Digital Stent Fabrication for Guided Implant Surgery: A Case Report

Abstract:
This case report highlights the role of digital technology in implant placement through the use of a computer-designed surgical stent. A fully digital workflow combining intraoral scanning, virtual implant planning, and 3D-printed surgical guide fabrication allowed for precise, minimally invasive implant placement in a mandibular edentulous patient. The use of a digital stent enhanced surgical accuracy, reduced chairside time, and improved patient comfort.

Key-words: Digital implant, Surgical stent, Prosthetically driven implant

Introduction:

Advancements in computer-aided design and computer-assisted manufacturing (CAD/CAM) have revolutionized implant dentistry, providing clinicians with tools for accurate, prosthetically driven implant placement. By integrating cone-beam computed tomography (CBCT) data with intraoral or model scans, it is possible to generate stereolithographic surgical templates that replicate the preplanned implant trajectory and angulation. Digital guides reduce the risk of anatomical complications, enhance precision, and allow flapless or minimally invasive surgery, improving patient outcomes and comfort [1–3].

This case report demonstrates the fabrication and clinical application of a digitally designed surgical stent for implant placement in an edentulous mandibular arch.

Case Presentation:

A 65-year-old male patient reported to the Department of Prosthodontics with a chief complaint of missing teeth in the lower arch and a desire for fixed replacement. Intraoral examination revealed a completely edentulous mandibular arch with healthy mucosa and adequate bone height and width to support implant placement. A preoperative orthopantomograph (OPG) confirmed sufficient bone availability in the interforaminal region.

After discussing various treatment options, the patient opted for an implant-supported fixed prosthesis using a digitally fabricated surgical stent to achieve precise, prosthetically driven implant placement.

The case was then planned and executed following a digital guided surgery protocol utilizing a computer-aided design and computer-assisted manufacturing (CAD/CAM) workflow to ensure accuracy and predictability of implant positioning.

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Procedure:

Step 1: Preoperative Evaluation:

- Intraoral photographs were made.
- Bone quality and quantity were assessed using **CBCT and OPG** to determine the optimal implant sites and angulations.

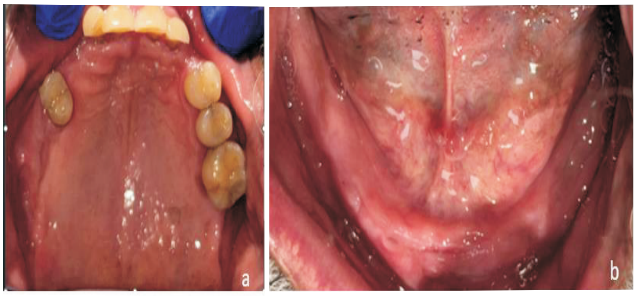

Figure 1: Preoperative Intraoral View of (a) Maxillary and (b)Mandibular Arch

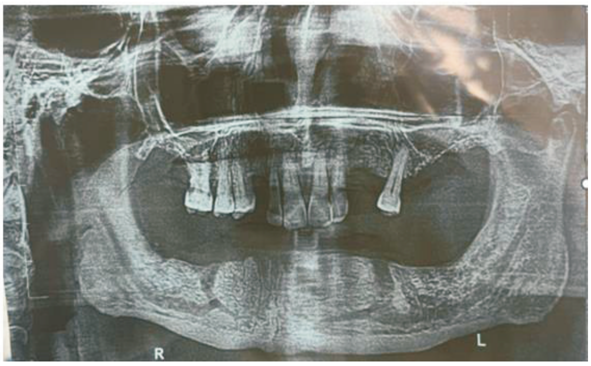

Figure 2: Preoperative OPG (orthopantomograph)

Step 2: Digital Workflow and Virtual Planning:

- An **intraoral scan of the mandibular arch** was performed using a digital scanner.(Figure 3)
- The scanned model was imported into **implant planning software (Exocad)** for virtual implant positioning according to prosthetic and anatomic considerations.
- Implant sites were virtually planned in the mandibular region with appropriate angulation and depth [4].

Figure 3: Intraoral Scan Data of Mandibular Arch

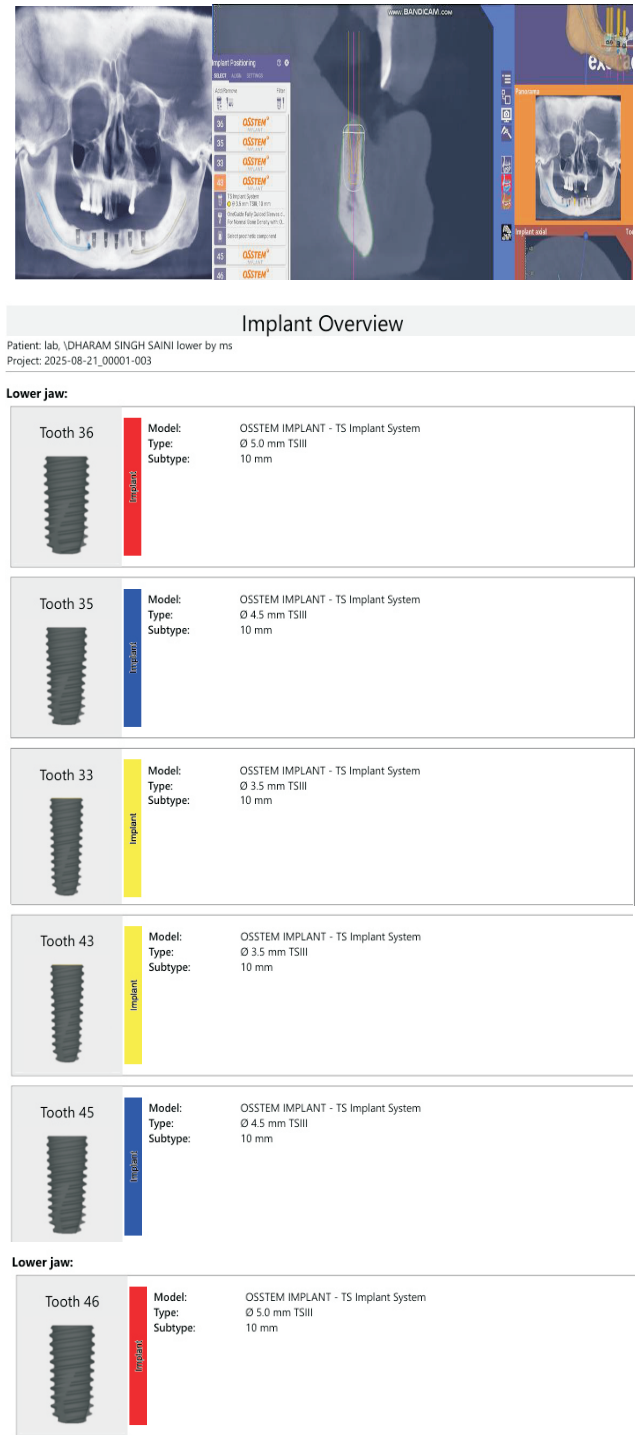

Figure 4: Virtual Implant Planning on CAD Software (Exocad)

Step 3: Surgical Stent Fabrication

- The finalized design was 3D printed using biocompatible resin through a stereolithographic process.(Figure 6)
- The printed stent was verified intraorally for passive fit and stability.

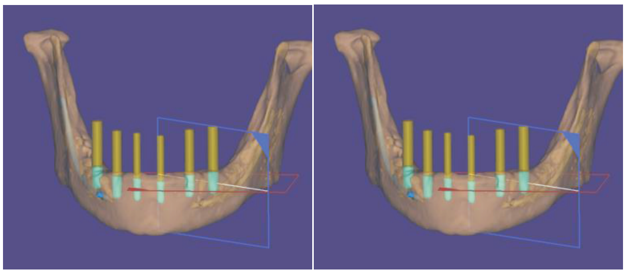

Figure 5: Digital Designing of the Surgical Stent]

Figure 6: 3D-Printed Stent

Step 4: Surgical Phase

- Under local anesthesia, a **flap elevation** was performed to expose the ridge.
- The **OSSTEM oneGuide kit** (Figure 7)was used for guided osteotomy preparation.
- The stent was **stabilized with anchorage pins**, ensuring accuracy during drilling.(Figure 8)
- Sequential osteotomy drilling was performed through the **metal sleeves** of the guide, maintaining the planned depth and angulation.
- Implants were placed with **cover screws**, and the flap was sutured. (Figure 11)
- **Postoperative OPG** confirmed ideal implant positioning. (Figure 12)

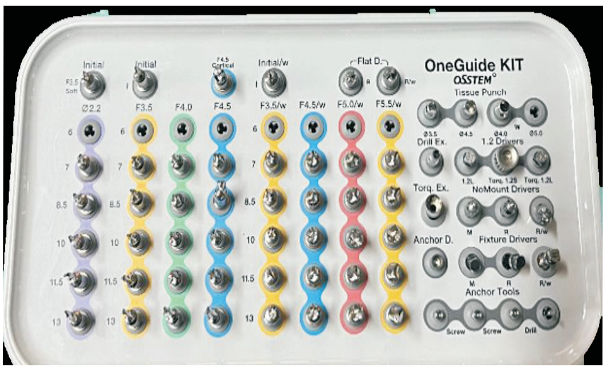

Figure 7: The OSSTEM oneGuide kit

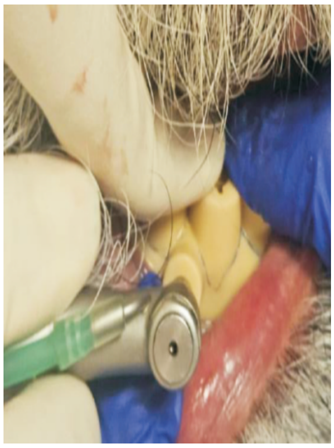

Figure 8: Stabilization of Stent with Anchorage Pins

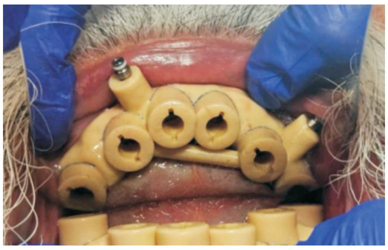

Figure 9: Placement of digital guide intraorally after flap elevation

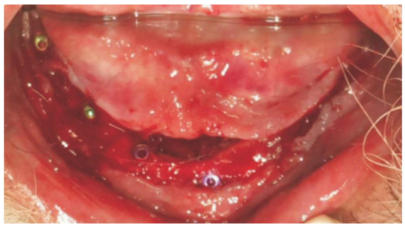

Figure 10: Implant Placement Through the Surgical Stent

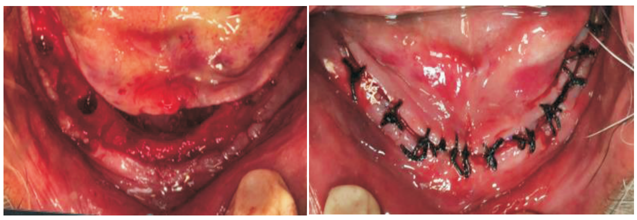

Figure 11: Cover screw placement and Suturing

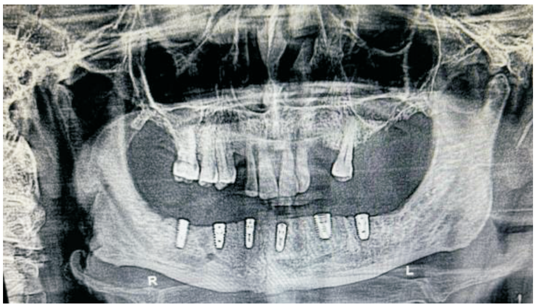

Figure 12: Postoperative OPG Confirming Implant Position

Results:

- The digital workflow accurately transferred the virtual plan to the clinical procedure.
- Implants were placed at the desired angulation and depth without intraoperative complications.
- Postoperative healing was uneventful, with minimal swelling and discomfort.
- The patient was satisfied with the procedure's comfort and reduced chairside duration.

Discussion:

Digitally guided implant surgery merges prosthetic-driven planning with anatomical precision, ensuring predictable implant positioning and optimal restorative outcomes. The CAD/CAM-guided workflow integrates CBCT and intraoral scan data to generate an accurate three-dimensional virtual plan, which can be precisely replicated clinically through stereolithographic surgical stents [5,6]. This approach minimizes operator-dependent variability and improves accuracy compared with conventional freehand techniques.

Accuracy and Precision:

Studies have shown that guided implant placement achieves mean linear deviations below 1.5 mm at the apex and angular deviations under 4°, demonstrating superior accuracy and safety [7,8]. Such precision is particularly advantageous in edentulous or anatomically challenging regions, where visual and spatial references are limited. In the present case, the OSSTEM oneGuide system allowed controlled osteotomy preparation through sequential drill sleeves, ensuring optimal depth and angulation. The rigid stent design provided excellent stability and minimized manual error, consistent with Vercruyssen et al., who reported that guided systems significantly enhance reproducibility and placement accuracy [8].

Clinical Advantages:

Digitally guided surgery offers several well-documented benefits:

- Enhanced accuracy and predictability of implant positioning, minimizing deviation from planned trajectories [5,7]. • Reduced surgical time and tissue trauma, leading to faster healing, less discomfort, and improved postoperative outcomes [6]. • Flapless or minimally invasive procedures that preserve periosteal blood supply and soft-tissue integrity, reducing postoperative morbidity [9,10]. • Prosthetically driven implant positioning that supports the definitive restoration, improving emergence profiles and occlusal harmony for long-term functional stability [4,5].

Limitations Despite its advantages, certain limitations must be acknowledged:

- High initial investment in digital equipment.
- Learning curve associated with planning software.
- Potential cumulative errors during CBCT scanning, data merging, or 3D printing if strict verification protocols are not followed [6,9].

To mitigate these risks, clinicians should ensure intraoral verification of the guide's passive fit before initiating osteotomy. A meticulous, stepwise workflow with validation at each stage helps minimize deviations and ensures reproducible outcomes.

Conclusion:

Digital stent–guided implant placement is a precise, minimally invasive, and prosthetically driven technique that enhances the accuracy and predictability of implant rehabilitation. By integrating CBCT imaging, intraoral scanning, and CAD/CAM planning, clinicians can transfer virtual implant positions to the surgical site with high fidelity. This approach minimizes intraoperative complications, ensures optimal implant orientation, and improves postoperative comfort. It also shortens surgical duration and enhances patient satisfaction by reducing invasiveness and recovery time. With continuing digital advancement, computer-guided implant surgery is rapidly becoming the clinical standard, especially for complex or edentulous cases.

Future innovations such as AI-assisted virtual planning and real-time navigation systems are expected to further refine this technology. These developments will continue to improve precision, efficiency, and long-term implant success. The combination of digital planning and 3D-printed surgical guides thus represents a transformative step toward fully predictable, patient-centered implant dentistry.

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