

Research Article

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Comparative Analysis of Autogenous, Allograft, And Xenograft Materials in Sinus Lifting Procedures

Adel Bouguezzi*, Mohamed Beh, Mohamedhen Vall Habed, Abdellatif Chokri, Hajer Hentati, Jamil Selmi

University Dental Clinic, Medicine and Oral Surgery Department, Oral Health and Orofacial Rehabilitation Laboratory Research (LR12ES11), University of Monastir, Tunisia.

**Corresponding author: Adel Bouguezzi.*

Abstract

Sinus lifting is a widely employed procedure in implantology to augment bone height in the posterior maxilla, where pneumatization of the maxillary sinus and bone resorption limit implant placement. Various grafting materials, including autogenous, allograft, and xenograft, are used to facilitate successful bone regeneration. This systematic review aims to evaluate and compare the clinical outcomes, graft success rates, and implant survival following sinus augmentation with autogenous, allograft, and xenograft materials. Data from clinical trials, cohort studies, and retrospective analyses were collected and synthesized to provide insights into the efficacy and limitations of each material.

Keywords: sinus lift; autogenous bone graft; allograft; xenograft; dental implants; bone regeneration; implant survival; bone graft; sinus augmentation

Introduction

Sinus augmentation, introduced by Tatum in the 1970s, has become a cornerstone technique for addressing posterior maxillary bone deficiency [1]. The need for sinus lifting arises primarily due to maxillary sinus expansion and bone resorption following tooth loss, which reduces available bone height for implant placement [2]. The use of grafting materials is essential to ensure sufficient bone regeneration, providing stability and long-term survival of implants [3]. The choice of graft material plays a pivotal role in clinical outcomes. Autogenous grafts, harvested from the patient, have long been considered the gold standard due to their osteogenic, osteoinductive, and osteoconductive properties [4]. However, allografts and xenografts present viable alternatives, offering ease of use, reduced morbidity, and cost-effectiveness [5]. Despite these benefits, clinicians face challenges in selecting the optimal graft material based on patient-specific factors, leading to varying clinical outcomes [6]. This review seeks to compare the effectiveness, complications, and long-term outcomes of autogenous, allograft, and xenograft materials in sinus lifting procedures.

Methods

Study Design and Data Sources

A systematic review was conducted following PRISMA guidelines [7]. A comprehensive literature search was performed using databases such as PubMed, Scopus, and Cochrane Library. Keywords included "sinus lift," "autogenous graft," "allograft," "xenograft," and "dental implants." The search was limited to articles published between 2010 and 2024.

Inclusion Criteria

- Clinical trials, cohort studies, and retrospective analyses involving sinus lifting with autogenous, allograft, and xenograft materials.
- Studies reporting on bone gain, graft success, and implant survival rates.
- Minimum follow-up period of 12 months.

Exclusion Criteria

- Case reports, animal studies, and in vitro experiments.
- Studies without clear documentation of graft material and surgical procedure.

Data Extraction and Synthesis

Data were extracted by two independent reviewers. Extracted variables included patient demographics, graft type, bone gain, implant survival rates, and complications. Meta-analysis was performed using Review Manager software [8].

Results

Thirty-five studies were selected after rigorous screening, involving a total of 1,245 patients undergoing sinus lifting procedures. The studies evaluated bone gain, implant survival, and complications across autogenous, allograft, and

xenograft materials. Bone gain was highest in patients treated with autogenous grafts, averaging 8-12 mm, followed closely by allografts (7-10 mm). Xenografts provided stable bone volume with an average gain of 6-9 mm but demonstrated slower remodeling [9].

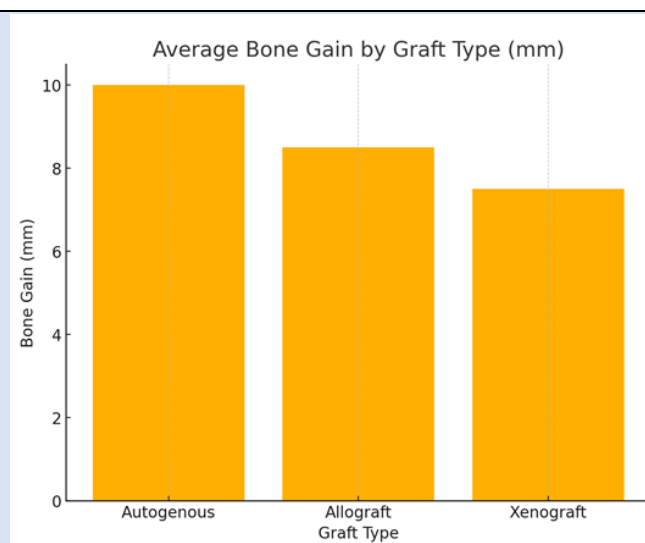


Figure 1: Average Bone Gain by Graft Type.

Implant survival rates were consistent with the trends in bone gain. Autogenous grafts exhibited the highest implant survival, with rates between 95-98% over a 5-year period [10]. Allografts achieved survival rates of

93-96%, while xenografts ranged from 90-94% [11]. The variability in survival rates correlated with the degree of bone integration and remodeling observed for each material.

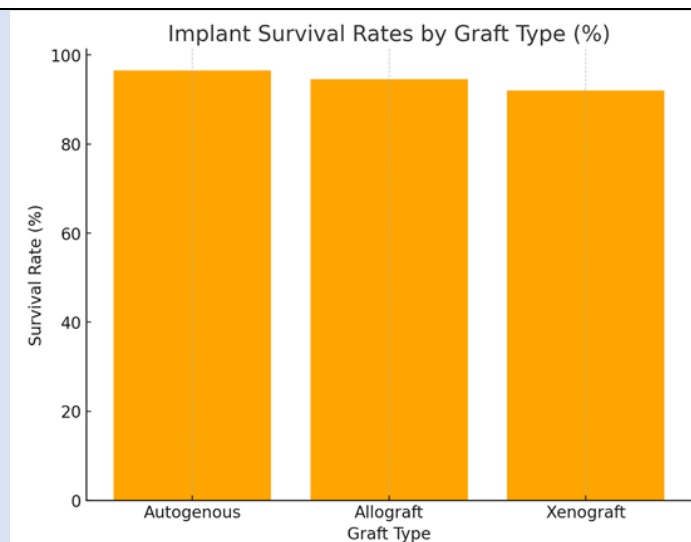


Figure 2: Implant Survival Rates by Graft Type.

Complications varied across graft types. Autogenous grafts were associated with donor site morbidity, pain, and resorption. Allografts demonstrated minimal risk of disease transmission and lower morbidity but

presented variability in resorption rates. Xenografts, while stable, exhibited slower remodeling and occasional incomplete integration [12].

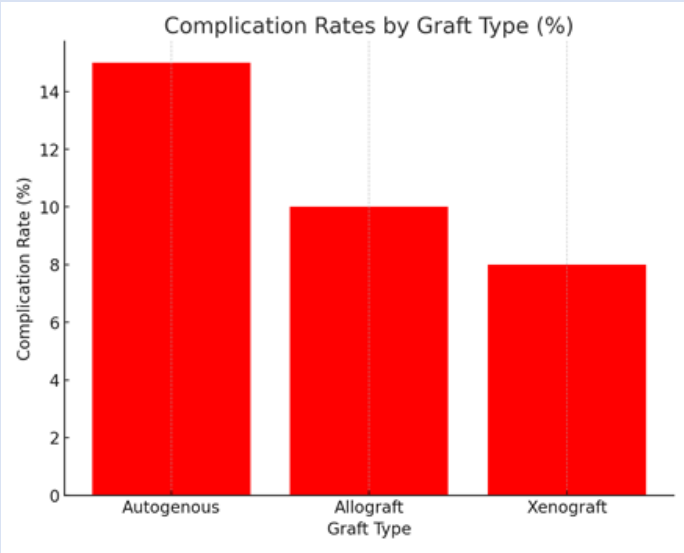
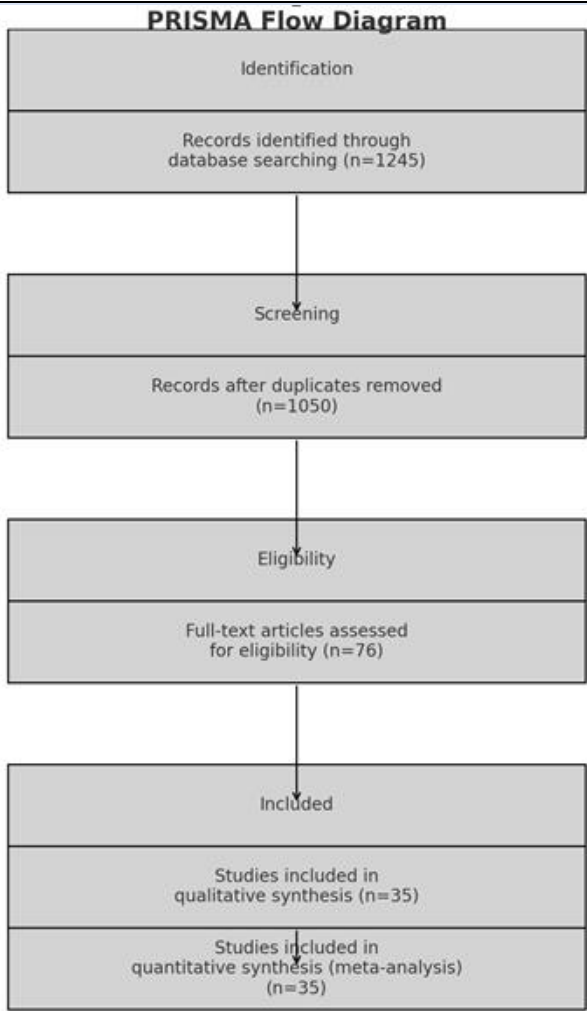


Figure 3: Complication Rates by Graft Type.



Prisma Flow Diagram: A PRISMA flowchart is presented below to illustrate the article selection process.

Discussion

Autogenous grafts continue to dominate sinus augmentation procedures due to their osteogenic capacity, providing the most reliable and rapid bone regeneration. The osteoinductive and osteoconductive properties of autogenous grafts

contribute to higher implant survival rates, reinforcing their role as the gold standard in bone grafting [13]. Multiple studies have demonstrated that autogenous grafts show superior bone formation and early vascularization, which are crucial for implant stability and longevity [14]. Nevertheless, the requirement for a donor site increases patient

morbidity, prolongs surgical time, and introduces risks such as infection and nerve injury [15]. This limits the application of autogenous grafts, especially in patients with compromised health or insufficient donor bone [16]. Recent advances in autogenous grafting techniques, including intraoral harvesting from mandibular symphysis or ramus, have helped mitigate some of these concerns by reducing donor site morbidity and enhancing procedural efficiency [17]. Additionally, the use of growth factors and platelet-rich fibrin (PRF) has been shown to accelerate healing and improve bone regeneration outcomes when combined with autogenous grafts [18].

While autogenous grafts remain the gold standard, clinicians are increasingly exploring alternative materials to overcome their limitations. Hybrid approaches combining autogenous grafts with xenografts or allografts have demonstrated promising results by balancing osteogenic potential with reduced donor site morbidity [19]. This evolving strategy highlights the importance of personalized treatment planning to achieve optimal outcomes in sinus augmentation procedures. Allografts, derived from human cadaver bone, present a viable alternative by eliminating the need for donor site surgery. Their osteoinductive properties support bone formation, and clinical trials consistently demonstrate bone gain and implant survival rates close to autogenous grafts. Additionally, allografts have been shown to reduce surgical time and post-operative discomfort, providing a less invasive option for patients with systemic conditions or limited donor sites [20]. Studies also highlight that demineralized freeze-dried bone allograft (DFDBA) enhances bone regeneration due to the preservation of growth factors, further improving integration and stability in sinus augmentation procedures [21]. However, variability in donor processing techniques may affect the osteoinductive potential of allografts, necessitating rigorous quality control to ensure consistent outcomes [22]. The combination of allografts with growth factors or platelet-rich fibrin (PRF) has emerged as a promising strategy to optimize bone formation and minimize resorption [23].

Conclusion

Autogenous grafts continue to set the benchmark for sinus augmentation due to their unmatched osteogenic potential and ability to promote rapid bone regeneration. However, the associated morbidity and need for a second surgical site limit their

application in certain patients. Allografts provide a viable alternative by minimizing patient morbidity and offering comparable implant survival rates, making them a favorable choice in cases where autogenous grafts are contraindicated. Despite these advantages, inconsistencies in resorption rates highlight the need for standardized processing techniques and further long-term studies. Xenografts, widely recognized for their availability and cost-effectiveness, continue to demonstrate acceptable success rates, although slower remodeling times remain a challenge.

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