Restoring severely discoloured anterior teeth using minimally invasive procedures

Daniel Edelhoff¹ and Oliver Brix²

Introduction
Endodontically treated incisors may entail serious esthetic deficiencies as a result of severe discoloration and present a challenge to the restorative team. The objective of the treatment is to reconstruct the biomechanical and optical properties of the affected teeth, at the expense of as little natural dental tissue as possible. By following a clearly coordinated procedure, the treatment team may achieve satisfactory results with an internal bleaching method, an adhesive post build-up and a preparation technique that suits the requirements of the restorative material. The invasiveness of this approach is considerably reduced as compared with conventional restorative techniques.

This article discusses the rehabilitation of two upper central incisors by placing fibre-reinforced composite posts, using build-up materials and subsequently restoring the teeth with 360° veneers made from lithium disilicate ceramic (LS²).

Initial situation
A 28-year-old male patient came to the practice and expressed the wish to have his endodontically treated and severely discoloured upper central incisors restored. He said that he had not experienced any problems since the resection of the root some years previously; however, he was dissatisfied with the impaired esthetic appearance caused by the affected teeth (Figures 1 to 3).

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Figure 1: The pronounced discolouration and the inadequate tooth position of the upper central incisors impaired the esthetic appearance.

Figure 2: The severe discolouration of tooth 11 also caused a discolouration of the marginal gingival area.
The clinical and radiological evaluations revealed tight and properly executed root canal obturations in teeth 11 and 21. There were no signs indicating the presence of root canal posts, but the extensive composite restorations in both teeth were leaking and showed secondary caries (Figure 4). At the time of the clinical evaluation, the restorations were already five years old. The specific challenges facing the treatment team was the patient’s wish to have the esthetic appearance of his teeth restored in a timely fashion. The patient required that his natural tooth shade and position be restored and, to the extent possible, that the remaining tooth structure be stabilized in the long term.

**Clinical**

**Treatment planning**

Before we proceeded to planning the permanent restoration, the inadequate fillings of the anterior teeth as well as the secondary caries were removed. This allowed us to assess the extent to which the teeth had been damaged. In addition, a possible contamination of the two root canals with microorganisms – resulting from the inadequate fillings which had been in place for years – had to be ruled out.

Both root canal fillings had been tightly sealed at the cemento-enamel junction with separate fillings. The canals therefore did not have to be re-opened. Internal bleaching of the crown portions of both teeth using the walking bleach technique was planned.

After an initial technical and clinical evaluation, the following treatment plan was determined: First, the tooth position and proportions should be corrected by means of an analytic wax-up. The brightness of the affected teeth was then to be adjusted by internal bleaching to match the brightness of the neighbouring teeth during a preliminary treatment phase. Given the extensive lesion, we opted for a direct adhesive build-up after endodontic treatment with cemented fibre-reinforced composite posts. For the final restoration of the severely destroyed anterior teeth, we decided to use 360° veneers based on a lithium disilicate material. In order to achieve an optimum esthetic outcome, the veneers were to be fabricated in the cut-back technique.

**Preliminary treatment and preparation**

After the coronal pulp chamber of the two incisors had been cleaned, an additional seal was placed at the cemento-enamel junction using a small amount of phosphate cement. This measure ensured that the bleaching agent which would be applied later did not diffuse into these sensitive areas (Figure 5). For the internal bleaching, a mixture of sodium perborate powder and distilled water was applied using the walking bleach method. The palatal access to the coronal...
be fabricated in a fairly straightforward manner using a Bis-GMA-based temporary material (Telio® C&B, A2). A bonding agent (HelioBond) was applied to the finished, non-etched preparation surfaces and to the inner side of the temporaries and light-cured after removal of excess material.

After a four-week evaluation phase of the tooth shape and position, which both were determined by the wax-up and transferred to the temporaries, a precision impression of the prepared teeth and an impression of the antagonist jaw were taken. This information was sent to the laboratory together with the facebow, the registration of the jaw relation and an image of the prepared abutment teeth. The image showing the preparations helped the laboratory to assess the required degree of opacity for the framework structure. Given the different levels of translucency, the different buildups of the abutment teeth and to ensure an improved masking capability in case of a relapse of the discolouration, the treatment team chose to use press pulp chamber was sealed with cotton pellets soaked in bonding agent (HelioBond) and a low-viscosity composite (Tetric EvoFlow®). The next appointment was scheduled one week later. The desired tooth shade had not yet been achieved, and therefore fresh bleaching agent was applied. After another week with the bleaching agent in place, a satisfactory brightness value was observed on both abutment teeth (Figure 6). A calcium hydroxide preparation (CalciPure®) was inserted into the pulp chamber and left in place for a week in order to neutralize the bleaching agent.

After the neutralization phase, we proceeded to the post-endodontic build-up of the abutment teeth. For this purpose, the coronal sealing of the root canal fillings was removed and standardized holes for the fibre-reinforced composite posts (FRC posts) were drilled. The posts were luted with Variolink II (dual-curing, low viscosity, shade: white-opaque) and a multi-step adhesive (Syntac®). After the posts had been covered with a low-viscosity composite (Tetric EvoFlow), a bright, highly filled viscous composite (Tetric EvoCeram®, Bleach XL) was applied to create the direct build-up (Figure 7). A high-power curing light (bluephase® G2 with > 1,000 mW/cm²) was used for the final polymerization of the cementation and buildup materials. A diagnostic pattern was employed for the minimally invasive preparation. This template was fabricated on the basis of the wax-up and contained all information relating to the correction of the tooth position and the outer contour of the final restoration.

**Temporization and fabrication of the final veneers**

The diagnostic template was also used for creating the direct veneer temporaries. The temporary restorations could thus be fabricated in a fairly straightforward manner using a Bis-GMA-based temporary material (Telio® C&B, A2). A bonding agent (HelioBond) was applied to the finished, non-etched preparation surfaces and to the inner side of the temporaries and light-cured after removal of excess material.

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**Figure 6:** Two weeks later: The severe discolourations were almost entirely removed by the internal bleaching treatment.

**Figure 7:** The built-up and prepared incisors. Given the severe degree of destruction, adhesively cemented fibre-reinforced composite posts combined with mouldable composite materials were used.

**Figure 8:** Lithium disilicate-based 360° veneers made of IPS e.max Press. In order to better mask the dental structure with a minimum layer thickness, an MO ingot was selected.
ceramic ingots with a medium opacity level in shade 0 (MO0). The IPS e.max® Press frameworks were veneered with the IPS e.max® Ceram veneering ceramic in the shade A2 (Figure 8).

Try-in and seating

After removal of the temporary restorations, residues of the bonding agent were removed with cleaning brushes and a fluoride-free cleaning paste. In order to check the shape and shade of the veneers in the patient's mouth, the restorations were tried in with a shaded glycerine gel (Try-in Paste, Variolink II, white-opaque). A perfect masking of the abutment teeth was already achieved at this stage and the resulting situation showed a harmonious appearance regardless of the substructure (Figures 9 and 10).

The inner aspects of the glass-ceramic veneers were etched with a hydrofluoric acid gel (< 5% IPS® Ceramic Etching Gel) for 20 seconds. Subsequently, a bonding agent (Monobond Plus) was applied. Only the multi-step dentin adhesive system Syntac was applied to the tooth. The restorations were luted into place with the Variolink II system (white-opaque) (Figure 11).

Conclusion

A light transmission which corresponds to that displayed by natural teeth was achieved by using translucent build-up materials in conjunction with glass-ceramic lithium disilicate veneers (Figure 12). The final outcome with regard to

Figure 9: The optimum masking of the extensively built-up abutment teeth achieved by an MO ingot coping and a try-in paste in the shade white-opaque became evident already during the try-in of the veneers.

Figure 10: Frontal view of the veneers during try-in. The use of lithium disilicate as the basis of the restoration ensured a homogeneous appearance regardless of the substructure.

Figure 11: The 360° veneers were seated with the luting cement that corresponded to the try-in paste used; a multi-step dentin adhesive system was used. Thus, an excellent esthetic outcome could be achieved reliably and predictably.

Figure 12: The restorations in transmitted light. By combining translucent build-up materials and glass-ceramic veneers, a light transmission that matches the properties of natural teeth was achieved.
The final check of the functional and esthetic parameters was satisfactory. The tooth shade excellently matched the adjacent teeth.

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Case Report on the use of bone level implants in an esthetically demanding case

Paul van Zyl and Gerrit Wyma

Introduction
Since the introduction of Straumann® Bone Level implants to the market, esthetically challenging cases can now be managed where Straumann® Tissue Level implants were previously contra-indicated. The importance of the correct three dimensional surgical placement of implants to achieve acceptable clinical and esthetic results is well documented. Limited interdental space and loss of buccal bone volume, especially where two or more teeth have been lost, have proven to be challenging esthetic cases. The bone volume can be preserved after extraction, or deficient areas can be predictably augmented by means of procedures using autogenous bone, with or without synthetic bone graft substitutes such as Straumann® BoneCeramic. While limited interdental space cannot be changed, the use of narrower platform implants emerging from the level of the bone has proved to produce predictable esthetic results.

Case Presentation
In the following case, a 30 year old male lost his two central incisors as a result of a traumatic incident. He presented with a removable plastic partial denture in position, replacing these two teeth. (Figures 1, 2, 3). His lower right central incisor was also devitalized during this incident, with subsequent discoloration and the development of a...
Surgery
A full thickness, with two vertical incisions flap, with a broad base was made (Figure 6) and the pilot drill osteotomies were done to determine parallelism (Figure 7). The implants were planned in a palatal position (Figure 8) to preserve the buccal bone plate and allow screw retained

Clinical

periapical radiolucent lesion. The ridge contour seemed to be well preserved and the interdental space measured 14.6 mm. The previous interdental papilla was also well preserved. (Figures 4, 5) A decision was made to place two adjacent 12 mm, 4.1 mm Regular Crossfit™ (RC) Straumann® Bone Level Implants (SLActive).

Figure 3: Pre operative presentation with the socket fit plastic partial denture in position.

Figure 4: Pre operative situation, note the preservation of the papillae between 11/21.

Figure 5: Inter dental space measured 14.6 mm, note the deficient buccal bone volume.

Figure 6: Full thickness flap with vertical relief incisions from the center of the adjacent lateral incisors.

Surgery
A full thickness, with two vertical incisions flap, with a broad base was made (Figure 6) and the pilot drill osteotomies were done to determine parallelism (Figure 7). The implants were planned in a palatal position (Figure 8) to preserve the buccal bone plate and allow screw retained

Figure 7: Pilot drills showing parallelism and distance between implants, as well as adjacent teeth.

Figure 8: Palatal positioning of the implants.
autogenous bone collected in a bone trap was used to additionally augment the buccal bone volume and contour. The bone trap was connected to a separate suction, used only during the drilling of the osteotomies (Figures 12a and b). This was covered with a collagen membrane (Figure 13) before wound closure with polylactic acid sutures.

restorations with a predictable esthetic outcome. After continuing through the drill sequence the implants were inserted (Figure 9). Note the depth of placement of the implants, 3.5mm below the adjacent cemento-enamel junctions (Figure 10).

With the 3 mm healing caps in position (Figure 11),
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After six weeks healing was allowed (Figure 17), the implants were exposed by means of a tissue punch and 5mm healing caps (Figures 18, 19).

Restoration
After initial healing the patient was referred for the
restorative phase (Figures 19, 20). Open tray impression copings were connected and the positive positioning verified with an digital x-ray (Figures 21, 22). A stock tray and polivynalsiloxane two phase impression material were used to record the position of the implants (Figures 22, 23)

No soft tissue contouring has been done at this stage, mainly due to the unavailability and financial restrictions of the patient.

Gold abutments fitting the CrossFit™ connection were used to wax up and cast on the ideal envisaged emergence profile of the two individual incisors. Porcelain was fused to these abutments to produce screw retained individual crowns (Figures 24, 25, 26). Due to the depth of the implants and narrow profile of the soft tissue, screw retained crowns are required to be able to produce enough pressure to be able to seat the restorations. Note the blanching of the soft tissue immediately after the seating of the restorations (Figures 27, 28, 29). As no soft tissue profile was generated before the final crowns were connected, these crowns should be connected with caution to prevent over “stretching” of the soft tissue.

The precise and snug connection of the CrossFit™ connection can be seen on the post operative radiograph (Figure 30). Also note the level of the bone in relation to the implant level and horizontal offset. This will nourish and support the soft tissue volume and profile as seen 12 days post insertion (Figure 31,32).

After 12 months the soft tissue profile and bone around the implants are stable and healthy with an overall very pleasing esthetic result (Figures 33, 34).

**Conclusion**

With the correct three dimensional placement of implants, even in limited space and esthetically
challenging areas, two adjacent implants can be inserted and restored with a long term predictable outcome. The esthetic outcome of these cases are totally dependent on the perfect positioning of the implants. It is imperative that the clinician and dental technician have the appropriate knowledge and experience in such challenging cases to achieve predictable results, both for function and esthetics. With Implants in the correct position, with sufficient surrounding tissues, and knowledge of the prosthetic shapes and space, final restoration can be finalized with great predictability.

Acknowledgement

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References

3. G.-G. K et al. Treatment of intrabony defects using guided tissue regeneration using autogenous spongiosa alone or combined with hydroxyapatite/beta tricalcium phosphate bone substitute or bovine derived xenograph. Periodontology 2007, 78; 2216-2225
Contemporary technologies for remineralization therapies: A review

Laurence J. Walsh

Introduction
In the last decade there has been a veritable explosion of interest in technologies which may have value for remineralization of enamel and dentine, or for desensitization of exposed dentine affected by dental erosion. The characteristics of an ideal remineralizing agent are summarized in Table 1, which provides a backdrop against which to contrast the available materials and technologies.

Enamel minerals
The mineral in dentine and enamel is not pure hydroxyapatite, but rather a mixture of compounds including a number of carbonated apatites, with greater diversity of composition in dentine than in enamel. Fluorapatite is less acid soluble than hydroxyapatite, which in turn is less soluble than carbonated apatites. Because of this chemical inhomogeneity of enamel, the process of enamel remineralization is rather complex. While a ratio of 10 calcium ions to 6 phosphate ions to 2 fluoride or hydroxyl ions (or one carbonate ion) appears suitable, there is evidence which supports other ratios for calcium to other components. Nevertheless, calcium availability remains the singular limiting factor in enamel remineralization.

One of the most important properties of calcium phosphate/calcium fluoride materials is their solubility behavior, bearing in mind that the majority of calcium compounds are very insoluble.

Remineralization
Remineralization is the natural repair process for non-cavitated lesions, and relies on calcium and phosphate ions assisted by fluoride to rebuild a new surface on existing crystal remnants in subsurface lesions remaining after demineralization. These remineralized crystals are less acid soluble than the original mineral. The composition and the concentration of inorganic ions in saliva and in dental plaque significantly influence the degree of saturation of the water-rich fluid which is in immediate contact with enamel.

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The role of saliva
The critical role played by salivary components in controlling the equilibrium between de- and remineralization is ably demonstrated when salivary output is compromised and patients suffer dramatic increases in risk for dental caries and/or dental erosion. Enhanced remineralization of white spot lesions by stimulated salivary flow (e.g. from chewing a sugar-free gum) illustrates dynamic protective effects of saliva. Protective properties of saliva which increase on stimulation include salivary clearance, buffering power, and degree of saturation with respect to tooth mineral.

It has been noted in the dental literature that the design of experiments using dental caries or dental erosion models must take into account the static and dynamic effects of saliva. In the context of remineralization, an important component of saliva are its proteins, such as the glycoproteins which adsorb onto tooth structure to form the protective pellicle layer, and the phosphoproteins which regulate calcium saturation of the saliva. Pellicle is known to reduce mineral loss from enamel under conditions of acid challenge, more so for enamel than for dentine.

Moreover, the early pellicle glycoproteins, acidic proline-rich proteins and stathern, are known to promote remineralization of the enamel by attracting calcium ions. (Table 2) Acidic proline-rich proteins bind strongly to hydroxyapatite, inhibit crystal growth of calcium phosphate salts from solutions supersaturated with respect to hydroxyapatite, bind calcium ions, and interact with several oral bacteria on adsorption to hydroxyapatite. Statherins, as well as histatins, and cystatins also exhibit affinities to mineral surfaces, and inhibit calcium phosphate precipitation.

Some experimental systems such as in situ studies which use enamel slabs embedded into appliances allow full expression of the impacts of saliva, whilst some laboratory bench models exclude the involvement of saliva, and create nonsensical interpretations from the standpoint of clinical practice. Laboratory testing protocols using ionic solutions have significant limitations, most particularly related to their inability to simulate the complex biological processes involved.

It appears that protective effects of salivary components and