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Type:	Review


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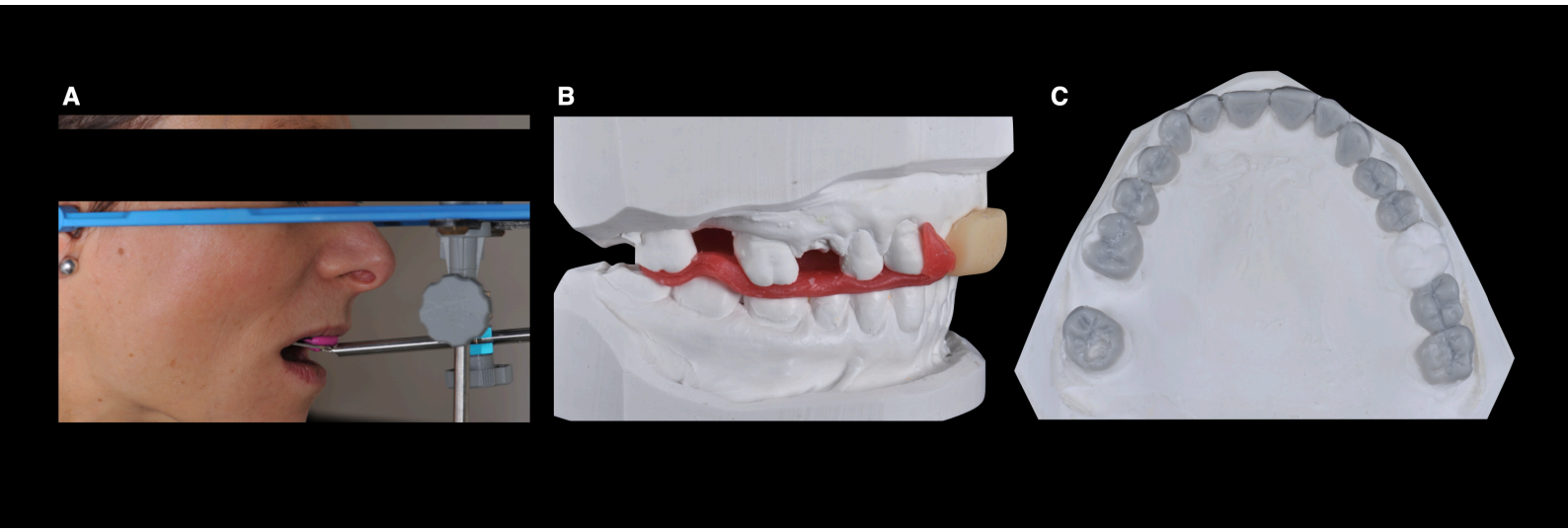
CASE 1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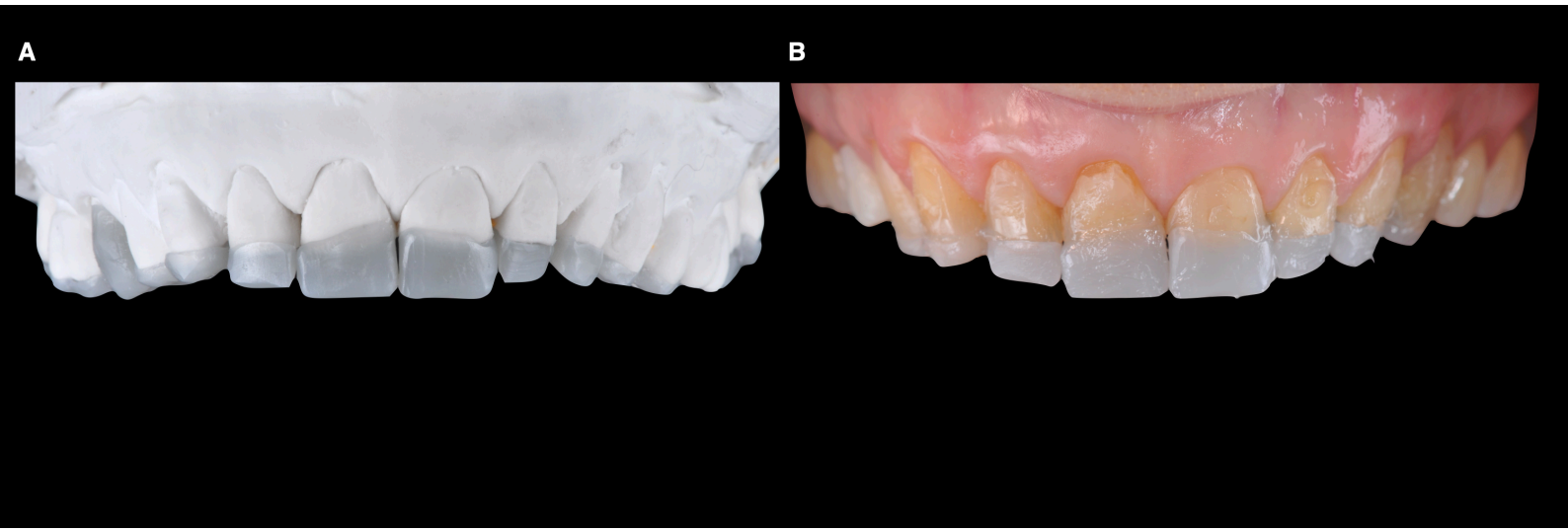
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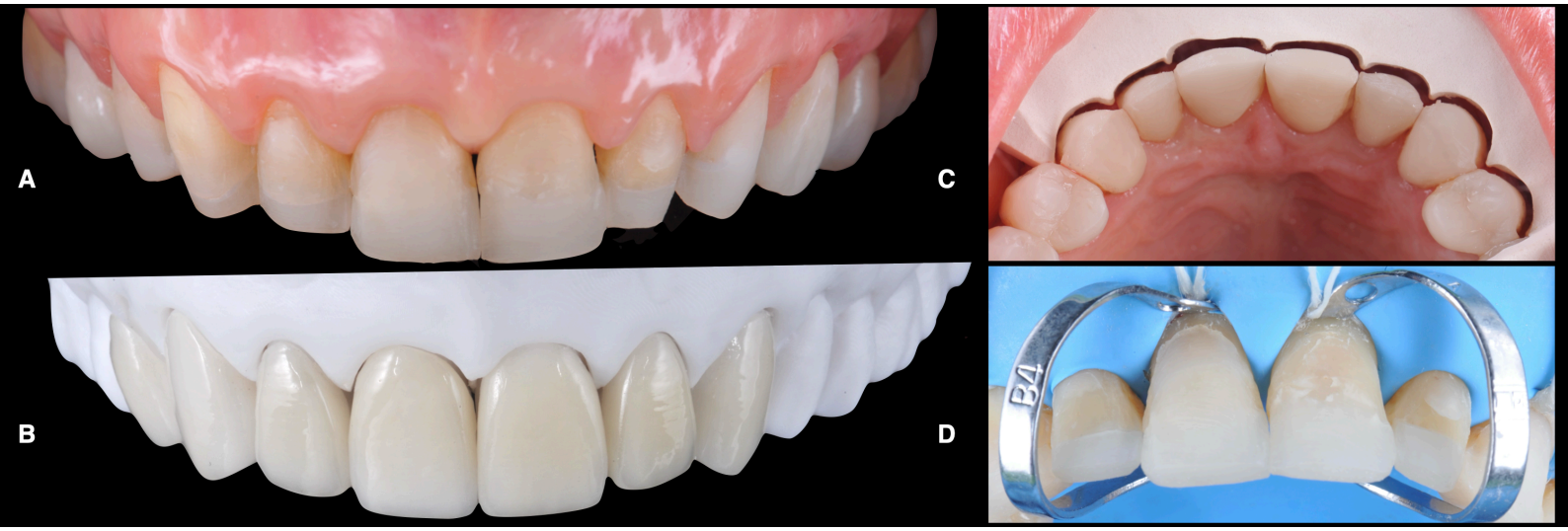
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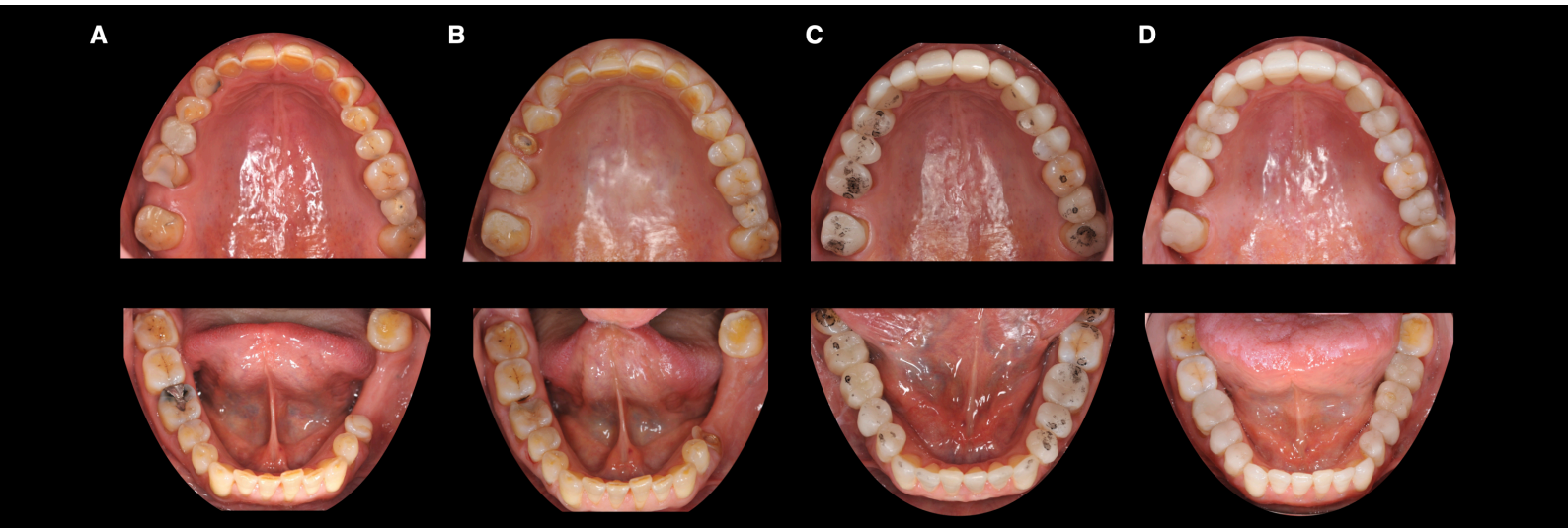
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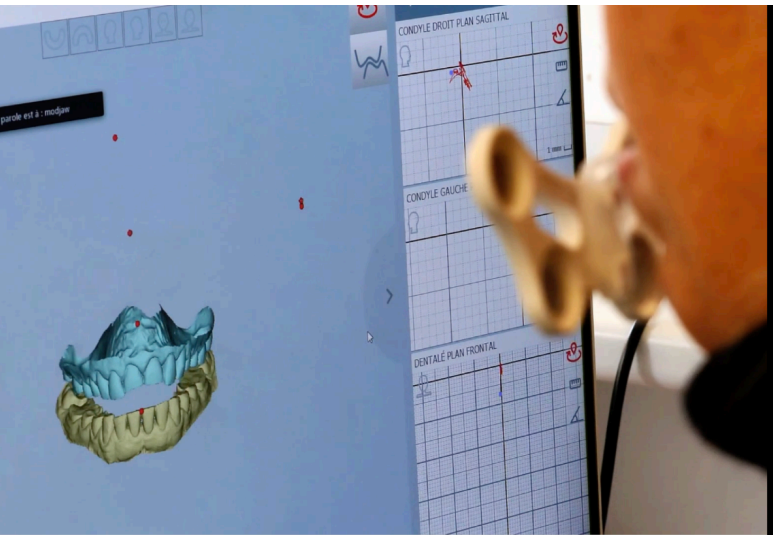
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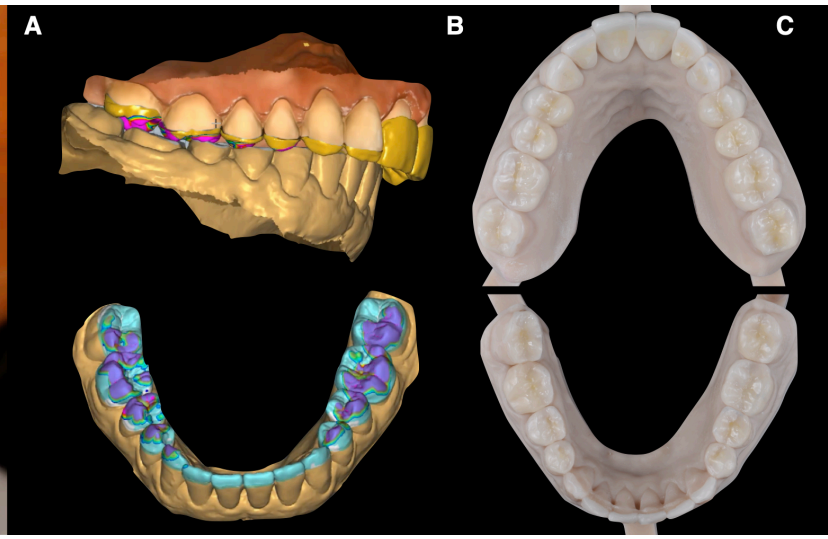
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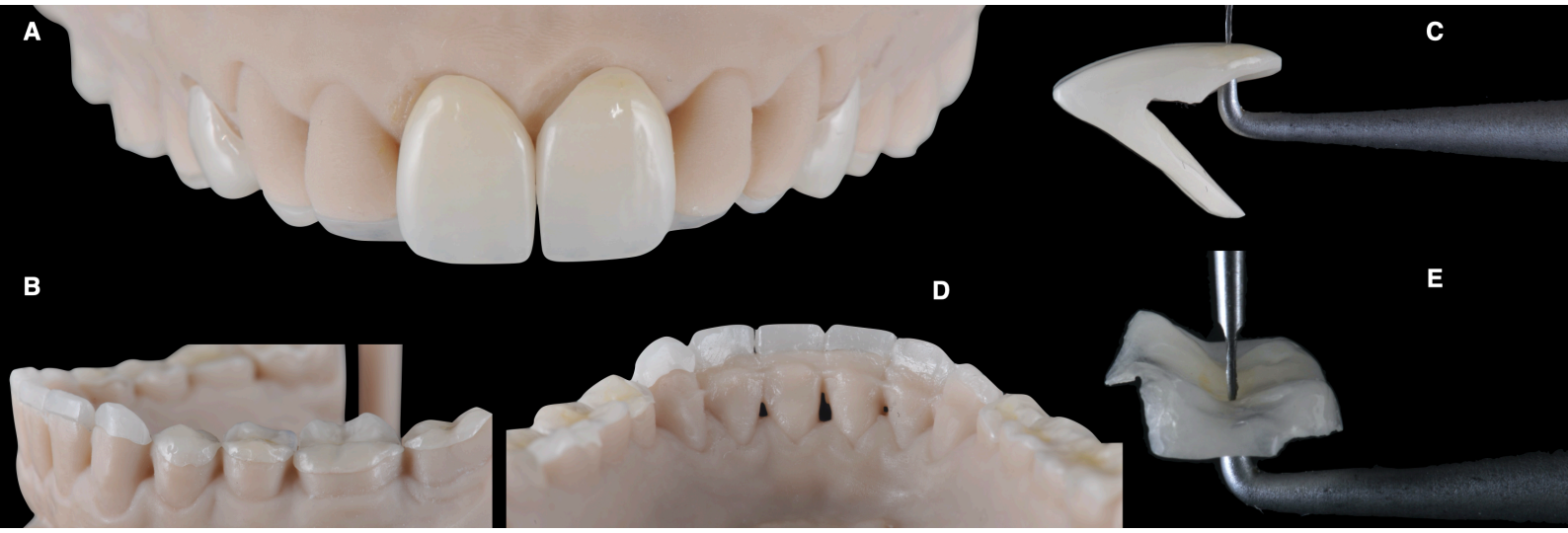
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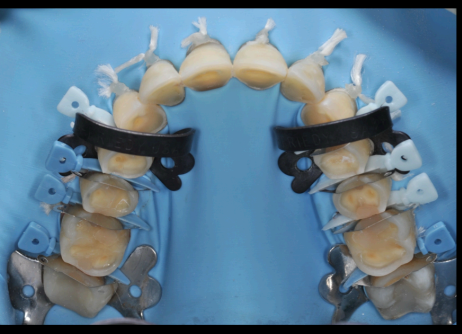

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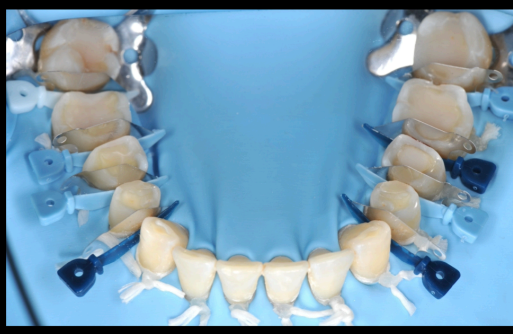

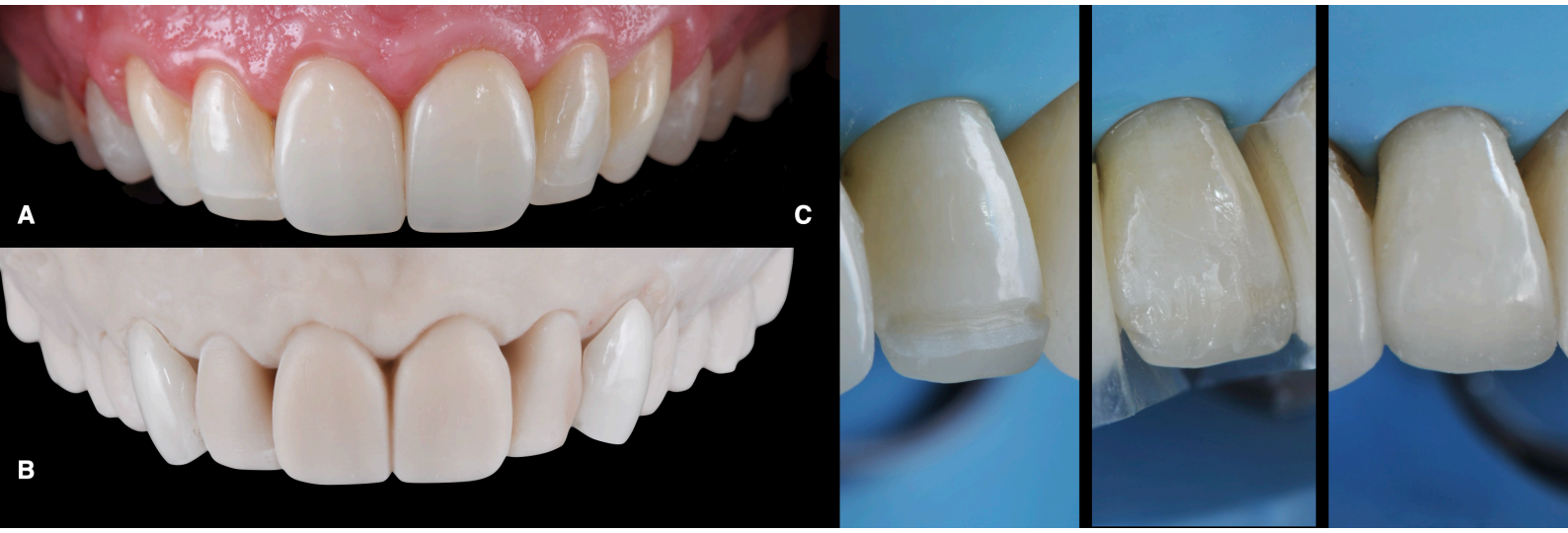
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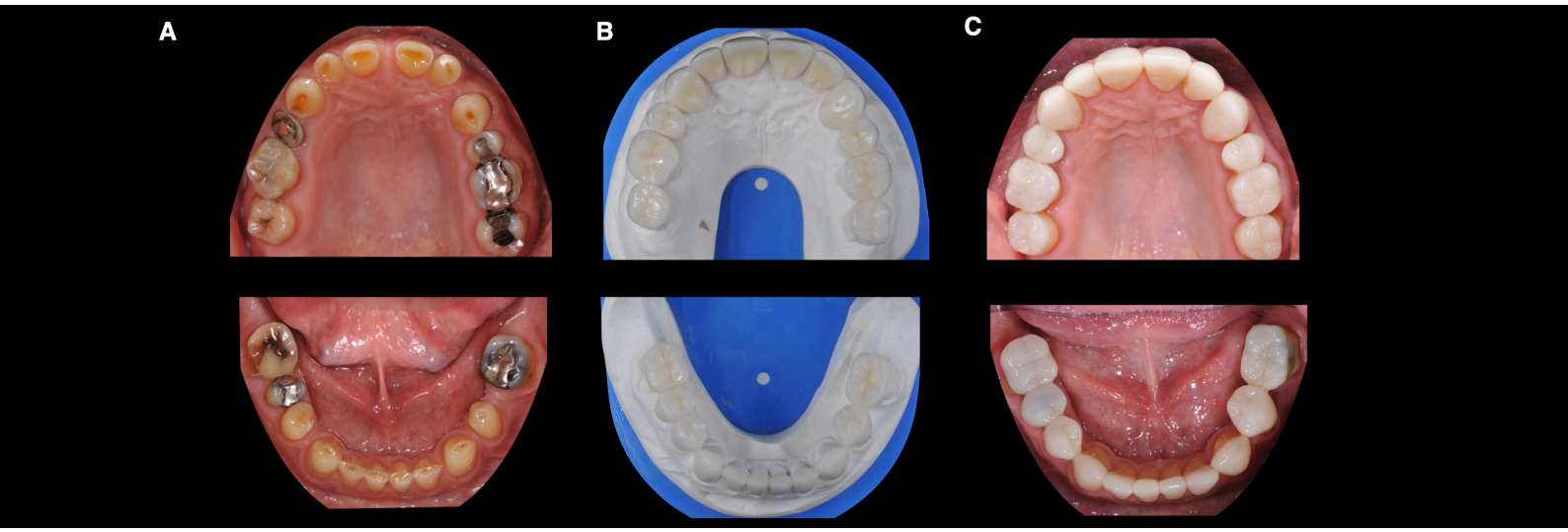
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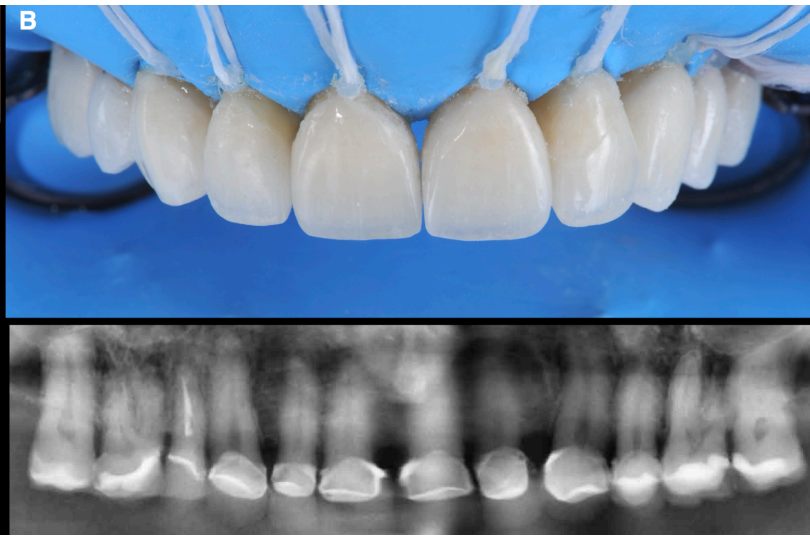
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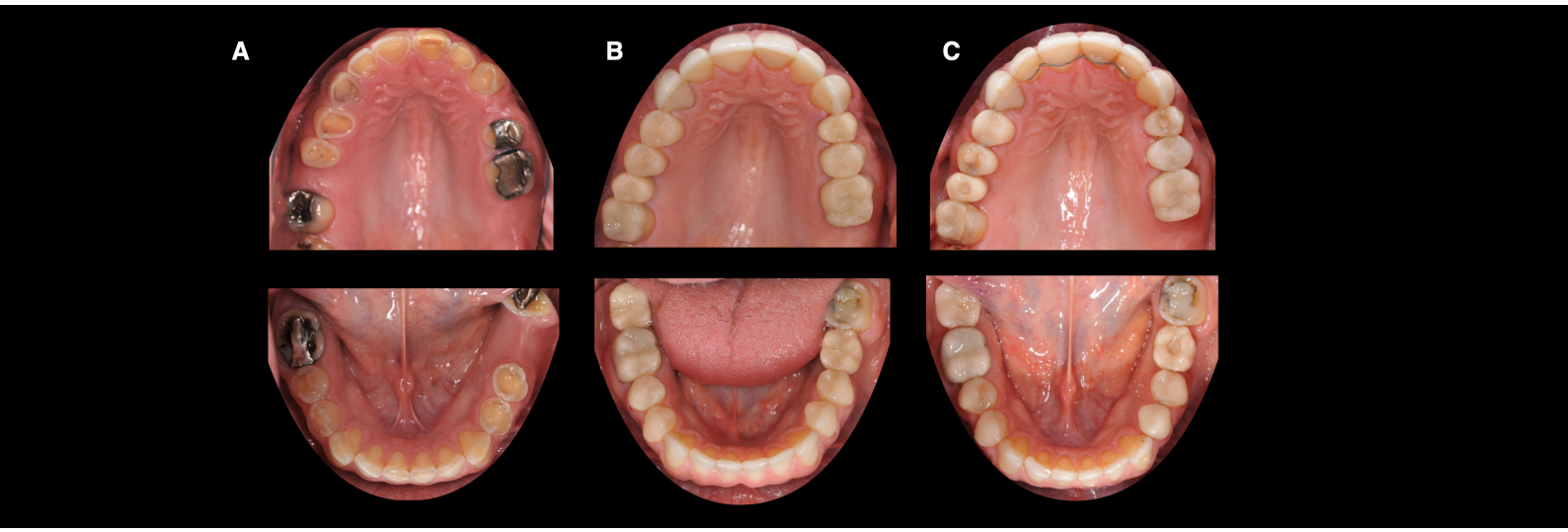
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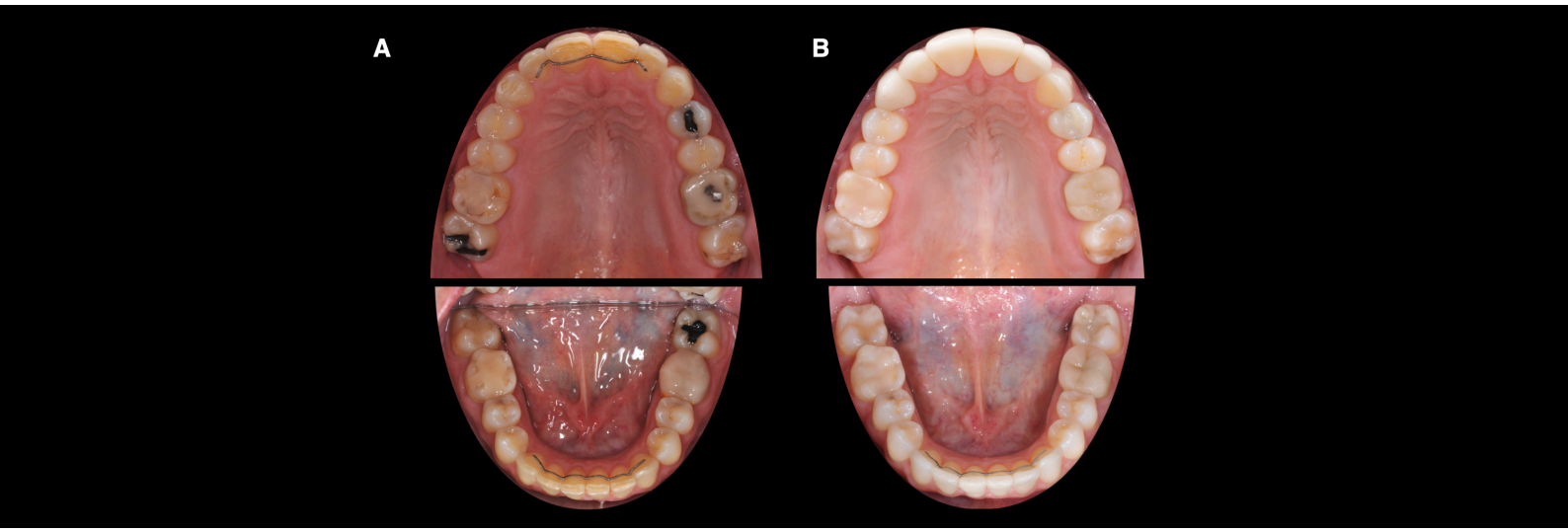
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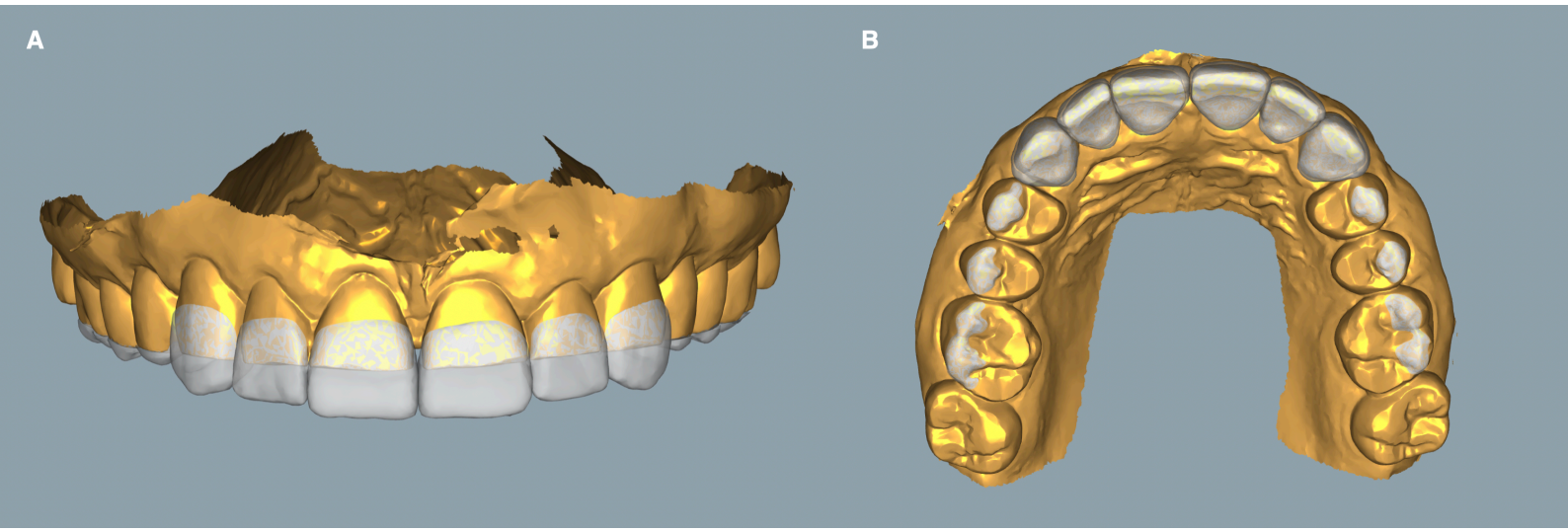
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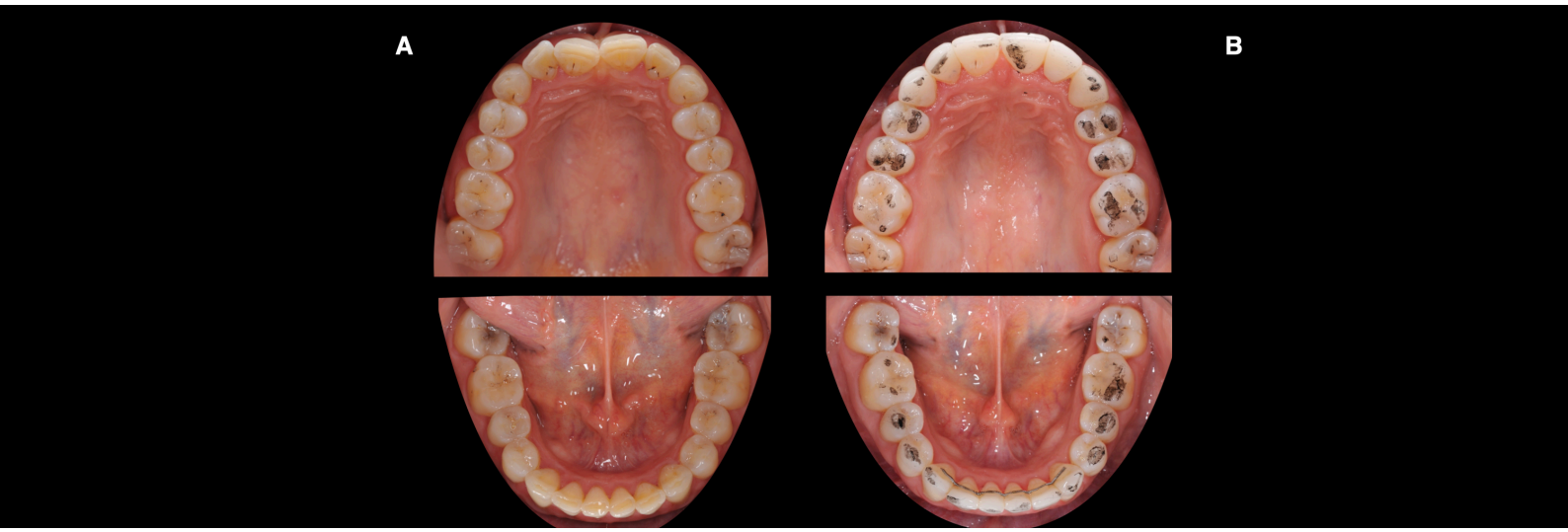
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ABSTRACT

Polymer-Infiltrated Ceramic Network (PICN), commonly referred to as "hybrid ceramic', represents a unique class of materials that integrates glass-ceramic and polymer. Vita Enamic is the only PICN available on the market, benefiting from over a decade of clinical use and research. It offers a balance between pure ceramics and direct and CAD-CAM composites, leveraging their advantages while minimizing their disadvantages in the context of severe tooth wear (TW) treatment. PICN exhibits properties that closely mimic tooth tissue, particularly its wear behaviour and stiffness, while polymer promotes the material's ability to dampen occlusal stress.

The introduction of PICN has been at the origin of the One-Step No-Prep technique for treating severe TW. This non-invasive and straightforward method provides a cost-effective alternative to traditional indirect approaches. This work reviews the properties of PICN and compares them to other materials used in TW treatment. Clinical cases illustrate the One-Step No-Prep technique for generalized severe TW and the Orthodontic-assisted One-Step No-Prep technique for localized cases, which is an evolution of the Dahl concept.

The review discusses the clinical and scientific background of PICN as used in the One-Step No-Prep technique and highlights excellent clinical outcomes from various perspectives. However, it also addresses limitations, such as the tendency for chipping at thin occlusal borders of posterior restorations and a lower gloss on occlusal surfaces compared to pure ceramics, which does not affect patient satisfaction but could be improved. Despite these drawbacks, PICN appears to be a suitable material for managing TW in a non-invasive way.

Keywords: minimally invasive dentistry, CAD-CAM, composites, occlusion, orthodontics, Dahl.

1. INTRODUCTION

Tooth wear & minimally invasive management

The majority of dental practitioners are confronted with the challenge of severe tooth wear (TW). Indeed, TW is known to have a high and increasing prevalence, particularly among younger patients [1-3]. TW is a multifactorial phenomenon with a multitude of potential origins [4]. Acidic foods and drinks, as well as gastroesophageal reflux (GER), are known to cause chemical wear of the teeth. Additionally, mechanical wear is frequently linked to bruxism, which mainly results in attrition (the loss of tooth tissue on the occlusal surface due to friction) [5 6]. TW can affect all the teeth (generalised TW) or only some of them (localised TW). In cases of severe TW, patients may experience dental pain, psychosocial handicap, masticatory dysfunction, temporo-mandibular joint disorders or muscular and orofacial pain [7,8]. In accordance with European guidelines, restorative procedures are only indicated in the event of patient-reported complaints, whereas risk factor diagnosis and management, as well as TW monitoring, are always mandatory [8]. In cases where intervention is indicated, it is advised that conservative and minimally invasive techniques be employed, involving the minimum number of teeth and limiting tooth preparation. The material and technique selected should align with the patient's expectations, aesthetic requirements, and risk profile, as well as the operator's familiarity and skills, patient availability for recall, and budgetary constraints [8]. A detailed explanation of the various treatment options and potential complications should be included in the patient informed consent. Indeed, patients with TW wear are at an elevated risk of restoration failure, given the considerable mechanical and/or chemical stresses to which biomaterials are subjected.

Considerations on materials & techniques for generalised and localised tooth wear treatment

In this context, the choice of material is critical and when it comes to choosing a material and a technique to restore teeth in severe TW, we should ask ourselves: what are the specifications of the ideal material? In fact, this material should promote minimally invasive treatment, have good fracture resistance and damping capacity of

occlusal stress, mimic the properties of tooth tissue, for example in terms of wear and abrasiveness, be easy to adjust and repair, have chemical stability without staining and discolouration over time, be aesthetic and biocompatible, and have a low cost. Unfortunately, this ideal biomaterial does not exist and we have to compromise.

A variety of materials and techniques have been described in the literature for the rehabilitation of patients with severe TW [9]. These include direct techniques utilising light-cured composites [10 11], as well as indirect techniques employing different materials, such as Computer-aided Design and Manufacturing (CAD-CAM) composites or ceramics [12 13 14-17]. Alternatively, a combination of these two techniques may be employed. However, the current lack of scientific studies in the literature means there is no definitive evidence to favour one type of restoration or material over another for generalized tooth wear treatment [9].

In the case of localised tooth wear, there is often a lack of occlusal space and the literature reports both invasive and minimally invasive options for tooth restoration. For example, Hansen et al. use full zirconia crowns for localised anterior tooth wear [18]. On the other hand, in 1975, Dahl et al [19,20] proposed a remarkably interesting and conservative approach to creating an anterior interocclusal space. Currently, the concept is to restore anterior teeth with direct composites that increase the vertical dimension of the occlusion (VDO) and are in supraocclusion, waiting for a combination of posterior extrusion and anterior intrusion. Although there are some reported drawbacks to this technique, for example in terms of duration, risk of malocclusion or failure of the anterior restoration [21], it has the advantage of being particularly minimally invasive.

The One-Step No-Prep technique

The advent of the Polymer-Infiltrated Ceramic Network (PICN) material (hybrid ceramic, Vita Enamic, Vita Zahnfabrik, Germany) prompted the author to introduce the One-Step No-Prep technique for the treatment of generalized severe TW in 2018 [22] and the orthodontic-assisted One-Step No-Prep technique for the treatment of localized severe TW in 2020 [23]. The main feature of this technique is that it requires no preparation of the tooth tissue ("no-prep" technique) and is performed in a single step, i.e. there is no phase with temporary restorations

("one-step"). The aim is to restore only the teeth that need to be restored and to reconstruct the missing tooth tissue in a non-invasive way. The technique combines the advantages of direct techniques (non-invasive and one-step procedure, restorations that are easy to repair) and indirect techniques (access to high-performance materials). It is particularly straightforward as there is no preparation of tooth tissue, no temporary restorations and all restorations are directly bonded within a maximum of 24 hours. The orthodontic-assisted One-Step No-Prep technique represents an advancement of the Dahl concept, whereby simple orthodontic extrusion (SOE) ensures rapid, correct, and predictable extrusion of the posterior teeth [24]. Additionally, the One-Step No-Prep technique includes bruxism management by maxillofacial physiotherapists.

2. What Is a Polymer-Infiltrated Ceramic Network (PICN) Material, Also Known as Hybrid Ceramic?

PICN (Polymer-Infiltrated Ceramic Network) material, or “hybrid ceramic”, represents a unique class of materials that integrates the characteristics of glass-ceramic and polymer, positioning itself as an interesting option for addressing tooth wear. With a patented process, the sole commercially available PICN material is Vita Enamic (Vita Zahnfabrik, Germany), launched in 2013, which benefits from a decade of clinical use and research background.

PICN/hybrid ceramic as part of the CAD-CAM composites family

PICN belongs to the CAD-CAM composites family since, as mentioned in the definition of composites, it is a mixture of materials from two different chemical families including a combination of inorganic and organic phases. CAD-CAM composites are indicated for single-unit restorations because of their flexural strength, which is inferior to that of lithium-based glass-ceramics or zirconia. However, composites are less brittle than ceramics and more suitable for milling, especially chairside. They can be milled in very thin thicknesses, the manufacturing process is fast, bur lifetime is increased, and they do not require firing, which can reduce cost compared to ceramics. The industrial manufacturing process of CAD-CAM blocks promotes material homogeneity and reduces the presence

of flaws [25]. Most importantly, it allows for the use of more performant polymerization modes and innovative material microstructure, resulting in composite materials with significantly better properties than direct light-cured composites [26,27].

Specificity of PICN/ hybrid ceramic

Currently, CAD-CAM composite blocks can be divided into two subclasses based on their microstructure: dispersed filler materials (DF) and Polymer-Infiltrated Ceramic Network (PICN) [28,29]. Dispersed filler materials are similar in composition and microstructure to direct composites, consisting of glass fillers incorporated into a monomer matrix. However, unlike direct composites, which are polymerised with light, DF materials are polymerised at high temperature. Note that DF materials are sometimes referred to as "resin nanoceramics" or "resin matrix ceramics", which can cause some confusion. In contrast, the manufacturing process of PICN involves several key steps. First, a glass ceramic block (Vita Mark II) is partially sintered. This block is then infiltrated with monomers, which are then polymerised under high temperature (>100°C) and high pressure (>150 MPa) (HT-HP) (**Figure 1**). PICN material is also referred to as a double network material, where the glass-ceramic particles are connected to each other, resulting in a 3D configuration.

PICN/ hybrid ceramic properties

Due to its specific microstructure, PICN is the only material with properties that closely mimic tooth tissue, in particular a modulus of elasticity between dentin and enamel and a wear behaviour close to enamel, whereas dispersed filler composites (direct or CAD-CAM) are too soft and subject to higher wear, and ceramics are too stiff and do not wear sufficiently [29,30]. In fact, PICN is an "in-between" material that combines several advantages without the disadvantages of light-cured direct composites on the one hand and pure ceramics on the other, while also showing some advantages over DF CAD-CAM composites in TW treatment.

Indeed, the presence of polymer in the PICN material offers several interesting properties. Like direct composites, PICN allows for a no-prep treatment that preserves tooth structure, as it can be milled in very low thickness (up to 0.2 mm). It also allows for a one-step, cost-effective procedure that does not require a provisional phase, as it can

be easily adapted to occlusal and proximal contact points. The viscoelastic properties of the polymer promote surface damping capacity and occlusal stress dissipation [31,32], which is important in patients with bruxism. Moreover, PICN is antagonist-friendly as it is not abrasive like lithium-based glass-ceramics. Finally, the presence of polymer gives PICN a chameleon effect that allows it to blend with natural tooth structure, contributing to favourable aesthetic outcomes. Regarding optical properties, Vita Enamic blocks are also available in a version with a colour gradient (multiColor blocks).

In terms of ageing resistance, the industrial HT-HP manufacturing process of PICN induces a very high degree of polymerisation of the monomers compared to a direct composite [33]. As a result, in addition to improved mechanical properties and wear resistance, chemical stability (water absorption and discolouration resistance) is significantly improved [29,30]. This high polymerisation rate also induces the absence of monomer release, which explains its good biocompatibility properties [34,35].

In addition, PICN shows excellent bonding properties to resin composite cement, which have been shown to be similar to those of glass-ceramics and higher than those of other CAD-CAM composites[36,37].

Finally, for TW treatment, PICN offers the advantage of an indirect technique: it can reduce in-mouth working time and facilitate the realisation of the correct anatomy.

In conclusion, in terms of the above specifications for the ideal material for TW treatment, PICN is not an optimal choice but it ticks most of the boxes compared to direct composites, glass-ceramics, zirconia or dispersed filler CAD-CAM composites. The main inconveniences of PICN are related to its loss of lustre in the friction (occlusal) area, its relatively low flexural strength, which can promote chipping, and its cost, which is higher than direct composites but lower than ceramics.

3. Clinical Protocol for Generalized Tooth Wear Treatment Using the One-Step No-Prep Technique With PICN/Hybrid Ceramic (Cases 1 to 4)

Clinical case preparation: Tooth wear diagnostic and dental care

Prior to the commencement of treatment, a comprehensive examination is conducted to assess the presence of dental caries, periodontal disease, and temporomandibular joint dysfunction. X-rays and photographs are taken. The ToWeR checklist [4] is employed to diagnose risk factors associated with tooth wear. A clinical diagnosis of bruxism is made. The patient is informed and risk factors are managed by discussing lifestyle changes and, if necessary, referring the patient to the relevant specialists. For example, if there is a suspicion of reflux, the patient is referred to a gastroenterologist, while if there is a suspicion of bruxism, the patient is referred to a maxillo-facial physiotherapist. The physiotherapist performs a massage of the muscles and provides the patient with instructions regarding the performance of exercises to be carried out at home, with the objective of relaxing the masticatory muscles. Furthermore, the physiotherapist provides the patient with education regarding their bruxism behaviour. Subsequently, the necessary classical dental (including endodontic treatment) and periodontal care is administered, along with the replacement of amalgam fillings and deficient composite restorations with direct composite restorations.

Planning

A digital smile analysis and design is conducted, utilizing software such as Keynote (Apple Inc., Cupertino, CA, USA).

No preparation of tooth tissues is performed, but sharp angles are softened with an Arkansas bur. Large direct composite fillings are partially removed to be replaced by indirect restorative material, but the cavity floor is left intact to avoid any sensitivity. Intraoral scans (or double mix impressions with polyvinyl siloxane material in older cases) are made.

An occlusal analysis is performed using a resin jig and a facebow (Quick facebow, Sintec Inc, New Hampshire, USA). The jig is placed for a few minutes to induce muscular relaxation and lower jaw repositioning, and then centric relation is registered with wax (Moyco Beauty Wax, Philadelphia, PA, USA) in double thickness (**See Case 1**). Nowadays, the occlusal analysis is digitally realized using a jaw tracking system (Modjaw, Villeurbanne,

France), which allow for the registering of all mandibular movements in 3D (**See Case 2**).

The dental technician proceeds to the digital design (or wax up in older cases) of the restoration. He is guided by the residual tissues to restore tooth anatomy, resulting in a very low restoration thickness on some posterior teeth, and by the 3D functional movements envelope (when Modjaw is used). He also uses the digital smile analysis for anterior teeth. In the absence of tooth wear on some teeth, they are not restored; when there is minor tissue loss, direct composite restorations are indicated. With this "tissue-guided" approach, the estimation of the new vertical dimension of occlusion (VDO) is empirical. It should be emphasized that the patients do not wear any occlusal splints to test the new VDO before treatment.

Occlusal function restoration with No-Prep PICN restorations

A CAD-CAM mock-up is realized in wax and tried with Vaseline to validate the restoration design and aesthetic result (Ceramill Wax, Amann Girrbach AG, Koblach, Austria) (**see Case 1**).

Restorations corresponding to the estimated tissue loss are milled from PICN blocks (Vita Enamic, Vita Zahnfabrik, Germany; Ceramill Motion 2, Amann Girrbach). Depending on the situation, different restoration designs are used. In the anterior region, palatal veneers, chips (restoring the incisal edge of lower teeth) or envelope restorations (no-prep partial-coverage restoration recovering the palatal and buccal surfaces of an anterior tooth, without recovering the proximal surfaces, **see Case 2**) are performed. In exceptional cases, full-coverage no-prep restorations can be performed (**see Case 3**). In the posterior region, occlusal tabletops, onlays or veneerlays are employed. At the present time, the Vita Enamic multiColor blocks are invariably employed; they are regarded as superior to the Monoblock Translucent or High Translucent for aesthetic reasons. Most of the restorations are only polished with the Vita Enamic technical polishing set. Additionally, a light-cured nanofilled composite coating agent (Optiglaze, GC Corporation, Tokyo, Japan or Vita Akzent Plus, Vita Zahnfabrik, Germany) can be applied after hydrofluoric acid (HF) etching or sandblasting and silane application, but only to the buccal surface (due to rapid wear on the occlusal surface).

Restorations are tried and then bonded within two consecutive days at two half-day appointments, one for each maxilla (the upper jaw on the first day, the lower on the second). Restorations are pretreated according to the

manufacturer's recommendations, i.e., etching the surface with HF for 60 seconds, cleaning it in an ultrasonic bath in ethanol, and then applying a layer of silane. A rubber dam is placed and tooth tissues are cleaned with pumice. A diamond burr at low speed is used to open the tubules of sclerotic dentin and a total etch is realized with phosphoric acid. Direct composites are sandblasted and a layer of silane is applied. Then an adhesive layer is applicated following manufacturer recommendations and is polymerized before restoration bonding. The restorations are bonded with a composite resin cement. Polymerization is performed after excess removal and final photopolymerization is carried out under a film of glycerin to avoid the persistence of a polymerization inhibition layer. Major occlusal adjustments are made immediately after bonding of the lower restorations with an Arkansas stone burr, followed by polishing with silicon gums (Vita Enamic polishing set) and fine adjustments performed within the subsequent weeks.

Aesthetic restoration

A bleaching procedure (home bleaching with a night guard using 10% carbamide peroxide gel) is performed in the following weeks (which is not possible when the dentin is still exposed). To mask the junction between the palatal veneer and the buccal face of the anterior teeth, direct composite (Inspiro, Edelweiss, Zug, Switzerland) is added on a slight chamfer performed across the junction (**see Case 2**). In recent times, buccal masking has been substituted by a restoration design that partially covers the buccal surfaces of the teeth, thereby facilitating a smooth transition between the material and the tooth (**see Cases 5 and 6** of localised tooth wear). In instances where TW is more pronounced on the buccal surface, lithium (di)silicate-reinforced glass-ceramic buccal veneers are subsequently provided in addition to the palatal veneers, a technique known as the "sandwich technique" (**see Cases 1 and 4**).

Finally, an acrylic occlusal nightguard (usually for the upper maxilla) is provided in case of bruxism.

4. Clinical Protocol for Localized Tooth Wear Treatment Using the Orthodontic-Assisted One-Step No-Prep Technique With PICN/Hybrid Ceramic (Cases 5 to 6)

Clinical case preparation: Tooth wear diagnostic and dental care

The preparation of clinical cases is identical to that of cases involving generalised tooth wear.

Planning

A digital smile analysis and design is conducted in the same way than for generalised toot wear, utilizing software such as Keynote (Apple Inc., Cupertino, CA, USA).

No preparation of tooth tissues is performed, but sharp angles are also softened with an Arkansas bur. Intraoral scans are made. The occlusal analysis is not necessary in simple cases.

The digital setup of upper anterior restorations is designed on the basis of the estimated amount of tooth tissue loss, the digital smile analysis, and the reconstruction of harmonious incisor proportions. Posterior occlusal relationships are not taken into account when designing the restorations. The technique resulted in an empirical estimate of the new VDO and in restorations in supraocclusion.

In some cases, lower anterior teeth and/or some posterior teeth (usually lower first molars) also need to be restored. When there is minor tissue loss, direct composite restorations are indicated (**see Cases 5 and 6**).

No-Prep PICN restorations realization

CAD-CAM mock-ups are created using wax material and tested to ensure the desired aesthetic outcome is achieved. Subsequently, restorations are milled from Vita Enamic blocks and tried-in, followed by bonding in a manner analogous to that employed for generalised tooth wear. Occlusal adjustments are performed with an Arkansas stone bur, followed by polishing with silicon gums. The occlusal adjustments only consist of equilibration of occlusal contacts on the anterior maxillary restorations. Orthodontic blue posterior bites (OptiBand, Ormco, CA, USA) are placed on molars to provide posterior occlusal contact and improve the comfort of the patient while waiting for the appointment with the orthodontist, scheduled for the week after restoration bonding. Indeed, bonding of restorations result in a significant open bite in the posterior region.

Simple orthodontic extrusion (SOE) [24]

The orthodontic blue posterior bites are removed. The orthodontist proceeds to SOE using intermaxillary elastics and various anchorage types (metallic buttons or composite buttons or brackets and wire). He adapts the elastic force and direction to the clinical situation, as well as the change frequency (usually twice a day, patient having to remove them when eating or drinking and brushing the teeth). The duration for re-establishment of the posterior occlusion varies in function of the open bite height but it is known from the literature that 5 weeks are necessary to get a 2 to 3 mm extrusion [38]. At this time, a retention phase is not systematically performed.

It is crucial that SOE is conducted by an orthodontist, who is equipped with the expertise to regulate tooth movements and occlusal relationships in more complex cases. Contraindications include untreated periodontitis, TMJ disorders and Class III, due to the lack of requisite background knowledge.

In comparison to the Dahl technique, the clinical success of restorations is enhanced by the rapid extrusion and the high mechanical properties of PICN, which are superior to those of direct composites. To date, the author has not observed any instances of failure in anterior restorations. The SOE technique is currently being evaluated, with a particular focus on its performance, understanding of tooth movement and stability of occlusal contact.

Aesthetic restoration

The aesthetic restoration is identical to that of cases involving generalised tooth wear.

An acrylic occlusal nightguard is also provided in case of bruxism.

5. Clinical And Scientific Background On the One-Step No-Prep Technique

Currently available studies results are related to the One-Step No-Prep technique for the treatment of generalized TW. The first three pilot cases of generalized severe TW were realized in 2014 and 2015 [39]. The 2-year results of a prospective study including material wear analysis of 7 additional clinical cases were published in 2020 [40]. All

the results were very promising, and our team developed the technique routinely. More recently, 5-year results of the evaluation of intraoral PICN wear in the 7 cases using ex vivo 3D profilometry have been published [41]. Finally, the up to 9-year results from a prospective and retrospective clinical study in 24 patients comprising 580 Vita Enamic restorations have been recently presented [42].

The treatment protocol has been shown to yield successful clinical results from both a functional and an aesthetic point of view. The one-step approach of VDO increase was well tolerated, and the global OHIP score related to patient quality of life was significantly improved [40].

In cases of severe tooth wear and the presence of bruxism-related clinical signs, PICN (Vita Enamic) has demonstrated lower material wear values over a five-year period than those reported for natural enamel [41]**.** The material does not induce a significant abrasive effect, which helps to maintain the stability of the recreated VDO while allowing the adaptation of occlusal contacts to function over time. At the five-year mark, the survival and success rates of restorations were 99.48% and 90.62%, respectively. The most common complication is minor chipping of very thin occlusal borders of posterior restorations (**see Case 4**) [40]. These can be either polished or repaired.

The results are comparable to those obtained with direct composites and other indirect materials at medium-term [11,43,44]. However, the need for regular intervention (refurbishment and repair) with direct resin composite restorations to treat tooth wear was frequently reported [45,46]. Moreover, longer-term clinical data are required given that direct composite restorations are known to be susceptible to aging processes, particularly due to the limited effectiveness of light-curing. Consequently, the primary concerns reported with direct composites are related to significant material wear and discoloration/staining [47,48].

The 5-year clinical performance of PICN restorations in the treatment of tooth wear (99.4% estimated survival rate) is also shown to be superior to the gold standard in fixed prosthodontics [49].

Regarding long-term data, the Kaplan-Meier survival rate of restorations at 9 years is 98.4% (100% for anterior and 96.7% for posterior) and the success rate is 79.7%, while the success rate excluding minor chipping requiring only polishing as failure was 86.7% [42]. Significantly more fractures were observed in the posterior region,

particularly in the first and second molars or when the restoration thickness was less than 0.56 mm. Therefore a 0.6 mm posterior occlusal thickness is recommended. Except for fracture, FDI evaluation showed clinically acceptable results for all restorations, mostly rated as excellent. Results remained consistent over time, including material luster and color, with no staining. MultiColor blocks showed superior aesthetics compared to Monoblock in terms of surface gloss, color match and translucency. Although the material may not be as glossy as a pure ceramic, the aesthetic properties are adequate for patients (particularly when recovered with saliva), as evidenced by the high patient satisfaction scores for aesthetics and function.

7. CONCLUSIONS

There is currently no ideal biomaterial available for the restoration of severe tooth wear. In this regard, Polymer-Infiltrated Ceramic Network (PICN), commonly referred to as "hybrid ceramic', represents a unique class of materials that integrates glass-ceramic and polymer. Vita Enamic is the only PICN available on the market, benefiting from over a decade of clinical use and research. It offers a balance between pure ceramics and direct and CAD-CAM composites, leveraging their advantages while minimizing their disadvantages in the context of severe tooth wear (TW) treatment. PICN exhibits properties that closely mimic tooth tissue, particularly its wear behaviour and stiffness, while polymer promotes the material's ability to dampen occlusal stress.

PICN has been shown to yield successful clinical outcomes when employed in the One-Step No-Prep technique for the treatment of severe tooth wear. This method is non-invasive, straightforward, and cost-effective in comparison to other indirect techniques. However, PICN/hybrid ceramic has two disadvantages: a loss of gloss on occlusal surfaces and limited fracture resistance, which can result in minor chipping of very thin borders in occlusal contact of posterior restorations. Such minor fractures do not represent significant failures, as they can be polished or repaired if necessary. To address this issue, it is crucial to maintain a minimum occlusal thickness (0.6 mm in generalised TW cases, according to recent research). While these constraints do not significantly affect patient satisfaction, future developments should prioritise enhancing the mechanical properties and surface lustre. In this regard, aesthetic properties have already been enhanced in multiColor blocks, which are

recommended. Despite these limitations, PICN appears to be a suitable material for managing TW in a non-invasive manner.

PICN is in accordance with the philosophy of modern restorative dentistry, which is 'Primum non nocere'. This approach requires that the restoration adapt to the tooth, rather than the tooth adapting to the restoration. The objective is to favour the longevity of the tooth, rather than that of the restoration. It is important to progress towards ethical aesthetic dentistry by selecting materials and techniques that promote long-term oral health through personalised treatments. Furthermore, it is essential to ensure that patient consent is obtained regarding the risks and benefits of the different available treatment strategies.

FIGURE LEGENDS

Figure 1: The manufacturing process of PICN involves several key steps. First, a glass ceramic block (Vita Mark II) is partially sintered. This block is then infiltrated with monomers, which are then polymerised under high temperature (>100°C) and high pressure (>150 MPa).

Figure 2: **Case #1**, a 52-year-old female patient suffering from generalised severe TW of mechanical (bruxism) and chemical origin. Frontal views before (A & B) and after treatment with the One-Step No-Prep technique using Vita Enamic multiColor blocks (C & D). In this case, in addition to the palatal veneers from #14 to #23, lithium-based glass-ceramic buccal veneers (Initial LiSi Press, GC, Tokyo, Japan) were subsequently placed in view of the buccal erosion and the patient's aesthetic demands, a technique known as the "sandwich technique". Direct composite restorations (Inspiro, Edelweiss DR, Zug, Switzerland) were placed to restore the minor tissue loss from #33 to #43 and on #38, #46 and #47. No restoration was placed on #26 and a table top was placed on the implant crown on #27. Dental laboratory for PICN restorations: Jean-Michel Paulus, Liege, Belgium. Dental laboratory for LiSi glass-ceramic veneers: Dental Team, Luc & Patrick Rutten, Tessenderlo, Belgium. Muco-gingival surgery (crown lengthening on #21 and soft tissue graft on 24) and implants on #36 and #37: Prof. France Lambert, University Hospital of Liège.

Figure 3: **Case #1**. A & B: Classical occlusal analysis with facebow and jig to determine the centric relation. C: Classical wax-up.

Figure 4: **Case #1**. CAD-CAM mock-up in wax (A), which is tried in with Vaseline to validate the restoration design and aesthetic result (Ceramill Wax, Amann Girrbach AG, Koblach, Austria).

Figure 5: **Case #1**. Occlusal function restoration with No-Prep PICN restorations. A: PICN/hybrid ceramic restorations (Vita Enamic, multiColor blocks to enhance aesthetics) on stone models. The restorations were lightly stained with a special light-curing nanofilled composite stain. However, it has been shown that stains wear off quickly on occlusal surfaces. Today, restorations are simply polished with the Vita Enamic technical polishing set, which gives a high lustre. B: In this case, screw-retained Vita Enamic restorations were later placed on implants #36 and #37.

Figure 6: **Case #1.** Aesthetic restoration. After muco-gingical surgery and bleaching, realisation of minimally

invasive lithium-based glass-ceramic buccal veneers (Initial LiSi Press, GC, Tokyo, Japan) from #14 to #23 ("sandwich technique"). A & C: Minimal preparation in the palatal veneers driven by an additive wax-up. B: Restorations on stone models. D: Bonding under a rubber dam.

Figure 7: **Case #1.** Occlusal views before treatment (A), before bonding (B), after bonding (C), and at 4-year follow-up (D).

Figure 8: **Case #1.** Frontal (A) and lateral views (B &C) at 3-year follow-up. Note that tooth #15 was extracted, immediately replaced by an implant, which was also immediately loaded with the final PICN crown (1T1T1 protocol [50,51]).

Figure 9: **Case #2,** a 32-year-old female patient with generalised severe TW of mechanical (bruxism) and chemical origin, with a class II skeletal and dental condition, which the patient did not wish to treat. However, the diagnosis of TW risk factors led to the detection of sleep hypopnoea and a mandibular advancement splint was prescribed by the neurologist. Frontal views before (A & B) and 2.5 after treatment with the One-Step No-Prep technique using Vita Enamic multiColor blocks and a fully digital workflow (C & D). In this case, orthodontic treatment with aligners was performed prior to restorative treatment to align the teeth and reduce the deep bite. Crown lengthening was carried out on the maxillary anteriors and premolars. No-prep envelope restorations, which covers the buccal surface, were performed on #11 and #21. Note that the patient suffers from chronic gingivitis promoted by poor plaque control despite follow-up with a dental hygienist, and buccal breathing. Dental laboratory for PICN restorations: Jean-Michel Paulus, Liège, Belgium. Orthodontics: Prof. Annick Bruwier, Liège University Hospital. Muco-gingival surgery: Prof. France Lambert, University Hospital of Liège. Dental hygienist: Mrs Chloé Mourier, University Hospital of Liège.

Figure 10: **Case #2.** Occlusal views before (A) and after bonding (B).

Figure 11: **Case #2**. Occlusal function restoration with No-Prep PICN restorations. A: Digital occlusal analysis with a jaw tracking system (Modjaw, Villeurbanne, France) and a CAD-CAM jig. B: Digital set up designed on the basis of the 3D functional movements envelope registered and the centric relation. C: PICN/hybrid ceramic restorations (Vita Enamic, multiColor blocks to enhance aesthetics) on printed models. The restorations were lightly stained with a special light-curing nanofilled composite stain. However, it has been shown that stains wear

off quickly on occlusal surfaces. Today, restorations are simply polished with the Vita Enamic technical polishing set, which gives a high lustre.

Figure 12: **Case #2**. PICN/hybrid ceramic restorations (Vita Enamic, multiColor blocks) on printed models, with no-prep envelope restorations on #11 and #21 (C), veneerlays on some premolars, very thin table tops on molars (E) and chips on lower incisors.

Figure 13: **Case #2**. Occlusal views during bonding, highlighting the isolation with the rubber dam and metal matrixes on the posterior teeth (Palodent V3, sectional matrix system, Denstply, Konstanz, Germany). All restorations were bonded within 24 hours, starting with the upper maxilla (posterior followed by anterior restorations), with the lower maxilla treated the following day.

Figure 14: **Case #2**. Aesthetic restoration on upper teeth, after bleaching. A: Frontal view before aesthetic restoration. B: No-prep Vita Enamic buccal veneers on #13 and #23 (here envelope restorations were not possible due to the presence of undercuts, then palatal and buccal veneers were planned). C: Procedure to mask the junction between the palatal veneer and buccal surface of the lateral incisors. A slight chamfer is performed across the junction. The PICN is sandblasted with alumina particles at 2.5 bar, the enamel is etched with phosphoric acid and then a layer of silane is applied to the PICN (Monobond S, Ivoclar, Schaan, Liechtenstein). After bonding (Clearfil SE Bond, Kuraray Dental, Ijmuiden, Holland), a high-quality direct composite (Dentin and Enamel, Inspiro, EdelweissDR, Zug, Switzerland) is applied.

Figure 15: **Case #2**. Face picture before (A) and after treatment (B), and close-up of smile (C) showing a satisfactory aesthetic result with PICN/hybrid ceramics on buccal surfaces.

Figure 16: **Case #3**, a 50-year-old male patient with generalised severe TW of mainly mechanical (bruxism) origin, with misaligned teeth and multiple diastemas, but who did not wish to undergo orthodontic treatment. In this particular case, no-prep PICN crowns were placed from #13 to #23 and buccal veneers from #33 to #43, in addition to partial coverage restorations on other teeth. Note that due to the presence of undercuts, the crowns were not adapted to the teeth on the cervical margins. Therefore, they were bonded with direct composite, which was sculpted to fill the gap between the tooth and the restoration. This treatment is particularly non-invasive and straightforward (no provisional phase performed). Frontal views before (A & B) and after treatment with the One-Step No-Prep technique using Vita Enamic multiColor blocks (C & D). Dental laboratory for PICN restorations: Jean-Michel Paulus, Liège, Belgium.

Figure 17: **Case #3**. A: Occlusal views before treatment. B: PICN/hybrid ceramic restorations (Vita Enamic, multiColor blocks to enhance aesthetics) on stone models. The restorations were lightly stained with a special light-curing nanofilled composite stain. However, they wore off quickly (PICN was not etched prior to application) and the restorations were then polished in the mouth using the Vita Enamic clinical polishing set, which gives a high lustre. C: Occlusal views after treatment.

Figure 18: **Case #3**. A & B: No-prep crown design. C: Frontal view after bonding with direct composite, which was heated to reduce its viscosity. D: Panoramic radiograph showing the presence of direct composite at the cervical margins, as a PICN endocrown on the #14.

Figure 19: **Case #4**, the first case of generalised severe TW treated with the with the One-Step No-Prep technique using Vita Enamic Monoblock in 2014. The patient is a 41-year-old male patient with mechanical and chemical TW. In this case, in addition to the palatal veneers from #13 to #23, lithium-based glass-ceramic buccal veneers (IPS e.max Press, Ivoclar) were subsequently placed in view of the buccal erosion and the patient's aesthetic demands ("sandwich technique"). Crown lengthening was performed on #13, #12 and #11 and a soft tissue graft was performed on #23. Direct composite restorations were placed to restore the minor tissue loss from #33 to #43 and on #47. Implants were placed to replace #16, #24 and #36 and Vita Enamic screw-retained restorations were made. A: Frontal view before treatment. B: Frontal view after treatment. C: Frontal view at 9-year follow-up. Dental laboratory for PICN restorations made with the Cerec system (Dentsply Sirona, Charlotte, CN, USA): Renaud Maka, University of Liège. Dental laboratory for LiSi glass-ceramic veneers: Pieter Ghijsens, Brussels. Surgery: Prof. France Lambert, University Hospital of Liège.

Figure 20: **Case #4**. A: Occlusal view before treatment. B: Occlusal view after treatment. C: Occlusal view at 9-year follow-up. Minor chipping of the thin margins of the restorations in occlusal contact can be seen on teeth #15, #17 and #35. Two more significant chips can be seen on teeth #44 and #45.

Figure 21: **Case #5**, a 49-year-old female patient with localised severe anterior TW of mechanical origin (bruxism). The patient was referred by her orthodontist after undergoing orthodontic treatment to align the teeth. Palatal veneers with buccal margin coverage (to avoid masking with direct composite) were placed from #13 to #22. Direct composites were placed on #23 and from #43 to #33 (Inspiro, Edelweiss). Simple orthodontic extrusion (SOE) was then performed for 5.5 months. In this particular case, additional orthodontic treatment with brackets and wire was performed for 3 months to lower the necks of #12 and #22 for aesthetic reasons. Frontal

views before (A & B) and after treatment with the Orthodontic-assisted One-Step No-Prep technique using Vita Enamic multiColor blocks (C & D). Dental laboratory: Jean-Michel Paulus, Liège, Belgium. Orthodontics: Dr Jean-Claude Bernard, University Hospital of Liège.

Figure 22: **Case #5**, PICN/hybrid ceramic restorations (Vita Enamic, multiColor blocks to enhance aesthetics) on printed models. The restorations were simply polished with the Vita Enamic technical polishing set, which gives a high lustre.

Figure 23: **Case #5**. Try-in of palatal veneers just before bonding, highlighting the design of the buccal coverage. After bonding, the buccal margins of the restorations are polished to remove slight overcontours and to finish as a knife edge to ensure a smooth transition between tooth and restoration (Vita Enamic clinical polishing set which includes a pre-polishing and a high-gloss silicone polisher).

Figure 24: **Case #5**. The restorative treatment of anterior teeth results in a significant posterior open bite. Simple orthodontic extrusion of molars was carried out with orthodontic metal buttons and intermaxillary elastics. After 5.5 months, the occlusal contacts were fully restored. (A & B) Lateral views at baseline. (C & D) Lateral views at the end of treatment.

Figure 25: **Case #5**. Occlusal views before (A) and after (B) treatment. Note that old posterior restorations were replaced before the One-Step No-Prep technique.

Figure 26: **Case #6**, a 40-year-old female patient with localised severe anterior TW of mechanical origin (bruxism) and a class II skeletal and dental condition, which the patient did not wish to treat. In the posterior region, only the buccal cusp tips from 4 to 6 in both jaws and the palatal cusp tips from 4 to 6 in the maxilla were worn. The patient first underwent orthodontic treatment to align the upper anterior teeth. Then, PICN (Vita Enamic multiColor blocks) palatal veneers with buccal margin coverage (to avoid masking with direct composite) were placed from #13 to #23 and chips from #42 to #32. In view of the low tissue loss, direct composites were placed on the posterior teeth and on teeth #43 and #33 (with a moulding technique using Inspiro, Edelweiss). Simple orthodontic extrusion (SOE) was then performed for 3 months. Frontal views before (A & B) and after treatment with the Orthodontic-assisted One-Step No-Prep technique (C & D). Dental laboratory: Jean-Michel Paulus, Liege, Belgium. Orthodontics: Dr Jean-Claude Bernard (SOE), Dr Paul Kling and Prof Carole Charavet (first step of tooth alignment), University Hospital of Liège.

Figure 27: **Case #6**. Digital set-up, based on the tissue loss, of the upper maxilla. An occlusal analysis was performed using the Modjaw system to design the restorations.

Figure 28: **Case #6**. Try-in of palatal veneers just before bonding, highlighting the design of the buccal coverage.

Figure 29: **Case #6.** The restorative treatment of the anterior teeth results in a significant posterior open bite, which is not compensated by the direct composite placed on the cusp tips of the posterior teeth. Simple orthodontic extrusion of the molars was performed using orthodontic metal buttons and intermaxillary elastics. After 4 months, the occlusal contacts were fully restored. The premolars, which were in slight infraocclusion, were subjected to passive eruption. In addition, an elastic orthodontic chain was placed on the lower incisors for 5 days to close the diastema and then a permanent retainer was placed. (A & B) Lateral views at baseline. (C & D) Lateral views at the end of treatment.

Figure 30: **Case #6**. Frontal views before (A & C) and after (B & D) treatment.

Figure 31: **Case #6**. Occlusal views before (A) and after (B) treatment.

Figure 32: **Case #6**. Smile pictures before (A) and after (B) treatment.

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