Vittorio Cacciafesta
Hans Ulrik Paulsen

Direct bonding of cast splint Herbst appliances: a clinical comparison between a resin-reinforced glass ionomer adhesive and a composite resin

Authors' affiliations:
Vittorio Cacciafesta, *Hans Ulrik Paulsen*, Department of Orthodontics, Royal Dental College, Aarhus University, Aarhus, Denmark

Correspondence to:
Dr. Vittorio Cacciafesta
Piazza Dante 3
27100 Pavia
Italy
Tel: +39-0382-27806
Fax: +39-0382-35075
E-mail: vcacciafesta@hotmail.com

Abstract: The purpose of this study was to compare the clinical performance of a resin-modified, self-cured glass ionomer adhesive for bonding cast splint Herbst appliances to that of a conventional composite resin in a split-mouth design. Ten patients (six females and four males) with cast splint Herbst appliances were followed for a mean period of 7 ± 1 months. The performance of 40 cobalt-chromium cast splints was evaluated: 20 cast splints were bonded with GC Fuji Ortho glass ionomer adhesive (GC America Inc., Alsip, IL, USA), and 20 bonded with Excel composite resin (Reliance Orthodontic Products Inc., Itasca, IL, USA). Excel recorded an overall failure rate (20%), which was higher than GC Fuji Ortho (15%), but not significantly different ($p > 0.05$). There were no statistically significant differences ($p > 0.05$) between the failure rates in the upper and lower arches within each material and between the two bonding agents. This study demonstrates that resin-modified, self-cured glass ionomers can be recommended as alternative materials for bonding cast splint Herbst appliances.

Key words: composite resins; direct bonding; Herbst appliance; randomized clinical trial; self-cured resin-modified glass ionomers

Introduction

The Herbst appliance was initially presented as a fixed bite-jumping device for the treatment of Class II malocclusions at the International Dental Congress in Berlin in 1909. Subsequently, in 1934, Herbst (1) presented a series of articles on his experience with the appliance. Following these reports, very little was published on that appliance until 1979, when Pancherz (2) showed the possibility of stimulating mandibular condylar growth by means of the Herbst appliance. After 1979, interest in the Herbst appliance increased and several scientific and clinical articles analyzing the effects of the appliance on the occlusion,

To cite this article:
Prog. Orthod. **2**, 2001; 4–8
Cacciafesta V, Paulsen HU:
Direct bonding of cast splint Herbst appliances: a clinical comparison between a resin-reinforced glass ionomer adhesive and a composite resin

ISSN 1399-7513

dentofacial complex, and masticatory system were published (3–11). In contrast to functional appliances, the Herbst appliance has several advantages: a) it works for 24 h per day; b) no co-operation is required; and c) active treatment time is short (approximately 6–8 months). The Herbst appliance works as an artificial joint between the maxilla and the mandible. A bilateral telescopic mechanism attached to orthodontic bands or, better, to cobalt-chromium cast splints keeps the mandible in a protruded position. The cast splint appliance has several advantages compared to the banded appliance: a) it reduces chair time; b) it is more hygienic; c) it has a precise fit on the teeth; d) it is stronger, which avoids certain clinical problems such as broken bands. Such an appliance has to withstand very high muscular forces, and at times, forces produced by quad helix appliances and lower lingual arches for 6–8 months. The type of adhesive used to bond this appliance, therefore, is of paramount importance.

Composite resins have been commonly used in orthodontics, but unfortunately their use has often been associated with surface enamel loss due to etching, bonding, debonding and rebonding procedures (12), and decalcification (13, 14). Conventional composite resins require a completely dry field of operation throughout the bonding procedure. Teeth to be bonded must be etched for 15–60 s (15) in order to produce a rough surface suitable for resin infiltration, and subsequently a primer be placed on the etched enamel surface. These steps increase chair time significantly (16). Glass ionomer materials have become popular and accepted by the dental practitioners; they are being used as cavity liners, luting agents, sealants, and restorative materials. Only lately have glass ionomer agents been available for bonding orthodontic brackets. Recently developed resin-modified glass ionomers seem to be a valuable alternative to composite resins. They possess desirable traits such as constant fluoride release upon contact with mouth liquids (17), thus assisting fluoride storage when it is absorbed from fluoride toothpastes and rinses (18). Additionally, they inhibit bacterial metabolism and acid production (19). Another important characteristic is the chemical bond both to enamel and dentine (20), without the need for surface conditioning. They provide clinically acceptable bond strengths if the bonding is performed onto wet enamel surfaces, as reported by *in vitro* and *in vivo* studies (21–25).

To date, there are no reports of randomized clinical trials comparing the efficacy of a glass ionomer adhesive as a bonding agent of Herbst appliances to that of a composite resin. Accordingly, the aim of this study was to compare the clinical performance of a resin-modified, self-cured glass ionomer for bonding cast splint Herbst appliances to that of a standard composite resin.

Materials and methods

Sample

From the Department of Orthodontics, Royal Dental College, Aarhus University, 10 consecutive patients (six females and four males) with a Class II malocclusion were selected and treated with a cast splint Herbst appliance. A selection criterion was the absence of occlusal interferences on any of the bonded cast splints in an effort to eliminate the influence of trauma on failure rate. Enamel surfaces with caries, fillings, or hypoplasia were also excluded from the study. In the split-mouth design employed for this study, the mouth was divided into quadrants, each consisting of three teeth (first and second premolars and first molars). In five patients, the maxillary left and mandibular right quadrants were bonded with the glass ionomer adhesive and the remaining quadrants using the control composite resin (Table 1a). In the other five patients the quadrants were inverted (Table 1b). Thus, the performance of 40 cobalt-chromium cast splints was evaluated: 20 cast splints were bonded with GC Fuji Ortho glass ionomer (GC America Inc., Alsip, IL, USA), and 20 bonded with Excel composite resin (Reliance Orthodontic Products Inc., Itasca, IL, USA). The split-mouth design was randomly alternated from patient to patient in order to eliminate any bias that may have been introduced from the clinician being right-handed.

Adhesives

The self-cured, resin-reinforced glass ionomer adhesive tested in this study was GC Fuji Ortho. It was compared to the control standard composite resin.

Method

After an initial prophylaxis with water and pumice and a rubber polishing cup on a low-speed handpiece, the teeth selected for bonding with GC Fuji Ortho received no enamel conditioning. After the removal of polishing paste by rinsing, water was applied to the labial surfaces using a brush until they were completely moist before bonding.

***Table 1*. The split-mouth design used in this study**

Excel	GC Fuji Ortho
GC Fuji Ortho	Excel
(a)	
GC Fuji Ortho	Excel
Excel	GC Fuji Ortho
(b)	

***Table 2*. Number and percentages of failed cast splints bonded with Excel and GC Fuji Ortho**

Bonding agent	No. bonded	No. Failed	Percentage failed	Paired *t*-test
Excel	20	4	20	NS
GC Fuji Ortho	20	3	15	
Total	40	7	17.5	

NS, not significant.
$^{*}p<0.05$.

GC Fuji Ortho was mixed according to the manufacturer's guidelines. A small amount was placed on the inner side of the cast splints, which were bonded onto the teeth. Excess adhesive was squeezed out by the seating pressure and was removed by an explorer before polymerization.

The teeth selected for bonding with Excel were rinsed, dried with an oil-free air syringe and then etched with 37% phosphoric acid for 60 s. Again, the material was handled according to the manufacturer's recommendations. The telescopic tubes were fitted 10 min after the bonding of the last cast splint.

Patients were followed for a mean period of 7 months (range, 6–8 months) and the number and date of cast splint failures were recorded for each adhesive. Appliances were checked at intervals of 6 weeks. Statistical analyses (paired *t*-tests) were performed by SPSS. The level of significance was set at $p = 0.05$.

Results

The distribution of the cast splint failures is presented in Table 2. Over the mean period of 7 months of Herbst treatment, there were seven failures, of which four (20%) occurred with the standard composite resin and three (15%) with the self-cured glass ionomer adhesive. The overall failure rate recorded with Excel was not significantly higher ($p > 0.05$) than that with GC Fuji Ortho.

No statistically significant differences were found ($p > 0.05$) between the upper and lower arches within each bonding material. Furthermore, no statistically significant differences were found when comparing the two bonding agents both in the upper and the lower arches. Table 3 illustrates the distribution of failures in the upper and lower arches.

Discussion

The results of this study indicate that resin-reinforced glass ionomers can be used to bond cast splint Herbst appliances in the clinic. No statistically significant differences were found when comparing the glass ionomer to the composite resin in the upper and lower arches.

GC Fuji Ortho is a self-curing, resin-modified glass ionomer, which has recently been introduced into the market. This adhesive shows an increase in bond strength and suggests its use with and without etching of enamel and in the presence of saliva. The main component of the powder is a fine fluoralumino-silicate glass, whereas the liquid contains polyacrylic acid, water, and a monomer as an activator. The resin compound is a mixture of three monomers, mainly 2-hydroxyethylmethacrylate, which enhances the polymerization reaction.

Previous clinical studies comparing the bracket failure rate of the first generation glass ionomer cements with conventional composite resins reported significantly higher failure rates when using glass ionomer cements (26–28). Recent clinical investigations comparing the

***Table 3*. Number and percentages of failed cast splints in the upper and lower arches**

Bonding agent	Upper arch			Lower arch			Paired t-test
	No. bonded	No. Failed	Percentage	No. bonded	No. Failed	Percentage	
Excel	10	3	30	10	1	10	NS
GC Fuji Ortho	10	1	10	10	2	20	NS
Total	20	4	20	20	3	15	NS
Paired *t*-test		NS	NS		NS	NS	

NS, not significant.
$^{*}p<0.05$.

bracket failure rate of resin-modified glass ionomers with that of composite resins report an improved clinical performance of these new products (24, 25, 29, 30). This study corroborates these findings for bonding cast splint Herbst appliances. The use of GC Fuji Ortho as a bonding agent offers the opportunity to save considerable chair time in comparison with conventional composite resins, because there is no need to etch the enamel and to use a primer. The latter advantage of these cements, associated with fluoride release and anticariogenic effect, should prove valuable in reducing the risk of pre-carious white-spot lesion development next to the bracket margins (18, 31).

At debonding, the glass ionomer exhibited a stronger adhesion to cobalt-chromium splints than to enamel, thus allowing an easy removal from enamel. The glass ionomer was desiccated with a stream of air from an air syringe and, as a result, easily removed. This reduces the amount of enamel surface loss often associated with debonding procedures. Conversely, the composite resin left more residual adhesive remnants over the enamel, which had to be removed by using a tungsten-carbide bur at low speed.

Conclusions

GC Fuji Ortho can be recommended as an alternative material for bonding cast splint Herbst appliances since it provides bond strengths adequate for clinical use. Moreover, it can be used in a wet field of operation and does not need enamel surface conditioning.

Riassunto

Lo scopo di questo studio é stato quello di confrontare la performance clinica di un adesivo vetro-ionomerico autopolimerizzante rinforzato con resina nel bondaggio di apparecchi di Herbst su fusioni con quella di una resina composita tradizionale in un design split-mouth. Dieci pazienti (6 femmine e 4 maschi) con apparecchi di Herbst su fusioni sono stati seguiti per un periodo medio di 7 mesi (range 6–8 mesi). È stata valutata la performance di 40 cast splints al cromo cobalto: 20 cast splints sono stati incollati con l' adesivo vetro-ionomerico GC Fuji Ortho (GC America Inc., Alsip, IL, USA) e 20 con la resina composita Excel (Reliance Orthodontic Products Inc., Itasca, IL, USA). Excel ha registrato una quota di distacchi totale (20%) superiore a quella registrata con GC Fuji Ortho (15%), ma non significativamente differente ($p > 0.05$). Non sono state riscontrate differenze significative ($p > 0.05$) tra la quota di distacchi all'arcata superiore ed inferiore per ciascun tipo di adesivo e tra i due agenti adesivi. Questo studio dimostra che gli adesivi vetro-ionomerici autopolimerizzanti rinforzati con resina possono essere impiegati come materiali alternativi per il bondaggio di apparecchi di Herbst su fusioni.

References

1. Herbst E. Dreissigjährige Erfahrungen mit dem Retentionss-charnier. *Zahnärztl Rundschau* 1934;**43**; 1515–1524, 1563–1568, 1611–1616.
2. Pancherz H. Treatment of Class II malocclusion by jumping the bite with the Herbst appliance. A cephalometric investigation. *Am J Orthod* 1979;**76**:423–42.
3. Pancherz H, Hansen K. Occlusal changes during and after Herbst treatment: a cephalometric investigation. *Eur J Orthod* 1986;**8**:215–28.
4. Pancherz H. The effect of continuous bite jumping on the dentofacial complex: a follow-up study after Herbst appliance treatment of Class II malocclusions. *Eur J Orthod* 1981;**3**:49–60.
5. Bakke M, Paulsen HU. Herbst treatment in late adolescence: a clinical, electromyographic, kinesiographic, and radiographic analysis of one case. *Eur J Orthod* 1989;**11**:397–407.
6. Paulsen HU, Karle A, Bakke M, Herskind A. CT-scanning and radiographic analysis of temporomandibular joints and cephalometric analysis in a case of Herbst treatment in late puberty. *Eur J Orthod* 1995;**17**:165–75.
7. Paulsen HU. Morphological changes of the TMJ condyles of 100 patients treated with the Herbst appliance in the period of puberty to adulthood: a long-term radiographic study. *Eur J Orthod* 1997;**19**:657–68.
8. Pancherz H, Anehus-Pancherz M. Muscle activity in Class II, Division 1 malocclusions treated by bite jumping with the Herbst appliance. *Am J Orthod* 1980;**78**:321–9.
9. Pancherz H, Anehus-Pancherz M. The effect of continuous bite jumping with the Herbst appliance on the masticatory system: a functional analysis of treated Class II malocclusions. *Eur J Orthod* 1982;**4**:37–44.
10. McNamara JA, Howe RP. Clinical management of the acrylic splint Herbst appliance. *Am J Orthod Dentofac Orthop* 1988;**94**:142–9.
11. Fiorentino G, Melsen B. Asymmetric mandibular space closure. *J Clin Orthod* 1996;**30**:519–23.
12. Fischer-Brandies H, Monsees M. Schmelzschäden bei Mehrfachdebonding in der Bracketadhäsivtechnik. *Fortschr Kieferorthop* 1993;**54**:143–7.
13. Gorelick L, Geiger AM, Gwinnett AJ. Incidence of white spot formation after bonding and banding. *Am J Orthod* 1982;**81**: 93–8.
14. Øgaard B, Rølla G, Arends J. Orthodontic appliances and enamel demineralization. Part I. Lesion development. *Am J Orthod Dentofac Orthop* 1988;**94**:68–73.
15. Silverman E, Cohen M. A universal direct bonding system for both metal and plastic brackets. *Am J Orthod* 1968;**62**:260–5.
16. Silverman E, Cohen M, Demke RS, Silverman M. A new light-cured glass ionomer cement that bonds brackets to teeth without etching in the presence of saliva. *Am J Orthod Dentofac Orthop* 1995;**108**:231–6.
17. Cook PA, Youngson CC. An in vitro study of the bond strength of glass ionomer cement in the direct bonding of orthodontic brackets. *Br J Orthod* 1988;**15**:247–53.
18. Hatibovic-Kofman S, Koch G. Fluoride release from glass ionomer cement in vivo and in vitro. *Swed Dent J* 1991;**15**:253–8.
19. Fajen VB, Duncanson MG, Nanda RS, Currier F, Angolkar PV. An in vitro evaluation of bond strength of three glass ionomer cements. *Am J Orthod Dentofac Orthop* 1990;**97**: 316–22.

20. Kent BE, Lewis GG, Wilson AD. The properties of a glass ionomer cement. *Br Dent J* 1973;**135**:322–6.
21. Jobalia SB, Valente RM, de Rijk WG, BeGole EA, Evans CA. Bond strength of visible light-cured glass ionomer orthodontic cement. *Am J Orthod Dentofac Orthop* 1997;**112**:205–8.
22. Cacciafesta V, Jost-Brinkmann P-G, Süßenberger U, Miethke R-R. Effects of saliva and water contamination on the enamel shear bond strength of a light-cured glass ionomer cement. *Am J Orthod Dentofac Orthop* 1998;**113**:402–7.
23. Lippitz SJ, Staley RN, Jakobsen JR. In vitro study of 24-hour and 30-day shear bond strengths of three resin-glass ionomer cements used to bond orthodontic brackets. *Am J Orthod Dentofac Orthop* 1998;**113**:620–4.
24. Cacciafesta V, Bosch C, Melsen B. Clinical comparison between a resin-reinforced self-cured glass ionomer cement and a composite resin for direct bonding of orthodontic brackets. Part 1: wetting with water. *Clin Orth Res* 1998;**1**:29–36.
25. Cacciafesta V, Bosch C, Melsen B. Clinical comparison between a resin-reinforced self-cured glass ionomer cement and a composite resin for direct bonding of orthodontic brackets. Part 2: bonding on dry enamel and on enamel soaked with saliva. *Clin Orth Res* 1999;**2**:186–93.
26. Norevall LI, Marcusson A, Persson M. A clinical evaluation of a glass ionomer cement as an orthodontic bonding adhesive compared with an acrylic resin. *Eur J Orthod* 1996;**18**:373–84.
27. Miguel JAM, Almeida MA, Chevitarese O. Clinical comparison between a glass ionomer cement and a composite for direct bonding of orthodontic brackets. *Am J Orthod Dentofac Orthop* 1995;**107**:484–7.
28. Miller JR, Mancl L, Arbuckle G, Baldwin J, Phillips RW. A three-year clinical trial using a glass ionomer cement for the bonding of orthodontic brackets. *Angle Orthod* 1996;**66**: 309–12.
29. Fricker JP. A new self-curing resin-modified glass-ionomer cement for the direct bonding of orthodontic brackets in vivo. *Am J Orthod Dentofac Orthop* 1998;**113**:384–6.
30. Fowler PV. A twelve-month clinical trial comparing the bracket failure rates of light-cured resin-modified glass-ionomer adhesive and acid-etch chemical-cured composite. *Aust Orthod J* 1998;**15**:186–90.
31. Hallgren A, Oliveby A, Twetman S. Caries associated microflora in plaque from orthodontic appliances retained with glass ionomer cement. *Scand J Dent Res* 1992;**100**:140–3.