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# Stackable surgical guides

## for predictable maxillary and mandibular full arch rehabilitation: A completely digital workflow

Scientific Paper

## Abstract:

**Objectives:** To describe the clinical protocol and report the outcome of using stackable surgical guides within a completely digital workflow for a simultaneous bi-maxillary full-arch rehabilitation.

**Methods:** A 59-year-old male patient with fully edentulous maxillary and mandibular arches was treated following a meticulous, prosthetically driven approach. The treatment involved comprehensive digital planning to fabricate a series of 3D-printed stackable surgical guides. These guides were used sequentially for bone reduction, osteotomies, and precise implant placement in both arches during a single surgical session, followed by the delivery of provisional prostheses.

**Results:** The simultaneous rehabilitation of both arches was successfully completed with high fidelity to the initial digital plan. The bone reduction, implant osteotomies, and prosthetic restoration were executed predictably, and no significant intraoperative or postoperative complications were observed. The patient received fixed full-arch provisional restorations two months after surgery, achieving the planned functional and esthetic goals.
Conclusions: The use of stackable surgical guides within a completely digital workflow is a safe, predictable, and viable treatment modality for complex, simultaneous bimaxillary rehabilitations. This technique provides an accurate and efficient protocol that can lead to successful clinical outcomes.

**Clinical Significance:** This paper demonstrates the first documented successful simultaneous full-mouth rehabilitation using stackable surgical guides. Its clinical significance is validating a safe, predictable, and viable protocol for highly complex bimaxillary cases, ensuring precise, prosthetically-driven outcomes and minimized complications for both arches, thereby enhancing treatment confidence for clinicians.

## INTRODUCTION:

As populations age, tooth loss becomes more prevalent, resulting in functional, nutritional, aesthetic, and psychological challenges. Completely edentulous patients often seek to enhance their quality of life, and fixed prostheses provide an effective solution by restoring masticatory function and fulfilling higher aesthetic demands.[1] Despite advances in dental implantology and restorative techniques, several challenges still persist in achieving foreseeable outcomes that satisfy both esthetic and functional criteria. The majority of these challenges arise from accurately positioning the planned implants in the patient's oral cavity.[2, 3]

Although guided surgery proves to be accurate when compared to free-hand implant placement[4], executing it in a practical environment introduces numerous variables that may jeopardize the desired result. Differences in patient anatomy, variable bone densities, different surgical approaches, and deviations from the pre-surgical plan can all influence the precise translation of the digital blueprint into the actual procedure.[2, 5-8]

These challenges underscore the necessity for ongoing improvements in digital technologies and surgical procedures to reduce disparities between planning and execution, guaranteeing the best outcomes for patients [7, 8]

To address these challenges, digital dentistry has emerged as a substantial advancement. Dentists can offer more precise, efficient, and minimally invasive treatments by utilizing digital imaging, stereolithography, and digital treatment planning. One of these advancements is the use of a predictable full digital workflow using stackable surgical templates for complete arch rehabilitation with implant-supported fixed restorations. [9, 10]

The completely edentulous arch poses a great clinical challenge even to experienced clinicians, especially when placing implants freehand. This is due to the variation in the jaw topography, which may result in malpositioned implants or even injury to vital anatomical structures. Hence, 3D imaging and pre-surgical planning allow the clinician to carefully evaluate the bone morphology, localize vital anatomical structures, and come up with an accurate surgical plan with optimum implant positions before the scalpel touches the patient.[11]

To achieve optimal implant placement in edentulous patients with non-uniform post-extraction bone, guided bone reduction may be indicated to create a suitable ridge for implant support and precise drill guide utilization.[11-14] Bone reduction or ostectomy is defined as “the excision of bone or a portion of a bone, usually using a saw or chisel, for the removal of a sequestrum, the correction of a deformity, or any other purpose.”[15] 15 Ostectomy should never be arbitrary; the procedure is governed by the anticipated occlusion, tooth positions, functional and esthetic needs of the patient. The amount of bone to be reduced should always be carefully planned to avoid possible surgical and prosthetic complications. [12]

Therefore, incorporating stackable surgical guides in the fully digital workflow allows the clinician to accurately determine the amount of bone to be reduced, in relation to the expected prosthetic plan, while maintaining sufficient bone height and width for optimum implant placement.[11]

This case report outlines a fully digital approach to rehabilitating fully edentulous maxillary and mandibular arches. To enhance the aesthetic and functional outcomes, stackable surgical guides were used to ensure precise implant placement during a minimally invasive procedure.

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## CLINICAL REPORT

## Stage 1: Global Statement of The Patient[10]

A 59-year-old Caucasian male was referred to the practice; his chief complaint was “I don’t have any teeth,” and his request was “I want to have any retentive dentures”. The patient had a full tooth extraction in July 2023 with no history of parafunctional habits. His medical history includes depression and congestive heart failure, for which he was hospitalized for 3 weeks in 2020. The patient is currently on Metoprolol, Abilify, and Jardiance. No history of allergies. The patient abstains from smoking, alcohol consumption, and recreational drug use. Upon clinical examination, the TMJs showed a full range of motion, no tenderness upon palpation, no clicking, popping, or crepitus, and no mandibular deviation upon opening or closing.

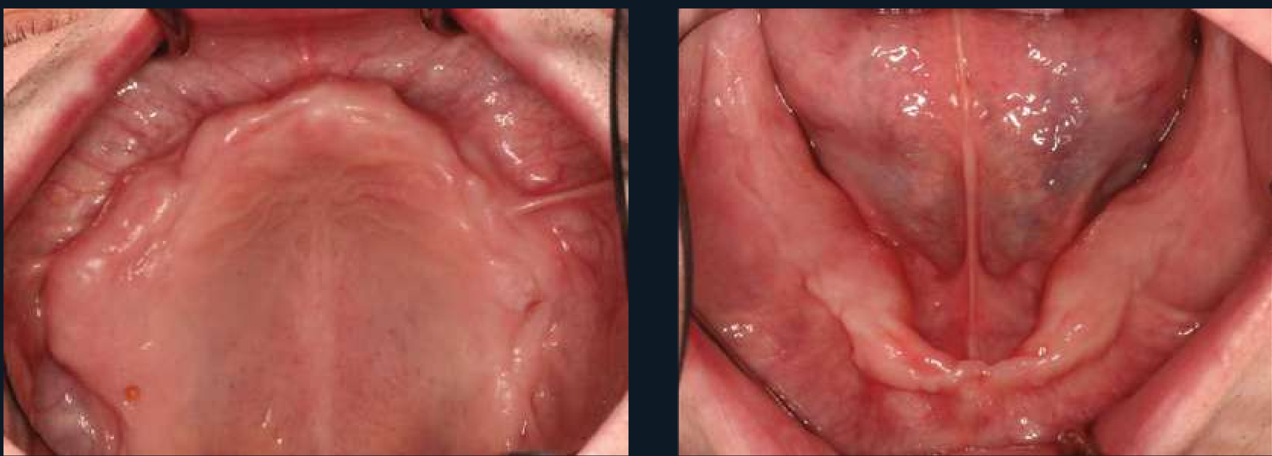
## Stage 2: Data Collection and Denture Delivery

Extraoral, intraoral photographs (Fig. 1), and dual scans (CBCT with and without the denture). By solely scanning the removable prosthesis, it was feasible to overlay it with the patient's CBCT scan, enabling the visualization of the future prosthetic plan aligned with the surgical approach.[16]

### *Profile*

A. Extraoral Pictures.

## *Side*



B. Intraoral photographs of the maxillary and mandibular arches.

## Complete removable dentures (Fig. 2)

were fabricated for the following reasons:

- Evaluation of the bite and esthetics.
- Provide immediate function allowing the patient to speak and smile normally.
- Aim to increase the patient's acceptance of the upcoming procedure.
- Will serve as a template for proper implant planning.
- To be used as a provisional restoration after the implant surgery, soft tissue conditioning, and alleviating swelling and discomfort.
- It can make the overall treatment process more comfortable and predictable for the patient.

A. Smiling patient with the provisional restoration.

B. The upper and lower dentures in maximum intercuspation.

## Stage 3: Digital Planning:

After evaluating the soft and hard tissue relationships, virtual implant planning (Fig. 3) was performed using implant planning software (RealGuide ver. 5; 3DIEMME). The planning process incorporated the sleeve offset length into the implant drill depth calculation. [10] Analysis of the patient's occlusal situation informed the positioning of the implants, guided by the prosthetic design. Considerations included accommodating the future prosthesis and various anatomical factors such as the inferior alveolar nerve, the mental foramen, and bone ridge thickness. Finally, bone segmentation was performed, followed by digital design of the stackable surgical guides.

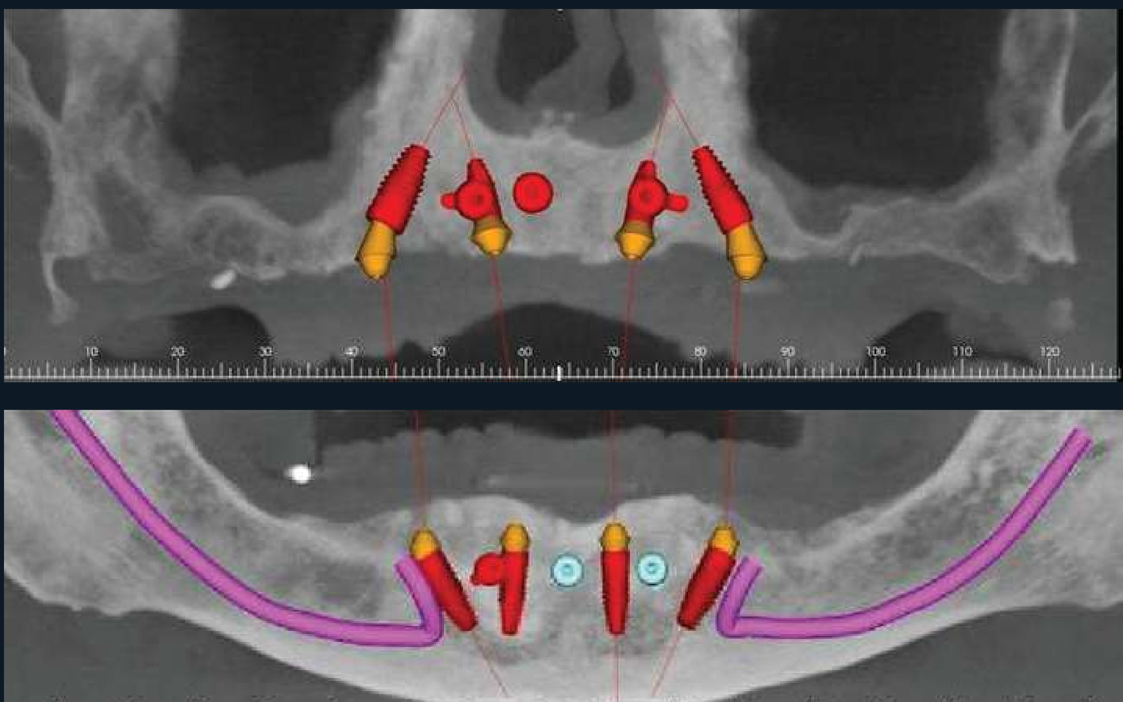



Figure 3. Reconstructed panorama showing the position of the virtually planned implants.

## Stage 4: Surgical Guide Manufacturing:

The surgical guide was designed and fabricated from three stackable parts (Fig. 4,): a bone foundation guide, a bone reduction guide, and an osteotomy guide. All the digital implant planning, guide design, fabrication, and delivery were performed by ITXPros Dental Lab, Tampa, Florida.

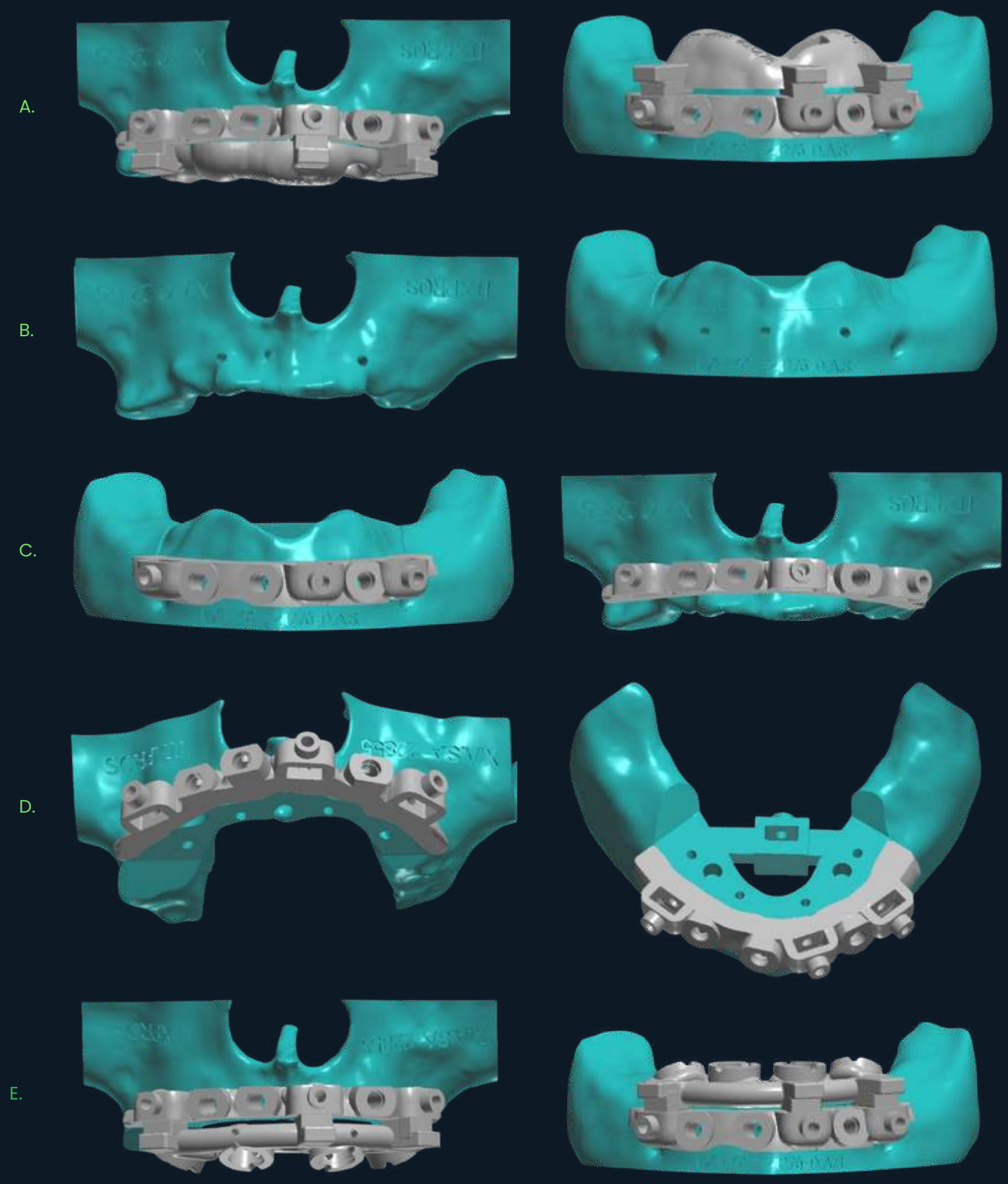



Figure 4. A, Bone segmentation of the maxillary arch and mandibular arches, respectively. B, Bone foundation guide with the crest vertical verifier. C, The bone foundation piece without the vertical verifier. D, Planned bone reduction. E, Osteotomy guide attached to the bone foundation guide.

## Stage 5: The Surgical Procedure:

After the incision, a full-thickness flap was reflected, and the bone foundation guide was then seated and supported by fixation pins (Fig. 5-A). The bone vertical verifier was then seated to ensure proper positioning of the foundation piece (Fig. 5-B). After verification, the verifying piece was removed followed by bone reduction (Fig. 5-C). After bone reduction was completed, the osteotomy guide was then attached to the bone foundation piece (Fig. 5-D). Implant drilling was performed while gradually increasing implant size and under double irrigation The last step was the attachment of the abutment timer piece (Fig. 5-E) to the bone foundation guide.

Following implant placement (Fig.5-F), suturing was performed using resorbable sutures. (Fig. 5-G)

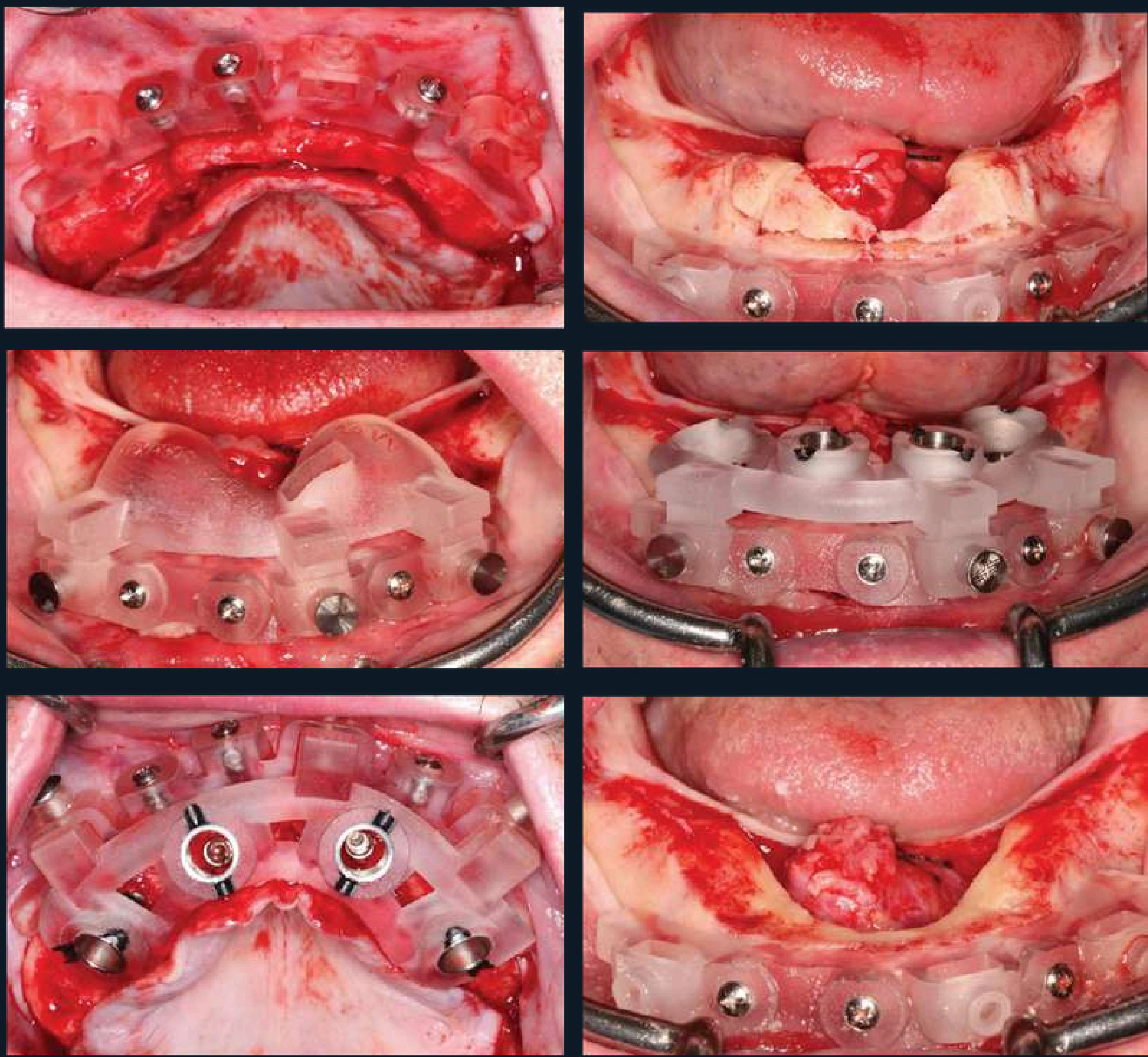
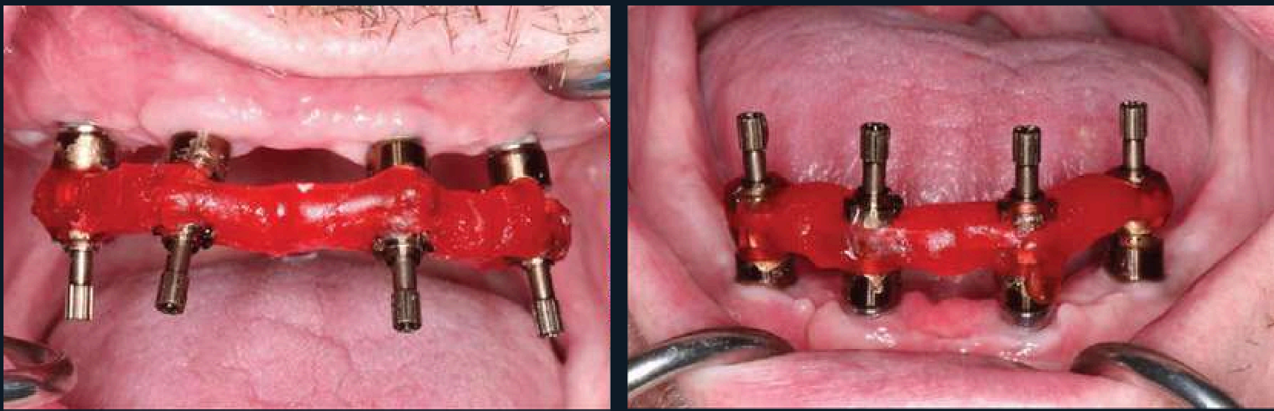


Figure 5. A, The bone foundation piece for the maxillary and mandibular arches, respectively. B, The bone foundation guide with the crest vertical verifier. C, Completed bone reduction. D, The osteotomy guide attached to the bone foundation guide. E, Abutment timer. F, Implant placement. G, Suturing.

## Stage 6: The Prosthetic Stage:

After the implants had healed for two months, they were uncovered, and impressions were taken using the open-tray technique with verification jigs (Fig. 6) to precisely record the implant positions. Zirconia final restorations were then delivered, and the patient was extremely happy with the final result. (Fig. 7)



A. B.

Figure 6. Verification jigs. A, Maxillary arch. B, Mandibular Arch.

Zirconia final restorations were then delivered,
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Figure 7. A, Maxillary and mandibular final zirconia restorations in occlusion. B, Extraoral picture of the patient after delivery of the final restoration.

B.

A.

## DISCUSSION

More than 20 years ago, manual bone reduction techniques were first documented for ideal implant placement with the Brånemark Novum implant system. The system was dedicated for the immediate loading of patients with mandibular edentulism. This procedure involved reducing bone in the anterior mandibular symphysis area to create adequate bone width for implant placement using a free-hand technique with twist reamer drills and sterile saline solution. The height of the alveolar crest was adjusted to achieve around 7 mm of bone width for the surgical implant guide templates.[17, 18]

As previously discussed, completely edentulous patients pose the greatest challenge, especially with the presence of bone undercuts and prominences that may compromise the accuracy and the fit of the desired prosthesis, by altering the maxilla-mandibular relationship and subsequently altering the proper alignment of artificial teeth. [19] Bone reduction has emerged as an essential surgical step to achieve the needed height and width of bone for implant placement in cases of knife-edge alveolar ridges. This procedure allows for increased restorative space without compromising phonetics, aesthetics, or vertical occlusal dimension (VDO). [14, 19-21]

Digital dentistry has made it possible to link all the surgical components and steps, from the amount of bone to be reduced, the drill guide, and linking them to the prosthesis on the day of the surgery [13]. To place dental implants in a way that truly serves the final restoration, the prosthetic outcome must be planned and approved beforehand. With an edentulous patient, it is indispensable to have a diagnostic wax-up or virtual tooth set-up at the proper centric and vertical dimension of occlusion that will govern the strategic placement of dental implants.. [11, 20, 22, 23]

In our case, the patient was fitted with upper and lower well-fitted, complete, removable dentures. These dentures served to establish a firm occlusion, were incorporated into the dual scan protocol, and provided the prosthetic reference for implant planning and placement.[24] The denture also served as an interim prosthesis during the healing phase following implant placement, to allow for soft tissue healing, maintain vertical dimension, centric occlusion, and guidance. [25-28]

Surgical guides play an invaluable role in assessing the necessary amount of bone reduction during surgical procedures, particularly in cases where substantial bone reduction is needed.[19, 29] Unlike traditional free-hand techniques, surgical guides offer superior precision, safety, efficiency, and predictability.[11, 12] By eliminating the guesswork inherent in free-hand techniques and basing treatment plans on specific bone anatomy, vital anatomical structures, and restorative needs, surgical guides enable the achievement of more successful and predictable treatment outcomes. [11]

In spite of the promising concept of stackable guides, various factors can contribute to potential errors throughout the treatment process, including CBCT acquisition, wax-up procedures, distortions during guide manufacturing, 3D printer calibration, surgical procedures, guide anchoring, and the stacking of different components. The experience of the practitioner is essential to closely monitor each step of the surgical process and effectively address any problems or mistakes that may occur.[23, 30-32] Also, the technique depends solely on the accurate initial positioning of the bone foundation guide. If there is any imprecision in the positioning of the foundation component, that error will translate through to the implant positioning, compromising the outcome of the entire procedure. [33]

Although there is limited high-quality evidence supporting the use of stackable surgical guides, this technique holds promise for improving surgical precision. It differs from traditional stereolithographic guides, which are widely used in clinical practice. Thorough case planning and execution are crucial for optimizing efficiency and patient comfort during the surgical procedure.[34]

In our case study, a multifaceted pre-operative evaluation, encompassing a detailed assessment of the patient's medical and dental history, patient education and expectation management, comprehensive virtual treatment planning, and thorough decision-making, culminated in a successful surgical outcome. The patient's satisfaction with the results underscores the value of this meticulous approach.

## SUMMARY

Full-arch rehabilitation has undergone a transformative evolution from rudimentary freehand techniques to a sophisticated, fully digital workflow, setting new standards for precision and patient care. Stackable surgical guides are at the forefront of this revolution, serving as an indispensable tool that seamlessly translates the meticulously crafted virtual prosthetic plan directly into the surgical theatre. This innovative, restoratively driven methodology significantly enhances predictability, safety, and efficiency, making it possible to achieve optimal fit, function, and unparalleled esthetics, even in the most challenging simultaneous maxillary and mandibular rehabilitations. While the clinician's expertise remains paramount, this advanced digital paradigm drastically reduces chair time and elevates overall patient satisfaction, defining the future of comprehensive oral reconstruction.

## PATIENT CONSENT

Written informed consent was obtained from the patient prior to the initiation of the treatment plan. This was done after a comprehensive and detailed explanation of the procedures, including a discussion of the potential risks, benefits, and available alternatives, was provided and understood by the patient.

## DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this work, the author(s) used Gemini AI in order to rephrase only. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

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