Interdisciplinary Treatment Planning for Single-Tooth Restorations in the Esthetic Zone

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ABSTRACT
This article presents a conservative approach for restoring single anterior teeth in patients with congenitally missing maxillary lateral incisors, emphasizing the importance of interdisciplinary treatment planning.

Minor orthodontic treatment was necessary to create the space for implant placement. Once the fixtures were inserted and the temporary abutments connected to the implants, the provisionals were relined with the use of a repositioning stone key. From the diagnostic wax-up, it was decided that in order to attain a satisfying final esthetic outcome, it was necessary to also restore the distal aspect of the central incisors and the right first premolar for anatomical and functional reasons. Finally, after having screwed the abutments on the implants, inducing a torque of 20 Ncm, the metal-ceramic restorations were cemented with temporary cement.

CLINICAL SIGNIFICANCE
This article presents a systematic approach for restoring anterior teeth in the esthetic zone using a diagnostic additive wax-up and an interdisciplinary approach to optimize the final esthetic outcome.

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INTRODUCTION

The primary consideration in all treatment plans should be the conservation of tooth structure. Generally, the treatment of choice should be the least invasive possible that still satisfies the expected esthetic and functional objectives.

Esthetics and function are of equal concern when restoring the anterior dentition. Modern concepts in restorative dentistry have brought new solutions through bonded porcelain veneers. They work as stress distributors and involve the crown of the tooth as a whole in supporting occlusal force and masticatory function. The recovery of the original biomechanics of the intact tooth and utilization of biomimetic principles are particularly important. Patients with congenitally missing maxillary lateral incisors also present challenging problems that often require veneers and orthodontics to achieve an acceptable esthetic outcome. In an interdisciplinary approach, the orthodontist plays a key role allowing the surgeon and the prosthodontist to have implants and teeth in the ideal restorative positions.

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CASE PRESENTATION

A 24-year-old female presented with congenitally missing lateral incisors that had previously been orthodontically treated for a Class II malocclusion.

The first examination revealed an inverse position between the upper right canine and first premolar. Additionally, root convergence existed, which prevented the implant placement in the lateral incisor sites.

Presurgery Orthodontic Treatment

Evaluation of the anterior tooth size relationship is important when substituting lateral incisors. There are three ways to determine the appropriate space for missing teeth.

The first is to utilize the "golden proportion"[1,2]; the second is the dimension of the contralateral lateral incisor[3]; and the third method of space appropriation is to conduct a Bolton analysis.[4] However, the quickest and most predictable guide for determining the ideal space is to construct a diagnostic wax-up, which will allow the dental team to evaluate the space necessary for optimal treatment, and therefore, to determine whether an esthetic functional result will be achievable.[5] In the present case, additive veneers were planned in order to manage the anterior proportions and the inverse canine and premolar positions instead of orthodontic therapy. Nevertheless, a minor orthodontic treatment was necessary to create the space for the implant placement (Figures 1 and 2).

Placement of Implants and Immediate Loading

Based on the current concepts of implant prosthodontics, it is no longer sufficient to merely attach a prosthetic device to an underlying fixture. In fact, it has become essential to reconstruct the site with a three-dimensional approach, where the soft tissue profile plays a crucial esthetic role. This approach invariably involves hard tissue regeneration, which allows implant placement in the desired position, as determined by the restoration. The soft tissue profiles are in turn generated by the actual form and contours of the prosthesis.

As with early loading procedures, the concept of immediate loading is grounded in the desire to reduce the length of implant treatment, improve its acceptance by patients, and most of all establish the correct transmucosal profile of the healing gingiva. The provisional is to be considered the key to managing the soft tissue geometry around implants.

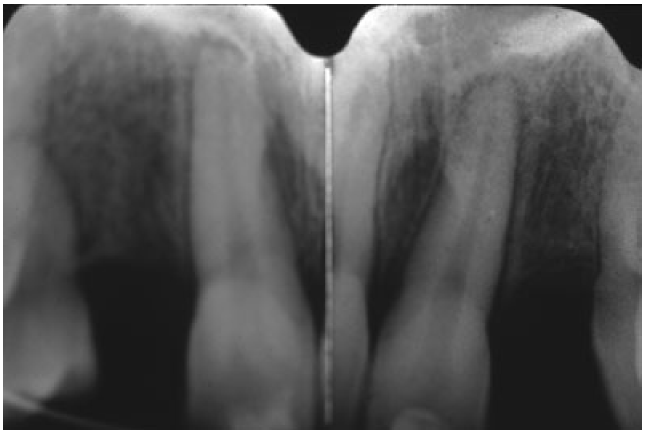

Figure 1. Initial phase of the orthodontic treatment. Note the shifting of the incisor roots and the remodeling of the periodontal support.

Figure 2. Clinical evaluation of the mesiodistal space.

Once the fixtures were inserted and the temporary abutments connected to the implants, the provisionals were relined with the use of a repositioning stone key in the position predetermined using the diagnostic wax-up[6] (Figures 3 and 4).

Generating Optimal Soft Tissue Contours

After the osseointegration of the implants and the healing of the soft tissue, the temporary crowns were modified to improve the anatomy of the clinical crowns and to generate the appropriate transmucosal contours, including gingival scalloping (Figures 5–7).

To optimally transfer the obtained soft tissue architecture, a preliminary direct impression of the provisionals was made.

Once the implant analogs were screwed into the provisionals and then repositioned into the impression material, the impression was poured, and the preliminary cast was obtained (Figure 8).

Individual transfer copings with acrylic resin (Pattern Resin LS, G.C., Tokyo, Japan), which were fabricated on the model, facilitate the replication of the soft tissue contours on this model (Figure 9).

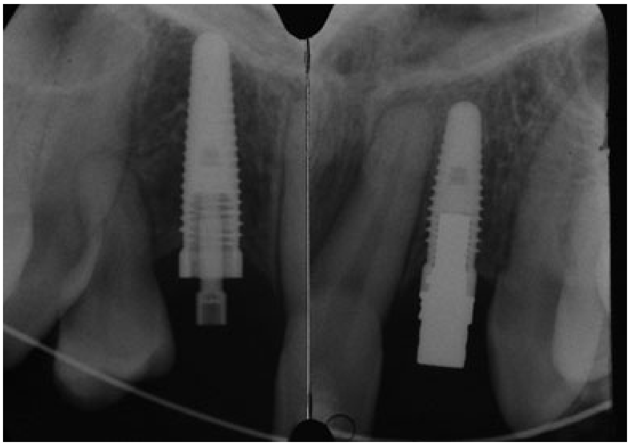

Figure 3. Implants in place and provisional restorations repositioned with no functional loading.

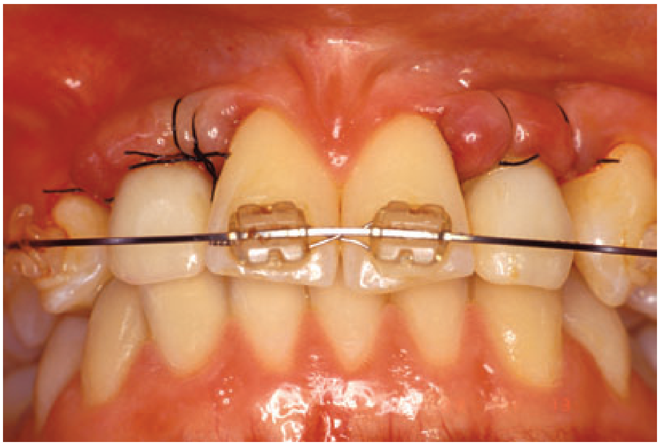

Figure 4. Implants in place and provisional restorations repositioned with no functional loading.

Figure 5. Ten weeks postoperative. The soft tissues were conditioned by the provisional restorations to generate scalloped contours.

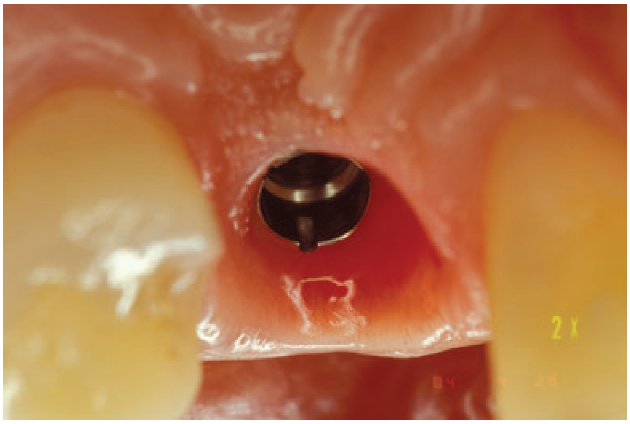

Figure 6. Note the healthy soft tissues.

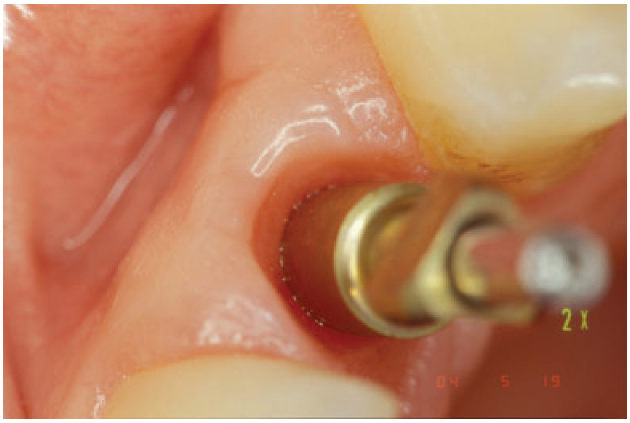

Figure 7. Note the different geometry between the gingiva and the transfer coping.

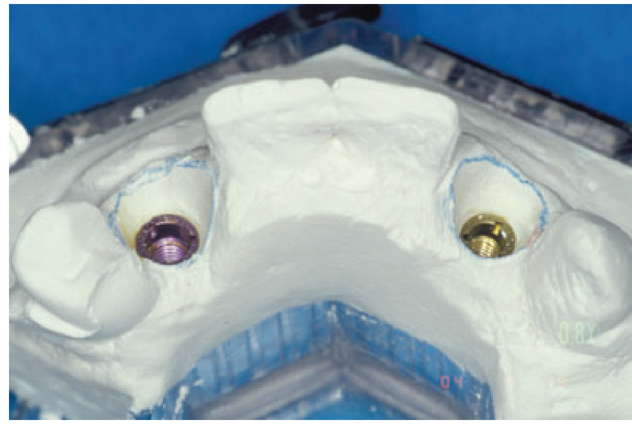

Figure 8. The preliminary cast obtained mimics the architecture of the soft tissues around the implants.

Figure 9. The application of acrylic resin to the transfer coping will assure the conservation of the soft tissue profile (starting from a correct preliminary cast, see Figure 8).

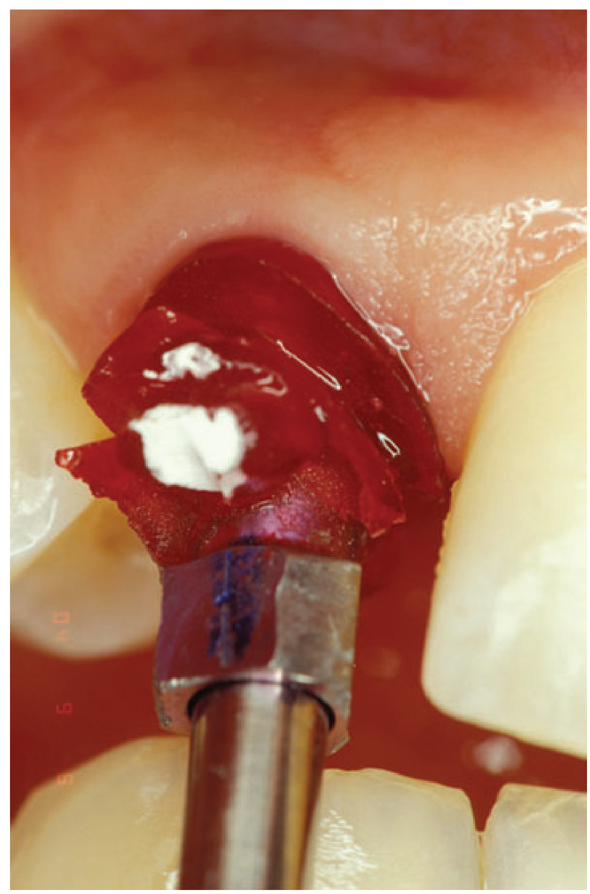

Figure 10. The use of the customized coping maintains the previously obtained soft tissue profile.

Figure 11. Impression made. Note that the new generation of the copings (pickup) for the internal connections are very short.

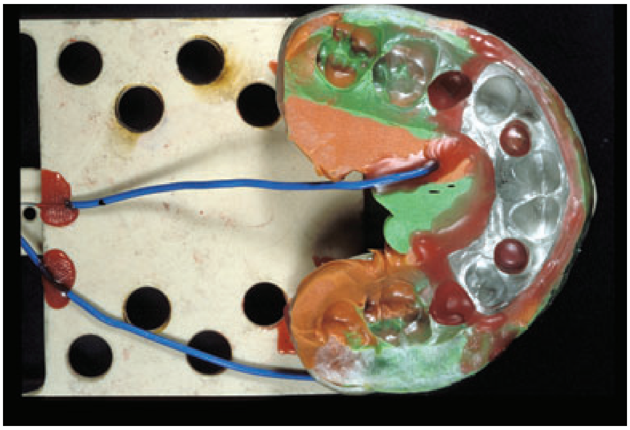

Figure 12. Electroplated impression phase.

In addition, the individual tray for the pick-up impression was fabricated.

With this technique, during the impression phase, one is able to preserve the transmucosal profile previously obtained and increase the stability of the transfer copings during the removal of the impression from the mouth. Moreover, the microhorizontal rotation of the transfer copings when the laboratory implant analogs are screwed into the transfer copings is bypassed, and the implant master cast is more accurate (Figures 10 and 11).

Laboratory Phases

When constructing an implant-supported prosthesis, the position of the implants must be transferred from the patient's mouth to the workbench of the dental laboratory through the impression. In the author's experience, it is very helpful to connect the transfer copings directly to the individual tray with the acrylic resin in order to increase their stability and therefore consolidate the whole system.[7–10]

It is necessary that the transfer copings are longer than the individual impression tray in order to allow the appropriate space for the acrylic resin.

This seemingly insignificant step will prove to be very important when the laboratory implant analogs are screwed into the transfer copings to develop the implant cast.

The quality of materials used in the laboratory is essential for the dimensional stability of the cast. The cast used for the present case was constructed using an electrodeposed metal and a highly stable epoxy resin that has the ability to reproduce details to an accuracy of 0.2 µm[11,12] (Figures 12 and 13).

For the production of the telescopic abutments (under guidance of the wax-up), an overcastable gold abutment was employed. This also allowed the technician to create the correct geometry with the correct axis, and the parallel walls needed ultimately for the cemented restorations, which is a fundamental requirement to achieve accuracy in the following working phases[11] (Figure 14).

The accuracy of the marginal surface and implant–abutment–crown interface significantly reduces the probability that the transmucosal portion of this system will become a receptacle for bacterial plaque, with a subsequent inflammatory response.[13,14]

Abutment Positioning Key

One of the biggest problems in implantology is represented by the rotational inconsistency that occurs

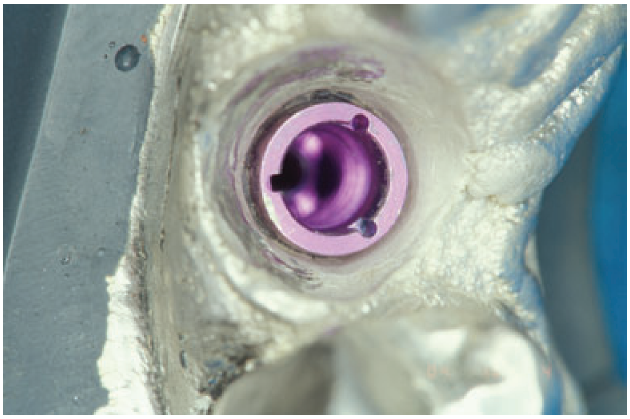

Figure 13. The geometry of the soft tissues around the implants is the same as that of the preliminary cast (see Figure 8).

Figure 14. Final abutment, with a layer of gold applied.

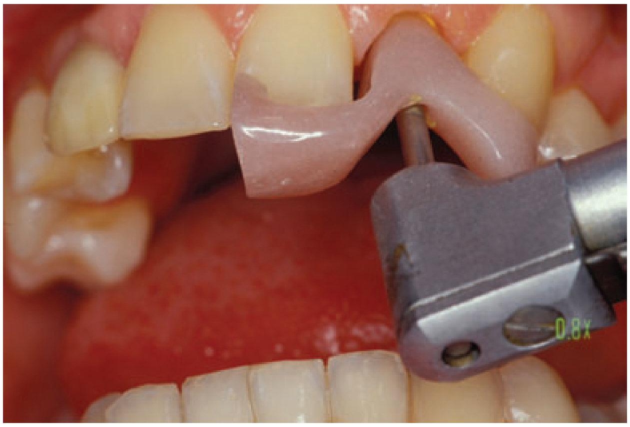

Figure 15. An antirotational abutment positioning key is fabricated in acrylic resin, and a 20-Ncm torque is applied.

when an abutment is fabricated on the implant analog of the working cast and transferred into the patient's mouth and screwed to the implant.

The torque induced by this operation causes inaccuracies in abutment position, implant–abutment interfaces, marginal closure, as well as misfit of superstructure and inappropriate interproximal and occlusal contact.[15]

Although some companies have tried to reduce this spatial inconsistency, nevertheless, the literature still reports the problem about an antirotational misfit ranging between 1.9 and 14.8 degrees and a vertical misfit that ranges between 6 and 51 µm.[16–18]

In order to eliminate this inaccuracy, the author used an antirotational abutment positioning key to transfer the telescopic's position from the cast to the mouth and vice versa. The same technique was used during each laboratory phase[11] (Figure 15).

Restorative Considerations

From the wax-up information, it was decided that in order to have a satisfying final esthetic outcome, it was necessary to also restore the distal aspect of the central incisors and the right first premolar for anatomical and functional reasons.

Metal-ceramic restorations were deemed optimal for the implant restorations because of mechanical reasons, and porcelain laminate veneers for the other teeth for a conservative approach.

With bonded porcelain veneers, a minimum amount of preparation is required to facilitate the insertion and positioning of the ceramic restoration during the final bonding procedure. The geometric and mechanical parameters of the tooth preparation are of secondary importance. This approach allows for maximal preservation of remaining sound enamel during the tooth preparation procedure.[19]

Many different tooth preparation techniques for porcelain veneers, called "subtractive," have been described in the literature. Nevertheless, as shown in the present case, it is possible to create the additive porcelain laminate veneers with a more conservative approach[20–31]; specifically the teeth receiving the veneers were not prepared at all because it was not necessary to restore them but only to improve their anatomical appearance and function.

Feldspathic porcelain was used for the veneers, because it is still considered more biomimetic than composite. In fact, it has been shown that because of color variation, plaque accumulation, and inadequate marginal precision, composite veneers may present poorer long-term results.[32–37] Also, the feldspathic ceramic technique was chosen for this case because the spaces were very narrow, and because of its long-term reliability.[28]

In metal-ceramic restorations there are two important requirements: rigidity and ability to control tensile stresses at the metal-ceramic interface and to transform them into compressive stresses.

Units used in the anterior region encounter forces that are oblique resulting in high-tensile forces in the incisal, incisal–labial, palatal–cervical, and labial–cervical areas. Therefore, it is important to strengthen the metal and support the ceramic in these areas.

According to these principles, the authors have used the framework design described by Sgrò in 2002,[38] which increases the resistance and the bond strength between ceramic and metal. This design offers an adequate support to the ceramic and allows light transmission for optimal esthetics as well.

Cementing Phase

Cementation is the last step, but it represents the culmination of the planned treatment and emphasizes the importance of interdisciplinary treatment planning (Figure 16).

First, retraction cords and a rubber dam were used in the teeth receiving laminate veneers to ensure a clean field for cementation. Adhesive bonding procedures were performed for the veneer restorations.

The inner surfaces of the restorations were etched for 100 seconds using 10% hydrofluoric acid. After immersion in the basic solution and abundant rinsing and drying, the same surface was coated with silane (Ultradent Products, Inc., South Jordan, UT, USA). Following etching of enamel (Ultra-etch 35%, Ultradent Products) for 30 seconds, the tooth surface and inner surface of the restorations were coated with adhesive resin. Once the restorations were loaded with the photopolymerizing composite (Variolink II, Ivoclar Vivadent Schaan, Liechtenstein), they were seated on the teeth. After the removal of the excess bonding composite, the margins were covered with a glycerin jelly and the curing light was applied intermittently for 120 seconds on each site of the restoration. The margins were then finished with a scalpel and a scaler for the removal of the excess composite resin.

Figure 16. The veneers are tried in.

Figure 17. The mandibular excursions were checked. The right canine functions as a protection guide for the premolar veneer.

Figure 18. The left side mandibular excursion was checked.

Figure 19. Final radiograph.

Figure 20. Final case: 2 weeks post-op. Note the proportions of the teeth and the dentogingival complex.

Finally, after having screwed the abutment on implants inducing a torque of 20 Ncm, the metal-ceramic restorations were cemented with temporary cement.

Care was also given to the occlusion in order to preserve an adequate and functional guidance during the mandibular excursions (Figures 17 and 18).

The palatal splint between the two central incisors was eliminated and no protection devices were provide to the patients (Figures 19–22).

The patient was recalled at 2, 4, and 12 weeks for checkups, and every 4 months for professional hygiene.

The follow-up showed the stability of the tissues and the preservation of the dentogingival relation (Figure 23).

CONCLUSION

This clinical report is a typical example of a previous orthodontic treatment that did not address all the problems with an interdisciplinary approach. The patient needed to be retreated, and communication

Figure 21. Final case: 2 weeks post-op. Note the proportions of the teeth and the dentogingival complex.

Figure 22. Final case: 2 weeks post-op. Note the proportions of the teeth and the dentogingival complex.

Figure. 23. Appearance of restorations upon 6 months recall.

Figure 24. The final result and the smile line relation are seen.

and coordination among the operators were the keys for a satisfying esthetic result. Coordinated treatment by the orthodontist, periodontist, prosthodontist, and dental technician, with careful consideration of patient expectations and requests, were critical for the successful outcome and patient satisfaction.

The comfort and the esthetic outcome were ensured by a specially developed strategy to redefine an adequate smile line that would match the unique and individual character and personality of the patient (Figure 24).

DISCLOSURE

The authors have no financial interest in the companies whose materials are included in this article.

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