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One-Year Clinical Evaluation of Indirect Resin Composite Inlay Luted with Different Strategies

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Abstract

Objective: To clinically evaluate the12-month adhesion durability of indirect resin composite inlays luted with three different resin cement strategies in MOD Class II restorations.

Materials and Methods: A randomized clinical trial was conducted following the protocol, 20 patients with three large cavities for each one that indicated for indirect MOD Class II restorations were enrolled in the current study. Then, 60 indirect resin composite inlay restorations (SR Nexco) were placed and luted with three different resin cement strategies; an etch-and-rinse (Variolink N), self-etch (Panavia F2.0) and self-adhesive (RelyX Unicem). Each resin cement was used for luting 20 inlay restorations. A single operator placed all restorations according to the manufacturer's instructions. Immediately after placement, the restorations were finished and polished. Clinical evaluation was performed at baseline and at 6 monthly intervals after placement by two independent examiners using modified USHPS criteria. The changes in the USHPS parameters during the 12-month period were analyzed with Fredman test. The baseline scores were compared with those at the recall visits using Wilcoxon signed rank test, where the level of significance was set at $p < 0.05$.

Results: The outcome of the clinical trial showed that, there was no loss of restorations and no recurrent caries after 12-month for all luting cements groups. Both self-etch (SE) Panavia F2.0 and self-adhesive (SA) RelyX Unicem resin cements exhibited minor differences between the evaluation periods regarding to marginal discoloration and marginal adaptation. At baseline, only 4 cases of etch and rinse (Variolink N) resin cement group exhibited post-operative sensitivity which relieved after short time.

Conclusion: All the three resin cement strategies tested, showed acceptable clinical performance after 12-month.

Keywords: *Clinical Evaluation; Indirect Resin Composite; Resin Cement*

Introduction

Due to the patient's demand for esthetic restorations and minimal invasive treatment modes, tooth-colored restorative materials are today preferred. Although resin composite can be applied directly to restore posterior teeth, it can be also indicated for indirect restorations. In particular, for medium-to-large sized cavities on the condition that sufficient tooth structure remains for adhesive cementation [1]. This restoration strategy is highly required due to the need of marginal adaptation, proximal contacts, anatomic form, color match, polymerization shrinkage and wear resistance controlling [1,2].

A brand of indirect resin composites, SR Nexco (Ivoclar Vivadent, Schaan, Liechtenstein) was introduced in 2012. SR Nexco Paste is a purely light-curing laboratory resin composite with high content of inorganic micro filled fillers. This affords optimum benefits in terms of abrasion, discoloration, processing and surface gloss. The balanced ratio between the matrix and filler components results in outstanding physical properties achieved with polymerization units [3].

The type of resin composite luting cement is considered an important factor that may influence the cementation step of indirect (composite) restorations. Therefore, it was referred to 'self-adhesive' luting systems not 'self-etch', as these systems don't require a separate step of tooth surface pretreatment [4,5]. In addition, auto-curing resin composite cement mostly results in lower bond strength than when the cement is light-cured [6-8]. For instance, restorations of 3 mm and thicker lead to a decreased degree of conversion (DC) of the luting composite [9]. Moreover, the environmental temperature has an effect on DC: a higher DC and faster polymerization rate are achieved with a higher temperature. The same effect was recorded for dual-cure composite [10]. As a result of etch and rinse resin cements are time consuming and sensitive to handling, efforts have been made to simplify the luting process and to provide a reliable as well as durable bond to dental tissues by producing self-adhesive resin cements. Which have attracted the interest of both manufacturers and clinicians, because they do not require any pretreatment of dentin surface [11,12]. The ideal resin luting cement should be impenetrable to oral fluids or acids produced by dental plaque and resist dissolution over the life time of restorations. In case of oral environment and presence of moisture or acids, there is increase risk of cement dissolution and bond degradation at the marginal gap leading to weakening and failure of restoration [13,14].

The present study was aimed to clinically evaluate 12-month adhesion durability of indirect resin composite inlays luted with three different resin cement strategies in MOD Class II restorations. The null hypothesis was there is no difference in the clinical effectiveness of the three different resin cement strategies: etch-and-rinse, self-etch and self-adhesive for luting indirect resin composite inlays in MOD cavities.

Materials and Methods

The present study was performed using a laboratory resin composite, SR Nexco (Ivoclar Vivadent AGSchaan, Liechtenstein), cemented with three different resin composite luting cements: an etch-and-rinse dual-cured Variolink N (Ivoclar Vivadent AGSchaan, Liechtenstein), self-etch dual-cured Panavia F2.0 (Kurary medical, Okayama, Japan) and self-adhesive dual-cured RelyX Unicem (3M ESPE, ST Paul, MN USA).

Material	Composition	Manufacturer
SR Nexco liner	Dimethacrylates (48wt.%), barium glass filler, silicone dioxide (51wt.%), additional contents are catalysts, stabilizers and pigments (< 1wt.%).	Ivoclar Vivadent AG Schaan, Liechtenstein
SR Nexco paste Layering materials (incisal and dentin)	Dimethacrylates (17 - 19wt.%), copolymer and silicone dioxide (82 - 83wt.%), inorganic filler (64 - 65wt.%), inorganic filler (64 - 65wt.%) (< 1wt.%).	Ivoclar Vivadent AG Schaan, Liechtenstein
SR Nexco stain	Dimethacrylates (47 - 48wt.%), copolymer and silicone dioxide (49 - 50wt.%), additional contents are catalysts, stabilizers and pigments (2 - 3wt.%).	Ivoclar Vivadent AG Schaan, Liechtenstein
SR Gel	Glycerine, silicone dioxide and aluminium oxide	Ivoclar Vivadent AG Schaan, Liechtenstein

***Table 1**: Indirect resin composite restorative system used in the study.*

Resin composite cement	Composition	Mechanism of adhesion	Manufacturer
N-Etch Syntac Heliobond Variolink N	Etchant: 37% phosphoric acid. -Syntac primer: 4% maleic acid, TEGDMA, PEGDMA, water, acetone. -Syntac adhesive: PEGDMA, glutaraldehyde, water. -Heliobond: Bis-GMA, UDMA, TEGDMA. -Variolink N base: Bis-GMA, UDMA, TEGDMA, fillers, ytterbium trifluoride, stabilisers, pigments. -Variolink N catalyst: Bis-GMA, UDMA, TEGDMA, fillers, ytterbiumtrifluoride, stabilizers, pigments, penzoyl peroxide.	Dual-cured 3-step etch-and-rinse	Ivoclar Vivadent AGSchaan, Liechtenstein
Panavia F 2.0	ED primer: -Primer A (HEMA,10- MDP, chemical initiator, water, 5-NMSA) - Primer B (5-NMSA, chemical initiator, water panavia F2.0) -A Paste (quartz, glass,10- MDP, methacrylate, photoinitiator) -B Paste (silanated barium glass, NaF, methacrylate, chemical initiator)	Dual-cure one step self-etch	Kurary medical (Okayama, Japan
Rely X Unicem	-Powder (silica, glass fillers, calcium hydroxide, chemical curing initiators, light curing initiators) -Liquid (methacrylated phosphoric esters, dimethacrylates, chemical curing initiators)	Dual-cure self-adhesive Translucent aplicap	3M ESPE (ST Paul, MN USA)

***Table 2**: Resin composite cements used in the study.*

Abbreviations: TEGDMA: triethylene glycol dimethacrylate; PEGDMA: polyethylene glycol dimethacrylate; UDMA: urethane dimethacrylate; Bis-GMA: bisphenol A di glycidylmethacrylate; HEMA: 2-hydroxyethyl methacrylate; MDP: 10-methacryloyloxydecyl dihydrogen phosphate; 5-NMSA: N-methacryloyl 5-aminosalicylic acid; NaF: sodium fluoride

Patient selection

Twenty patients from the outpatient Clinic, College of Dentistry at Prince Sattam Bin Abdulaziz University, with 60 posterior carious lesions were enrolled in this study. Prior to participating in the study, each patient signed a consent form. The form and protocol were approved by our institution's ethics committee. Criteria for their inclusion included the presence of primary large carious lesions that indicated for indirect restorations. Pregnant and nursing females were excluded. Each patient received three posterior indirect MOD restorations, cemented with three luting strategies. They were required to have complete and normal occlusion as well as good oral hygiene. The patient population was selected to achieve balance in age from 20 to 54 years, with a mean of 33 years old.

Clinical Procedures

Before restorative procedures, periapical radiographs of teeth to be treated were taken. Vitality test scores of the teeth were recorded with a vitality tester (Parkell Pulp Vitality Tester, Parkell Electronics DN, and Farmingdale, NY, USA). An impression was taken for each patient using equal amounts of the base and catalyst of high-viscosity impression paste (SHERATWIST 60), which were mixed together and seated in an impression tray.

For cavity preparation, local anesthesia was applied to prevent patient discomfort during the restorative procedures. The cavities were prepared using special kit for inlay preparation (Komet, Brasseler GmbH and Co. KG, Lemgo, Germany) and high speed handpiece with water coolant. Hand instruments and low-speed carbide burs were used to remove the caries. Control of the excavated preparation floor was mainly conducted by probing with a sharp explorer and by means of the color of the underlying dentin.

The common characteristics of this preparation design were the following: 1) none of the cavity preparations involved one or more cusps; 2) all of the gingival margins included sound enamel and were placed above the gingival sulcus; and 3) no beveling was applied to the preparation walls and margins. The bucco-lingual width of the preparations did not exceed one-third of this distance. All the internal line angles were rounded to avoid stress concentration.

Then, a final impression was taken for each cavity using mix of light-viscosity impression paste (SHERATWIST 60), which syringed into the prepared cavity, on the surrounding tooth structure and over the high-viscosity of the primary impression. After that, each cavity was restored with temporary restoration till inlay fabrication, and every impression was sent to the dental laboratory so as to be cast into a die stone.

Inlays Fabrication

A professional dental technician fabricated all the restorations on the die stone, following the manufacturer's instructions. Firstly, any undercuts were blocked with wax to ensure that the restoration can be easily removed after the polymerization process without damaging the die model, and then the die margins were clearly defined by a red pencil. The model sealer was applied so as to harden the surface of the stone and protect the die model. SR model Separator (Ivoclar Vivadent AG Schaan, Liechtenstein) was placed in two thin coats, the first coat was applied to cover all areas of the model for 3 minutes then the second coat was applied and left for another 3 minutes [3].

SR Nexo Liner (Ivoclar Vivadent AG Schaan, Liechtenstein) was applied into the cavity walls and floor in a thick coat then cured by light-curing unit (LEDition, Ivoclar Vivadent AG). A disposable sponge was used to remove the resulting inhibiting layer after liner polymerization. SR Nexo Dentin (Ivoclar Vivadent AG Schaan, Liechtenstein) was applied in increments, and each segment was cured for 20 seconds. Finally, SR Nexo Incisal (Ivoclar Vivadent AG Schaan, Liechtenstein) was applied and also cured for 20 seconds. After completing the layering procedure, all the restorations were cured from each direction for 20 seconds. SR Nexo gel (Ivoclar Vivadent AG Schaan, Liechtenstein) was applied on the outer surface of resin composite restorations, then were placed in the furnace (Targis Power TP3 Upgrade, Ivoclar Vivadent AG Schaan, Liechtenstein) using program P2 for 11 minutes in order to complete polymerization according to manufacturer's instructions [3].

After complete curing, the gel was removed; every resin composite inlay was carefully removed from the die model then finished using carbide burs and fine diamonds with low-speed and light pressure. The occlusal and proximal surfaces were smoothed by rubber polishers and silicone polishing wheels. Then, the inlays were polished by using leather buff wheels and Universal Polishing Paste (Ivoclar Vivadent AG Schaan, Liechtenstein) [3]. Finally, the internal surface of inlays was sandblasted by 80 - 100 µm AL2 O3 at 1 bar pressure so as to achieve good bond with the luting resin cement.

Inlays Cementation

After finishing the laboratory processing of resin composite inlays, they were carefully tried-in intraorally and assessed for interproximal contact, marginal fit, and occlusal contact before their cementation. Then, inlays cementation was performed in each group (from group I to III) according to the manufacturer's instructions, under complete isolation and suction using LED light-curing unit. A well-controlled light intensity of 600 mW/cm^2 was used and checked by light meter [30,31].

Group I: 20 inlays were cemented by Variolink N resin cement with using etch-and rinse adhesive system: 37% phosphoric acid etchant was applied on the enamel portion of the cavity for 30 seconds, and on dentin portion for 15 seconds, then rinsed with vigorous air/water spray for 10 seconds leaving dentin surface moist (with a slight glossy wet appearance). Syntac Primer was applied for 15 seconds using light scrubbing action then air-dried, followed by Syntac Adhesive which was placed for 10 seconds, then gently air-dried. Heliobond (bonding agent) was applied and blown to a thin layer and kept unpolymerized (to be polymerized with Variolink N after inlay placement). Equal amounts of Variolink N base and catalyst were mixed together on a mixing pad for 10 seconds, applied to the inlay surface, then the inlay was placed on the pretreated tooth surface that previously coated with uncured Heliobond using finger pressure, then light-cured for only 5 seconds so as to remove the excess of cement by explorer, and finally light-cured for 20 seconds in all directions.

Group II: 20 inlays were cemented by Panavia F2.0 resin cement: one drop of liquid A and B of ED Primer (use within 5 min) were mixed together on a mixing pad, applied to the prepared tooth and leaved for 30 seconds, then gently air-dried. Equal amounts of paste A and paste B were mixed on mixing pad for 20 seconds, used within 3 min after mixing. This mix was applied on the inlay surface, then the inlay was placed on the previously pretreated tooth surface using finger pressure, then light-cured for only 5 seconds so as to remove the excess of cement by explorer, and finally light-cured for 20 seconds in all directions.

Group III: 20 inlays were cemented by RelyX Unicem resin cement: The aplicap was activated for 2 seconds with the dispenser, then mixed for 7 seconds using the amalgamator and applied on the inlay surface. Then, the inlay was placed on the tooth surface without any pretreatment using finger pressure, then light-cured for only 5 seconds so as to remove the excess of cement by explorer, and finally light-cured for 20 seconds in all directions.

Inlays Finishing and Polishing

Finally, the restorations in the three groups were finished with flexible discs (Sof-Lex XT Pop On, 3M ESPE) following the recommended sequence of finishing and polishing discs (coarse, medium, fine and superfine) so as to have a smooth surface.

Clinical Follow-up

Each restoration was clinically evaluated immediately following finishing and polishing procedures (baseline), after 6-months and 12-month by two independent examiners. The Cohen Kappa index was used as a measurement of interexaminer agreement. Examiners were not involved in the restorative procedures. When disagreement occurred during evaluations, the restorations were reevaluated by both examiners and a consensus was obtained.

Restorations were evaluated using the modified United States Public Health Service (modified-USPHS) criteria for retention, marginal discoloration (interfacial staining), recurrent caries, marginal adaptation/integrity and post-operative sensitivity [31,32]. Restorations were given the score Alpha for the ideal clinical situation, Bravo for clinically acceptable and Charlie for clinically unacceptable and in need for replacement. Each restoration was assessed for post-operative sensitivity 1 week after placement and at each follow-up examination. To detect secondary caries, the presence of softness, opacity, etching, or white spots are considered as evidence of undermining or demineralization in areas where the explorer catches or resists removal after insertion.

Statistical Analysis

The data were collected and statistically analyzed using SPSS software program (SPSS version 22, IBM, Chicago, IL, USA). Wilcoxon signed rank test was used to compare results of the recall visits of each material with its baseline ones. The changes in parameters during the 12-month were analyzed using Friedman test (significance at $p < 0.05$).

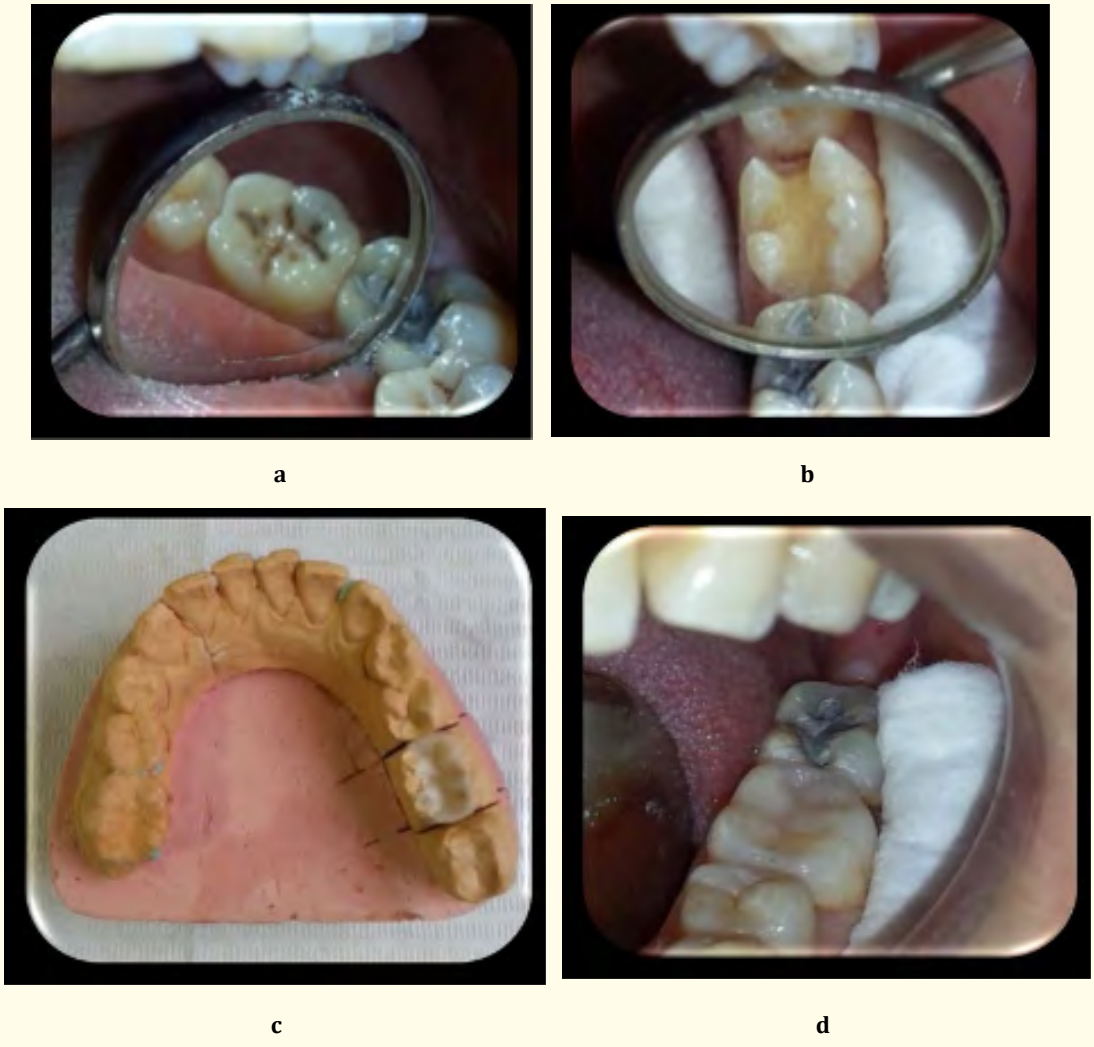

Figure 1: *Steps of cavity preparation and restoration; a: pre-operative tooth, b: cavity preparation, c: Resin composite inlay on die stone and d: Cementation of inlay.*

Results

Results of the clinical evaluation after 12-month follow-up period appeared that all the patients attended and no patient reported negative appreciation for restorative procedures that were performed. The Cohen Kappa statistics (Kappa = 0.90) showed strong examiners agreement, and no statistical difference was observed in their answers ($p > 0.05$). The changes between different resin cements were

analyzed using Friedman test, as shown in table 3. Every evaluation criteria will be discussed within the same material at different periods of follow-up (6 - 12 months). Also, discussed between all the materials at each evaluation period (from baseline to 12-month).

Recall times	Test values	Retention	Marginal discoloration	Secondary caries	Marginal adaptation	Postoperative sensitivity	Interproximal contact
Base line	Chi square	0.000	0.000	0.000	0.000	8.000	0.000
	p value	1.000	1.000	1.000	1.000	0.018	1.000
6 month	Chi square	0.000	0.000	0.000	0.000	0.000	0.000
	p value	1.000	1.000	1.000	1.000	1.000	1.000
12 month	Chi square	0.000	4.67	0.000	4	0.000	0.000
	p value	1.000	0.097	1.000	0.135	1.000	1.000

Retention

All the restorations were retained after 12-month recall visits, so there was no significant difference ($p > 0.05$) between different evaluation periods within each resin cement. Also, results revealed that no significant difference ($p > 0.05$) between the three resin cements at each recall visit.

Marginal Discoloration

Within each resin cement, there was no significant difference ($p > 0.05$) between different evaluation periods in case of Variolink N. But, both SE (Panavia F2.0) and SA (RelyX Unicem) resin cements results showed minor significant difference ($p < 0.05$) between 6 and 12 month. In case of the comparison between materials, it was noticed that, there was no significant difference ($p > 0.05$) between them at baseline, 6 and12-month.

Recurrent Caries

There was no recurrent caries manifested after 12-month for all the restorations in all recall visits of evaluation. So, there was no significant difference ($p > 0.05$) between evaluation periods within each material. Moreover, no significant difference ($p > 0.05$) between all resin cements at every follow-up period.

Marginal Adaptation

Some cases with score Bravo and Charlie were found after 12-month follow-up within both SE Panavia F2.0 and SA RelyX Unicem resin cements only. Hence, there was significant difference ($p < 0.05$) between different evaluation periods within each of them. But, there was no significant difference ($p > 0.05$) between evaluation periods in case of Variolink N resin cement. Moreover, results revealed that, no significant difference ($p > 0.05$) between all materials at each evaluation period.

Post-operative Sensitivity

Only four restorations exhibited post-operative sensitivity with Variolink N resin cement, but were relieved after a short time. So, there was significant difference ($p < 0.05$) between different evaluation periods in case of Variolink N resin cement only. While, there was no significant difference ($p > 0.05$) between evaluation periods within Panavia F2.0 or SA RelyX Unicem resin cements. Results showed significant difference ($p < 0.05$) between all materials at baseline only, but there was no significant difference ($p > 0.05$) between them at 6 and 12 month.

Discussion

In the current study, the effect of different luting resin cement strategies on the quality of resin composite inlays was evaluated after 6 and 12 month. The clinical trial was randomized and the examiners were blinded for the resin cement used.

Many *in-vitro* tests have been studied, that were designed to evaluate the durability and performance of resin composite restorations as in clinical applications [33,34]. Unfortunately, it seems impossible to adequately simulate the intraoral environment or the patient's habits with current test designs and laboratory conditions. For these reasons, clinical studies have great importance and need objective, reliable, and relevant criteria in order to evaluate the performance of restorations. The USPHS evaluation system is the most widely-used direct method for assessment of restorations. Resin composite inlays have been followed in several short-term and long-term clinical studies [35-38].

This study revealed that, the three resin cement strategies had no significant effect on the quality of MOD resin composite inlays at least after 12-month compared to baseline results, so we can say that the null hypothesis of the study is accepted.

Retention

Based on ADA guidelines, retention rates at 6-months and 12-month must be at least 95% and 90% respectively to be accepted [39]. All the three types of resin cements in this study fulfilled these guidelines. This may be attributed to meticulous technique following the manufacturer's instructions. Moreover, the presence of functional monomer in the composition of SE Panavia F2.0 resin cement strategy such as 10-MDP (methacryloxy decyl-dihydrogen phosphate), that contains phosphate groups in its molecular structure. Thus, effectively chemically interact with hydroxyapatites present in dentin substrate, this may result in superior and hydrolytically stable bonding effectiveness [40].

In case of SA resin cement strategy, some studies reported high bond strength values to dentin with RelyX Unicem in spite of the fact that it is SA resin cement and interacts superficially with dentin. It interacts well with calcium in hydroxyapatite, improving their mechanical properties. Moreover, it has low shrinkage due to its viscoelasticity, leading to intimate contact with dentin and sealing performance [4,25,41-43]. Concerning with etch and rinse Variolink N resin cement strategy, results showed good retention and marginal seal for restorations, in spite of acid-etching of dentin substrate, and leading to have lower bond strength with dentin. But, it can be attributed to good bonding and seal with enamel margins of the cavity, due to etching and creating micropores in enamel [44].

Marginal Discoloration

Both SE Panavia F2.0 and SA RelyX Unicem resin cements in the present study showed significant difference in marginal discoloration around the enamel margins from baseline to 12-month. This may be due to the reduced bonding to enamel substrate and reduced sealing ability compared to etch and rinse approach. This was in agreement with previous studies which explained the presence of the marginal staining by a poor ability of SE and SA resin cements to etch the enamel surface [27]. Although, there was significant difference but, it was minor to affect the other evaluation criteria.

Recurrent Caries

Previous microbiological studies showed that salivary pellicles cover the restorative material immediately after placement of restorations [45] The dental biofilms generally attach the surface irregularities, especially micro-gaps at restoration/tooth structure interface. In case of bad oral hygiene condition, this pellicle would be invaded by cariogenic micro-organisms in order to form pathogenic biofilms that may lead to demineralization of tooth surface [46]. However, in the present study all the restorations behaved well in this regard. This may be because of good seal at tooth/restoration interface in all used strategies. Furthermore, the role of oral hygiene instructions that have been given to the patients during the treatment could not be neglected.

Marginal Adaptation

There are many factors affecting the marginal adaptation involving: tooth/restoration bonding, polymerization shrinkage and stresses, hygroscopic properties, coefficient of thermal expansion of the restorative material and the finishing methods. Bonding of resin cements to dentin is mainly based on micro-mechanical retention in case of etch and rinse strategy, and additional chemical retention in case of SE and SA resin cements. This may explain the significant deterioration of marginal adaptation from baseline to 12-month for both SE Panavia F2.0 and SA RelyX Unicem resin cements, which do not etch enamel margins to the same depth as phosphoric acid in case of etch and rinse Variolink N resin cement. The conventional resin luting cement Variolink N depends on prior conditioning of tooth substrate with phosphoric acid, priming then adhesive agent and finally resin cement application resulting in achieving good bond with enamel. The efficiency of this system is dependent on its ability to penetrate the demineralized dentin forming an interdiffusion zone with the exposed collagen fibrils known as hybrid layer, which responsible for both retention and marginal seal [19,20].

SE adhesives combine the etching and priming processes into a single step, eliminate the separate acid etching and rinsing by containing acidic monomers that are responsible for superficial demineralization. This bonding mechanism is based upon the simultaneous etching and priming of enamel and smear layer that cover dentin surface with acidic primer, followed by the application of adhesive resin, where the acidic monomers are copolymerized with the adhesive monomers after surface conditioning resulting in good bond with dentin [21-24]. SA resin cements reduce the steps as well as time consumed during bonding procedures. Because they require neither tooth conditioning nor surface treatment of restorations [25]. These cements differ from conventional etch and rinse or SE resin cements by their interaction with dentin, which is only superficial because of limited decalcification, low diffusion, and partial exposure of collagen fibrils at the base of the adhesive interface [18]. Although, there was significant difference in case of SE and SA resin cements from baseline to 12-month but, it was minor to affect the other evaluation criteria.

Post-operative Sensitivity

Post-operative sensitivity has been attributed to many factors including; operative procedures trauma, dentin etching, desiccation, lack of perfect bonding to entire pulpal floor leaves a gap due to polymerization stresses which fills with pulpal fluids, leakage and bacterial penetration to the pulp. Occlusion of the exposed dentinal tubules by a dental adhesive should eliminate possible thermal and mechanical oral stimuli [47,48]. Usually many cases of post-operative sensitivity resolve in several weeks after restoration placement [49,50]. The absence of post-operative sensitivity at 12-month in this study was related to using sharp cutting bur under adequate water irrigation, careful drying of the cavity. In addition, the restorations made in this study were in medium deep cavities showed significantly lower post-operative sensitivity than those made in deep cavities. It is interesting that the incidence of post-operative sensitivity in clinical trials is typically very low [51].

In case of etch and rinse (Variolink N) resin cement some cases showed post-operative sensitivity. This can be attributed to the effect of etching, removal of smear layer, exposure of dentinal tubules, dentinal fluid movement and liability of uncured monomers penetration to the pulp. But, absence of dentin etching with phosphoric acid or rinsing in case of SE Panavia F 2.0 and SA RelyX Unicem resin cements during the luting procedure, providing a good dentinal seal due to the superficial chemical interaction of both of them with dental tissues and maintenance of smear layer as a protective layer, avoiding long resin tags so no uncured monomers could get in contact with the pulp. In addition, SA RelyX Unicem resin cement revealed low solubility and self-neutralization mechanism during setting reaction [26].

It is difficult to compare the results of one clinical trial to another, because the trials can significantly differ from the examiners themselves, the methodology, restoration procedure and clinical evaluation. The Long-term clinical use of resin composite inlays as restorative materials in the posterior region has been studied through different trials. Some trials showed success rate for resin composite inlays as a 90% after 2-years [52], 94% for inlays evaluated after 1-year from placement, and 90% after 2-years [53,54]. Other studies showed clini-

cally acceptable in 100% of cases after 18-month [55], in 95% after 4 - 6 years [56], and around 80% after 10-years [57]. While long-term research investigating such restorations at 5 - 11 years after placement showed a low rate of restoration failure [16,58].

The present study agreed with Azevedo., *et a*l. clinical trial where, little or no visible changes in the marginal quality after 1-year, even though a probe could detect all the restorations margins. No restorations failed and no secondary caries manifested for indirect composite resin restorations luted with RelyX Unicem after 1-year of follow-up [28]. Also, it was in agreement with Barabanti., *et al*. where, no restorations required replacement during or after 10-years of clinical evaluation [17]. In addition, Jongsma., *et al*. showed success and survival rates after 3-years of clinical evaluations of inlay restorations similar to the present trial [29]. But, Huth., *et al*. clinical trial disagreed with this study where, inlay restorations recorded failure after 4-years follow up, mainly because of bulk fracture, post-operative sensitivity, marginal discoloration and loss of marginal integrity [15].

Conclusion

Based on the results of the current study, and despite of the limitation of small sample size, it seems reasonable to conclude that: All the three resin cements tested, exhibited acceptable clinical performance over an evaluation periods of 12-month.

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