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Clinical Evaluation of Using Etch and Rinse and Self-Etch Adhesive Systems on Primary Molars for One Year

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Abstract. Dentin bonding systems are available as three, two and one-step systems, depending on how these etching, priming and bonding steps have done. The objective of this study is to evaluate the clinical outcomes of composite restorations performed on primary molars using self-etch and etch & rinse adhesive systems over one year. Twenty-eight children ages 7-9 years old; with class II carious lesions on their lower second molars have been enrolled in this study. All molars (56) were restored by composite (Tetric Evo Ceram, Ivoclar Vivadent). Self-etch (AdheSE One F, Ivoclar Vivadent), and etch & rinse (ExciTE, Ivoclar Vivadent) adhesive bonding systems were used. Clinical evaluation has been performed according to Modified United States Public Health Service criteria at baseline, after 3, 6, and 12 months. Results were analyzed using Mann-Whitney U test. There were no significantly statistical differences ($P < 0.05$) in the clinical evaluation at (base line, 3, 6, and 12 months) between two groups. The class II composite restorations have shown to be satisfactory for two kind of dentin bonding systems. It would be useful to use self-etch adhesive bonding systems with children to shorten the processing time.

Keywords: Primary teeth, Self-etching adhesive system, Etch & rinse adhesive system.

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Introduction

Adhesion of restorative material to enamel has become a routine and reliable aspect of modern restorative dentistry, but adhesion to the dentin has proved to be more difficult and less predictable[1,2].

Nowadays, the interaction of adhesives with the dental substrate is based on two different strategies, commonly described as an etch-and-rinse and a self-etch approach. In an attempt to simplify the bonding technique, manufacturers have decreased the number of steps necessary for the accomplishment of the bonding procedure. As a consequence, two-step etch-and-rinse and one-step (self-etch) adhesives were introduced and gained rapid popularity in the dental market due to their claimed user-friendliness and lower technique sensitivity[3]. One-step dentin bonding agents appeared in 2003 as self-etching systems that do not need to be mixed, it was available as one step includes the etching agent, primer and the adhesive all together, thus it is characterized by eliminating the two phases etching by acid and washing[4,5]. However, despite the similarity of the etching model resulting from the use of systems that depend on the method of etching and then washing, and the model of adhesives with self-etching, the results of researches about the resulting bonding strength were dissimilar, and therefore the clinical results too. While Silva de Souza *et al*.[6] confirmed in their study that the bonding strength associated with the use of self-etching dentin adhesives remains weaker, especially when applied to the dentin. The results of other studies[7,8] showed that self-etching adhesives have proven to be having good effectiveness with respect to bonding strength to the dentin and thus clinical outcome.

A demonstrative study for the clinical efficacy of the recent adhesive systems showed that the annual failure rate of the one-step adhesives reached an average of about 6%, which was slightly higher than the one related of two and three steps, which was 5%[9].

An experimental study conducted in Japan to assess the effectiveness of the self-etching dentin bonding with the primary and permanent teeth dentin, the dentin surfaces were prepared and restored. The dentin bonding systems were applied according to the

manufacturer's instructions. The teeth were preserved in distilled water for 24 hrs to prepare for the tensile bond strength test, with a speed of (1 mm/min). The bonding systems used in their study showed a good average of bonding strength with both primary and permanent teeth, but there was a significant statistical difference between them ($P < 0.001$), where the average bonding strength with the dentin of primary teeth was less than that with the dentin of permanent teeth. Nevertheless, the self-etching dentin bonding systems could provide an excellent adaptation with the dentin surfaces as shown by images of the scanning electronic microscope of resin/dentin interface[10]. However, with the successive development of the dentin self-etching bonding systems, different types are available commercially without having adequate studies, particularly with regard to its results and effects on the primary teeth. The clinical studies remain the best proof of the effectiveness of the clinical performance of these systems.

Materials and Methods

Selection of Patient and Teeth

The study included 28 boys and girls, ages of 7-9 years, clinical examination showed class II cavity in their primary lower molars. The model of symmetrical pairs was followed to restore these molars to get 56 primary molars (28 molars for each group) restored using hybrid composite. The results of clinical follow-up of the sample have been recorded during a monitoring period continued (baseline, 3-, 6-, and 12-months). Children were selected randomly from kindergarten to meet the following conditions:

1. The child was in good health and was not suffering from diseases or oral diseases that may prevent restoration work (*e.g.,* cases of severe periodontal infections, or very poor oral care).

2. To be cooperative and the parents agreed to put the child under observation for a year.

Clinical Procedures

The prepared cavities got a rating of (2.2) in terms of location and width according to the classification of Mount 1998. They are class II cavities in terms of location, and the width of the prepared cavity it should not weaken the cusps. The enamel is well supported by the dentin, and there is no possibility for the tooth to collapse due to chewing[11].

The cavities (56 molars) divided into two main groups according to the used bonding system; Table 1 shows the chemical composition of the adhesive systems used in this study.

Table 1. The chemical composition of the adhesive systems used in this study.

Materials	Compositions	
AdheS One F (Ivoclar Vivadent)	Derivate of bis-acrylamide, water, alcohol, bis-metacrylamide hydrogen phosphate, amino acid acrylamide, highly dispersed silicon dioxide, initiators, stabilizers	Self-etching adhesive system, one step
ExciTE (Ivoclar Vivadent)	HEMA, DMA, phosphoric acid acrylate, highly dispersed silicone dioxide, initiators and stabilizers	Etch & rinse adhesive system, two steps
Tetric Evo ceram (Ivoclar Vivadent)	Hybrid composite	

Group 1 used two steps etch and rinse adhesive system ExciTE (Ivoclar Vivadent Inc., Amherst, NY USA) contains filler particles.

Group 2 used one-step self-etching adhesive system AdheSE One F (Ivoclar Vivadent Inc., Amherst, NY USA) contains filler particles. The dentin bonding was applied and then the cavity restores using hybrid composite (Tetric Evo Ceram, (Ivoclar Vivadent Inc., Amherst, NY USA)) as manufacturer's instructions. We anesthetized part of work using a local anesthetic lidocaine 2%. The first and second primary molars were cleaned using a brush loaded with pumice paste, and washing it using water. After that, we installed a rubber dam, then applying a wood wedge between the first and second molar in order to protect the adjacent periodontal gum during

the preparation of the cavity, and at the same time guarantee the teeth separation.

The cavity was prepared using diamond burs under water coolant, and sometimes using small excavators when necessary in some places. Upon finishing the preparation, tooth was washed using water spray, and then dried using nice air stream. Afterwards, we applied a matrix "Auto matrix, Dentsply" with a thinness of (0.0015 mm) using its own carrier, and then re-install the wooden wedge so that it presses the support towards the periodontal gum wall. Subsequently, applied bonding system "ExciTE" in Group 1 according to the manufacturer's instructions as indicated: A nice air stream is directed towards the prepared cavity for 2-3 seconds to remove extra water. 37% phosphoric acid (Total Etch (Ivoclar Vivadent Inc., Amherst, NY USA)) for 15 seconds was applied, then washing the tooth using water stream for 15 seconds and drying it using nice air stream for 2-3 sec. After that, we applied abundant quantity of the bonding material using its own attached brush and left on the prepared surfaces of the teeth for 15 seconds. Next, we directed a light air stream for 5 seconds then light curing for 15 seconds using the LED device Bluephase®, (Ivoclar Vivadent Inc., Amherst, NY USA).

The composite was injected using the special gun of the restoration capsules starting with the hole adjacent to the area of the gingival wall, ending with the buccal surface using layers technique (with not more than 2 mm for each layer) applying composite tools. Wood wedge and rubber dam were removed after light cure the last layer of the composite. Occlusion was examined using articulating paper, and then, finishing restoration using finishing burs of the composite.

In Group 2, we applied bonding system "AdheSE One F" according to the manufacturer's instructions as follows: A nice air stream is directed towards the prepared cavity for 2-3 seconds to remove extra water. Next, the adhesive material has been applied with plenty amount moving nicely over the entire prepared surface for a period of 20 seconds. Surplus has been removed by applying a strong stream of air to get a thin layer non-animated and shiny on the

tooth surface. Then, forwards a mild air flow for five seconds and light curing for 15 seconds using the Bluephase® LED device, (Ivoclar Vivadent Inc., Amherst, NY USA). The composite was applied and finished in the same way of Group (1).

Clinical Evaluation

A modified version of the US Public Health Service (USPHS) criteria[9,12,13] was used to evaluate the color match, secondary caries, anatomical form, marginal discoloration, and marginal adaptation (Table 2). Restorations were assessed at baseline, after three-, six-months, and one year (Figs. 1-4). Baseline was defined as one week

Table 2. Criteria used to evaluate the restorations (USPHS method).

	Alpha (A)	**Bravo (B)**	**Charlie (C)**
Color match	The restoration matches the adjacent tooth structure in color, shade and translucency	There is a light mismatch in color, shade or translucency but within the normal range of adjacent toot structure	There a mismatch in color, shade or translucency outside the normal adjacent tooth structure
Secondary caries	No evidence of caries	Evidence of caries along the margin	
Anatomical form	Continuous restoration with existing anatomic form	Restoration is not in continuity with the existing anatomic form	Sufficient loss of the restoration has occurred to expose dentin. Restoration requires replacement
Marginal discoloration	There is no discoloration anywhere along the margin between the restoration and the tooth structure	There is slight discoloration along the margin between the restoration and the tooth structure but the discoloration had not penetrated along the margin in a pulpal direction	The discoloration has penetrated along the margin in pulp direction
Marginal adaptation	An explorer will not catch on being drawn across the margin, or if it will catch, then only in one direction	Visible evidence of early crevice formation is apparent into which the explorer penetrate	A blunted explorer will catch in a visible crevice between the tooth and restoration

after the polishing procedures were performed. Each clinical evaluation was carried out independently by two clinicians were not involved in the original placement of the restorations. In cases of disagreement, consensus was reached by discussion and re-examination. For each mentioned variables, a degree was stated as mentioned above.

For Alfa degree, the ideal class, the restoration gets in any evaluated aspect. For the Bravo case, there is a defect in the previous aspects, but within the acceptable range. It does not need modifications and can be repaired. For Charlie case, restoration had to be completely changed, as repairs and modifications did not work.

Fig. 1. Second molars at baseline.

Fig. 2. Second molars after 3 months.

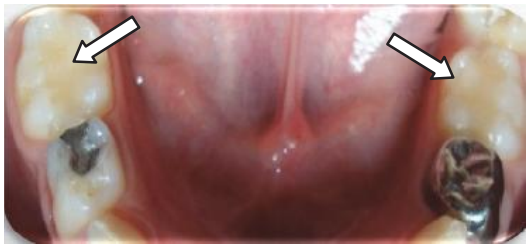


Fig. 3. Second molars after 6 months.

Fig. 4. Second molars after 12 months.

Results

Statistical analysis program SPSS version 13.0 (IBM SPSS, Chicago IL, USA) was used. The results of the parameters evaluated for the two groups at different follow-up times are presented in Tables 3 and 4. All the restorations evaluated at 3 months scored as alpha for color match, secondary caries, anatomical form, marginal adaptation.

After 6 months, 92.9% (n = 26 of adhesive one F restorations) and 96.4% (n = 27 of ExciTE restorations) gained alpha score for marginal discoloration. After 12 months 89.3% (n = 25 of adhesive one F restorations) and 92.9% (n = 26 of ExciTE restorations) received alpha score related to marginal discoloration. Mann-Whitney U Test was performed to study the significance of

Table 3. The results of the parameters evaluated for Adhes One F at different follow-up time.

Parameter	Baseline			3 m			6 m			12 m			Total
	A	B	C	A	B	C	A	B	C	A	B	C	
Color Match	28 100%	-	-	28 100%	-	-	-	-	-	28 100%	-	-	28 100%
Secondary Caries	28 100%	-	-	28 100%	-	-	28 100%	-	-	28 100%	-	-	28 100%
Anatomical Form	28 100%	-	-	28 100%	-	-	28 100%	-	-	28 100%	-	-	28 100%
Marginal Discoloration	28 100%	-	-	28 100%	-	-	26 92.9%	2 7.1%	-	25 89.3%	3 10.7%	-	28 100%
Marginal Adaptation	28	-	-	28	-	-	28	-	-	28	-	-	28 100%

Table 4. The results of the parameters evaluated for ExciTE at different follow-up times.

Parameter	Baseline			3 m			6 m			12 m			Total
	A	B	C	A	B	C	A	B	C	A	B	C	
Color Match	28 100%	-	-	28 100%	-	-	28 100%	-	-	28 100%	-	-	28 100%
Secondary Caries	28 100%	-	-	28 100%	-	-	28 100%	-	-	28 100%	-	-	28 100%
Anatomical Form	28 100%	-	-	28 100%	-	-	28 100%	-	-	28 100%	-	-	28 100%
Marginal Discoloration	28 100%	-	-	28 100%	-	-	27 96.4%	1 3.6%	-	26 92.9%	2 7.1%	-	28 100%
Marginal Adaptation	28 100%	-	-	28 100%	-	-	28 100%	-	-	28 100%	-	-	28 100%

Table 5. Results of the Mann-Whitney U test to study the significance of differences in marginal discoloration between AdheSE One F group and ExciTE group according to the period time studied.

A Variable	Observation Time	U Value	P-Value
Marginal discoloration	baseline	392.0	1.000
	3 months	392.0	1.000
	6 months	378.0	0.556
	12 month	378.0	0.642

differences in the occurrences of marginal discoloration between the group of (AdheSE One F) system and the group of (ExciTE) system according to the time period studied Table 5 and Chart 1. The tables show that the value of the significance level estimated is much larger than the value of 0.05 whatever the time period studied. This means that at 95% confidence level; there is no significant statistical difference in the marginal discoloration between the group of AdheSE One F system and the group of ExciTE system, regardless of the period studied. Friedman test was conducted to know the influence of periods time study on the occurrence of marginal discoloration according to the bonding system used (Graph 1). The test shows that the value of the significance level estimated is much larger than the value of 0.05 whatever bonding system used, *i.e.,* at 95% confidence level there is no significant statistical difference in the marginal discoloration between the two studied groups through the time periods of the study (after one week, three months, six months, after one year).

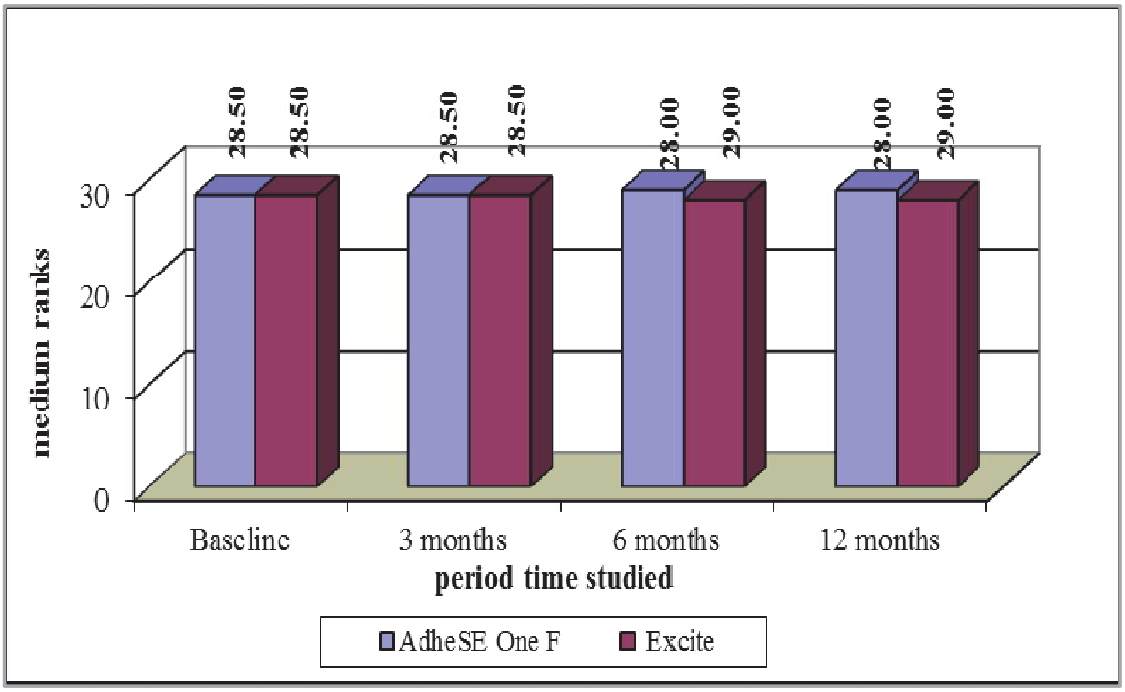
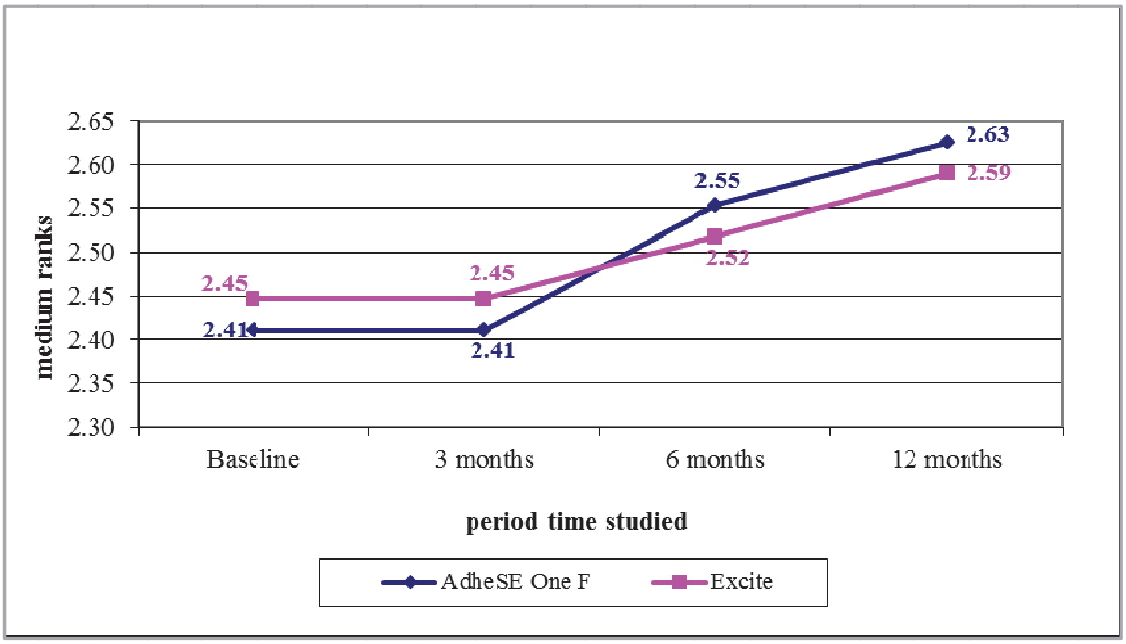


Chart 1. The medium ranks of marginal discoloration between two groups according to the period time studied.



Graph 1. Results of Friedman test to study the significant differences in the marginal discoloration at baseline, 3 months, 6 months and 12 months according to the bonding system.

Discussion

The direct clinical evaluation using the USPHS method, although having low sensitivity and accuracy, has been used to analyze the clinical performance of resin composite restorations[12].

In this study, the direct clinical evaluation using the USPHS method showed evidence of high percentile of clinical success presented by the materials and technique used in primary teeth. At the 3 months evaluation, all the restorations (n = 56) presented score Alpha for all evaluated criteria. This result agrees with other studies that use etch and rinse, and self-etching bonding systems on primary teeth[12,14]. At the 6 months postoperative evaluation, the samples exhibited (92.9% and 96.4%) of Alpha score for marginal discoloration for self-etching and etch & rinse groups', respectively. It is important to note that the marginal discoloration recorded in this study was seen in a very small space, but more was seen at the mesial edges where it was sometimes difficult to do finishing and polishing procedures. Therefore, it is possible to refer to the explanation resulting in marginal discoloration; which could be related to an

accumulation of pigments and not being the result of marginal leakage which is in agreement with the results of other studies[15,16].

The percent of Alpha score reported in other studies[17,18], using different resin composite was lower than that observed in this study. However, it should be taken into consideration that the reported values in the previous studies (70-100%) were based on the parameters analyzed individually using older generation adhesives and composites.

At the 12 months postoperative evaluation, the samples exhibited (89.3% and 92.9%) of Alpha score for marginal discoloration for self-etching and etch and rinse groups', respectively. The statistical results of the study after 12 months showed no statistical significant differences between the two groups regarding the marginal discoloration at 5% level of significance. The results of this study agreed with other studies[19,20], which indicate that the bonding systems containing silica fillers particles show good physical properties through deposition, and infiltrate those fillers within the micro spaces in the hybrid layer. They have abilities to impose in the dentinal tubules so as to participate in the formation of resin tags and that what makes them have better marginal seals. On the other hand, there was a study[21] that did not note any effect of filler particles that are added to the adhesive systems to improve the resulting bonding strength, or improve marginal sealing, when compared to the systems that are not filled.

The results of studies conducted on the primary teeth using different methods (bond strength or dyes), showed contrasting results regarding to the performance of these systems in terms of microleakage and thus, subsequent marginal discoloration. However, any of those studies mentioned in the literature were not able to achieve level (0) of microleakage [22,23].

Probably, in regards to user-friendliness, clinically, the most promising approach is self-etch. It no longer needs an “etch & rinse” phase, which not only lessens clinical application time, but also significantly reduces technique-sensitivity or the risk of making errors during application[24]. Self-etching bonding system with mild acidity

-used in this study- contributes in a partial subsidence of dentin demineralization. This helps the hydroxyl crystals chemically bonded - in turn - with functional monomers, and produces a hybrid layer of good stability, which is composed of a micro-mechanical network with collagen located under it. This mechanism is believed to be responsible for the resistance of the disengagement stress, and good marginal adaptation for the restorations[25]. Kurokawa *et al*.[13] stated in their study that aimed at evaluating the clinical performance during a year for five types of dentin self-etching bonding systems "self-etching adhesives simplified the clinical procedures by eliminating the separate etching stage. Besides that removing of the smear layer is no longer necessary, and therefore, the likelihood of subsequent restoration sensitivity and the associated problems with the infiltration dentin fluid across open dentin tubules has decreased. The materials of this generation also secured the bonding to the dental structures by improving the ability of monomers to penetrate and moisturize the dental structures due to their resin components; however, careful handling of these materials is still required for optimal clinical performance.

Conclusion

Under the conditions of this study, and since there is no significant statistical difference in the clinical evaluation of the composite restorations, we recommend the use of self-etching adhesive systems in the restoration of primary molars, in order to simplify the stages necessary to complete the restoration work for children and shorten the time required for treatment.

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التقييم السريري لاستخدام نظام ربط عاجي تخريش وغسل ونظام ربط عاجي ذاتيّ التخريش على الأرحاء المؤقتة لمدة سنة

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دمشق – الجمهورية العربية السورية

المستخلص. تهدف الدراسة إلى تقييم الأداء السريري الترميمات المركبة، والمنجزة على الأرحاء المؤقتة باستخدام نظام ربط عاجي تخريش وغسل، ونظام ربط عاجي ذاتي التخريش على الأرحاء المؤقتة لمدة ١٢شهر.المنهج البحثي: اشتملت الدراسة على ٢٨ طفلاً وطفلة تراوحت أعمارهم بين(٧–٩) سنوات لديهم نخور صنف ثانٍ على الأرحاء المؤقتة الثانية السفلية. تمَّ ترميم ٥٦ رحى بالهجين المركب (Tetric Evo Ceram, Ivoclar Vivadent) مع استخدام نظام رابط (AdheSE One F, Ivoclar Vivadent) ذاتي التخريش، ونظام رابط (ExciTE, Ivoclar Vivadent) تخريش ثمَّ غسل ثنائي المرحلة. تمَّ تسجيل نتائج التقييم السريري حسب المعايير المعدلة لمنظمة الرعاية الصحية الأمريكية USPHS بعد (أسبوع، ٣ أشهر، ٦ أشهر، سنة). تمَّ إجراء اختبار Mann-

Whitney U للدراسة الإحصائية. النتائج: عند مستوى الثقة ٩٥٪ لم تكن هناك فروق دالة إحصائياً (P <٠،٠٥) في تكرار نتائج التقييم السريري في الترميمات المركبة بعد (أسبوع، ٣ أشهر، ٦ أشهر، ١٢ شهر) بين مجموعتي نظام الربط المستخدمين في عينة البحث سريرياً. الاستنتاجات: سجلت الترميمات المركبة نتائج جيدة سريرياً مع كل من نظامي الربط العاجي، وبالتالي قد يكون من المفيد إستخدام أنظمة إلربط العاجي ذاتية التخريش عند الأطفال لإختصار زمن المعالجة.