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Blending White and Pink Esthetics: Restoring Central Incisors Using a Complete Digital Workflow- A Case Report

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Abstract **Case Report**

***Background/Objectives*:** Collapse in the anterior maxillary region often follows extractions, posing significant esthetic challenges. Restoring lost central incisors requires a balance of functional and esthetic results, especially in the highly visible anterior region. With advancements in CAD/CAM technology, restorative dentistry has become more precise and efficient. This study aims to explore the use of CAD/CAM technology for restoring two missing central incisors through a fixed ceramic bridge. ***Methods*:** The treatment process included the design and fabrication of a fixed ceramic bridge using CAD/CAM technology. An interim bridge with an ovate pontic was placed to shape the soft tissue and prepare the edentulous ridge. Gingivoplasty was performed using a 3D-printed guide to enhance the harmony between gingival and dental structures. The final restoration employed stratified zirconia for its natural esthetic properties. ***Results*:** The integration of digital workflows allowed precise planning and execution, resulting in improved predictability of the esthetic outcomes. The interim bridge effectively supported the soft tissue, and the gingivoplasty helped achieve a harmonious gingival contour. The use of CAD/CAM technology contributed to a functional and visually pleasing restoration of the lost central incisors. ***Conclusions*:** Digital technology, especially CAD/CAM, significantly enhances the predictability and success of complex dental restorations. It enables the seamless integration of esthetic and functional outcomes, making it an invaluable tool in modern restorative dentistry. This case demonstrates the potential of digital approaches in achieving optimal results in challenging esthetic cases.

Keywords: CAD/CAM technology, ovate pontic, gingivoplasty, gingival modeling, stratified zirconia.

INTRODUCTION

In modern restorative dentistry, achieving the perfect balance between pink and white esthetics—the harmony between the gingival tissues and dental restorations—is a critical challenge. This balance is essential for creating a natural and visually appealing smile, particularly in the highly visible anterior region [1]. The success of restorative procedures hinges not only on the accurate reconstruction of teeth (white esthetics) but also on the meticulous management of the surrounding soft tissues (pink esthetics) [1]. The cervical contour of a restoration must follow an anatomical curvature, as it influences both the cervical embrasures and periodontal health. Traditional methods, while effective, often involve time-consuming and imprecise processes that rely heavily on the clinician's manual skills.

The advent of CAD/CAM (Computer-Aided Design and Computer-Aided Manufacturing) technologies, within the broader scope of digital workflow, has revolutionized this aspect of dentistry [2, 3]. These digital tools provide unparalleled precision and predictability in both planning and executing restorative procedures, significantly enhancing the ability to achieve optimal pink and white esthetics. By leveraging CAD/CAM technologies, dental professionals can design restorations that perfectly mimic the natural curvature and contours of teeth while ensuring the surrounding gingiva integrates seamlessly [2].

An essential component of this digital approach is the use of advanced ceramic systems. Stratified zirconia have become a popular choice for anterior restorations due to their exceptional strength and ability to closely mimic the optical properties of enamel [4, 5].

These materials play an important role in achieving seamless integration between restorations and natural dentition, helping to maintain a harmonious balance between the appearance of the teeth and the surrounding gingival tissues. The combination of CAD/CAM technology and high-quality ceramics allows dental professionals to overcome the challenges of pink and white esthetics with greater consistency and success than ever before.

This case study will explore how the integration of digital workflow, particularly through the use of CAD/CAM technology, played a crucial role in restoring two central incisors lost due to trauma. Thanks to these advanced tools, the dental team was able to achieve a result that was both functionally and esthetically satisfying.

CASE PRESENTATION

A 29-year-old male patient had presented to the department of fixed prosthodontics with a chief complaint of post traumatic upper central incisors loss. On clinical examination, the patient showed good oral hygiene and an insufficient mesio-distal space for the two central incisors replacement. An open bite was noticed while examining the occlusion. The patient had been oriented to an orthodontist to manage the space for two implant-supported fixed dental prosthesis and to correct the openbite. Unfortunately, the patient abandoned the orthodontic treatment before the bite had completely been corrected.

Figure 1: Pre-operative clinical view during the orthodontic treatment

On radiographic examination, the closure of the inter-maxillary suture was incomplete, the edentulous area presented a reduced space in mesio-distal direction for two implant supported crowns therefore this option was discarded.

Figure 2: Pre-operative clinical view with braces off

Figure 3: Panoramic radiograph

Initial Assessment and Challenges

The patient presented with a history of trauma that resulted in the loss of both central incisors. The primary challenges included a compromised gingival contour, and the absence of the interdental papilla. These factors were critical in planning the restoration, as achieving a natural and esthetically pleasing outcome depended heavily on the accurate recreation of the gingival architecture.

Step 1: Digital Impression and Planning

The first step in the digital workflow was acquiring a digital impression of the patient's oral cavity. This was done using an intraoral scanner, which captured highly accurate 3D images of the existing dentition, edentulous ridge, and surrounding soft tissues.

The digital impression was then imported into specialized software for planning. Using the digital impression, the ideal gingival contours and interdental papillae were virtually designed. The desired outcomes were visualized in the software, allowing for precise planning. The virtual model served as the basis for the final decision. A porcelain bridge from canine to canine with a modified ovate pontic was then decided instead.

Teeth #12, #13, #22, #23 were prepared and a new digital impression was taken.

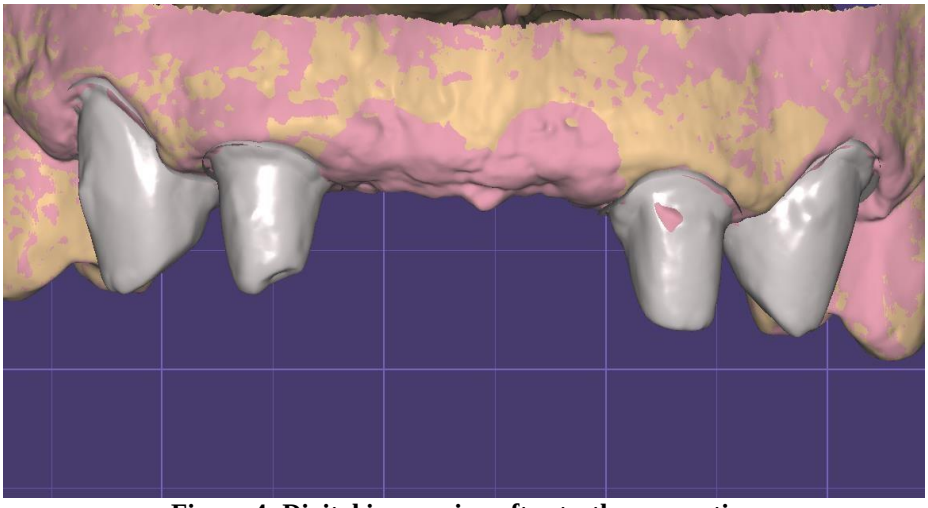

Figure 4: Digital impression after teeth preparation

Step 2: Design and Fabrication of the 3D-Printed Guide

The virtual design of the gingival contours was used to create a 3D model of the surgical guide. This guide was designed to fit perfectly over the patient's existing teeth and ridge, with precise cutouts that indicated the areas where gingival tissue needed to be removed or contoured.

The guide was then fabricated using a 3D printer, typically utilizing biocompatible resin materials. The 3D printing process allowed for high precision, ensuring that the guide would fit accurately in the patient's mouth and direct the gingivoplasty with exactness [6]. The guide was sterilized and prepared for use during the surgical procedure.

Gingivoplasty Procedure

With the 3D-printed guide in place, gingivoplasty was performed using rotary diamond instruments.

The guide ensured that the gingival tissue was contoured precisely according to the pre-planned design, minimizing the risk of error and enhancing the predictability of the outcome. This step was critical in establishing the foundation for the final esthetic restoration.

Figure 5: 3D printed guide for gingivoplasty showing the desired gingival margin

Fabrication of the CAD/CAM Interim Bridge

Step 1: Designing the Interim Bridge

Following the gingivoplasty, the next phase involved the fabrication of a CAD/CAM interim bridge. The digital impression taken earlier was also used to design the interim bridge, which extended from canine to canine and included the missing central incisors.

The design of the interim bridge incorporated an ovate pontic for the central incisors. The ovate pontic design is characterized by its convex shape, which extends into the soft tissue, mimicking the emergence profile of a natural tooth [7, 8]. This design was chosen for its ability to support and maintain the gingival tissue contour established during gingivoplasty. The pontic's shape also helps to create a more natural appearance and facilitates the preservation of the interdental papillae during the healing process [9].

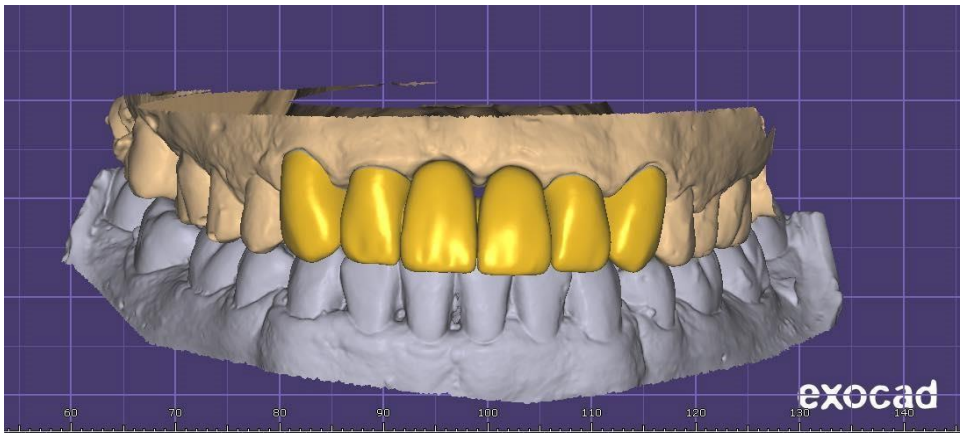

Figure 6: Interim bridge designed

Step 2: Fabrication and Placement

The interim bridge was fabricated using CAD/CAM technology. High-quality materials, such as PMMA (polymethyl methacrylate), were used for the interim bridge due to their durability and esthetic properties [6]. The digital design was processed by the milling machine, which precisely carved the bridge out of the selected material. Once fabricated, the interim bridge was polished and fitted in the patient's mouth. The ovate pontic design ensured that the soft tissues were adequately supported, which is crucial during the healing phase. The interim bridge provided both functional and esthetic benefits while the tissues stabilized and matured, preparing for the final restoration.

Figure 7: CAD/CAM interim bridge placed to induce the shape of the gingiva margin and the interdental papilla

Definitive Ceramic Restoration

After the soft tissues had healed and the gingival contours were stable, the final restoration was planned. The definitive restoration involved using stratified zirconia, known for its excellent strength and esthetic qualities. This material was selected to match the natural appearance of the patient's dentition, particularly for the central incisors, which play a significant role in the overall smile esthetics.

The final restorations were designed using the same digital workflow, ensuring continuity from the interim phase to the final result. The restorations were milled using high-precision CAD/CAM technology, followed by a layering process to add translucency and color, matching the adjacent natural teeth. The restorations were then bonded into place, completing the treatment [9].

Figure 8: 1 month after the gingival induction by the CAD/CAM interim bridge

Figure 9: Scalloped gingival contour

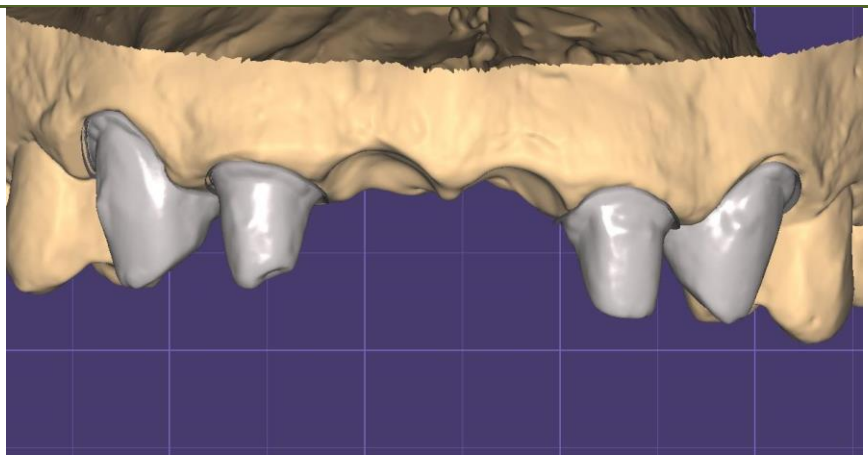

Figure 10: Digital impression after the gingival contouring to prepare the definitive restoration

Figure 11: Fabrication of the final ceramic bridge

Figure 12: Cementation of the definitive restoration

DISCUSSION

Anterior teeth loss can be esthetically and psychologically disturbing for the patient. Adjacent anterior teeth loss can be even more challenging to the prosthodontist. The key to an esthetically pleasant smile is proper management of the soft tissues around natural teeth and prosthesis.

Esthetic soft-tissue contours are described by a harmoniously scalloped gingival contour, the avoidance of an abrupt change in clinical crown length between adjacent teeth, a sufficient thickness of the buccal mucosa and distinct papilla [10].

Immediate teeth replacement results in a much more esthetically pleasant result combining a natural in appearance gingival contour and prosthesis.

However, in some cases, patients only seek replacement when the edentulous ridge has lost its original contour. Here, a new challenge of regenerating a lost interdental papillae rises.

In fact, inter-dental papilla is the gingival portion that occupies the space between two adjacent teeth. It provides a seal to withstand the microbial invasion of the periodontal structures and plays a critical role in the esthetics. Hence, it is very important to respect its integrity during all dental procedures and to minimize as much as possible its disappearance [11]. Teeth loss causes bone resorption and therefore papilla disappearance. Many approaches exist to manage the absence of the interdental papillae according to the etiology of its disappearance. Bone support augmentation and surgical papillary reconstruction with its different techniques were both described in the literature as viable alternatives to help reconstruct the interdental papillae [11].

Combining fixed prosthesis and periodontal plastic surgeries to correct the esthetic challenge were also proposed to guide the soft tissue into the interdental space [11].

Previously, prosthodontists used handmade interim crowns with a rough surface that may not only harm the soft tissue health but also badly influence the marginal contour of the gingiva [6].

Periodontists, on the other hand, used to rely on handmade surgical templates to rebuild an ideal marginal gingiva contour. By means of using the naked eye, they cannot avoid making deviations in their templates [6].

After the breakthrough of new digital tools and the advent of CAD/CAM technology, patient digitalization became possible, and allowed clinicians to translate all treatment options into 3D simulations [12].

Digital dentistry is highly effective in overcoming one of the greatest challenges in restorative dentistry: the discrepancies between initial plans and final outcomes. In the past, the differences between an initial diagnostic wax-up and the final treatment result were often significant, and unfortunately, this was the norm rather than the exception. Analog protocols have been unable to address these limitations. It is anticipated that, in the future, freehand intraoral procedures will be phased out, with all procedures utilizing some form of digitally designed guide or device. This is the concept of Guided Dentistry [12].

The 3-dimensional (3D)–printing technique is based on computer-aided design (CAD) and rapid prototyping (RP) technologies. Using a gingivoplasty 3 D printed guide helps the clinician customize the marginal gingiva contour [6]. It not only enhances the accuracy of this procedure but also minimizes trauma to the gingival tissue, promoting better healing and tissue stability. This precision is particularly important in the anterior region, where even slight discrepancies in gingival contour can be highly noticeable and detract from the overall appearance of the restoration.

Following the gingivoplasty, the next phase involved the fabrication of a CAD/CAM interim bridge to rebuild the interdental papilla. The distances from the contact point to the underlying alveolar bone crest should be less than 5 mm on the basis of the results of the study by Tarnow and colleagues in 1992 [13].

Using CAD/CAM interim crowns offers two key advantages. First, since they are designed and manufactured using computer software, the edges of CAD/CAM crowns can be made thinner and smoother compared to manually crafted crowns. This reduces the likelihood of bacterial plaque accumulation. Second, the computer-designed cervical line contour can be more precise, which better guides the growth of the interdental papilla. In this case, we utilized interim CAD/CAM crowns to help induce and shape the contour of the marginal gingiva [6].

Another crucial factor to consider is the pontic shape. In fact, the ovate pontic is ideal for achieving high esthetic standards in anterior bridgework. For successful implementation, there must be adequate height and width of the alveolar ridge [10]. The design involves increased mucosal contact, applying gentle pressure to the underlying tissue to enhance esthetics. The pontic should be shaped so that its convex surface extends 1–2 mm into the mucosa, depending on the mucosa's thickness and viscoelastic properties. This depth creates the appearance of the pontic emerging naturally from the gingival tissue, resulting in a more realistic tooth replacement [10].

CONCLUSION

The integration of digital workflows in dentistry, particularly through the use of CAD/CAM technology, has fundamentally transformed the approach to restorative procedures. These advancements have bridged the gap between the initial planning and the final outcome, providing unparalleled precision, efficiency, and predictability. By utilizing digital impressions, 3D modeling, and computer-aided design, dental professionals can meticulously plan each step of the restoration process, ensuring that both the functional and esthetic aspects of the treatment are optimally addressed.

Moreover, digital workflows streamline the entire restorative process, reducing the time and labor involved while minimizing the potential for human error. This leads to higher consistency in outcomes, greater patient satisfaction, and a more efficient use of clinical resources. As digital technologies continue to evolve, their role in dentistry will only expand, further enhancing the ability to deliver high-quality, aesthetically pleasing, and functionally effective restorations. The adoption of these technologies represents a significant step forward in the pursuit of excellence in restorative dentistry, offering a powerful combination of precision, artistry, and patient-centered care.

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CONFLICT OF INTEREST

The authors of this article certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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