Porcelain Veneers with Digitally Guided Preparations

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Anamnesis

- **Reason for consultation.** Female patient, 31 years old, who visits the clinic to improve her aesthetics. Her main concern is to achieve a younger and more attractive smile by improving the color, shape, and size of her teeth.
- **Medical History:** The patient is a non-smoker and is in good health with no significant medical history.
- **Dental History:** The patient has healthy periodontal tissues and good oral hygiene practices. One month before the consultation, she completed treatment with invisible orthodontics. She presents dental wear and fractured composite resin restorations on the upper anterior incisors 7, 8, 9 and 10.

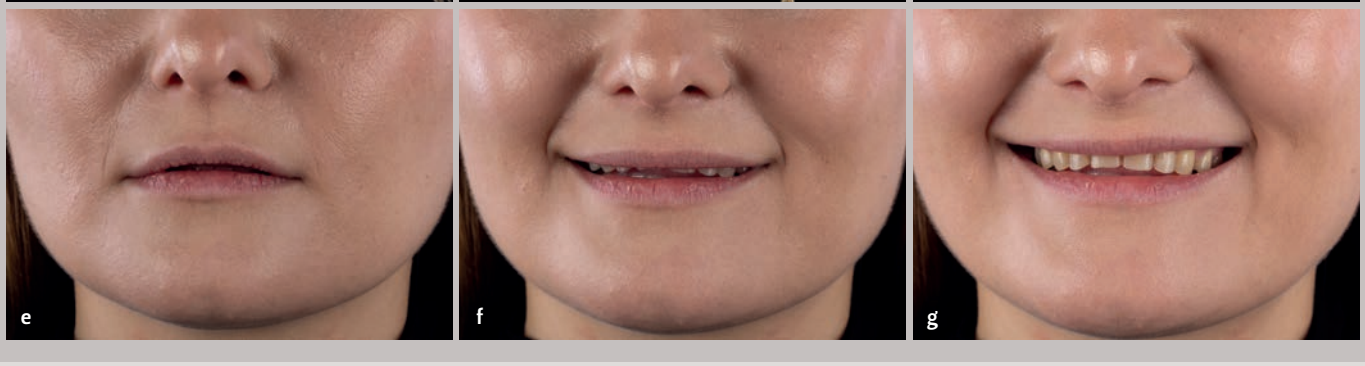
Clinical and Radiographic Examination

- **Extraoral Aesthetic Examination:** The patient has a brachyfacial profile with proportional facial thirds. She presents facial asymmetry and deviation of the midline in relation to the upper and lower interincisal lines. There is a tilt of the occlusal plane and a negative exposure of -1 mm of the incisal edge. The smile line is average (Robbins, 2001), and the patient has a concave profile. (📷 7.1).
- **Intraoral Examination:** Bilateral dental Class I canine and molar relationship. There is a 2 mm overjet with a slight anterior open bite. Significant wear is observed, resulting in the upper central incisor having a 100% crown-to-root ratio.
- **Periodontal Examination:** The patient is in periodontal health and has all her teeth.
- **Radiological Examination:** The panoramic X-ray does not show any noteworthy findings.
- **Functional Examination:** The patient does not present any temporomandibular joint (TMJ) disorders.

Aesthetic Smile Assessment

To select the most appropriate treatment and considering all the previously mentioned data, a digital smile study is conducted based on photographs. The initial aesthetic goal is to correct the position of the upper central incisor in relation to the lip at rest.

7.1 Extraoral Aesthetic Examination. a) Face at rest.. b) Left lateral smile. c) Frontal smile. d) Right lateral smile. e-g) Lip mobility: at rest (e), slight smile (f), broad smile (g).



Case Summary:
A young woman with favorable periodontal health, exhibiting dental wear in the upper anterior region and fractured composite resin restorations, which makes her smile noticeably improvable. To address this, the patient wishes to enhance the color, shape, and size of her teeth.

Treatment alternatives:

In this case, given the patient's situation and desired outcome, a single treatment option was proposed: the placement of upper ceramic veneers from the right second premolar to the left second premolar.

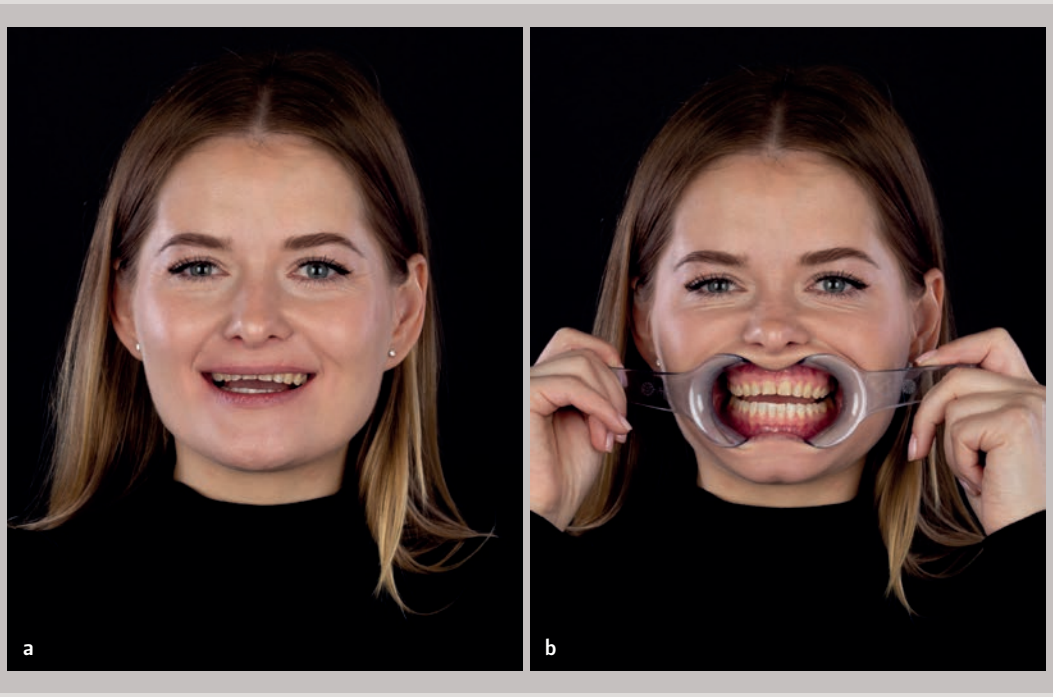
Next, we will describe the step-by-step process of a digital workflow that allows the dentist to plan, design, and digitally manufacture 3D-printed guides for the preparation of ceramic veneers in a fully guided manner, from dental preparation to final cementation, all in a single appointment.

Treatment Plan

Step 1: Clinical Procedure. First Appointment

In the first clinical appointment, we digitally scan the patient's face in two dimensions using a DSLR camera (EOS 750D; Canon). This photographic protocol requires two photographs: one extraoral with a broad smile and another extraoral with retractors. (📷 7.2).

During this same appointment, an intraoral digital scan is performed using an IOS (Itero Element 5D; Align Technology). The necessary records include the maxilla, mandible, right occlusion, and left occlusion. Once the digital scans are completed and processed, the IOS software creates standard tessellation language (STL) files for the maxilla and mandible in the position of maximum intercuspation (MIP).



📷 **7.2** a) Extraoral image with a broad smile. b) Extraoral image with retractors.

Step 2: CAD Design

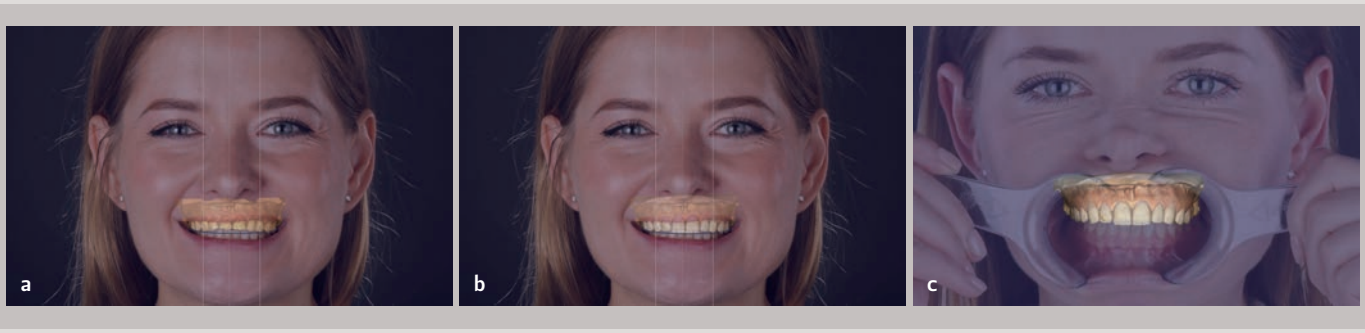
Once all this information is gathered, we import both STL files into dental CAD software (Exocad DentalCAD; Exocad GmbH) and design the smile following the known aesthetic parameters of the digital smile analysis (DSD) (Coachman, 2012). This involves a thorough facial analysis using the photographs taken and the STL file from the intraoral scanner. (📷 7.3). All this allows for correct alignment, facilitating a design proposal that addresses the patient's facial asymmetry and aligns with the aesthetic treatment goals.

It is also important to highlight that, since the preparation will be planned and executed through specific dental preparation software (FirstFit; Viax Dental Technologies), the virtual diagnostic wax-up must be performed to an ideal volume of the treated teeth. This follows the EIA concept, placing the restorations in their functional and final position in the mouth from the very beginning.

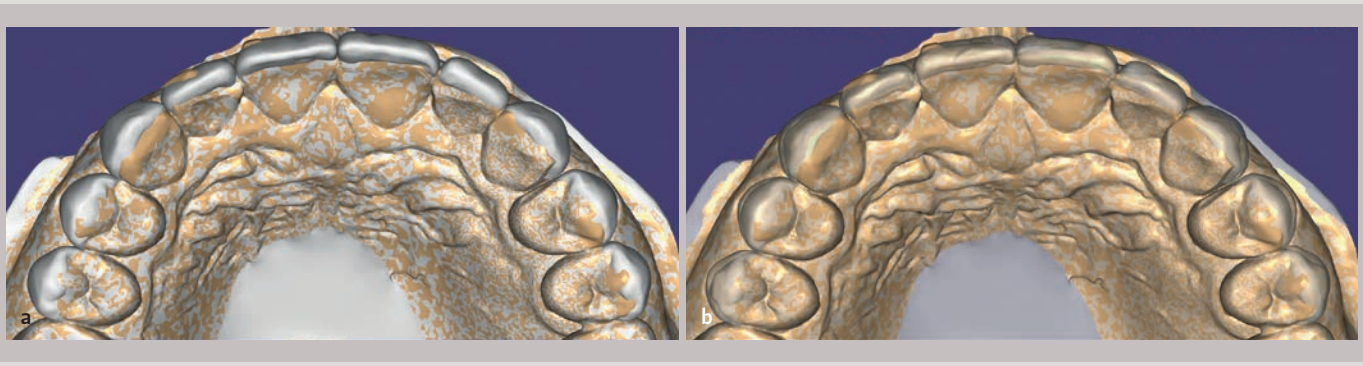
This changes the classic concept of additive waxing for preps through the mock-up (Magne et al., 2002), transforming it into a new concept of smile design that adapts to modern times with guided digital preparations, known as the biofunctional mock-up. (📷 7.4).

Following these new design parameters, a digital analysis is performed, which must then be clinically confirmed in the patient's mouth using the biofunctional mock-up. In this case, the patient presents with dental wear and deteriorated composite restorations, resulting in an inverted smile curve. The design has been carried out with the initial aesthetic goal of positioning the upper central incisor in relation to the lip at rest, ensuring occlusal balance without excessive overbite to prevent a deep bite. (📷 7.5).

Once the virtual diagnostic wax-up is approved, it is 3D printed using an SLA-DLP 3D printer (Nextdent 5100; Nextdent) with a layer thickness of 50 µm using model material (Nextdent Model 2.0).



📷 **7.3** Facial Alignment of STL: a) Alignment with smile photo. b) Alignment with biofunctional smile design. c) Alignment with biofunctional smile design with retractors.



📷 **7.4** Biofunctional Mock-up: a) Occlusal view of the biofunctional design with subtractive areas. b) Occlusal view of the biofunctional design in transparency.

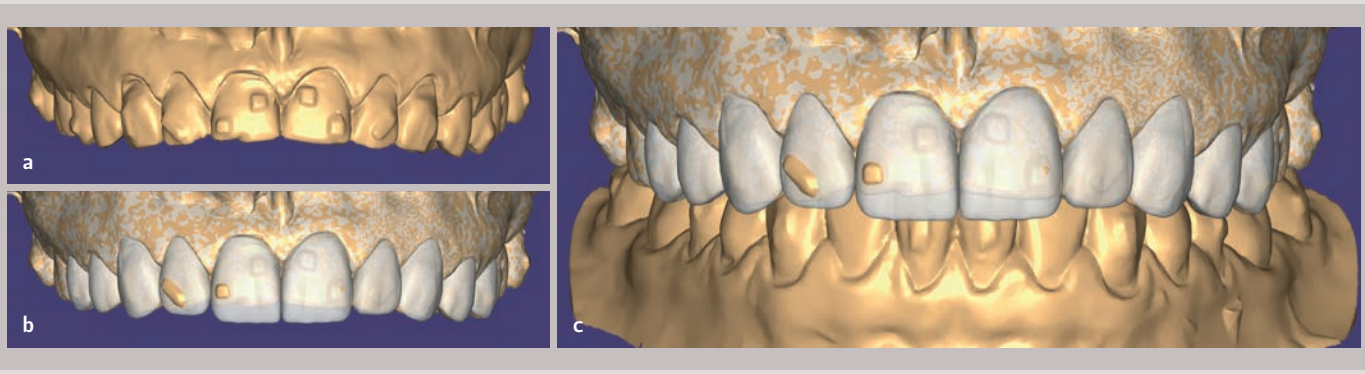
Finally, a silicone key is made on the 3D printed model using polyvinyl siloxane materials in heavy (Virtual Putty; Ivoclar Vivadent) and light (Virtual Light Body; Ivoclar Vivadent) consistencies.

Step 3: Clinical Procedure. Second Appointment

To create the biofunctional mock-up, we use a silicone key and a self-curing bisacrylic provisional resin (Voco Structur 2 SC, A1).

Once polymerized, we remove the silicone key and analyze the results with the patient.(📷 7.6). This test served as guidance for both the clinician and the patient and, if necessary, can be easily modified to meet all the patient's aesthetic needs. Once we obtained the patient's validation, the preparation phase began.

In this case, we performed a preliminary cervical reshaping on the necessary teeth to achieve a natural emergence profile, avoiding overcontoured restorations by following the EIA concept.



📷 **7.5** Smile Design: a) Initial situation. b) Smile design in transparency. c) Smile design in occlusion.

📷 **7.6** Intraoral Mock-up: a) Right lateral view. b) Upper frontal view. c) Left lateral view. d) Biofunctional mock-up with subtractive areas.

This determines the ideal horizontal volume of the restorations to ensure a natural, not artificial, aesthetic result. Finally, we perform an intraoral digital scan of the patient's reshaped teeth following the same protocol described in Step 1. With this scan, we proceed to the preparation and fabrication of the final veneers. (📷 7.7).

Step 4: Laboratory Procedure. Digital Preparations, Guides, and Ceramic Veneers

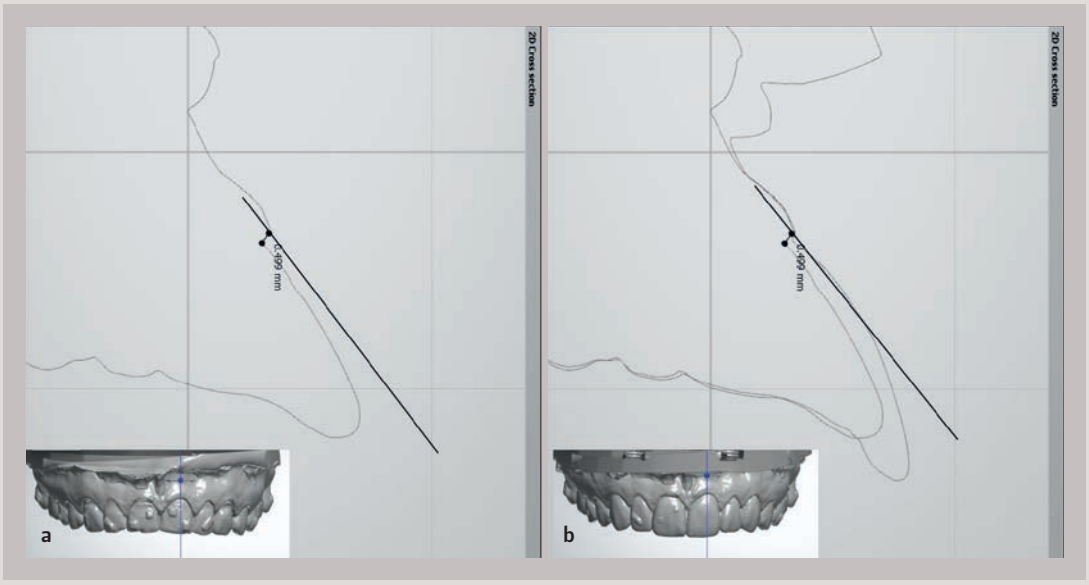
Various authors have emphasized the importance of precise control over preparations due to the need to achieve a balance of minimum thicknesses in restorations for supporting bite forces. In this regard, different techniques have emerged that offer the clinician a guide for making the necessary preparations, aiming to achieve a balance between the chosen restorative material and the thickness of the final restoration. However, this poses a significant challenge and difficulty, as it requires precise freehand work, which is critical to ensure the planned outcome.

The advent of digital technologies in dentistry has opened up a wide range of new possibilities, thanks to the introduction of new workflows that reduce time and minimize errors, increasing the predictability of final treatment results.

The introduction of new digital preparation control software for CAD/CAM workflow (FirstFit, Viax Dental Technologies) allows the dentist to design and plan dental preparations on the computer before performing the preparation in the patient's mouth. This process uses the anatomy of the virtual biofunctional diagnostic wax-up as a reference, which, as previously explained, places the restorations in their definitive position. (📷 7.8).

The software uses precise digital tools that allow dental preparations to be adjusted according to the case's requirements. This technique ensures a perfect relationship between the minimally invasive preparation needed and the actual preparation performed, adhering to all planned aesthetic, biological, and functional factors. It clearly, easily, and efficiently increases precision and predictability, guaranteeing highly aesthetic results in less time.

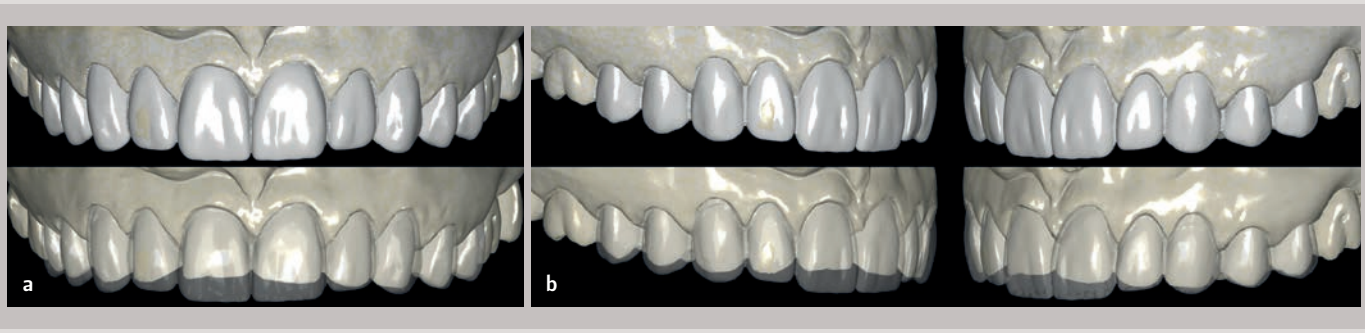
Using this type of technology through preparation software (FirstFit, Viax Dental Technologies) allows for the planning of a guided digital preparation. The software calculates, in real microns, a minimal reduction in the tooth volume, generating preparation guides in STL digital format printed using stereolithography (ProJet MJP 2500 3D Systems) so that the clinician can replicate the digitally planned preparation in the patient's mouth.



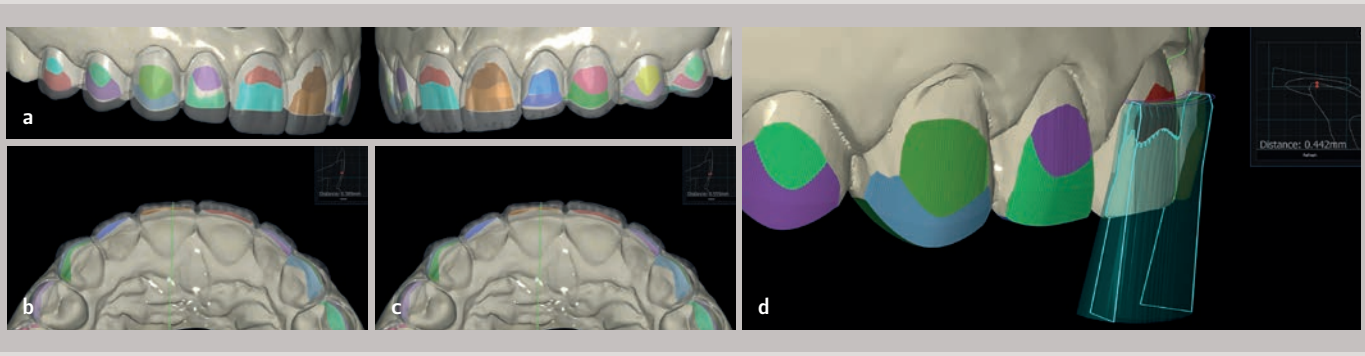
7.7 Diagnosis of the Aesthetic Integration Area: a) Sagittal section of tooth 21 at the dental axis (initial situation). We measure from the buccal surface to the maximum volume of the gingival margin to obtain the restorative space. Our goal is not to exceed this point with the final restoration, as the more we surpass this imaginary line, the poorer the aesthetic results will be. b) It can be seen how this imaginary space, known as the aesthetic integration area, was respected.

This allows for obtaining a balanced overall thickness, ensuring a conservative tooth preparation in enamel, with a successful prognosis in adhesion values, as well as an excellent relationship in bite force support and long-term color dimension balance (7.9). To achieve this, calculations and measurements are performed through the software to conduct a comprehensive analysis of the various planes that need to be prepped on each tooth. Then, digitalized burs,(7.9d), which were previously scanned, are used to generate the appropriate volume reduction on the tooth surfaces. The software generates a "digitally" prepped model, which will be used to design and manufacture the final restorations, before physically and actually preparing the patient's teeth. (7.10). This completely eliminates the need for provisional restorations in an intermediate phase. Consequently, the program generates preparation guides with preparation slots specifically designed to reduce the different surfaces of the tooth.(7.11). These "preparation boxes" specifically match (lock-and-key effect) with a handpiece, which has a modified disc-shaped head, allowing the clinician to slide along a rail, faithfully reproducing the digitally planned tooth preparation

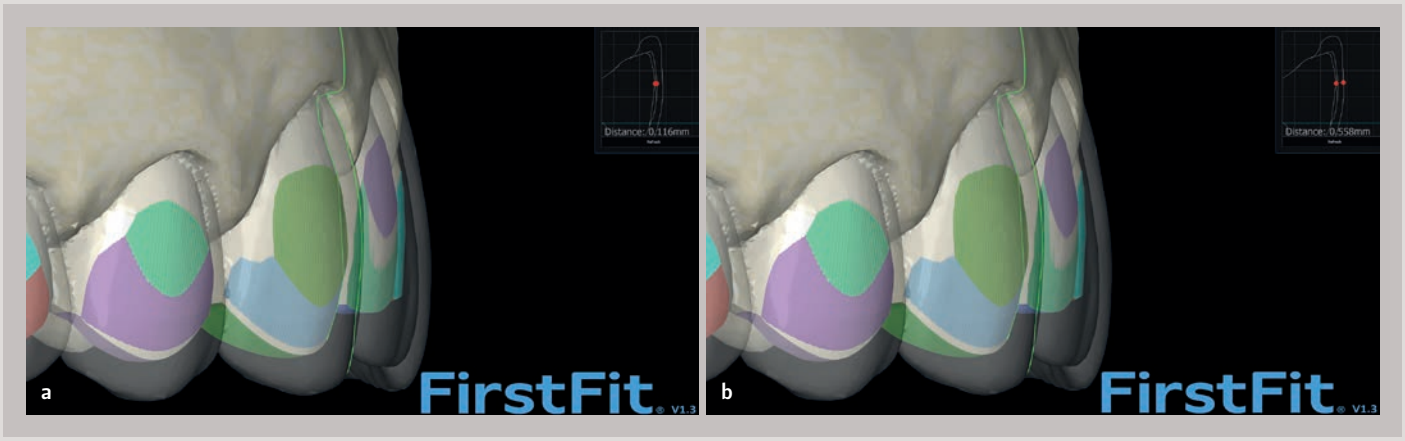
The aim of this new digitally guided preparation technology is to enable the clinician to prepare and cement definitive restorations in a single appointment. For this purpose, the technique not only relies on preparation guides that replicate the digital preparations but also utilizes a veneer positioning template, which is also digitally designed to ensure the exact position of the restorations during the cementation phase. (7.12). This provides the clinician with precise positioning of the final restorations, ensuring compliance with the previously planned aesthetics. The laboratory will fabricate the veneers with all the necessary information. (7.13).



7.8 Digital Analysis of Dental Preparations: a) Frontal view. b) Left lateral view and right lateral view.

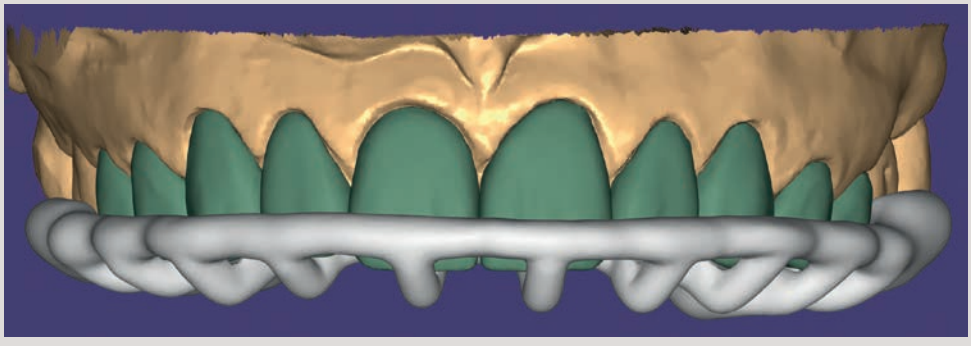


7.9 Thickness Balance in Digital Preparations According to Biofunctional Design: a) Lateral view. b) Occlusal view: measurement of digital preparation in the middle third of tooth 11. c) Occlusal view: measurement of final thickness of restoration in middle third of tooth 11. d) Digital preparation bur for vestibular preparation with measurement of preparation in relation to the biofunctional veneer design.

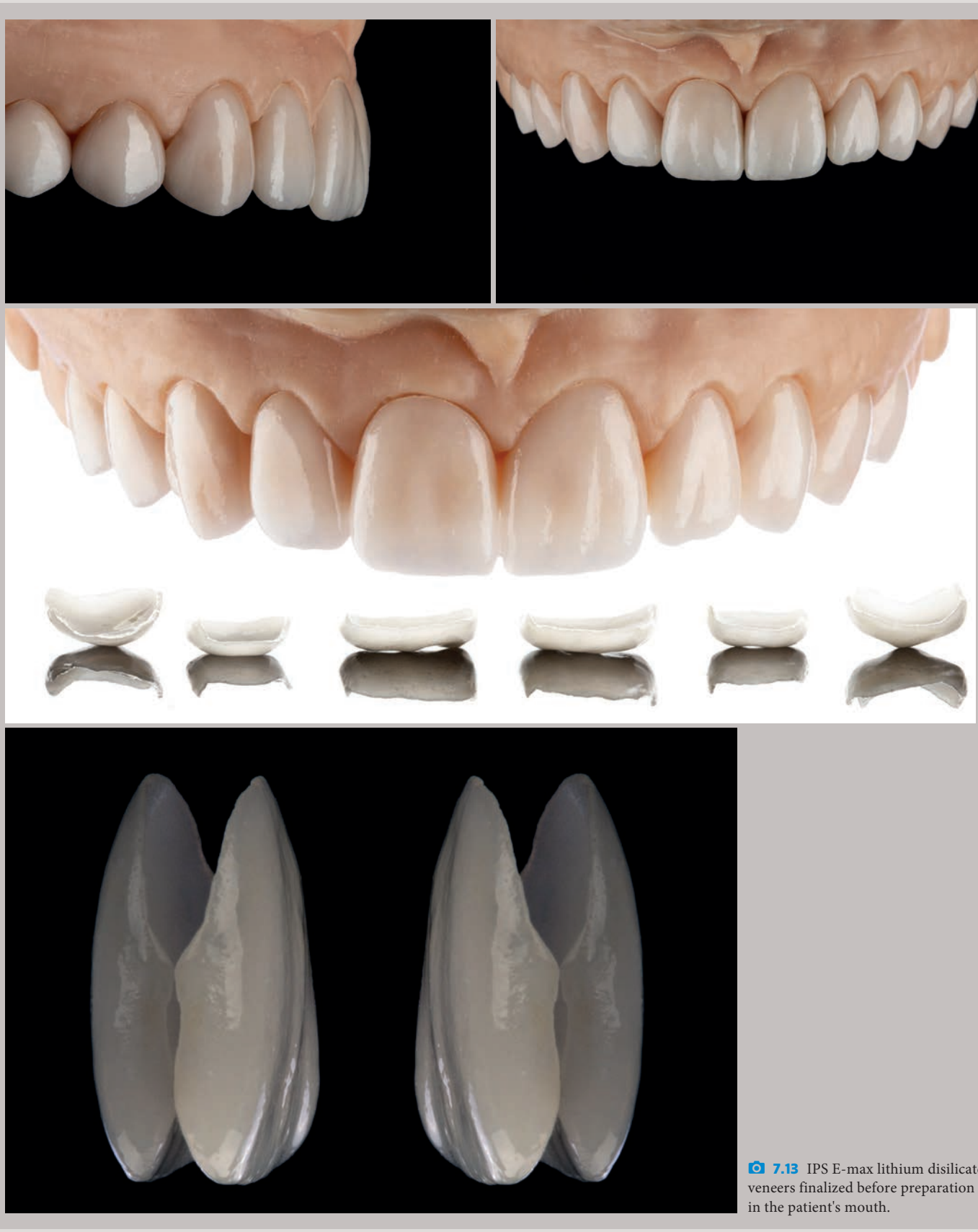


7.10 Lateral view of digital preparations with measurements: a) Measurement of vestibular preparation on tooth 13. b) Measurement of final restoration thickness.

7.11 Digital Preparation Guides: First column: Vestibular guides; second column: Incisal guides; third column: Cervical guides.



7.12 Digital design of the positioning and seating tray for the final restorations.



7.13 IPS E-max lithium disilicate veneers finalized before preparation in the patient's mouth.

Step 5. Clinical Procedure. Third Appointment

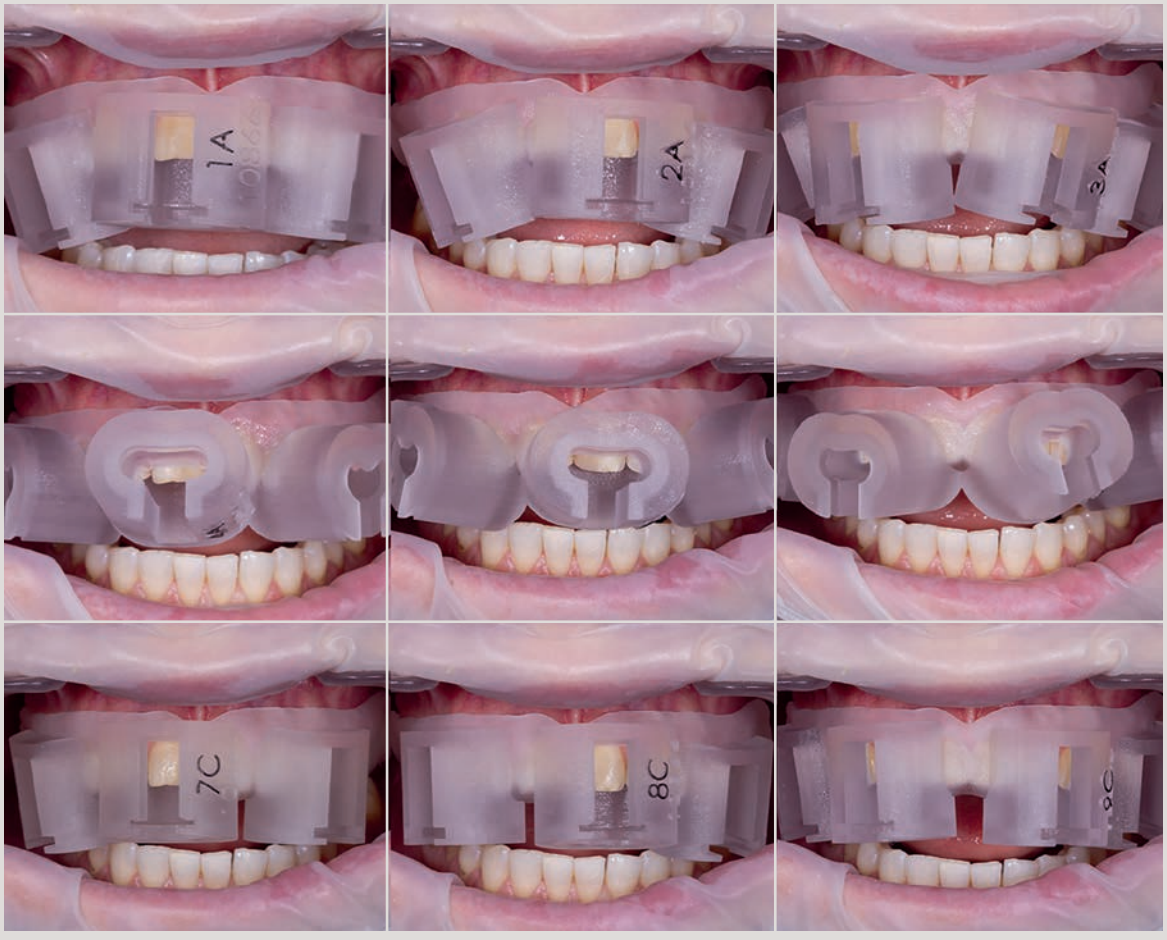
To begin with the placement of the veneers on the patient, we first place the 3D preparation guides. (📷 7.14) following the order marked on these to perform the preparation of the veneers in the digitally planned areas using a special handpiece and specific diamond burs. These burs are specified in the guide with a letter.

Once the guided preparations are finished, we will use a Sof-Lex Fine 3M polishing disc to round off any sharp angles; primarily focusing on the incisal edges and the inner surfaces of the teeth.(📷 7.15).

Subsequently, we will individually try on each veneer to verify marginal fit, contact points, color, and shape. The try-in will be conducted dry, using Variolink Esthetic Try-In pastes (In this case, we use the Light shade; 📷 7.16). We seat the veneers on the printed model and temporarily attach them to a semi-rigid, 3D-printed positioning tray.

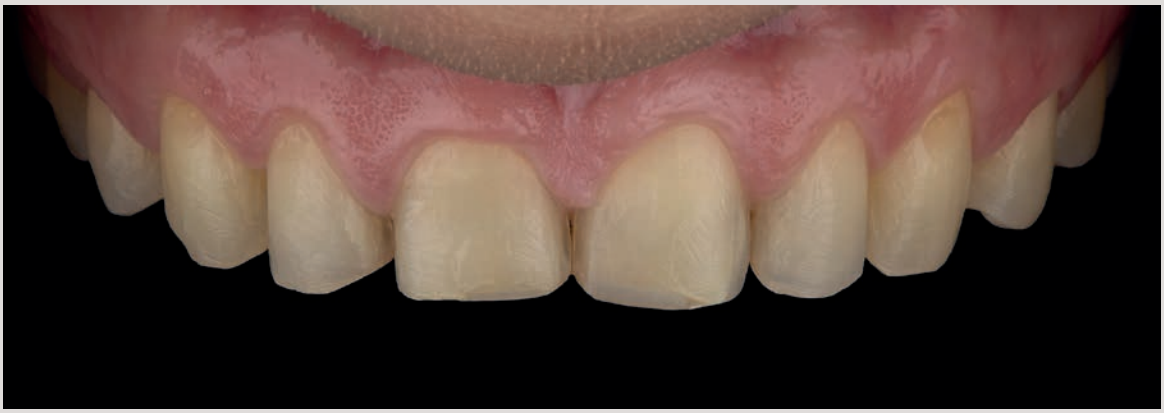
We prepare the lithium disilicate IPS E-max ceramic restorations (📷 7.17); we etch the veneers with hydrofluoric acid (IPS Ceramic Etching Gel; Ivoclar Vivandent) for 20 seconds each veneer. We rinse the veneers with water, dry them, and apply orthophosphoric acid (Total Etch; Ivoclar Vivadent), then rinse them thoroughly with water and dry them. Finally, we apply silane (Monobond Plus; Ivoclar Vivadent) and let it evaporate for 60 seconds.

We perform a modified relative isolation using a rubber dam (Nic Tone, MDC Dental). We prepare the tooth surfaces with orthophosphoric acid (Total Etch; Ivoclar Vivadent) for 30 seconds. We clean, dry the tooth surfaces, and apply universal adhesive (Adhese Universal Vivapen; Ivoclar Vivadent).

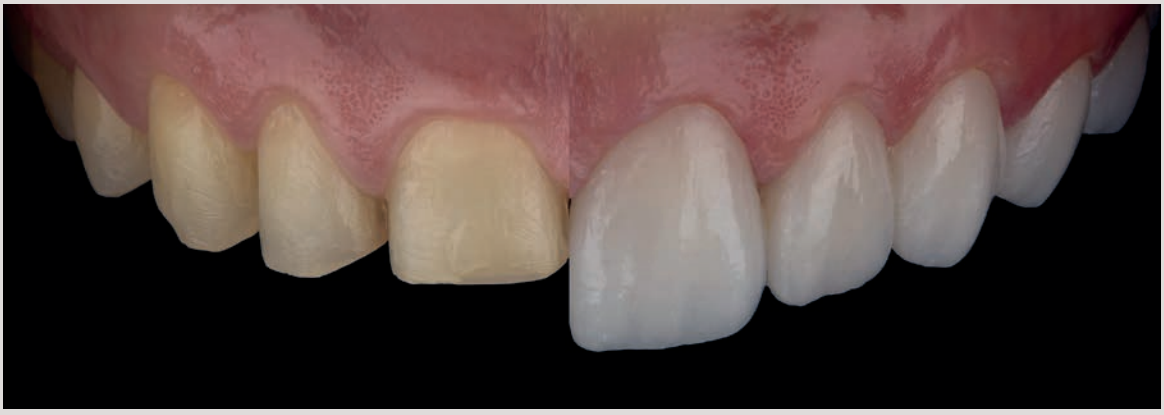


📷 **7.14** Digital Preparation Guides. Prepping Sequence: 1st column: Vestibular guides; 2nd column: Incisal guides; 3rd column: Cervical guides.

We treat the surface of the tooth for 20 seconds, disperse the universal adhesive with oil-free compressed air until obtaining a moving, non-liquid and shiny layer. Then, we photo-polymerize each surface of the teeth for 20 seconds (500 to 1400 mW/cm2). We place the light-curing resin cement (Variolink Esthetic LC; Ivoclar Vivandent) on the veneers positioned in the semi-rigid positioning guide and simultaneously insert them into the mouth. We remove excess material with a brush (Gradia; GC Corp). The cleaning motion with the brush should follow the veneer-cervical margin direction to avoid removing cement from the interface. (📷 7.18).



📷 **7.15** Final preps.



📷 **7.16** Final preps and dry individual veneer try-in.

📷 **7.17** Veneers in the positioning tray. Preparation of IPS E-max lithium disilicate veneers: a) IPS Ceramic Etching Gel hydrofluoric acid. b) Total Etch orthophosphoric acid. c) Silane (Monobond Plus).

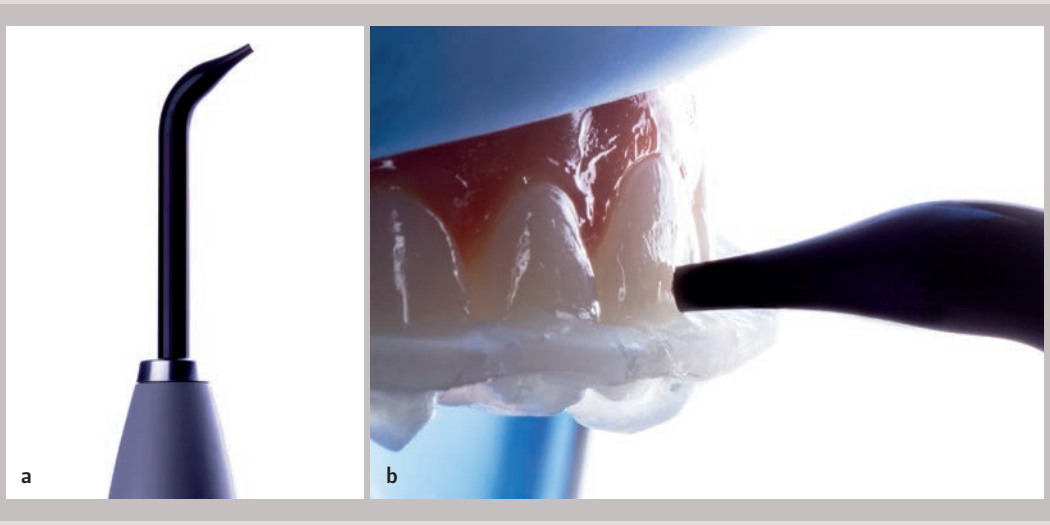
We focus the light on the center of the veneer using the Light Probe Pin-Point tip with the Bluephase Style lamp; this tip has a diameter of 2 mm, so it is smaller than the usual tip and allows focusing the light spot on a specific area of the veneer without polymerizing in the proximal and gingival areas. A light spot is applied in the center of the veneer for 3 seconds to prevent displacements, and excess material is removed with brushes. (📷 7.19).

With the help of a curette, we dislodge the positioning tray, starting at the posterior and making a small levering movement. Once the positioning tray is removed, we clean again in the proximal, cervical, and palatal areas with the help of brushes.

We apply glycerin to the margins to inhibit the oxygen inhibition layer and polymerize with the Bluephase Style lamp for 20 seconds vestibularly and 20 seconds palatally on each veneer. We refine the margins with a yellow spear bur or a No. 12 scalpel, check and adjust the occlusion. If necessary, we polish the restoration using appropriate ceramic instruments (such as OptraFine®). (📷 7.20 y 7.21).

We deliver the night guard and explain to the patient the importance of wearing it every night. It is essential to consider that if the patient had any parafunction, it would have been necessary to make a different type of guard (for example, a Michigan splint).

📷 **7.18** Cementation. Excess cleaning with a Gradia brush; GC Corp.



📷 **7.19** Photopolymerization. a) Light Probe Pin-Point. b) Light focused on the center of the veneer.

7.20 a, b) Comparison of the initial and final situation. c) Appearance of the veneers immediately after cementation.

7.21 Photographs of the patient at the end of the case.

Maintenance Phase

At the end of the treatment, function, aesthetics, and gingival health were checked at one week, one month, three months, and currently, we review the patient every six months. (📷 7.22). Furthermore, an upper occlusal night guard was fabricated for her, and she was encouraged to use it regularly to protect the restorations in the long term.

📷 **7.22** Photograph of the patient during the maintenance phase.

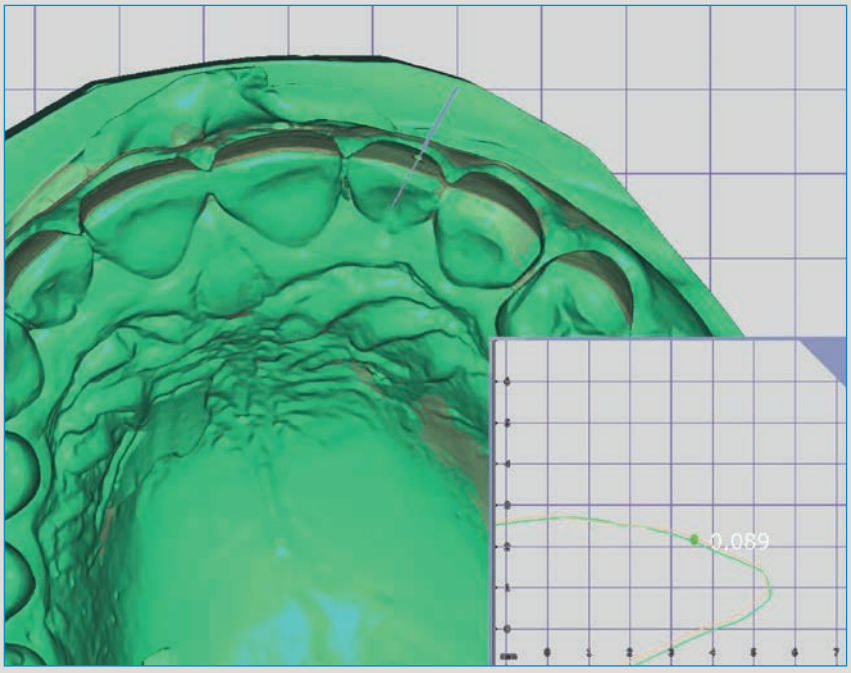
Finals Comments

Digital technologies have entered our profession to simplify much of the workflow in different areas of dentistry. While there are well-known digital techniques for surgery, implants, orthodontics, periodontics, and prosthetics, there were few precise options for guiding veneer preparation procedures.

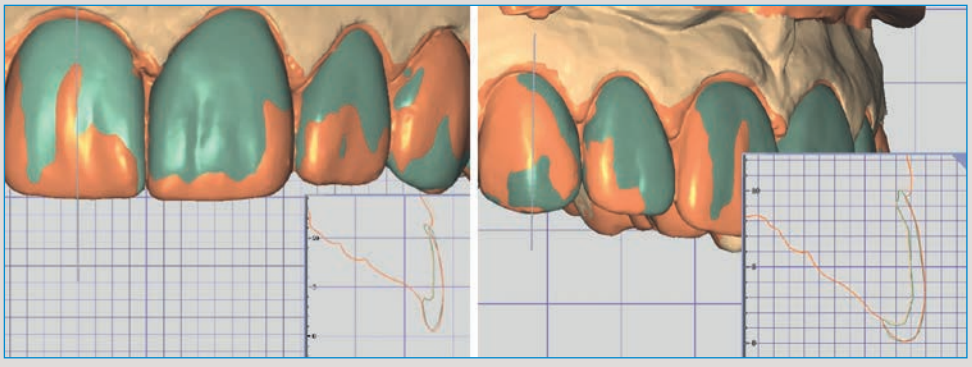
History has shown that minimally invasive preparations that preserve enamel ensure better adhesive results and, consequently, the future of restorations.

Similarly, achieving preparations with a true balance of final thickness minimizes potential fracture problems related to biomechanical stress and flexural strength. In this regard, it is important to emphasize some final considerations:

- Digitally guided preparations allow for a more precise, conservative, and predictable planning of the necessary preparations.
- The 3D printed preparation guides allow the clinician to faithfully reproduce and replicate what has been previously planned, with a margin of error ranging from 50 to 100 µm. (📷 7.23 y 7.24).



📷 **7.23** Comparison and measurement of the margin of error of digital preparation compared to guided preparation in the patient.



📷 **7.24** Comparison of the functional smile design planning compared to the veneers cemented in the mouth.

- The biofunctional mock-up is necessary to ensure a correct aesthetic outcome in the guided digital preparation workflow.
- The preparation performed with printed guides is indeed conservative, with a noticeable preservation of enamel tissue.
- The final thickness balance in veneer restorations greatly minimizes the risk of fractures over the years.
- Currently, digital preparations have limitations in extending towards subgingival areas and, in some cases, strictly proximal areas. Therefore, it is necessary for the clinician to support the technology by performing prior enamel reshaping procedures according to the indications described in the EIA Concept.
- The veneers cemented with a positioning tray and under guided digital preparation workflow faithfully reproduce the planned smile design.
- The cementation of restorations immediately after preparation avoids the use of provisionals and their potential consequences on tissue contamination and periodontal health.
- The clinician can complete a case of 10 veneers, including preparation, conditioning, and cementation, in 60 minutes. In this regard, this technique demonstrates a significant reduction in chair time.

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