

# Guided Versus Freehand Implant Surgery: A Systematic Review of Accuracy, Efficiency, and Clinical Outcomes

HANINE Yasmine, FINNAOUI Oumaima, CHERKAOUI Amine

Methods

| PICOS Criteria |                                                                                                                                                    |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| Population     | Adult patients receiving dental implants (single or multiple, edentulous or posterior teeth)                                                       |
| Intervention   | Guided implant surgery (static/digital/flapless) using computer-assisted systems (GS, S-CAIS, R2Gate®)                                             |
| Outcomes       | Accuracy (linear, angular, depth deviations), marginal bone level (MBL/PIBL), procedural time, pain, medication use, operator/patient satisfaction |
| Study design   | Randomized controlled trials or randomized split-mouth clinical trials with follow-up ranging from immediate to 3 years.                           |

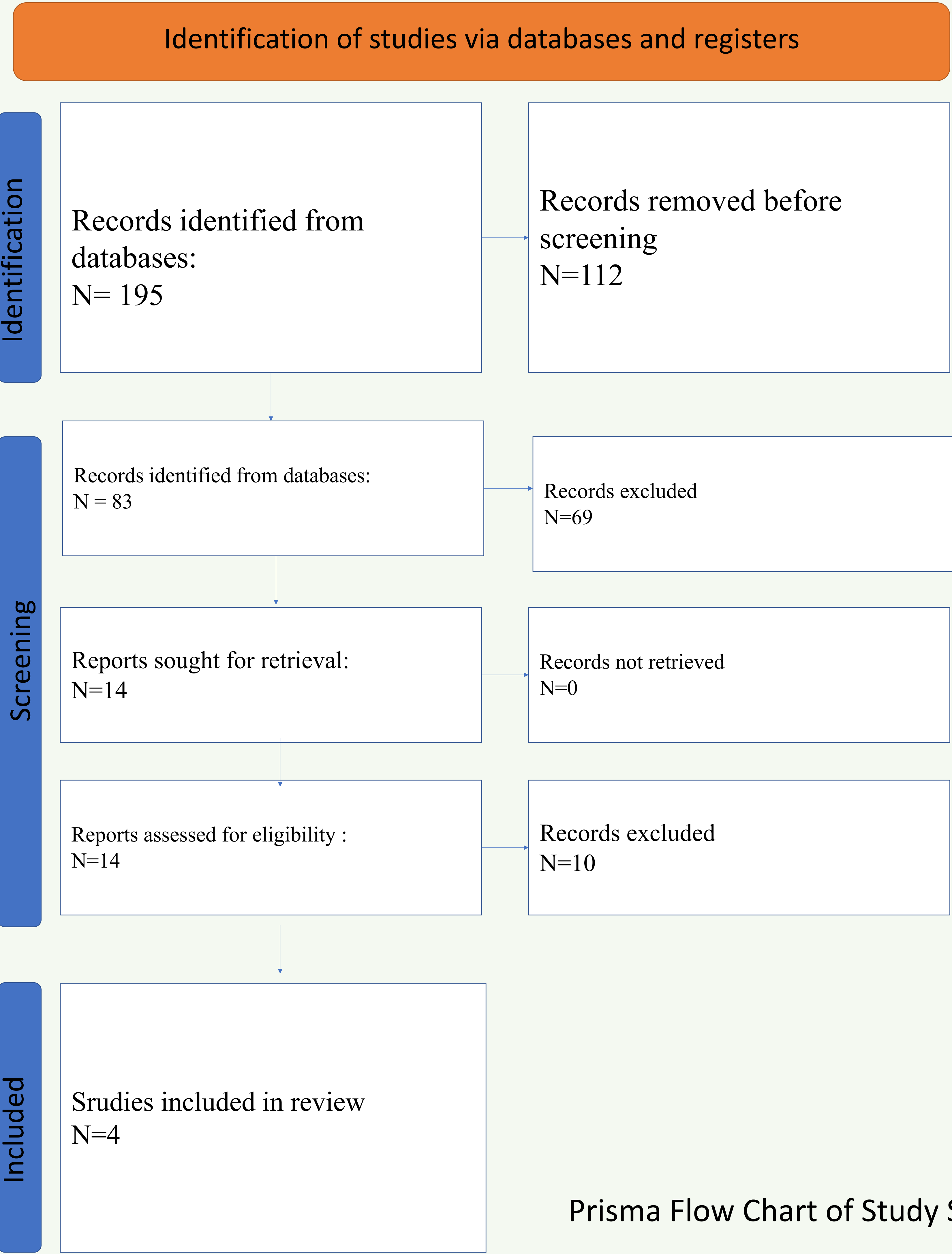
Research question

Strategy Research



Databases

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Inclusion criteria | <ul style="list-style-type: none"><li>Randomized controlled trials (RCTs) or split-mouth RCTs evaluating dental implant placement.</li><li>Studies comparing guided (static/digital/flapless) implant surgery with freehand or conventional techniques.</li><li>Studies reporting at least one of the following outcomes: Human clinical studies with follow-up ranging from immediate post-op to ≥12 months.</li></ul>           |
| Exclusion criteria | <ul style="list-style-type: none"><li>Animal or in vitro studies.</li><li>Reviews, case reports, conference abstracts, or letters to editors without original data.</li><li>Studies not comparing guided versus freehand/conventional implant placement.</li><li>Studies lacking relevant outcome measurements (accuracy, MBL, patient/operator outcomes).</li><li>Duplicate publications of the same study population.</li></ul> |



Prisma Flow Chart of Study Selection

| Results               |                                                           |                              |                               |                                                                                    |                                                                         |                  |                                                                                                             |
|-----------------------|-----------------------------------------------------------|------------------------------|-------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------|------------------|-------------------------------------------------------------------------------------------------------------|
| Study                 | Surgery Type                                              | Operator Experience          | Number of Patients / Implants | Precision / Accuracy                                                               | Marginal Bone Level (MBL) / PIBL                                        | Patient Outcomes | Clinical Significance / Notes                                                                               |
| Lops et al., 2024     | Guided vs Freehand                                        | GS: Non-expert<br>FH: Expert | 18 patients / 60 implants     | No difference in MBL changes; GS comparable to FH                                  | Stable MBL at 3 years; STH < 3 mm slightly higher MBL (ns)              | –                | Guided surgery by non-expert did not limit marginal bone remodeling; comparable outcomes to expert freehand |
| Chandran et al., 2023 | Guided (R2Gate®) vs Freehand                              | Not specified                | 61 patients / 80 implants     | Crestal, apical, and angular deviations lower with guided; depth deviation similar | –                                                                       | –                | Guided surgery more accurate in immediate implant placement; fewer deviations than freehand                 |
| Nomiyama et al., 2023 | Flapless Guided (S-CAIS) vs Conventional Surgery          | Not specified                | 29 patients                   | Linear & angular deviations lower with guided; greater depth discrepancy           | Vertical PIBL higher for guided; horizontal PIBL lower for conventional | –                | Flapless guided more accurate; conventional technique led to higher bone remodeling and angiogenic activity |
| Frizzera et al., 2021 | Flapless Guided vs Conventional by undergraduate students | Inexperienced students       | 10 patients (split-mouth)     | –                                                                                  | –                                                                       |                  |                                                                                                             |

## Discussion

Guided implant surgery has consistently demonstrated superior accuracy compared to freehand or conventional techniques, particularly in terms of linear, angular, and apical deviations. This advantage is observed not only when performed by experienced clinicians but also by non-expert or inexperienced operators, highlighting the potential of digital planning to standardize implant placement and reduce operator-dependent variability. The studies reviewed indicate that guided approaches, including flapless techniques, can achieve precise implant positioning without compromising marginal bone levels. In fact, long-term outcomes suggest that peri-implant bone stability is maintained, while conventional surgery may induce greater bone remodeling due to flap manipulation. Beyond accuracy, guided surgery offers additional clinical benefits such as reduced procedural time, lower intraoperative and postoperative pain, decreased analgesic consumption, and reduced operator anxiety. These factors enhance patient comfort and procedural efficiency, making guided approaches particularly valuable in settings where operator experience is limited. Overall, guided implant surgery provides a reliable and reproducible method for implant placement, combining precise outcomes with improved patient-centered results, and should be considered a preferred approach in modern clinical practice.

## Conclusion

Guided implant surgery improves accuracy, procedural efficiency, and patient outcomes compared to freehand or conventional techniques. It maintains long-term peri-implant bone stability and reduces variability due to operator experience. These findings support the adoption of guided approaches, including flapless techniques, as a reliable and reproducible method for modern implant placement.

## References

- Chandran K R S, Goyal M, Mittal N, George JS. Accuracy of freehand versus guided immediate implant placement: A randomized controlled trial. J Dent. 2023 Sep;136:104620
- Lops D, Palazzolo A, Calza S, Proietto L, Sordillo A, Mensi M, Romeo E. Guided versus freehand single implant placement: A 3-year parallel randomized clinical trial. J Dent. 2024 Oct;149:105317.
- Nomiya LM, Matumoto EK, Corrêa MG, Cirano FR, Ribeiro FV, Pimentel SP, Casati MZ. Comparison between flapless-guided and conventional surgery for implant placement: a 12-month randomized clinical trial. Clin Oral Investig. 2023 Apr;27(4):1665-1679
- Frizzera F, Calazans NNN, Pascoal CH, Martins ME, Mendonça G. Flapless Guided Implant Surgeries Compared with Conventional Surgeries Performed by Nonexperienced Individuals: Randomized and Controlled Split-Mouth Clinical Trial. Int J Oral Maxillofac Implants. 2021 Jul-Aug;36(4):755-761