

Digital Precision, Human Design: A Prosthetically Oriented Guided Approach to Implant Placement- A Case Report

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Abstract

Prosthetically-driven guided implant surgery has transformed modern dental implantology, offering improved accuracy, predictability, and patient outcomes. This case report presents the clinical workflow and outcome of a digitally planned implant placement in the mandibular right first molar region, highlighting the integration of advanced imaging and planning technologies in routine practice. A fully digital approach was utilized, beginning with cone-beam computed tomography (NewTom VG-one). Virtual implant planning was carried out with a focus on prosthetic considerations, ensuring ideal implant angulation, depth, and emergence profile in relation to the planned final restoration.

A customized 3D-printed surgical guide was fabricated based on the digital plan and used during surgery to direct precise implant placement. The procedure was minimally invasive, with no complications, and resulted in excellent primary stability. Postoperative assessment included superimposition of pre- and post-surgical data using digital analysis software, which revealed minimal deviation from the planned implant position, confirming the accuracy of the guided approach.

The outcome demonstrated favorable soft tissue healing and an optimal prosthetic profile, facilitating a natural and functional restoration. This case supports the growing body of evidence that digital planning and guided surgery improve surgical precision, reduce chair time, and contribute to long-term prosthetic success.

Importantly, it emphasizes the value of a prosthetically-driven approach in achieving both functional and aesthetic outcomes.

Keywords: Guided implant surgery, prosthetically-driven implantology, digital workflow, CBCT, surgical guide, implant accuracy, implant planning.

Introduction

Dental implantology has witnessed remarkable advancements over the past few decades, with digital technology playing a pivotal role in transforming traditional surgical and restorative protocols. One of the most significant developments is the introduction and growing adoption of prosthetically-driven guided implant surgery. This approach marks a departure from the conventional freehand method, emphasizing meticulous planning based on the final prosthetic outcome, and utilizing digital tools to achieve highly accurate and predictable results.

In traditional implant placement, clinicians often rely on clinical judgment, two-dimensional radiographs, and tactile feedback to determine the optimal implant position. While experienced clinicians can achieve satisfactory outcomes, this method carries a greater risk of implant malposition, especially in areas with limited visibility or complex anatomical features. Suboptimal implant angulation or depth can compromise prosthetic rehabilitation, lead to biomechanical complications, and in some cases, necessitate revision surgery.

The prosthetically-driven approach addresses these limitations by integrating restorative planning into the surgical phase. It begins with the desired final prosthesis and works backward to plan the ideal implant position in three dimensions. Digital workflows, combining cone-beam computed tomography (CBCT) with intraoral optical scanning or primary impressions with tabletop scanning, provide a comprehensive, accurate

representation of the patient's anatomical and dental structures. This fusion of data allows for virtual planning of the implant in relation to bone volume, soft tissue contours, and the planned prosthetic emergence profile.

Virtual planning is then translated into the clinical setting through the fabrication of a customized surgical guide, usually manufactured using 3D printing technologies. These guides help position the implant with high accuracy according to the pre-defined plan, minimizing the risk of deviation and enhancing surgical precision with a master guided kit, which ensures controlled depth, angulation, and drill sequence alignment during osteotomy. Numerous studies have shown that the guided implant surgery can significantly reduce positional discrepancies, improve esthetic and functional outcomes, and reduce surgical time and morbidity.

From a restorative perspective, prosthetically-driven placement ensures that implants are positioned to support the optimal contour, function, and hygiene accessibility of the final prosthesis. This is particularly crucial in posterior regions such as the mandibular molar area, where functional load is high and anatomical considerations—such as proximity to the mandibular canal—demand careful preoperative assessment. Poor angulation in such regions can lead to complications, including nerve injury, compromised osseointegration, or prosthetic misfit.

This case report presents the clinical workflow and outcome of an implant placed in the mandibular first molar region (tooth 46) using a prosthetically driven guided approach. It illustrates the practical application of digital planning and guided surgery in a real-world clinical scenario, demonstrating the accuracy, efficiency, and prosthetic success that can be achieved through this technique. By highlighting each stage of the process—from diagnostic imaging and digital planning to guided

placement and postoperative evaluation—this report aims to contribute to the growing evidence supporting guided implantology as a standard of care in modern dental practice.

Case Report

A 44-year-old male patient visited the Department of Prosthodontics at H.K.E.S's S. Nijalingappa Institute of Dental Sciences and Research, Kalaburagi, with the chief complaint of a missing tooth in the lower right back region. The patient had previously undergone the extraction of tooth 46 due to extensive dental caries. Clinical examination revealed a completely healed edentulous site with adequate soft tissue coverage and no signs of active infection or inflammation.

The patient expressed interest in a fixed prosthetic solution and specifically requested a minimally invasive surgical approach. After discussing all available treatment options—including fixed partial dentures and implant-supported restorations—the patient elected to proceed with implant placement using a prosthetically-driven guided surgical technique.

A complete medical history was reviewed, and the patient underwent routine preoperative investigations to rule out any systemic conditions that could contraindicate implant therapy. The results confirmed systemic fitness for surgery. A cone-beam computed tomography (NewTom VG-one) scan of the mandibular arch was performed to assess bone volume, density, and the position of vital anatomical structures such as the inferior alveolar canal. [Fig 1]

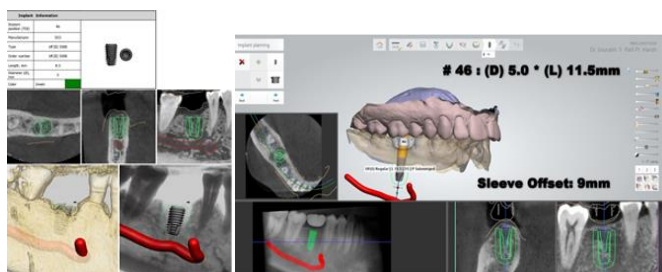


Figure 1: Virtual Planning of the Implant

A primary impression of the mandibular arch was made using irreversible hydrocolloid material (imprint), and a diagnostic cast was fabricated. The cast was scanned using a tabletop scanner (medit), and the resulting data were converted into STL format. This STL file was then merged with the DICOM data obtained from the CBCT scan using digital implant planning software. Virtual implant planning (3 shape) was carried out, ensuring ideal three-dimensional implant positioning based on the desired prosthetic emergence profile and anatomical limitations.

A customized surgical guide was digitally designed and fabricated using a 3D printer with biocompatible resin material. The guide was sterilized and verified intraorally for passive fit and stability before the surgical procedure. [Fig 2]

Under local anesthesia, osteotomy was performed through the surgical guide using a master guided kit following the standardized sequential drilling protocol recommended by the implant manufacturer [Fig 3]. A dental implant of 5x11.5mm (Dio navi UF II) was placed using the guided system, ensuring that its angulation, depth, and trajectory precisely matched the digital treatment plan [Fig 4, 5, 6]. The implant exhibited excellent primary stability, and a healing abutment was placed on the same day, allowing for a single-stage protocol [Fig 7].



Figure 2: Fit of The Surgical Guide Intraorally



Figure 3: Dio Navi Master Kit



Figure 4: Dio Navi Uf Ii Implant Fixture & Healing Abutment



Figure 5: Osteotomy Preparation Using Surgical Guide

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A follow-up CBCT scan was obtained and superimposed over the preoperative plan using dedicated digital software to assess the accuracy of implant placement [Fig 8]. The analysis demonstrated excellent congruence between planned and actual implant positions, confirming the high precision of the guided surgical approach. Following a healing period of three months, the final prosthesis was successfully delivered [Fig 9].

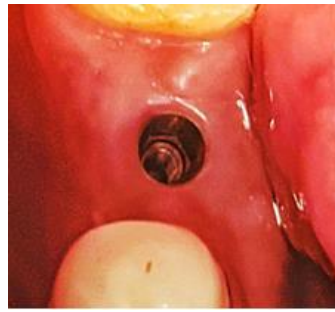


Figure 6: Implant Placement Done Using Surgical Guide



Figure 7: Healing Abutment Placed

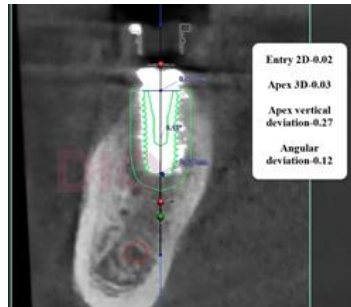


Figure 8: Superimposition of Planned & Placed Implant



Figure 9: Final Prosthesis Delivered

Results

Post-operative assessment revealed a coronal deviation of just 0.02 mm, an apical deviation of 0.27 mm, and an angular deviation of 0.12°. These values not only reflect technical accuracy but also the synergy between careful

planning, digital diagnostics, and meticulous surgical execution.

Discussion

Implant placement in the posterior mandibular region presents several clinical challenges, including limited visibility, dense cortical bone, and proximity to vital anatomical structures such as the inferior alveolar nerve. Traditionally, freehand placement in such areas can result in positional inaccuracies, compromising both function and esthetics. The introduction of computer-guided implant surgery, particularly when driven by prosthetic considerations, has significantly improved clinical predictability and surgical outcomes.

In the present case, a digital workflow was employed, incorporating CBCT imaging and 3D surgical guide fabrication. This digital synergy allowed precise planning of implant angulation, depth, and location in accordance with the final prosthetic design. The use of a static surgical guide helped transfer the virtual plan to the surgical field with minimal deviation.

Numerous studies support the advantages of guided implant surgery. Van Assche et al. (2012) and D'haese et al. (2012) reported that guided approaches significantly reduce horizontal and vertical deviations compared to freehand techniques. Furthermore, single-stage guided implant surgery, as performed in this case, has been associated with reduced surgical time, faster healing, and improved patient comfort (Vercruyssen et al., 2014).

The postoperative CBCT superimposition confirmed high placement accuracy, validating the effectiveness of the guided approach. Clinically, the implant showed excellent primary stability and was well-positioned to support a prosthesis with an ideal emergence profile. The minimally invasive nature of the guided technique also contributed to patient satisfaction and reduced postoperative discomfort.

However, despite its advantages, guided surgery requires meticulous planning and technical proficiency. Errors in digital merging, guide design, or fabrication can propagate to clinical inaccuracies. Therefore, clinicians must be thoroughly trained in digital workflows and case selection must be appropriate.

This case reinforces the value of prosthetically driven guided surgery in achieving functionally and esthetically favorable outcomes in implant therapy.

Conclusion

Prosthetically-driven guided implant surgery represents a reliable and efficient treatment modality in modern dental implantology. By integrating digital planning with precise surgical execution, clinicians can achieve optimal implant positioning, enhance prosthetic outcomes, and reduce the risk of intraoperative complications. This case highlights the importance of digital workflows in achieving accurate, minimally invasive, and patient-centered implant placements, particularly in anatomically sensitive regions such as the posterior mandible.

Despite the clear advantages, it is important to note that the successful implementation of guided surgery requires comprehensive planning, appropriate case selection, and familiarity with digital tools. Errors in the planning phase or inaccuracies in guide fabrication can propagate through to the surgical outcome. Therefore, a thorough understanding of digital workflows and surgical protocols is essential for achieving consistent and reliable results.

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