Better treatment outcomes

Iain Hathorn discusses the changing role of orthodontics in modern multi-disciplinary treatment planning

The quality of orthodontic treatment outcomes have improved dramatically over the last 20 years. The widespread use of fixed appliances has meant that more precise tooth movements are achievable and there is a greater appreciation of the need for careful treatment planning. In treatment planning, the precision of the tooth movements achievable, allows more subtle issues such as profile and details within a smile to be considered.

The ideal smile

Orthodontic patients are usually referred to their specialist by general dental practitioners or hospital-based specialists, such as paediatric dental consultants, restorative consultants or maxillo-facial consultants. Orthodontic treatment increasingly requires a joint planning process to achieve the best results. For those with missing teeth, it is often the case that replacement of the teeth will give the ideal smile. This is only achievable with a full joint discussion between the GDP or restorative specialist and the specialist orthodontist. Whether the restorative solution is a bonded bridge or an implant, there are very particular space needs and the roots of the adjacent teeth to the space will also require careful consideration. This joint planning and close working is a very exciting process, which is increasingly a key part of our working lives as specialist orthodontists. Our patients are without doubt given a much greater range of opportunities with careful joint planning.

Long-term results

Our paediatric dental colleagues are encouraged to refer a considerable number of severe hypodontia patients who can be offered very achievable joint results with the introduction of multi-implant anchorage devices. These exciting anchorage devices allow much better control of tooth movement. We can give these patients a considered long-term result with careful multidisciplinary planning. This can include a number of stages in the patient’s care which may involve short-term use of prosthetic appliances, to take our young patients through the mixed dentition into the orthodontic phase, followed by careful retention before the final definitive treatment perhaps involving restorative implants in the patient’s early twenties.

For many years, hospital-based orthodontic colleagues in orthodontics and maxillo-facial surgery have worked together to prepare cases with severe facial deformity and those with misplaced teeth, for carefully planned surgery. The orthodontist’s role has been to gather the appropriate records for planning jointly, using ever more sophisticated computer planning aids for facial deformity and for the many dento-alveolar problems a carefully integrated joint plan to achieve an ideal outcome.

Two very important responsibilities of these exciting areas of joint planning and execution of treatment, is the need for long-term care and audit/research.

Rare specialist skills

The joint restorative planning of replacement of missing teeth can only be achieved by including a long-term view of the on-going support for the retention of the newly aligned teeth and the support and maintenance of the restorations. Unfortunately, though we are capable of achieving stunning joint work, the specialist skills are spread very thinly in certain parts of the UK.

Joint working in many areas, such as cleft care has set a very good example of how health changes can be achieved based on good audit and research. You only have to read the CSAG report on cleft care, which in turn led to the establishment of new multi-disciplinary units, to appreciate the virtues of collecting good orthodontic records. In the multi-disciplinary care for facial deformity and restorative problems, we should build up a bank of evidence to guide future joint planning. Already, single implants have been seen to have problems, as differential tooth eruption takes place – this can only be judged by accumulating good joint clinical evidence.
Fibre reinforced composites in dentistry

Dr L Gregor and Dr V Pavelka look at the development of Dentapreg technology, fibres pre-impregnated with light-curing dental resin

Fibre Reinforced Composites (FRCs) were introduced to the art of dentistry in the 1980s. The first generation of these materials was based on dry woven strips made of Ultra High Molecular Weight Polyethylene (UHMWPE) under the trade name Ribbond (Ribbond Inc., USA) and Connect (kerr, Inc., USA) or glass fibres GlasSpan (GlasSpan Inc., USA) which were, after proper impregnation with dental resins, used for preparation of oral or vestibular splints and post-or-thodontic retainers.

However, the need to hand impregnate the ‘dry’ fibrous reinforcement in the office or lab resulted in poor reproducibility and reliability of these devices. Low fibre content in these strips resulted in low stiffness and strength of the cured structures and led to relatively bulky devices. Moreover, complicated lab and office procedures to prepare the semi-finished impregnated strip prior to forming the device required special handling.

Learning by mistakes

The shortcomings of dry reinforcements led to the development of the factory pre-impregnated FRC material combining high stiffness and strength, superior aesthetics, easy handling and ensures the reproducibility of the procedures. On the basis of these requirements, the researchers at the University of Connecticut developed fibre reinforced composite materials in which fibres were pre-impregnated with thermoplastic resins in the late 1980s. These pre-impregnated glass fibre strips were protected under a US patent.

Further research by Professor Janczar and his group at Brno University of Technology in the Czech Republic resulted in development of the Dentapreg technology, producing fibres pre-impregnated with light-curing dental resin.

Commercial versions of light-curing pre-impregnated fibre strips were introduced by ADM, at the Greater New York Dental Meeting in November 1995 under the name ‘ES – Comp’ (renamed in 2001 to Dentapreg). Two years after Ivoclar (Lichtenstein) and Pentron (USA) introduced their versions of pre-impregnated fibrous reinforcements under trade names Vectris (Ivoclar) and Fibrebond (Pentron). Stick-Tech (Finland) in late 1990s and Angelus (Brazil) in early 2000s followed with their products.

What FRCs are made of

Usually, the FRCs consists of three main parts. These are polymer matrix, reinforcing fibres and the fibre-matrix interphase. Neat uncured resin has low viscosity and can be relatively easily processed. Also, it usually exhibits good chemical resistance and a bond ability to tooth structure. On the other hand, low Young’s modulus of elasticity, strength, brittleness and relatively poor creep resistance means it isn’t suitable for use in structural components. On the other hand, fibres exhibit required strength and stiffness;

Table 1: Comparison of Dentapreg products with the commonly used FRC materials in dentistry showing its advantages.

<table>
<thead>
<tr>
<th>Other fibre composites used in dentistry</th>
<th>Dentapreg</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of used fibres</td>
<td>E – glass, Polyethylene</td>
<td>E – glass, S2 – glass</td>
</tr>
<tr>
<td>Fibre surface treatment</td>
<td>Silanisation of (E – glass) Plasma etching (Polyethylene)</td>
<td>Silanisation (E – glass) PECVD (S2 – glass)</td>
</tr>
<tr>
<td>Type of monomer</td>
<td>MMA, PMMA, derivate of monomer dimetacrylate and dimethacrylate monomers</td>
<td>Mixture of monomers with enhanced properties</td>
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Fig. 1: SEM of the Dentapreg PECVD Inter-phase Showing Excellent Adhesion between Resin Matrix and Glass Fibres.

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however, they are very brittle and of low resistance in aggressive environments. This makes it very difficult to process them and stabilise them into the required shape.

The matrix-fibre contact area plays a crucial role in determining properties and stability of cured FRC structures. It is necessary to have good bond between fibres and the polymer matrix, for at least two main reasons. First, fibre-matrix adhesion controls the stress transfer from relatively a weak matrix to strong fibres. This ensures good mechanical properties of FRCs. At the same time, good interfacial adhesion is needed to seal the boundary between fibres and the matrix to prevent diffusion of liquids along the fibres, which would deteriorate properties and result in discoloration of the cured structures. The surface of glass fibre is very sensitive to moisture. Thus, the appropriate surface treatment, in addition to ensuring good properties and environmental stability of FRCs, protects fibres from the environment during handling.

The unique fibre surface treatment in Dentapreg’s FRCs is obtained utilising plasma enhanced chemical vapor deposition (PE-CVD). This technique enables formation of a direct chemical bond between the fibres and polymeric matrix (see Figure 1) and substantially enhances the hydrolytic stability of the cured FRC device in the oral environment. The types of commercially most used glass fibres, polymer matrixes and fibre surface treatment are shown in Table 1. There are some apparent differences between individual products.

The FRC products currently on the market, can be used for preparation of oral, vestibular and occlusal splints, post-orthodontic retainers permanent or temporary bridges in anterior or posterior area, for reinforcing and repair of dentures or acrylic devices, for repair of metal fused to ceramic veneers, reinforcing of large restorations, preparing of anatomical posts. Three typical applications (Maryland two members bridge, inlay posterior bridge and anatomical posts from Dentapreg products) follow:
enhanced usage. Their biomechanical properties are near dentinal tissue. The reconstruction of endodontically treated teeth significantly reduces the potential risk of root fracture. Root canals are of different shapes. Prefabricated FRC posts are always of rounded diameter and sometimes don’t correspond with the shape of root canal. In this case, it is possible to employ the ‘anatomical post’ technique, by using pre-impregnated non-polymerised Dentapreg strips.

**FRC splinting**

Splinting is a treatment procedure, which helps us stabilise teeth and support the periodontal tissues during healing. Many different techniques have been described various studies through time, and it seems the most popular technique involves using orthodontic wire fastened to teeth by composite. FRC splints in combination with adhesive systems performed the latest technique in splinting of periodontal teeth.

Sometimes, if teeth are missing, we can combine FRC splinting with direct replacement of missing teeth.

**Non-metallic IFPDs**

Resin bonded inlay fixed partial denture is a treatment alternative for replacement of missing teeth when conservation of tooth structure is needed (Freilich et al. 1998). Until now, the clinical application of dental restorations to restore missing posterior teeth could only be performed using conventional metal systems, due to high mechanical loading in this area. The development of FRC brought the possibility of using this material like framework for IFPDs.

Fibre-reinforced materials are recommended for their ability to withstand high mastication forces. Generally we can divide IFPDs in two basic groups: laboratory made IFPDs (indirect technique) and in office made IFPDs (direct technique). For long term success (permanent IFPDs restoration) it is proposed to use indirect technique. Direct technique is used for temporary replacement of missing teeth (in the case of implant healing or periodontal treatment).

For more information on the Dentapreg fibres, call Abacus on 01274 865444, or email sales@abacusdental.eu

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