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Digital Precision In Full-Mouth Implant Rehabilitation: From Extraction To Prosthetic Loading

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Abstract

Background: Rehabilitation of patients with advanced periodontitis and terminal dentition presents significant functional and esthetic challenges. Digital implant planning and computer-guided surgery facilitate prosthetically driven implant placement and full-arch rehabilitation.

Case Presentation: A 45-year-old male with type 2 diabetes mellitus (HbA1c 6.5%) presented with generalized tooth mobility and masticatory discomfort. Clinical and radiographic assessments revealed generalized Stage IV, Grade C periodontitis. Following treatment planning and informed consent, full-mouth extractions and guided placement of ten Straumann implants—six in the maxilla and four in the mandible—were performed using a CBCT-based digital workflow. Insertion torque values ranged from 45 to 55 N·cm, indicating high primary stability. A fixed full-arch provisional prosthesis was delivered according to the planned loading protocol, with careful occlusal adjustment. Early postoperative evaluation demonstrated satisfactory soft-tissue healing and reported improvements in esthetics, phonetics, and masticatory function.

Conclusion: Integration of CBCT-based planning, computer-guided implant placement, and controlled prosthetic rehabilitation provides a systematic approach to full-mouth implant treatment in patients with advanced periodontal destruction. Long-term follow-up is necessary to establish implant success and prosthetic stability.

Keywords: Computer-guided surgery; digital dentistry; full-mouth rehabilitation; implant-supported prosthesis; periodontitis.

INTRODUCTION

Rehabilitation of patients presenting with multiple missing teeth or severely compromised dentition remains a complex clinical challenge, particularly when extensive periodontal destruction, compromised function, and esthetic concerns coexist. Full-mouth implant-supported rehabilitation has emerged as a valuable treatment option for restoring masticatory function, facial support, esthetics, and oral health-related quality of life. However, successful rehabilitation depends not only on implant osseointegration but also on comprehensive diagnosis, appropriate treatment planning, accurate three-dimensional implant positioning, and harmonious integration of the definitive prosthesis. A prosthetically driven approach is therefore essential to ensure that implant placement accommodates the functional, biological, and esthetic requirements of the planned restoration.[1],[2]

The advancement of digital dentistry has transformed the planning and execution of complex implant rehabilitation. The integration of cone-beam computed tomography (CBCT), intraoral scanning, and computer-aided design software facilitates the comprehensive assessment of residual alveolar bone, anatomical landmarks, and the anticipated prosthetic outcome. By superimposing three-dimensional radiographic data with digital surface scans, clinicians can establish a virtual representation of the patient's oral anatomy and plan implant positions in relation to the proposed prosthesis. This approach facilitates the evaluation of implant angulation, depth, inter-implant relationships, and proximity to vital anatomical structures, thereby supporting more informed and individualized treatment decisions. [3]

Computer-assisted guided implant surgery enables the transfer of the virtual treatment plan to the clinical setting through digitally designed and fabricated surgical guides. Compared with conventional freehand placement, static computer-assisted implant surgery can improve the accuracy and reproducibility of implant positioning, particularly when multiple implants must be placed in a coordinated full-arch rehabilitation. Nevertheless, deviations between planned and actual implant positions may occur; hence, careful verification of guide fit, appropriate surgical execution, and adequate safety margins remain essential.[2],[4] The integration of digital planning with surgical and prosthetic workflows also facilitates interdisciplinary communication, procedural coordination, and the fabrication of restorations that are more closely aligned with the intended implant positions.(Fig-5)

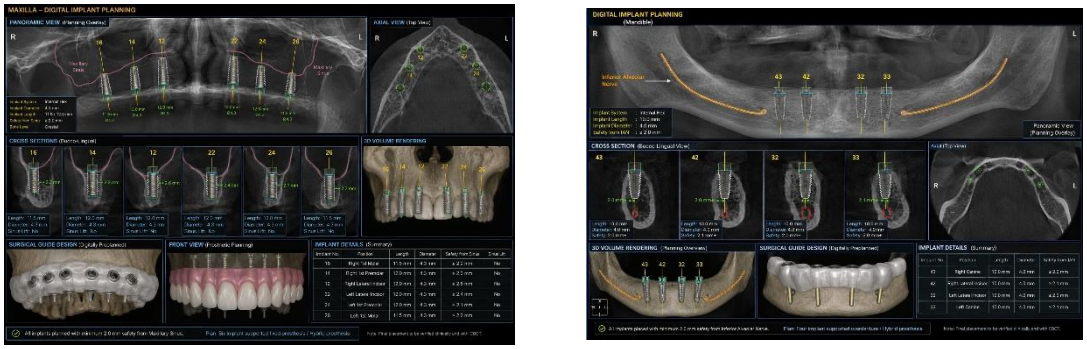

Fig-5 Digital Implant treatment planning

Furthermore, a coordinated workflow extending from extraction of compromised teeth to implant placement and subsequent prosthetic loading requires careful consideration of residual bone volume, primary implant stability, soft-tissue conditions, and patient-related risk factors. Digital planning can assist in coordinating these stages; however, the timing of implant placement and loading must be determined according to the individual clinical situation rather than digital accuracy alone.[5]

The present case report describes full-mouth rehabilitation following extraction of severely compromised teeth using a digitally planned, computer-guided implant placement protocol, followed by prosthetic restoration. It highlights the clinical application of digital integration in treatment planning, surgical execution, and prosthetic rehabilitation, emphasizing the importance of a prosthetically driven workflow in achieving functional and esthetic outcomes.

CASE REPORT

1. Patient History and Clinical Evaluation

Mr. Velmurugan, a 45-y male, reported to the Department of Periodontology with the chief complaint of generalized tooth mobility and masticatory discomfort involving the maxillary and mandibular anterior and posterior regions for approximately one year. The patient had a history of type 2 diabetes mellitus for the past six years and was receiving antidiabetic medication. His glycated hemoglobin (HbA1c) level was recorded as 6.5%, indicating relatively controlled glycemic status at the time of presentation. Intraoral hard-tissue examination revealed missing teeth in relation to 46, 47, 42, 41, and 31(Fig-2).

Fig-2 Intra oral image

Periodontal examination revealed generalized severe clinical attachment loss of up to 10 mm, deep periodontal pockets, (Fig-1) gen bleeding on probing, pathological tooth migration, and advanced tooth mobility ranging from Grade II to Grade III.

Fig-1 Pre-op OPG

Based on the clinical and radiographic findings and the 2017 World Workshop classification of periodontal and peri-implant diseases and conditions, the patient was diagnosed with generalized Stage IV, Grade C periodontitis.

2. Treatment Planning and Digital Workflow

Considering the advanced periodontal breakdown and the compromised condition of the remaining dentition, extraction of all hopeless teeth in sequential quadrant wise manner, followed by full-arch fixed implant-supported rehabilitation, was selected as the treatment approach. The proposed treatment plan, including the surgical and prosthetic procedures, was explained to the patient, and informed consent was obtained prior to treatment.

CBCT and Three-Dimensional Assessment: A preoperative cone-beam computed tomography (CBCT) scan was acquired using a radiopaque marker-containing scan prosthesis derived from the patient's provisional complete denture. This facilitated the assessment of the three-dimensional alveolar bone anatomy and its relationship to the

planned tooth positions.

Computer-Guided Implant Planning: Using dedicated implant planning software, the virtual tooth arrangement was correlated with the underlying bone anatomy to facilitate prosthetically driven implant placement. Implant positions and angulations were planned to optimize available bone engagement, achieve adequate primary stability, and facilitate the planned screw-retained prosthetic rehabilitation.

Surgical Strategy: A computer-guided surgical approach was selected to facilitate the accurate transfer of the virtual implant plan to the clinical setting and support-controlled implant placement following full-mouth extractions.

Implant Distribution: A total of ten endosseous implants were planned, comprising six implants in the maxillary arch and four in the mandibular arch. The mandibular implants were distributed in the canine and second-premolar regions bilaterally. In the maxillary arch, the six implants were distributed across strategically selected anterior and posterior sites according to the prosthetic plan and available bone anatomy.

3. Surgical and Prosthetic Execution

3.1 Surgical Phase: Extractions and Guided Implant Placement

Full-Mouth Extractions: Atraumatic extraction of the remaining maxillary and mandibular teeth was performed under local anesthesia, with careful preservation of the available alveolar bone. Following extraction, the sockets were thoroughly curetted and debrided to remove granulation tissue and residual inflammatory tissue. Complte interim denture was given to the patient to prevent residual alveolar ridge resorption.

Guided Implant Placement: Following extraction and preparation of the surgical sites, six Straumann dental implants were placed in the maxillary arch using the computer-generated surgical guide(Fig-3).

Fig-3 Surgical guide Maxilla, Mandible

Four Straumann implants were placed in the mandibular interforaminal region, with implant angulations planned to optimize the anteroposterior distribution and prosthetic support.

Primary Stability and Immediate Provisionalization: Primary stability was assessed at the time of implant placement, with insertion torque values ranging from 45 to 55 N·cm across the implant sites. These values indicated high initial mechanical stability and supported the clinical decision to proceed with immediate provisionalization. The achieved primary stability, together with the prosthetic plan and occlusal considerations, informed the decision to proceed with the planned loading protocol.

3.2 Prosthetic Phase and Provisional Rehabilitation

Impression and Verification: Following the initial healing period of two weeks,healing abutments given over the site (Fig-7) multi-unit abutments were connected, and an impression was obtained using a precision putty-wash technique with appropriate impression copings.

Fig-7 Healing abutments placed

A clinical verification jig was used to assess the accuracy of the implant-level impression and verify the passive fit of the prosthetic framework before fabrication and delivery.(Fig-8)

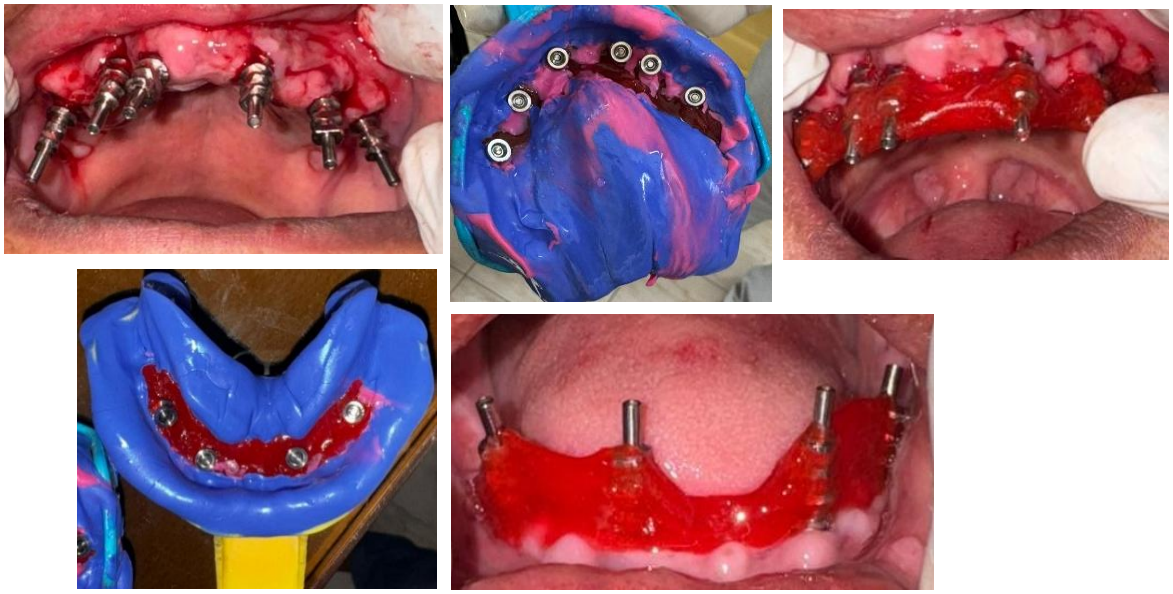

Fig-8 Prosthetic planning and impression

Provisional Prosthesis Delivery: A full-arch fixed provisional prosthesis was delivered following the impression and verification procedures. The prosthesis was evaluated for fit, stability, and occlusal contacts. Occlusal adjustments were performed to eliminate premature contacts and minimize excessive loading during the initial osseointegration period. The occlusal scheme was established according to the patient's prosthetic requirements, with the aim of promoting functional rehabilitation while protecting the newly placed implants.(Fig-9)

Fig-9 Prosthetic restoration before and after

4. Postoperative Evaluation and Clinical Outcomes

Postoperative CBCT Assessment: Postoperative CBCT imaging was used to assess the three-dimensional positions and angulations of the implants in relation to the preoperative virtual plan and surrounding anatomical structures. The imaging findings were evaluated for implant positioning and proximity to relevant anatomical landmarks.(Fig-6)

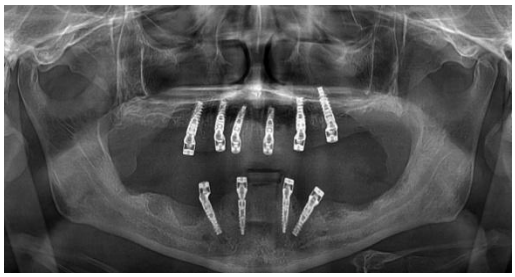

Fig-6 Post-op implant placement

Clinical Evaluation: Early postoperative assessment revealed satisfactory soft-tissue healing without clinically evident suppuration or abnormal marginal inflammation. The patient reported improvement in esthetics, phonetics, and masticatory function following provisional rehabilitation, along with a positive subjective response to the treatment. Continued clinical and radiographic follow-up was required to monitor peri-implant tissue health, implant stability, marginal bone levels, prosthetic function, and the maintenance of oral hygiene during the healing and maintenance phases.

DISCUSSION

The management of Stage IV, Grade C periodontitis in a diabetic patient presents a significant clinical challenge due to advanced periodontal destruction, extensive tooth mobility, and an increased risk of further tooth loss. Diabetes mellitus can adversely influence periodontal healing through hyperglycemia, oxidative stress, and dysregulated inflammatory responses. A systematic review by Naujokat et al. highlighted that implant outcomes in diabetic patients are influenced by glycemic control, with poorly controlled diabetes associated with an increased risk of complications.6 In the present case, extraction of the hopeless dentition followed by full-arch implant-supported rehabilitation was planned to restore function and esthetics after considering the severity of periodontal destruction and the prognosis of the remaining teeth.

The integration of cone-beam computed tomography (CBCT), radiopaque markers,(Fig-4) and computer-guided implant surgery enabled three-dimensional assessment of the available bone and prosthetically driven implant positioning. Digital planning facilitates the evaluation of anatomical limitations and the distribution of

implants according to the intended prosthetic design. systematic review on static computer-assisted implant surgery in full arches demonstrated clinically acceptable accuracy, while emphasizing the importance of maintaining appropriate safety margins during planning.7 In this case, six maxillary and four mandibular implants were planned and placed to support the full-arch fixed prostheses. This approach facilitated coordinated surgical and prosthetic planning; however, implant number alone does not determine success, which also depends on primary stability, implant distribution, bone quality, occlusal loading, and prosthetic design.

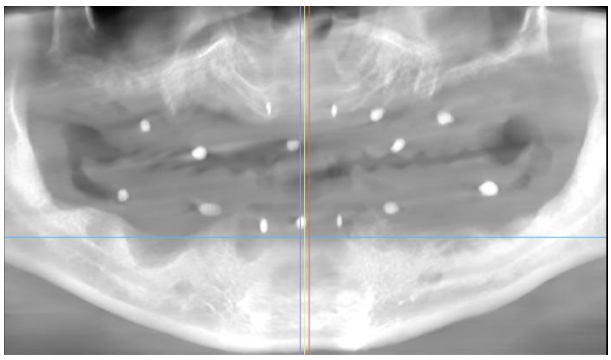

Fig-4 Post extraction CBCT planing with markers

Patients with a history of severe periodontitis require particular attention during implant rehabilitation because of their increased susceptibility to peri-implant diseases. A systematic review and meta-analysis by Serroni et al. reported a significantly higher risk of implant failure, peri-implantitis, and marginal bone loss among patients with a history of periodontitis.8Therefore, eliminating hopeless teeth does not eliminate the patient's underlying susceptibility to inflammatory disease. In diabetic patients, glycemic control, effective plaque control, appropriate prosthetic cleansability, and regular supportive periodontal and peri-implant maintenance are essential to minimize biological complications and preserve implant health.

Immediate loading of full-arch implant-supported prostheses can provide early functional and esthetic rehabilitation in appropriately selected patients. However, successful outcomes depend on adequate primary implant stability, favourable implant distribution, rigid prosthetic splinting, and controlled occlusal loading. Papaspyridakos et al. reported high implant and prosthesis survival rates for fixed complete dental prostheses, while emphasizing the importance of appropriate treatment protocols and maintenance.9 Furthermore, the consensus report by Morton et al. highlighted the importance of patient selection, implant stability, prosthetic design, and occlusal management when determining the suitability of immediate loading.10 These considerations are particularly relevant in diabetic patients with a history of severe periodontitis, in whom systemic risk assessment and long-term supportive care are essential.

Overall, the present case demonstrates the application of digitally guided, prosthetically driven full-mouth rehabilitation in a patient with advanced periodontal destruction and diabetes mellitus. The combination of CBCT-based planning and computer-guided implant placement facilitated the coordinated rehabilitation of both arches. Nevertheless, the long-term prognosis depends on glycemic control, successful osseointegration, favourable occlusal loading, maintenance of peri-implant tissue health, and regular follow-up. Continued clinical and radiographic evaluation is therefore essential to assess the stability and long-term success of the rehabilitation.

CONCLUSION

The full-mouth rehabilitation of a patient with Stage IV, Grade C periodontitis and

diabetes mellitus using a digitally planned, guided immediate-loading protocol (6 upper, 4 lower implants) is a highly predictable and efficient treatment modality. By planning accurate 3D diagnostics, computer-guided surgery, and immediate fixed prosthodontics, clinicians can successfully restore function, esthetics, and long-term oral health to patients with severely compromised dentitions.

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