

## Loss of vertical dimension: Extensive therapy in dentitions with erosion and abrasion. A treatment strategy for the dental practitioner

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There has been an increase in the incidence of tooth structures altered through abrasion and erosion. Such patients need to be offered adequate treatment. This case report shows that consistent treatment planning leads to functional and esthetic rehabilitation, even in cases with severe tooth wear. (*Quintessence Int* 2013;10:733–740; doi: 10.3290/j.qi.a30181; originally published (in German) in *Quintessenz* 2012;63(8):1011–1020)

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Dental erosion is defined as a chemically induced loss of tooth structure by acidic dissolution without bacterial involvement.<sup>1</sup> In contrast, abrasion is defined as a pathological loss of tooth structure through the impact of abnormal mechanical forces from a foreign element.<sup>2</sup> Attrition is caused by physiologic or pathologic tooth-to-tooth contact. These three factors cause nonbacterial loss of tooth structure. They belong to noncaries lesions affecting enamel, dentin, and cementum (Fig 1).

In contrast to caries lesions, erosions arise abacterially from chronic interaction of acids on the biofilm-free tooth surface.<sup>3,4</sup> They represent a self-contained disease pattern with their specific etiology and pathohistology. Therefore, specific treatment strategies for prevention and restoration are required. At first, causal therapy is important, as described by Ganss and coworkers.<sup>3,5</sup> In cases of advanced tooth wear with functional and esthetic impairment, extensive therapy with explicit treatment planning is required.<sup>6,7</sup>

Various treatment concepts have been described for reconstruction of the vertical dimension. To avoid complications, all concepts primarily postulate a reversible treatment. The aspired jaw relation as determined by a wax-up can be tested by

wearing a Michigan splint.<sup>8</sup> This new vertical relation from the prosthodontic phase can be transferred into the provisional phase. Alternatively, the wax-up setting can be transferred to the clinical baseline using an adhesive technique.

Another interesting concept is the three-step technique described by Vailati and Belser.<sup>9–11</sup> Starting with the first step, the esthetic achievable is created using a wax-up of the anterior teeth. Second, the defined vertical relation is temporarily transferred to the posterior teeth. As a third step, ceramic restoration of the anterior teeth is followed by the restoration of the posterior teeth.

All techniques described have the conservative approach in common, using an adhesive technique to enable minimally invasive and maximally esthetic outcomes. This case report shows how consistent treatment planning leads to a concept that enables the realization of a functional and esthetic reconstruction of advanced tooth wear in daily practice.

### CASE REPORT

#### Medical history and examination

A long-term patient, a dentist himself, decided at the age of 43 to undergo his own dental rehabilitation (Fig 2). At initial examination 11 years ago, occlusal tooth wear and functional changes with loss of canine

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**Fig 1a** Female patient with severe tooth wear: frontal view.

**Figs 1b and c** Maxilla and mandible: occlusal view. Anterior teeth and premolars are eroded up to the gingival margin at oral sites. Generalized loss of tooth structure exists.



**Figs 2a to c** Baseline: frontal and lateral view. The loss of tooth structure at anterior and posterior teeth is plain to see.

guidance were documented. The patient complained of recurrent painful muscle tension. A Michigan splint for the maxilla was applied.<sup>12</sup> The painful muscle tension was cured by splint therapy. Splint therapy was maintained and controlled at regular intervals. In subsequent years, progressive tooth wear was found. In addition to increasing abrasion of maxillary and mandibular cusps, loss of tooth structure at the oral sites of anterior teeth, and erosively changed tooth structure up to the dentin (Figs 3 and 4), a decrease of vertical dimension occurred. Therefore, the aim of treatment was a functional and esthetic reconstruction.

Diagnostic findings showed erosively changed occlusal surfaces with flattened cusps and dents up to the dentin.<sup>1</sup> In part, the existing gold inlays topped the adjacent tooth structure marginally. Insufficient restorations were found in the mandibular right second molar and the mandibular left first molar. The mandibular left first premolar showed a primary caries lesion. All maxillary anterior teeth were supplied with approximal composite resin restorations. Periodontal examination showed no pathologic findings, the absence of attachment loss, and excellent oral hygiene.

During lateral extrusion, functional findings showed a unilateral group function. Mouth opening was symmetrical and non-restrictive. Temporomandibular joint noises, occlusal noises, and muscular palpation pain could not be found.

**Treatment plan**

Functional findings revealed a loss of vertical dimension due to erosion and abrasion with a rotation of the temporomandibular joint. Thus bite raising could be performed without negative implications for the temporomandibular joint.<sup>13</sup> A mounted diagnostic wax-up (Fig 5) was used to measure the raised bite. The incisal pin was raised by approximately 3 mm.

The aim was to achieve the required bite raising and functional canine guidance by reconstruction of the complete dentition. The treatment plan included all-ceramic crown restoration of the mandibular right second molar and maxillary left second premolar. The remaining posterior teeth were to be restored with all-ceramic partial crowns or onlays. The maxillary and mandibular anterior teeth were to be lengthened with veneers.



**Fig 3** Maxilla: occlusal view. Dents and cavities on the erosively changed surface are plain to see.



**Fig 4** Mandible with clearly visible erosively changed surfaces: occlusal view.



**Figs 5a and b** Maxillary and mandibular wax-up. This setting was duplicated and a thermoforming tray for provisional restoration was made.



**Fig 6** Mandibular preparation, all sharp line angles are rounded.



**Figs 7a and b** Preparation of maxillary posterior teeth: detailed view. The main focus is on rounded edges and angles.

**Prosthodontic therapy**

Based on the wax-up, the blocking of the equilibrated Michigan splint was controlled and adjusted minimally. In this treatment phase, insufficient restorations were replaced by composite resin cores (Clearfil Core, Kuraray). The maxillary left second premolar with root canal filling was restored with a fiber post (Style-Post, Cendres+Metaux)

and a composite resin core (Clearfil Core).<sup>14,15</sup>

The maxilla and mandible (Fig 6) were prepared completely, in one session each. To ensure an ideal all-ceramic restoration, a smooth, rounded, and harmonious preparation (Fig 7) of all surfaces and transitions is required. The veneer preparation was carried out equigingival to slightly subgingi-







**Fig 8** Maxillary anterior teeth with veneer preparation: detailed view.



**Fig 9** Laboratory prepared record base.



**Fig 10** Control record base.



**Fig 11** Laboratory made provisional restoration of anterior teeth, veneer- interim in one piece: frontal view.

val. The incisal edge was overlapped; interproximal preparation was extended because of the existing restorations. Here, a smooth preparation with rounded edges and angles is also important (Fig 8).

The impressions were performed with individual impression trays and polyether impression material (Permadyne, 3M Espe). A facebow (SAM Präzisionstechnik) was used to record the maxillary position; centric jaw relation was recorded (Fig 9).

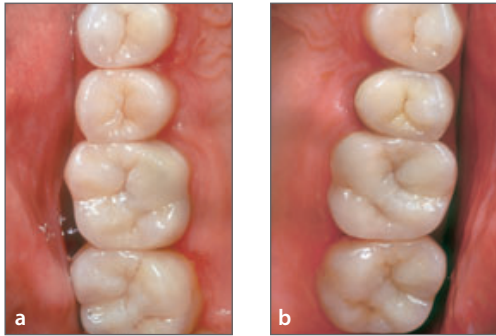
During preparation sessions, jaw relation was recorded without losing centric condylar position if possible. After preparation and disintegration of the support zone in the first quadrant, jaw relation was recorded with solid, sliceable silicone (Futar, Kettenbach). After preparation of the left side, the right registration was inserted while recording the registration on the left side. This procedure ensured the maintenance of the existing jaw relation. The right maxillary registration was used to adjust the position of the second and third quadrant

after preparation of the third quadrant. Adjacent, this new registration enabled the adjustment of the first and fourth quadrant after preparation. In this way, each jaw registration allowed control of whether the patient finds the same position, repeatedly.

Fabrication of the master cast was carried out with Fuji Rock (GC Europe). To conduct a back-checkup at the following treatment session, the dental laboratory produced a concise and sliceable silicone registration (Futar) with the mounted master casts (Fig 10).

Based on the wax-up, a vacuum-formed thermoplastic was used to prepare the provisional restorations (Structur 2 SC, Voco), already in therapeutic vertical dimension. Due to esthetic reasons and because of the two preparation sessions, the dental laboratory was able to make a linked veneer provisional restoration (Fig 11).

All-ceramic restorations were made by powder metallurgy using feldspathic ceramic Initial MC and fire resistant material



**Figs 12a and b** Permanent restoration of maxillary posterior teeth: detailed view.



**Fig 13** Cemented mandibular restoration: occlusal view.



**Fig 14** Maxillary and mandibular veneers from canine to canine: frontal view.



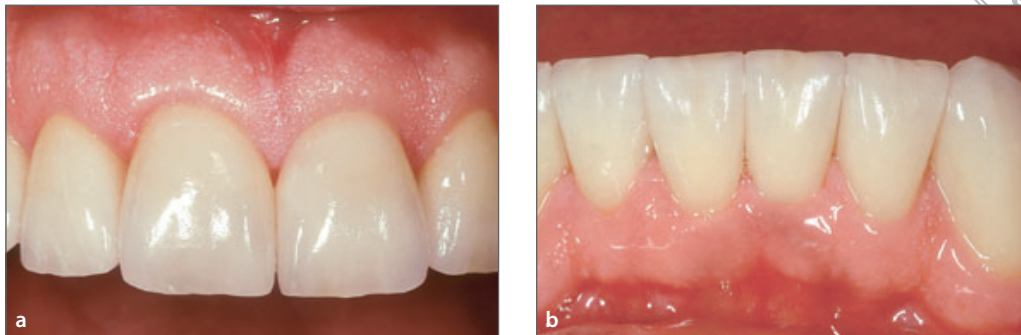
**Fig 15** Lip appearance, posttreatment.

Cosmotech Vest (both GC Europe; duplicating material, coppi-sil 22, Dentona). Rubber dam was used during permanent cementation of posterior restorations. Enamel and dentin were conditioned using the “etch & rinse” technique: phosphoric acid (Ultra-etch, Ultradent) was applied beginning with enamel and followed by dentin for a maximum of 20 seconds. Ceramic restorations were etched with hydrogen fluoride (5%, Vita), silanated (Espe Sil, Espe) and permanently cemented following the total-bonding technique (Syntac Classic, Ivoclar Vivadent) with composite resin (Variolink Ultra, Ivoclar Vivadent). Drying during veneer cementation was performed with a plain cord size 000 (Ultrapak, Ultradent). It was placed after conditioning of enamel and dentin in order to prevent soaking with phosphoric acid by mistake. The cementation procedure equated to the posterior restorations, while only the used cementation composite differed: The low viscosity Variolink Veneer was used (Ivoclar Vivadent).

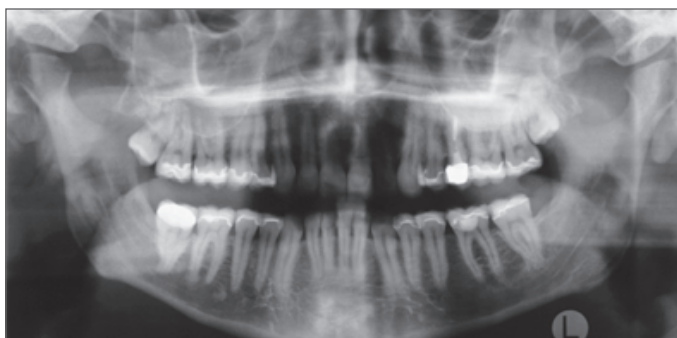
Margins were polished with ceramic bur-nisher (Ceramiste Standard Ultra and Fine, Shofu).

At first, all maxillary restorations were cemented (Fig 12). The finished mandibular restorations were fitted again and another registration was taken. An impression of the new maxillary situation was used to control all occlusal contacts in the dental laboratory. Thus only slight adjustments were necessary after cementation of the mandibular restorations (Fig 13). The close-up view of the maxillary anterior teeth (Fig 12) and the occlusal view display a successful restoration. The anterior view (Fig 14) shows attractive esthetics and the regained length of anterior teeth (Fig 15). The close-up views of the maxillary (Fig 16a) and mandibular (Fig 16b) veneers exhibit perfect periodontal conditions. Figure 17 shows the posttreatment radiograph. Posttreatment a new Michigan splint was prepared.<sup>16</sup>





**Figs 16a and b** Maxillary and mandibular veneers: detailed view. Healthy gingival conditions at restoration margins.



**Fig 17** Radiograph, posttreatment.

## DISCUSSION

A long-lasting interaction of erosion and abrasion, the occurrence of which has increased<sup>3</sup> over recent years, leads to severe loss of tooth structure. Multiple causes have been attributed to this damage.<sup>2,12,17,18,19</sup> Improved dietary and health awareness are exogenous causes for erosion: The increased consumption of acidic food and beverages (fruit, sport beverages, fruit juice, wine) results in critical pH-value reduction in the oral cavity.<sup>18,20</sup> Endogenous causes are eating disorders with vomiting, reflux, and regurgitation. The burped gastric acid (pH 1.0 to 1.5) also leads to critical pH-values.<sup>21</sup> During these phases the entry of another medium such as toothpaste causes additional damage through abrasion.<sup>17,20</sup>

As prescribed by Ganss and Schlüter,<sup>3</sup> causal therapy is the first step of rehabilitation. If exogenous causes exist, nutrition and oral hygiene instructions are adequate methods to prevent further damage. A protective aid is the use of fluoride rinse.<sup>22</sup> If

endogenous causes appear, psychotherapy is initially recommended. However, if tooth wear up to the dentin with loss of vertical dimension is present, further therapeutic interventions will be needed.

When raising the vertical dimension, it is important to test out the designated dimension in order to prevent irreversible damage. A Michigan splint is a suitable instrument to ensure physiologic and functional movements of the mandible.<sup>23</sup> Subsequently, these results can be carried over into the prosthodontic phase by provisional restorations based on the wax-up, followed by permanent restorations. Maintaining the centric condylar relation is very important. The vertical dimension has to be adapted to individual anatomic and physiologic conditions.<sup>24,25</sup>

An alternative to the first step with splint therapy described above, is the method presented by Schmidlin and Filli.<sup>26</sup> Based on the wax-up, a thermoformed tray is used to build up the raised bite with composite resin restoration directly (limited reversible). The advantage is that in this first phase of



raising the bite or rather the reconstruction of the vertical dimension, the patient is able to immediately estimate the esthetic outcome. Furthermore, the patient can test out the reconstructed vertical dimension under complete functional loading. Primary findings recommend this method as an alternative to cost-intensive provisional restorations.<sup>27</sup>

The three-step technique by Vailati and Belser<sup>9-11</sup> is a very intensive approach, with the main focus being on the checking of esthetic options. The authors also describe too little increase of vertical dimension in order to rest tooth structure as a common problem. The results are not only inappropriate esthetic appearance but also an insufficiently shaped buccal corridor.<sup>28</sup>

Instead of a wax-up of the complete denture, this three-step technique starts with a wax-up of the anterior teeth (up to premolars), which is transferred into the oral cavity as a mock-up. On this basis, individual requests and available options may be discussed with the patient. As a second step, a wax-up of posterior teeth (including the first molars) is carried out accordingly. With the help of a transparent silicone index, this setting is built up with composite resin directly on the present intraoral situation. The third step follows once the new situation has been proven to be stable for at least a month. The wax-up is completed on the anterior teeth and carried out as a permanent ceramic restoration. The same is performed in the posterior teeth.

This technique is very demanding and requires steps that are not easy to perform. One example is the sandwich technique: oral tooth wear in anterior teeth is corrected with ceramic veneers at labial tooth surfaces and oral tooth surfaces with direct or indirect composite resin restorations.

On the basis of the case report presented, the proceeding illustrates a reliable way for the dentist and patient to reconstruct severely worn dentitions. If required, several techniques, as described above, can be included. Doubtless, a mock-up of the anterior teeth is recommended to check and illustrate the required esthetic outcome. Furthermore the adhesive technique on the existing dentition is a low-cost alternative. A mere posterior restoration, as described in

step two of the technique of Vailati and Belser,<sup>9-11</sup> has to be discussed carefully with the patient, because in this treatment phase the resulting open bite could be problematic.

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