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Case Report

Advanced Digital Techniques in Full-Arch Maxillary Restoration for Edentulous Patients

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Abstract

The goal of this clinical report is to describe a maxillary full-arch implant supported restoration performed using an entirely digital work flow. A male patient had multiple upper teeth showing terminal mobility caused by periodontal disease. Visited the dental clinic seeking a maxillary fixed restoration. After explaining the various treatment modalities, He underwent treatment with full-arch screw-retained restorations supported by six implants.

The imaging data from the CBCT were overlaid with files from the intraoral scans, as well as with the diagnostic wax-up after dental smile design, we were able to plan the ideal implant position.

This method allowed for accurate implant placement, taking into account factors like anatomical constraints as well as the patient's overall aesthetic and soft tissue anatomy.

Keywords: Full-Arch Restoration; Digital Impression; Digital Workflow; Full-Arch Rehabilitations; Implant-Prosthodontic Restorations; Digital Implant Dentistry

Introduction

Digitally guided techniques have enhanced the predictability, efficiency, and minimally invasive nature of associated surgical protocols [15,16].

Digital workflows are increasingly enabling the development of prosthesis that achieve optimal aesthetics tailored precisely to the individual anatomical conditions of each patient [4,6].

This case report presents an advanced digital workflow for fixed maxillary full-arch restoration, facilitated by specific surgical guides serving as landmarks.

It illustrates the application of digital techniques in a comprehensive treatment plan for edentulous rehabilitation.

Case Report

A 54-year-old man in good overall healthHaut du formulaire presented Maxillary teeth with severe bone loss due to advanced periodontal disease and mobility degree three seeking for oral rehabilitation. In the mandible, teeth 36, 37, and 41 were absent. Teeth 42 and 31 were mobile with bone resorption reaching the apical third. Tooth 47 was slightly tilted with no mobility (Figure 1).

Figure 1: Initial clinical and radiographic evaluation. (a) Initial intraoral view (b)Panoramic radiograph.

After clinical examination and Evaluation of cone beam computed tomography (CBCT) and intraoral digital impression.

The majority of the maxillary teeth were considered not restorable due to the severity of mobility, only the 28 was retained due to being well-implanted, intact, and non-mobile.

In the mandible, teeth 42 and 31 were extracted, and a dental scaling was performed. Patient education on proper brushing techniques and motivation for oral hygiene were provided.

After explaining the various treatment options to the patient, whether a conventional complete denture or an implant-supported complete denture.

The patient, without financial constraints, wishes to undergo implant-supported fixed rehabilitation.

Both dental arches were scanned using an intraoral scanner also the occlusal vertical dimension. Frontal photographs of the patient were also taken. All data from the digital impressions, photos, and cone beam scans were superimposed to create diagnostic digital wax-ups, which were subsequently refined using digital smile design.

The patient did not indicate any discomfort or temporomandibular disorder. Based on this evaluation, the decision was made to maintain the occlusal vertical dimension and solely adjust the occlusal plane in the subsequent restoration.

The imaging data from the CBCT were overlaid with files from the intraoral scans, as well as with the diagnostic wax-up after dental smile design, it became feasible to strategize the optimal implant placement.

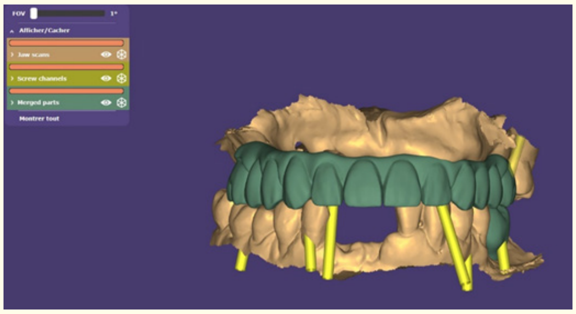

Figure 2: Six implants were virtually planned based on aesthetic and anatomical considerations.

Cone beam computed tomography (CBCT) imaging has revolutionized the planning process for dental implant placement, providing detailed three-dimensional information about the patient's anatomy. By utilizing CBCT scans and carefully analyzing the cross-sectional images, clinicians can accurately assess bone density, morphology, and proximity to vital structures, which are crucial factors in determining implant diameter and position. (Figure 3)

In Figure 4 and 5, we observe the cross-sectional slices from the cone beam and the placement of implants that respect the vital structures and available bone thickness.

A surgical guide for the maxilla was created using a 3D printer to transfer the virtual design to the surgical site (Figure 6)

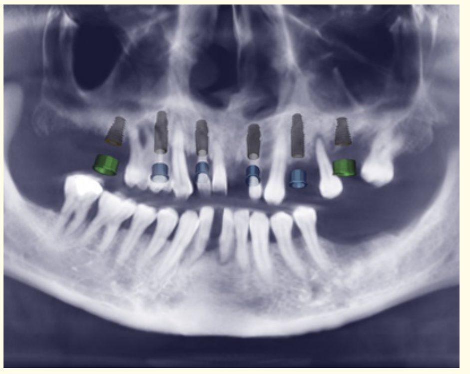

Figure 3: Simulation of implant placement on the panoramic slice of the cone beam.

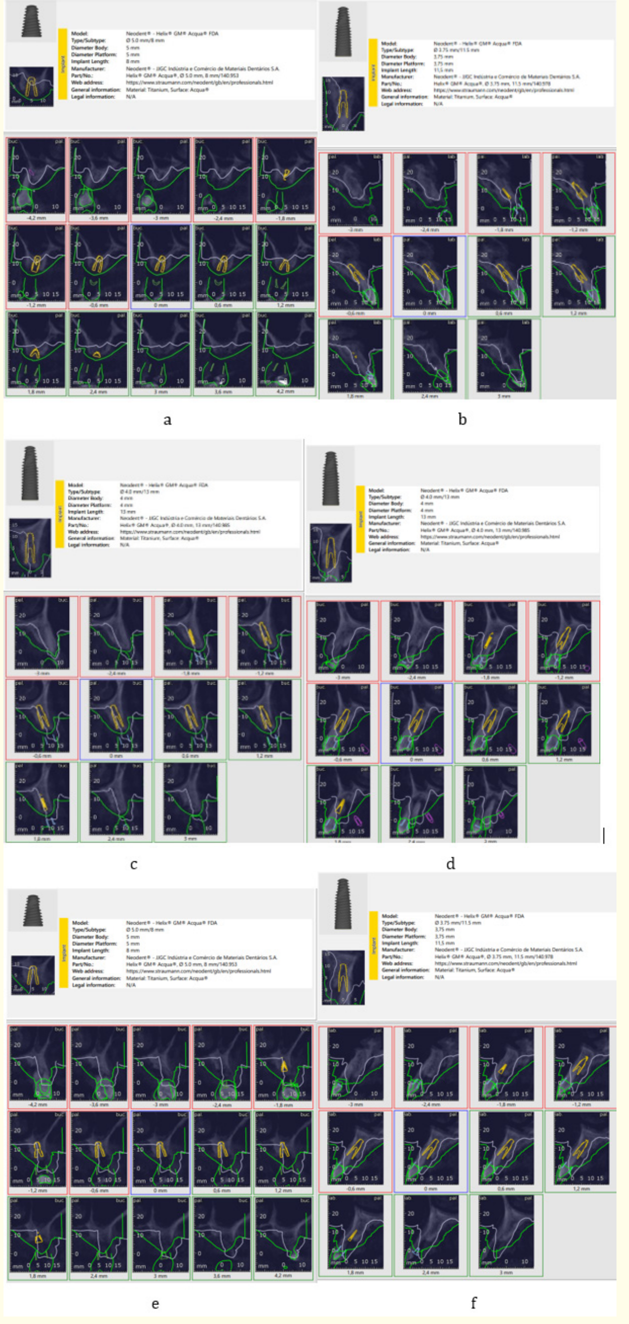

Figure 4: Cone Beam Cross-Sectional Slices with Virtual Implant Placement, Length, and Diameter. Selection: (a) Implant site 16 (b) Implant site 22 (c) Implant site 24 (d) Implant site 14 (e) Implant site 26 (f) Implant site 12.

Tooth 12: Neodent® - Helix® GM® Acqua® FDA
Additional comment for implant: Material: Titanium, Surface: Acqua®
Additional part name for implant: Helix® GM® Acqua®, Ø 3.75 mm, 11.5 mm

Tooth 14: Neodent® - Helix® GM® Acqua® FDA
Additional comment for implant: Material: Titanium, Surface: Acqua®
Additional part name for implant: Helix® GM® Acqua®, Ø 4.0 mm, 13 mm

Tooth 16: Neodent® - Helix® GM® Acqua® FDA
Additional comment for implant: Material: Titanium, Surface: Acqua®
Additional part name for implant: Helix® GM® Acqua®, Ø 5.0 mm, 8 mm

Tooth 22: Neodent® - Helix® GM® Acqua® FDA
Additional comment for implant: Material: Titanium, Surface: Acqua®
Additional part name for implant: Helix® GM® Acqua®, Ø 3.75 mm, 11.5 mm

Tooth 24: Neodent® - Helix® GM® Acqua® FDA
Additional comment for implant: Material: Titanium, Surface: Acqua®
Additional part name for implant: Helix® GM® Acqua®, Ø 4.0 mm, 13 mm

Tooth 26: Neodent® - Helix® GM® Acqua® FDA
Additional comment for implant: Material: Titanium, Surface: Acqua®
Additional part name for implant: Helix® GM® Acqua®, Ø 5.0 mm, 8 mm

Figure 5: Detailed Overview of Implant Names and Characteristics.

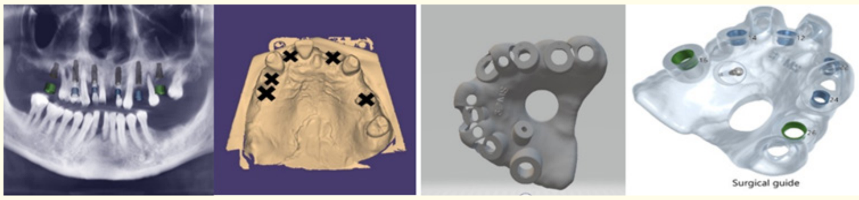

Figure 6: Digital Design of the Surgical Guide.

For the mandible, since only one implant site, 36, will be addressed, a surgical guide was not necessary.

The patient wishes not to undergo the extraction of all teeth simultaneously. Therefore, it was decided to perform extractions of only the teeth adjacent to the implant sites initially (Figure 6).

After tooth extraction at the implant sites, six implants were placed at positions 12, 14, 16, 22, 24, and 26 using flapless guided implant surgery in accordance with the manufacturer's instructions (Figure 7).

Figure 7: (a) Extraction of teeth, (b)Surgical guide fixation and placement of implant fixtures; (c) PRF grafting and suturing.

Following the osseointegration period, extractions of the remaining teeth were carried out, and provisional prosthesis was placed (Figure 8). A post-operative panoramic radiograph was taken to ensure the proper positioning of the implants (Figure 9).

Following soft-tissue healing and full osteointegration, a subsequent intraoral scan was conducted to record the contours of the soft tissue (Figure 10).

Figure 8: Provisional prosthesis.

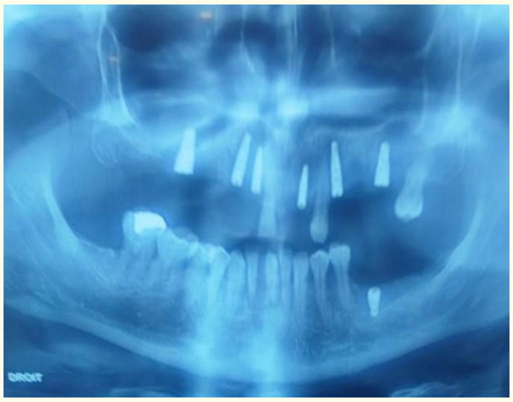

Figure 9: A post-implant placement panoramic X-ray for follow-up.

Figure 10: Inner intraoral scanning after gingival healing.

The patient was very happy with both the treatment plan and the aesthetic and functional outcomes. Additionally, there was a noticeable positive change in the patient's appearance and his self-esteem.

Figure 11 illustrates the final complete restoration, which replicates the provisional prosthesis as the patient expressed satisfaction with its occlusion and design. The definitive bridge is screwed.

Figure 11: Definitive intraorally screw-retained restorations.

Sculpting the false gum in pink ceramic is to avoid having excessively long and unaesthetic teeth. By carefully crafting the ceramic gum to match the natural gum line, it creates a seamless transition between the prosthetic teeth and the gums, enhancing the overall aesthetic appearance of the dental restoration. This approach not only ensures a natural and harmonious look but also helps to maintain a more lifelike smile.

Discussion

The case report presented details the implementation of an advanced direct digital workflow, which is schematically outlined in figure 12.

Figure 12: The prosthesis is finished before placement in the mouth.

In digital prosthetic workflows, it's common to merge different digital impressions to precisely capture the positions of implants in relation to the patient's gum line and soft tissue contours [1,2].

The approach of maintaining the maxillo-mandibular relationship and occlusal vertical dimension is used if the patient has no temporomandibular joint pathology or parafunction, and if maintaining the aesthetic of the lower facial height is desired [3].

Computer-guided implantology offers a high level of precision in planning and placing dental implants. By superimposing cone beam computed tomography (CBCT) data onto intraoral scans and diagnostic wax-ups, clinicians can meticulously plan the position of dental implants [11].

By virtually planning implant placement, surgical risks such as nerve injuries, sinus perforations, and implant mispositioning are minimized. Virtual planning allows for precise visualization of patient anatomy, ensuring optimal implant sites and avoiding potential obstacles before surgery. This leads to safer procedures, fewer postoperative complications, and more predictable clinical outcomes [14].

Another key aspect of the workflow was providing a temporary bridge, customized to the patient's facial aesthetics and specific soft tissue contours. If both the patient and clinician are satisfied, this temporary bridge will be replicated in the final restoration [4].

The fusion of digital photographs and intraoral scans provided comprehensive guidance for the Digital Smile Design process. This integration allowed for detailed analysis of smile aesthetics and occlusal relationships, enhancing treatment planning accuracy and predictability [5,6].

In a study conducted by Cappar., *et al*. [7]. The test group showed that intraoral scanning is an effective alternative to traditional impression methods for full-arch implant treatments. Both methods were equally reliable, but the digital approach was less invasive and saved time for patients. However, more research is needed to fully assess the accuracy and efficiency of digital workflows for full-arch restorations. similar conclusions were drawn by Konstantinos Chochlidakis [8].

The findings of previous studies are confirmed by George, he indicates that the workflow offers several advantages, including improved accuracy, efficiency, and patient comfort. It allows for precise planning, fabrication, and delivery of implant-supported restorations, leading to predictable clinical outcomes [9].

Guided implant surgery has become increasingly popular in the field of dental implantology, promising enhanced precision, predictability, and surgical safety, however, the findings of this review [10] indicate that despite an extensive search, only two randomized controlled trials (RCTs) were found for data extraction. These trials analyzed outcomes such as prosthesis and implant failure, as well as complications. While there were no significant differences between cases treated with digital or conventional protocols, one trial reported higher pain and swelling in the conventional group during post-surgery evaluation. Overall, the results suggest that implant survival rates are similar for both methods. However, more research is needed to confirm these findings and explore the potential benefits of fully digital surgical protocols.

In the integration of digital workflows into dental practice, ethical considerations must be carefully addressed. Firstly, practitioners must prioritize patient consent. Patients should be fully informed about the use of digital technologies, including how their data will be collected, stored, and used. Additionally, practitioners have a professional responsibility to ensure the accuracy, reliability, and integrity of digital data and technology. Proper training and ongoing education are essential to competency in using digital tools effectively and ethically. Dentists must stay updated on best practices, guidelines, and regulations governing the use of digital workflows in clinical practice [12].

Although the initial setup costs associated with digital workflows may be higher compared to traditional methods, it is essential to consider the long-term benefits. By investing in digital technologies, dental practices can streamline their workflows, leading to reduced chair time and improved treatment efficiency. This not only enhances the overall patient experience but also contributes to better treatment outcomes. Over time, the cost savings achieved through reduced chair time and improved treatment outcomes can offset the initial setup costs, making digital workflows a cost-effective investment in the long run. Additionally, digital workflows offer opportunities for improved communication and collaboration among dental teams, further enhancing the quality and efficiency of patient care. Therefore, while the upfront investment may seem significant, the long-term benefits of digital workflows make them a prudent choice for dental practices aiming to optimize both clinical and financial outcomes [13].

In cases where the available prosthetic space is substantial, it is crucial to ensure that the final restoration achieves optimal aesthetic outcomes. This is particularly important to prevent the occurrence of excessively long or unattractive teeth. To address this challenge, a technique known as sculpting a ceramic gingiva is employed. This technique involves meticulously crafting a false gum using ceramic material to create the illusion of a natural gum line. By sculpting the ceramic gingiva to blend seamlessly with the surrounding tissues, it becomes possible to achieve a harmonious and aesthetically pleasing result. Moreover, the use of ceramic materials offers the advantage of durability and biocompatibility, further contributing to the long-term success of the restoration.

Conclusion

The case report illustrates the successful maxillary fixed full-arch rehabilitation. By employing guided surgery and an advanced integrated digital prosthetic workflow, we aimed to enhance prosthetic planning accuracy and clinical efficiency. This approach facilitated the sequential adaptation of the restoration to the patient's unique aesthetic and anatomical characteristics, resulting in a natural-looking rehabilitation. Looking ahead, further research could explore the long-term outcomes and patient satisfaction associated with this digital workflow. Additionally, investigating the cost-effectiveness and accessibility of implementing such digital protocols in routine clinical practice would be valuable for widespread adoption.

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