

A twelve-month clinical trial comparing the bracket failure rates of light-cured resin-modified glass-ionomer adhesive and acid-etch chemical-cured composite

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A clinical study was undertaken to compare the failure rate over a twelve-month period of orthodontic brackets bonded with a light-cured resin-modified glass-ionomer (Fuji Ortho LC- GC International Japan) and an acid-etch chemically-cured two-paste composite (Orthodontic Concise - 3M USA). Failure rates of 6.1 per cent and 5.4 per cent respectively were reported, with no statistically significant difference between the two adhesives. This finding, along with the relative ease of use and possible advantages of reduced risk of peri-bracket demineralisation, suggests that the resin-modified glass-ionomer adhesive may become more popular as a bracket adhesive.

Key words: Bonding failures,
Resin-modified glass-ionomer adhesive,
Acid-etch Composite adhesive

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Introduction

Since the introduction of the acid-etch composite adhesive technique, the bonding of orthodontic brackets has become routine. Most conventional composite adhesives used in Orthodontics are either chemically cured using a two-paste system or light cured using visible light. Clinically, both types of composite have been demonstrated to have adequate bond strength for orthodontic brackets.^{1,2,3} The bonding to enamel is achieved by mechanically locking on enamel tags generated by the application of the acid-etch.

A common risk of orthodontic treatment is the development of decalcification or white spots lesions around the margins of the bracket.⁴ This is of particular concern for those patients who display poor oral hygiene and/or have a high sugar/acid dietary intake during treatment. Accumulation of plaque around the bracket margins can be associated with undetected composite flash.⁵

Recently, glass-ionomer adhesives have been modified for use as a bonding agent for orthodontic brackets. These adhesives are cured chemically by an acid base reaction that can be supplemented by a polymerisation reaction induced by visible light. Fuji Ortho LC* is a resin-modified glass-ionomer adhesive specifically marketed for the bonding of orthodontic brackets. The main component of the Fuji Ortho LC powder is ground fluoro-alumino-silicate glass while the liquid consists of polyacrylic acid, water, monomer and an activator. The resin component is a mixture of three monomers, two hydroxyethyl methacrylate (HEMA) being the major proportion. The HEMA allows for a rapid setting reaction to occur when the adhesive is exposed to visible light. One advantage of the resin-modified glass-ionomer adhesives is their ability to release fluoride.⁶ It has also been shown that glass-ionomer cements act as a reservoir by taking up fluoride from fluoride

toothpaste or rinses for later release.⁷ Fluoride has known anti-cariogenic properties and aids in remineralisation of enamel.^{8,9,10}

Previous studies have suggested that the resin-modified glass-ionomers have a limited bond strength in comparison with acid-etch composites.^{11,12} It has been suggested in these studies that, because of this limitation, these adhesives should not be used where occlusal interferences are likely.

There are two different techniques recommended for the bonding of brackets using the resin-modified glass-ionomer adhesives. According to Fricker¹¹ previously pumiced enamel should be prepared with a ten-second application of ten per cent polyacrylic acid, followed by thorough washing and drying prior to bonding. Fricker¹³ suggests the conditioning agent reduces the surface tension of the enamel in preparation for the ionic exchange between the polyacrylic acid and displaced phosphate and calcium ions, which allows attachment to the hydroxyapatite within the enamel. He also points out that the resin component is strongly hydrophilic and excess water at the bracket site during bonding will cause an uptake of water into the structure of the cement, leading to greater plasticity and reduced strength. In contrast, Silverman *et al.*¹² suggest that adequate adhesive strength can be obtained with previously pumiced enamel, without the use of any conditioning or etching agents and in a field where moisture control is absent. Fuji Ortho LC is promoted by GC International as a product for which no etching is required and a dry field not necessary.

Purpose of Study

This is a retrospective study to compare the twelve-month bonding failure rate of resin-modified glass-ionomer placed without the use of a conditioning agent and in a moist field with that of an acid-etch composite adhesive. This, the preliminary study is part of an ongoing study that will review a larger sample of cases at the completion of treatment.

Method

Two groups were selected from a private orthodontic practice, each comprising fifty consecutive patients who presented for full upper and lower fixed appliance treatment. Group 1 had all their brackets bonded using acid-etch chemically-cured two-paste composite adhesive (Orthodontic Concise)[†]. Group 2 had all their brackets bonded with a resin-modified glass-ionomer adhesive that was supplementally cured with visible light (Fuji Ortho LC)[‡].

The same bracket type was used in both groups (Optimesh 0.022 slot)[§]. Miniature twin brackets were placed on the upper anteriors, and gingivally-offset twin brackets on the premolars. Both groups were bonded by the same orthodontist, the bracket positioning consistent with Andrews' guidelines¹⁴ for bracket placement using the FACC and FA point land marks.¹⁵ The bracket positioning was carried out regardless of the presence of any occlusal interference at the time of bonding. Cases that exhibited deep bite and crossbite tendencies were included.

Both groups received a thorough cleaning with pumice, and lip retractors were placed prior to bonding. The order of bracket placement was the same in both groups: the lower bonded before the upper and the buccal segments bonded before the anteriors. In Group 1, the teeth were etched at least 60 seconds with 30 per cent phosphoric acid^{||} prior to thorough irrigation and drying. No unfilled or liquid resin was used. The two-paste system was mixed to the manufacture's instruction, and two brackets placed with each fresh mix. Any excessive adhesive was removed before the next bracket was placed. At least five minutes was allowed from the time of the last bracket placement to placement of the initial 0.016 NiTi aligning archwires.

In Group 2, the liquid and paste was dispensed according to the manufacturer's instructions, and mixed on a chilled glass slab. The brackets were placed in a moist field without the prior use of any etching or conditioning agent. All the brackets within each arch were placed with the adhesive from the same mix. A fresh mix was made for the upper arch using the same glass slab. All brackets were light cured for at least 40 seconds and any excess adhesive flash removed following the light curing. Initial 0.016 NiTi aligning archwires were placed at least five minutes after the final light curing.

Clinical notes of both groups were then reviewed and breakages noted; all breakages were recorded, including those attributable to technique error or occlusal trauma. The duration of treatment for each breakage was calculated as the difference between the date the breakage was noted and the date the initial bonding was carried out. The bracket location was recorded for each breakage. Multiple breakages of the same bracket were not recorded as not all bracket failures were repaired, and some repairs were carried out using different adhesives or involved banding.

† M Dental Products, St Paul, Mn, USA

‡ GC International Co., Tokyo, Japan

§ Ormco Corp, Glendora, California

|| Esticid, Kulzer, Germany

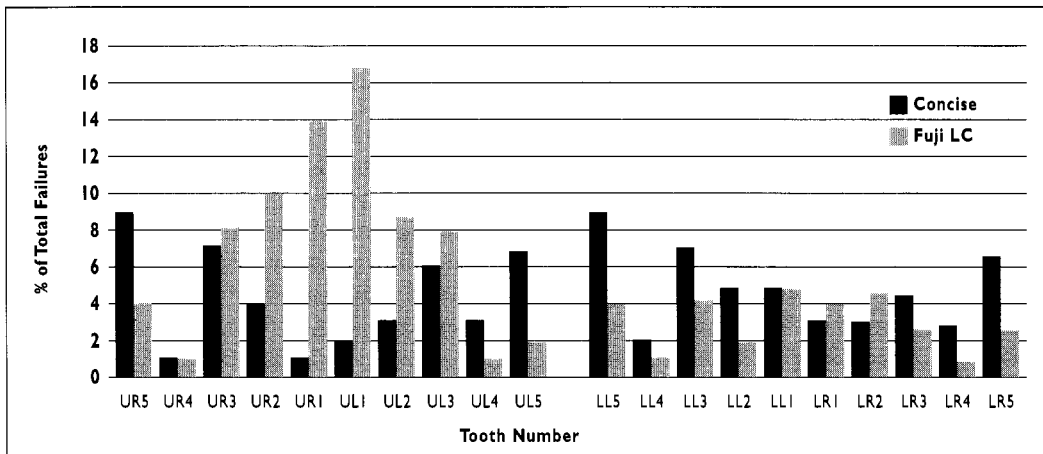


Figure 1. Location of bracket failures.

Results

The failure rate for Group 1 (5.4 per cent) and Group 2 (6.1 per cent) was recorded over the first twelve months of treatment (Table I). A Chi-Square analysis (Table II) showed no statistical significance between the two groups. More breakages were observed in the premolar region in Group 1 than in Group 2, while more breakages were observed in the upper anterior region in Group 2 than in Group 1 (Figure 1).

Table I.

	Group 1 (Orthodontic Concise)	Group 2 (Fuji Ortho LC)
Total No. of Patients	50	50
Total No. of Brackets	1674	1747
Total No. of Breakages	90	107
% of Bracket Failure	5.4	6.1

Table II. Chi-Square Analysis.

	Group 1 (Orthodontic Concise)	Group 2 (Fuji Ortho LC)	Total
Yes	90	107	197
No	1584	1640	3224
Total	1674	1747	3421

Expected frequencies (E)

(E = 0 Row Total x 0 Column Total / 0 Grand Total)

Yes	96.3	100.6
No	1577.6	1646.3

X² = 0.855

df = 1

p < 3.841 (at 0.05)

Therefore no significant difference in failure rates for each adhesive.

Discussion

The failure rate of Orthodontic Concise in this study (5.4 per cent) appears to be similar to that reported by Newman,¹ Greiger *et al.*² and Zachrisson,³ which ranged from four to ten per cent, allowing for the time difference between this study and the time taken to the completion of treatment in the above studies. The failure rate of the Fuji Ortho LC reported in this study (6.1 per cent) initially appears greater than that reported by both Fricker¹¹ and Silverman *et al.*¹² However, the different methodology of this study may explain the apparent increase in failure rate.

Fricker,¹¹ usingOrmco Optimesh brackets in a split-mouth technique involving ten patients, reported failure rates of 3.3 per cent for light-cured Fuji II and 1.6 per cent for an acid-etch composite during the first twelve months of treatment. Fuji II light-cured adhesive is similar to Fuji Ortho LC and shares the same chemical foundation. However, premolar brackets were excluded from Fricker's study, as well as any brackets that exhibited any occlusal interferences at the time of bonding. In another study, which involved ten patients and used chemically-cured Fuji Ortho adhesive over the first twelve months of treatment, Fricker¹⁶ found a five per cent failure rate. These cases also were selected on the basis that there were no occlusal interferences. Bracketed premolar teeth were excluded from the study. In both studies, Fricker used a conditioning agent and thorough drying prior to bracket placement.

Silverman *et al.*,¹² using the Fuji Ortho LC adhesive, reported a failure rate of 3.2 per cent in 150 patients. However, their data included patients who were eight months or less into treatment. Although premolar and molar brackets were included in the study, brackets

were placed on these teeth to avoid any occlusal interference. Any failures that were due to errors in technique or occlusal trauma were not included in the reported failure rate.

Silverman *et al.*¹⁷ also reported a 3.3 per cent failure rate with chemically-cured Fuji Ortho adhesive in a study involving 352 patients, a third of whom were in the mixed dentition. However, their data included cases as little as one month into treatment and, again, failures due to errors in technique or occlusal trauma were excluded. In both studies Silverman *et al.* bonded their brackets without the prior use of conditioning agents and in the absence of any moisture control. Four to five brackets were bonded with the same adhesive mix.

It was interesting to note the increased failure rate for the Fuji Ortho LC on the upper anterior brackets. These teeth were the last to be bonded, suggesting that either the enamel had dried over time while the cheek retractors were in place, or the adhesive was starting to set. Fricker¹⁴ places up to six brackets with the same adhesive mixed on a chilled glass slab to extend the working time. Although a chilled slab was used routinely, the second mix, which was for the upper arch, was carried out on the same slab. This slab would have warmed during the time taken to place the lower brackets and may have lead to a decreased working time of the adhesive.

It appears from the author's study that occlusal interferences at the time of bonding may not necessarily lead to an increased failure rate when using Fuji Ortho LC. As a percentage of total failures, the Orthodontic Concise had more failures in the lower premolar region than Fuji Ortho LC. This may reflect the difficulties with moisture control in this region when using the acid-etch composite technique. The percentage of breakages over time was similar for both adhesives, suggesting that the adhesive strength for both does not appear to diminish with time, which could be expected with continual leaching of fluoride from the resin-modified glass-ionomer adhesives during treatment.

The advantages of using an adhesive that can be applied in a moist field without the need for conditioning the enamel has a major attraction. Jobalia *et al.*,¹⁸ using Fuji Ortho LC on extracted teeth, found that moisture was required for optimal adherence of the glass-ionomer to enamel. They also found that a higher bond strength is obtained with the use of ten per cent polyacrylic acid for twenty seconds prior to bracket placement. Jobalia *et al.* also suggest that the polyacrylic acid in

the freshly mixed adhesive may itself act initially as a conditioning agent on the enamel as the adhesive commences its setting reaction.

The possibility of reducing the risk of decalcification around the bracket margins is also an exciting feature of this adhesive. Easier debonding with less risk of damage to the enamel has been reported by Silverman *et al.*^{12,17} and Fricker.^{13,16} (There is also an advantage for stock inventory if the same adhesive can be used for both bands and brackets.) Fricker¹⁹ recently reported a 2.9 per cent failure rate for band cementation using Fuji Ortho over a twelve-month period. Occasionally, excessive flash associated with the Fuji Ortho LC turns a brownish colour over time in some patients; although this can be easily removed, it does cause the patient some initial concern.

Conclusion

1. This, the preliminary study found that there was no statistically significant difference between the performance of the new resin-modified glass-ionomer cement and that of acid-etch composite in reference to bracket failures during the first twelve months of treatment.
2. Contrary to previous recommendations, it appears that the resin-modified glass-ionomer adhesives can adequately withstand initial occlusal interferences at the time of bonding.
3. The relative ease of use and perceived advantages of the reduced risk of peri-bracket decalcification due to prolonged fluoride release, suggest that the use of this type of cement should become more popular.

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