



Anterior rehabilitation using 3D-printed dental implants and custom-made immediate restorations through additive manufacturing.

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Short Communication

ABSTRACT

Dental implants have evolved significantly, but various failures continue to arise, initially focused on osseointegration and, more recently, involving aesthetic concerns. However, the criteria for evaluating aesthetic failures are still not well defined. These failures can be classified into issues related to the white tissue (crowns) and pink tissue (gingiva). This study presents a rehabilitation protocol that uses 3D-printed surgical guides and adaptations for bone and tissue grafts, with a focus on aesthetic restoration. The case of a fractured upper left central incisor illustrates the application of an implant system for immediate rehabilitation, highlighting the effectiveness of immediate implant and restoration techniques in achieving ideal aesthetic and functional outcomes.

Keywords: Dental Implants, Aesthetic Zone, Dental Ceramics.

Reabilitação anterior usando implantes dentários impressos e restaurações imediatas personalizadas por meio de manufatura aditiva.

RESUMO

Os implantes dentários evoluíram exponencialmente, entretanto inúmeras falhas se manifestaram, sendo essa uma preocupação exclusiva com a osseointegração para incluir aspectos estéticos, mas os critérios para avaliar falhas estéticas ainda são pouco definidos. Estas falhas podem ser divididas em problemas com o tecido branco (coroas) e o tecido rosa (gingiva). Este estudo descreve um protocolo de reabilitação utilizando guias cirúrgicas impressas e adaptações para enxertos ósseos e teciduais, visando a restauração estética. O caso de um incisivo central superior esquerdo fraturado ilustra a aplicação de um sistema de implantes para reabilitação imediata, destacando a eficácia das técnicas de implantação e restauração imediata para alcançar resultados estéticos e funcionais ideais.

Palavras-chave: Implantes Dentários, Zona Estética, Cerâmicas Odontológicas.

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INTRODUCTION

Dental extractions followed by the immediate placement of implants have become a widely accepted practice in modern dentistry, offering significant benefits in reducing treatment time and preserving alveolar bone.¹ This approach leverages advancements in implantology to maintain the natural contours of soft and hard tissues while ensuring functional and aesthetic restoration.^{2,3} When combined with immediate prosthetic rehabilitation using zirconia crowns, this technique enhances patient satisfaction by providing a highly durable, biocompatible, and aesthetically pleasing solution.⁴

Zirconia crowns, known for their superior mechanical properties and natural appearance, are particularly advantageous in immediate restorations due to their high fracture resistance and excellent biocompatibility with soft tissues.⁴ These qualities make them an ideal choice for restoring anterior and posterior regions where both strength and aesthetics are paramount.⁵ However, the success of such procedures depends on precise clinical protocols, adequate primary stability of the implant, and careful management of the surrounding soft and hard tissues.⁶

Despite its benefits, the immediate placement of implants and restorations poses challenges, including the risk of implant failure due to insufficient osseointegration and potential complications with soft tissue healing.⁸ Ongoing research and clinical studies aim to refine techniques and materials to improve long-term outcomes, emphasizing the importance of multidisciplinary planning in achieving optimal results.^{9,10}

CASE REPORT

A 28-year-old male patient presented seeking dental rehabilitation for his central incisor. A computed tomography (CT) scan revealed severe atrophy in the anterior maxillary region, classified as Cawood & Howell Class VI. The patient had a history of dental trauma sustained during a motorcycle accident, which resulted in several complications and necessitated multiple interventions over the years due to recurrent

infections and aesthetic dissatisfaction.

The patient's dental history indicated extensive prior treatments related to the trauma. These included an initially unsatisfactory endodontic procedure, which led to recurrent periapical infections, failed attempts at reprofiling and endodontic surgery, and three crown replacements due to persistent aesthetic and functional challenges. Furthermore, the patient expressed a primary concern regarding aesthetic discomfort caused by an uneven gingival margin and significant gingival recession affecting the central incisor (Figure 1). This issue was exacerbated by the patient's high smile line, which prominently exposed the affected gingival margin when smiling.



Figure. 1 - Aesthetic discomfort caused by an uneven gingival margin and significant gingival recession affecting the central incisor.

Clinical and tomographic examinations revealed an extensive bone defect in the anterior maxillary region, necessitating a more aggressive and carefully planned approach to achieve satisfactory aesthetic and functional outcomes. Consequently, rehabilitation using the immediate implant technique was proposed, aiming to restore both white and red aesthetics.

The procedure began with intraoral and extraoral asepsis, followed by the



administration of infiltration anesthesia in the vestibular and palatal regions of the affected area. Atraumatic extraction of the compromised tooth was performed without creating a flap, utilizing syndesmotomy and excision with a straight extractor. This approach aimed to preserve the gingival contour, maintain the papilla in position, and minimize bone loss (Figure 2).

After extraction, a pre-planned surgical guide (3D STUDIO – Plano Virtual da Face[®], Natal-RN, Brazil) was employed to assist in the alveolar bone osteotomy. This ensured the ideal implant positioning for future prosthetic rehabilitation. The guide utilized Cone Morse Guided Surgery sleeves (Plenum[®], Jundiaí-SP, Brazil). Subsequently, a 4.0 x 11.5 mm 3D-printed implant (Plenum[®], Jundiaí-SP, Brazil) was inserted into the central incisor site with a torque of 45 N (Figure 2).

Next, the left greater palatine nerve was anesthetized to facilitate the harvest of subepithelial connective tissue. The graft site was carefully delineated, and epithelial tissue was removed via dermabrasion using a #8 round diamond bur, leaving behind the connective tissue graft (Figure 2). The removal was performed without full-thickness excision to preserve a residual tissue layer over the bone, minimizing bleeding risk and enhancing patient comfort during healing.



Figure. 2 – The extraction of the dental element was accompanied by procedures to restore and optimize the bone and soft tissue architecture in the region designated for implant placement.

The anterior maxillary defect was then grafted with a biphasic bioceramic (HA/ β -TCP, 70:30) with a particle size of 500–1000 μ m (Plenum[®], Jundiaí-SP, Brazil). A resorbable poly(dioxanone)-based membrane (Plenum[®], Jundiaí-SP, Brazil) was adapted and positioned over the vestibular access (Figure 3). The connective tissue graft was placed internally to the flap and secured using 6.0 monofilament polypropylene sutures (Techsuture[®], Bauru-SP, Brazil). Finally, the soft tissues were sutured and stabilized

using the same suture material.



Figure. 3 - The connective tissue graft was placed internally to the flap and secured using 6.0 monofilament polypropylene sutures.

Following implant placement with a torque of 45 N, an immediate provisional crown was fabricated to ensure proper three-dimensional positioning and structural contouring of the dental element. The procedure involved initial impressions taken with heavy condensation silicone and the creation of a stone model in type IV plaster, used for designing the surgical guide and future prosthesis through additive manufacturing. The provisional crown was polished, glazed, and installed after selective adjustments, aligning with the incisal leveling pattern. Postoperative follow-ups at 7 days, 4 weeks, 8 weeks, and 12 weeks confirmed successful healing without signs of inflammation or

infection. The emergence profile of the soft tissue was monitored and transferred via the provisional crown.

A temporary zirconia prosthesis was milled and sintered following precise manufacturing guidelines, with surface preparation involving ceramic primers and air abrasion. The prosthesis was cemented with dual-cure resin cement after proper light-curing. Veneer preparation included sulcular retraction, feather-edge design, and open-tray impressions. Both the crown and veneer were fabricated from high-translucency zirconia polycrystalline ceramic and underwent detailed color characterization. Adhesive cementation was performed under relative isolation, using etching and bonding techniques for both the tooth and ceramic surfaces. The restoration achieved excellent functional and aesthetic outcomes, with the patient reporting full satisfaction.



Figure. 4 – The final appearance of the fixed restoration on implant after the surgical procedure.



DISCUSSION

Dental implant rehabilitation is considered successful when the natural contours of the missing tooth are accurately restored in the prosthesis, achieving harmony with the adjacent teeth.¹⁻³ The clinical case presented highlights the critical role of atraumatic extraction in preserving supporting bone tissue and ensuring a natural appearance of the peri-implant soft tissue.^{5,6} Immediate loading with a well-designed temporary crown featuring a concave, polished emergence profile promotes optimal tissue adaptation after surgery, minimizing undesirable remodeling and improving the prognosis. Crucially, the emergence profile established during healing must be precisely transferred to the working model to ensure anatomical consistency between the provisional and final crowns.^{7,8}

In this case, fabricating veneers for the adjacent tooth using the same material as the implant-supported crown contributed to achieving a harmonious final smile.⁶⁻⁹ However, such an approach should only be pursued when the adjacent healthy tooth is a suitable candidate, as demonstrated in this case. The favorable prognosis for anterior region treatment was enhanced by the presence of higher bone levels, attributed to altered passive eruption. A limitation of this study was the unavailability of radiographic documentation.^{7,9,10}

Zirconia ceramic was selected for its reliability, characterized by high fracture resistance and minimal risk of crack propagation. Additionally, its high translucency makes it particularly advantageous in anterior restorations, where aesthetic demands are elevated.⁴ In such cases, high-translucency zirconia allows the restoration to mimic the natural optical properties of enamel, providing lifelike aesthetics with improved light transmission and shade matching.⁴ These qualities are essential for achieving seamless integration with the surrounding dentition, making zirconia an ideal material for anterior region prostheses.^{9,10} This case underscores the importance of material selection in meeting both functional and aesthetic goals in implant rehabilitation.

FINAL CONSIDERATIONS



It is concluded that oral rehabilitation through the installation of implants using guided surgery and immediate loading techniques is a procedure that offers comfort and predictability in the rehabilitation of single tooth loss. The use of a fixed zirconia prosthesis resulted in significant aesthetic enhancement in the anterior dental region. This report highlights a single clinical case; therefore, additional studies with extended follow-up periods are required to validate the effectiveness and long-term outcomes of the proposed treatment approach.

DATA AVAILABILITY

All data analyzed during this study are available from the corresponding author upon reasonable request.

DISCLAIMER OF LIABILITY AND DISCLOSURE

All data analyzed during this study are available from the corresponding author upon reasonable request. The authors report no conflicts of interest regarding any of the products or companies discussed in this article.

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