Dental Traumatology 2004; 20: 172–177
Printed in Denmark. All rights reserved

DENTAL TRAUMATOLOGY

Case Report

Combined technique with polyethylene fibers and composite resins in restoration of traumatized anterior teeth

Vitale MC, Caprioglio C, Martignone A, Marchesi U, Botticelli AR. Combined technique with polyethylene fibers and composite resins in restoration of traumatized anterior teeth. Dent Traumatol 2004; 20: 172–177. © Blackwell Munksgaard, 2004.

Abstract – Traumatized anterior teeth need quick esthetic and functional repair. Esthetic requirements of anterior teeth require the use of composite materials which, in the most complex cases, can be used in association with fibers so as to improve their mechanical resistance. Many kinds of fibers are available. The authors considered parameters such as physical properties, water absorption, ease of cutting and of laying. Polyethylene fibers appear to have the best properties in elasticity, translucency, adaptability, tenaciousness, resistance to traction and to impact. Fifteen children, between 7 and 13 years old, with crown fractures of the anterior sector were treated. In the case of a simple crown fracture, the missing part was restored by polyethylene fibers and composite resins. In the case of a complex crown fracture needing endodontic treatment, the fibers were used as a central core stump in order to restore the dental morphology. At control examinations, the teeth restored by this technique were acceptable, both in function and in aesthetics. Thus, the authors recommend this combined technique for predictable restoration of traumatized anterior teeth.

Marina Consuelo Vitale[1], Claudia Caprioglio[3], Alessandra Martignone[1], Umberto Marchesi[1], A. R. Botticelli[2]

[1]Department of Paediatric Dentistry, Faculty of Dentistry, University of Pavia, [2]Department of Human Pathology, University of Pavia, [3]Consultant, Pavia, Italy

Key words: trauma; restoration; polyethylene fibers

Dr Vitale Marina Consuelo, Department of Paediatric Dentistry, Faculty of Dentistry, University of Pavia, 2, Piazzale Golgi, 27100 Pavia, Italy
Telefax: +39 0382 423029
e-mail: vitalemc@libero.it

Accepted 18 February, 2003

Traumatized anterior teeth require quick functional and esthetic repair. Composite materials are commonly used in clinical dentistry for esthetic restorations, particularly in the anterior dentition. However, these materials have poor mechanical resistance. Approaches to strengthening composite materials have included reinforcing their resinous matrix with fibers. Different fiber types have been added to composite materials to improve their physical and mechanical properties (1).

Glass fibers, consisting of glass interlaced filaments, improve the impact strength of composite materials. They have appreciable esthetic properties, but do not easily stick to resinous matrix (2).

Carbon fibers prevent fatigue fracture and strengthen composite materials, but they have a dark color, which is undesirable esthetically (3–7).

Kevlar fibers, made of an aromatic polyamide, are the evolution of nylon polyamide. They increase the impact strength of composite materials. However, they are also unesthetic, and thus their use is limited (8).

Vectran fibers are synthetic fibers of a new generation, made of aromatic polyesters. They show a good resistance to abrasion and impact strength, but they are expensive and unwieldy.

Polyethylene fibers improve the impact strength, modulus of elasticity, and flexural strength of composite materials. Unlike carbon and Kevlar fibers, polyethylene fibers are almost invisible in resinous matrix and, for these reasons, seem to be the most appropriate and esthetic strengtheners of composite materials (1, 7).

In these clinical cases, we used a polyethylene fiber (Ribbond Reinforcement Ribbon, Ribbon, Scottle,

WA, USA), which is suited to strengthen composite materials.

Our choice considered the following parameters: physical properties, wetting ability, ease of cutting and laying.

Ribbond® is a spectrum of 215 fibers with a very high molecular weight. These fibers have a very high coefficient of elasticity (117 GPa); this means an excellent resistance to stretch and distortion. They also have a very high resistance to traction (3 GPa), as a result of their 'closed stitch' configuration, and a good adaptability. Ribbond® fibers are also characterized by an impact strength five times higher than that of iron. They are translucent and assume the color of the resin to which they are added. Ribbond® fibers easily absorb water because of the 'gas-plasma' treatment to which they are exposed. This treatment reduces the fibers' superficial tension, ensuring a good chemical bond to composite materials.

Ribbond® fibers can also be cut by using special nippers without fraying or losing their original dimensions (9–15).

These polyethylene fibers can be used in pediatric dentistry to splint traumatized teeth, restore fractured teeth, as a space keeper, or in the postorthodontic fixed retainers.

The aim is to increase composites' mechanical properties by using polyethylene fibers, in order to restore traumatized anterior teeth, and also to evaluate their life span in terms of resistance to masticatory loads and esthetic results. This clinical study has a 2-year follow-up.

This paper presents two cases, one simple and one complex, where this technique was successfully used.

In the case of a simple crown fracture, the missing part was restored by using polyethylene fibers and composite resins.

In the case of a complex crown fracture associated with the necessity for endodontic treatment, the use of fibers was aimed at the creation of a central support stump to restore the dental morphology.

Case 1

A.B., a 13-year-old patient, presented a complex crown fracture of the upper left maxillary incisor with pulp involvement. After radiographic examination, a decision was made to start an endodontic treatment (Fig. 1).

A local anesthetic was administered (Ubistein 4%, articaine 4%, and epinephrine 1:200 000, 1.7 ml, Espe, Norristown, PA, USA), and the tooth was isolated by a rubber dam (Hygenic Dental Dam, Coltène, Mahwah, NJ, USA). Following biomechanical preparation, the root canal was treated with K-type files (Dentsply Maillefer, Paris, France) and was irrigated with sodium hypochlorite and EDTA solution

Fig. 1. First examination: complex crown fracture of upper left central incisor (ULCI).

to remove the smear layer. Finally, the root canal was dried with adsorbent paper points and filled with gutta-percha points (Dentsply Maillefer, Paris, France) and sealer (N2 Endodontic Cement, Ghimas, Bologna, Italy) using the lateral condensation technique. The cervical access of the canal was temporarily closed with Cavit (Espe, Norristown, PA, USA).

Two weeks later, it was decided to restore the dental morphology by a central support stump created using polyethylene fibers and composite resins. The dental element was isolated by a rubber dam, and a slot was created into the root canal in order to lay polyethylene fibers. (Fig. 2)

After a conventional etching by orthophosphoric acid (Conditioner 36, Dentsply De Trey Gmbh, Konstanz, Germany), the bonding agent (Scotchbond 1, 3M Dental Products, St. Paul, MN, USA) was applied to the dental surface. Polyethylene fibers (Ribbond Reinforcement Ribbon, Ribbon, Scottle, WA, USA), previously conditioned by the bonding agent (Scotchbond 1, 3M Dental Products, MN, USA), were laid

Fig. 2. After a traditional endodontic treatment, a slot is created in the root canal in order to lay the fibers.

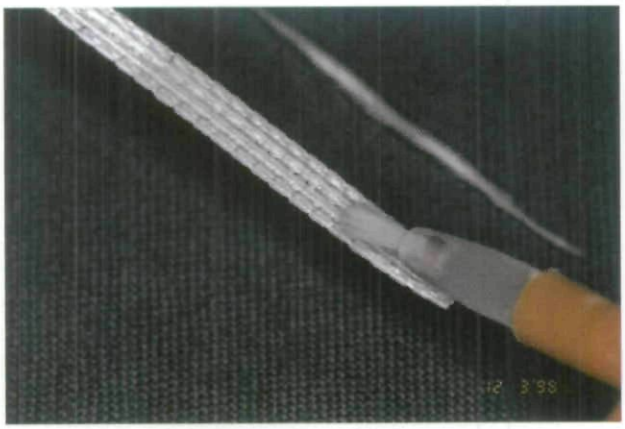

Fig. 3. A Ribbond® fiber is conditioning by the bonding agent.

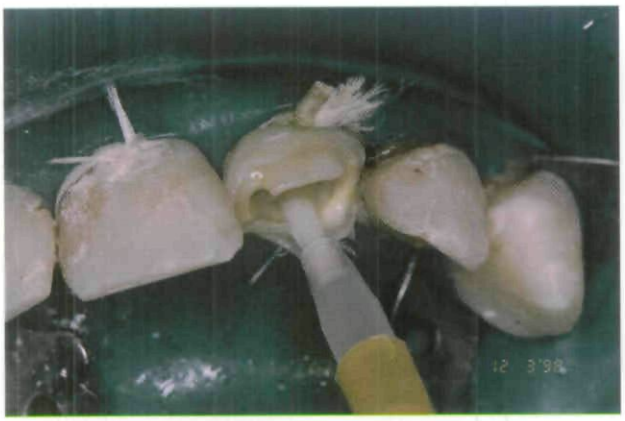

Fig. 4. After a conventional etching by orthophosphoric acid, the bonding agent is applied to the dental surface.

in the slot of the root canal in association with composite material (Spectrum T.P.H., Light-Cure Composite, Dentsply De Trey GmbH, Konstanz, Germany). (Figs. 3–6). A central support stump was created (Fig. 7). Finally, the dental restoration was completed using the composite's incremental technique (Fig. 8).

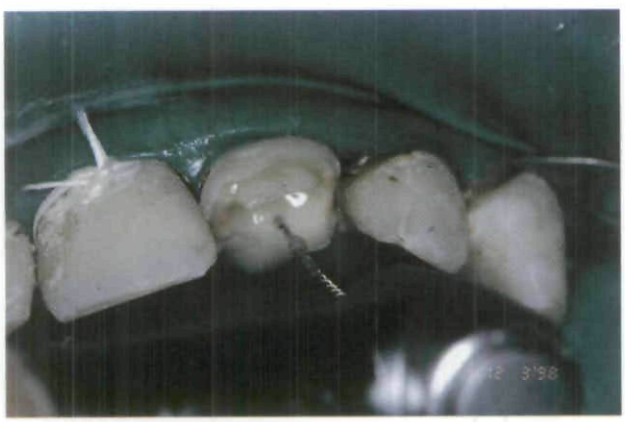

Fig. 5. Application of the composite material in the slot created in the root canal.

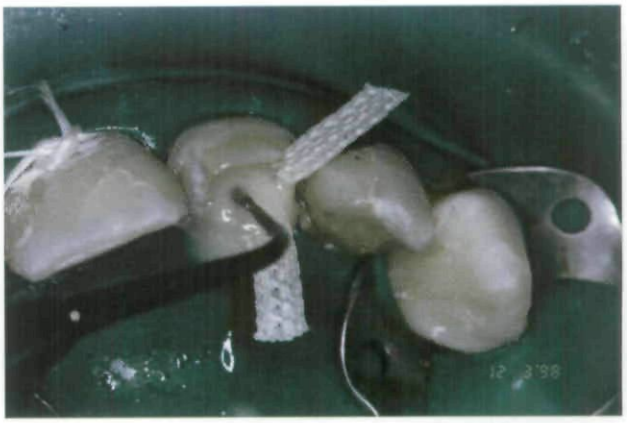

Fig. 6. Laying of Ribbond® fibers.

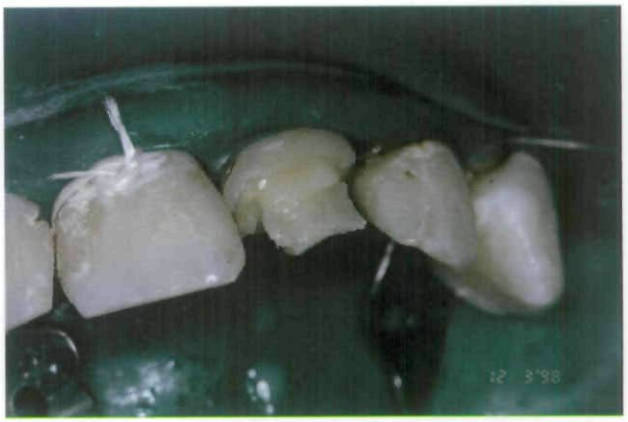

Fig. 7. Creation of a central support stump.

According to the esthetic requirements of the anterior sector, the dental morphology was perfectly restored together with a complete functional recovery. Clinical and X-ray control examinations (3, 6, 12, and 24 months later) confirmed the efficacy of the combined technique with polyethylene fibers and composite materials.

Fig. 8. Final result: ULCI is completely restored by composite materials.

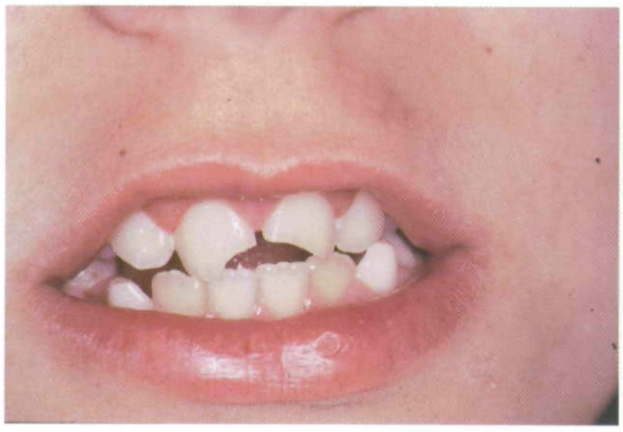

Fig. 9. First examination: crown fracture of both upper right central incisor (URCI) and upper left central incisor (ULCI).

Fig. 10. Crown fragment of ULCI.

Case 2

C.N, a 9-year-old patient, showed a crown fracture of both maxillary central incisors (Fig. 9). The vitality test was positive, and the crown fragment of the left incisor was available (Fig. 10). We restored the right incisor using the acid-etch composite resin technique. On the contrary, the dental morphology of the left incisor was restored using the crown fragment. Both the dental element and the crown fragment were etched by orthophosphoric acid (Conditioner 36, Dentsply De Trey Gmbh, Konstanz, Germany) and conditioned by the bonding agent (Scotchbond 1, 3M Dental Products, St. Paul, MN, USA). Then, the crown fragment was stuck to the tooth using a thin layer of composite resin (Spectrum T.P.H., Light-Cure Composite, Dentsply De Trey Gmbh, Konstanz, Germany) (Fig. 11).

Fig. 12. Failure of ULCI restoration by sticking the crown fragment.

Two months later, the crown fragment broke off (Fig. 12), and we decided to restore it using the combined technique with polyethylene fibers and composite resins. The anterior sector was isolated by a rubber dam (Hygenic Dental Dam, Coltène, Mahwah, NJ, USA), and the enamel surface was etched by orthophosphoric acid (Conditioner 36, Dentsply De Trey Gmbh, Konstanz, Germany) (Fig. 13).

Having evaluated the required length, polyethylene fibers (Ribbond Reinforcement Ribbon, Ribbon, Scottle, WA, USA) were cut by special nippers (Figs. 14 and 15).

Both the dental element and the polyethylene fibers were conditioned by the bonding agent (Scotchbond

Fig. 11. Final result after first restoration without fibers.

Fig. 13. Isolation of the anterior sector by a rubber dam.

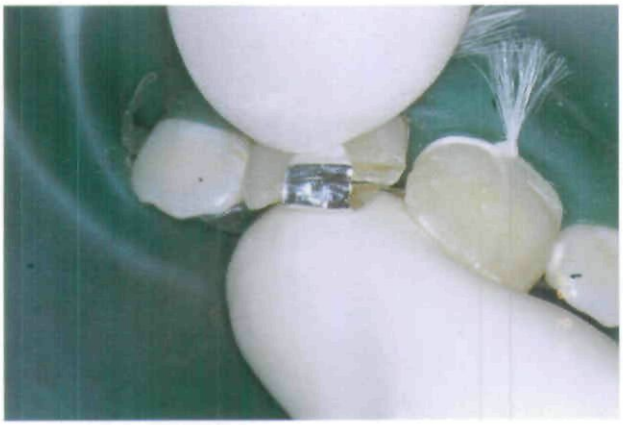

Fig. 14. Evaluation of fiber length required.

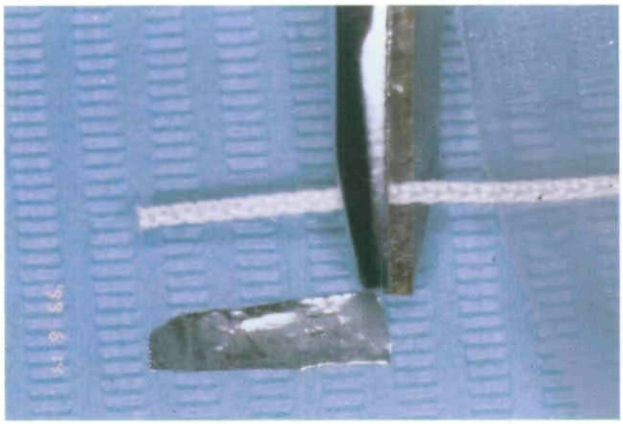

Fig. 15. Cutting of a Ribbond® fiber by using special nippers.

1, 3M Dental Products, St. Paul, MN, USA) (Figs 16 and 17).

Polyethylene fibers were laid correctly, and restoration was completed by stratifying composite resin (Spectrum T.P.H., Light-Cure Composite, Dentsply De Trey Gmbh, Konstanz, Germany) (Figs. 18–21).

The patient was recalled for periodic control examinations during which pulpal vitality and occlusion of the restored teeth were tested.

Fig. 16. A Ribbond® fiber is conditioning by the bonding agent.

Fig. 17. ULCI enamel surface is etched by orthophosphoric acid.

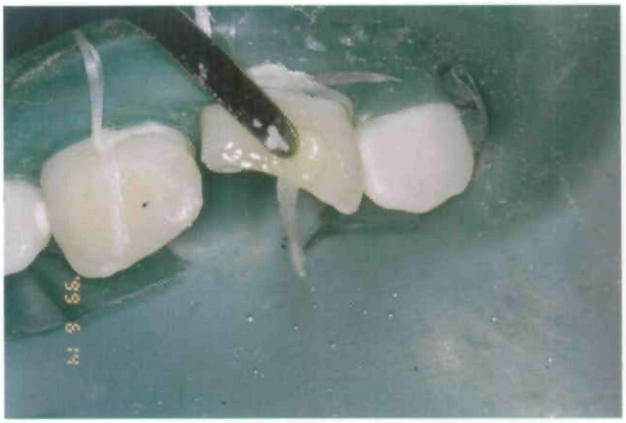

Fig. 18. Laying of Ribbond® fibers.

Discussion and conclusions

In the restoration of traumatized anterior teeth, both esthetics and mechanical resistance to fracture are of great importance in obtaining a good long-lasting result.

Ribbond® fibers represent an effective means to confer a higher mechanical strength to composite restorations, without changing the esthetic result.

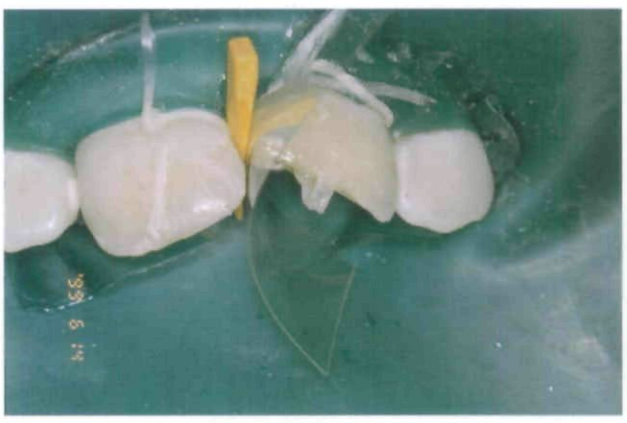

Fig. 19. Restoration of ULCI by the composite's incremental technique.

Fig. 20. Final results.

Fig. 21. Control examination after 18 months.

The translucency of Ribbond® fibers makes them more esthetic than Kevlar or carbon fibers.

In the clinical cases treated, we found it very easy to lay Ribbond® fibers and stratify composite materials, allowing a quick restoration of the dental morphology.

During control examinations, the efficiency of the combined technique of polyethylene fibers and composite resins was confirmed; in fact, there were no restoration fractures or dimensional changes.

In the case of a complex crown fracture, the dental restoration by Ribbond® fibers and composites to create a central support stump could be a useful therapeutic approach in order to shorten the recovery period following prosthetic restoration. In fact, it is possible to avoid a new intervention on the stump and to proceed directly to prosthetic shaping.

In conclusion, the authors suggest that this combined technique of polyethylene fibers and composite materials could be a very efficient alternative procedure to conventional plans of treatments in traumatized anterior teeth, with excellent esthetic and functional results.

References

1. Samadzadeh A, Kugel G. Fracture strengths of provisional restorations reinforced with plasma-treated woven polyethylene fiber. J Prosthet Dent 1997;78(5):447–9.
2. Vallittu PK, Vojtkova H, Lassila VP. Impact strength of venture polymethyl methacrylate reinforced with continuous glass fibers or metal wire. Acta Odontol Scand 1995; 53:392–6.
3. Manley TR, Bowman AJ, Cook M. Denture bases reinforced with carbon fibres. Br Dent J 1979;146:25.
4. DeBoer J, Vermilyea SG, Brady RE. The effect of carbon fiber orientation on the fatigue resistance and bending properties of two denture resins. J Prosthet Dent 1984;51:119–21.
5. Yazdanie N, Mahood M. Carbon fiber acrylic resin composite: an investigation of transverse strength. J Prosthet Dent 1985;54:543–7.
6. Goldberg AJ, Burnstone CJ. The use of continuous fiber reinforcement in dentistry. Dent Mater 1992;8:197–202.
7. Uzun G, Hersek N, Tincer T. Effect of five woven fiber reinforcements on the impact and transverse strength of a denture base resin. J Prosthet Dent 1999;81(5):616–20.
8. Berrong JM, Weed RM, Young JM. Fracture resistance of Kevlar-reinforced polymethyl methacrylate resin: a preliminary study. Int J Prosthodont 1990;3:391–5.
9. Ramos V, Runyan D, Christensen L. The effect of plasma-treated polyethylene fiber on the fracture strength of polymethyl methacrylate. J Prosthet Dent 1996;76(1):94–6.
10. Vallittu PK, Lassila VP, Lappaleinen R. Acrylic resin-fiber composite. Part I. The effect of fiber concentration on fracture resistance. J Prosthet Dent 1994;71:607–12.
11. Vallittu PK. Ultra high modulus polyethylene ribbon as reinforcement for denture polymethyl methacrylate: a short communication. Dent Mater 1997;13:381–2.
12. Ladizesky NH, Cheng YY, Chow TW, Ward IM. Acrylic resin reinforced with chopped high performance polyethylene fiber – properties and denture construction. Dent Mater 1993;9:128–35.
13. Gutteridge DL. The effect of including ultra-high-modulus polyethylene fibre on the impact strength of acrylic resin. Br Dent J 1988;164:177–80.
14. Branden M, Davy KWM, Parker S, Ladizesky NH, Ward IM. Denture base poly (methyl methacrylate) reinforced with ultra high modulus polyethylene fibres. Br Dent J 1988;164:109–13.
15. Dixon DL, Breeding LC. The transverse strengths of three denture base resins reinforced with polyethylene fibers. J Prosthet Dent 1992;67:417–9.