

STACKABLE SURGICAL GUIDES IN FULL-ARCH IMPLANT REHABILITATION: A SYSTEMATIC REVIEW

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ABSTRACT

Aim of the study Stackable surgical guides have emerged as a key innovation in the digital workflow for full-arch implant rehabilitation, particularly in completely edentulous patients. These multi-level systems allow for precise and sequential execution of bone reduction, implant placement, and prosthetic delivery in a single surgical session. This systematic review aims to evaluate the current literature regarding the clinical application, workflow, and outcomes of stackable surgical guides in fully guided full-arch implant rehabilitation. **Materials and methods** Three distinct searches were conducted in the PubMed database. The first used the terms “stackable surgical guide” OR “stacked guide” OR “bone reduction guide,” which returned 197 results from the last 5 years, of which only 7 were relevant to dental implantology. Then we decided to extend the period and use a clearer term. So, a second search using only “stackable guide” over the last 10 years yielded 20 articles, with 13 included after screening. A third search using “facially driven treatment planning” identified 15 articles, with 2 meeting inclusion criteria. After merging and full-text review, 15 articles were included in this review. **Results** Stackable guide workflows consistently enabled guided osteotomy, implant placement, and provisional prosthesis installation. Common benefits included reduced chair time, improved accuracy, and predictable esthetic and functional outcomes. Limitations included cost, complexity, and limited long-term data. **Conclusions** Stackable surgical guides represent a promising advancement in fully guided full-arch implant rehabilitation. Prosthetically driven workflows—especially those starting from smile design and facial analysis—appear to offer greater clinical precision and patient satisfaction. More high-level clinical trials and long-term outcome data are needed to validate their widespread adoption.

Key words: stackable surgical guides, facially driven treatment planning, digital workflow, edentulous patients

INTRODUCTION

The restoration of completely edentulous arches using dental implants has undergone significant transformation in recent years, driven by advances in digital planning, guided surgery, and prosthetically driven workflows (1). Traditional approaches to full-arch implant rehabilitation relied heavily on clinician experience, freehand implant placement, and staged prosthetic fabrication. However, the integration of digital technologies has introduced a more predictable and efficient treatment pathway,

particularly in complex cases (2).

Stackable surgical guides represent a major milestone in this evolution. These multi-component systems, typically fabricated from CBCT and intraoral scans, allow for sequential and fully guided execution of bone reduction, implant placement, and provisional prosthesis delivery. Their design enables surgeons to follow a prosthetically driven treatment plan with improved accuracy, surgical control, and reduced intraoperative time (3, 4).

Initially, our literature search using broader terms such as “stackable surgical guide,”

“stacked guide,” and “bone reduction guide” yielded 197 articles from the past five years. However, only 7 of these were related to dental implantology, with most articles originating from the medical field. To narrow the scope, a second search using only the term “stackable guide” over the last 10 years identified 20 results, of which 13 were deemed relevant after title and abstract screening. Recognizing the importance of prosthetic-first and esthetic planning, a third search using the term “facially driven treatment planning” returned 15 articles, with 2 directly addressing full-arch implant rehabilitation using stackable guides.

This review aims to synthesize the available literature on the clinical use, planning workflow, and reported outcomes of stackable surgical guides in full-arch rehabilitation. Emphasis is placed on the integration of digital technologies and the growing trend toward facially guided, prosthetically driven treatment planning. By reviewing the clinical evidence from the last ten years, this article seeks to define the advantages, limitations, and future potential of stackable guide protocols in modern implant dentistry.

MATERIALS AND METHODS

Search Strategy

A systematic review was conducted using the PubMed database to evaluate the use of stackable surgical guides in full-arch implant rehabilitation. Three distinct searches were performed:

- **Search 1:** “stackable surgical guide” OR “stacked guide” OR “bone reduction guide” (last 5 years) – **197 results**, of which only 7 were related to dental applications.
- **Search 2:** “stackable guide” (last 10 years, English, humans) – **20 results**, with **13** meeting inclusion criteria after screening.

- **Search 3:** “facially driven treatment planning” (last 10 years, English, humans) – **15 results**, with **2** found relevant to implant rehabilitation using stackable guides.

After merging the results and removing duplicates, **the articles** were manually screened. Following full-text assessment, **15 articles** were included in the final review (1).

Eligibility Criteria

Studies were included if they:

- Described fully guided surgery
- Involved completely edentulous jaws (maxilla, mandible, or both)
- Used stackable, multi-level, or sequential surgical guide systems
- Included bone reduction and/or immediate prosthesis delivery
- Were human clinical studies, case reports, or technical articles

Exclusion criteria included:

- Partially edentulous jaws
- Freehand surgery
- Single-level (non-stackable) guides
- In vitro, animal, or non-English studies
- Reviews without original clinical data

Study Selection

Two independent reviewers screened all retrieved articles by title and abstract. Disagreements were resolved through consensus and the final selection included **15 studies**, comprising clinical case reports, case series, technical notes, one scoping review, one retrospective cohort study (2).

Data Extraction and Synthesis

The following data were extracted into a standardized chart:

- Author(s) and publication year
- Study design and sample size

- Type and manufacturer of the guide system
- Arches treated (maxilla, mandible, or both)
- Surgical steps covered by the guides
- Prosthesis type (temporary and/or definitive)
- Reported clinical outcomes, complications, and follow-up duration

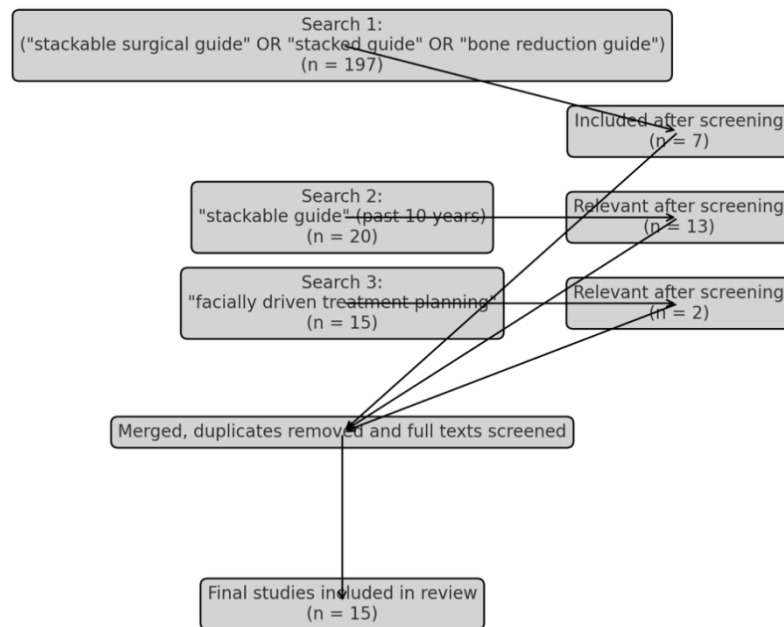


Figure 1. PRISMA flow diagram showing the selection process for included studies.

RESULTS

Study Characteristics

The included studies were published between 2015 and 2025 and originated from diverse international settings, including both academic institutions and private clinics. Most involved full-arch rehabilitation in the maxilla, mandible, or both jaws. Stackable guides were typically fabricated using 3D printing or CAD/CAM techniques, with some using **magnetic retention** or **titanium-reinforced sleeves** (3, 4).

Stackable Guide Systems and Workflow

All studies used stackable or sequential guide systems, often consisting of:

1. A fixation base or positioning guide
2. A bone reduction guide
3. An implant placement guide
4. A prosthesis carrier or delivery guide

The workflows began with **digital planning** using CBCT scans and intraoral or facial scans, followed by virtual data alignment and CAD-based guide design. The surgical steps were performed using fully guided, often flapless or minimally invasive, protocols (4, 5).

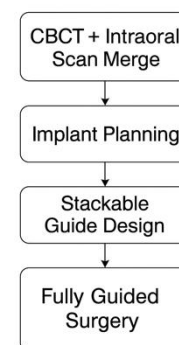


Figure 2. Conventional fully guided digital workflow in full-arch rehabilitation

using stackable surgical guides (without facially driven smile design integration).

Prosthetic Phase

Nearly all studies reported **immediate loading** using screw-retained provisional prostheses. In several cases, final prostheses were delivered within two to three visits using workflows such as:

- Double digital scanning (DDS)
- Virtual articulation
- Prefabricated PMMA bridges (6, 7)

Clinical Outcomes

Reported **implant success rates ranged from 96% to 100%** in short-term follow-up (up to 12 months). Some studies reported full-arch surgery times under 3 hours. Mean angular and positional deviations were

typically less than 2°, with one study noting a mean angular deviation of 5.4° in magnetically retained stackable systems (8).

Complications and Limitations

Minor complications included:

- Guide misfit or rotation
- Limited access in posterior areas
- Inconsistent bone reduction
- Difficulties in merging intraoral and CBCT data

Commonly cited limitations were high fabrication costs and the need for extensive training in CAD/CAM and guided surgery software (9, 10).

DISCUSSIONS

The use of stackable surgical guides in full-arch rehabilitation represents a significant evolution in computer-guided implantology. Across the literature, these systems have consistently demonstrated the ability to translate comprehensive digital treatment plans into highly accurate and reproducible surgical and prosthetic outcomes—particularly in completely edentulous jaws (1, 2).

Clinical Success and Reproducibility: Lessons from the STAGE Study

One of the most robust data sets in the field comes from the STAGE study by Levy-Bohbot et al. (3), a retrospective cohort involving **43 edentulous arches and 284 implants** placed using stackable guides with immediate loading. The study reported a **96.5% implant survival rate after 4 months** and **100% prosthetic success after one year**, regardless of bone grafting procedures.

Subgroup analysis demonstrated similarly

high survival rates in challenging clinical scenarios:

- 100% in native bone
- 96% in Le Fort I osteotomy grafted maxillae
- 95.4% in grafted mandibles
- 92.5% in maxillae with sinus lifts and anterior grafts

Notably, the protocol was used in patients with **severe bone atrophy, limited mouth opening due to scleroderma, and bruxism**. Bruxism was the only factor statistically associated with increased implant loss ($p = 0.0002$), underlining the general reliability of stackable guide systems across patient populations.

Workflow Consistency and Guided Surgical Control

The STAGE protocol and similar studies (4, 5) described a **four-part guide sequence**:

1. Base guide (anchored with screws)
2. Bone reduction guide

3. Drilling guide
4. Prefabricated PMMA prosthesis

These components were virtually designed based on radiopaque prosthetic markers, CBCT scans, and STL datasets. Most workflows began with digital planning and included CBCT, intraoral scanning, and facial scans where applicable. Once aligned and merged, these data streams guided the design of surgical guides in CAD software and were produced using 3D printing or milling technologies (6).

Surgical execution was fully guided, often flapless or minimally invasive, and completed within highly efficient timelines. Several studies reported total dual-arch treatment times under 3 hours (7).

Immediate Loading and Esthetic Integration

Nearly all studies included **immediate loading protocols** using prefabricated screw-retained interim prostheses. This approach eliminated the need for intraoperative impressions, thanks to precise data merging and wax-up integration. Digital workflows such as **double digital scanning (DDS)** and **virtual articulation** supported the rapid transition to final prostheses in just two or three appointments in some cases (8, 9).

Limitations and Clinical Challenges

Despite the benefits, several limitations were noted:

- **Guide misfit or rotational instability** (especially in resin-based systems)
- Inaccurate or inconsistent **bone reduction** due to alignment errors
- **Limited access** in posterior zones due to vertical space constraints

- **High cost** of software, materials, and fabrication
- A **steep learning curve** for digital planning, CAD/CAM design, and system-specific workflows (2, 4, 6)

These challenges were consistently reported across studies and are particularly important in complex or atrophic cases. The scoping review by Lan et al. (2) emphasized the lack of high-level clinical trials and standardized validation procedures, especially in edentulous workflows.

Facially Driven Implant Planning: The Emerging Gold Standard

A forward-looking dimension in this field is the integration of **facially guided, prosthetically driven workflows**. As described by Creagh et al. (10), digital smile design and facially referenced planning are now increasingly used as the first step in full-arch treatment.

In this protocol:

- A 2D smile frame is established based on facial photographs
- Ideal tooth position and arch form are defined before implant planning
- CBCT and intraoral data are merged only after the esthetic plan is complete

This approach ensures that the **surgical and prosthetic sequence follows patient-specific esthetic and functional goals**, rather than bone availability alone. The result is a workflow that improves:

- **Patient visualization and communication**
- **Esthetic outcomes**
- **Accuracy of prosthesis fit and function**

As the field evolves, this **facially driven planning philosophy** is likely to become the standard in complex, high-demand cases, aligning with patient expectations and digital

treatment possibilities.

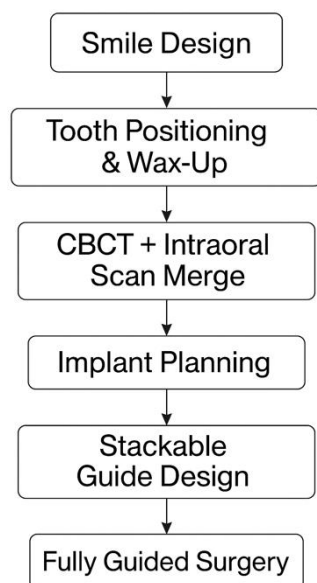


Figure 3. Linear workflow for full-arch rehabilitation guided by facially driven smile design, followed by stackable guide planning and immediate prosthesis

delivery.

A notable example of facially driven digital workflow integration is presented by Creagh et al. (7), who described the full-arch rehabilitation of a 71-year-old edentulous patient using a combination of smile design protocols and stackable surgical guides. The treatment began with comprehensive digital documentation, including intraoral scans, facial scans, and photographs. A digital smile frame was created to guide the prosthetic design, which was then aligned with CBCT data for accurate implant planning. Using three-dimensionally printed stackable guides, a flapless implant placement was performed with immediate loading of a CAD-CAM interim prosthesis. This case highlights the precision and esthetic predictability achieved when facially guided prosthetic planning is directly transferred to surgical execution via stackable templates.

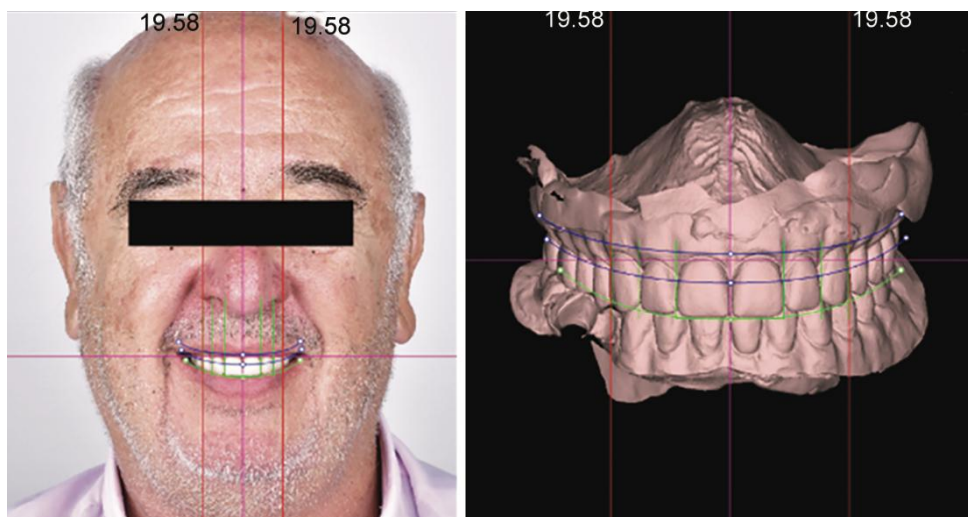


Figure 4. Facial analysis and digital smile design. Reproduced from Creagh J, Bohner L, Sesma N, Coachman C. Integrating a facially driven treatment planning to the digital workflow for rehabilitation of edentulous arches: A case report. *J Contemp Dent Pract.* 2020;21(12):1393–1397.

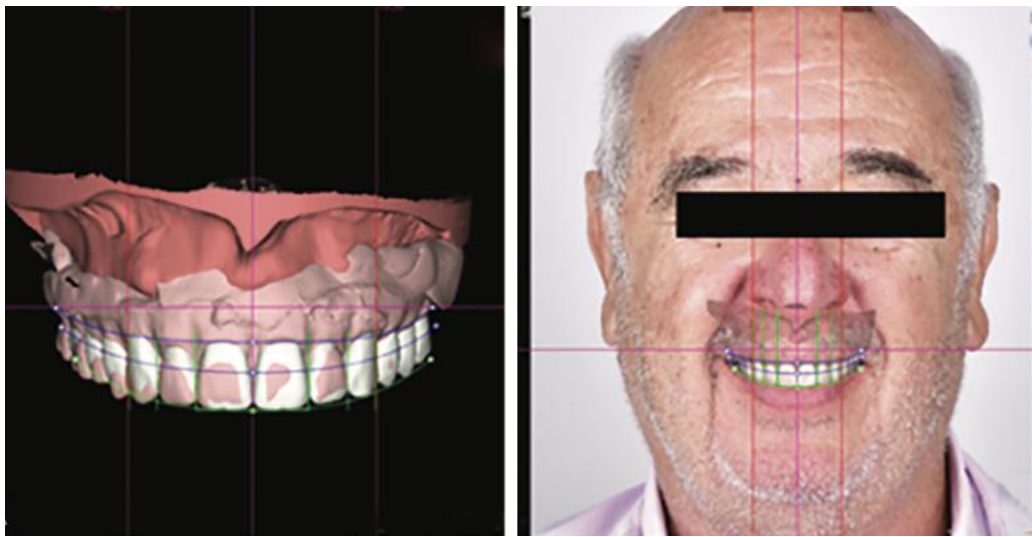


Figure 5. Digital wax-up demonstrating harmony between smile and facial profile. Reproduced from Creagh J, Bohner L, Sesma N, Coachman C. Integrating a facially driven treatment planning to the digital workflow for rehabilitation of edentulous arches: A case report. J Contemp Dent Pract. 2020;21(12):1393–1397.

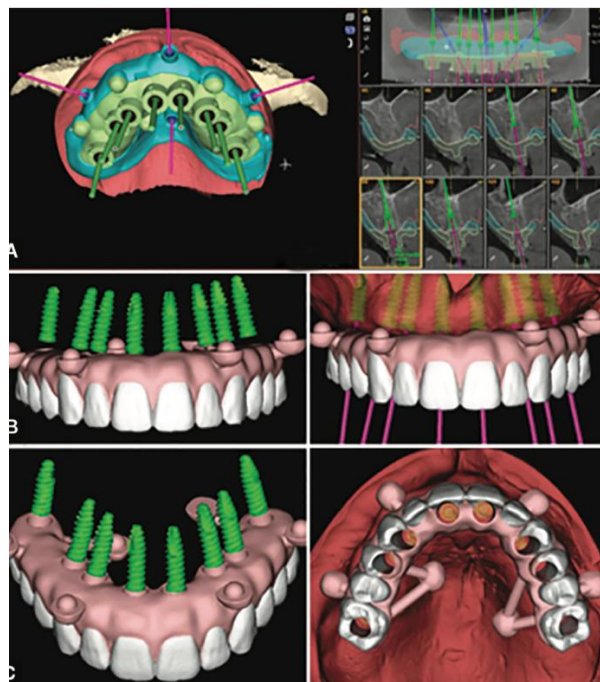


Figure 6. Dental implant surgical planning integrating intraoral and CBCT scans. Reproduced from Creagh J, Bohner L, Sesma N, Coachman C. Integrating a facially driven treatment planning to the digital workflow for rehabilitation of edentulous arches: A case report. J Contemp Dent Pract. 2020;21(12):1393–1397.

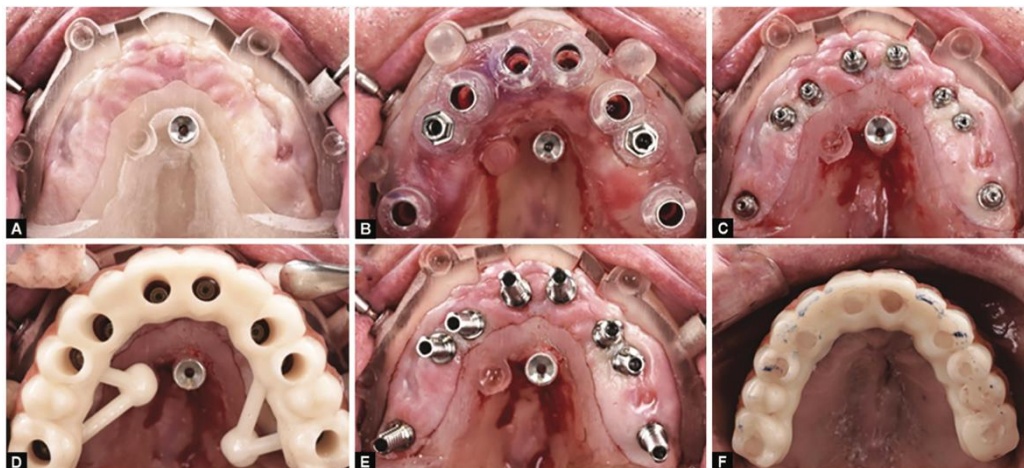


Figure 7. Clinical application of surgical guides and installation of CAD-CAM interim prostheses. Reproduced from Creagh J, Bohner L, Sesma N, Coachman C. Integrating a facially driven treatment planning to the digital workflow for rehabilitation of edentulous arches: A case report. *J Contemp Dent Pract.* 2020;21(12):1393–1397.

CONCLUSIONS

This systematic review highlights the growing clinical relevance of **stackable surgical guides** in fully guided, full-arch implant rehabilitation. Over the past decade, these systems have consistently proven to be reliable tools for managing complex surgical workflows — including bone reduction, implant placement, and immediate provisional prosthesis delivery — within a streamlined, prosthetically driven, and digitally planned framework (1, 2).

The included studies demonstrate that stackable guide protocols facilitate **high surgical accuracy, shortened chair time, and immediate esthetic and functional outcomes**, even in patients with severe atrophy or challenging anatomical limitations. Their sequential structure enhances predictability by enabling clinicians to predefine each step of the procedure, especially when integrated with CBCT, intraoral scanning, and 3D smile design (3, 4).

Importantly, the evolution toward **facially guided planning** represents a paradigm shift. Starting with esthetic outcomes and planning backward to implant placement ensures that treatment aligns more closely with patient expectations — offering not just osseointegration, but natural appearance and confidence (5).

However, the current literature is still dominated by **case reports, technical notes, and retrospective case series**. There is a clear need for high-quality **prospective studies** and **randomized controlled trials** to validate long-term outcomes, cost-effectiveness, and patient satisfaction.

In conclusion, stackable guide systems represent a pivotal step forward in the digital transformation of implant dentistry. Their continued refinement — especially within facially and prosthetically driven workflows — will play a crucial role in shaping the future standard of care in full-arch implant rehabilitation.

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