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Abstract

This case report describes a minimally invasive step-by-step approach to treat a patient with amelogenesis imperfecta. This is a genetic developmental disorder of the dental enamel, which clinically manifests as white and dark discolorations of the teeth. The clinical examination did not reveal the true depth of the staining. Therefore, a step-wise treatment approach was chosen. The first step consisted of a home bleaching procedure, which led to a slight improvement of the esthetic appearance, but the stains were still clearly visible. The next step was the application of a microabrasion technique. This led to further improvement, but not to a satisfactory result for this patient who had high esthetic expectations. Thus, the third step was undertaken: it was planned to restore the maxillary incisors and canines with ceramic veneers. The dental technician prepared a wax-up, which served as a basis for a clinical mock-up. After discussing the mock-up and the treatment plan with the patient, crown lengthening was performed on teeth 11 and 23 to improve the pink esthetics. Subsequently, the teeth were prepared in a minimally invasive way and a final impression was taken. Following try-in, the six veneers were inserted with resin cement.

in enamel formation. Different types of amelogenesis imperfecta can be distinguished clinically and histologically. Interferences during the formation, arrangement (hypoplasia), mineralization (hypocalcification) and maturation (hypomaturation) process of hydroxyapatite crystals are responsible for the clinical appearance of the affected teeth. The dentin is not affected by this developmental disorder.

Clinically, amelogenesis imperfecta manifests as light and dark discolorations, as well as atypical crown morphology. The enamel of teeth affected by the hypocalcified and hypomatured form is much softer and less radiopaque than the enamel of healthy teeth.

In this article, we would like to present a minimally invasive treatment approach consisting of three steps. The aim of the presented approach is to sacrifice as little healthy enamel as possible and to replace only the fraction of enamel that is severely affected.

Assessment and treatment planning

A 27-year-old healthy and almost caries-free woman presented at the clinic seeking treatment for her dark spots on the maxillary incisors and unesthetic gingival margin (Figs 1a to 1c). A history of trauma, tetracycline staining or fluorosis could be excluded. The clinical examination did not fully reveal the severity of the amelogenesis imperfecta nor the depth of the staining. In agreement with the patient, a step-by-step treatment plan was es-

Introduction

Amelogenesis imperfecta is a genetic developmental disorder that affects the crystal structure of dental enamel. It is caused by mutations of proteins involved
established. The first step consisted of a home bleaching procedure. If the stains were still present in the deeper layers of the tooth, a microabrasion technique would be applied. This procedure implies the removal of a 0.03 mm thin layer of enamel. Depending on the result of microabrasion, the third step would be undertaken: preparation of the teeth for ceramic veneers or crowns. The latter option would be considered if the enamel could not be etched due to
the hypoplasia. Since the patient did not like the appearance of her gingival margin, a crown lengthening procedure was planned.

Diagnostics

The patient's chief complaint was the dark and white opaque staining of the maxillary incisors and canines. However, she was also bothered by the asymmetrical gingival margin and the difference between the incisal edges of teeth 11 and 23. Furthermore, the patient asked for the overlapping of teeth 21 and 11 to be corrected.

Initially, all corrections were performed digitally by means of an image editing software (Photoshop Elements, Adobe Systems) to visualize the patient's treatment (Figs 2a to 2c). Thereafter, all the planned changes were transferred into a wax-up (Figs 2d to 2e). The position of the two incisors was adjusted to better fit into the arch. At teeth 11 and 23, the gingiva on the plaster model was modified in order to simulate future crown lengthening.

Mock-up

In order to transfer the simulations into the patient's mouth, the incisal edge of tooth 23 and the cusp of tooth 24 had to be shortened. A resin cap served as a reference for the amount of incisal reduction required (Acryline clear, Anaxdent) (Figs 3a and 3b). Following preparation, the enamel was smoothened with fine-grit diamond burs (Universal Prep Set, Intensiv SA).

A silicone index of the wax-up was prepared in order to directly fabricate a mock-up in the patient's mouth (Memosil 2, Heraeus Kulzer) (Figs 4a and 4b). This silicone index was filled with a chemically curing composite material, in shade Vita A1 (Protemp, 3M Espe) and placed over the teeth. The resulting mock-up served as a communication tool, and the prospective treatment result could now be discussed with the patient. The mock-up also helped to estimate the extent of the crown lengthening that would be necessary.
Crown lengthening

On tooth 11, the gingival level had to be moved about 1 mm apically and on tooth 23 about 1.5 mm apically. The periodontal examination revealed that both teeth had pseudo pockets. The vertical distance to the bone was around 4 mm. A gingivectomy was carried out without violating the biological width (Figs 5a and 5b).\(^\text{13,14}\) The mock-up was used to verify the total prospective crown length. To ensure the success of the crown lengthening, the treatment plan then had a healing and stabilizing break of 2 months.

Home bleaching

For the home bleaching procedure of all teeth, bleaching trays were fabricated in the dental laboratory (Erkodur). Carbamide peroxide bleaching gel with a concentration of 15% (Opalescence, Ultradent Products) was administered to the patient to be used for 2 hours a day for the following 3 weeks. At the follow-up 2 weeks after the last bleaching,
a major improvement in the color was observed (Fig 6). The patient became more and more aware of dental esthetics – she noticed a positive change and was motivated to seek further improvement.

Microabrasion

The next stage of the treatment plan was the application of the microabrasion technique (Opalustre, Ultradent Products). The most superficial enamel layer was etched and subsequently removed with an abrasive paste and a rubber cup (Fig 7). Again in the follow-up visit, a clear improvement was noticed, but the stains could not be fully removed. Moreover, the patient wanted to continue in order to correct the position and shape of her anterior teeth.

Reevaluation before prosthetic treatment phase

After the pretreatment, the clinical situation was re-evaluated in order to determine that the planed treatment by means of veneers was still mandatory for the desired esthetic improvement. The shade of the teeth had been improved by bleaching and microabrasion so that veneers were possible from

Figs 8a to 8c Prepared teeth with silicone key.
an esthetic point of view. The teeth no longer had dark spots that would possibly shine through thin ceramic veneers. The gingival margin had successfully been harmonized by the gingivectomy. The biological conditions, such as vitality of the teeth, pocket depth, bleeding on probing and plaque index were ideal.

Veneer preparation and impression

A silicone index was fabricated based on the wax-up to facilitate the correct preparation of the teeth. Teeth 13 to 23 were prepared in a minimally invasive way to receive veneers (Figs 8a to 8c). With an epigingival margin line solely in the enamel. The final impression was taken using two retraction cords (Figs 9a and 9b). In order to avoid traumatization of the gingiva and to minimize the risk of recessions, a surgical suturing material (size 4-0, Vicryl Ethicon, Johnson & Johnson) was used as the first retraction cord. The second retraction cord was the thinnest cord available on the market (000 Ultrapak, UP Dental). The preparation margins could be sufficiently exposed with this technique.

Fabrication of the veneers in the laboratory

Before the dental technician initiated the fabrication of the final reconstruction, all the information gathered during the diagnostic phase was reviewed in order to ensure that the prospective shape, position and shade of the teeth would fulfill the patient's and the dental team's expectations.

The first step for the final restoration was the fabrication of an alveolar model. This model offers a big advantage in comparison with conventional saw cut models because it preserves all the information on gingival morphology. Refractory dies were manufactured (anax-Vest, Anaxdent) to guarantee the best possible fit of the veneers.

For the fabrication of the veneers, a reverse planning concept was applied. The laboratory work was guided by the information from the wax-up and
mock-up, which was transferred with the aid of silicon indexes (Matrix Form 60, Anaxdent). The ceramic masses were then applied (Creation Classic, Willi Geller) according to the custom shade that was developed by the dental technician in collaboration with the patient (Fig 10a). After two dentin firings, the surface texture and the final shape was obtained with diamond burs. Gold powder highlights the microstructure of the surface and makes the texture clearly visible (Fig 10b). The glaze firing was followed by a mechanical polishing procedure (Figs 10c and 10d). The polished veneers were removed from the refractory dies by sandblasting and cleaned in an ultrasonic waterbed.

Integration of the reconstruction

A try-in session was carried out where the veneers were inserted with glycerin gel in order to improve color assessment. Both the patient and the dentist expressed their satisfaction with the esthetic result. Subsequently, in a dry environment (rubber dam) the fragile ceramic veneers were cemented. The abutment teeth were etched with 35% phosphoric acid (Ultra-Etch, Ultradent Products) and bonded with a multi-step
adhesive system (Syntac Classic, Ivoclar Vivadent). The bond was not light cured in order not to compromise the fit of the veneers. The veneers were etched with hydrofluoric acid (9% concentration for 1 min) (Porcelain Etch, Ultradent Products). A silane (Monobond S, Ivoclar Vivadent) and a bonding system (HelioBond, Ivoclar Vivadent) were applied. The veneers were then cemented with a dual-curing resin cement (Variolink Transparent, Ivoclar Vivadent). Ex-
cess cement was removed with rotating diamond instruments. The occlusal and functional contacts were analyzed, and no adjustments were necessary.

All participants were very satisfied with the final treatment outcome (Figs 11a to 11e). At a follow-up visit 18 months post-insertion, all the veneers looked well integrated without any discoloration of the margin, or chipping or fractures of the ceramic (Fig 12).

Discussion and conclusion

An excellent esthetic result could be achieved with this minimally invasive prosthetic treatment. The patient was heavily involved in the process of decision-making and, therefore, her esthetic expectations could be integrated into the final treatment.

Since all teeth showed a sufficient amount of enamel – even in the marginal areas – the choice of reconstructive material was based on the fact of a possi-

ble adhesive cementation. In this case, it was decided to use a leucite-reinforced glass-ceramic with its near to ideal light dynamic effects. Leucite-reinforced glass-ceramic has been described to show long-term survival for crowns and veneers.\textsuperscript{16-18}

As an alternative to the present treatment option, a direct reconstruction of the two incisors with composite could have been considered. This treatment option might have been even less invasive than the presented one. However, since the patient’s main wish was to improve both the color and the shape of the teeth, the esthetic predictability of the treatment outcome was considered to be more predictable with the use of ceramics. Furthermore, the longevity of the ceramic veneers was shown to be higher than that of composite veneers.\textsuperscript{19}

For the ceramic veneers, slight tooth preparation was necessary. It may be questioned why the etching and micro-abrasion steps were performed considering the following preparation of the tooth substance. The main aim of the pretreatment was to first treat the problem with the discoloration as noninvasively as possible, and to then reevaluate whether or not reconstructions were still needed. Since the discolorations could not be fully removed, minimally invasive reconstructions out of ceramics were planned as demonstrated. The pretreatment had an additional positive effect on the invasiveness of the final reconstructions. Since glass ceramics are highly translucent, without the bleaching, an increase of the thickness of the ceramic veneers would have been necessary to mask the discoloration.\textsuperscript{20}
Hence, more space would have been necessary and consequently the invasiveness of the preparation would have been higher.

The presented treatment led to an esthetically satisfying result for the young woman. Considering the excellent outcomes reported for veneers in the literature, a good long-term perspective can be expected for the present treatment modality. For the predictability of the treatment a meticulous prediagnostics and a stepwise treatment protocol is crucial, otherwise the outcome may be compromised.

References