Combined Ceramic Restorations at the Smile Zone

Rationale & Considerations, with Clinical & Laboratory Workflow

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Abstract

Treating the deficient dentition of a patient with high esthetic needs presents a challenge for the treatment team. To enable a correct diagnosis and fluid workflow and achieve a predictable healthy and esthetic result, an interdisciplinary approach often is needed along with effective and efficient communication among the team members based on clinical images, radiographs, and models. This article describes the rationale for choosing a restoration type, and the most relevant clinical and laboratory steps in the rehabilitation of four maxillary incisor teeth for which a combination of crowns and a veneer is the treatment of choice. Management of the different substrates' colors and restorative thicknesses is discussed, as are relevant technical and clinical aspects of the interface between the soft tissue margins and the restorative cervical contours.

Key Words: clinical and laboratory workflows, ceramic restorations, minimally invasive preparations, interdisciplinary approach, cervical contouring concept

CE CREDIT

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Learning Objectives

After reading this article, the participant should be able to:

1. Establish correct workflow and timing for multidisciplinary anterior restorations including endodontics and orthodontics.
2. Utilize tools for communicating exact gingival contours and tooth shape and size to a dental laboratory.
3. Develop a rationale for the selection of restorative materials in anterior "smile zone" restorations that combine differing thicknesses and restoration types along with varying preparation shades.

Introduction

Due to advances in ceramic materials and adhesive techniques, restoring deficient teeth at the smile zone can be a predictable procedure even in complex situations when different types of restorations such as crowns and veneers are involved.[1-5] In such cases, it is important that two main aspects be correctly evaluated and planned: the required amount of tooth structure to be removed,[6] with a proper configuration of the preparation design; and the management of a correct cervical profile of the different restoration types in relationship with the soft tissue margins.[7,8]

An interdisciplinary approach that involves orthodontic movement[9,10] enables the clinician to be minimally invasive when it comes to the amount of tooth structure removed. An ideal or close to ideal positioning of the teeth in the arch following orthodontic treatment allows for maximum preservation of enamel[11,12] essential for long-term bonding, being more additive than subtractive in the restorative approach.

Many adult patients present with a combination of old crowns at the smile zone that need to be replaced and adjacent teeth that require esthetic treatment. The final esthetic result depends on the treating team's ability to efficiently communicate during the different steps, for which a previsualization of the final result with the help of a wax-up and a mock-up is imperative.[13]

Clinical examination should begin with a comprehensive facial and intraoral examination.[14] With the assistance of new concepts and technologies such as Visagism/Rebel[15,16] and Digital Smile Design (DSD),[17] the communication process and synchronization between the different team members and the implementation of the various treatment modalities is optimized.

This article presents a clinical case report describing an accurate, controllable, and efficient operative protocol implementing an interdisciplinary approach, together with the step-by-step laboratory workflow.

> **"An interdisciplinary approach that involves orthodontic movement enables the clinician to be minimally invasive when it comes to the amount of tooth structure removed."**

Figure 1a: Portrait images with lips in repose and full smile for treatment analysis.

Case Report

Patient Complaint and Esthetic Analysis

A 38-year-old female wished to improve her smile. The teeth in her smile zone had undergone treatment several times in the past, and her major concern was the unesthetic appearance of her upper anterior teeth **(Figs 1a & 1b)**.

The initial appointment included clinical and radiographic examinations **(Fig 1c)** and periodontal and endodontic evaluations. Extra- and intraoral images were taken, as was a video registration for a static and dynamic smile analysis, along with accurate impressions for models.

Based on the clinical images and utilizing the DSD concept, an initial plan was made regarding the ideal length, width, and position of the teeth in the arch **(Fig 2)**.[18] This enabled the treating team to decide the following:

- The reference point for the length of the future restorations would be the existing tooth #9.
- Tooth #7 would undergo a minor orthodontic movement to allow for maximum enamel preservation in the preparation phase.

After the preliminary esthetic analysis, a diagnostic wax-up **(Fig 3)** was fabricated and replicated in acrylic shells for provisional restorations for #8-#10. Due to the endodontic periapical radiolucency related to #8 and #9 **(Fig 1c)**, it was decided to treat the sites surgically and an apicoectomy was performed, followed by a five-month healing period for reevaluation.

Figure 1b: Close-up images of the lips in repose and smiling; retracted anterior maxillary view.

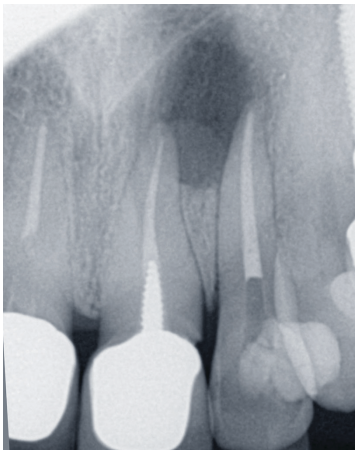


Figure 1c: Preoperative radiographic image showing roots of #9 and #10 to be addressed.

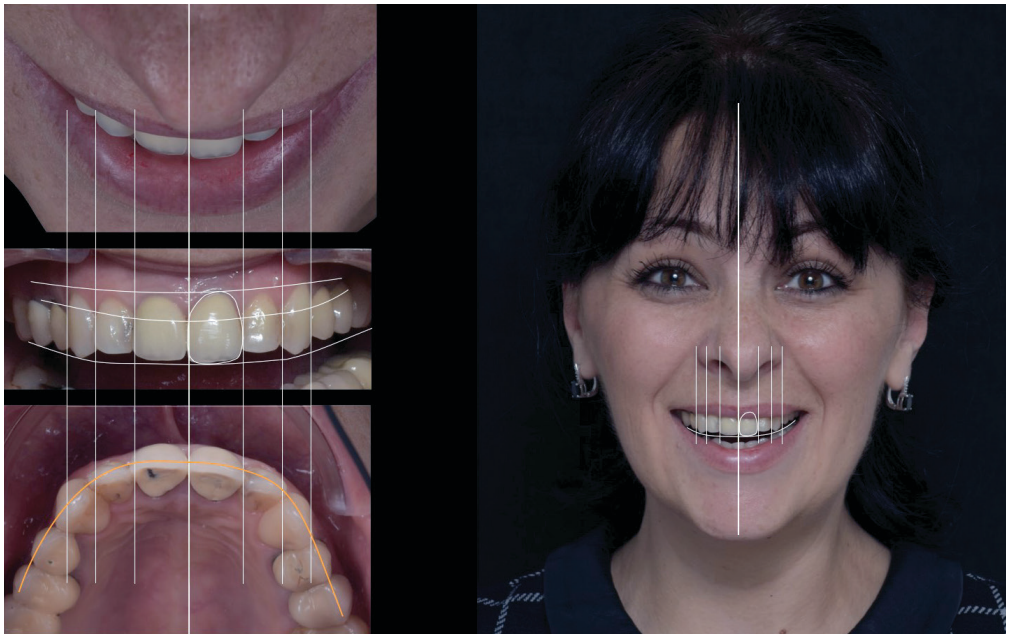


Figure 2: DSD aided in designing the future position of the teeth in the arch, along with the ideal dimensions of the future restorations.

Figure 3: Diagnostic wax-up.

Clinical Workflow

The workflow for the clinical restorative steps was as follows:

- Direct composite resin restorations were used to treat all the decayed teeth (#7, #10, and #11) **(Fig 4)**.
- The old ceramic crowns at #8 and #9 were removed and new post and core buildups restored the missing tooth structure **(Figs 5a & 5b)**. A light chamfer preparation design **(Fig 6)** was selected for these abutments, followed by smoothing and polishing with silicone points and caps (Enhance, Dentsply Sirona; York, PA, and OptiClean, Kerr Dental; Orange, CA) and contouring disks (Sof-Lex, 3M ESPE; St. Paul, MN) **(Fig 7)**.
- The provisional acrylic shells were relined intraorally with acrylic resin (Unifast A2, GC America; Alsip, IL) followed by trimming, polishing, and provisional cementation (FujiCem, GC America). Actually, in such situations, two sets of provisional crowns are made. The first set was for #8 and #9 **(Fig 8)** immediately after the core buildups. After esthetic analysis of the mock-up and patient approval of the anterior teeth's new design, a second set **(Fig 9)** was made for #8-#10 as a blueprint of the diagnostic wax-up.
- Based on the DSD, minor orthodontic movement was planned for #7 for a better alignment in the arch, to enable minimal enamel reduction at the preparation phase. An intraoral scan was performed for this (Trios, 3Shape; Copenhagen, Denmark) and the orthodontic movement was achieved with clear aligners **(Fig 10)**. A two-month stabilization period followed.
- Minimally invasive preparation design was performed for #7 guided by the mock-up[19] (Elite Glass, Zhermack SpA; Badia Polesine, RO Italy) and the wax-up-based silicone guides (Platinum Touch, Zhermack) **(Figs 11a & 11b)**.
- A traditional elastomeric one-stage impression was performed (Hydrorise heavy body and light body, Zhermack) with a double cord for #8-#10 and a single cord around #7 **(Fig 12)**.
- Lithium disilicate (e.max, Ivoclar Vivadent; Amherst, NY) ceramic restorations were made **(Figs 13a & 13b)**.
- After the try-in **(Fig 14a)**, an adhesive bonding protocol was implemented respecting the conditioning steps of the substrates: the ceramics and the dental structures **(Figs 14b-14d)**.[20,21] Variolink Esthetic DC neutral (Ivoclar Vivadent) was used for the crowns' cementation and Variolink Esthetic LC neutral for the #7 veneer.

Figure 4: Replacement of the defective composite restorations: pre- and postoperative.


Figure 5a: Removal of the old crowns on #9 and #10.

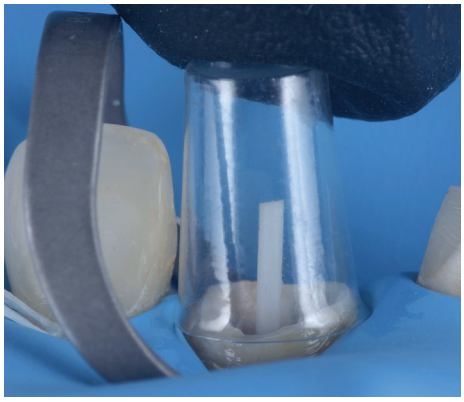



Figure 5b: New composite core buildup with a fiber post for #10.

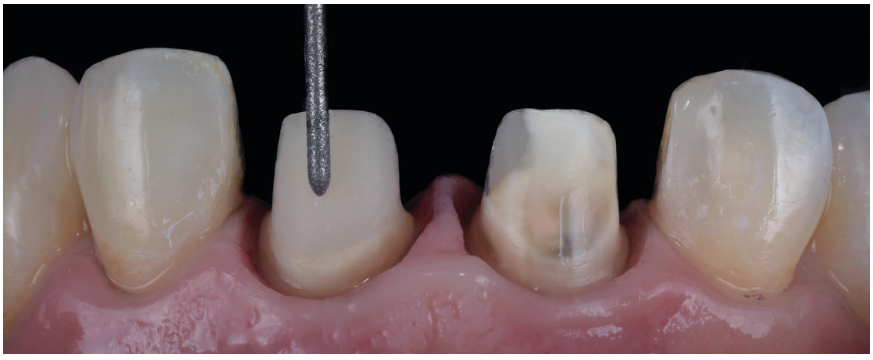


Figure 6: Light chamfer design of the two re-prepared central incisors for the new crowns.

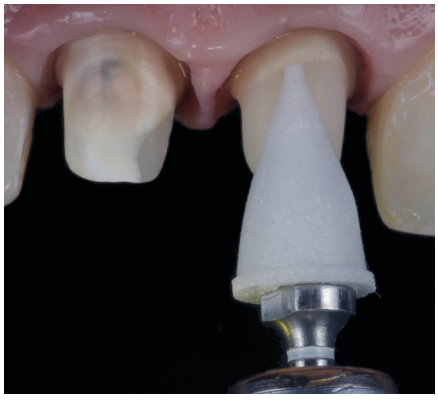
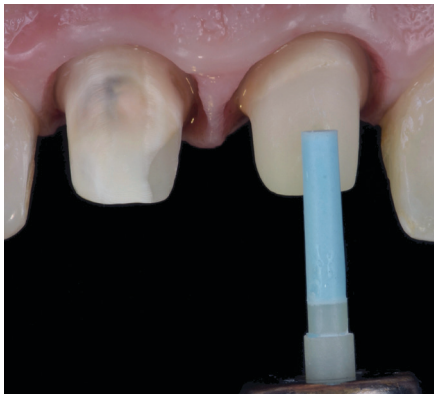




Figure 7: Fine-tuning the preparations with silicone points and contouring discs.

Figure 8: The first set of provisional crowns.

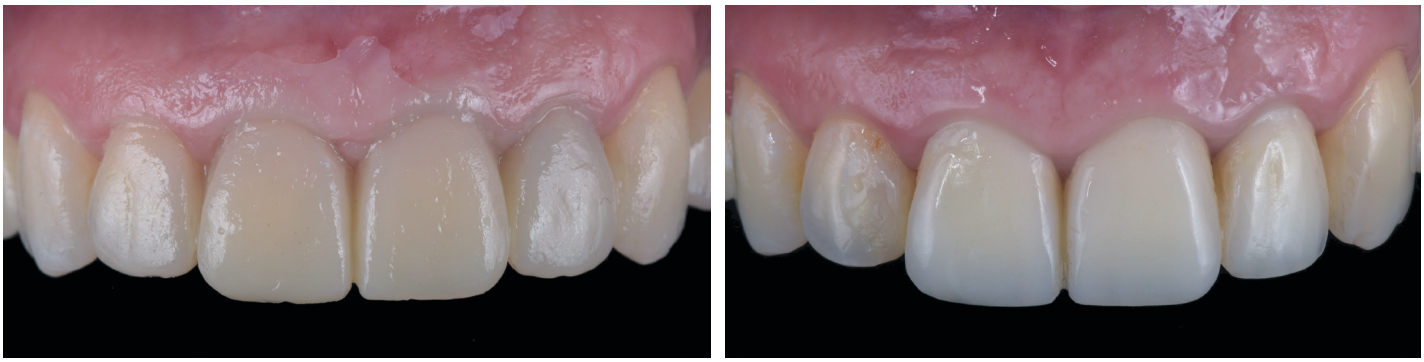


Figure 9: Intraoral mock-up followed by a second set of provisional restorations as a blueprint of the diagnostic wax-up.

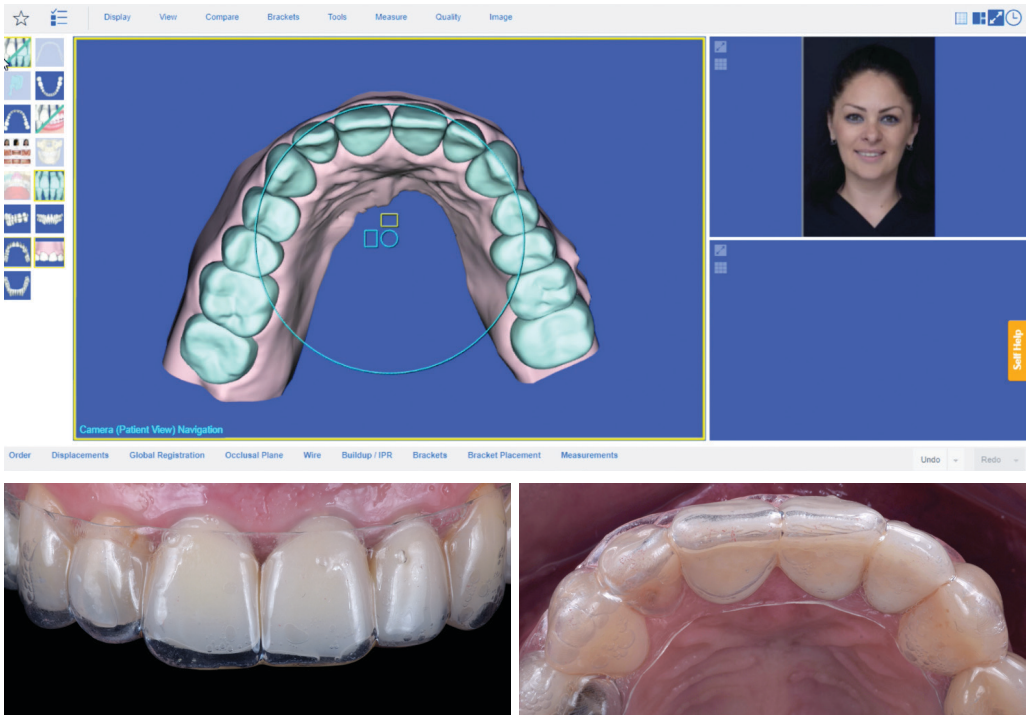


Figure 10: Clear aligners produced for minor orthodontic movement of #7, planned and based on an intraoral scan.

Figures 11a & 11b: Minimally invasive preparation for a veneer on #7 guided by the mock-up and wax-up based silicone guides.

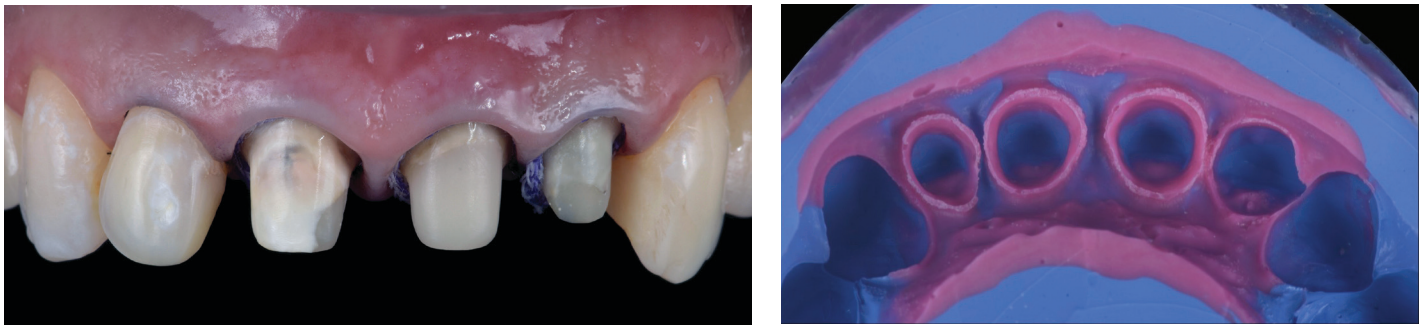
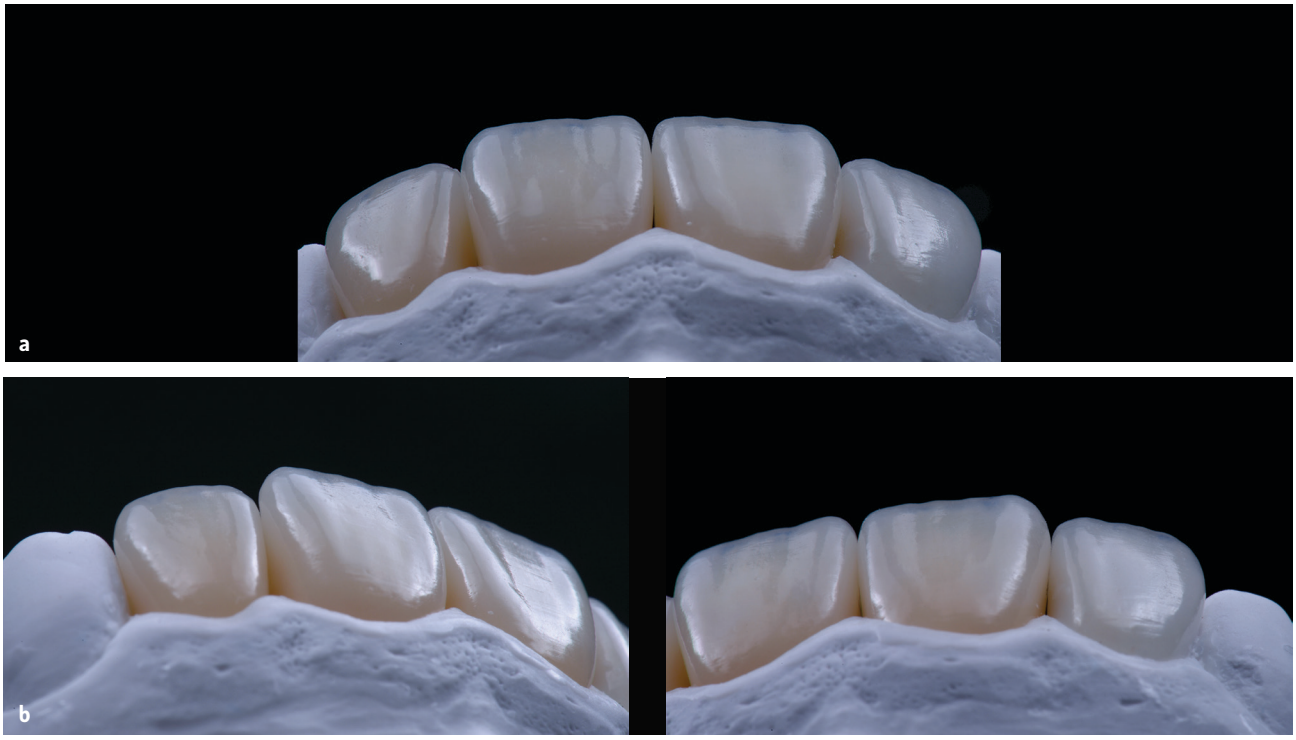


Figure 12: Prepared teeth with retraction cords inserted (double- and single-cord techniques) and the one-stage impression (heavy body and light body).



Figures 13a & 13b: Bilayered lithium disilicate restorations on the model. Note the contours of the cervical area and the natural appearance of the surface texture.

Figure 14a: Try-in of the four ceramic restorations.

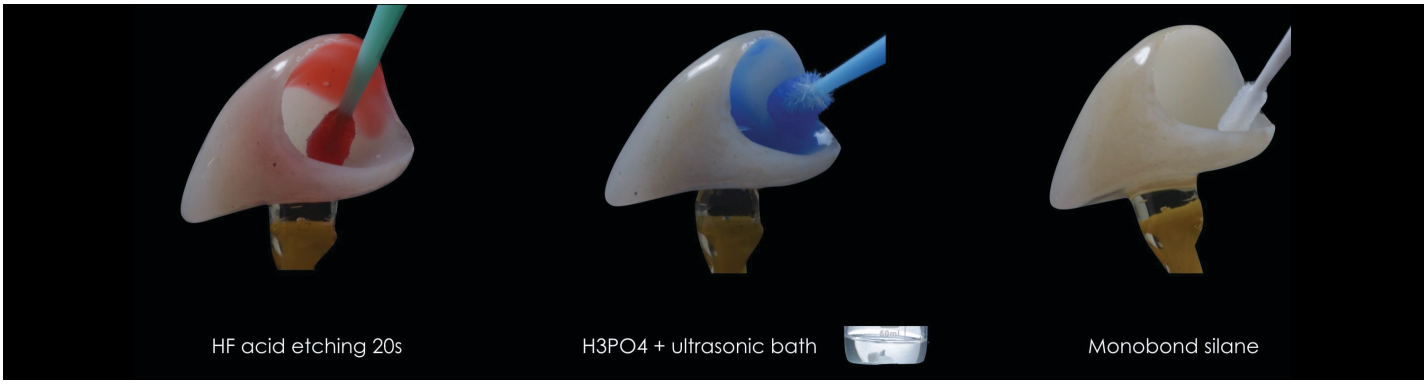


Figure 14b: Conditioning steps of the ceramic material (lithium disilicate) before the adhesive bonding procedure.

Figure 14c: Substrates' (teeth abutments) conditioning for individual bonding of each ceramic restoration under ultimate isolation. This technique protects the periodontium, ensures a perfect operative field to control the bonding procedure, and enables a visible perfect marginal adaptation of the restorations.

Figure 14d: The four ceramic restorations bonded.

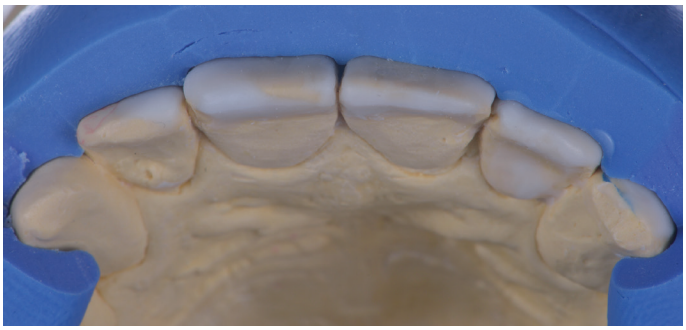


Figure 15: The laboratory workflow begins with a silicone key made on the diagnostic wax-up.

Figure 16: Minor discrepancy exists between the silicone key (made from the wax-up model) and the master model.

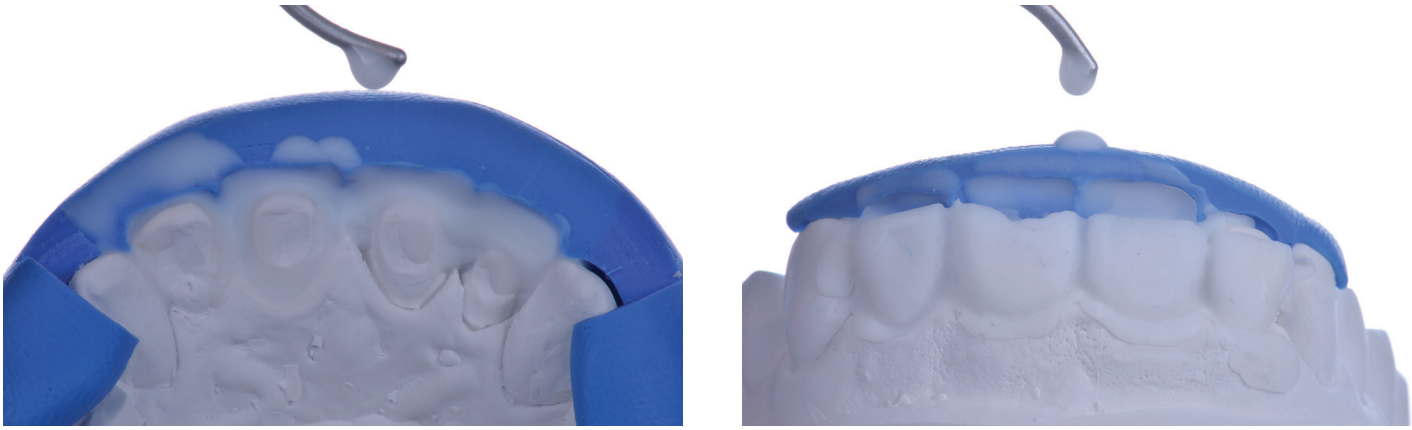
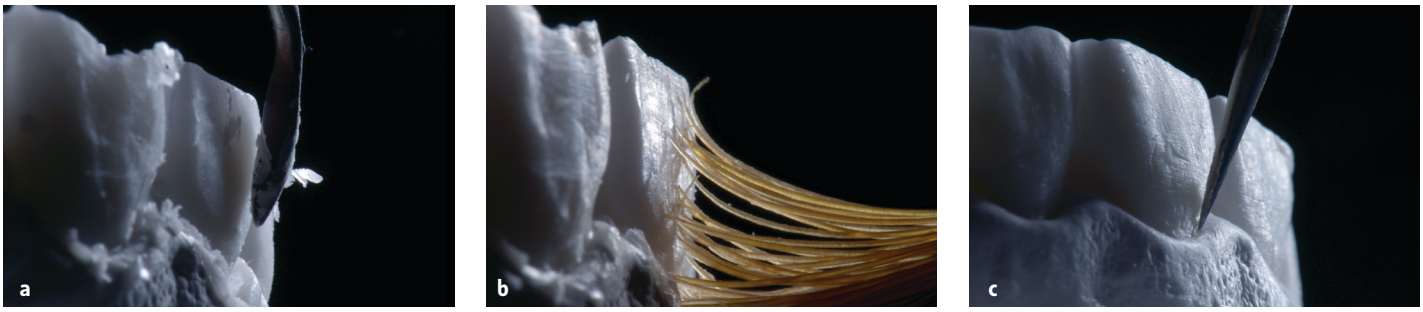


Figure 17: Correction in wax of the discrepancy, facial and palatal aspects.



Figures 18a-18c: Steps in the finishing and adaptation of the new wax-up made on the working model.

Laboratory Workflow

The workflow for the laboratory steps, based on the cervical contouring concept,[22] was as follows:

- The gingival contours from the ideally designed wax-up model were transferred to the master cast via a silicone guide (Platinum Touch) **(Fig 15)**. This was necessary because of a difference in gingival contours between the wax-up model and the master cast **(Fig 16)**.
- The new gingival contours were created on the master cast by duplicating the wax-up on the prepared teeth and gingiva **(Fig 17)**.
- A needle-sharp instrument was used to mark all the cervical contours that were changed **(Figs 18a-18c)**.
- A new cervical silicone guide was made **(Fig 19)**.
- The wax was removed from the master model and the corresponding areas of the needle grooves were marked with a pencil to indicate the free gingival margins of the final restorations' cervical contours **(Fig 20)**.
- The marginal tissue on the master model was trimmed within the marked lines with a scalpel under high magnification for maximum precision **(Fig 21)**.

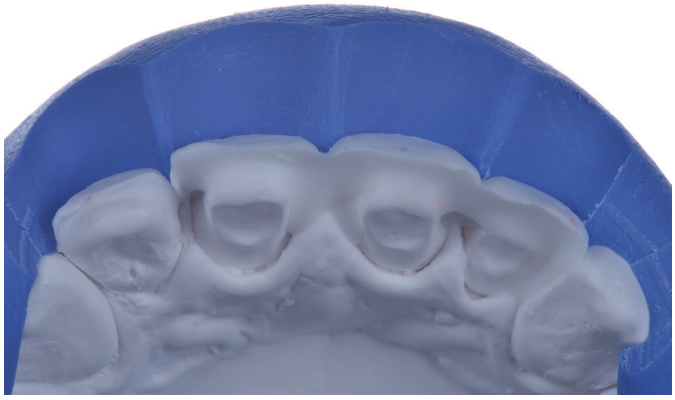


Figure 19: A new silicone guide was made according to the new contours of the master model wax-up.

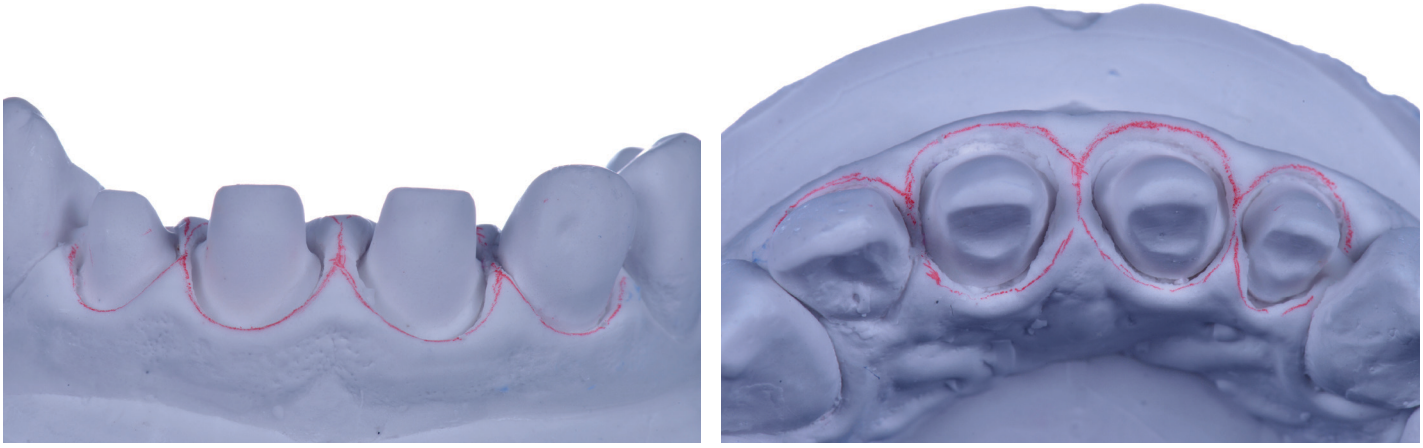


Figure 20: Marking the enhanced free gingiva contours on the master model, corresponding to the ideal wax-up cervical contours.

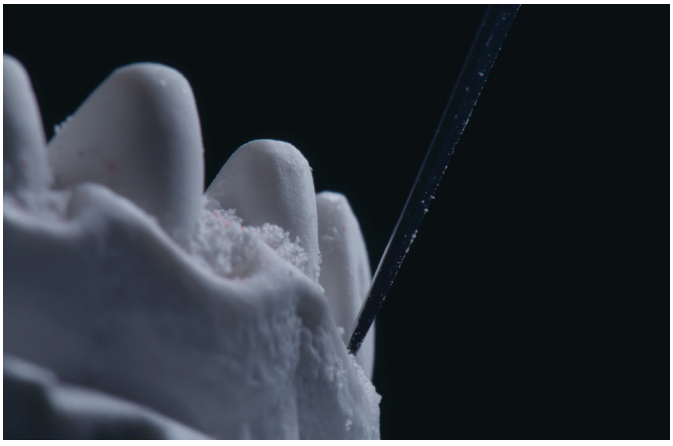


Figure 21: Trimming the new gingival contours with a sharp scalpel under high magnification.

- The artificial gingival profile (Gingifast Rigid, Zhermack) was designed on the working model, assisted by the silicone guide (Platinum Touch) from the master cast **(Fig 22)**.
- Based on the ideal cervical contours, the volume of the future ceramic restorations was controlled by the silicone guide. This allowed for a precise and controllable coping design for the pressed ceramic structure and the definitive volume of the final layered restorations.
- A crucial factor in the entire workflow was the ability to reproduce and maintain the precision and perfect adaptation throughout all of the intraoral and the laboratory steps **(Fig 23)**.
- A fluorescence treatment before the porcelain layering process was essential for disilicate materials, to improve the value and diversify the brightness and chroma in relation to the different thicknesses of the ceramic layering and the substructure teeth colors **(Fig 24)**.
- LT B1 e.max ingots were chosen for the manufacturing of the base copings. The crowns' coping thickness is dictated by the

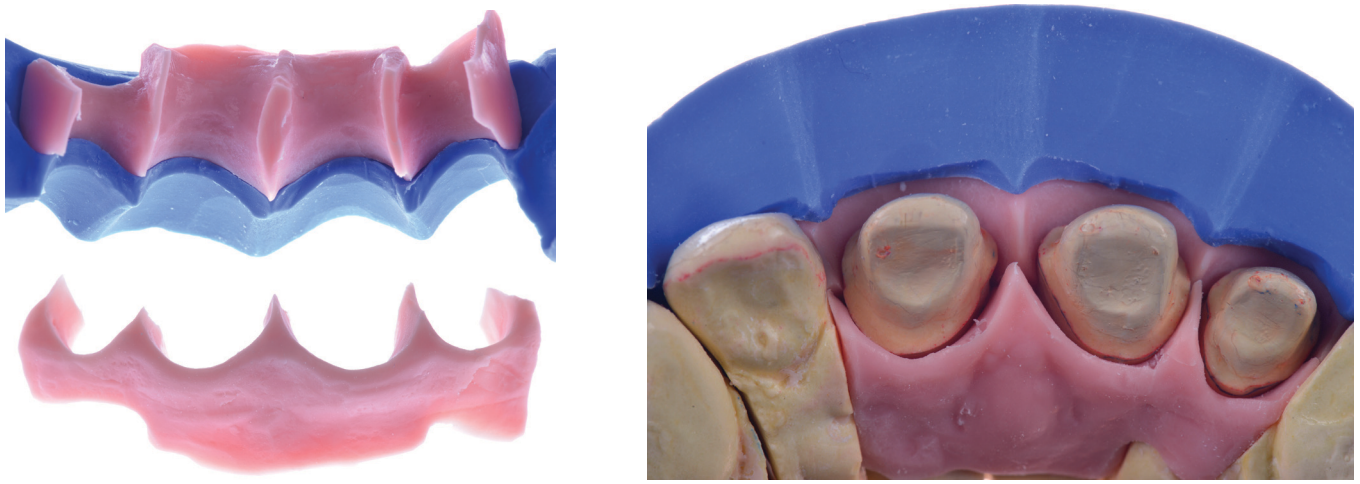


Figure 22: Duplicating the enhanced configuration of the artificial gingiva (with the help of the silicone guide) on the working model.

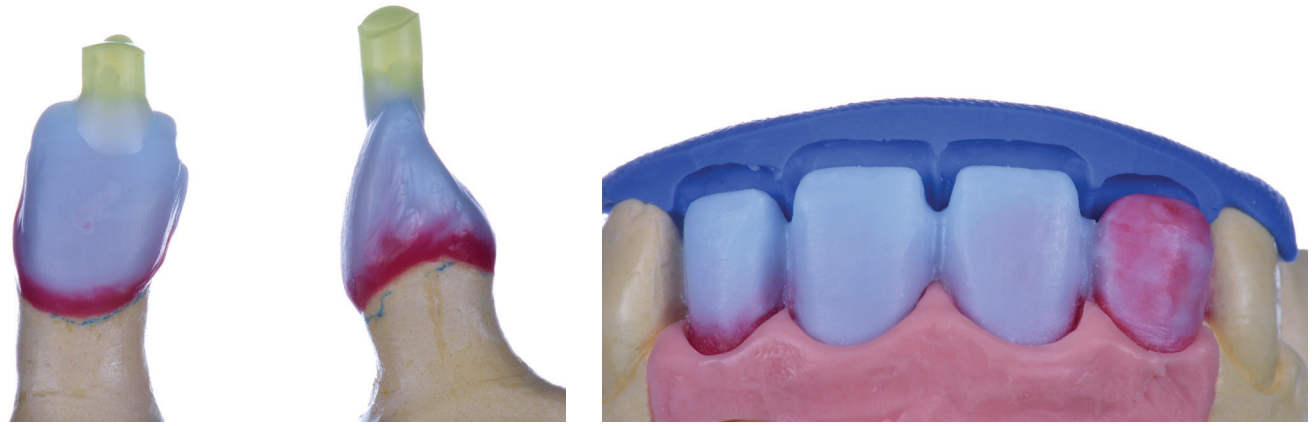


Figure 23: Fabrication of pressed restorations: high precision and adaptation of the wax-up copings made for the pressing is controlled by the silicone guide for optimal volumetric design.

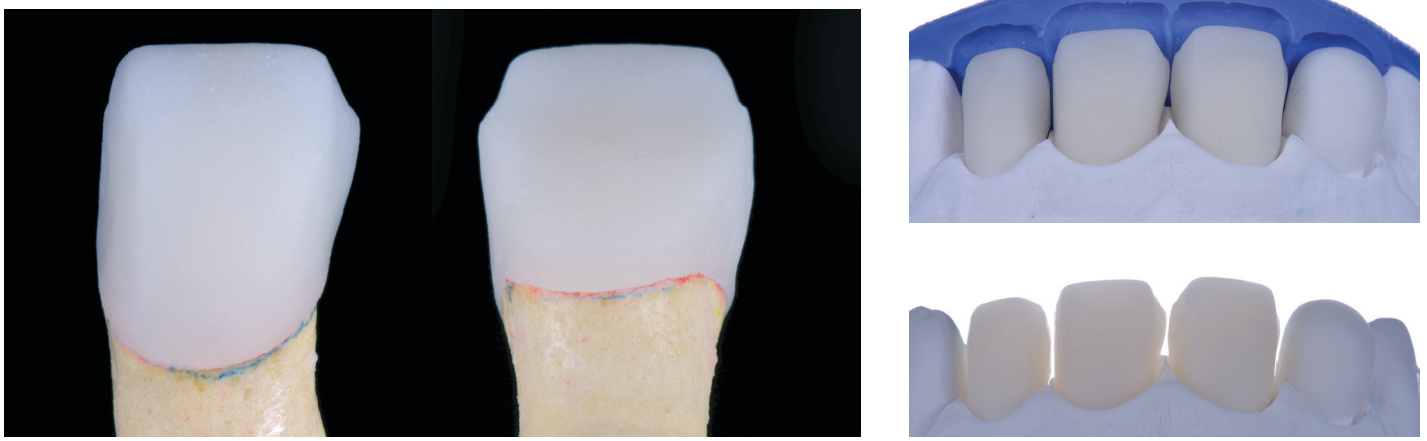


Figure 24: Highly precise adaptation of the ceramic copings on the dies. The solid master cast serves as the ultimate verification. Control of the remaining volume for the layering step is guided by the silicone keys.

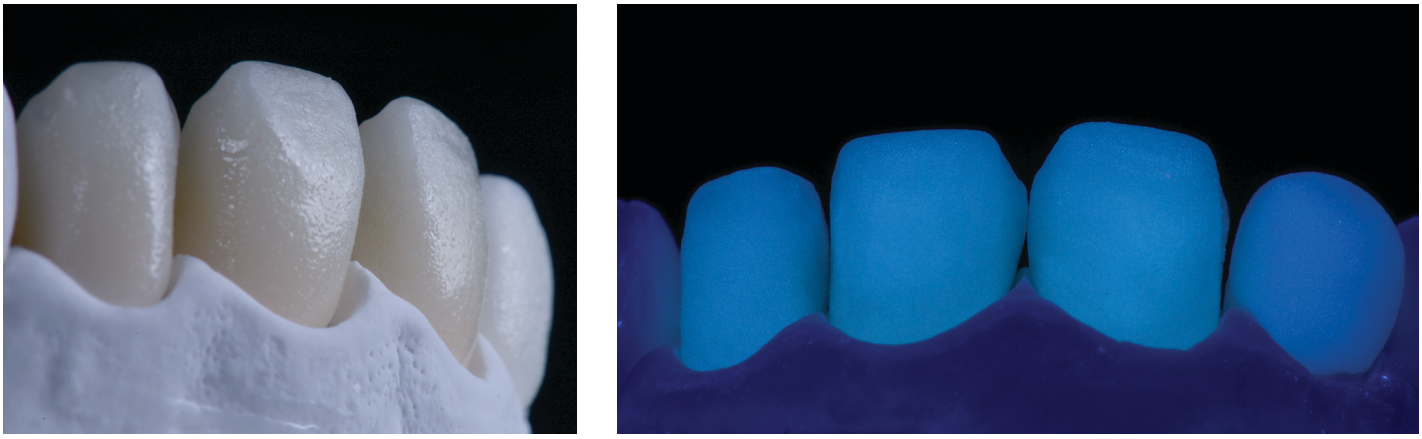


Figure 25: Fluorescence treatment of the copings before the porcelain layering.

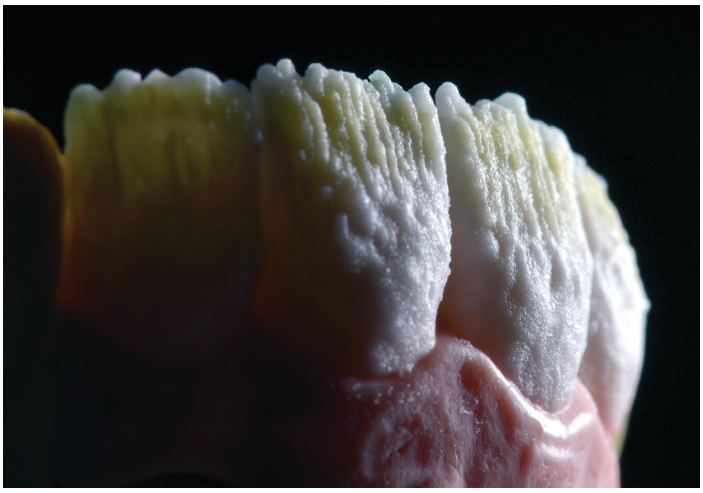


Figure 26: Layering of the four ceramic restorations with different ceramic masses.

> "...in such situations, two sets of provisional crowns are made."

amount of space available in relation to the final volume of the restorations, with a minimum of 0.5 to 0.6 mm for crowns, while veneers can be reduced to 0.2 mm to ensure mechanical structural stability **(Fig 25)**.

- Controlling the value of all four different restorations was another critical factor in the final esthetic result. This is true especially in situations that involve a combination of crowns and thin veneers, and even more so when the abutment colors differ. Power dentin was used as a base for the veneer (cervical and middle third) and mamelon powders wash for the crowns, to control the value, chroma, and fluorescence, and to cover any discoloration of the prepared teeth **(Fig 26)**.[23]
- Corrections and pre-glazing were done in a single bake to reduce the number of bakes and prevent their negative influence on the optical properties of the ceramic material **(Fig 27)**.
- Final restorations were fitted on the solid master cast after their mechanical polishing with rubber wheels and pumice. Such manual polishing is required to gradually fine-tune the surface and control its light reflection/deflection to mimic a natural enamel effect. The fitting on the solid master model was important to verify the cervical contours in relation to the optimal soft tissues and the interproximal contact areas in between the restorations and with the adjacent teeth **(Fig 28)**.

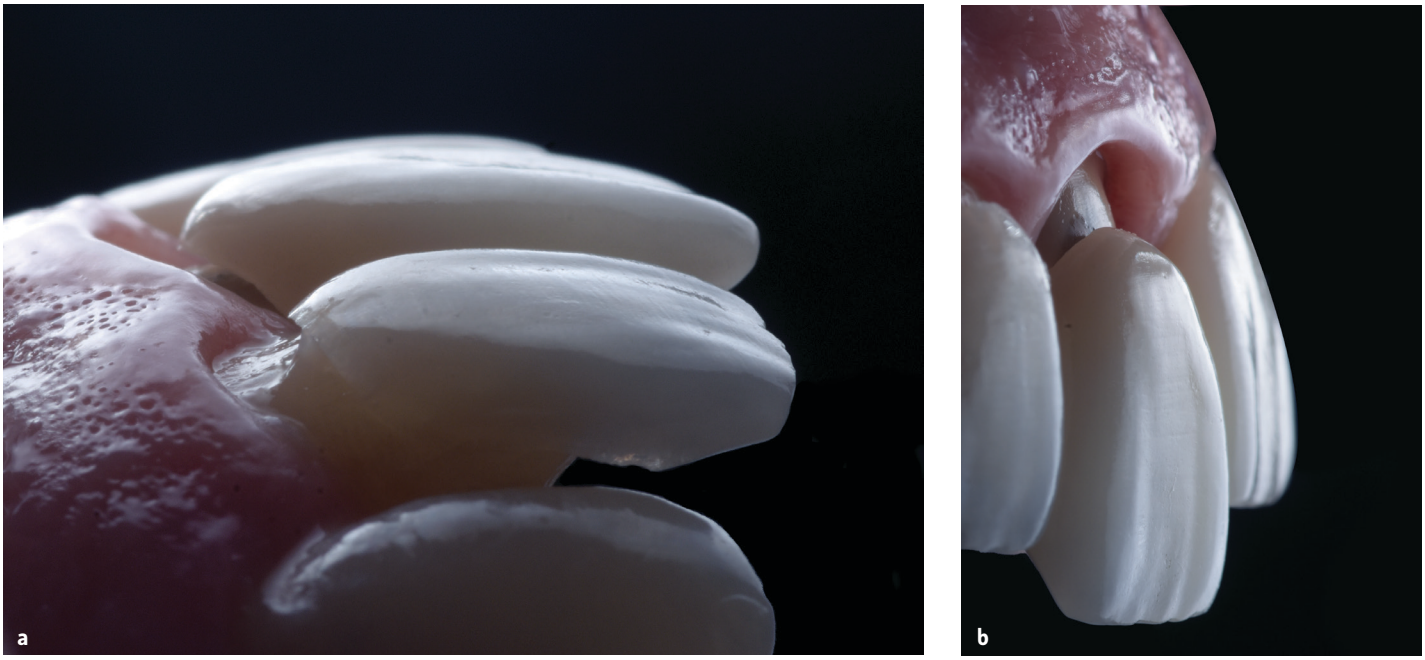
Figure 27: Corrections and pre-glaze in a single bake to minimize the number of bakes. Multiple bakes are unfavorable for all ceramic materials.

Figure 28: Final lithium disilicate restorations on the solid master model verifying the cervical contour in relation to the gingiva and the interproximal contact areas.

Cervical Profile and Soft Tissue Interface

An essential aspect of a beautiful smile, aside from its supragingival appearance, is the harmonious and healthy integration of the intracrevicular interface between the gingival margins and the restoration's cervical profile. Accurate analysis and a tridimensional evaluation of the space between the prepared tooth and the adjacent soft tissue margins **(Fig 29)** are imperative so the restoration's proper cervical profile, 360 degrees, can be created to support the gingival tissue to its optimal contours at all its aspects. This becomes even more important when a combination of crowns and veneers exists, due to the difference in tooth reduction, the apicocoronal preparation margin location, and its relationship to the inner aspect of the gingival sulcus **(Figs 30a & 30b)**. The tridimensional space for the cervical restorative volume is directly linked to the amount of tooth structure removed, which is usually different between a crown and a veneer. This poses a technical challenge when layering the restorations' ceramic masses due to the difference in the restorations' thicknesses **(Fig 31)**. The laboratory workflow described previously enables predictable control and precision of an enhanced model-based cervical contour for each type of restorative design, allowing biologic accommodation of healthy gingival surroundings to achieve a biocompatible and esthetic result. The final treatment outcome successfully combined optimal morphological, functional, and esthetic integration within the surrounding tissues that complemented the patient's face **(Figs 32a-32e)**.

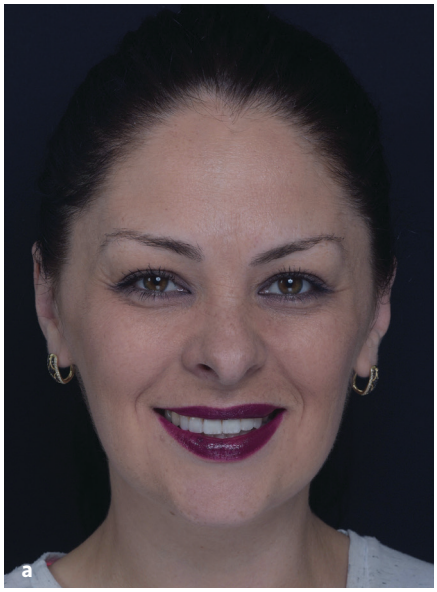
Figure 29: Lateral image of the relationship between the prepared tooth and surrounding gingiva. Note the tridimensional space created between the gingival inner aspect and margin and the prepared crown abutment.



Figures 30a & 30b: The cervical profile design related to the soft tissue. Note the difference between the design of the veneer (a) compared to the crown (b).

Figure 31: Thickness difference of the ceramic restorations, veneer and crown.

> "It can be easier to control the optical result of different ceramic thicknesses when certain protocols…are applied during the clinical and laboratory workflows."



Figures 32a-32c: Postoperative smile: full-face, 1:2, and retracted views.

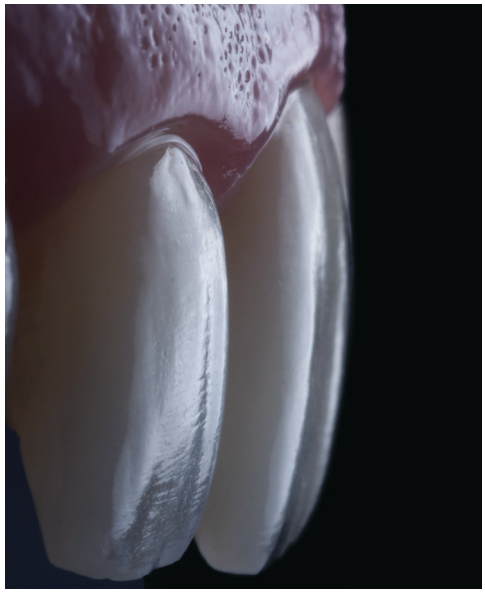


Figure 32d: Postoperative profile view. Note the harmonious and healthy relationship between the cervical contour of the ceramic restoration and the soft tissue margins.

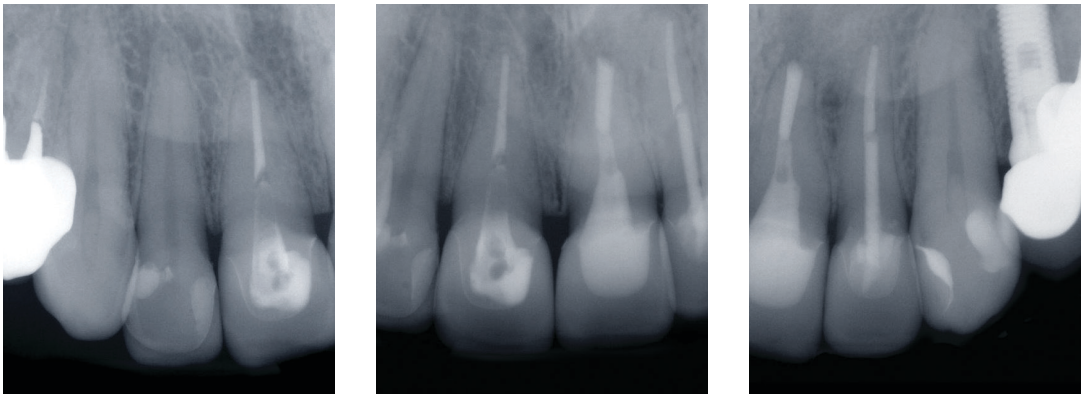


Figure 32e: Postoperative radiographs. Note the perfect adaptation of the proximal restorative margins.

Summary

Combining different ceramic restorations when treating defective teeth in the smile zone presents an ongoing challenge due to the different restorative thicknesses as well as the different substrate types and colors. The main issue in such situations is achieving a harmonious appearance of the restored teeth.

It can be easier to control the optical result of different ceramic thicknesses when certain protocols, such as those described here, are applied during the clinical and laboratory workflows. The model previsualization of the final result, the subsequent controlled intraoral procedures, and the controlled laboratory steps for the definitive restorations, as well as the augmented shapes of the restorations' cervical profiles, enabled predictable, natural-looking, and biocompatible results.

Acknowledgments

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