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UNIVERSIDADE ESTADUAL PAULISTA
"JÚLIO DE MESQUITA FILHO"
Instituto de Ciência e Tecnologia
Campus de São José dos Campos

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How reverse planning and the use o digital devices revolutionize implantology? – Case report

Como o planejamento reverso e o uso de ferramentas digitais revolucionam a implantodontia? – Relato de caso

Tatiana Cursino PEREIRA[1], **Fernanda GODOY**[1], **Diana CUNHA**[1], **Diogo Cabecinha VIEGAS**[2], **Guilherme de Siqueira Ferreira Anzaloni SAAVEDRA**[1,2]

1 - Universidade Estadual Paulista, Departamento de Prótese Dentária e Materiais Odontológicos. São José dos Campos, SP, Brazil.
2 - Faculdade de Medicina Dentária da Universidade de Lisboa. Departamento de Prótese Fixa. Lisboa, Portugal.

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ABSTRACT

Objectives: The aim of the study was to demonstrate how digital devices can be applied in the field of implant dentistry. By integrating data from computed tomography, panoramic radiography, and intraoral scanning into software, it is feasible to perform virtual planning of prosthetic rehabilitation and implant placement predictably. The adoption of reverse planning increases the chances of treatment success. **Material and Methods:** In this case report, oral rehabilitation of the area of tooth 36 was conducted through implant placement. The implant was installed based on the virtual planning done in the software, followed by the production of a rigid static guide and guided surgery. **Results:** It was noted that there is a learning curve associated with the use of these technologies, requiring professionals to have theoretical and practical knowledge of digital devices. By using software and surgical guides obtained through 3D printing, it was possible to achieve high precision and preserve vital structures such as blood vessels and nerves, resulting in aesthetic and functional satisfaction for the patient. **Conclusion:** The use of digital devices in implant dentistry offers speed and predictability in treatment.

KEYWORDS

CAD/CAM; Dental planning; Dental prosthesis; Guided surgery; Implant.

RESUMO

Objetivos: O objetivo do estudo foi evidenciar como as ferramentas digitais podem ser aplicadas na área da implantodontia. Ao integrar dados de tomografia computadorizada, radiografia panorâmica e escaneamento intraoral em um software, é viável realizar o planejamento virtual da reabilitação protética e implante de forma previsível. A adoção do planejamento reverso aumenta as probabilidades de sucesso do tratamento. **Material e Métodos:** Neste relato de caso, a reabilitação oral da área do dente 36 foi conduzida por meio da instalação de um implante. O implante foi instalado com base no planejamento virtual realizado no software, seguido pela produção de um guia estático rígido e cirurgia guiada. **Resultados:** Notou-se que há uma curva de aprendizado associada ao uso dessas tecnologias, exigindo que os profissionais possuam conhecimento teórico e prático dos dispositivos digitais. Ao utilizar softwares e guias cirúrgicos personalizados obtidos por impressão 3D, foi possível alcançar alta precisão e preservar estruturas vitais como vasos sanguíneos e nervos, resultando em satisfação estética e funcional para o paciente. **Conclusão:** O emprego de ferramentas digitais na implantodontia oferece rapidez e previsibilidade no tratamento.

PALAVRAS-CHAVE

CAD-CAM; Planejamento dental; Prótese dentária; Cirurgia guiada; Implante.

INTRODUCTION

Dental implant surgery stands out as a widely adopted solution for the replacement of one or more missing teeth. The correct positioning of the implant is crucial for the treatment's success, ensuring not only aesthetics but also proper function in the dental arch [1]. Currently, there are two predominant methods for implant placement: the conventional approach, where the dentist makes incisions in the gums to assess oral anatomy and position the implant, and the guided technique, which utilizes software enabling meticulous analysis of oral elements and virtual surgical planning [2,3].

A guided surgical approach can be classified into static and dynamic methods [4,5]. In dynamic guided surgery, there is preplanning, but surgery is performed using real-time optical tracking via a computer that monitors and guides the surgeon regarding anatomical landmarks [6]. This approach is advantageous for experienced professionals, who possess greater skill, confidence, and speed, and can make more autonomous decisions during surgery. Conversely, less experienced professionals may face difficulties due to the need for prior skills and the required adaptation time [5,6]. This increases the potential for errors in dynamic guided surgery [6,7].

The technique of static guided surgery employs a rigid guide printed from a specific plan and is used in conjunction with a guided surgery kit [3]. This results in a reduced dependence on the experience and skill of the professional, thereby increasing the accuracy and predictability of outcomes [4]. The fabrication of a rigid plate guides both the initial bone drilling and the guided implant insertion, providing precision in angle and depth. Among its advantages, it eliminates incisions in the gums, preserving blood supply to the bone tissue and reducing surgical trauma, thus accelerating the healing process and providing greater post-surgical comfort [3,4].

The placement of implants without prior planning that takes into account anatomical structures and future prosthetic rehabilitation can lead to functional and aesthetic problems [8,9]. The main reason for prosthesis failure and subsequent implant loss is attributed to poor planning [9,10]. Improper implant positioning is identified in some studies as a key factor for future loss of hard and/or soft tissues [11,12]. Therefore, this work aims to demonstrate the advantages offered by digital technologies through reverse planning and the performance of static guided surgery for implant installation and prosthetic rehabilitation.

CLINICAL REPORT

A healthy 60-year-old male patient sought treatment at the Institute of Science and Technology of São Paulo State University (ICT Unesp) in São José dos Campos (Figure 1). An anamnesis was conducted, and the patient underwent an intraoral scanning (CS 3600 Carestream).

It was observed that tooth 36 presented extensive coronal fracture, and after periapical radiography, it was found that the tooth also had a fractured root. Prior to performing the surgery for extraction of the remaining tooth and installation of the implant, complementary laboratory tests were requested from the patient to assess systemic condition, and a computed tomography scan was requested for evaluation of the region in question.

The mandibular image was obtained in PLY format through intraoral scanning. Subsequently, it was integrated into the DICOM volumetric file, containing cone beam tomographic image, using Exoplan Rijeka 3.1 software (exocad, Darmstadt, Germany). Thus, the planning for implant installation and prosthetic rehabilitation was initiated. As it was a rehabilitation of only one element in the mandible, the case presented high chances of success, given the region's high bone density. It was possible to virtually plan and analyze anatomical structures in three dimensions using Exoplan Rijeka 3.1 software (exocad, Darmstadt, Germany).

Figure 1 - Initial intraoral register.

Through the software, virtual extraction of tooth 36 was performed. Subsequently, simulations were conducted with different diameters and sizes of implants, respecting a 2mm distance from the nerve to avoid damaging it, and also aiming to respect axial inclination and avoid detrimental horizontal forces (Figures 2, 3, and 4).

After selecting the implant, a simulation of the crown for tooth 36 was performed, conceptualizing the virtual reverse planning (Figures 5 and 6).

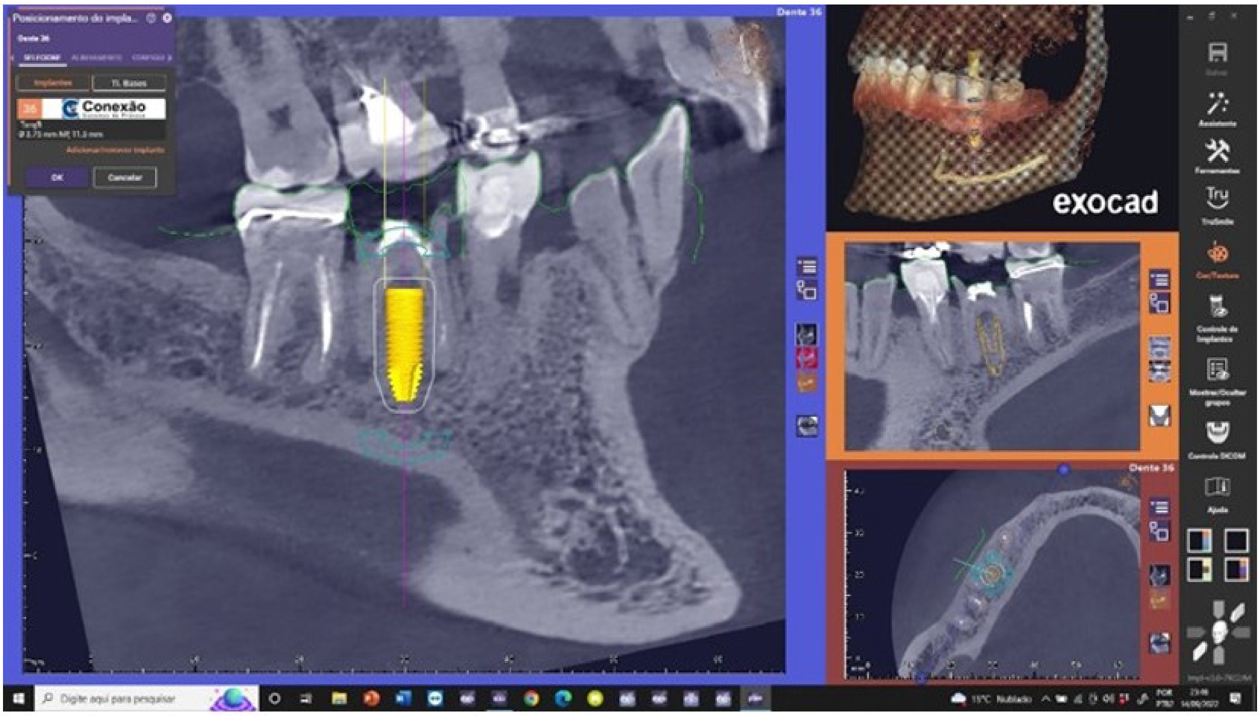


Figure 2 - Sagittal section - virtual implant planning respecting 2mm from the nerve, Exoplan Rijeka 3.1 software (Exocad).

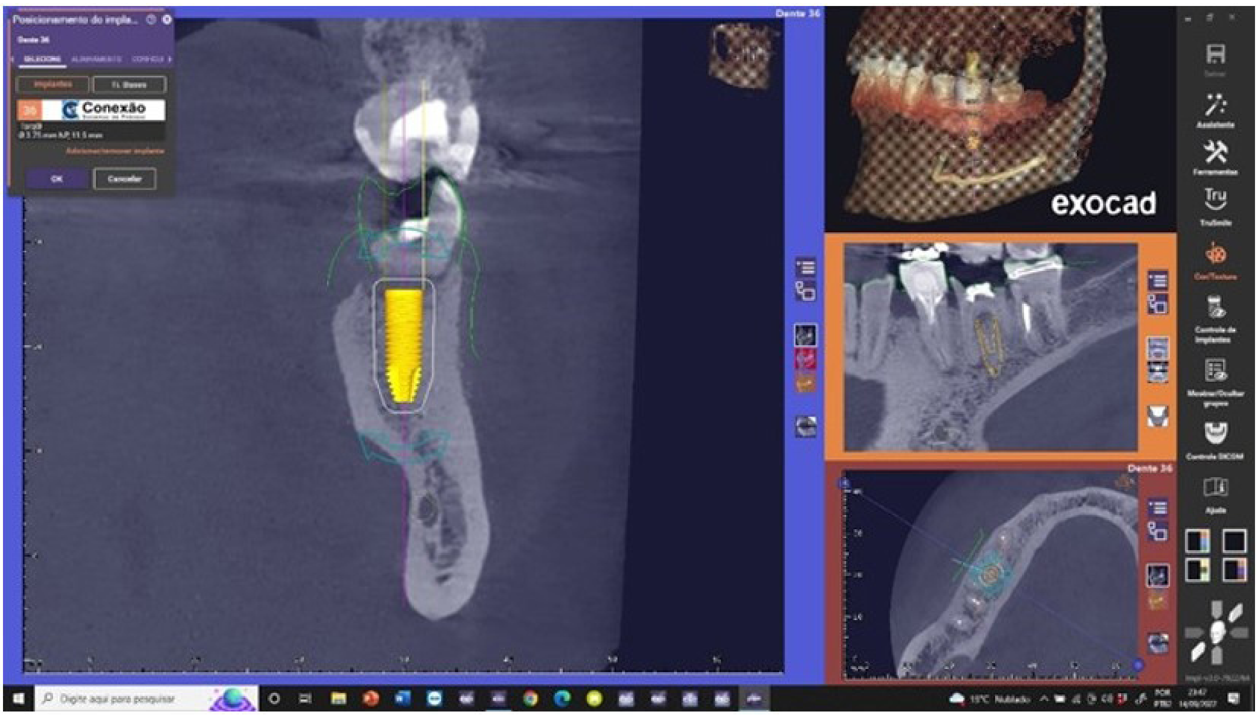


Figure 3 - Cross-sectional view - virtual implant planning respecting 2mm from the nerve, Exoplan Rijeka 3.1 software (Exocad).

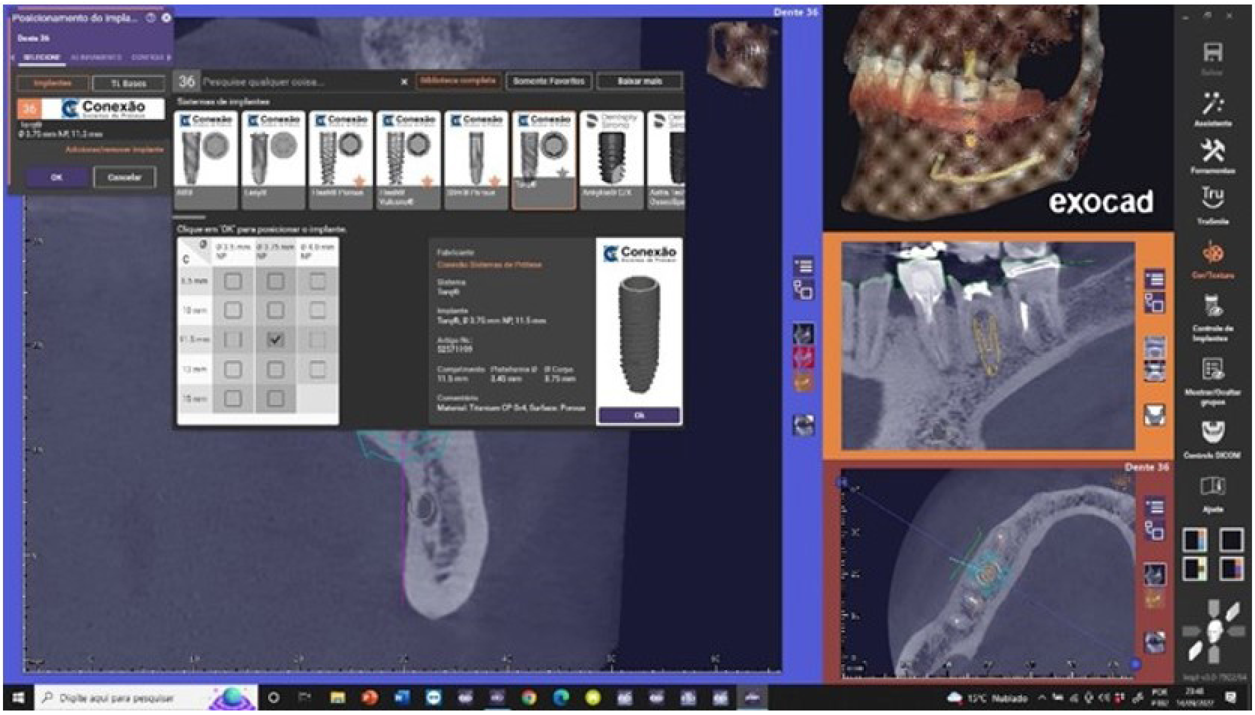


Figure 4 - Selection of the most suitable implant for the case.

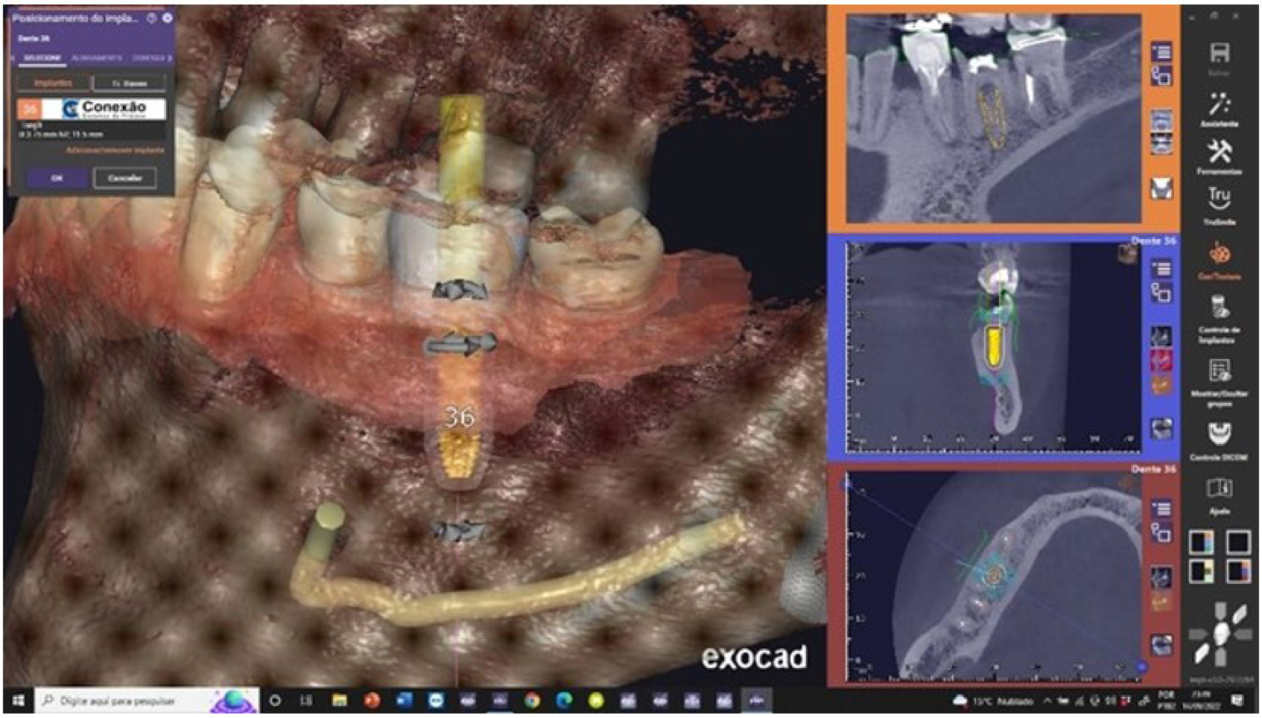


Figure 5 - Reverse Virtual Planning.

Due to the presence of neighboring teeth adjacent to the prosthetic space, it was possible to establish appropriate proximal contact points.

After planning the crown, the surgical guide design was created, generating a new PLY file covering only the hemiarch of the prosthetically relevant side, using the same software. The teeth within the hemiarch itself contribute to a design that promotes better stability and adaptation (Figures 7 and 8).

The guide was obtained using the Cara Print printer (Kulzer) with Dima Print Guide resin

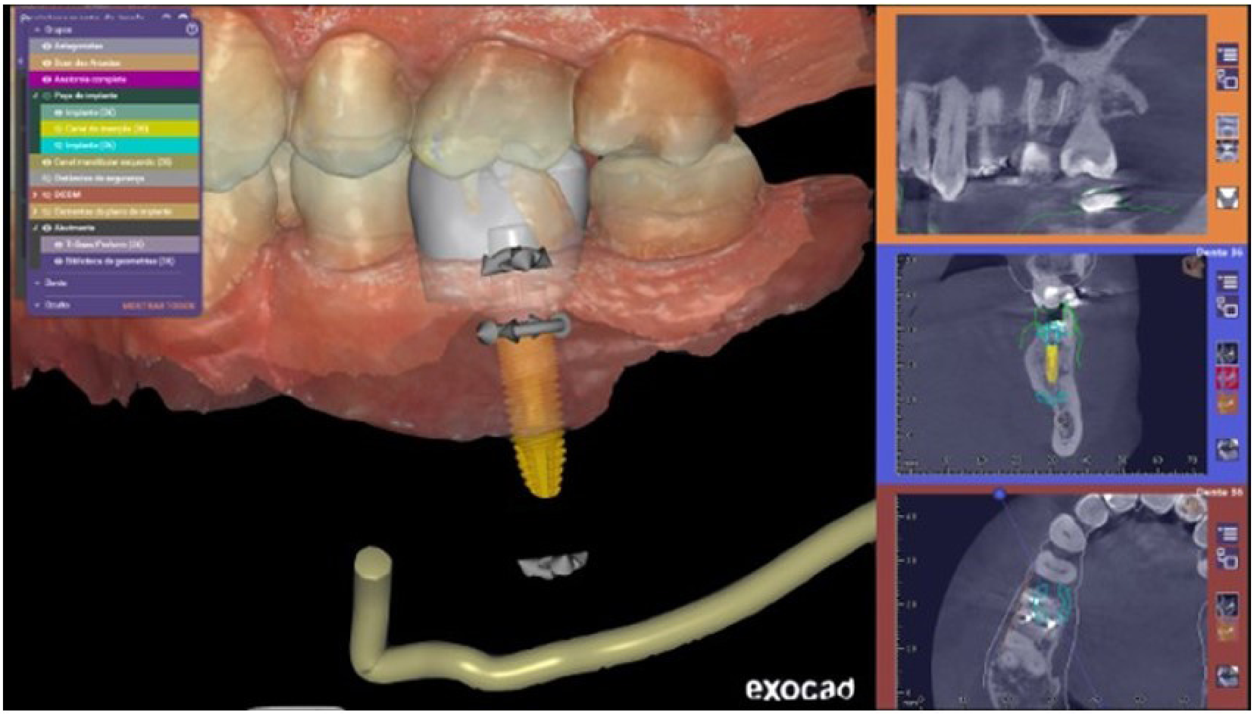


Figure 6 - Reverse Virtual Planning

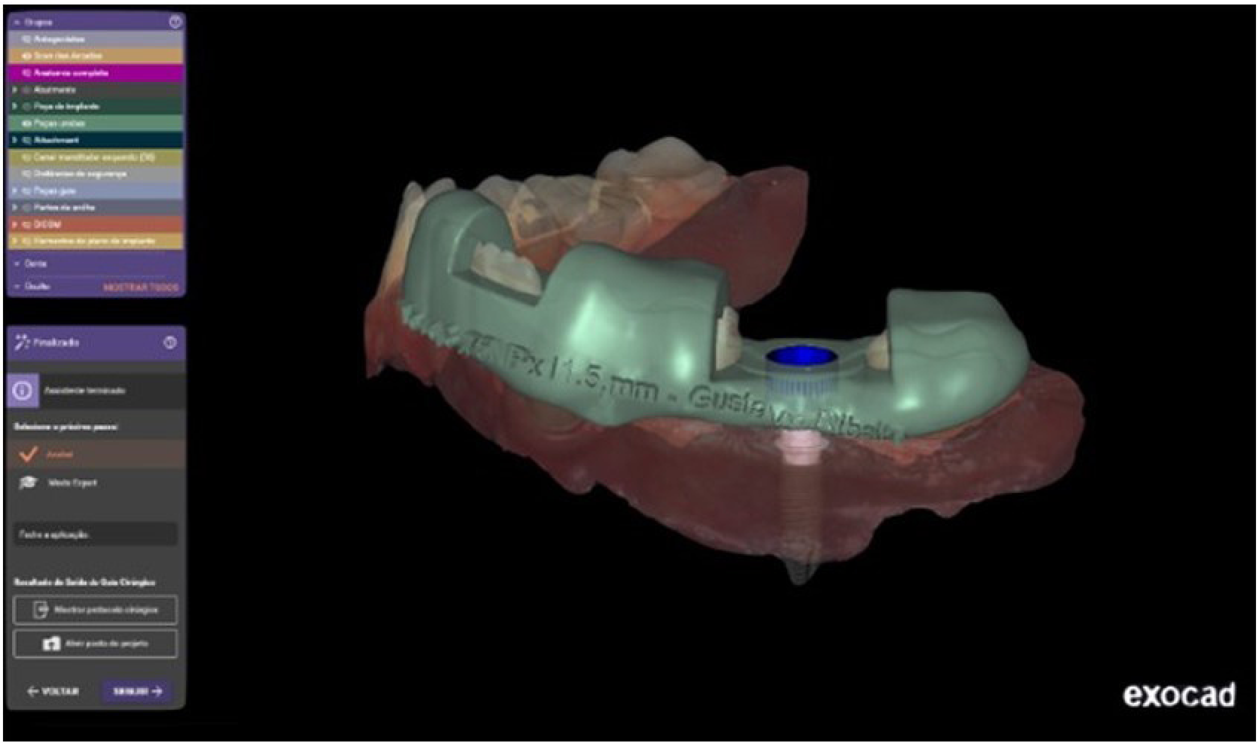


Figure 7 - Lateral view of the digital guide. Conexão Sistemas de Prótese Ltda.

(Kulzer) after transferring the digital planning file to Cara Print CAM slicing software (Kulzer). Subsequently, the guide was sanitized with isopropyl alcohol and polymerized using the Hi Lite Power 3D device (Kulzer).

Extraction of tooth 36, which was condemned due to crown and root fracture, was performed (Figure 9). Subsequently, the adaptation of the obtained guide in the mouth was verified (Figure 10).

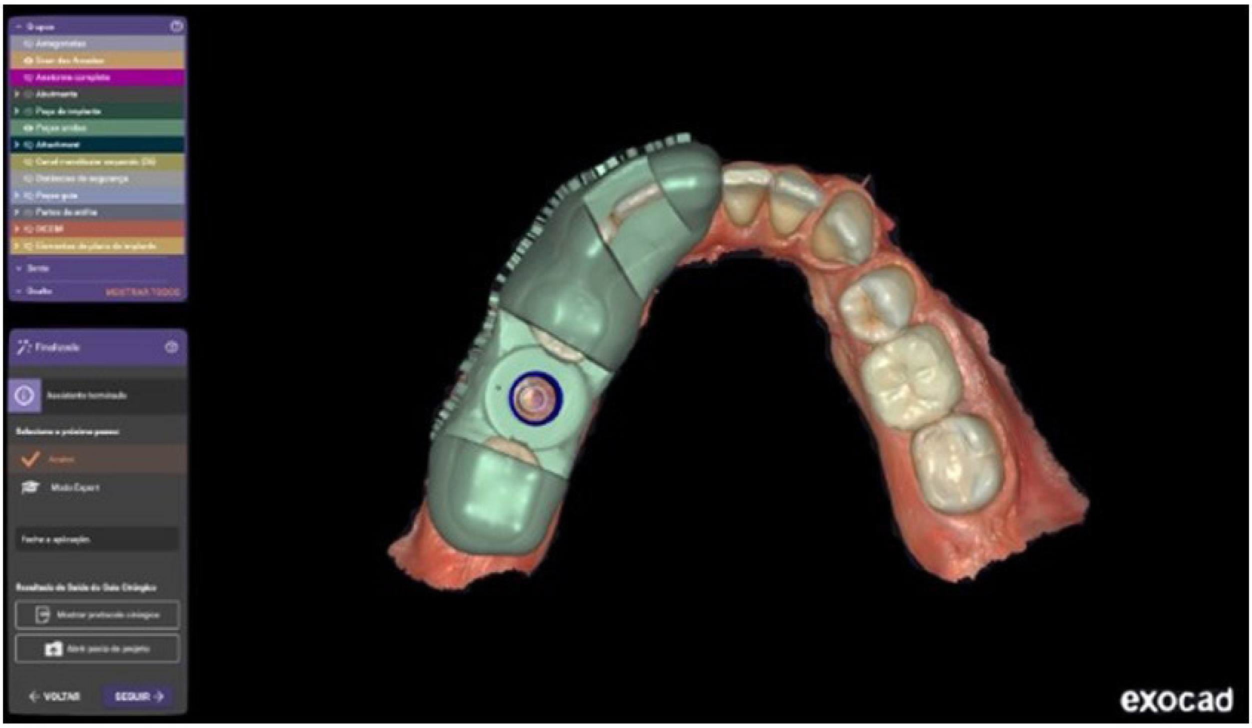


Figure 8 - Occlusal view of the digital guide. Conexão Sistemas de Prótese Ltda.

The surgical phase began with the minimally traumatic extraction of tooth 36, aiming to preserve the remaining bone and periodontal condition. Immediately after the extraction of tooth 36, a new periapical radiograph of the region was taken, and the implant installation was initiated using a specific surgical kit for guided surgery. The platform used was a Morse cone, Torq 3.75mm NP x 11.5mm (Conexão Sistemas de Prótese, Brazil). After implant installation, the outcome of the extraction and immediate implant placement was analyzed through clinical evaluation and a new periapical radiograph of the region (Figures 11 and 12).

After implant installation, it was possible to perform immediate loading with a temporary restoration printed from Dima Print C&B Temp resin (Kulzer, Germany). A Large Ti base, with a 1.5mm collar height (Conexão Sistemas de Prótese Ltda, Brazil) was used and finalized with occlusal adjustment (Figure 13 and 14).

DISCUSSION

The case report highlights a positive change brought about by static guided surgery performed. This technique offers benefits for professionals and, consequently, for patients, due to its tools that bring greater clarity and accuracy in communication [3]. This technique demonstrates effectiveness and agility in diagnosis, detailed virtual planning, and fabrication of precise surgical guides, offering predictable outcomes [1,2]. This approach significantly reduces procedure time and provides greater precision in the final positioning of the implant and dental prosthesis [3,4].

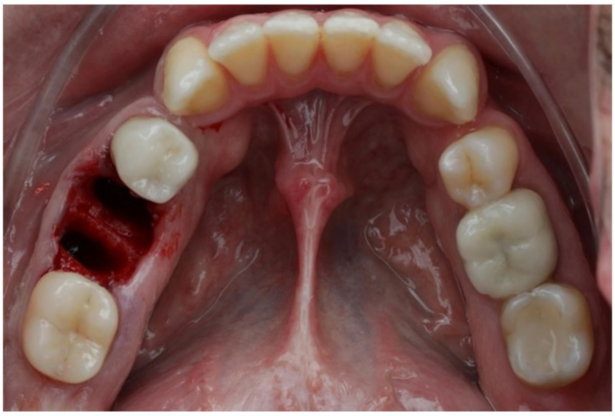


Figure 9 - Intraoral photo after extraction of tooth 36.

Despite the evident benefits, assimilating the use of digital tools in this workflow may be perceived as a significant challenge in terms of the learning curve. It is crucial to have a deep understanding of this aspect to evaluate the effectiveness of various dental approaches [13-16]. However, studies, such as the one conducted by

Clayton T. Rau et al., highlight that the learning curve when employing digital tools is notably more favorable compared to analog methods. Furthermore, the use of digital tools results in a reduction in the number of clinical steps, thus minimizing the chances of errors. This body of evidence reinforces how digital technologies not only contribute to a smoother learning curve, enhancing the skills of dental professionals, but also offer a more efficient approach with lower error propensity when compared to traditional analog methodologies [15,16].

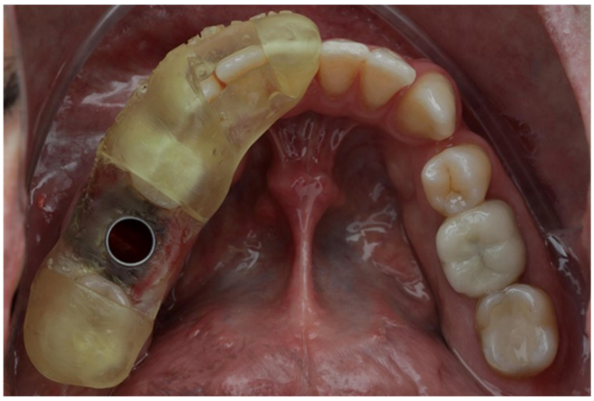


Figure 10 - Surgical guide trial, occlusal view.

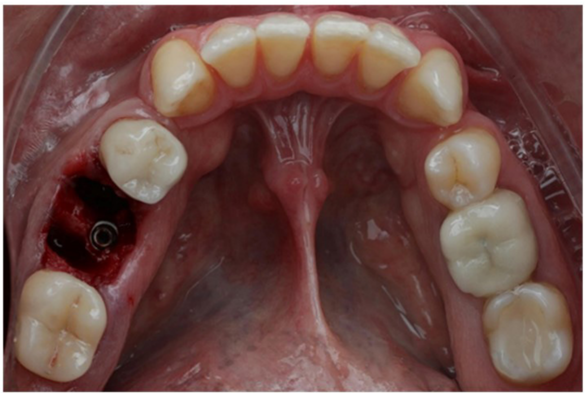
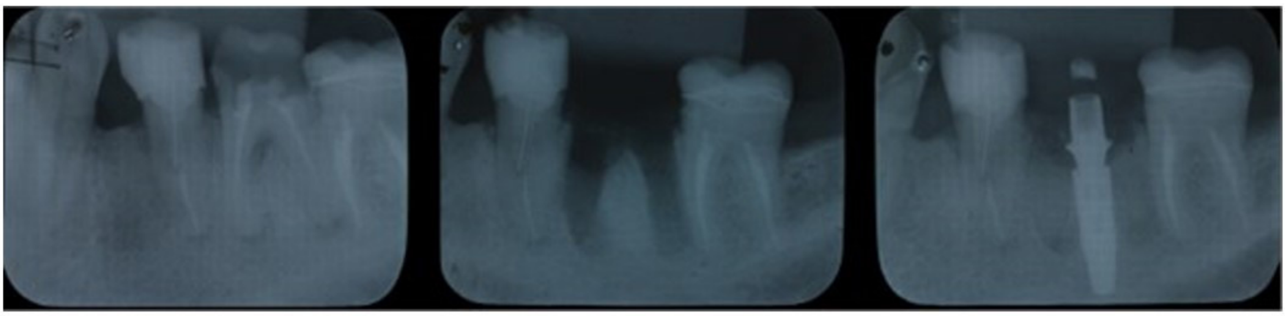


Figure 11 - Intraoral post-surgical photograph.

The adopted technology not only transforms clinical practice but also communication between professionals and patients. Clear visualization of the treatment plan, planned implant position, and occlusal adaptation of the prosthetic rehabilitation through virtual models facilitate patient understanding, promoting more effective and transparent communication [17]. Additionally, the integration of these technological tools enhances the relationship between the dentist and the laboratory technician and ensures assertive communication, resulting in fewer prosthetic reworks [2,17].

The assertion that static guided surgery is considered minimally invasive and conservative is supported in the literature and presents a series of benefits [1-4,16]. Precise virtual planning allows for a highly focused surgical approach, preserving healthy tissues and reducing the need for extensive incisions. This results in less trauma for the patient, decreased trans- and post-operative discomfort, and quicker recovery [2,3].

However, the perceived ease of use of this technique compared to traditional techniques of conventional surgery may lead to less caution on the part of experienced surgeons [11,15,18]. As evidenced by studies evaluating the accuracy of implants installed with guided or conventional surgery according to the surgeon's level of experience, experienced surgeons may exhibit greater deviations, raising the possibility of decreased caution due to long practice of the technique [4]. On the other hand, inexperienced surgeons may be more cautious, resulting in fewer



A B C

Figure 12 - Periapical radiographs of the region (A) initial; (B) immediately after extraction, and (C) final.

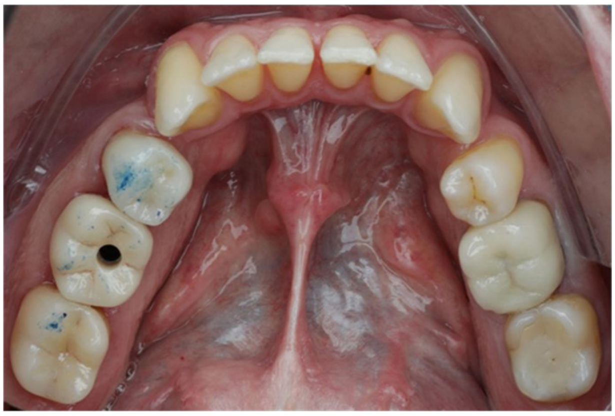


Figure 13 - Installation of the immediate prosthetic crown and occlusal adjustment.

Figure 14 - Case completed with immediate prosthetic crown.

deviations, making guided surgery a crucial tool for reducing undesirable angulations [11,12,18].

Thus, it is important to recognize that, although minimally invasive, static guided surgery is not without limitations. Dependency on technology may pose a challenge in cases of malfunction or technical errors. The essence of these technological advances lies in the direct benefits to the patient [18]. Static guided surgery not only provides faster, more accurate, and predictable treatments but also results in a safer and more satisfactory experience for the patient [2,3,13]. The democratization of access to high-quality treatments, regardless of the dentist's experience, underscores the importance of technology in promoting inclusive and effective dentistry.

CONCLUSION

It can be concluded that through the use of reverse planning, oral rehabilitation by dental implants becomes more predictable and precise, generating satisfactory functional and aesthetic prosthetic results, which increases the longevity of the rehabilitation. This method also makes the intraoperative period more comfortable for the patient, as well as providing a more favorable postoperative period. Static guided surgery represents an evolution in dental practice as it is a minimally invasive and conservative technique. The incorporation of these technologies has improved not only communication between dentist and technician but also with the patient, who has the possibility to participate clearly and actively in their own treatment.

Author's Contributions

TCP: Conceptualization, Investigation, Methodology, Writing – Original Draft, Writing – Review & Editing. FG: Investigation, Methodology, Writing – Original Draft, Writing – Review & Editing. DC: Investigation, Methodology, Writing – Original Draft, Writing – Review & Editing. DCV: Writing – Original Draft, Writing – Review & Editing. GSFAS: Conceptualization, Project Administration.

Conflict of Interest

The authors declare that they have no conflicts of interest.

Funding

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Regulatory Statement

For the development of this study, the patient signed the free and informed consent form.

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Tatiana Cursino Pereira
(Corresponding address)
Universidade Estadual Paulista, São José dos Campos, SP, Brazil.
Email: tatiana.pereira@unesp.br

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