Immediate Anterior Tooth Replacement using Fibre-reinforced Composite

G. Auplish and U.R. Darbar

Abstract: The loss of anterior teeth can be psychologically and socially damaging to the patient the trauma of which can be minimized by immediate replacement of the teeth, preferably using a fixed prosthesis. This paper describes the immediate replacement of a lateral incisor using a fibre-reinforced composite with the natural tooth as the pontic. The abutment teeth can be conserved with minimal or no preparation, thus keeping the technique reversible, and can be completed at the chairside thereby avoiding laboratory costs. It can be used as an interim measure or as a definitive prosthesis. The advantages of this technique over other methods are also discussed.

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Clinical Relevance: The method presented is an expedient, cost-effective and simple way of replacing anterior teeth and maintaining the aesthetics.

Fibre-reinforced materials have been used for a number of years in the aircraft and boat industries. This concept was first applied to denture acrylics[1] in the early 1960s to improve fracture resistance and more recently has been used with composite resins to overcome problems of low resilience, fracture resistance and toughness.[2] The principle of fibre reinforcement involves incorporation of thin filaments of a foreign material into a base resin. The surface configuration of each filament has intrinsic mechanical roughness which helps to lock the filaments into the composite mass. These filaments impart increased flexural strength, fracture resistance and increased tensile strength to the finished restoration by bonding into the structure and preventing crack propagation through the restoration.[3]

Although carbon and kevlar fibres were initially used, these have largely been superseded with fibres made of high-density polyethylene, glass or polypropylene in bundles of 10–20 microns because their appearance is superior. The bundles are usually white, however, when wetted with the resin they become invisible. The fibre bundles are available either as loose, twisted or woven fibres. Woven fibres have a thickness of 0.25–0.50 mm and, owing to their multidirectional reinforcement to the composite resin, impart better strength characteristics.[4] The strength of the resulting structure depends on the volume of fibres embedded in the resin matrix. The higher the number of fibres, the better the strength characteristics. Complete wetting of the fibres is crucial to maintain maximum strength characteristics.

Currently available fibre bundles are manufactured as two types:

- pre-impregnated with resin;
- non-impregnated.

In the former the 'fibre bundles' are pre-wetted with a low-viscosity resin in the laboratory in a controlled manufacturing process. The fibres used in these materials are usually continuous and long and have been shown to impart higher flexural properties due to their higher fibre content.[5,6] The main use of these pre-impregnated fibre-reinforced composites (FRCs) has been in the manufacture of indirect bridges.[7]

The non-impregnated fibres are 'wetted' at the chairside using a low-viscosity unfilled resin. A large number are currently available. Most are made of woven fibre bundles and provide similar results clinically (see below). The most widely described in this group are:

- Ribbond (Ribbond Inc., Seattle, WA, USA), a polyethylene fibre which is open weave with the threads twisted in pairs (leno weave); and
- GlasSpan (GlasSpan, Exton, PA, USA), a braided open weave glass fibre.

In the latter the internal reinforcement system of the fibre is composed of a silane etched glass and hence there is no need for a special cutting device. GlasSpan is available as a 4 mm tape and a 2 and 3 mm rope. Successful results have been reported with both systems for splinting of teeth, replacement of periodontally involved teeth and for use as substructures for bridges.[8,9]

This article describes the immediate replacement of a periodontally involved, traumatized maxillary lateral incisor

G. Auplish BDS, MSc, Clinical Assistant, Department of Periodontology, and **U.R. Darbar**, BDS, MSc, FDS (Rest Dent) RCS, Consultant in Restorative Dentistry, Department of Periodontology, Eastman Dental Hospital and Institute, London.

Figure 1. *The extruded |2 is clearly visible when the patient smiles.*

using the fibre-reinforced composite GlasSpan. The natural tooth was used as the pontic with the fibre-reinforced composite as the substructure.

CASE REPORT

A 48-year-old fit and healthy woman was referred to the Periodontology Department of the Eastman Dental Hospital by her general dental practitioner. She presented complaining of discomfort and poor appearance associated with |2. The tooth had been traumatized by a hit from a badminton racket a few years previously and had since dropped, leading to it catching on her lower lip. The tooth was visible because it rested on the lower lip when the patient smiled (Figure 1).

Clinically |2 had extruded (Figure 2a) and was grade I mobile, but it was not in traumatic occlusion and gave a positive response to vitality testing. An isolated 8 mm probing depth with immediate bleeding on probing was noted on the mid-palatal aspect, where a palatogingival groove was also present (Figure 2b). Elsewhere, despite some gingival recession, periodontal health was good. Radiographs revealed a localized crater defect associated with |2 (Figure 3). A diagnosis of localized adult periodontitis was made, and the prognosis of |2 was considered poor.

Initial Treatment

Initial treatment was aimed at eliminating the inflammation associated with the tooth by carrying out non-surgical debridement at the same time as flattening the palatogingival groove and reinforcing the oral hygiene. At review a few weeks later the discomfort associated with the tooth had decreased; however, a persisting 5 mm probing depth remained midpalatally and the patient had now become more concerned about the aesthetics. Different treatment options to improve the tooth position were considered and included orthodontics and extraction. The patient was not keen on pursuing orthodontic treatment and requested a simple option that provided her with immediate improvement of her appearance. She was also keen to avoid a removable prosthesis.

A mutual decision was made to extract the |2 and replace it immediately using the natural tooth as a pontic. The GlasSpan fibre-reinforced composite was chosen as the retainer. The procedure was explained to the patient and the inter-occlusal space assessed and occlusion checked. Adequate space was available inter-occlusally and hence no preparation of the abutment teeth was indicated. The patient was scheduled for the extraction and restoration of the space at the next visit.

a b

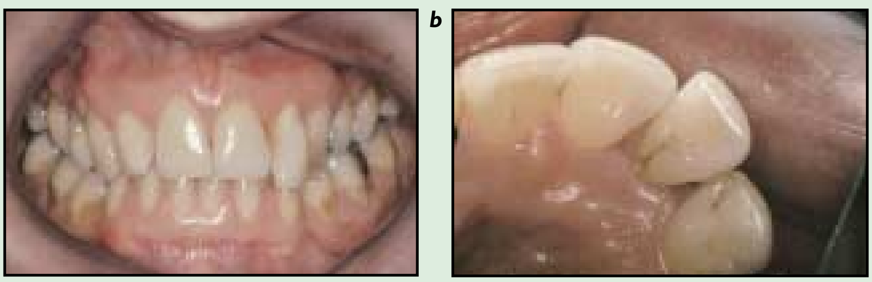

Figure 2. (a) *Intra-oral view, showing the extruded |2.* ***(b)*** *Palatal view, showing the palatogingival groove contributing to the localized 8 mm probing depth.*

Figure 3. *The bony defect associated with |2.*

Treatment

The tooth was atraumatically extracted under local anaesthesia and haemostasis achieved. The extracted tooth was sectioned at the root to the required length, allowing for post-extraction resorption and tissue shrinkage (Figure 4) and the palatal aspect of the fitting surface was contoured to facilitate cleaning. The newly prepared pontic was tried in, and shown to, the patient to ensure that she was happy with the appearance. An index with the tooth in this position was made with beading wax. The root canal and pulp chamber were accessed via the newly formed root apex and all residual pulpal contents removed. The chamber was then dried and the resulting cavity restored with glass ionomer (Ketac Fil, Espe America Inc., PA, USA) (Figure 5).

Cementing the Pontic

- The abutment teeth were isolated with rubber dam, cleaned with pumice, washed and dried.
- The pontic was also cleaned with pumice, washed and dried and then placed in the mouth to the required position using the index prepared earlier.
- Dental floss was used to measure the length of fibre required (mesial surface of |1 to the distal surface of

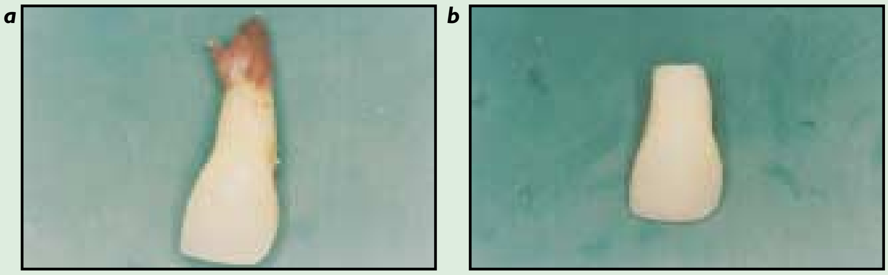

Figure 4. (a) *The* |2 *immediately following extraction.* **(b)** *The prepared pontic following extraction.*

|3) and cut. This was used as a template to cut the GlasSpan tape as per the manufacturer's instructions. Care was taken not to handle the fibre with gloves to avoid contamination.

- The abutment teeth and pontic were then etched with 40% phosphoric acid for 30 seconds, washed and dried.
- Unfilled bonding resin (Kerr XR, Kerr, MI, USA) was applied to the etched enamel and cured. Wooden wedges were then placed interdentally to maintain the embrasure spaces.
- A thin layer of composite resin (Herculite XRV, Kerr, MI, USA) was placed across the abutment teeth and the pontic.
- The pre-cut fibre was thoroughly wetted using the unfilled resin, placed over the composite and cured.
- A further layer of composite was then placed over the tape, ensuring that all of it was covered by composite, and cured.
- Excess composite was removed and the occlusion was checked in protrusion and lateral excursions. In the latter, canine guidance was maintained with no contact on the pontic. Final polishing of the bridge was completed (Figure 6).

Figure 5. *Palatal view, showing the root canal filled with glass ionomer and shape of the root face.*

The patient was pleased with the outcome and was given instructions on cleaning under the pontic and maintaining her oral hygiene. At review one week later she remained happy with the outcome and was subsequently seen for three-monthly reviews. One year after treatment the bridge remained intact with no problems and the aesthetics continued to be good (Figure 7). The patient will be kept under yearly surveillance.

DISCUSSION

The advantages of immediate replacement of teeth using resin-bonded bridges have been previously reported.[10] However, with this technique problems with compromised aesthetics due to metal shine through and laboratory costs persist. The case presented describes a technique based on similar principles but which overcomes the aesthetic compromise by using a composite resin with a fibre-reinforced tape as the retainer.

Although composites have been used extensively for aesthetic replacement of teeth, the biggest drawback with these materials has been their low fracture resistance and resilience, which limits their use in fixed bridgework. In the past these properties have been improved by reinforcing the composite with wire, wire mesh or fibre mesh. It was necessary to use the material in bulk in order to cover the strengthening material and failure commonly occurred at the composite/strengthener interface, providing only limited success.

Fibre reinforcement has helped overcome this problem, largely by creating a chemical bond between the strengthening fibre and composite – thus preventing crack propagation.[3] Tests have shown that the FRCs demonstrate rigidity and flexural strength seven times that of particulate composite resin alone[11] and when used appropriately the strength parameters can be increased by 400–500%.[4] Additionally the flexure strength of the FRCs is comparable with that of the fixed partial denture alloys.[12] The use of GlasSpan in the replacement of periodontally involved teeth has been reported, with few failures over a 4-year period,[9] and similar results have been documented with other FRCs with no significant differences between types.

The technique itself is relatively straightforward, although for maximum results optimum moisture control is necessary. Complete wetting of the fibre and full coverage with composite is essential to obtain maximum strength. Incomplete wetting of the fibre results in the fibre becoming a weak contaminant in the system and leads to early failure.

The one-stage bonding systems should not be used with fibre reinforced composites. In these systems, as the primer and bond are incorporated together, the presence of the primer can lead to incomplete wetting of the fibres. The tape was used in this case to give extra volume of fibres in the restoration for greater strength.

Figure 6. *Immediate postoperative appearance: note the improved position.*

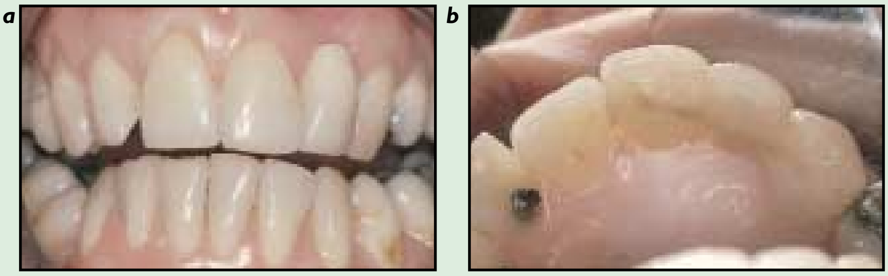

Figure 7. *Appearance labially **(a)** and palatally **(b)** at one year recall. The restoration remains intact although mild staining has occurred.*

Beading wax was used as a locating index for simplicity; however, other materials (such as silicone putty) may also be used. Although the fibre enables the composite to be used in thin sections, the restoration was slightly bulky palatally as no preparation of the teeth was carried out. Some have advocated extensive tooth preparation[13] when using adhesive techniques but this remains controversial – high success rates have been quoted with adhesive bridges where minimal (or no) tooth preparation has been carried out.[14,15] It is essential that adequate space is available inter-occlusally for the restoration, especially if no tooth preparation is carried out. Special luting cements are not required as the material used is composite resin which bonds onto the tooth and the fibre.

Although the technique can be time consuming and technically demanding, requiring increased chairside time, the key advantages are the excellent aesthetic result, the preservation of tooth structure and reduced patient costs. Most importantly, the extracted tooth can be replaced at the same visit as the extraction because no laboratory work is required, which reduces the psychological impact on the patient of tooth loss. Additionally, as the technique is reversible it allows other restorative options to be evaluated if the need arises and can be used as an interim or definitive prosthesis. Although limitations can be encountered with spaced teeth, good aesthetics can be achieved by considering composite build-up of the abutment teeth to allow space closure.

The use of FRCs for this purpose is relatively recent, with most documentation relating to the pre-impregnated fibres used in the laboratory fabrication of restorations. When used as splints these materials have shown excellent promise. Long-term follow up of the non-impregnated systems will be required to prove their success, however, with the excellent long-term results shown by the use of adhesive restorations this should not be a problem – providing the technique is executed with care.

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