Extending the boundaries of feasibility in direct restorative procedures

A clinical case combining a high-performance material and clearly defined protocol

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**Fig. 1**: Severely discoloured tooth #11.
**Fig. 2**: The shape of tooth #11 appeared to be harmonious with tooth #21. The substance loss amounted to somewhat less than half of the tooth.
**Fig. 3**: After the bleaching procedure, the shade of tooth #11 was optimal.
**Fig. 4**: Prepared tooth #11 with vestibular chamfer and straight, right-angle palatal margin.

Modern high-performance composite materials and standardised treatment protocols have led to more direct composite restorations being fabricated in the anterior region than ever. Even extremely challenging cases may now be treated chairside with predictable results and minimal loss of tooth structure.

A 24-year-old female patient presented at our practice with a request regarding aesthetics. She disliked the appearance of tooth #11, which showed severe discolouration after endodontic treatment. A clinical examination revealed that the root had been extirpated after an accident and that a fractured piece had been reattached with a composite material (Figs. 1 & 2). Upon radiological examination, it was found that the root-canal treatment had been performed correctly. However, a post had not been used.

Owing to the fact that approximately half of the original tooth structure had been lost, we opted...
for a direct composite restoration, provided that a tooth-whitening procedure could be successfully completed. Along the spectrum of possible treatments, this approach is located between "conventional" composite restoration and ceramic veneering and, therefore, appeared to be clinically appropriate.

The patient, whose primary concerns were a natural tooth shade and minimal loss of tooth structure, agreed to the recommended procedure. We decided to use the nano-hybrid composite IPS Empress Direct (Ivoclar Vivadent) to fabricate the restorations. In addition to dentine and enamel materials, this product is also available in an opalescent material version.

_Preliminary treatment_

First, internal bleaching was performed on the tooth, on which the success of treatment would depend. Access to the endodontic chamber was created through the old restoration. The gutta-percha increment was removed up to 3 mm below the cemento-dentinal junction. At the bottom of the cavity, a plug with a thickness of 2 mm made of glass ionomer cement was inserted to prevent the bleaching agent from accessing the sensitive areas. We used a mixture of sodium perborate and distilled water for the bleaching procedure. The access to the cavity was then sealed with a temporary material.

Since the desired tooth shade was not achieved upon initial bleaching, the entire procedure had to be repeated after one week. After another week, the result was finally optimal (Fig. 3). In order to neutralise the bleaching agent, calcium hydroxide was placed into the cavity and left in place for at least one week. (An adhesive may only be applied 15 days after conclusion of the bleaching procedure, in order to ensure optimum adhesion and stable shade.)

_Aesthetic diagnosis and shade determination_

After tooth-shape analysis, we concluded that the proportions were harmonious compared with tooth #21. In order to avoid a misinterpretation of the shade owing to dry adjacent teeth, the tooth shade was determined prior to any intervention and in daylight. The IPS Empress Direct shade guide was used for the determination of the enamel and dentine materials. We determined the dentine shade based on the cervical third and the enamel material based on the incisal third of the adjacent tooth. Particular attention was paid to the anatomical structure of the adjacent tooth and the various opalescent reflections visible on the incisal surface, since it was our aim to imitate these features.

A layering diagram detailing all the materials that we planned to use was prepared. In this case, only four shades were used: A3/A2 Dentin, A2 Enamel and Trans Opal.
Subsequently, we created a palatal silicone key on tooth #11 with the appropriate shape and occlusion. Once in place intra-orally, this key helped to create the palatal wall of the restoration in one step. The key included the teeth adjacent to the tooth that needed to be restored and covered the incisal area.

Preparation and application of the adhesive

The existing restoration was removed with the help of both rotary and ultrasonic instruments and with care to prevent any damage to the adjacent teeth. During the preparation of the tooth, the mechanical properties of the material used and the aesthetic integration needed to be taken into account. In the case of IPS Empress Direct, the ideal preparation design involved a vestibular chamfer and a straight, right-angle proximal and palatal margin (Fig. 4).

Before proceeding with the adhesive cementation, it was necessary to protect the operatory field from saliva or blood in the oral cavity. Therefore, we isolated the anterior teeth, including the canines, with a rubber dam. The expanded treatment area allowed us to assess the incisal line, and the size and shape of the adjacent teeth.

We checked whether the silicone key could be positioned exactly. (If required, interfering areas can be adjusted using a scalpel until a precise fit is achieved.) The enamel areas were etched for 30 seconds and the dentine for 15 seconds. Both were then thoroughly rinsed and dried.

Subsequently, the adhesive was applied, while the adjacent teeth were protected with a metal matrix. We used the ExciTE F total-etch adhesive (Ivoclar Vivadent) for this step. Owing to the non-retentive preparation design and the fact that most of the restoration would be created on enamel, this type of adhesive proved superior to self-etching products. In order to facilitate penetration into the dentine tubules, the adhesive was gently massaged into the cavity walls. (After the adhesive has dried, the cavity must exhibit a glossy appearance. If this is not the case, the procedure needs to be repeated.)

The adhesive was then light-cured for 10 seconds with a bluephase curing light (Ivoclar Vivadent).

Building up the palatal and proximal walls

As a first step, the palatal enamel was built up. A thin layer of enamel material (shade A2) of less than 0.5 mm was applied to the palatal key and smoothed out with a brush. Then the key loaded with composite material was placed in the mouth and the fit was checked again. If necessary, the material may be modified before it is polymerised for 10 seconds.

The palatal wall created in the process showed the exact desired shade and did not touch the adjacent teeth (Fig. 5).

Applying a thin layer of enamel material (A2) to the proximal walls changed the complex cavity into a simple one. In order to create the thin layer, we fixed a transparent matrix in place with a wooden wedge, which allowed us to create the transition lines (the convex area that separates the proximal from the vestibular area)—the restorative outcome is influenced by the successful design of these transitional areas because it is not possible to design them with rotary instruments. We then applied composite material from the distal side of tooth #11, while tightening the matrix from the opposite side and polymerising the material in this position (Fig. 6). Thus, sufficient composite material could be added until the desired transition area was achieved. The mesial side was built up in the same manner (Fig. 7).

Building up the dentine core

Using dentine materials, a restoration is created that shows decreasing saturation from the cervical
to the incisal and from the palatal to the vestibular area. In order to achieve this, a 3-D layering technique is applied, using materials with different levels of saturation. In our case, a material with a saturation one degree higher than the desired final tooth shade was applied. Therefore, dentine material in shade A3 was used in the area of the cervical margin.

The layer was applied to the palatal wall using a flat spatula suitable for composite resins (Fig. 8). Subsequently, a layer consisting of dentine material with a lower saturation was applied (shade A2). A pointed silicone instrument was used to design a slightly wavy margin covering half of the chamfer up to 1 mm below the incisal edge (Fig. 9). (If this technique is applied, the translucency of the enamel material becomes visible in the area of the incisal edge and the transition from tooth structure to composite material is masked.)

Each layer was polymerised with the bluephase curing light for ten seconds.

_Designing the enamel portion_

The opalescence effect was enhanced by applying a thin layer of Trans Opal material in the area of the incisal edge. Since the visible effect of this material is very intense, only a small amount could be used. An enamel layer (shade A2) was applied in several steps to the vestibular area, then contoured with brushes and cured for ten seconds. This enamel material covered the entire restoration (Fig. 10).

_Finishing and polishing_

The patient’s teeth exhibited a very pronounced macro- and microtexture (vertical pits and horizontal streaks, respectively). Imitating these features to achieve a lifelike reflection on the restorative surfaces was a challenging task.

This step was similarly important to determining the appropriate shade. We imitated the surface texture with fine-grain diamond-coated burs, using flame- and lens-shaped instruments (first with the red and then with the yellow colour code). The burs were used in the red handpiece without water irrigation.

Another important step was the finishing of the transition lines and the interproximal areas. It is advisable to use abrasive strips for this purpose because rotary instruments may produce flat areas that cause inappropriate reflections. OptraPol Next Generation polishers (Ivoclar Vivadent) with water irrigation were used for the polishing process. We always take great care to polish restorations perfectly whilst avoiding any damage to the surface texture we design. The polishing was greatly facilitated as a result of the extraordinary polishability of this composite material (Figs. 11 & 12).

_Conclusion_

Owing to high-performance materials such as IPS Empress Direct, which are consistently improving, and a clearly defined approach, we may use direct restorations for more indications than ever before, thus constantly extending the boundaries of feasibility. The advantage of direct restoration procedures is that they are time saving and conservative. Nevertheless, it may happen that directly restored teeth show discolouration again in spite of the perfect aesthetic outcome. In this case, another treatment is inevitable.

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The composite restoration is the basic foundation of the general dental practice. Countless composites are placed by dentists every day. Through the science of adhesive dentistry, these restorations can be conservative and provide long-term service. With time and function some breakdown may occur, usually at the margin of the restoration, the interface between the tooth structure and composite resin. In many cases, while the margin shows localised breakdown, the rest of the restoration remains intact. The dentist is then faced with the decision of replacing or repairing the restoration.

In the days before adhesive dentistry, when an amalgam margin began to break down, the entire restoration was soon compromised. There was no tooth–amalgam bond or seal to prevent the leakage and percolation of saliva, bacteria and bacterial products into the area under the amalgam and the adjacent tooth structure. This environment allowed bacteria to thrive, creating further breakdown and secondary caries.

With the advent of adhesive dentistry, leakage is no longer a major concern. Even in situations where the restorative margin has become defective, the bulk of the restoration is still sealed against bacterial challenge. It is, however, important not to leave these margins open over the long term. With time, there can be further marginal breakdown and secondary decay around the perimeter of the restoration. The dentist should not leave the restoration until it becomes unsalvageable and must be replaced entirely. With today's technology and materials, there are tools to address the situation proactively at an early stage, before more extensive treatment becomes necessary. This approach is the perimeter preparation.

The ultimate wish list

What tools are needed to repair and restore the defective margins of a composite resin restoration? First, there must be an excisional instrument (bur) that is conservative and minimally invasive. This bur should access marginal decay with minimal tooth removal. Second, the restorative material must flow easily into all the irregularities of the perimeter preparation. The typical preparation is very narrow. It may also be long and convoluted, following the defects at the margins of the restoration and the surrounding tooth. The dental material of choice is a flowable composite resin, which can easily penetrate the intricate geometry of the narrow preparation without bubbles or gaps. The ideal material should have strength and wear resistance to withstand all oral forces. It must be radiopaque to allow for monitoring of treated sites. Additional features to this ultimate wish list are plaque resistance and remineralising properties, to prevent future perimeter breakdown. The ultimate wish list is no longer dental science fiction. These tools, materials and techniques are available, as discussed below.

Fissurotomy Bur

The Fissurotomy Bur system (SS White Burs) was developed to detect and remove incipient decay in enamel proactively (Fig. 1). The shape and size of the Fissurotomy Bur are designed specifically for treating early pit and fissure lesions. The head length is 2.5 mm, allowing the dentist to control the bur tip to cut just below the amelodentinal junction and...
no further. The tapered shape of the bur allows the cutting tip to encounter very few dentinal tubules, and to minimise heat build-up and vibration. This has the added advantage of decreasing patient discomfort and the need for local aesthetic. Traditional cutting burs remove far more enamel at any depth of cut and are far more invasive.

The Fissurotomy Bur is the ideal excisional tool for the perimeter preparation. It is conservative and minimally invasive. It can access decay with little tooth removal. The Fissurotomy Bur is the proactive tool for the repair of defective composite restoration margins.

_Giomer flowable restorative materials_

Giomers (Beautifil II and Beautifil Flow Plus, both SHOFU) are the latest category of hybrid restorative materials. Giomer technology represents the true integration of glass ionomers and composite resins with the benefits of both. Giomers provide the fluoride release and recharge of glass ionomers, and the aesthetics, physical properties and handling of composite resins.1

Studies have demonstrated that dentine remineralisation occurs at the preparation surface adjacent to the giomer.2 Furthermore, giomer restorations take up the extra fluoride ions released by fluoride toothpastes, rinses and varnishes in oral fluids. The giomer restorations then function as reservoirs when fluoride is needed in the oral cavity.3, 4

Giomer restorations resist plaque formation owing to a film that forms on the restorative surface when it contacts saliva. This film consists of aluminium, silica, strontium and other ions that originate from the giomer fillers and act to inhibit bacterial adhesion.5
A giomer flowable (Beautifil Flow Plus) has recently been introduced (Fig. 2). It combines all the healing advantages of giomer science with the ease of use, handling and adaptability of flowable composites. The physical performance (compressive strength, wear resistance, etc.) of Beautifil Flow Plus has been tested against leading hybrid composites and has been found to be equal or better. In addition, Beautifil Flow Plus is radiopaque. Beautifil Flow Plus is the ideal restorative material for the perimeter preparation. It fulfils all the necessary criteria: a flowable composite resin that easily conforms to the intricate geometry of the narrow preparation without creating voids, has strength and wear resistance to withstand oral forces, is bacteriostatic and remineralising to prevent secondary caries, and is radiopaque. The tools and materials for the perimeter preparation are now readily available and so is the simple technique that can be incorporated into daily dental practice.

**The perimeter preparation technique**

1. The occlusal margins of a composite restoration have begun to break down. There is no radiographic evidence that decay has spread far beyond the surface (Fig. 3).
2. All decay and questionable tooth material are removed with the Fissurotomy Bur (Fig. 4).
3. The perimeter preparation is examined for any remaining decay (Fig. 5).
4. Micro-abrasion can be used to increase the surface roughness and bondability of the preparation (Fig. 6).
5. Shofu BeautiBond the seventh-generation adhesive is applied to the cavity preparation (Fig. 7).
6. The adhesive is thoroughly air dried (Fig. 8).
7. A brief three to five seconds of LED light curing is all that is required for the adhesive (Fig. 9).
8. Beautifil Flow Plus is placed in the perimeter preparation and light cured (Fig. 10).

The completed perimeter preparation technique offers a restoration that will serve the patient effectively for many years (Fig. 11).

The perimeter preparation is an effective treatment option for proactive intervention dentistry. The dentist has the tools, materials and techniques to manage restorative marginal breakdown at an early stage, before more extensive treatment becomes necessary. This is simpler and more predictable for the dentist, as well as more comfortable and less invasive for the patient._

Editorial note: A complete list of references is available from the publisher.

**Fig. 9** The adhesive is light cured.
**Fig. 10** Beautifil Flow Plus (SHOFU) is placed in the Perimeter Preparation and light cured.
**Fig. 11** The completed Perimeter Restoration will now serve the patient effectively for many years.

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**_The perimeter preparation technique_**

Dr Fay Goldstep (FACD, FADI, FADFE) has been an ADA Seminar Series Speaker, and has lectured at the ADA, Yankee, AACD, AGD, and the Big Apple dental conferences. She has lectured nationally and internationally on Proactive Intervention Dentistry, Minimally Invasive Dentistry, soft tissue lasers, electronic caries detection and magnification. Dr. Goldstep has served on the teaching faculties of the Post-graduate Programs in Esthetic Dentistry at SUNY Buffalo, Universities of Florida (Gainesville), Minnesota (Minneapolis) and UMKC (Kansas City). Dr Goldstep sits on the Editorial Boards of Oral Health Magazine (Healing/Preventive Dentistry) and Dental Tribune (US Edition) as well as the Advisory Board of Dental Asia. She is a Fellow of the American College of Dentists, American Society for Dental Aesthetics, International Academy of Dental-Facial Esthetics and the Academy of Dentistry International. Dr Goldstep has been a contributing author to 4 textbooks and has published over 60 articles. She has been listed as one of the leaders in Continuing Education by Dentistry Today since 2002. Dr Goldstep is a consultant to a number of dental companies and maintains a private practice in Toronto, Canada. She can be contacted at epdnt@rogers.com.