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3D PRINTING IN DENTISTRY: ORAL REHABILITATION THROUGH DIGITAL WORKFLOW.

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Short Communication

ABSTRACT

The rapid evolution of technology in the field of dentistry has led to significant advancements in the treatment of complex dental conditions, enabling interventions that were previously highly challenging. In recent years, the use of 3D printing in dentistry has emerged as an innovative approach, enhancing treatment customization and surgical precision. This advancement is particularly notable in the rehabilitation of dental structures through customized implants. This article aims to present a detailed clinical case report illustrating the practical application of these technologies in the rehabilitation of a missing maxillary central incisor, analyzing the benefits and challenges encountered throughout the process.

Keywords: Dental Implants, Aesthetic Zone, Dental Ceramics.

IMPRESSÃO 3D NA ODONTOLOGIA: REABILITAÇÃO ORAL ATRÁVES DO FLUXO DIGITAL.

RESUMO

A rápida evolução da tecnologia na área da odontologia levou a avanços significativos no tratamento de condições dentárias complexas, permitindo intervenções que antes eram altamente desafiadoras. Nos últimos anos, o uso da impressão 3D na odontologia surgiu como uma abordagem inovadora, aprimorando a personalização do tratamento e a precisão cirúrgica. Esse avanço é particularmente notável na reabilitação de estruturas dentárias por meio de implantes personalizados. Este artigo tem como objetivo apresentar um relato de caso clínico detalhado ilustrando a aplicação prática dessas tecnologias na reabilitação de um incisivo central maxilar ausente, analisando os benefícios e os desafios encontrados ao longo do processo.

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

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INTRODUCTION

The rapid evolution of technology in the field of dentistry has led to significant advancements in the treatment of complex dental conditions, enabling interventions that were previously highly challenging. In recent years, the use of 3D printing in dentistry has emerged as an innovative approach, enhancing treatment customization and surgical precision. This advancement is particularly notable in the rehabilitation of dental structures through customized implants (ROCHA & PEREIRA, 2022).

Within the context of oral rehabilitation, 3D printing allows us to produce implants that are precisely tailored to the patient's anatomy, optimizing both aesthetic and functional outcomes (DE PONTES & PAVANE, 2024). Additionally, the use of bone grafts such as Bio-Oss and membranes like Bio-Guide are essential strategies for tissue regeneration, ensuring implant stability and integrity (SOLARES et al., 2023).

Combined with ceramic crowns, these techniques provide comprehensive rehabilitative solutions. The integration of different methods and materials, such as grafts and membranes, contributes to bone regeneration and enhances the stability of personalized implants. Exploring these techniques can significantly improve patients' quality of life (SARTORI et al., 2023).

This article aims to present a detailed clinical case report illustrating the practical application of these technologies in the rehabilitation of a missing maxillary central incisor, analyzing the benefits and challenges encountered throughout the process.

CASE REPORT

A 48-year-old patient, F.M., sought treatment at the Guilherme Scalzer Institute due to the absence of the upper right central incisor, commonly referred to as tooth 11. This condition presents a significant challenge, as it not only raises aesthetic concerns but also directly affects masticatory function and speech, leading to a substantial impact on the patient's quality of life. Despite having no relevant systemic conditions or health issues, the patient reported considerable aesthetic and functional discomfort, which negatively affected his confidence and daily social interactions.

During the initial evaluation, a comprehensive clinical and radiographic examination was performed, revealing bone resorption in the affected area. This finding is common in cases of tooth loss, as the absence of dental structures leads to a reduction in mechanical stimulation, ultimately resulting in progressive bone resorption over time.

To establish a precise diagnosis, the patient was advised to undergo complementary imaging exams, including a Cone Beam Computed Tomography (CBCT) scan and a periapical radiograph. These imaging techniques provided a detailed view of the patient's bone structure, enabling precise treatment planning. Based on the imaging findings, 3D-printed titanium implant (3.75 x 11.5mm) from Plenum Bioengineering (Plenum®, Jundiaí-SP, Brazil). This approach allowed for a customized implant design tailored to the patient's exact anatomical specifications, thereby increasing the likelihood of procedural success.

Given the presence of bone resorption, the treatment plan included the placement of the implant in combination with a Bio-Oss bone graft and a Bio-Guide membrane. The socket was filled with bovine mineral particulate bone graft (Bio-oss® 0.5g (500-1000 µm) (Geistlich Pharmaceutical, Wolhusen, Switzerland) and the entire area of the bone graft was covered with a resorbable membrane based on poly (dioxanone) (Bio-guide® Geistlich Pharmaceutical, Wolhusen, Switzerland) to prevent the migration of connective tissue cells into the space. The connective tissue graft was positioned internally to the flap and stabilized with sutures using 6.0 polypropylene monofilament thread (Techsuture®, Bauru, SP, Brazil). These materials are widely recognized in dentistry for their effectiveness in bone regeneration and implant stability.

The surgical procedure began with a careful elevation of a mucoperiosteal flap, followed by the application of the bone graft, mixed with Bio-Oss, into the defective area. This step aimed to compensate for bone loss and create a suitable site for implant placement. A Bio-Guide membrane was then positioned over the graft to ensure stability and minimize the risk of unwanted cellular migration, which could compromise localized bone regeneration. In the advanced stage of surgery, the 3D-printed implant—digitally designed with precision—was successfully inserted into the prepared site.

After approximately four months, a crucial period for osseointegration, during which the bone integrates with the implant to ensure stability, the prosthetic phase commenced. A digital scan was performed to design a ceramic crown that would

seamlessly align with the patient's existing dental arch, optimizing both aesthetic and functional outcomes.

Postoperative follow-up included periodic evaluations and necessary adjustments. Observations confirmed successful osseointegration and excellent periodontal health. The patient expressed great satisfaction with the final outcome, highlighting the natural appearance and comfort provided by the new tooth. The rehabilitation not only restored his smile but also fully reestablished his masticatory function, significantly enhancing his daily life, overall well-being, and self-confidence.

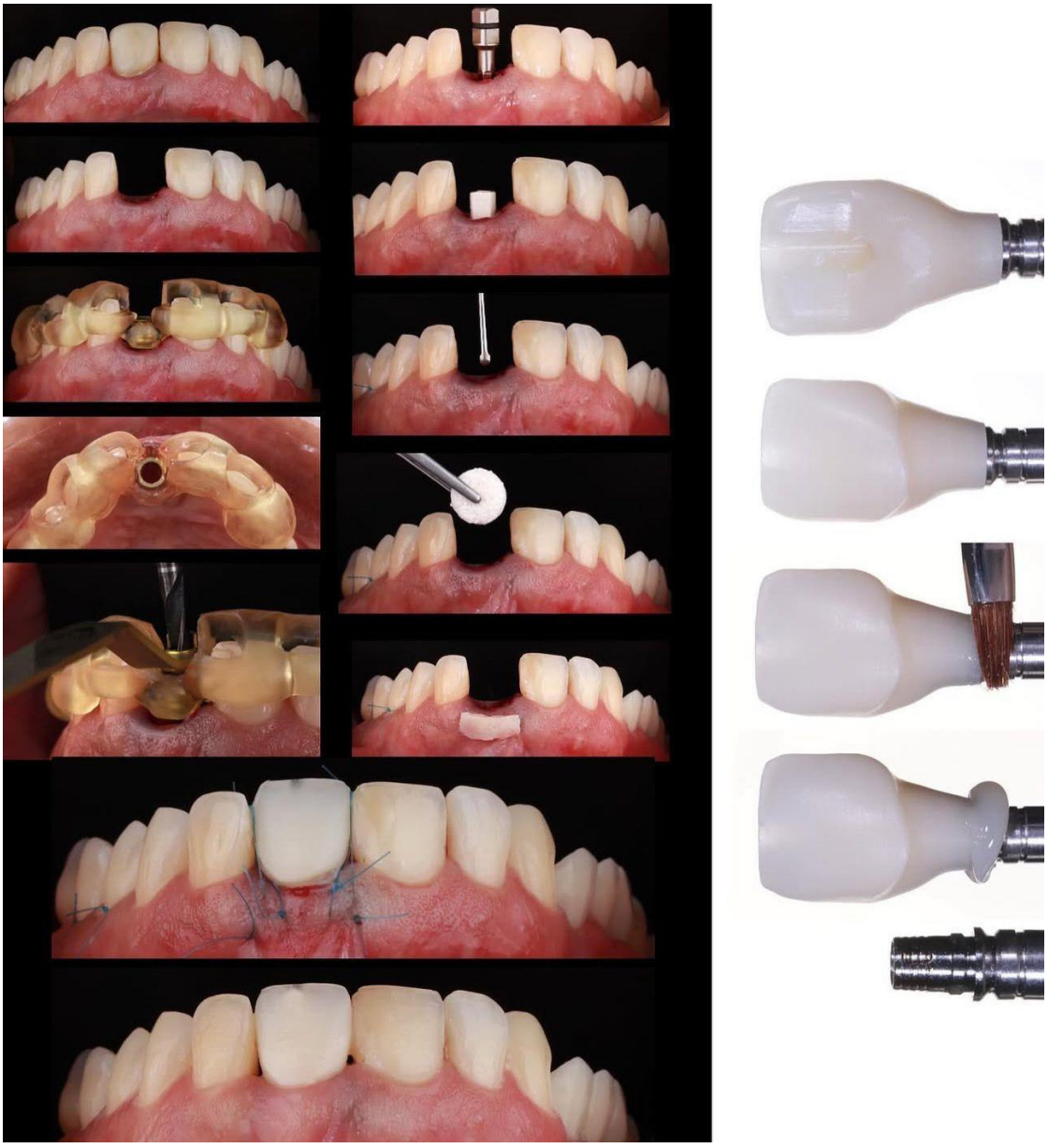

Figure. 1 - The extraction of the dental element was accompanied by procedures to restore and optimize the bone and soft tissue architecture in the region designated for

implant placement. The connective tissue graft was placed internally to the flap and secured using 6.0 monofilament polypropylene sutures. The final appearance of the fixed restoration on implant after the surgical procedure.

DISCUSSION

3D printing has revolutionized various fields of medicine, with particular emphasis on medical and dental implants, where its application has enabled an unprecedented level of personalization. The fabrication of implants using this technology has allowed for a precise adaptation of devices to the unique anatomy of each patient, yielding promising clinical outcomes. Specifically in dental surgery, the ability to create implants that seamlessly conform to the morphology of the mandible or maxilla not only reduces surgical time but also elevates aesthetic outcomes to a new standard, significantly enhancing both the psychological and physical well-being of patients (DA SILVA & RODRIGUES, 2024). Furthermore, the personalized approach to implant fabrication minimizes the risk of postoperative complications and improves the integration of the implant with natural tissues, promoting faster and more effective healing (SARLO et al., 2023).

In the context of materials used for these procedures, Bio-Oss and Bio-Guide have emerged as widely accepted and well-documented options. Bio-Oss, a bone grafting material, has been employed due to its proven effectiveness in promoting osteoconduction and facilitating bone regeneration, while the Bio-Guide membrane serves as a physical barrier that protects the graft by preventing the unwanted proliferation of soft tissues at the regeneration site. Recent studies support the use of these biomaterials, highlighting their efficacy in assisting bone regeneration in complex dental rehabilitation treatments (LIMA et al., 2024). The combination of these biomaterials with digital technology represents a significant advancement in treatment predictability and success, offering a less invasive approach with precisely planned outcomes (ROCHA & PEREIRA, 2022; MOREIRA, 2021).

Although the benefits of these technologies are indisputable, inherent challenges remain, driving ongoing research and advancements in the field. Achieving

maximum precision in 3D printing remains a primary concern, as even minor discrepancies during the fabrication of implants can impact clinical outcomes. Additionally, the biological interaction between implants and surrounding tissues requires further in-depth studies. Understanding how implant materials interact with living tissues to prevent inflammation or rejection is crucial for the long-term success of these procedures. This biological interface remains a critical area of intensive research and development, ensuring that implants not only integrate successfully but also contribute to the enhancement of surrounding tissues, thereby ensuring the longevity of treatment (PENNEC, 2024; COELHO & ARASHIRO, 2023).

Despite these challenges, there is no doubt that the potential of 3D printing technology and biomaterials in the field of rehabilitative dentistry presents a promising horizon for continuous innovation and improvement. Current research is focused not only on expanding the range of available materials but also on refining digital planning methods, which are essential for maximizing the accuracy and success of dental treatments (MOREIRA, 2021). These innovations contribute not only to clinical efficiency but also drive a paradigm shift in dental practices, aligning them more closely with patient needs and expectations while ensuring that quality and safety standards are maintained and continuously improved (SARTORI et al., 2023).

FINAL CONSIDERATIONS

The presented case highlights the advancements and applicability of digital technologies in dental rehabilitation, demonstrating the effectiveness of customized 3D-printed implants combined with biomaterials such as bone grafts and membranes. This approach not only ensures satisfactory aesthetic and functional outcomes but also enhances patient well-being by providing personalized, minimally invasive solutions with greater predictability in the rehabilitation process.

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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