



# Full-mouth adhesive rehabilitation in case of severe dental erosion, a minimally invasive approach following the 3-step technique

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## Abstract

A full-mouth adhesive rehabilitation in case of severe dental erosion (ACE class V) may present a challenge for both the clinician and the laboratory technician, not only for the multiple teeth to be restored, but also for their time schedule, difficult to be included in a busy agenda of a private practice.

Thanks to the simplicity of the three-step technique, full-mouth rehabilitations become easier to handle. In this article

the treatment of a very compromised case of dental erosion (ACE class V) is illustrated, implementing only adhesive techniques.

The very pleasing clinical outcome was the result of the esthetic, mechanic and most of all biological success achieved, confirming that minimally invasive dentistry should always be the driving motor of any rehabilitation, especially in patients who have already suffer of conspicuous tooth destruction.

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## Introduction

Tooth destruction related to erosive wear has started becoming a very common diagnosis among clinicians. Epidemiological studies, but also daily clinical observation are confirming the worrying data.<sup>1-8</sup>

There are different attitudes after the recognition of the problem, generally related to the patient's age.

In case of young patients, clinicians tend to wait, not only because often these patients cannot afford full-mouth rehabilitation, but also because the degree of the tooth loss may not be so important as to justify the treatment.

Early cases of dental erosion present a dental esthetic that is still acceptable with no functional problem. Moreover, unless there is very aggressive erosion (such as bulimic/anorexic patients), erosive patients seldom feel pain related to the tooth destruction. For the above reasons, young patients themselves are not willing to accept a full-mouth rehabilitation.

In an older population affected by dental erosion, clinicians are keener to start the therapy, pushed also by the patients' esthetic demand. This intervention, however, is not always all-inclusive (with the increase of the vertical dimension of occlusion), and it remains localized at the anterior maxillary teeth, where the fractured incisal edges are restored with direct composite resin restorations or facial veneers.

Consequently, the occlusal surfaces of the posterior teeth and the palatal aspects of the anterior teeth remain frequently untreated and continue to wear away.

Finally there is a category of clinicians who treat the erosive patients with con-

ventional therapy, such as crowns, leading to with an aggressive removal of the remaining tooth structure. Several of the treated teeth, especially in the anterior quadrant are then devitalized, and crown lengthening is often required.<sup>9-31</sup>

At the University of Geneva, patients affected by dental erosion are treated as soon as possible after identification of dentin exposure through the Geneva Erosion Study. Only adhesive techniques are implemented, with minimal, if any, tooth preparation (principle of minimal to no invasiveness). Despite the tendency for adhesive modalities to simplify the involved clinical and laboratory procedures, the therapy of such patients still remains a challenge because of the great number of teeth affected in the same dentition.<sup>32</sup>

To simplify the dental treatment and reduce the financial costs, an innovative approach termed the "three-step technique" has been developed in connection with the Geneva Erosion Study.

This article describes the full-mouth adhesive rehabilitation of one of the study patients, who was affected by severe dental erosion (ACE class V). Since emphasis should always be placed on removing only the minimal amount of tooth structure when repairing the teeth, the patient's maxillary anterior teeth were restored following the "sandwich approach", which consists of reconstructing the palatal aspect with composite restorations (composite palatal veneers), followed by the restoration of the facial aspect (ceramic facial veneers). The treatment objective was attained using the most conservative approach possible, as the remaining tooth structure was preserved and located in



**Figs 1a and b** Initial status. The vestibular aspect of all the teeth, except the mandibular anterior teeth, was extremely affected by dental erosion. On the other hand, the palatal aspect was almost intact. Although the damage distribution pattern indicated an extrinsic etiology, the patient denied any excessive consumption of acidic food or drink.

the centre between the two different restorations.

For more details, it is recommended to review a series of three articles on full-mouth adhesive rehabilitation by Vailati and Belser.<sup>33-35</sup>

## Case presentation

A 37-year-old woman presented at the School of Dental Medicine at the University of Geneva. Her chief complaint was the deterioration of the aspect of her maxillary anterior teeth. The patient was extremely hesitant to discuss the problem about her dentition. For years she was aware of the irreversible changes, but her dentist was only treating the teeth for caries, neglecting the progressive degradation of her dentition.

The clinical examination revealed that the patient suffered from severe dental erosion, involving both the anterior and posterior teeth. Only the mandibular anterior teeth were intact.

The most peculiar aspect of the tooth damage was the location, which was mostly on the labial aspect of all the maxillary teeth and the posterior mandibular teeth. The occlusal surfaces were also involved, but to a lesser extent.

The palatal aspect of the maxillary anterior teeth was also less involved, indicating a more extrinsic etiology of the erosive problem. On the anamnesis, however, the patient denied any excessive consumption of acidic food or beverages (Figs 1 and 2).

No parafunctional habits were detected. According to the ACE classification (Vailati Belser), the patient was considered ACE class V, since the palatal dentin was exposed, the loss of length of the clinical crowns was more than two millimetres and the facial enamel was lost on several teeth, such as the canines.<sup>36</sup>

On the other hand, all the teeth were vital, even though several of them present hypersensitivity to air or temperature changes.



**Figs 2a to 2c** Close view of the posterior teeth's vestibular damage. The facial aspect was almost completely lost. The teeth were still vital, but very sensitive.



**Figs 3a to 3c** Maximum tooth display obtained during the first visit, indicating how uncomfortable smiling was for the patient. Even with her attempt to hide her teeth, it was noticeable that the occlusal plane on the right side was lower than the one of the left side. There was also an asymmetry among the incisal edges of the maxillary teeth, due to the supraeruption of the right canine and incisors.

During the first 1-hour visit, after an intensive, but not productive discussion on the possible causes of the dental erosion, two alginate impressions, photos and radiographs were taken. The initial

visit was concluded with a facebow record.

The two casts, obtained by the alginate impressions, were articulated on a semi-adjustable articulator in maximum



**Figs 4a and 4b** A maxillary vestibular mock-up (1st clinical step) was planned to evaluate the final position of the occlusal plane for the full-mouth rehabilitation. To keep the tooth preparation to a minimum, an additional mock-up was tested, not only to bulk up the facial aspect of the teeth, but also to increase their length. The incisal edge's position of the supraerupted right teeth was kept as a reference to test directly in the mouth if the patient had accepted longer teeth.

intercuspidation position (MIP). As extensively explained in previous published articles, thanks to the 3-step technique, every full-mouth rehabilitation is planned in a way that allows to deal with quadrants instead of both dental arches simultaneously. Since the two key parameters (vertical dimension of occlusion [VDO] and the interarches relation) are constantly maintained by the contralateral side of the mouth, using centric relation (CR) is not so crucial. In the Geneva Erosion Study, all 40 patients treated and restored at an increase VDO in MIP had responded very well to the treatment, confirming clinically that a simplified usage of the MIP could be comfortable advocated. The laboratory technician involved in the case was instructed to wax up only the labial aspect of the maxillary teeth (1st laboratory step), without including the second molars.

Several pictures of the patient, showing the interaction between her lips and the teeth were provided. Special atten-

tion was made on the position of the incisal edges and the occlusal plane.

In this patient, there was, in fact, a discrepancy between the occlusal plane on the right and the one on the left side. The patient was not aware of the supraeruption of the right part of the maxillary dentition, distracted by the very compromised overall esthetic.

To reduce the need of tooth preparation, a wax-up that reconstructed the vestibular aspect of the maxillary teeth was requested. Keeping the right side of her mouth as a reference point for the maximum tooth length, it was asked to lengthen the anterior teeth on the left side and lower the left occlusal plane to recreate harmony.

The strategy behind this choice was to try to deliver longer final facial veneers, requiring minimal tooth preparation at the incisal edges too.

The wax-up was duplicated with a rigid silicon key, and the patient was scheduled for a 1-hour appointment to discuss



**Figs 5a and 5b** The position of the left occlusal plane was considerably lowered and clinically tested to evaluate its harmony with the incisal edge plane and the lower lip. The patient was very pleased with the result. Delivering longer maxillary final restorations would have required only minimal tooth preparation. In Fig 5a the mock-up was reduced to only the six maxillary anterior teeth. The discrepancy of size with the posterior teeth was shocking for the patient, who no longer accepted the length of the anterior teeth.

the form of the future restorations. Without any isolation of the teeth, the silicon key was loaded with a provisional composite and placed in the mouth (Telio, Ivoclar, Vivadent).

After 3 minutes the key was removed and all labial surfaces of the maxillary teeth were covered with a thin layer of composite, reproducing the shape defined by the wax-up for the future restorations. The excesses at the level of the gingival margins were cleaned with a no. 11 scalpel.

To make the mock-up more realistic, its surface was covered with a layer of bond mixed to laboratory colorants (Kerr).

The patient was allowed to look at her new dentition standing up, in a very large mirror, to give her the opportunity and the time to get used to the new look.

Often patients affected by severe dental erosion are very uncomfortable in accepting bigger final restorations, since they are used to see themselves

with small yellowish teeth. Consequently, communication with the mock-up is crucial to let the patient get used to the new dentition and to express her/his desires.

In this case, the longer whiter teeth of the mock-up did not shock the patient, and her consensus was easily obtained.

After the acceptance of the maxillary vestibular mock-up, which extended up to the first molars, an experiment was done; the posterior part of the mock-up was removed and the patient had the opportunity to comment on the shape only of the final 6 maxillary anterior teeth.

As expected, the patient was very shocked and she asked immediately to reduce the length of the “rabbit” teeth. This test confirmed the authors’ opinion on the necessity to extend the mock-up to at least the two premolars both sides, in cases of full-mouth rehabilitation of very compromised dentition, to give the patient and the dentist a more correct idea on the final outcome (Figs 5 and 6).



**Fig 6** With only the mock-up of the six maxillary anterior teeth in place, the patient was disturbed by the length of these teeth. Asking to shorten them would have required more tooth preparation to deliver the facial veneers. Thanks to the presence of the mock-up also on the posterior teeth, final restorations with an increased length were selected with the patient's approval.

Pleased with the discussion on the final outcome, the patient accepted the treatment plan. After clinically validating the plane of occlusion, the clinician arbitrarily selected the increase of the VDO, to obtain enough interocclusal space and to reduce the need for posterior tooth preparation.

At the selected new VDO, the laboratory technician waxed up the two premolars and the first molar in each sextant (2nd laboratory step).

Four transparent keys were made by the clinician (Elite Transparent, Zhermack), reproducing the four sextants, from the waxed-up casts.

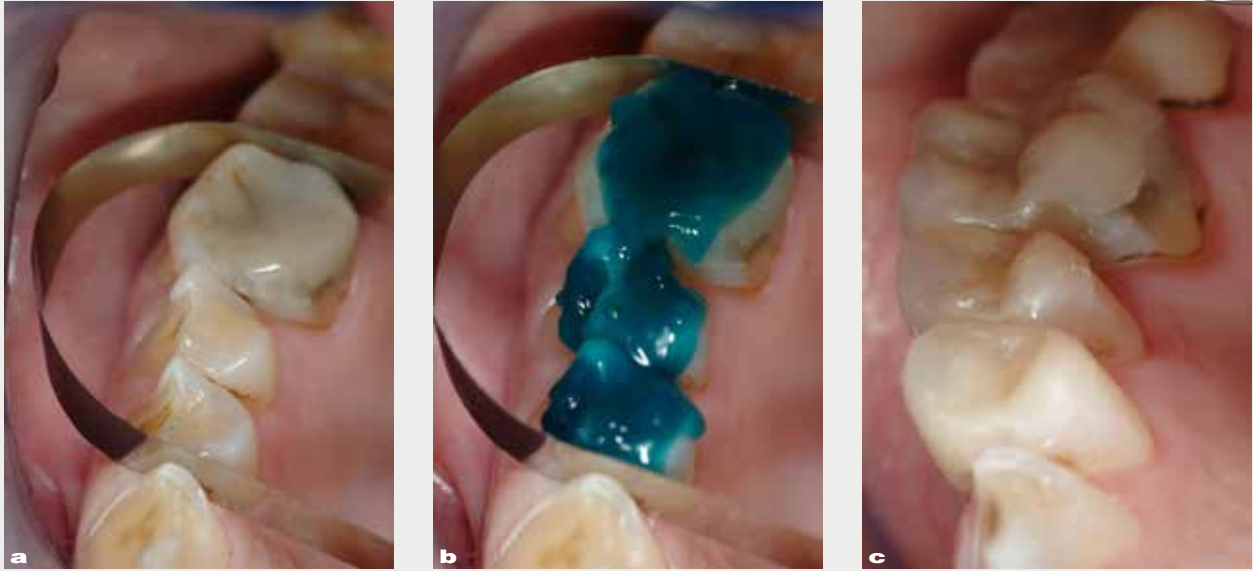
During a 2-hour appointment, without anesthesia, the patient was restored with 12 provisional posterior composite restorations (Figs 7 and 8).

After etching (37% phosphoric acid) and application of primer and bond (Optibond FL, Kerr), the clinician loaded each translucent key with nano-hybrid composite (Miris, Coltène, Whaledent,

Altstätten, Switzerland), positioned the key in the patient's mouth, verified the seating and light-cured the composite through the keys. As a result, in one single visit, without any tooth preparation, the occlusal surfaces of all posterior teeth, except the 2nd molars, were restored with a layer of composite resin, reproducing the diagnostic wax-up (2nd clinical step). No rubber dam was used, since the margins of the provisional posterior composite restorations were considered to be sufficiently occlusal to assure moisture control. Generally, the second step of the three-step technique is performed without anesthetizing the patient, not just because no tooth preparation is required, but also to benefit from the patient's full cooperation in checking and adjusting the occlusion.

With the posterior restorations in place, and the anterior teeth not involved in the treatment, a temporarily anterior open bite was created.





**Figs 7a to 7c** After the clinical validation of the plane of occlusion (1st step), the patient was scheduled for a 2-hour appointment. Without the need of anesthetic, two premolars and the first molar were restored with provisional posterior composite restorations at an increased VDO, arbitrarily selected on the articulator (2nd clinical step).



**Figs 8a and 8b** The vestibular aspect was partially restored, a provisional occlusal plane was obtained, and the patient had a stable posterior support.

The patient was informed on the possibility of speech impairment, especially for the consonant “s”. However she adapted very rapidly to the new occlusion and her speech was not affected by the open bite at any time (Fig 9).

The patient returned for a 1-hour follow-up after one week where minimal oc-

clusal adjustments were done. This time schedule is part of the protocol, since in the authors’ experience, the patient should not be seen for at least the first three days from the time of delivering the posterior restorations.

It is a common report that patients become more comfortable with their new



**Figs 9a and 9b** Due to the presence of the posterior composite restorations, an anterior open bite was created. Patient did not feel uncomfortable with the new occlusion. At the 1-week follow-up appointment, she was perfectly adapted to the new jaw's position.

occlusion after the first few days (2 days generally) and they do not ask for any more changes. Seeing the patient too early after the 2nd step may lead to unnecessary modifications.

Following the Geneva Erosion Study, the VDO is tested for one month, to give the muscles the possibility to relax and to detect any possible non adaptation to the new VDO before delivering the final anterior palatal restorations, to reestablish the anterior contacts.

In the Geneva Erosion Study with more than 50 patients included, none of the treated patients had difficulty in adapting to the increased VDO (or to the generated open bite), which would have required major modifications of the posterior provisional composite restorations.

In this case, the patient was already very comfortable with the new occlusion after the first two days and she was scheduled for a 1-hour appointment 4 weeks later for the 3rd step.

During this visit (3rd clinical step), local anesthesia was necessary, due to the patient's hypersensitivity; the ex-

posed dentin on the palatal aspect of her maxillary anterior teeth was roughened with a very course diamond round bur, and immediately sealed with Optibond FI (Kerr), following the manufacturer's instructions. To reinforce the hybrid layer, a final application of flowable composite (Tetric flow T, Ivoclar Vivadent) was placed on the dentin, and polymerized for 40 seconds (20 seconds covered with glicerine).<sup>37-41</sup>

Without any tooth preparation, only stripping of the interproximal contact points, a final impression was taken (Express 2, 3M ESPE). No provisional restorations were delivered.

The appointment was concluded with facebow registration, an alginate impression of the mandibular arch and a bite registration at the level of the anterior teeth. The obtained casts were mounted in an articulator, using the facebow, and six composite palatal veneers were fabricated in composite (3rd laboratory step).

After 1 week, a 2-hour appointment was scheduled to deliver the palatal ve-



neers and reestablish the anterior contacts.

The palatal veneers were bonded, one at a time, using the rubber dam. The palatal sealed dentin was sandblasted (Cojet (27[m], 3M Espe), the surrounding enamel was etched (37% phosphoric acid), and the bond (Optibond FL, Kerr) was applied but not cured. The composite veneers were sandblasted (Cojet) and cleaned in alcohol with ultrasound. Three coats of silane were applied (Silicup, Heraeus). A final layer of bond (Optibond FL, Kerr) was used without curing, the warmed-up composite was then applied to the restoration (Miris, Coltene, Whaledent) before placing them one at the time on the teeth and light curing.

The open contact points facilitated the bonding procedures, from the positioning of the veneers to excess removal.

Thanks also to the presence of a composite “hook” at the level of the incisal edges of the veneers, it was easier to achieve correct positioning, even on the “slippery” palatal surfaces. The hooks were subsequently removed during finishing and polishing (Fig 10)

With the fitting of the palatal veneers, this 3-step technique was concluded and the patient’s occlusion stabilized at an increased VDO.

Afterwards, the patient was scheduled to carry on the full-mouth adhesive rehabilitation.

Before replacement of the posterior provisional composite resin, the restorations of the facial aspect of the maxillary anterior teeth was completed with ceramic veneers (sandwich approach), as suggested in the ACE classification for class V patients.

The patient was scheduled for a brief control, where an alginate impression of the maxillary arch and several extraoral pictures of the patient’s smile were taken.

The laboratory technician waxed up the 6 maxillary anterior teeth, and another silicone key (mock-up-provisional key) was made.

The wax-up model served also to fabricate the other keys necessary for the veneers’ preparation (the vestibular reduction and the palatal keys).

The patient accepted the esthetic outcome of the 6 facial veneers, thanks to a mock-up 1-hour visit, and a 2-hour appointment was scheduled to prepare the 6 maxillary anterior teeth for veneers.

In this appointment, the facial dentin was immediately sealed and only minimal preparation was required, mostly interproximally and at the level of the incisal edges.

Since the palatal aspects, restored with composite veneers, were considered an integral part of the respective teeth, no particular effort was made to place the preparation margins on tooth structure. At the incisal level, all the length created by the palatal veneer was removed, and a flat preparation was performed, paying attention to smooth all the line angles. **was again required due to the present tooth hypersensitivity.**

After the impression, a **provisional** was fabricated with the same silicone key used for the mock-up. The key was loaded with provisional composite material (Telio, Ivoclar Vivadent), and retention was achieved by both the contraction of the product and the presence of minimal interproximal excess (Fig 11).

The time for delivering the 6 ceramic facial veneers was planned for 3 hours,



**Figs 10a to 10c** After testing the increase of VDO for 1 month, six composite palatal veneers were delivered without anesthesia to reestablish the anterior contact points (3rd step)



**Figs 11a and 11b** Initial status and minimal facial veneer preparation. The exposed dentin was immediately sealed, before the final impression was taken.

since each veneer was bonded individually, following the protocol developed by Pascal Magne.<sup>42-45</sup> The only difference was the type of hybrid composite used to bond the veneers (Micerium HRI

dentin composite, Micerium). The rubber dam was placed and each veneer was bonded individually.

The intaglio surfaces of the ceramic veneers were etched for 60 seconds



**Fig 12** Try-in of 6 feldspathic ceramic facial veneers, before rubber dam's placement to test the color. There was no need to anesthetize the patient while delivering these restorations, thanks to the minimal preparation required and the immediate dentin sealing.

with hydrofluoric acid, and then placed in alcohol and ultrasonically cleaned for 2 minutes. Then, three coats of silane (Mondobond Plus, Ivoclar Vivadent,) were applied and dried in the oven. Finally a coat of bond (Optibond FL, Kerr) was applied without curing. The veneer was placed under a light protection box, while the sealed dentin on the prepared teeth was air abraded (Cojet, 3M Espe) and the existing enamel was etched (37% phosphoric acid for 30 seconds).

A coat of adhesive resin (Optibond FL) was applied, but not cured before seating the restoration.

A warmed-up composite was then applied to the restorations (Micerium), before placing them on the teeth and light curing them.

Any excess of the luting composite was removed before the polymerization; however, after the rubber dam removal, additional cleaning of the gingival margins was performed using only a scalpel. No rotatory instruments were used. The choice of feldspathic ceramic for

the veneers was due to the superior esthetic outcome in the technician's hands. There was no need for stronger ceramic.

Moreover, all the patients restored with facial veneers in the Geneva Erosion study, even if affected by parafunctional habits, were treated using feldspathic ceramic, and no mechanical failure have been recorded up to now (up to 6-year follow-up)<sup>32</sup> (Fig 12).

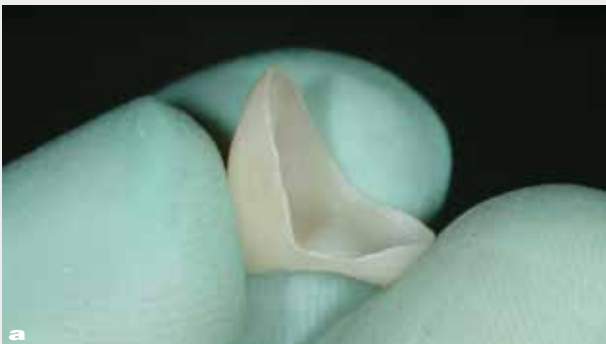
Even though the patient needed a full-mouth rehabilitation, thanks to the 3-step technique, the case was transformed in rehabilitation for quadrants.

After the facial veneers were fitted, to restore each posterior quadrant, two further appointments were necessary, one to remove the provisional composite restorations, and the second to deliver the final restorations.

This part of the treatment was technically very challenging, because of the very cervical location of the future restorations. It was particularly difficult to place the rubber dam in these conditions on the premolar position to deliver the veneer/onlays (Fig 13).



**Figs 13a to 13c** Initial status, after the completion of the 3-step technique and after restoring the maxillary anterior teeth and quadrant 1 with adhesive restorations.



**Figs 14a and 14b** Following the concept of a “quadrant rehabilitation,” in each posterior quadrant, the two premolars were restored with lithium disilicate veneer/onlays and the first molar with an indirect composite restoration. The second molars were left as the last to be restored.

During the treatment of the posterior teeth, the remaining dentition was perfectly stable, due to the presence of the posterior provisional composite restoration and the palatal veneers.

The patient was always restored in MIP (Figs 14 and 15).

A total of eight appointments of 2 hours each were necessary to complete the full-mouth rehabilitation in the poster-



**Fig 15** Frontal view showing the progression of the case. After stabilizing the occlusion with the 3-step technique, 6 facial veneers were delivered, followed by adhesive restorations in quadrant 1.



**Figs 16a and 16b** Three-quarter view of the initial status and after the completion of the full-mouth adhesive rehabilitation. Thanks to the 3-step technique, a perfect harmony was easily achieved between the occlusal plane and the incisal edges.

ior quadrants. The second molars were restored last with direct composite resin restorations, due to the reduced interocclusal space available (Figs 16 and 17).

No occlusal guard was delivered to the patient, since parafunctional habits were not diagnosed. The use of fluoride gel at home on a regular basis was prescribed instead, as the origin of her erosive problem was never discovered.

She entered in the Geneva Erosion Study follow-up group, where the patients are seen twice in the first year after completing the rehabilitation and afterwards once a year as part of the protocol.

The patient was clearly satisfied with the overall treatment, although she was very timid in expressing her satisfaction. The restorations integrated nicely with the rest of the dentition (colour and shape), and the soft tissues remained very healthy (esthetic success). Finally, since the amount of tooth structure removed to restore the case with adhesive restorations was minimal, all the teeth retained their vitality (biological success).

Time will tell if the mechanical success will also be achieved. At the 1-year follow-up the three successes were still confirmed (Fig 18).



**Figs 17a to 17c** Before and after treatment. The occlusion was stable throughout the therapy. The hypersensitivity improved, and all the teeth preserved their vitality.



**Figs 18a and 18b** Initial and final smile at the 1-year follow-up. The patient was extremely pleased with the result, even though it was still difficult for her to relax her lips.

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