Journal of Clinical Medicine and Surgical Advance
ISSN *(Online)*: **3105-1871**
Volume 1, Issue 3, Aug-Sept, 2025, Page 01-06

Review Article Received: 09-08-2025| Accepted: 31-08-2025| Published: 10-09-2025

Advancements in Preprosthetic Surgery: A Narrative Review

Rasha Adel Almahdawi*

Abstract
Preprosthetic surgery has evolved from conventional alveoloplasty to advanced interventions that incorporate bone augmentation, soft tissue grafting, and digital navigation systems. This narrative review critically examines historical development, current and evolving techniques, clinical outcomes, and future perspectives. A literature review covering publications from 2000 to 2025 was conducted, supplemented with landmark historical references. Emphasis is placed on the comparison between static and dynamic navigation systems, clinical evidence, and patient-centered outcomes. Challenges in resource-limited settings and psychological aspects of rehabilitation are discussed. Recommendations are provided to optimize clinical practice and accessibility.

Keywords
Preprosthetic surgery, Bone augmentation, Surgical navigation, Sinus lift, Prosthodontic outcomes, Digital workflow.

College of Dentistry, Uruk University, Karada, Baghdad10069, Iraq

INTRODUCTION
Preprosthetic surgery encompasses surgical techniques aimed at optimizing the oral and maxillofacial region for prosthetic rehabilitation. Historically limited to tooth extractions and alveolar reshaping (Terheyden *et al.,* 2023; & Devaki *et al.,* 2013), advances in imaging, grafting techniques, and surgical navigation have expanded treatment possibilities (Badr *et al.,* 2025; & Buschman, 2025). Despite these advancements, barriers such as cost, training, and limited accessibility persist, particularly in developing regions. This review integrates historical, clinical, and technological perspectives.

METHODOLOGY
This article is designed as a narrative review, aiming to provide an overview of the historical development, current practices, and future perspectives in preprosthetic surgery. Unlike systematic reviews, narrative reviews do not follow a rigid protocol for literature selection but instead synthesize evidence based on the authors' expertise and the relevance of published studies to the topic.

A search of the literature was performed in PubMed, Scopus, and Google Scholar using keywords such as "preprosthetic surgery," "bone augmentation," "sinus lift," "surgical navigation," and "prosthodontic outcomes." Publications between 2000 and 2025 were considered, with additional earlier references included for historical context. Priority was given to systematic reviews, randomized controlled trials, prospective cohort studies, and landmark articles. Only studies published in English were included.

The selected studies were critically reviewed and synthesized to highlight key advancements, clinical outcomes, controversies, and future directions relevant to dental practice.

Historical Background
The origins of preprosthetic surgery lie in simple ridge contouring and tooth extractions. In the 1970s, Baker and Connole introduced rib grafting for maxillary augmentation, while Bell and McBride pioneered the Le Fort I osteotomy for maxillary repositioning (Badr *et al.,* 2025). These foundational procedures established the principles of skeletal augmentation and significantly improved prosthetic outcomes.

In the 1980s and 1990s, advancements in biomaterials such as autogenous bone grafts,

***Corresponding Author:** Rasha Adel Almahdawi

allografts, and xenografts expanded the possibilities for ridge augmentation. The introduction of titanium dental implants by Brånemark further emphasized the need for adequate bone and soft tissue conditions, leading to a more structured role for preprosthetic surgery in implantology. During this period, soft tissue management gained importance, with procedures designed to improve keratinized mucosa and prosthesis stability. Later, detailed studies of the implant–tissue interface further shaped surgical approaches, as described by Gruber and Bosshardt (Gruber *et al.,* 20215). These historical milestones laid the groundwork for the integration of digital imaging and computer-assisted surgery in the 21st century.

Current and Evolving Techniques

Modern approaches address both hard and soft tissues. Bone augmentation procedures include sinus lifts and ridge augmentation, which provide sufficient support for implants (Starch-Jensen & Becktor, 2019; & Guerrero *et al.,* 2020). Soft tissue grafting methods—such as connective tissue and free gingival grafts—enhance esthetics and peri-implant stability (Cairo *et al.,* 2008). Advanced imaging such as cone-beam computed tomography (CBCT) and computer-assisted implant surgery (CAIS) have revolutionized precision and planning (Block *et al.,* 2017).

Table 1. Summary of Preprosthetic Surgical Techniques

Procedure	Indications	Reported Outcomes
Sinus Lift	Insufficient posterior maxillary bone height	Bone height increased; >90% implant survival [6]
Ridge Augmentation	Horizontal/vertical bone defects	Improved ridge volume; predictable support [7]
Soft Tissue Graft	Thin gingiva, esthetic concerns	Enhanced esthetics, reduced complications [8]
Alveoloplasty	Irregular alveolar ridges pre-denture	Improved prosthesis fit; less morbidity with digital guides [3]

Surgical Navigation Systems

Computer-assisted implant surgery includes static and dynamic systems. Static CAIS uses prefabricated guides that provide accuracy but lack flexibility. Dynamic CAIS uses optical tracking for real-time adjustments (Block *et al.,* 2017; & Tallarico *et al.,* 2018).

Table 2. Comparison of Static vs Dynamic Navigation Systems

Feature	Static CAIS	Dynamic CAIS	Clinical Notes
Accuracy	High	Comparable or slightly higher [9]	Dynamic adapts in complex cases
Flexibility	Low	High; intraoperative adjustment	Useful in limited mouth opening
Cost	Lower	Higher (hardware/software)	Limits adoption in low-resource settings
Learning Curve	Moderate	Steeper [12]	Simulation-based training needed

Note: Data in this table are representative of clinical outcomes reported in multiple trials. Values are illustrative.

Clinical Outcomes and Patient Satisfaction

Studies report implant survival rates above 95% at five years for guided approaches (Tallarico *et*

al., 2018). Soft tissue augmentation contributes to esthetics, reduced pain, and faster healing (Sanz *et al.,* 2000; & Cairo *et al.,* 2008). Patient-reported outcomes highlight improved speech, mastication, and self-esteem. Nevertheless, high costs and limited availability remain challenges.

Surgical Considerations

Successful outcomes in preprosthetic surgery require meticulous case selection, atraumatic surgical technique, and careful management of anatomical limitations. Among the biologic adjuncts, Platelet-Rich Plasma (PRP) has gained attention for its potential to accelerate wound healing and enhance graft integration.

PRP is an autologous concentration of platelets suspended in plasma, rich in growth factors such as platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF-β), and vascular endothelial growth factor (VEGF). These molecules stimulate angiogenesis, fibroblast proliferation, and osteoblast differentiation, which are crucial in both hard and soft tissue regeneration (Del Fabbro *et al.,* 2013; & Al-Dajani, 2020).

Clinical studies have suggested that PRP may enhance early bone maturation when combined with autogenous or xenograft bone during ridge augmentation, improve soft tissue healing by reducing postoperative pain, swelling, and risk of infection, and increase implant stability in the early stages by accelerating bone-to-implant contact. However, evidence remains controversial: while some systematic reviews report significant benefits, others demonstrate no clear long-term improvement in implant survival or prosthodontic outcomes compared to conventional techniques. Variability may stem from differences in PRP preparation methods, centrifugation protocols, and patient-related factors.

PRP is relatively simple and inexpensive to prepare chairside, making it attractive in both high-resource and developing settings. Yet, its routine application should be guided by evidence-based protocols, and further large-scale randomized controlled trials are needed to clarify its true clinical value. Recent systematic reviews have further highlighted the role of autologous platelet concentrates, including PRP, PRF, and CGF, particularly in maxillary sinus augmentation, where they appear to enhance graft consolidation and early healing, although long-term survival benefits remain debated (Del Fabbro *et al.,* 2013; Al-Dajani, 2020; Lubkowska *et al.,* 2012; & Malcangi *et al.,* 2023).

Bone grafting remains a cornerstone of preprosthetic surgery, with several materials available depending on patient needs and defect size. Autografts, harvested from intraoral or extraoral donor sites, remain the gold standard due to their osteogenic, osteoinductive, and osteoconductive properties. However, morbidity at the donor site and limited availability restrict their routine use. Allografts, derived from human donors, provide osteoconductive scaffolds and are widely available, but they carry potential immunologic and disease-transmission risks despite rigorous processing. Xenografts, commonly bovine-derived, are favored for their slow resorption and volume maintenance but may result in incomplete substitution by host bone. Alloplasts, such as hydroxyapatite and β-tricalcium phosphate, represent synthetic alternatives that are biocompatible and safe, though their regenerative potential is considered inferior compared to biologic grafts. The choice of grafting material should therefore be individualized, balancing biological properties, patient preference, and cost considerations (Al-Nawas & Schiegnitz, 2014).

Bone Grafting Materials

While preprosthetic interventions have high reported success rates, complications can significantly affect outcomes. Intraoperative complications include excessive bleeding, sinus membrane perforation during sinus lift, and neurovascular injury in the mandibular region. Postoperative complications may involve infection, wound dehiscence, graft exposure, or partial resorption of grafted material. In sinus augmentation, membrane perforation is the most common complication, with an incidence of up to 30%. Long-term complications include poor esthetic outcomes, inadequate ridge stability, and

peri-implantitis. Prevention relies on meticulous preoperative planning using Cone Beam Computed Tomography (CBCT), adherence to aseptic surgical technique, and cautious flap design. Early recognition and prompt management of complications are essential to avoid implant failure and compromised prosthetic outcomes (Pjetursson *et al.,* 2008).

Complications in Preprosthetic Surgery

Beyond clinical parameters, the success of preprosthetic surgery is measured by improvements in patient-reported outcomes. Restoring mastication and phonetics positively influences nutrition and communication, while the esthetic dimension plays a critical role in self-esteem and social interactions. Studies indicate that implant-supported prostheses result in higher satisfaction levels compared to conventional dentures, with significant improvements in oral health-related quality of life (OHRQoL). Importantly, patient expectations must be managed to align with realistic outcomes, as unmet esthetic goals can lead to dissatisfaction despite technical success. Incorporating psychological and social perspectives ensures a holistic approach to preprosthetic rehabilitation (Awad *et al.,* 2000).

Psychological and Quality-of-Life Outcomes

In Iraq and similar developing regions, the implementation of advanced preprosthetic techniques faces unique obstacles. The high cost of bone graft materials, implants, and digital navigation systems often exceeds patients' financial capacity, especially in the absence of widespread health insurance coverage. Access to advanced biomaterials and CBCT technology is limited to major urban centers, creating disparities in care. Furthermore, there is a shortage of structured training programs for surgical navigation and regenerative procedures, hindering the dissemination of updated skills. Cultural perceptions may prioritize functional rehabilitation over esthetics, influencing treatment acceptance. Strategies to overcome these barriers include strengthening academic collaborations, establishing regional training centers, promoting government subsidies for essential biomaterials, and encouraging local manufacturing of affordable graft substitutes. Such measures would enhance accessibility, reduce costs, and align treatment outcomes with global standards (Al-Juboori, 2016).

REGIONAL CHALLENGES IN DEVELOPING COUNTRIES (FOCUS ON IRAQ AND ARAB COUNTRIES)

Limitations of Current Evidence

Despite significant advancements in preprosthetic surgery, current evidence is limited by heterogeneity in study design, small sample sizes, and short follow-up periods. The scarcity of randomized controlled trials and comparative studies between techniques hampers the ability to establish standardized protocols. Furthermore, most data originate from high-resource settings, limiting generalizability to developing regions. Publication bias may further exaggerate the perceived success of certain interventions. Addressing these gaps requires multicenter trials with long-term follow-up, inclusion of diverse patient populations, and critical evaluation of both positive and negative outcomes.

Future Directions

Future research will integrate artificial intelligence, augmented reality, and robotic systems into surgical navigation. Greater emphasis on affordable solutions is essential for adoption in developing regions. Training programs with simulation and mentorship will help reduce learning curves (Del Fabbro *et al.,* 2013). Patient-centered outcomes, including psychological and social well-being, should be prioritized in future studies.

CONCLUSION AND FUTURE PERSPECTIVES

Preprosthetic surgery continues to evolve through integration of novel biomaterials, digital navigation systems, and biologic adjuncts such as platelet concentrates. Evidence highlights significant progress in achieving predictable functional and esthetic outcomes, yet gaps remain in standardizing protocols and ensuring equitable access, particularly in developing regions. Future directions should prioritize multicenter

randomized trials, innovations in cost-effective graft substitutes, and broader incorporation of patient-reported outcomes to define true success in oral rehabilitation.

REFERENCES

Al-Dajani, M. (2020). Advances in computer-guided implant surgery training: Simulation and education. *International Journal of Oral and Maxillofacial Surgery, 49*(2), 249–256. https://doi.org/10.1016/j.ijom.2019.05.010

Al-Juboori, M. J. (2016). Current trends in dental implantology in Iraq: challenges and future directions. *Journal of Oral Implantology, 42*(5), 453–458.

Al-Nawas, B., & Schiegnitz, E. (2014). Augmentation procedures using bone substitute materials or autogenous bone—a systematic review and meta-analysis. *European Journal of Oral Implantology, 7*(Suppl. 2), S219–S234.

Awad, M. A., Locker, D., Korner-Bitensky, N., & Feine, J. S. (2000). Measuring the effect of intra-oral implant rehabilitation on health-related quality of life in a randomized controlled clinical trial. *Journal of Dental Research, 79*(9), 1659–1663.

Badr, Z., Jaworski, J., D'Acquisto, S., & Hamdan, M. (2025). Digitally-driven surgical guide for alveoloplasty prior to immediate denture placement. *Dentistry Journal, 13*(8), 333. https://doi.org/10.3390/dj13080333

Block, M. S., Emery, R. W., Lank, K., & Ryan, J. (2017). Implant placement accuracy using dynamic navigation. *International Journal of Oral & Maxillofacial Implants, 32*(1), 92–99. https://doi.org/10.11607/jomi.4818

Buschman, J. A. (2025). Alveoloplasty: A paradigm shift to a more efficient surgical technique. *Journal of Oral and Maxillofacial Surgery, 83*(8), 996–999. https://doi.org/10.1016/j.joms.2025.04.016

Cairo, F., Pagliaro, U., & Nieri, M. (2008). Soft tissue management at implant sites. *Journal of Clinical Periodontology, 35*(8 Suppl.), 163–167. https://doi.org/10.1111/j.1600-051X.2008.01268.x

Del Fabbro, M., Corbella, S., Taschieri, S., Francetti, L., & Weinstein, R. (2013). Plasma rich in growth factors in preprosthetic surgery: A systematic review. *Clinical Implant Dentistry and Related Research, 15*(6), 847–856. https://doi.org/10.1111/cid.12071

Devaki, V. N., Balu, K., Ramesh, S. B., & Arvind, R. J. (2013). Pre-prosthetic procedures in maxillofacial surgery: A review. *Journal of Pharmacy and Bioallied Sciences, 5*(Suppl. 1), S13–S16. https://doi.org/10.4103/0975-7406.113291

Gruber, R., & Bosshardt, D. D. (2015). Dental implantology and implants-tissue interface. In A. Vishwakarma, P. Sharpe, S. Shi, & M. Ramalingam (Eds.), *Stem cell biology and tissue engineering in dental sciences* (pp. 735–747). Academic Press.

Guerrero, M. E., Noriega, J., Castro-Ruiz, C., & Jacobs, R. (2020). CBCT and computer-guided implant surgery. *Dental Clinics of North America, 64*(1), 39–57. https://doi.org/10.1016/j.cden.2019.08.003

Lubkowska, A., Dolegowska, B., & Banfi, G. (2012). Growth factor content in PRP and their applicability in medicine. *Journal of Biological Regulators and Homeostatic Agents, 26*(2 Suppl. 1), 3S–22S.

Malcangi, G., Patano, A., Palmieri, G., Di Pede, C., Latini, G., Inchingolo, A. D., Hazballa, D., de Ruvo, E., Garofoli, G., Inchingolo, F., & Dipalma, G. (2023). Maxillary sinus augmentation using autologous platelet concentrates (platelet-rich plasma, platelet-rich fibrin, and concentrated growth factor) combined with bone graft: a systematic review. *Cells, 12*(13), 1797. https://doi.org/10.3390/cells12131797

Pjetursson, B. E., Tan, W. C., Zwahlen, M., & Lang, N. P. (2008). A systematic review of the success of sinus floor elevation and survival of implants inserted in combination with sinus floor elevation. *Journal of Clinical Periodontology, 35*(8 Suppl.), 216–240.

Sanz, M., & Vignoletti, F. (2015). Key aspects on peri-implant soft tissues management. *Periodontology 2000, 68*(1), 180–188. https://doi.org/10.1111/prd.12074

Starch-Jensen, T., & Becktor, J. P. (2019). Maxillary sinus floor augmentation: A review of selected treatment modalities. *Journal of Oral & Maxillofacial Research, 10*(3), e2. https://doi.org/10.5037/jomr.2019.10302

Tallarico, M., Esposito, M., Xhanari, E., Caneva, M., & Meloni, S. M. (2018). Computer-assisted vs. freehand implant placement: 5-year survival and

success rates. *Clinical Implant Dentistry and Related Research, 20*(6), 882–889. https://doi.org/10.1111/cid.12668

Terheyden, H., Raghoebar, G. M., Sjöström, M., Starch-Jensen, T., & Cawood, J. (2023). Preprosthetic surgery–narrative review and current debate. *Journal of Clinical Medicine, 12*(23), 7262. https://doi.org/10.3390/jcm12237262

Conflict of Interest: No Conflict of Interest

Source of Funding: Author(s) Funded the Research

How to Cite: Almahdawi, R. A. (2025). Advancements in Preprosthetic Surgery: A Narrative Review. *Journal of Clinical Medicine and Surgical Advance, 1*(3), 01-06.