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Effect of EDTA conditioning upon the retention of fibre posts luted with resin cements

B. J. Rasimick, R. P. Shah, B. L. Musikant & A. S. Deutsch
Essential Dental Laboratories, South Hackensack, NJ, USA

Abstract

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Aim To determine if a final rinse with EDTA improves the short-term in-tooth retentive strength of adhesively luted fibre-reinforced composite posts.

Methodology Six different commercial fibre post systems were tested. Post spaces in extracted human anterior teeth were irrigated with either 6% NaOCl or 6% NaOCl followed by 17% EDTA. Posts were luted using the manufacturer's recommended bonding agent and luting cement. Two different sizes of post were tested for each post system. After 24 h of storage, the retentive strength of the post to the tooth (14 per group, 336 total) was tested using a pull-out technique. Three-way ANOVA and the Student–Newman–Kuels test were used to test the effects of irrigation regimen, post size and post brand on the retentive strength of the fibre post.

Results Almost every sample failed at the interface between dentine and luting cement. Irrigation method did not have any significant effect ($P > 0.14$) for any group other than ParaPost Fibre White ($P < 0.001$). The overall retention of a post appeared to be correlated to the amount of surface texture on the post; the smooth ICEPost was the least retentive brand, the textured FibreKor and the ParaPost Fibre White posts were moderately retained, and the threaded Flexi-Post Fibre and the Flexi-Flange Fibre posts were the most retentive brands tested. For all brands, larger diameter posts were more retentive than smaller diameter posts ($P < 0.008$).

Conclusions A final rinse of EDTA did not improve the short-term retention of fibre posts except for ParaPost Fibre White.

Keywords: EDTA, fibre post, retention, root canal posts.

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Introduction

Two recent reviews of published studies on adhesively luted fibre-reinforced composite post systems (Bateman *et al.* 2003, Bitter & Kielbassa 2007) concluded that a common mode of clinical failure for these restorations was loss of retention. Hence, there is a definite need for materials and methods that improve the retention of these increasingly popular restorations.

One commonly proposed method of improving the retention of posts is by conditioning the post space with EDTA (ethylenediaminetetracetic acid, typically neutralized to pH 7–8) before applying the luting cement. At least five laboratory studies (Goldman *et al.* 1984a,b, Burns *et al.* 1993, Mohammed *et al.* 1995, Baldissara *et al.* 2006) have measured the change in retentive strength after irrigation with sodium hypochlorite (NaOCl) alone versus an EDTA rinse prior to the NaOCl rinse. Four of these studies (Goldman *et al.* 1984a,b, Burns *et al.* 1993, Mohammed *et al.* 1995) reported that EDTA provided a statistically significant improvement. EDTA is speculated to improve the retention of the post by removing the smear layer, opening the dentine tubules, and/or etching the inter-tubular dentine which in turn allows for better contact between the luting cement and the dentine.

Correspondence: Dr Brian Rasimick, Essential Dental Systems, 89 Leuning Street, South Hackensack, NJ 07606, USA (Tel.: +1201 487 9090; fax: +1201 487 5120; e-mail: brasimick@edsdental.com).

In the previously mentioned studies, application of the EDTA was followed by a rinse of sodium hypochlorite. However, there are two reasons to suspect that EDTA may be more beneficial as the final rinse. Three studies (Torri *et al.* 2003, Goracci *et al.* 2005b, Doyle *et al.* 2006) have suggested that certain 'all-in-one' self-etch bonding agents may have insufficient etching power, possibly because of high pH, and could therefore benefit from a final EDTA rinse to pre-etch the canal. The other potential benefit of EDTA as the final rinse before applying the resin composite is the reported (Osorio *et al.* 2005) improvement in the resistance of the final resin–dentine bond to degradation.

The purpose of this study was to determine whether a final rinse with EDTA improves the short-term in-tooth retentive strength of adhesively luted fibre-reinforced composite posts. There is no one accepted method of placing a fibre post. In an effort to consider various combinations of factors such as luting cement, bonding agent, etchant, or post insertion depth, this study tested six different commercial fibre post systems used according to their manufacturer's recommendations (with the exception of irrigation). Two sizes of each post were tested to ensure that minor variations in post size were not a significant complicating factor. The null hypothesis is that neither irrigation regimen nor post size have an effect upon retention.

Materials and methods

The fibre posts used in this study were ICEPost (Danville Materials, San Ramon, CA, USA), ParaPost Fibre White (Colténe Whaledent, Cuyahoga Falls, OH, USA), FibreKor (Pentron Clinical Technologies, Wallingford, CT, USA), Flexi-Post Fibre (Essential Dental Systems, South Hackensack, NJ, USA) and Flexi-Flange Fibre (Essential Dental Systems). Two sizes of each post were tested, corresponding to post space preparations of either 1.2 or 1.4 mm in diameter.

Extracted human anterior teeth stored in 0.07% thymol (Fisher Scientific, Fair Lawn, NJ, USA) were cut at the cemento-enamel junction with a diamond disc. Teeth with circular root canals were then drilled to accept a fibre post according to the manufacturer's instructions and irrigated with a 27-gauge notch-tip needle (Henry Schein Inc. Melville, NY, USA). All samples received a 1 m rinse with 1 mL of 6% NaOCl followed by a 1 m rinse with 1 mL of water. Half of the samples received an additional 1 m rinse with 1 mL of 17% EDTA (Henry Schein) followed by a 1 m rinse with 1 mL water. Excess water was removed from the canals using paper points (Henry Schein) and posts were then luted according to the manufacturer's recommended instructions. Table 1 summarizes the materials and insertion depths used. FibreKor TE samples were prepared by etching the canal with 37% phosphoric acid gel (Pentron Clinical Technologies) for 20 s, rinsing with water, blotting the excess water with paper points, applying two coats of Bond-1 Adhesive (Pentron Clinical Technologies) with paper points, drying for 10 s with a gentle air jet, light curing (Radii, SDI, Bayswater, Australia) for 10 s, mixing the two components of Lute-it (Pentron Clinical Technologies), applying the mixed cement to the canal with a lentulo spiral (Dentsply Maillefer, Tulsa, OK, USA), coating the post in luting cement, inserting the post, and light curing the luting cement for 50 s. FibreKor SE samples were prepared by applying Breeze luting cement (Pentron Clinical Technologies) with a lentulo spiral, coating the post in luting cement, and inserting the post. ICEPost samples were prepared by mixing the ED Primer II (Kuraray Medical), applying two coats of ED Primer II using the included brushes, waiting for 30 s, drying with a gentle air jet for 10 s, removing excess primer with paper points, mixing the luting

Table 1 Details of the sample preparation procedure

Testing Group	Etching Mode	Approximate pH	Etchant	Bonding agent	Luting Cement	Apical depth (mm)
FibreKor TE	Total-etch	0.5	37% Phosphoric acid	Bond 1 primer/adhesive	Lute-It	13, 12
ICEPost	Self-etch	2.5		ED Primer II	Panavia F 2.0	13, 12
FibreKor SE	Self-etch	3.5			Breeze	13, 12
ParaPost	Self-etch	4.0		Adhesive conditioner	ParaPost Self Cure	10, 9
Flexi-Post Fibre	No-etch	5.5			Flexi-Flow Auto E	9.9, 10.9
Flexi-Flange Fibre	No-etch	5.5			Flexi-Flow Auto E	9.5, 10.4

cement components, applying the cement to the canal using a lentulo spiral, coating the post with cement, and inserting the post. ParaPost samples were prepared by mixing the ParaPost Adhesive Conditioner (Colténe Whaledent), applying two coats of the conditioner with the included brushes for 30 s, removing excess conditioner with paper points, drying with a gentle air jet for 2 s, mixing the ParaPost Cement for 30 s, applying the cement with a lentulo spiral, coating the post in cement, and inserting the post into the canal. Flexi-Flange Fibre and Flexi-Post Fibre samples were prepared by applying Flexi-Flow Auto E luting cement (Essential Dental Systems) to the canal with the included dispensing tip and then screwing the post into the canal using the supplied wrench.

pH was measured by mixing 0.5 mL of material with 0.5 mL of distilled water and pouring onto a set of six pH sensitive papers (Fisher Scientific) which change colour for every 0.5 pH units.

All samples (14 in each post-size-irrigation group, 336 total) were stored at 37 °C and 100% humidity for 24 h before testing. Afterwards, they were cured into acrylic blocks (Acratray; Henry Schein). Wax paper was placed on the coronal dentine and Ti-Core Auto E (Essential Dental Systems) was applied to the post in order to provide a better gripping surface for the retention test. The maximum retention strength was measured using a model 810 Material Test System (Material Test System Corp Minneapolis, MN, USA) with a crosshead speed of 3 cm min^{-1}. Some of the extracted posts were analysed under a stereomicroscope at 45 × magnification to estimate the mode of failure.

Three-way analysis of variance (ANOVA) was used to test the effects of irrigation routine, post size and post brand on the retentive strength of the fibre post. A significant ANOVA result was followed by the Student–Neuman–Keuls (SNK) multiple comparisons test. For all tests, the results were considered significant if $P < 0.05$.

Results

Retentive strengths ranged from approximately 200 to 450 N (Fig. 1). In the vast majority of samples, the failure mode was loss of adhesion between the luting cement and the dentine. Three-way ANOVA testing revealed that the following factors and interactions were significant: post system ($P < 0.001$), post size ($P < 0.001$), the interaction between post system and post size ($P = 0.021$) and the interaction between post system and irrigation type ($P = 0.007$). Irrigation type was not a significant factor ($P > 0.14$) for any group

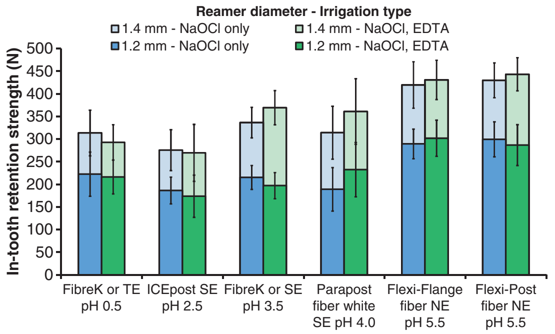

Figure 1 Overlay bar chart of the retentive strengths. Note that the 1.2 mm data is overlaid directly on top of the 1.4 mm data in order to highlight the effect of post size.

other than ParaPost Fibre White ($P < 0.001$). The size of the post had a significant impact on the measured retention strength for all groups ($P < 0.008$). The SNK ranking for the 1.2 mm diameter posts was as follows: Flexi-Flange Fibre = Flexi-Post Fibre > FibreKor TE = FibreKor SE = ParaPost Fibre White > ICEPost. The SNK ranking for the 1.4 mm diameter posts was as follows: Flexi-Post Fibre = Flexi-Flange Fibre > FibreKor TE > FibreKor SE = ParaPost Fibre White > ICEPost.

Discussion

The results of this study indicated that for most post systems, rinsing the post space with EDTA after NaOCl does not increase the short-term retention of the post to the tooth any more than a rinse of NaOCl alone. The only system in which EDTA improved retention is for ParaPost Fibre White, a system that uses a very mild pH 4 self-etching adhesive. This result agrees with previous studies (Torri *et al.* 2003, Doyle *et al.* 2006) that reported the final rinse of EDTA was beneficial only for certain 'all-in-one' self-etch bonding agents which may have insufficient etching power. Although the Flexi-Post Fibre and Flexi-Flange Fibre also had a very mild pH of 5.5, these posts did not benefit from the final EDTA rinse. It is believed that these active threaded posts are primarily retained in the canal by mechanical forces rather than chemical bonding. As a result, any improved chemical bonding because of EDTA would not be readily apparent. The results for the active posts do suggest that potential weakening of the dentine because of EDTA demineralization (Saleh & Ettman 1999, Eldeniz *et al.* 2005, Sayin *et al.* 2007) did not seem to affect the overall retention of the post.

The size of the post was found to have a significant effect ($P < 0.008$) for all tested brands of post. On average, the 1.4 mm diameter reamer posts were 28 ± 12% more retentive than their 1.2 mm counterparts. Such an increase was expected because the 1.4 mm posts have approximately 35% more surface area available for adhesive bonding or frictional retention. The length of a post should theoretically influence retention as well. Although this has not yet been tested for resin-luted, parallel-sided fibre posts, an investigation of a double-tapered fibre post found no significant effect (Innella *et al.* 2005). Investigations on resin-luted, parallel-sided metal posts also did not detect any significant difference because of the length of the post (Cohen *et al.* 1992, El-Mowafy & Milenkovic 1994).

A rigorous analysis of the modes of failure was not conducted in this study. Approximately 20% of the dislodged posts were examined under a 45 × steromicroscope; every sample was at least partially covered with luting cement with coverage being nearly total in most cases. The luting cement surface did not generally show jagged edges or other evidence of fracture. The presence or absence of the bonding agent could not be reliably detected using the steromicroscope. Based on these observations, it appears that the dominant mode of failure was loss of adhesion between the dentine and the luting cement (or bonding agent). Such a result has been commonly reported by other pull-out studies on fibre posts (Pithan *et al.* 2002, Nagase *et al.* 2005, Bonfante *et al.* 2007, D'Arcangelo *et al.* 2007). However, studies have also reported primarily mixed failure (Nagase *et al.* 2005) or adhesive failure between the luting cement and the post (Balbosh & Kern 2006). Some breakage of the active threads on the Flexi-Post Fibre and the Flexi-Flange Fibre was evident.

It is interesting to note that the overall retention of a post seemed to be correlated to the amount of surface texture on the post. The smooth ICEPost was the least retentive brand, the textured FibreKor and ParaPost Fibre White posts were moderately retained, and the threaded Flexi-Post Fibre and Flexi-Flange Fibre posts were the most retentive brands tested. The correlation between surface texture and in-tooth retention might indicate that a major component of the retention of fibre post is frictional forces between the post and the canal wall. Such an effect has been previously suggested by numerous other studies (Goracci *et al.* 2005a, Pirani *et al.* 2005, Cury *et al.* 2006, Sadek *et al.* 2006) which used a thin-slice push-out methodology. Although the post itself does not contact the observed point of failure, the luting cement/dentine interface, a textured post surface is speculated to help transfer evenly the tensile force to the luting cement. This will prevent excessive stress from accumulating in a single area of the luting cement/dentine interface.

The pull-out methodology used in this study is considerably different from the more commonly used push-out method. In the push-out method, the tooth is sectioned into thin slices and the post is pushed out of the slice. The push-out force is compressive in nature and unlike the pull-out force, which is tensile. These two forces would be largely equivalent if the post were infinitely rigid; however, fibre posts can and do flex in response to forces. The amount of flexture can be estimated using a material's Poisson's ratio and Young's modulus. To illustrate the type of flexture, imagine what happens to a cylinder of rubber under axial compression versus axial tension. Under compression, the cylinder will become short and fat whilst under tension the material will become tall and skinny. The deformation will affect the magnitude of the frictional forces between the post and root. As a result, push-out testing tends to exaggerate the effects of frictional retention whilst pull-out testing tends to minimize them (Kerans & Parthasarathy 1991, Goracci *et al.* 2005a, 2007). It is interesting to note that in the current study frictional forces appeared to be more influential than adhesive forces, despite the use of a pull-out methodology.

The clinical significance of this study should be tempered by its limitations. First and foremost, the current study ignores the role of the core material and crown upon the retention of a fibre post. Furthermore, the retention strength was evaluated using a single-tensile load rather than a cyclical compressive-tensile load. In the clinical case, it seems likely that a post restoration, which fails as a result of the rare tensile oral forces, was probably first damaged by a large compressive load. Finally, a short-term study may not be a good predictor of the retentive strength of the post systems after months or years of function in the mouth.

The preparation of the samples for this experiment involved several deviations from clinical methodology done out of necessity or in order to improve the reproducibility of the results. First, a reliable source of freshly extracted teeth could not be obtained and therefore the teeth used in this study had to be stored for less than 1 year in 0.07% thymol. Thymol is an antiseptic commonly used in mouthwashes. Studies have shown that teeth aged in similar conditions produce shear bond strengths of approximately 20% less than those obtained with freshly extracted teeth

(Retief *et al.* 1989, Goodis *et al.* 1993, Titley *et al.* 1998, Zheng *et al.* 2005). Therefore, the current study may underestimate the true retentive strength of these post systems. Another significant deviation from clinical methodology is that the root canals were neither instrumented nor filled prior to the preparation of the post space. Most studies (Burns *et al.* 2000, Hagge *et al.* 2002, Muniz & Mathias 2005) other than Mayhew *et al.* (2000) agree that this has little effect on the retention of posts luted with non-eugenol endodontic cements. For example, during instrumentation the canal space may be soaked in various irrigants. However, this soaking is believed to predominantly affect the superficial dentine which is removed from the tooth during preparation of the post space. Therefore, the irrigation sequence used during canal instrumentation should not affect the retention of the post. The choice of irrigation for the completed post space was originally hypothesized to have a significant effect. The goal of this study was to determine if the modification of the post space dentine by the irrigant had a significant effect. To eliminate potential chemical interactions of the irrigation solution with the bonding agent or luting cement, such as EDTA's moderately alkaline pH or NaOCl's oxidizing power, the post space was irrigated with water after the treatment solution. Although irrigation with water is seldom done clinically, it was incorporated into this experiment to allow us to eliminate undesired chemical interactions for the purposes of this study.

Conclusions

Despite limitations, several conclusions can be drawn from this study. Rinsing the post space preparation with EDTA after the initial NaOCl rinse does not improve the short-term retention strength of most fibre post systems. The only system that was affected, ParaPost Fibre White used with a self-etch bonding agent, showed a modest 20% improvement in post-tooth retentive strength after the EDTA rinse. For all post systems, larger diameter posts were found to be significantly more retentive. The active fibre post systems were found to be more retentive than their passive counterparts.

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References

Balbosh A, Kern M (2006) Effect of surface treatment on retention of glass-fiber endodontic posts. *Journal of Prosthetic Dentistry* **95**, 218–23.

Baldissara P, Zicari F, Valandro LF, Scotti R (2006) Effect of root canal treatments on quartz fiber posts bonding to root dentin. *Journal of Endodontics* **32**, 985–8.

Bateman G, Ricketts DNJ, Saunders WP (2003) Fibre-based post systems: a review. *British Dental Journal* **195**, 43–8.

Bitter K, Kielbassa AM (2007) Post-endodontic restorations with adhesively luted fiber-reinforce composite post systems: a review. *American Journal of Dentistry* **20**, 353–60.

Bonfante G, Kaizer OB, Pegoraro LF, do Valle AL (2007) Tensile bond strength of glass fiber posts luted with different cements. *Brazilian Oral Research* **21**, 159–64.

Burns DR, Douglas HB, Moon PC (1993) Comparison of the retention of endodontic posts after preparation with EDTA. *Journal of Prosthetic Dentistry* **69**, 262–6.

Burns DR, Moon PC, Webster NP, Burns DA (2000) Effect of endodontic sealers on dowels luted with resin cement. *Journal of Prosthodontics* **9**, 137–41.

Cohen BI, Condos S, Musikant BL, Deutsch AS (1992) Retention properties of a split-shaft threaded post: cut at different apical lengths. *Journal of Prosthetic Dentistry* **68**, 894–8.

Cury AH, Goracci C, de Lima Navarro MF *et al.* (2006) Effect of hygroscopic expansion on the push-out resistance of glass ionomer-based cements used for the luting of glass fiber posts. *Journal of Endodontics* **32**, 537–40.

D'Arcangelo C, Cinelli M, De Angelis F, D'Amario M (2007) The effect of resin cement film thickness on the pullout strength of a fiber-reinforced post system. *Journal of Prosthetic Dentistry* **98**, 193–8.

Doyle MD, Loushine RJ, Agee KA *et al.* (2006) Improving the performance of EndoRez root canal sealer with a dual-cured two-step self-etch adhesive. I. Adhesive strength to dentin. *Journal of Endodontics* **32**, 766–70.

Eldeniz AU, Erdemir A, Belli S (2005) Effect of EDTA and citric acid solutions on the microhardness and the roughness of human root canal dentin. *Journal of Endodontics* **31**, 107–10.

El-Mowafy OM, Milenkovic M (1994) Retention of paraposts cemented with dentin-bonded resin cements. *Operative Dentistry* **19**, 176–82.

Goldman M, DeVitre R, Pier M (1984a) Effect of the dentin smeared layer on tensile strength of cemented posts. *Journal of Prosthetic Dentistry* **52**, 485–8.

Goldman M, DeVitre R, Tenca J (1984b) Cement distribution and bond strength in cemented posts. *Journal of Dental Research* **63**, 1392–5.

Goodis HE, Marshall GW Jr, White JM, Gee L, Hornberger B, Marshall SJ (1993) Storage effects on dentin permeability and shear bond strengths. *Dental Materials* **9**, 79–84.

Goracci C, Fabianelli A, Sadek FT, Papacchini F, Tay FR, Ferrari M (2005a) The contribution of friction to the dislocation resistance of bonded fiber posts. *Journal of Endodontics* **31**, 608–12.

Goracci C, Sadek FT, Fabianelli A, Tay FR, Ferrari M (2005b) Evaluation of the adhesion of fiber posts to intraradicular dentin. *Operative Dentistry* **30**, 627–5.

Goracci C, Grandini S, Bossù M, Bertelli E, Ferrari M (2007) Laboratory assessment of the retentive potential of adhesive posts: a review. *Journal of Dentistry* **35**, 827–35.

Hagge MS, Wong RD, Lindemuth JS (2002) Effect of three root canal sealers on the retentive strength of endodontic posts luted with a resin cement. *International Endodontic Journal* **35**, 372–8.

Innella R, Autieri G, Ceruti P, Gassino G (2005) Relation between length of fiber post and its mechanical retention. *Minerva Stomatologica* **54**, 481–8.

Kerans RJ, Parthasarathy TA (1991) Theoretical Analysis of the Fiber Pullout and Pushout Tests. *Journal of the American Ceramic Society* **74**, 1585–96.

Mayhew JT, Windchy AM, Goldsmith LJ, Gettleman L (2000) Effect of root canal sealers and irrigation agents on retention of preformed posts luted with a resin cement. *Journal of Endodontics* **26**, 341–4.

Mohammed AN, Seif RE, Wahbi M (1995) An in-vitro comparative study of the retention of grooved and flat endodontic posts in treated root canals using two different types of cements. *Egyptian Dental Journal* **41**, 1463–8.

Muniz L, Mathias P (2005) The influence of sodium hypochlorite and root canal sealers on post retention in different dentin regions. *Operative Dentistry* **30**, 533–9.

Nagase DY, Takemoto S, Hattori M, Yoshinari M, Kawada E, Oda Y (2005) Influence of fabrication techniques on retention force of fiber-reinforced composite posts. *Dental Materials Journal* **24**, 280–5.

Osorio R, Erhardt MC, Pimenta LA, Osorio E, Toledano M (2005) EDTA treatment improves resin-dentin bonds' resistance to degradation. *Journal of Dental Research* **84**, 736–40.

Pirani C, Chersoni S, Foschi F *et al.* (2005) Does hybridization of intraradicular dentin really improve fiber post retention in endodontically treated teeth? *Journal of Endodontics* **31**, 891–4.

Pithan S, Vieira Rde S, Chain MC (2002) Tensile bond strength of intracanal posts in primary anterior teeth: an *in vitro* study. *Journal of Clinical Pediatric Dentistry* **27**, 35–9.

Retief DH, Wendt SL, Bradley EL, Denys FR (1989) The effect of storage media and duration of storage of extracted teeth on the shear bond strength of Scotchbond 2/Silux to dentin. *American Journal of Dentistry* **5**, 269–73.

Sadek FT, Goracci C, Monticelli F *et al.* (2006) Immediate and 24-hour evaluation of the interfacial strengths of fiber posts. *Journal of Endodontics* **32**, 1174–7.

Saleh AA, Ettman WM (1999) Effect of endodontic irrigation solutions on microhardness of root canal dentine. *Journal of Dentistry* **27**, 43–6.

Sayin TC, Serper A, Cehreli ZC, Otlu HG (2007) The effect of EDTA, EGTA, EDTAC, and tetracycline-HCl with and without subsequent NaOCl treatment on the microhardness of root canal dentin. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics* **104**, 418–24.

Titley KC, Chernecky R, Rossouw PE, Kulkarni GV (1998) The effect of various storage methods and media on shear-bond strengths of dental composite resin to bovine dentine. *Archives of Oral Biology* **43**, 305–11.

Torri Y, Hikasa R, Iwate S, Oyama F, Itou K, Yoshiyama M (2003) Effect of EDTA conditioning on bond strength to bovine dentin promoted by four current adhesives. *American Journal of Dentistry* **16**, 395–9.

Zheng TL, Huang C, Zhang ZX, Wang S, Zhang G (2005) Influence of storage methods on microtensile bond strength of dentin adhesive system [article in chinese]. *Shanghai Kou Qiang Yi Xue* **14**, 147–50.

