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Two Years Clinical Evaluation of Sonic-Resin Placement System with Self-Etch and Total-Etch Adhesive Modes

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ABSTRACT

Introduction*: Incrementally placed composite resins are preferred due to several advantages such as lower polymerization shrinkage, stresses, and cavity configuration factor. However, in recent years, bulk-fill composites are started to be used as resin-based, tooth-colored restorative materials that incorporate increased polymerization depth and also decreased polymerization shrinkage stresses.*

Aim: *The objective of this split-mouth controlled study is to compare two-years clinical performance of two restorative techniques and materials with self-etched and total-etched adhesive modes.*

Materials and Methods: *Sixty child-patients, aged between seven-16 received two Class I cavities on a total of 120 first and second permanent molar teeth performed with one of two systems: incrementally placed conventional posterior composite resin and sonic-resin placement system with either self-etch or total-etch adhesive systems. According to the United States Public Health Service modified criteria, two blind observers evaluated restorations at sixth, ninth months, one and two years recalls. Kruskal-Wallis test and Mann-Whitney U-test were used to compare the clinical performance of the restorative systems.*

Results: *Although there was no statistically significant difference amongst all the groups at the end of two-years, the best results were obtained for self-etched sonic-resin placement system in terms of marginal continuity ($p<0.05$).*

Conclusions: *Sonic-resin placement system demonstrated high clinical success with both adhesive systems similar with conventional composite resin. So, considering advantages of providing practice facilities up to five mm single-layer; adjustability of the viscosity; short chair-time; self-etched sonic resin placement system seems to be a good alternative for posterior class I composite restorations.*

Key words: Adhesive, Bulk-fill, Composite, Self-etch, Total-etch.

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INTRODUCTION

Composite resins have been increasingly used as the restoration of choice in both posterior and anterior teeth for a long time, due to the reasons of improved esthetics, and ability to prepare a cavity more conservatively as resins bond and support adjacent tooth structure [1]. However, to minimize side effects such as prolonged post-operative sensitivity, marginal degradation and tenderness under occlusal forces, it has been recommended that composite resins should be placed in increments of no more than two mm to allow for limited cure depth [2]. Although incrementally technique has several advantages; better light penetration and polymerization of the composite resin; reduction of the cavity configuration factor, cuspal deflection, polymerization shrinkage stresses; and ensures that the resin adheres better to cavity walls. In this context, to overcome many of the downsides associated with incrementally placed composites, new "bulk-fill" composites have emerged that are marketed [3,4].

Bulk-fill composites are resin-based, tooth-colored restorative materials that incorporate increased polymerization depth, decreased

polymerization shrinkage stresses, and cuspal deflection rates associated with incremental techniques [5]. They can be inserted into prepared cavities in layers that are up to four- or five-mm thickness. According to some researchers, bulk-fill composites offer several advantages for restoring preparations. These include simplifying the restorative process and saving time [6]. Today, by the help of self-etch adhesive modes and bulk-fill technology composite resin restorative procedure steps can be minimized and this is one of the primary goals of today's dentistry.

A sonic-resin placement system with another name sonic-activated bulk-fill system (Sonicfill, Kerr Corp, USA/KaVo, Germany) comprised of a specially designed hand piece and composite material in unidose tips was introduced to the market for posterior bulk restorations. According to the manufacturer's data, the composite is a combination of flowable and universal composites and incorporates a highly filled proprietary resin with special modifiers that react to sonic energy. As sonic energy is applied to the hand piece with five different levels of flowability, and when the sonic energy is stopped, the composite [7] returns to a more viscous, non-slumping state for carving and contouring [6-8]. In addition, it is emphasized that increased levels of photo initiators in the composite material allow a full five mm depth of cure in 20 seconds with a 550 mW/cm2 light source. Generally, on curing, posterior composite resins have been shown to shrink up to 3% whereas sonic-resin placement system shrinks up to 1.6% [8]. Although the Sonicfill system seems to present some advantages for dentists, few clinical studies [1,8,9] has been published which evaluated the clinical performances of low shrinkage composites, especially in children. In fact, chair-time is particularly critical for children, clinical success of emerging technologies for especially child-patients should be investigated. In this context, the aim of this controlled trial was to compare the clinical performance of sonic-resin placement system and incrementally placed conventional resin with self-etch and total-etch adhesive modes for posterior permanent carious teeth in children.

MATERIALS AND METHODS

All children and their parents signed a written informed consent of each, before participating in the study. Children of families who signed the informed consent document with the ethics committee letter and accepted to participate with his/her own willing were included in the study.

Inclusion criteria and restorative procedures

The inclusion criteria were a patient presenting with: (a) A need for at least two posterior tooth-colored restorations; (b) The presence of teeth to be restored in occlusion; (c) Teeth that were symptomless and vital; (d) A normal periodontal status; (e) Radiographically four-five mm depth sized cavities with no more than two thirds of the intercuspal distance and the gingival margin of the cavities above the cement enamel junction; and (f) A good likelihood of recall availability. The exclusion criteria were as follows: (a) Xerostomia and bruxism; (b) Absence of adjacent and antagonist teeth; (c) Extremely poor oral hygiene, severe or chronic periodontitis; (d) Adverse medical history; (e) Potential behavioral problems. Sixty patients aged seven-16 who met the inclusion criteria required two class I-occlusal cavities with split mouth technique (Table 1).

For each tooth, a periapical digital radiograph was taken prior to the administration of the treatment to select the teeth can be created cavities with four- or five-mm depth. All restorations were performed by the same experienced operator (more than 10 years) and placed under local anesthesia (four percent Articaine with 1:100.000 epinephrine, Ultracaine® D-S Forte ampule, Sanofi-Aventis, Germany). The class I

Table 1: Number of evaluated restorations according to the groups of this study

Groups	Restorative Materials	Number of restorations	Teeth	
		(Class I)	1st Molar	2nd Molar
Group 1	Self-etched SonicFill System (Optibond All in One/Kerr/Kavo, Germany)	30	18	12
Group 2	Self-etched Herculite Ultra (Kerr, USA)	30	16	14
Group 3	Total-etched SonicFill System (Optibond FL Kerr/Kavo, Germany)	30	18	12
Group 4	Total-etched Herculite Ultra (Kerr, USA)	30	15	15
All Groups		120	67	53

preparation was performed using diamond burs of the appropriate size at high speed with water cooling. The depthness of the cavities as five mm was standardized using sonicfill handpiece. Each patient received two restorations that were as similar in size and location as possible.

For 30 patients' each tooth, without using any kind of base material, was restored with either A2 shade sonic-resin placement system (SonicFill, Kerr/Kavo, Germany) (n=30) as Group 1 or incrementally placed A2 shade conventional composite resin (Herculite Ultra, Kerr, USA) (n=30) as Group 2 with self-etch adhesive system (OptiBond All In One, Kerr/Kavo, Germany). In the other 30 patients, the total-etch (Opti-Bond FL, Kerr/Kavo, Germany) adhesive system was used for the same procedures according to the manufacturers' directions by the same operator with either A2 shade sonic-resin placement system (SonicFill, Kerr/Kavo, Germany) (n=30) as Group 3 or incrementally placed A2 shade conventional composite resin as Group 4 (n=30). After establishing appropriate occlusal morphology and contact by the help of articulating paper (Bausch, Nashua, NH, USA), finishing burs and polishing brushes impregnated with silicone dioxide were used to obtain smooth surfaces (Optishine, Kerr/Kavo, Germany) at the same appointment. The materials used in the study are listed in full in Table 2. All light-curing procedures were performed with the same LED-curing unit (Elipar S10, 3M ESPE, Seefeld, Germany) operating in a continuous mode while emitting a light-intensity of 1200 mW/ cm2.

Clinical Evaluation Method

All restorations were clinically evaluated by two separate investigators who were calibrated to 100% agreement on an additional 10 patients who were not included in this study prior to the investigation and unaware of the materials used in this study at six, nine months, one and two years. The radiographic evaluation was performed at baseline and at the end of one- and two-years follow-up. The inter-examiner kappa index was 0.78. The modified United States Public Health Service (USPHS) criteria for retention, color matching, marginal discoloration, marginal adaptation, secondary caries, surface texture, anatomic form, and postoperative sensitivity were used [10].

Statistical analysis

Data were analyzed using statistical computer software (SPSS version 16; SPSS, Chicago, IL, USA). The Kruskal–Wallis and Mann-Whitney U-tests were used as non-parametric tests to compare the differences between the results taken at six, nine months', one- and two-years' post treatment. In addition, Friedman test was also used to evaluate the changes of intragroup results between baseline and two-years. The confidence level was set to 95% ($p<0.05$).

RESULTS

A total of 120 teeth (67 first molar, 53 second molar) of 60 patients were recruited to the study with split mouth technique. A total of 60 Class I cavities were restored with sonic-resin placement system with either self-etched or total-etched bulk-fill technique; whereas 60 of class I cavities were restored with incrementally placed conventional posterior composite resin with either self-etched or total-etched. At the

Table 2: Composition, application steps, batch number and manufacturer of each materials used in the study

Adhesives	Compositions	Instructions for use	Type
Opti-Bond All-In-One (Kerr/Kavo, Germany)	Acetone, ethyl alcohol, TEGDMA, mineral fillers, ytterbium fluoride, photoinitiators, accelerators, stabilizers, water	Shake the bottle for 10 s, apply the adhesive and rub for 20 s, repeat the procedure, air-dry lightly for 5 s, and light cure for 10 s	Single Component Self-Etch
OptiBond FL (Kerr/Kavo, Germany)	Etchant: 37.5% phosphoric acid Primer: HEMA, ethanol, water (3093079); adhesive: TEGDMA, UDMA, Bis-GMA, HEMA, 48% barium glass filler	Etch with 37.5% phosphoric acid for 15 s, rinse for 15 s and dry for 5 s, apply primer with light brushing motion for 15 s, air-dry for 5 s, apply adhesive with light brushing motion for 15 s, air-dry for 3 s, and light cure for 20 s	Three Step Total-etch
Resin Composites			
SonicFill System (Kerr/Kavo, Germany)	Barium glass, silicon dioxide (83.5% weight) TMSPMA, EBPADMA, TEGDMA, bisfenol-Abis- (2- hydroxy-methacryloxypropyl) ether	5-mm layers using the SonicFill hand piece Light cured 20 s.	BulkFill, sonic-resin replacement system
Herculite Ultra (Kerr, USA)	Bis-GMA, TEGDMA, Al-B-Si glass, SiO (59% weight)	2 mm layers, Light cured 20 s.	Incrementally placed Nanohybrid composite resin

end of the two years follow-up, participation was still 100%. The results after all evaluations are shown in Table 3 and Table 4.

In the six months evaluation shown in Table 3, the evaluation criteria (surface roughness, marginal continuity, marginal coloring, gingival adaptation, postoperative sensitivity, color matching, retention, and secondary caries variable) in all groups were scored as A ($p>0.05$). In the ninth month, while no change was observed in the other groups for marginal continuity compare to the 6th month results, one B score was given to one tooth in Group 2 (Table 3). In addition, one tooth in Group 3 was given B score according to the retention criteria ($p>0.05$).

At the end of the one year shown in Table 4, the change in the score in Group 2 was maintained according to the marginal continuity criterion, while one tooth in Group 4 was given B score. On the other hand, the surface roughness criteria in Group 2, marginal color criteria in Group 1 and 4, and the postoperative sensitivity criteria in Group 1, one tooth had a score change and these teeth were given B score ($p>0.05$).

At the end of the two years, 30 patients for each group underwent final control shown in Table 4. When the results obtained from the groups were examined, the score of the tooth who was scored as B in the one year in the marginal color criterion in Group 1 was not changed, while the

Table 3: Results of the evaluation of restorations for each experimental group according to the each USPHS criteria at 6th and 9th months recall

		6 Months				9 Months			
		Group 1 (Self Sonic)	Group 2 (Self Herculite)	Group 3 (Total Sonic)	Group 4 (Total Herculite)	Group 1 (Self Sonic)	Group 2 (Self Herculite)	Group 3 (Total Sonic)	Group 4 (Total Herculite)
Surface Roughness	A	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)
	B	0	0	0	0	0	0	0	0
Marginal Continuity	A	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	29 (96,67%)	30 (100%)	30 (100%)
	B	0	0	0	0	0	1 (3,33%)	0	0
Marginal Discoloration	A	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)
	B	0	0	0	0	0	0	0	0
Gingival Adaptation	A	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)
	B	0	0	0	0	0	0	0	0
Postoperative Sensitivity	A	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)
	B	0	0	0	0	0	0	0	0
Color Match	A	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)
	B	0	0	0	0	0	0	0	0
Retantion	A	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	29 (96,67%)	30 (100%)
	B	0	0	0	0	0	0	1 (3,33%)	0
Secondary Caries	A	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)
	B	0	0	0	0	0	0	0	0

Table 4: Results of the evaluation of restorations for each experimental group according to the each USPHS criteria at 1st and 2nd years recall

		1st year				2nd years			
		Group 1 (Self Sonic)	Group 2 (Self Herculite)	Group 3 (Total Sonic)	Group 4 (Total Herculite)	Group 1 (Self Sonic)	Group 2 (Self Herculite)	Group 3 (Total Sonic)	Group 4 (Total Herculite)
Surface Roughness	A	30 (100%)	29 (96,67%)	30 (100%)	30 (100%)	29(96,67%)	28 (93,33%)	30 (100%)	30 (100%)
	B	0	1 (3,33%)	0	0	1 (3,33%)	2 (6,67%)	0	0
Marginal Continuity	A	30 (100%)	29 (96,67%)	30 (100%)	29 (96,67%)	30 (100%)	29 (96,67%)	29 (96,67%)	29 (96,67%)
	B	0	1 (3,33%)	0	1 (3,33%)	0	1 (3,33%)	1 (3,33%)	1 (3,33%)
Marginal Discoloration	A	29(96,67%)	30 (100%)	30 (100%)	29 (96,67%)	29(96,67%)	29 (96,67%)	30 (100%)	29(96,67%)
	B	1 (3,33%)	0	0	1 (3,33%)	1 (3,33%)	1 (3,33%)	0	1 (3,33%)
Gingival Adaptation	A	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (x100%)
	B	0	0	0	0	0	0	0	0
Postoperative Sensitivity	A	29(96,67%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)
	B	1 (%3,33)	0	0	0	0	0	0	0
Color Match	A	30 (100%)	30 (100%)	30 (100%)	30 (100%)	29(96,67%)	28 (93,33%)	29(96,67%)	29(96,67%)
	B	0	0	0	0	1 (3,33%)	2 (6,67%)	1 (3,33%)	1 (3,33%)
Retantion	A	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)
	B	0	0	0	0	0	0	0	0
Secondary Caries	A	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	29(96,67%)
	B	0	0	0	0	0	0	0	1 (3,33%)

B score was given to one patient in the surface roughness and color matching criteria. One of the remarkable aspects of this control is the change in color matching criteria in all groups. In this criterion, observation in one tooth in Group 1 was given as B score for two teeth in Group 2 and one in Group 3 and 4. In Group 2, the change in the marginal continuity criterion at one year was maintained, while the B score observed in a marginal color patient increased to B in two teeth. In the marginal continuity criterion, the B score observed in Group 4 at one year was maintained, but in Group 3, one tooth received B score. In Group 4, although the B score change in the marginal color criterion at one year persisted at two years, B score was observed in one tooth for secondary caries ($p>0.05$).

As a result, at the end of two years, color match was impaired in all groups and the best result was obtained in Group 1 in terms of marginal continuity (Table 4). However, the differences between the groups in terms of surface roughness, marginal continuity, marginal coloring, postoperative sensitivity, and color matching were not statistically significant at six, nine months, one and two years ($p>0.05$).

DISCUSSION

Dental caries continues to be considered as a public health problem and direct composite restorations are the first choice for posterior permanent teeth amongst all the restorative materials by dentists in recent decades [11,12]. Despite increasing use of the resin-based materials in the posterior region, several problems, mainly related to the reasons for failure, technique sensitivity, long chair-time still have not been solved.

In addition, sensitive technique and numerous steps required for proper placement of conventional composite resins, it is believed that the idea of filling all a tooth cavity with a composite at one time will provide obvious advantages for both practitioners and patients. In this regard, sonic-resin placement system which is a combination of flowable and universal composites and incorporates a highly-filled proprietary resin with special modifiers that react to sonic energy allows a full four or five mm depth of cure in 20 seconds [13]. Many studies [5,14,15] on the mechanical and physical properties of sonic-resin placement system have indicated similar or/and better success with/than conventional incrementally placed composite resins. On the other hand, there are many questions in the minds of dentists about bulk-fill technology so the clinical success will only be discovered after long periods of use by practitioners [6].

Today one of the most critical factors for success of the dental restorations is chair-time, especially for children. Self-etching adhesives are based on infiltration and modification of the smear layer by acidic monomers or by dissolving the smear layer and demineralizing the underlying outer layer of dentin. The bond strength and clinical performance of one-step self-etching adhesives thought to shorten technical precision and chair time have been questioned in the literature for many years, and recently, good clinical durability has been reported for several new products [5,16,17]. In this context, sonic-resin placement system and self-etch adhesives seem to shorten the chair-time by eliminating the increments and reduce the technical sensitivity. Therefore, the aim of the study was to evaluate the clinical success of the sonic-resin placement system with self-etch and total-etch adhesive modes in posterior Class I cavities of children.

The modified USPHS criteria, a long-established method used in the present study for the purpose of evaluating the restorations. This method remains the most used system for evaluating the important characteristics of dental restorations, such as color match, secondary caries, marginal discoloration, and postoperative sensitivity, and is widely regarded as representing a reliable means of generating data that is of significance [1,10,18]. For two years, all the included restorations were evaluated, classified as acceptable, and received either an Alfa or Bravo score for all the parameters analyzed. Considering the overall results of the study the differences between the groups were not statistically significant at six, nine months, one and two years. When considering all assessments, the variations were observed in a small number of samples that were statistically insignificant.

Regarding the retention rate, there were no significant differences between the groups. Based on the American Dental Association guideline [19], an adhesive material must have a retention

failure rate less than 10% at the 18-months recall, and this recall time is sufficient to show the presence of an acceptable seal in clinical tests. In this study, at the end of the two years, Alfa ratings of 100% for retention rates were observed in all groups like as gingival adaptation and post-operative sensitivity.

In terms of marginal continuity, one Bravo score was observed in the self-etched incrementally placed composite group at nine months, while one Bravo score was observed in the total-etched incrementally placed composite group at one-year recall. At two years, no deterioration was observed only in the self-etched sonic resin placement system in terms of marginal continuity. It was reported that the thermal effect of sonic vibration may promote polymerization by increasing free radicals' mobility directly and indirectly because of decreased viscosity. Another interesting finding is the presence of secondary caries only in incrementally placed composite samples at the end of two years. This finding is thought to be related to the marginal continuity deterioration that started early in the incrementally placed composite groups [20].

Meanwhile, the best result was obtained in total-etched sonic [21] resin placement system in terms of marginal discoloration. It may be considered a clinical sign indicating that a restoration is prone to failure or, at least, that the adhesive interface degrades with time [19]. Clinical trials [20-22] have indicated that self-etch adhesives have higher rates of marginal discoloration than total-etch systems and negatively influence the esthetic appearance of restorations. These findings can be the explanation of changes in marginal discoloration in time for self-etched groups. On the other hand, in the present study the results were statistically similar amongst the groups except the total-etched sonic resin placement system. In accordance with our findings, another study with three years recall, bulk-fill composite resins demonstrated better clinical performance in terms of marginal discoloration [17]. The minimal amount of polymerization shrinkage occurring in the use of the sonic system with total-etched mode may explain the absence of marginal discoloration in this group.

In terms of surface roughness, one or two Bravo scores were only detected in self-etched groups at the end of two years. In the total-etched groups, the presence of fillers and the use of a hydrophobic layer may be two major reasons for higher surface performance compared with the self-etched groups [19,23]. One more explanation for surface roughness may be the degree of conversion that does not occur completely in self-etch adhesives because of the existence of water and more hydrophilic monomers in their contents [24]. Incomplete conversion of the adhesive can affect the conversion of the resin. As a result of this, the increased surface roughness can be observed over time.

On the other hand, color match was achieved by Bravo score in one or two samples in all groups at two years follow up insignificantly. Within the limitation of our research, the shade of the tested materials is fixed, and the surrounding shades were multiple, so this variation does not seem to be realistic [4]. In addition, the tested materials are indicated as posterior fillings for classes I and II restorations, not in anterior teeth and classes III and IV restorations. So, in this study since the restorations were in the posterior region and the patients were not disturbed by their appearance, the replacement due to color mismatch was not considered.

To our knowledge, no published data has compared the clinical performance of sonic resin placement system in different etching modes. The results of the study reveals that the self-etched or total-etched bulk-fill technology exhibit similar clinical success with total-etched incrementally placed conventional composite resin application considered to be the gold standard on the USPHS criteria. In addition, the current philosophy of simplifying the application process, saving time, and eliminating errors that may arise from multiple steps, is promoting the use of self-etched adhesives and bulk-fill resins [25]. The self-etch adhesives are being widely adopted, as they are more user-friendly, have a reduced number of steps and eliminate the need to use phosphoric acid. Similarly, bulk-fill composites are simplifying the restorative process and saving time. Moreover, the sonic resin placement system used in this study is in unidose tips and standardized form, which simplifies transporting the material to the cavity and does not require manual mixing. It is a recommendable approach in posterior composite applications with its clinical success, ease of use and time saving

advantages. Moreover, long term follow-up is needed to make further comparisons.

CONCLUSION

Considering the similar two years' clinical performance with incrementally placed composite resin and the advantages of providing practice facilities up to five mm single-layer; adjustability of the viscosity, the sonic-resin placement system with either self-etched or total-etched mode is simplifying the restorative process and saving time. In this respect, sonic resin placement system seems to be a suitable alternative for posterior class I composite restorations especially for children.

AUTHORSHIP DECLARATION

We confirm that this manuscript has not been published elsewhere and is not under consideration by another journal. All authors have approved the manuscript and agree with submission to Journal of Research in Medical and Dental Science.

DISCLOSURE STATEMENT

The authors deny any conflicts about financial support or relationships that may pose conflict of interest by disclosing any financial arrangements they have with a company whose product figures prominently in the submitted manuscript or with a company making a competing product, or any conflict relating to technology or methodology.

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ETHICAL APPROVAL

The manuscript was cleared by Institutional review board for publication.

PATIENT CONSENT

Consent has been taken.

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