



Clinical Evaluation of different incremental Placement Techniques of Resin Composite Restorations in Class V: A Randomized Controlled Trial

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Abstract: The purpose of this study was to evaluate the clinical performance of two placement techniques of resin composite (Horizontal and Mat incremental) using omnichroma in class V carious lesions over 6 months.

Materials and methods: A total of 11 patients with two carious cervical lesions participated in this study after obtaining informed consent. A total of 22 restorations were placed. The distributions of the techniques and the teeth locations were randomized. Cavities were prepared limited to just removal of carious lesions with incisal and gingival margins in enamel and beveling of incisal cavosurface margin. All cavities for both techniques were restored with omnichroma resin composite following manufacturer's instructions. Finishing and polishing were performed using finishing stones and polishing discs. Each restoration was clinically evaluated at baseline (one week), 3 months and 6 months for retention, margin discoloration and postoperative sensitivity using modified United State public health service (USPHS) criteria.

Results

The recall rate was 79.6 % after 6 months. Also, the retention rate for all restorations was 100% after 6 months. Using χ^2 -test, there was no statistically significant differences between the tested groups at all evaluation periods regarding retention, marginal discoloration, and postoperative sensitivity ($P > 0.05$).

Conclusion

Within the limitation of this short-term evaluation, there was no significant clinical difference between both composite placement techniques.

Clinical significances

Both horizontal and mat incremental technique achieved excellent results after 6 months of clinical service.

Keywords: class V, clinical, nanocomposite resin, self-etch adhesive, Mat, universal adhesives

Introduction: Composite restorations became widely used restorative materials in dental offices, in coexistence with the improvements in their performance. Despite this enhancement, polymerization contraction and associated stresses remain a challenge. Many factors possibly

influencing stress development are the cavity configuration (C-factor), composite application technique as well as the elastic behavior of restorative materials ⁽¹⁾.

Class V cavities have unfavorable C-factors, resulting in high contraction stresses within an adhesively fixed resin material. Moreover, these cavities gingival margin frequently placed in dentin, exhibiting an additional challenge to obtain a proper marginal sealing ^(2, 3). The primary problem associated with the restoration of this kind of cavity is leakage at the gingival margin located in dentin, several restorative techniques have been proposed to minimize the polymerization shrinkage consequences and achieve a better marginal adaptation in Class V cavities, because the bond strength to enamel is usually greater than to the dentin ⁽⁴⁾.

The development and improvement of resin composite materials is continuous, the addition of nanoparticles had led to excellent physico-mechanical properties, such as surface smoothness and reduction of polymerization shrinkage ⁽⁵⁾. Another improvement in the resin composite material was the introduction of the bulk-fill resin composite in the markets. They were developed to overcome issues such as volumetric shrinkage and polymerization shrinkage stress, in addition reducing the clinical application steps and time ⁽⁶⁾. Other potential advantages are related to the simplification of the clinical technique, more compact fillings, and time savings ^(7, 8). Another way to overcome the effect of polymerization shrinkage and its consequences is the application of resin composite in different application techniques. Various application techniques of the restoration have been designed to reduce the effects of polymerization shrinkage, improve marginal adaptation, and seal to enhance and provide the clinician with maximum benefit for their application. Studies have shown that the incremental technique tends to improve marginal adaptation by resisting resin composite shrinkage stress ⁽⁹⁾. Recently a new technique, the Mat incremental, has been proposed in the Department of Pedodontics and Preventive Dentistry, Divya Jyoti College of Dental Sciences and Research, Modinagar. In the Mat incremental technique, the horizontal increment placed is further split to reduce the "C" factor, thereby reducing the polymerization shrinkage stress ⁽¹⁰⁾. Therefore, the purpose of this study is to evaluate and compare the effect of various placement techniques on the clinical performance of composite restoration in class V restorations up to 6 months follow up period.

Materials and methods: In this study, class V carious lesions were restored with omnichroma resin composite using two different resin composite placement techniques (Horizontal and Mat incremental) using (palfique eighth generation universal self-etch adhesive). The materials, Specifications composition, manufacturer, Batch number and website are shown in Table1.

Table1: The materials, Specifications composition, manufacturer, Batch number and website

Material	Specifications	Composition	Manufacturer	Batch no.	Website
Omnichroma	light-cured, radiopaque single-shade universal composite	The Filler System: 79% by weight (68% by volume) of spherical silica zirconia filler (mean particle size: 0.3 μm , particle size range: 0.2 to 0.6 μm) and composite filler. The resin system (UDMA)*, (TEGDMA)**, Mequinol, Dibutyl hydroxyl toluene and UV absorber.	Tokuyama Dental, Tokyo, Japan	209S2	https://tokuyama-dental.com/

Palfique universal bond	Universal Self-etch adhesive contains MDP (pH=2.2)	Bond A: Phosphoric acid monomer, Bis-GMA ^{***} , HEMA [#] , TEGDMA ^{**} MTU-6, Acetone (solvent). Bond B: γ -MPTES, Borate, Peroxide, Isopropyl alcohol, Acetone and Water	Tokuyama Dental, Tokyo, Japan	Bond A:091 Bond B:571	https://tokuyamadental.com/products/bonding-agents/self-etching_bonding_system/palfique-universal-bond/
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*Urethane dimethacrylate, **Tri-ethylene-glycol dimethacrylate, ***Bisphenol A glycidyl methacrylate, # Hydroxyl ethyl methacrylate.

A total of 11 patients of both sexes with ages ranging between 18 and 35 years regularly visiting dental clinic of Faculty of Dentistry, Al Azhar Cairo, boys participated in the study following detailed inclusion and exclusion criteria. Approval for this study was obtained from Faculty of Dentistry, AL Azhar University Research Ethics Committee. The purpose of the present study was explained to the patients and informed consents were taken from these patients to restore their teeth, according to the guidelines on human research published by the Research Ethics Committee at Faculty of Dentistry, Al-Azhar university.

Sample size calculation: Sample size and power test expected SD of each group = 0.1 Significance level (alpha) = 0.05 (two-tailed) detailed explanation, based on previous studies ^(6, 10, 11, 12). A sample sizes of 11 cavities in each group giving a total of 22 cavities. Each group has a 95% power with a significance level (alpha) of 0.05 (two-tailed). In 95% (the power) of those experiments, the P value will be less than 0.05 (two-tailed) so the results were deemed "statistically significant". In the remaining 5% of the experiments, the difference between means was deemed "not statistically significant. Sample size calculation was performed using IBM^(R) SPSS^(R) Power^(R) Release 3.0.1. This number is to be increased to a total number of 15 in each group to compensate for losses during follow up with a total number of 30 teeth.

Eligibility criteria for patients: Inclusion criteria: a) Patient with at least one cervical caries. b) Patient able to read and sign the informed consent form. c) Cooperative patients who are willing to participate. d) Have no medical or behavioral problems preventing from attending recall treatment. e) Patient with good oral hygiene. While the exclusion criteria: a) Rampant uncontrolled caries. b) Para-functional habit, bruxism or abnormal occlusion) Pregnant or breast-feeding females. d) Heavy smokers. **Eligibility criteria for teeth:** inclusion criteria for teeth were a) Any tooth to be selected with average mesio-distal diameter of 4 ± 1 mm. b) Absence of tooth mobility, tenderness, extensive carious lesion, and severe pain or pre-operative sensitivity. While the exclusion criteria of teeth were a) Teeth with periapical pathology, internal or external resorption. b) Questionable pulp vitality or have root canal therapy. c) Any teeth with developmental or formative abnormalities. d) Teeth with periodontal pocket and bleeding on probing. e) Cracked teeth. f) Teeth had previous restorations.

Recruitment: Eligible participants who fulfilled eligibility criteria were recruited in outpatient clinics, Department of Operative Dentistry, Faculty of Dental Medicine, Cairo, boys, Al-Azhar University. Twenty-two cavities were divided into two main groups according to the technique of composite placement used for class V restoration; group A) Horizontal, B) Mat incremental and then clinical evaluation was done by using modified USPHS criteria at baseline (7day), 3 months and 6 months.

Cavities preparation, materials application, intervention and outcome: All the patients were given oral hygiene instructions before operative treatment and when needed they were referred to the Periodontology Department for Scaling and Polishing. Each patient received two restorations representing the two tested techniques and grouped as follow: (1) Horizontal group (2) Mat incremental group. The distribution of the tested materials and teeth locations were randomized as shown in (figure 1).

Assessed for eligibility (n=26)

Patients who attended the outpatient clinics, Faculty of dental medicine, Cairo, boys, suffering from at least one class V assessed for eligibility (n=26)

Excluded patients at study (n=12)

Not meeting inclusion criteria (n=4)

declined to participate (n=8)

Final included participants (n=14, 28 cavities)

Randomized (n=14, 28 cavities)

Allocation

Horizontal (n=14)

Mat (n=14)

Follow up

Baseline (one week) (no lost to follow up n=14)

3 months later (1 patients lost to follow-up (13 patients, n=13 with 26 cavities)

6 months later (2 patients lost to follow up (11 patients, n=11 with 22 cavities)

Analysis

(Final total analyzed=11 patients n=11 with 22 cavities)

Figure (1) flow diagram of the study

After anesthesia, first; the isolation was achieved with rubber dam and saliva ejector. Conservative class V cavity was prepared on the buccal surface of each tooth with #330 carbide bur fixed to a high-speed contra-angle handpiece with water coolant system. Soft carious dentin was removed with sharp spoon excavator and the margins of cavity were finished using ultrafine grain diamond stone. Cavity preparation was limited to the removal of caries and the exact cavity form and size

were obtained after caries removal. Each bur was discarded after 5 preparations. The incisal wall of the prepared cavity was beveled by rounded end finishing stone.

Final restoration procedure:Both groups were restored with Omnichroma resin composite as a final direct restoration according to the manufacturer's instructions where the restorative composite was placed incrementally not exceeding 2- mm layers with gold plated hand instrument. Each layer was cured for 40 seconds using a LED light-curing unit.

Horizontal Incremental Technique:Omnichroma resin composite material was placed to fill half of the cavity depth and was light cured for 40 second then the second increment will be placed to fill the cavity up to the cavosurface margin of the cavity and was light-cured for 40 seconds with LED light curing unit with light intensity $\geq 1200\text{mW/cm}^2$ and uniform continuous curing mode⁽¹¹⁾.

Mat Incremental Technique:Omnichroma resin composite material was placed to fill half of the cavity depth, and one mesio-distal and two occlusal-gingival cuts were made to split the first uncured increment into six square-shaped portions using a blunt probe up to the entire depth of the cavity and will be light-cured for 40 seconds. Then the horizontal and vertical cuts in the form of Mat were filled with restorative composite and light cured followed by the third increment that was Placed horizontally up to cavosurface margin to fill the rest of the cavity and light-cured for 40 seconds⁽¹¹⁾.

Final finishing & polishing of the restorations were performed at the same appointment using fine Dura white stone (KERR abrasives) under water-coolant. Patients were instructed to maintain optimum oral hygiene measures. They were instructed for tooth brushing twice daily at least. The importance of periodic follow-up and recall were highlighted. All restorations were evaluated clinically at baseline (7 days), 3 months and after 6 months using modified USPHS (Table 2), including retention rate, marginal discoloration, and postoperative sensitivity.

The patients were asked to record whether any sensitivity, pain, or discomfort (yes/no) occurred before and after the treatment to air from the dental unit. Also, intraoral color digital photographs were taken at each evaluation visit as a permanent record for subsequent indirect evaluation and later reference. Two calibrated investigators evaluated the restorations, an initial agreement of at least 85% between evaluators was considered significant. If disagreement occurred between the examiners, a third equally calibrated expert was asked for evaluation. The restorations were scored as follows: Alpha represented the ideal clinical situation, Bravo was clinically acceptable, and Charlie represented a clinically unacceptable situation. **Observation:** Clinical evaluation was performed at baseline (7 days), 3 months and 6 months clinically according to the modified US Public Health Service criteria (USPHS) retention, marginal discoloration and postoperative sensitivity⁽⁶⁾.

Statistical Analysis:Qualitative data were presented as frequencies and percentages. Chi-square and Fisher's Exact test were used to compare clinical evaluation scores in the two groups. Friedman's test was used to study the changes by time within each group. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.

Table 2. Modified US Public Health Service criteria (USPHS):

Category	Rating	Criteria	Measuring device
Retention	Alpha	Restoration is present	Visual inspection with mirror at 18 inches
	Charlie	Restoration is partially or totally lost	
Marginal discoloration	Alpha	No discoloration	Visual inspection with mirror at 18 inches.
	Bravo	Superficial staining	
	Charlie	Deep staining penetrating in a pulpal direction	
Post-operative sensitivity	Alpha	No postoperative sensitivity directly after the restorative process and during the study period	Ask the patient. "Questionnaire"
	Charlie	Sensitivity presents at any time during the study period	

Results: Study results table 3 shows percentages (%), frequencies, and Chi-square test results for the comparisons of demographic data of (Horizontal and Mat incremental) groups. No statistically significant difference between age categories, gender distributions, marital status, arch and tooth types in the two groups were shown. Tables 4, 5, 6, 7 present data for modified USPHS criteria evaluated for both techniques in means of retention, marginal discoloration, postoperative sensitivity and clinical success. There were dropped out cases (21.4%) in all groups at three and six months follow up periods. No statistically significant difference was found between both groups at each follow up period in all evaluation criteria.

Table 3: Descriptive statistics and results of Chi-square and Fisher’s Exact test for comparisons percentages (%), frequencies of demographic data of (horizontal and mat incremental) groups

Base line characteristics	Horizontal (n = 11)		Mat incremental (n = 11)		P-value
	N	%	n	%	
Gender					
Male	7	63.6	6	54.5	0.611
Female	4	36.4	5	45.5	
Tooth					
Lower anterior	2	18.2	2	18.2	0.534
Upper anterior	7	63.6	5	45.5	
Lower posterior	0	0	4	36.4	
Upper posterior	2	18.2	0	0	

* Significant at $P \leq 0.05$

Table 4: Frequencies (n), percentages (%) and results of Fisher's Exact test for comparison between retention scores in the two groups:

Retention	Horizontal (n = 11)		Mat incremental (n = 11)		P- value	Effect size (v)
	N	%	N	%		
1 week						
Alpha	11	100	11	100	Not computed	
Bravo	0	0	0	0		
Charlie	0	0	0	0		
3 months						
Alpha	11	100	11	100	Not computed	
Bravo	0	0	0	0		
Charlie	0	0	0	0		
6 months						
Alpha	11	100	11	100	Not computed	
Bravo	0	0	0	0		
Charlie	0	0	0	0		

*: Significant at $P \leq 0.05$

Table 5: Frequencies (n), percentages (%) and results of Fisher's Exact test for comparison between marginal discoloration scores in the two groups:

Marginal discoloration	Horizontal (n = 11)		Mat incremental (n = 11)		P-value	Effect size (v)
	N	%	N	%		
1 week						
Alpha	11	100	11	100	Not computed	
Bravo	0	0	0	0		
Charlie	0	0	0	0		
3 months						
Alpha	11	100	11	100	Not Computed	
Bravo	0	0	0	0		
Charlie	0	0	0	0		
6 months						
Alpha	9	81.8	10	90.9	1	0.124
Bravo	2	18.2	1	9.1		
Charlie	0	0	0	0		

*: Significant at $P \leq 0.05$

Table 6: Frequencies (n), percentages (%) and results of Fisher's Exact test for comparison between post-operative sensitivity scores in the two groups:

Post-operative sensitivity	Horizontal (n = 11)		Mat incremental (n = 11)		P-value	Effect size (v)
	N	%	N	%		
1 week						
Alpha	8	72.7	11	100	0.142	0.372
Bravo	3	27.3	0	0		
Charlie	0	0	0	0		
3 months						
Alpha	11	100	11	100	Not computed	
Bravo	0	0	0	0		
Charlie	0	0	0	0		
6 months						
Alpha	11	100	11	100	Not computed	
Bravo	0	0	0	0		
Charlie	0	0	0	0		

*: Significant at $P \leq 0.05$

Table 7: Descriptive statistics and results of Fisher's Exact test for comparison between clinical success in both groups

Clinical success	Horizontal (n = 11)		Mat incremental (n = 11)		P-value	Effect size (v)
	N	%	n	%		
1 week						
Success	8	72.7	11	100	0.142	0.372
Failure	3	27.3	0	0		
3 months						
Success	11	100	11	100	Not computed	
Failure	0	0	0	0		
6 months						
Success	11	100	11	100	Not computed	
Failure	0	0	0	0		

*: Significant at $P \leq 0.05$

Regarding retention and marginal discoloration, no statistically significant change was found throughout the period of the study among both groups, while regarding postoperative sensitivity, 3 restorations among horizontal group exhibiting postoperative sensitivity after one week then

after that this sensitivity subsides and no statistically significant change was found between both groups through the study follow up periods.

A 100% overall cumulative survival rate was obtained, both tested restorative materials showed (Alpha) and (Bravo) scores which was considered success.

Discussion

This randomized clinical study compared different resin composite placement techniques on carious class V using Omnicroma resin composite. The performance of the restorations was assessed by the modified USPHS criteria. Microleakage had always been the major challenge in resin-based restorations. Studies, developments and newly introduced materials are aimed to overcome and solve the problem. In class V restorations microleakage is the major problem since it exhibits the highest amount of C factor which 'is the ratio of bonded surface of the restoration to the un-bonded surfaces. Various methods are presented to decrease the polymerization shrinkage such as reducing filler content of the composite material, adopting layering placement techniques, and decreasing the configuration factor (C-factor). If number of bonded surfaces is increased, it will lead to higher C-factor and greater contraction stress on adhesive bond, which results in potential for bond disruption from polymerization effects. On the other hand, if number of unbounded surfaces is increased, it leads to a low C-factor, which minimizes the polymerization shrinkage⁽¹⁰⁾.

Resin-based restorative materials have been a common choice of dental practitioners for restoring cervical lesions due to their esthetic quality and ability to be bonded to tooth structure. However, cervical lesions have been a restorative challenge for dentists for many years. The complex morphology of Class V cavities with margins partly in enamel and partly in dentin presents a challenging scenario for the restorative material. The primary problem associated with the restoration of this kind of cavity is leakage at the gingival margin located in dentin. Several restorative techniques have been proposed to minimize the polymerization shrinkage consequences and achieve a better marginal adaptation in Class V cavities, because the bond strength to enamel is usually greater than to the dentin.⁽¹²⁾

Selection of materials: Adhesive system that was used in this study Palfique universal bond's contents of new '3D-SR adhesive monomer' (phosphoric acid monomer) for demineralization of the tooth substance and provides chemical bonding to the tooth structure and the adhesive SR monomer in the bonding material achieves; multiple-point interactions with dentin, three-dimensional crosslinking reactions with calcium ions and three-dimensional crosslinking polymerization. Additionally, since there is no curing step that avoids the possibility of losing its effectiveness makes this system having superior results when compared with others.⁽¹³⁾

According to the manufacturer, Omnicroma does not contain pigment, and its color properties are based on structural colors, a smart chromatic technology with the goal of controlling the optical properties of the resin composite. This approach had enabled the engineering of a resin composite that responds to light waves at a given frequency by perfectly reflecting a specific wavelength inside the tooth color space. To express structural color, it is important that the filler of the composite consists of specific, single-sized spherical particles only. As is demonstrated, Tokuyama's research found that 260nm spherical filler generates the a and b color parameter necessary to match natural teeth. Variations in the size and shape of the filler material can alter or impede the structural color phenomenon, and ultimately the composite's shade matching ability. Therefore, omnichroma uses 260nm spherical filler (omnichroma Filler) material exclusively⁽¹⁴⁾.

Class V cavities were chosen in this study because they remain a challenge for restorative procedures. The reason for studying Class V cavities was that it is easier to standardize the preparation of Class V cavities, Class V restoration margins are located in enamel as well as in dentin, preparation and restoration of Class V lesions are minimal and relatively easy, thereby somewhat reducing practitioner variability, and finally Class V cavities have unfavorable C-factors, resulting in high-contraction scores within an adhesively fixed resin material⁽⁴⁾. Beveling of the cavosurface margins had been employed for many years as an accepted modification for composite restorations in permanent anterior teeth. The bevel exposes more enamel rods for bonding. It is known that a beveled margin with enamel prisms is a configuration more favorable than a butt-joint margins. Probably, the bonding strength to enamel was sufficient to resist polymerization stresses, but these stresses exceeded the cohesive resistance of enamel, originating cracks in the mass of enamel⁽¹⁵⁾.

In Class V cavities enamel margins are beveled based on the notion that beveling decreases marginal leakage, improves esthetics, and increases adhesion. However, on the other hand it has been suggested that bonding to beveled margins did not produce a better marginal seal than the unbeveled margins but only improves esthetics. This agree with Santini and colleagues⁽¹⁶⁾ who compared microleakage in Class V cavities restored with micro hybrid composite using self-etch and total etch bond with 90° cavosurface margin and enamel bevel restored with micro hybrid composite and concluded that no significant difference in microleakage was found. Also, according to Bagheri and Ghavamnasiri⁽¹²⁾ who compared the marginal leakage of hybrid and microfilled composite resin in class V restorations with and without an enamel bevel and found no significant difference between the two types of composites and two types of enamel margins with respect to microleakage were noted.

The incremental technique, which had been used for many years in restorative dentistry, had an important role in polymerization shrinkage and the microleakage reduction. However, it had some disadvantages like lengthy procedure and risk of voids and contamination between composite layers. In recent years, bulk fill composite resins have been introduced, that showed low polymerization shrinkage and greater curing depth thus eliminating risk of contamination and voids. Although, there are various studies that evaluate different composite resins application techniques on microleakage in the literature, but studies evaluating the effect of these techniques on microleakage in class V cavities are limited⁽¹⁷⁾.

Although there are studies reporting that incremental technique can be preferred over bulk technique in posterior resin restorations because of better marginal adaptation⁽¹⁸⁾. There are also studies stating that neither bulk nor incremental technique is superior to each other in terms of microleakage⁽¹⁹⁾. Moezizadehet al⁽²⁰⁾ reported that in the restorations using bulk technique, higher microleakage was observed than in restorations using incremental technique. Incremental techniques are known to reduce stresses that occurred at the tooth-restoration interface⁽²¹⁾.

Clinical evaluation in this study was performed by using modified USPHS criteria because they are still widely used in randomized clinical studies and reflect an appropriate guide to assess the performance of current restorative materials clinically.

Regarding Retention: Results of this study showed that all restorations in means of retention (after one week ,3 months and 6 months) among horizontal and mat incremental groups showed (Alpha) scores. There was no statistically significant difference between both groups, the good results of retention among all tested groups might be due to the use of self-cure universal palfique adhesive which utilized a new '3D-SR adhesive monomer' (phosphoric acid monomer) for

demineralization of the tooth substance and provides chemical bonding to tooth and the adhesive SR monomer in the bonding material achieves; multiple-point interactions with dentin, three-dimensional crosslinking reactions with calcium ions and three-dimensional crosslinking polymerization. Also having BoSE technology which uses borate catalyst which exhibit high catalyst activity under acidic condition and a thin bonding layer formed after air blow becomes hard due to the rapid progression of polymerization and curing on its adhesive surface when it comes into contact with resin-based materials, and its compatibility with all etching techniques and with dual and self-cured composite resins. Additionally, since there is no curing step that avoids the possibility of losing its effectiveness makes this system to have superior results when compared with others⁽¹³⁾. The results of this study came in accordance with study done by Morsyetal 2018⁽²²⁾. Also, the retention obtained by Palfique self-cured universal adhesive of PH (2.2) might be related to the low pH that can affect the bonding to the surface of dentin, too. In self-etch bonding systems, a pH value of >2 slows removal of minerals from the dentin surface and results in adequate time for the residual hydroxyapatite crystals to protect and open collagen fibers⁽²³⁾.

The 8th generation (Palfique universal bond) adhesive system had up to 50 MPa micro-tensile bond strength to dentin, and had over 30MPa shear bond strength while 6th generation (One up bond F plus) adhesive system had only 20 MPa shear bond strength to dentin, which makes 8th generation (Palfique universal bond) adhesive system more strong, durable and effective when compared to the 6th generation (One up bond F plus) adhesive system⁽¹³⁾.

Solvents are one of the most important components of universal bonding systems. The bonding systems evaluated in a previous study were different from each other in relation to their solvents. Clearfil S3 Bond Universal and Single Bond Universal contain water and ethanol; according to the results they exhibited less microleakage compared to G-Premio Bond, which contains acetone. This is consistent with the results of previous studies which have reported a higher bonding ability in all-in-one adhesives containing a higher amount of ethanol. In addition, previous studies have shown that the acetone in G-Premio Bond might affect the formation of nano-layering through a change in the polarity of the solvent, with the subsequent hydrophobic effect of methacryloyloxydecyl- dihydrogen phosphate (MDP) in the adhesive⁽²⁴⁾.

The good results regarding retention might also be due to the use of 37% phosphoric acid which reduced microleakage in composite restorations in comparison to self-etch adhesives.

While for marginal discoloration: After one week, all restorations in both groups showed (Alpha) scores, so no statistical comparisons were performed. After three months, all the restorations in horizontal and mat incremental showed (Alpha) scores. After six months, nine restorations in horizontal groups showed (Alpha) scores, two restorations (18.2%) showed (Bravo) scores while in mat incremental ten cases (90.9%) showed (Alpha) score and one case (9.1%) showed (Charlie) score. There was no statistically significant difference between both groups. By time, in all groups, there was no statistically significant change in marginal discoloration scores by time.

Marginal staining may be the first clinical sign of restoration failure. It is usually caused by the faults present between the cavity margins and composite restoration because of ineffective composite placement, substandard bonding, or polishing methods, and/ or by successive stress fatigue. Higher marginal discoloration may be linked to the presence of poor marginal adaptation. Marginal discoloration has been documented in previous study to occur more frequently in cases using the self-etch technique according to a study, low bravo scores for marginal discoloration of both nanohybrid (TetricEvoCeram) and TetricEvoCeram bulk-fill restorations may be because

etching with phosphoric acid was not done. Significantly lower marginal discoloration was observed with the restoration of cavities with bulkfill composite in a single layer, compared to conventional composites in two included studies. But this was disregarded by both the studies as no additional treatment was required for minor surface discoloration. Conversely, higher marginal discoloration was presented by bulk-fill composite systems than the conventional one in a study of this systematic review⁽²⁵⁾.

Marginal discoloration may be caused by three factors, such as the presence of excess filling materials (positive marginal adaptation), a deficit of filling materials at the margin (negative marginal adaptation) and the formation of gaps. It is thought that these mild discolorations are due to the retention of microscopic pigments derived from colored beverages and food at marginal defects which can be solved by polishing⁽²²⁾.

The results of the marginal discoloration showed no statistically significant change in marginal discoloration throughout the study for both groups. This was in accordance with studies^(26, 27).

Finally, regarding post-operative sensitivity: After one week, eight restorations (72.7%) in horizontal group showed (Alpha) scores and three restorations (27.3%) showed (Bravo) scores. While in mat incremental, all restorations showed (Alpha) scores.

Changes by time showed that there was no statistically significant difference between both groups after three as well as six months, all restorations in both groups showed (Alpha) scores, so no statistical comparisons were performed. Postoperative sensitivity had been attributed to several factors including operative trauma, dentin etching, desiccation, leakage, and bacterial penetration to the pulp⁽²²⁾.

The results of the current study showed that, three restorations had immediate postoperative sensitivity in the horizontal group after one week that improves with time with no statistically significant differences between the other three groups at baseline. This result agrees with Perdigo et al⁽²⁸⁾, who found that the increased sensitivity at the beginning of the evaluation results from retraction of the gingiva and tooth root surface exposure, which occurs immediately after placing a restoration or after its finishing and polishing. These successful findings might be related to the relatively short evaluation period, which is consistent with many studies in which there were no significant differences between the tested materials in early evaluation periods. This baseline post-operative sensitivity could be due to mechanical irritation during the cavity preparation and restorations finishing and polishing procedures. Initial hypersensitivity was declined with time and vanished totally at the three months follow-up which might be related to the absence of marginal leakage that reduce the hydrostatic fluid movement inside the cut dentinal tubules. This finding was in accordance with Hussainy et al⁽²⁹⁾. Majority of the included studies^(30, 31) recorded no post-operative sensitivity in the teeth restored. According to one report, higher sensitivity was recorded with the use of incrementally applied Filtek Z250XT compared to Filtek bulk-fill posterior restorative, which may be linked to adhesive failure.

Conclusions: Under limitations of the present clinical trial, it could be inferred that both composite application techniques had beneficial effect on the clinical performance in class V cavities.

Recommendations: Long-term clinical studies are further required for better evaluation of the clinical performance of both composite application techniques in class V cavities.

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