluso-cervical length - 2mm, depth pulpally - 2mm. The cavity margins, both occlusal and gingival, were in enamel. All the dimensions were evaluated using a digital caliper and a periodontal probe.

In group 1 modified class V cavity preparation was done and not restored with any restorative material.

In group 2 no cavity preparation was done.

Group 3 was filled with SDR Plus Bulk Fill flowable.

Group 4 was restored with resin-modified glass ionomer cement (GC II LC).

Group 5 was filled with tetric N flow flowable composite.

Group 6 was filled with Giomer (Beautiful II).

All the experimental groups were restored according to the manufacturer's instructions. After the restoration of all the teeth, the restoration was finished with a fine-grit diamond bur and polished with graded abrasive discs. To simulate the oral environment specimens were subjected to a thermocycling regimen of 3000 cycles with a temperature range of 1± 5°C to 1± 55°C with a dwell time of 30 seconds for each temperature. The specimens were coated with two layers of nail polish, leaving a 1 mm space around the cavity margins to avoid ingress of dye through other micro fissures and cracks. Teeth were kept in methylene blue dye for 24 h.

The teeth were then sectioned in a buccolingual direction through the center of the restorations using a low-speed diamond disc. The sections were scored according to the criteria and assessed with a stereomicroscope. The results were scored as described by Khamverdi Z et al[11].

Samples were ranked as follows for their occlusal and gingival margin:

Grade 0 - no influence of colour.

Grade 1 - dye penetration to 1/3 of depth of the cavity preparation.

Grade 2 - dye penetration to 2/3 of the depth of the cavity preparation.

Grade 3 - dye penetration to the entire depth of the cavity preparation.

STATISTICS: The statistical analysis was done using Statistical Package for the Social Sciences (SPSS for Windows, Version 16.0. Chicago, SPSS Inc.). The comparison of micro leakage scores among the study groups was done using Kruskal-Wallis test followed by Mann-Whitney U test for multiple comparisons. The level of significance for the present study was fixed at a p-value of less than 0.05.

RESULT: Tables 1& 2 represent the comparison of micro leakage scores among the study groups showing that there was a statistically significant difference in mean micro leakage scores (P<0.001), using the Kruskal-Wallis test. Tables 3&4 represent multiple comparisons among the group that showed a statistically significant difference in scores (P<0.05), using the Mann-Whitney U test. Graphs 1 & 2 show a comparison of mean microleakage at occlusal and gingival margins. Results showed that the maximum microleakage was for Beautifil II and the lowest microleakage related to SDR Plus. The study depicts similar results at occlusal and gingival margins because both occlusal and gingival margins were in the enamel.

Statistically significant (P<0.05, Kruskal-Wallis test)

A comparison of micro leakage scores among the study groups (Table 1) showed that there was a statistically significant difference in mean micro leakage scores (P<0.001)

Thereafter, multiple comparisons (Table 2) showed the following findings:

There was a statistically significant difference in mean micro leakage scores between SDR Plus and GC II LC (P=0.012).
There was no statistically significant difference in mean micro leakage scores between SDR Plus and Tetric N Flow (P=0.283).
There was a statistically significant difference in mean micro leakage scores between SDR Plus and BEAUTIFIL II (P<0.001).
There was no statistically significant difference in mean micro leakage scores between GC II LC and Tetric N Flow (P=0.126).

There was no statistically significant difference in mean micro leakage scores between GC II LC and BEAUTIFIL II (P=0.233).
There was a statistically significant difference in mean micro leakage scores between Tetric N Flow and BEAUTIFIL II (P=0.009).

Comparison of micro leakage scores among the study groups (Table 2) showed that there was a statistically significant difference in mean micro leakage scores (P<0.001).

Thereafter, multiple comparisons (Table 4) showed the following findings:

There was a statistically significant difference in mean micro leakage scores between SDR Plus and GC II LC (P=0.012).
There was no statistically significant difference in mean micro leakage scores between SDR Plus and Tetric N Flow (P=0.629).
There was a statistically significant difference in mean micro leakage scores between SDR Plus and BEAUTIFIL II (P=0.004).
There was a statistically significant difference in mean micro leakage scores between GC II LC and Tetric N Flow (P=0.035).
There was no statistically significant difference in mean micro leakage scores between GC II LC and BEAUTIFIL II (P=0.256).
There was a statistically significant difference in mean micro leakage scores between Tetric N Flow and BEAUTIFIL II (P=0.008).

GRAPH 1: Comparison at the occlusal margin

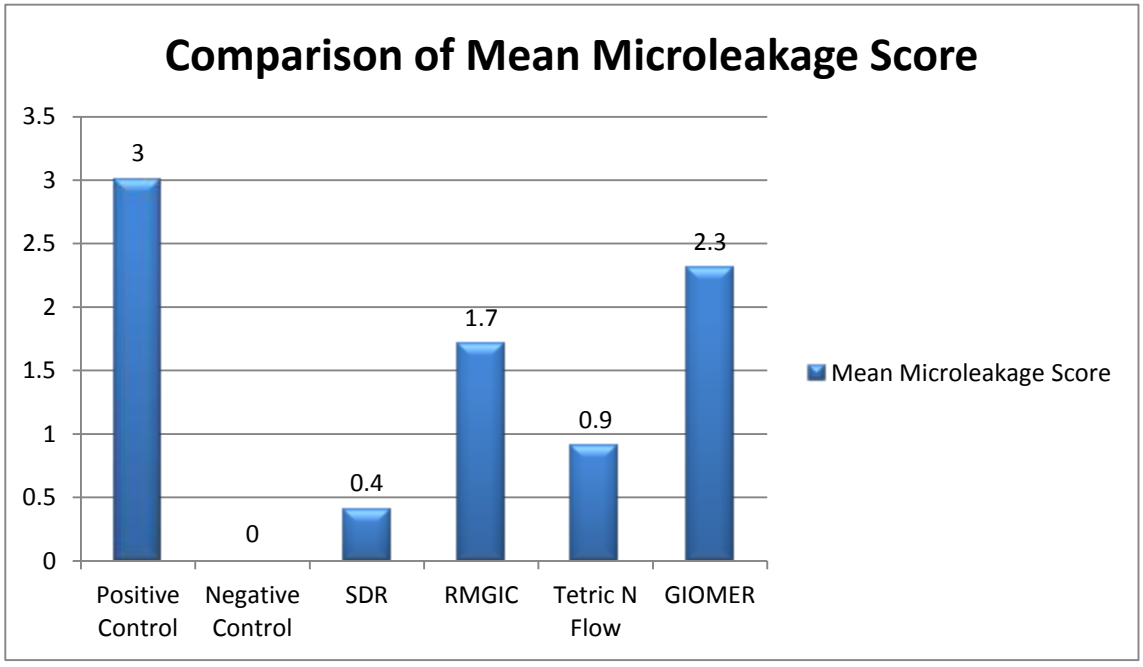


Table 1. Comparison of micro leakage in occlusal margin

	Group	N	Mean Rank	P value
Microleakage	Positive Control	5	43.50	<0.001*
	Negative Control	5	10.00	
	SDR Plus	10	14.90	
	GC II LC	10	29.35	
	Tetric N Flow	10	20.45	
	BEAUTIL II	10	36.05	
	Total	50		

Statistically significant (P<0.05, Kruskal-Wallis test)

A comparison of micro leakage scores among the study groups (Table 1) showed that there was a statistically significant difference in mean micro leakage scores (P<0.001

Table 2. Multiple comparisons

Group	Group	Mean Difference	P value	95% Confidence Interval	
				Lower Bound	Upper Bound
SDR Plus	GC II LC	-1.30000*	.012*	-2.4624	-.1376
SDR Plus	Tetric N Flow	-.50000	.283	-1.6624	.6624
SDR Plus	BEAUTIFIL II	-1.90000*	<.001*	-3.0624	-.7376
GC II LC	Tetric N Flow	.80000	.126	-.3624	1.9624
GC II LC	BEAUTIFIL II	-.60000	.233	-1.7624	.5624
Tetric N Flow	BEAUTIFIL II	-1.40000*	.009*	-2.5624	-.2376

*Statistically significant (P<0.05, Mann-Whitney U test)

Graph 2. Comparison at gingival margin:

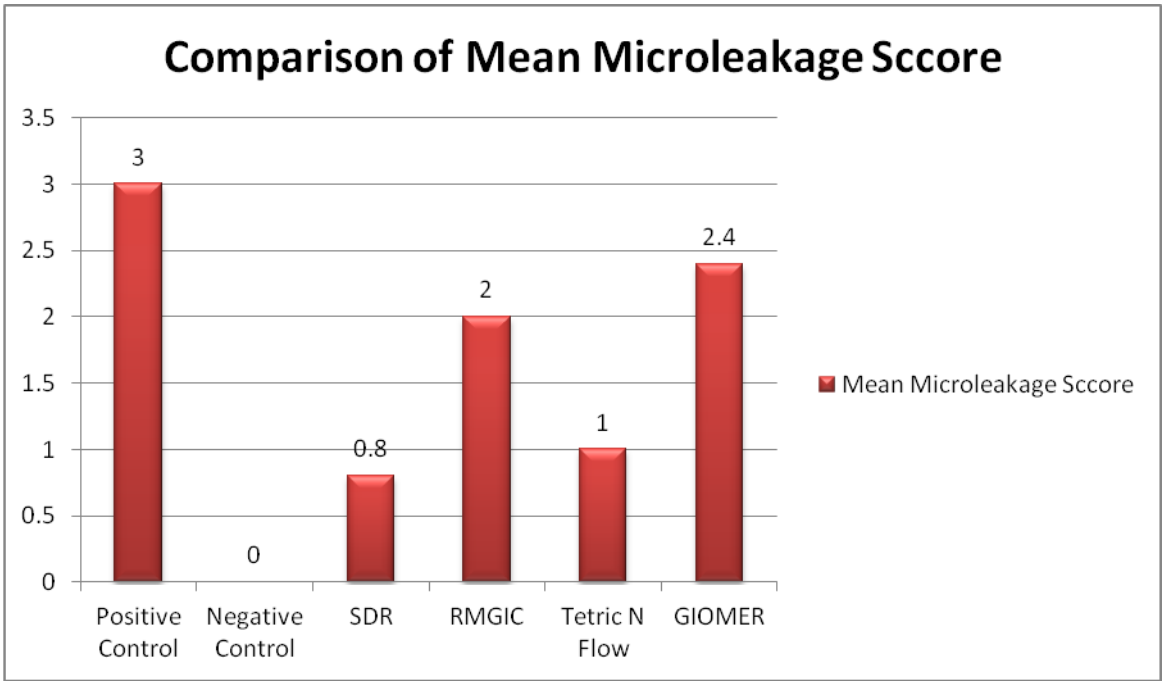


Table 3. Comparison of micro leakage in gingival margin				
	Group	N	Mean Rank	P value
Microleakage	Positive Control	5	42.50	
	Negative Control	5	7.50	
	SDR Plus	10	17.00	<0.001*
	GC II LC	10	30.75	
	Tetric N Flow	10	19.25	
	BEAUTIFIL II	10	35.50	
	Total	50		

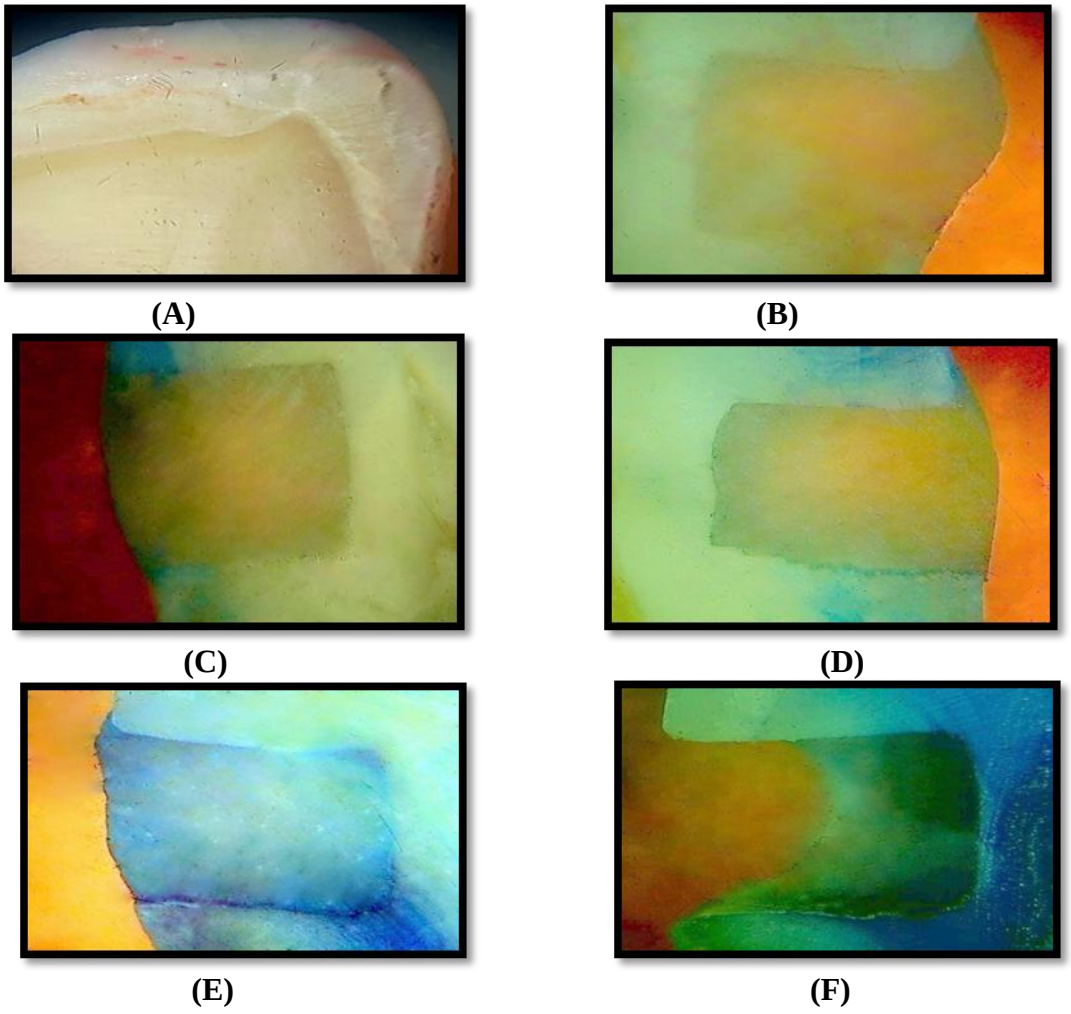
***Statistically significant (P<0.05, Kruskal-Wallis test)**

Comparison of micro leakage scores among the study groups (Table 2) showed that there was a statistically significant difference in mean micro leakage scores (P<0.001).

Table 4. Multiple comparisons

(I) Group	(J) Group	Mean Difference	P value	95% Confidence Interval	
				Lower Bound	Upper Bound
SDR Plus	**GC II LC**	**-1.20000***	**.012***	**-2.3361**	**-.0639**
SDR Plus	**Tetric N Flow**	**-.20000**	**.629**	**-1.3361**	**.9361**
SDR Plus	**BEAUTIFIL II**	**-1.60000***	**.004***	**-2.7361**	**-.4639**
RMGIC	**Tetric N Flow**	**1.00000**	**.035***	**-.1361**	**2.1361**
RMGIC	**BEAUTIFIL II**	**-.40000**	**.256**	**-1.5361**	**.7361**
Tetric N Flow		**-1.40000***	**.008**	**-2.5361**	**-.2639**

***Statistically significant (P<0.05, Mann Whitney U test)**



IMAGES: (A) Grade 0 for intact tooth (B) Restoration showing dye penetration with Grade 0 (C) Restoration showing dye penetration with Grade 1 (D) Restoration with dye penetration showing Grade 2 (E) Restoration showing dye penetration with Grade 3 (F) Unrestored tooth with dye penetration showing Grade 3.

STEREOMICROSCOPE IMAGES:

Image A showed grade 0 for intact tooth

Image B revealed that restoration showed dye penetration with grade 0

Image C revealed that restoration showed dye penetration with grade 1

Image D revealed that restoration with dye penetration showed grade 2

Image E revealed that restoration showed dye penetration with grade 3

Image F revealed that unrestored tooth with dye penetration showed grade 3.

DISCUSSION:

The study depicts similar results at occlusal and gingival margins because both occlusal and gingival margins were in the enamel. A difference could have been between the results when the gingival margins would have been placed in cementum, as supported by Khamverdi Z et al [11].

Nevertheless, the interpretation and explanation of various results obtained using the Mann-Whitney U test are as follows:

GROUP 3 (SDR plus) showed higher marginal integrity with the least mean microleakage score of 0.4 and 0.8 at occlusal and gingival margins, respectively. The group showed statistically significant results ($P<0.05$) in terms of microleakage.

This can be attributed to its patented Urethane Dimethacrylate structure that is responsible for the reduction in polymerisation shrinkage stress, as supported by Kapoor et al.[12] The high filler content 70.5 wt% / 47.4 vol% would have been another contributing factor to decreasing the polymerisation shrinkage thereby reducing the microleakage.[11]

The use of polymerisation modulator results in a slow polymerisation rate; produces lesser polymerization shrinkage stresses; further reducing the microleakage.[10]

The presence of urethane dimethacrylate (UDMA) must have delayed the gel point which gives one more explanation for decreased shrinkage stresses.[13]

GROUP 5 (Tetric N Flow) showed lesser microleakage than group 4 and group 6 with mean microleakage scores of 0.9 and 1 at occlusal and gingival walls respectively. The group had excellent flowable properties and must have created an intimate union with microstructural defects and that is why the microleakage was not statistically significant compared to group 3 (SDR Plus) but the mean values show higher microleakage as compared to group 3(SDR Plus) as the material has lesser filler loading of 68.2 wt %/ 46.4 vol % resulting in more polymerization shrinkage. The second possible explanation could be the presence of monomethacrylate and dimethacrylate which causes more shrinkage as compared to Urethane dimethacrylate (UDMA).[14]

Tetric N Flow exhibited as promising results as SDR Plus statistically in the present in-vitro study. The possible explanation for this could be that sometimes composites do not cure completely but Tetric N Flow contains the highly reactive initiator Ivocerin ® which makes the material to demonstrate a high photoreactivity which helped in achieving a reliable cure hence less microleakage occurred.[13]

Although, in the present study group 3 (SDR Plus) and group 5 (Tetric N Flow) were almost parallel statistically yet their comparisons (Table no. 2 and 4) with the negative control group (group 1) statistically, clearly indicates that SDR Plus (group 3) was the only material which could match the microleakage in a normal tooth at occlusal and gingival levels; clearly establishing the fact that SDR Plus was indeed the most promising one.

GROUP 4 (GC II LC) showed lesser microleakage than group 6 (Beautifil II) at occlusal and gingival margins with a mean microleakage score of 1.7 and 2 respectively and was statistically significant ($P<0.05$) according to Mann- Whitney U test.

This can be attributed to the fact that GC II LC which is a Resin Modified Glass ionomer cement (RMGIC) has new, smaller glass particles which allow greater density and assure a smoother, glossier, and more attractive finish of the restoration. The harder the material offers higher abrasion resistance so the restoration retains a brilliant, longer discoloration-free surface finish. RMGICs have gained favor because of their excellent ability to decrease postoperative sensitivity and their capacity to release fluoride.[15]

Although RMGIC provides many advantages yet the resins added to its structure are of great concern as these resins cause polymerization shrinkage that leads to microleakage. According to Ayna B et al [16], the porous structure & micro cracked surface of RMGIC and the air cavities entrapped in the restoration due to lack of condensation are responsible for higher microleakage around the cavity.

GROUP 6 (Beautifill II) on comparing the group with

others, it was observed that its mean microleakage score at occlusal and gingival margins were 2.3 and 2.4 respectively. This was a highly statistically significant score compared to other groups($P<0.05$) according to the Mann-Whitney U test. This can be ascribed to the fact that Giomer shows reduced marginal adaptation due to polymerization shrinkage. This is because of its typical resin composite-like nature. The hygroscopic expansion which is an intrinsic property of this restorative material is the main cause of marginal deterioration of restorations and also results in water sorption and discolouration, as explained by Gonulol et al [17]. These results were supported by Deliperi S et al[18] and Yadav G et al[19]too. Moreover, Abdel-karim UM et al[20] explained that the inevitable high filler content in giomer without bonding of the resin with S-PRG filler (surface pre-reacted glass) could be the cause of higher microleakage.

CONCLUSION: The results of the present study corroborated with studies in the literature showing that no restorative material can completely eliminate marginal leakage. Within the limitations of this study, SDR Plus bulk fill flowable composite showed the least microleakage than other groups restored with GC II LC, Tetric N Flow, and Beautifil II. Beautifil II though has many advantages yet showed maximum microleakage.

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