Increasing VDO and the Use of CAD/CAM

Prosthodontic Principles and the Full-Mouth Reconstruction

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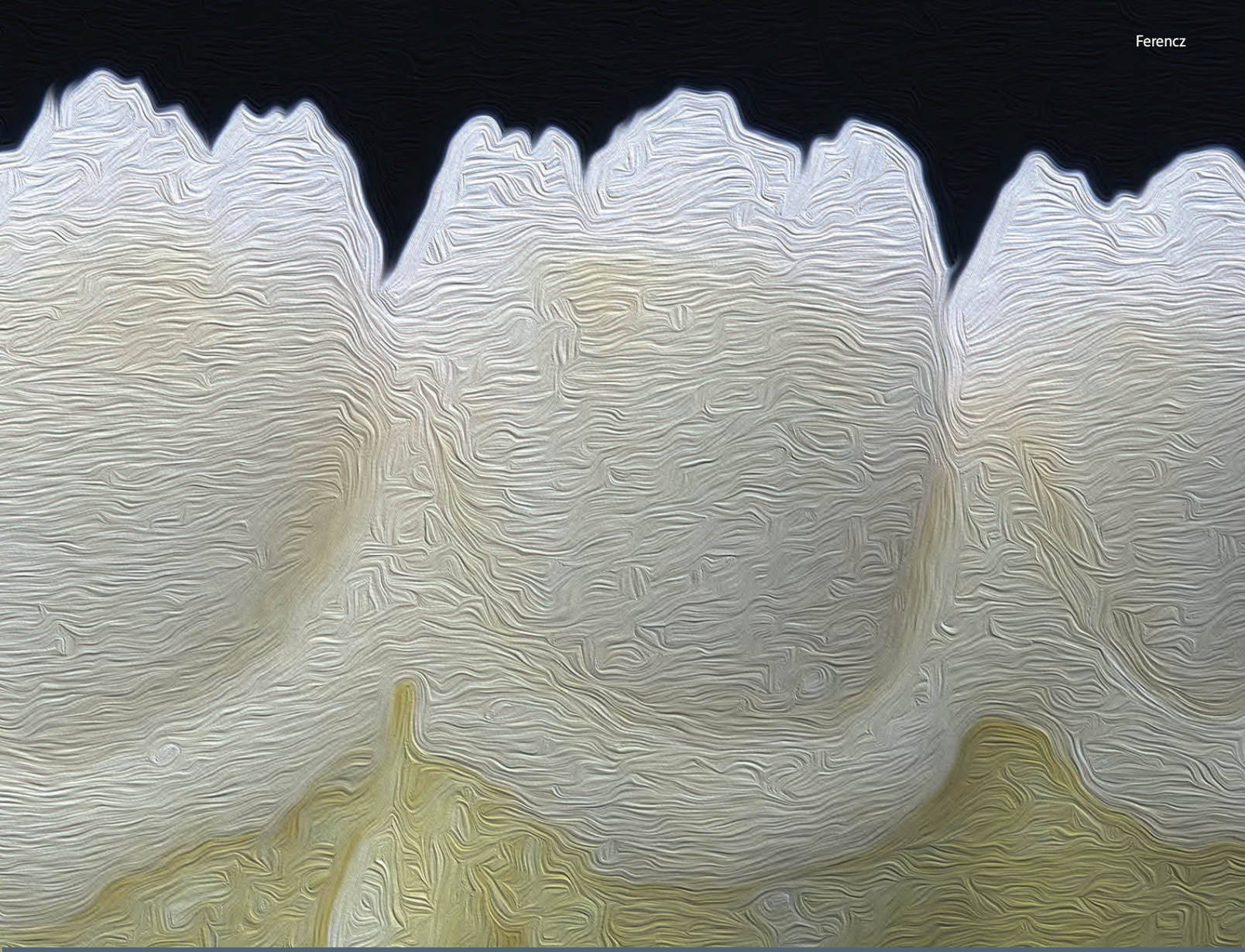
Abstract

This article describes the treatment of a young adult female with severe enamel erosion and the resultant loss of vertical dimension of occlusion (VDO). Her chief complaint was the appearance of her anterior teeth. The prosthodontic rehabilitation required to restore her VDO necessitated treating her posteriors with full coverage to create the needed space anteriorly. Pressed monolithic lithium disilicate was used for the posteriors and the lower canines. After the posteriors were completed and cemented, the maxillary anteriors were restored with computer-aided design (CAD) lithium disilicate using the E4D system and the lower incisors were restored with pressed lithium disilicate veneers. All of the restorations were fabricated with monolithic lithium disilicate and stained and glazed to achieve the desired esthetic outcome.

Key Words: erosion, vertical dimension, monolithic lithium disilicate, CAD/CAM



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Introduction

An increasing number of patients are presenting at dental practices with visible signs of tooth wear and erosion accompanied by complaints of tooth sensitivity. Many different factors can contribute to premature tooth wear and its resulting sensitivity. These can include extrinsic causes, such as a highly acidic diet containing large quantities of certain fruits and beverages such as orange juice, wine, and soft drinks[1]; and also pathological aspects that can cause wear, such as acid erosion from repeated regurgitation (i.e., bulimia or gastric reflux disease).

Dental acid erosion can be caused by acids repeatedly contacting the surfaces of teeth without adequate neutralization. In small doses, the acid that contacts the teeth is neutralized by saliva, restoring the oral environment to a stable pH and thus inhibiting erosion. During repeated contact, such as results from gastric reflux disease, acid is no longer neutralized by saliva. As a consequence, the enamel and underlying tooth structures are eventually weakened.

Several case studies have implicated gastric reflux as the probable reason for tooth wear.[2-4] This can lead to increased sensitivity and, in extreme cases, wear that results in loss of vertical dimension of occlusion (VDO).[5]

Loss of VDO can be problematic functionally, parafunctionally, and esthetically. Patients who present with loss of VDO can demonstrate alterations in bite force, temporomandibular joint (TMJ) loading, neuromuscular activity/stability, and an esthetic loss of occlusal facial height.[6] Dentoalveolar form also is often compromised, as a loss in VDO typically correlates with a compensatory elongation of alveolar tissues.[7,8] Cumulatively, this may translate into a patient requiring full-mouth reconstruction to restore the "collapsed appearance" of facial esthetics, oral function, and parafunctional capabilities.

The need to restore tooth structure, function, and esthetics in patients presenting with lost VDO can create challenges for dentists. These cases require reconstruction of esthetic form, as well as a harmonious occlusal relationship.[9,10] If form and function are not properly restored, the patient will not receive both esthetic and physiological benefits from the restorations.

These cases are also challenging from patient management and treatment sequencing perspectives. While the patient may be more concerned with the esthetics of his or her smile and believe the anterior teeth should be restored first, loss of VDO requires an increase in vertical dimension—and thus requires restoration of posterior teeth first—prior to addressing any cosmetic concerns in the esthetic zone (i.e., anterior teeth).[6]

It is also important to carefully consider materials when devising the treatment plan in order to provide optimum masticatory viability. The materials chosen must withstand the masticatory forces as well as provide an esthetically pleasing outcome that satisfies all patient and practitioner requirements.[9] Advances in treatment planning, diagnostic imaging, reconstructive techniques, metal-free materials, and computer-aided design/computer-aided manufacturing (CAD/CAM) processing allow dentists to complete these complex restorative cases in a timely manner, with excellent functional and esthetic results.[11]

This article demonstrates the manner in which a full-mouth reconstruction was undertaken to increase a patient's lost VDO in a phased manner. In particular, treatment was initiated in the posterior region. Additionally, a combination of lithium disilicate all-ceramic fabrication processes (e.g., IPS e.max Press and machined IPS e.max CAD, Ivoclar Vivadent; Amherst, NY) was used.

Challenges of Full-Mouth Rehabilitation Cases

From a prosthodontic perspective, treating a patient with a loss of VDO requires an advanced, phased treatment plan. This is an extremely important step because in cases where mixed restorations are used, the dentist must ensure that all the restoration types and materials are properly selected and compatible from the standpoint of occlusal wear. They must also be placed at the correct intervals to ensure stable, esthetically pleasing results.

In general, the posterior teeth should be restored first. The addition of VDO alters overall occlusion. Patients may be more concerned about the appearance of anterior teeth, but functionally and parafunctionally, restoring anterior teeth first usually is ill advised. A restoration placed without considering the anticipated and altered occlusal contacts and anatomy is a restoration that is likely to fail.[6]

Additionally, in this type of case, to create adequate space for anterior teeth (e.g., additional incisal edge length), proper height of VDO must first be created. Translated to proper planning and treatment, this is best accomplished by temporizing and finalizing the posterior restorations first, then adding anterior tooth restorations to complete a full-mouth rehabilitation. To achieve stability during function and parafunction, all quadrants of the posterior teeth must be prepared and temporized simultaneously. These requirements include stable TMJs, as well as equally and evenly distributed forces across all teeth.[12]

When executing changes in VDO, it is possible to see that even minute adjustments can greatly alter a patient's overall occlusion. Therefore, the vertical dimension must be increased only within the patient's tolerance.[13]

Diagnostic tools such as articulated casts and wax-ups are utilized to fabricate provisional restorations for these patients. These casts are built upon to determine the new occlusal scheme, as well as the overall shape, length, and contour of the proposed restorations. They then enable creation of provisional restorations that allow patients to "test drive" the anticipated changes.

Provisional restorations must be fabricated for—and worn by—the patient before final restorations are

placed. This allows a new occlusal plan to be tested and determined safe for the patient prior to placing definitive restorations. Any necessary adjustments that are to be made to enhance proper occlusion or patient comfort can occur in the weeks before the restorations are cemented into place.

Additionally, other challenges with full-mouth reconstructions have involved successfully combining restorations fabricated from different materials, and/or which were fabricated using different processes. In the past, when dentists and laboratories utilized mixed restorations (i.e., pressed ceramics and CAD/CAM-processed monolithic restorations), the results were less than optimal. A difference in optical properties that occurs among dental materials during processing often left the final appearance of two restorations with the same chemical makeup, processed in different ways, dramatically different. For instance, a pressed restoration could appear significantly more translucent than a CAD/CAM "milled" restoration.

In recent years, however, advances in metal-free materials and processing have led to the increased use of lithium disilicate for various types of restorations. Due to its unique optical properties and excellent durability, it has become a viable material for mixed restorations that blend seamlessly in the esthetic zone.

Digital technology has also increased the dentist's and laboratory's capabilities to create and duplicate custom smile designs. The increasing availability and wide variety of chairside digital imaging equipment allows dental teams to accurately capture all aspects of tooth arrangement, form, surface texture, and color of provisional restorations. This digital record can be saved, after which the information can be applied with CAD/CAM software and machining technology to "clone" restorations for the patient in the future.

Case Presentation

Clinical Findings

A 30-year-old female with a history of gastric reflux presented with a significant loss of enamel due to acid erosion **(Figs 1-3)**. She was concerned with the esthetics of her smile, as well as the "collapsed appearance" of and sensitivity of all of her teeth **(Figs 4 & 5)**. Clinical examination revealed extensive loss of enamel. In addition to the maxillary anteriors, there was loss of enamel on virtually every tooth except the maxillary second molars. The maxillary anteriors had extensive bonding on their facial surfaces, as did the maxillary premolars. The loss of tooth structure on the palatal aspect of the maxillary anteriors made it nearly impossible to restore without restoring

Figure 1: Full-facial preoperative view of the patient in natural smile.

Figure 2: Preoperative close-up view of the anterior teeth showing wear.

Figure 3: Close-up retracted preoperative view of worn teeth.

This was a long and challenging appointment, because it was imperative that all four quadrants be completed during the same visit.

Figure 4: Preoperative occlusal view of the maxillary arch.

Figure 5: Preoperative occlusal view of the mandibular arch.

Figures 6-8: Diagnostic casts were made of the patient's preoperative condition.

Figures 9-11: View of the diagnostic wax-up demonstrating the proposed increased vertical dimension.

the lost vertical dimension to the posterior teeth. Diagnostic casts were created and analyzed **(Figs 6-8)**, and a diagnostic wax-up was made **(Figs 9-11)**. The critical step in the diagnostic phase of this case was the wax-up, which revealed that the only way to restore the missing tooth structure in the anterior region would be to increase the VDO on the posterior teeth to create sufficient room to restore the anteriors.

Unfortunately, many patients do not understand that in order to improve the appearance of the anterior teeth, a phased treatment plan is required, with the posterior teeth reconstructed first to increase the lost vertical dimension. In this case, the collapsed vertical dimension resulted from the loss of 1-mm to 2-mm of enamel on the posteriors caused by the acidic erosion from the patient's gastric reflux. Once the posteriors were restored to an increased vertical dimension, the anterior teeth could be separated by approximately 3 mm, which would create the room necessary to increase the length of the maxillary anteriors and allow a more pleasing and attractive smile.

Treatment Plan

Based upon an analysis of the patient's occlusion and collapsed vertical dimension, the following treatment plan was developed:

- extraction of #13
- placement of full-coverage lithium disilicate restorations (IPS e.max) on ##3-5, #12, #14, ##18-22, and ##27-31
- increasing the vertical dimension by approximately 1 mm in the molar area to create sufficient room in the anterior region to restore the patient's teeth to their original length
- placement of full-coverage lithium disilicate crowns (IPS e.max) on ##6-11
- placement of lithium disilicate veneers (IPS e.max) on ##23-26 to enhance the patient's esthetics.

Clinical Protocol

After the extraction site of #13 healed **(Fig 12)**, all of the posterior teeth were prepared for crown restorations and temporized. This was a long and challenging appointment, because it was imperative that all four quadrants be completed during the same visit. This would provide the patient with an altered occlusal relationship at an increased vertical dimension.

The patient tolerated the procedure well and was allowed to function in the provisionals for six to eight weeks to test the new vertical dimension. Other than being slightly self-conscious about the appearance of her anterior open bite, she reported no problems. She had no TMJ symptoms, no muscular symptoms, and had no problems with function. With the new occlusal relationship created and tested, the posterior crown restorations could be finalized. The right side was restored first **(Fig 13)**, followed by the left side **(Fig 14)**, with full-contour, monolithic pressed lithium disilicate crowns (IPS e.max). The patient was very comfortable with the finalized posteriors and liked the color of the minimally stained monolithic crowns. As planned, the new occlusal relationship created space for restoring the anteriors **(Figs 15 & 16)**.

Figure 12: Tooth #13 was extracted.

New impressions were taken to enable the wax-up of the anteriors **(Fig 17)**, which was duplicated in silicone **(Fig 18)**. The teeth were prepared on the cast to create the anterior provisional restorations. A tooth reduction guide was constructed to allow for conservative reduction of only the amount of tooth structure needed to create the esthetic arrangement demonstrated in the wax-up **(Fig 19)**. Provisional restorations were then fabricated for the anterior teeth **(Figs 20-22)**.

The anterior teeth were then prepared **(Figs 23 & 24)**. The provisional were tried in **(Fig 25)**, relined **(Fig 26)**, and seated into place **(Fig 27)**. The patient was allowed to function with the anterior provisionals for two weeks.

When the patient returned to the office, she reported that she loved the new appearance of her smile and had no recommendation for changes **(Figs 28 & 29)**. It was decided that the temporaries were so good that they could serve as a mock-up or guide for the final crowns.

The most effective way to copy the contour, surface texture, and arrangement of the temporaries was to scan them. For this case, the E4D scanner (D4D; Arlington, TX) was used to scan the patient's provisional restorations and save the images as a mock-up or clone for the final crowns **(Fig 30)**. Her preparations were also scanned **(Fig 31)**, and the cloned image of her approved provisional was applied to create a "custom tooth library" for her final anterior restorations **(Fig 32)**.

Figure 13: Right lateral view of the posterior IPS e.max crown restorations in place.

Figure 14: Left lateral view of the posterior IPS e.max crown restorations in place.

Figure 15: Retracted intercuspation view demonstrating the amount of anterior interocclusal space obtained by increasing the vertical dimension by 1 to 1.5 mm in the molar region.

Figure 16: Close-up, upward angle view demonstrating the interocclusal space obtained by increasing the vertical dimension by 1 to 1.5 mm in the molar region.

Figure 17: A wax-up was created for use in creating the anterior provisional restorations.

Figure 18: A silicone impression was made of the wax-up.

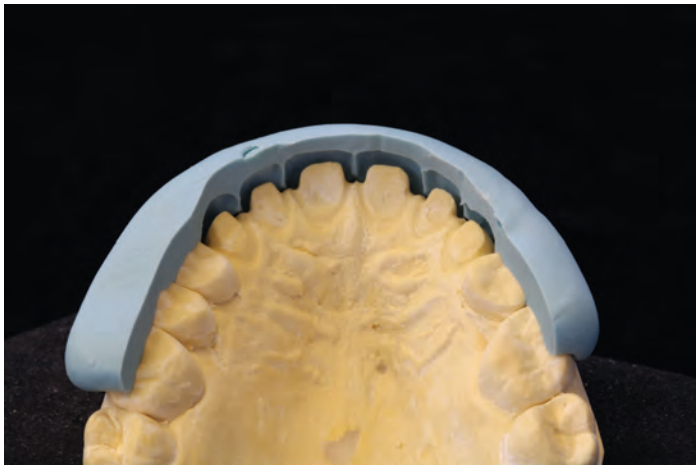

Figure 19: A preparation guide was created to facilitate tooth reduction.

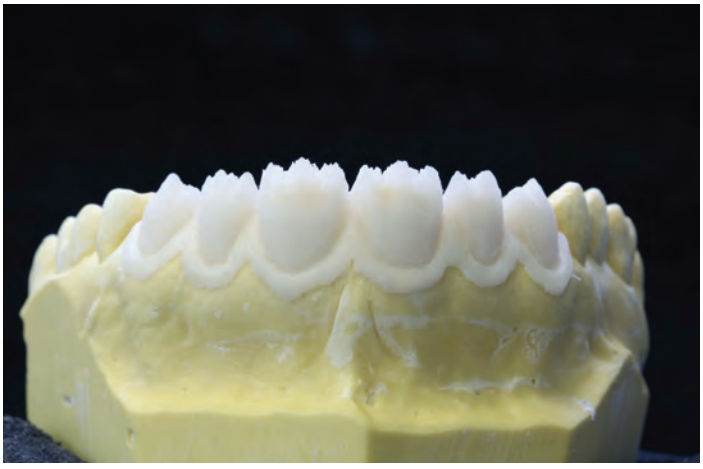

Figure 20: The anterior provisional restorations prior to application of the enamel colored acrylic.

Figure 21: Enamel acrylic was added to the provisional restorations.

Figure 22: The completed maxillary anterior provisional restorations.

Figure 23: The patient's anterior teeth prior to preparation.

Figure 24: The prepared teeth with the retraction cord in place.

Figure 25: The processed provisional was tried in prior to relining.

Figure 26: The provisional restorations were relined prior to seating.

Figure 27: The maxillary anterior provisional restorations were seated into place.

Figure 28. Close-up view of the provisionals after two weeks, with the patient showing her natural smile.

Figure 29: Close-up retracted view of the maxillary anterior provisional restorations after two weeks.

The materials chosen must be able to withstand masticatory forces, and the treatment must be planned and completed in a specified protocol in order to achieve predictable, long-term results.

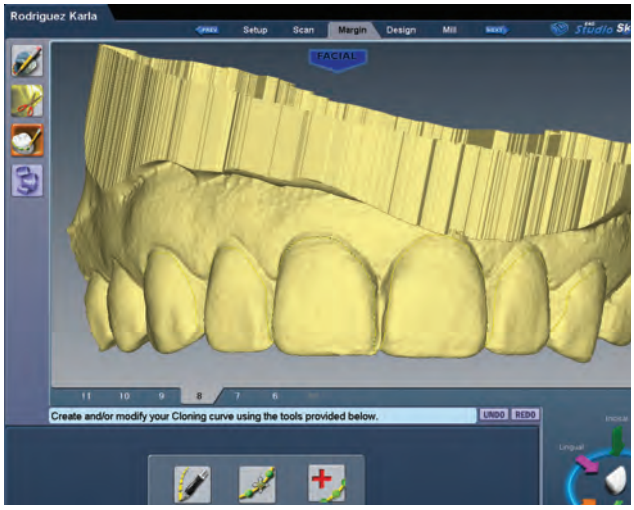

Figure 30: The provisionals were scanned and would be used as clones for the final crown restorations.

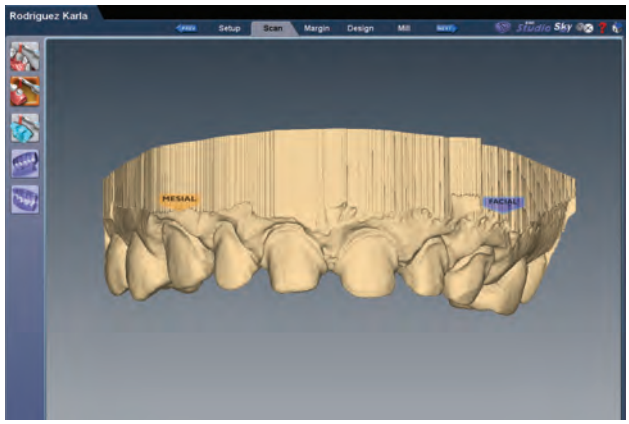

Figure 31: The scanned maxillary preparations.

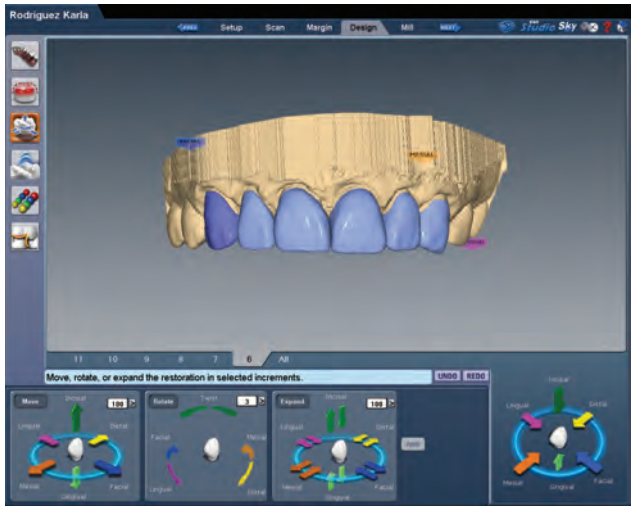

Figure 32: The final crown design prior to milling from a monolithic IPS e.max block and slight staining to match the patient's posteriors.

The maxillary anterior restorations were milled from a monolithic lithium disilicate block (IPS e.max CAD) and slightly stained to match the patient's posteriors, which she liked very much. Upon completion, the maxillary anterior restorations were cemented, and the pressed lithium disilicate veneers for the lower incisors (IPS e.max Press) were placed to modify color and increase length that had been lost.

The papilla, although healthy, was a bit blunted, probably due to gingival retraction during preparation and digital impression and then once again during final cementation. The final photographs were taken soon after cementation **(Figs 33-36)**. The author is certain the papilla will fill the space, because the contours of the crowns are correct. Closing the space with an addition of ceramic in the case of a healthy 30-year-old would not be the author's first choice, since in most cases this slight triangle usually fills with a healed papilla. In addition, the patient was happy with the esthetics.

Summary

When performing an occlusally complex full-mouth reconstruction, proper treatment planning, phasing, sequencing, and material selection are imperative for long-term success. The materials chosen must be able to withstand masticatory forces, and the treatment must be planned and completed in a specified protocol in order to achieve predictable, long-term results.

In this case, all posterior teeth were restored with IPS e.max Press lithium disilicate to increase the loss in VDO. Only then could the anterior maxillary incisors be restored with IPS e.max CAD lithium disilicate, cloned from the provisional anterior restorations. Excellent esthetics were achieved using this material and a combination of fabrication processes. No layering was required; only staining and glazing were performed to achieve ideal color matching with the posterior restorations and lower incisor veneers.

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Figure 33. Retracted view of the completed case after the maxillary anterior restorations were cemented and the four mandibular incisors were restored.

Figure 34. Close-up retracted view of the maxillary anterior teeth restored with IPS e.max CAD monolithic crowns to replace lost enamel to improve the esthetics. The papilla will fill the "black triangle," because the contours of the crowns are correct.

Figure 35. Postoperative full-facial view of the patient showing her natural smile.

Figure 36. Close-up postoperative view of the patient's smile showing enhanced length and esthetics.

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