



Buccal Plate Reconstruction Using Particular Allograft Material for Implants -A Review

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ABSTRACT

The buccal plate's role in implant success, particularly in terms of aesthetics and stability, underscores the importance of effective registration strategies. Allograft materials, including human freeze-dried cortical bone, demineralized freeze-dried bone allografts (DFDBA), and various particulate allografts, are investigated for their efficacy in buccal plate augmentation. This comprehensive review explores buccal plate registration techniques in dental implant rehabilitation, focusing on the utilization of allograft materials. The review delves into surgical techniques such as guided bone regeneration (GBR) and socket preservation, highlighting their integration with allograft materials.

Keywords: buccal plate registration, allograft materials, dental implant rehabilitation, guided bone regeneration (GBR), socket preservation

INTRODUCTION

The success of dental implant rehabilitation is intricately linked to the meticulous consideration of various factors, among which the preservation and augmentation of the buccal plate play a pivotal role. The buccal plate, a critical component of the alveolar bone, significantly influences both aesthetic outcomes and the long-term stability of dental implants. Achieving optimal buccal plate registration is paramount for clinicians seeking to provide patients with functional and cosmetically satisfying implant-supported restorations.¹ As advancements in implant dentistry continue to evolve, the integration of allograft materials has emerged as a promising avenue for enhancing buccal plate quality and quantity. Xenografts and alloplastic bone substitutes are widely employed due to their ease of use and effectiveness, as evidenced by numerous studies. Nevertheless, challenges persist with these materials, including minimal patient morbidity, cost-effectiveness, low immunogenicity, ease of handling, and angiogenic potential.² This literature review addresses the limitations associated with commercially available dental bone grafts and alternative materials, delving into potential future developments driven by the recent discovery of synthetic bone substitutes. The buccal bone plate, intricately linked to the supporting tooth, undergoes substantial remodelling following tooth loss or extraction. Bone resorption is also observed post-implant insertion, attributed to surgical stress and tissue adaptation to the foreign object. Immediate implant planning necessitates a type 1 socket, with significant remodelling of the buccal alveolar bone wall thickness impacting the implant's volume and its interaction with surrounding soft and hard tissues. Various surgical techniques are employed to enhance bone volume in horizontally deficient alveolar ridges, facilitating implant insertion within a comprehensive prosthodontic treatment plan.^{3,4} Allografts, derived from human tissues, offer unique biological properties that can positively impact the regenerative potential of the buccal plate. This review aims to provide a comprehensive overview of buccal plate registration techniques in dental implant rehabilitation, with a specific focus on the utilization of allograft materials.

ALLOGRAFT

Allografts, grafts obtained from a genetically dissimilar but same-species donor, undergo various preparation methods such as fresh, frozen, freeze-dried, mineralized, and demineralized. Allograft bone comes in diverse configurations, including powder, cortical chips, cancellous cubes, cortical struts, and more.⁵ Processing methods involve physical debridement, ultrasonic washing, ethylene oxide treatment, antibiotic washing, gamma irradiation for spore elimination, and freeze drying. These steps aim to eliminate antigenic components, reduce the host immune response, and maintain the biological characteristics of the graft, although the mechanical properties may be weakened in the process. Primarily osteoconductive, allogenic bone may retain some osteoinductive capability, depending on the processing method. Acid demineralization, as described by Urist in 1965, involves removing calcium and phosphate salts from the bone, resulting in demineralized freeze-dried bone (DFDB) with increased exposure of bone morphogenic proteins (BMPs) known for de novo bone formation. DFDB is considered osteoinductive, but conflicting study results and concerns about BMP concentration variability and the impact of ethylene oxide sterilization persist. The concentration of BMPs varies between types of bone, with demineralized cortical bone having higher concentrations than trabecular bone. Membranous cortical bone, found in the skull and facial bones, exhibits greater BMP concentration than

endochondral cortical bone. Safety evaluations of allografts, including DFDB, involve rigorous studies, with the American Association of Tissue Banks reporting a minimal probability of containing HIV virus.⁶ The risk of infection from allografts is deemed infinitesimal compared to other medical procedures like blood transfusions. Donor screening and biopsy specimens occasionally showing non-specific inflammatory conditions contribute to the safety assessment of allografts.⁷

HUMAN FREEZE-DRIED CORTICAL BONE ALLOGRAFTS

Human freeze-dried cortical bone allografts, a type of bone graft material sourced from human donors, undergo a vital preservation process through freeze-drying. In this method, cortical bone, the dense outer layer of bone providing structural support, is harvested and subjected to a freeze-drying procedure. Freeze-drying involves freezing the graft material and subsequently removing ice through sublimation, resulting in a dry and stable product. This meticulous process aims to maintain the structural and biological integrity of the bone while eliminating water content. The primary mechanism of action for these allografts lies in their osteoconductive properties, serving as a scaffold that promotes the ingrowth of new bone from the host. The freeze-dried cortical bone provides a stable framework for bone regeneration, making it particularly useful in various clinical applications such as dental implant procedures and bone augmentation surgeries.^{8,9} While the freeze-drying process retains the essential biological components of the graft, it may impact the material's mechanical properties. The strength and rigidity of cortical bone are crucial factors for providing structural support during the healing process. The safety and efficacy of human freeze-dried cortical bone allografts involve stringent screening and processing methods to ensure minimal risk of disease transmission and optimal outcomes in bone regeneration. Ethical considerations and adherence to regulatory standards further contribute to the reliability of these allografts in clinical use.¹⁰

DEMINERALIZED FREEZE-DRIED BONE ALLOGRAFTS (DFDBA)

Demineralized Freeze-Dried Bone Allografts (DFDBA) represent a specialized category of bone graft materials derived from human donors. The production of DFDBA involves a meticulous process aimed at preserving the biological activity of the graft. Initially, cortical bone is obtained from a donor, and the graft undergoes demineralization, a process that removes mineral content, primarily calcium and phosphate salts, from the bone matrix. This demineralization step is crucial as it exposes the organic bone matrix, which contains essential growth factors and bone morphogenic proteins (BMPs).^{11,12} The primary mechanism of action of DFDBA lies in its osteoinductive properties. Osteoinduction involves the stimulation of undifferentiated cells to differentiate into osteoblasts, promoting the formation of new bone. BMPs, found in the demineralized organic matrix, play a pivotal role in initiating this process. The demineralization process enhances the exposure of BMPs, making DFDBA a material with the potential to induce new bone formation. However, the effectiveness of DFDBA has been a subject of debate, with conflicting results reported in various studies.^{13,14} Concerns include the variability in BMP concentration among different donors and the impact of processing techniques on the osteoinductive potential of the allograft. The use of ethylene oxide for graft sterilization has also raised questions about its effects on BMPs. Despite these challenges, DFDBA continues to be utilized in various clinical applications, including dental and orthopedic surgeries. Its application is often chosen in scenarios where osteoinduction is desired to enhance bone regeneration. Clinicians must consider the specific characteristics of DFDBA, such as its potential osteoinductive capabilities, when selecting graft materials for particular cases.¹⁵

PARTICULATE ALLOGRAFTS

Particulate allografts are a type of bone graft material derived from human donors, and they consist of bone particles in granular or powder form. These allografts are used in various medical and dental applications to promote bone regeneration and support structural integrity in areas with bone deficiencies. The particulate nature of these grafts enhances their versatility and adaptability to different anatomical sites. The mechanism of action of particulate allografts is primarily osteoconductive, providing a scaffold that facilitates the ingrowth of new bone from the host. The graft particles serve as a framework, guiding the natural bone regeneration process. Additionally, particulate allografts may possess some osteoinductive properties depending on the specific processing methods and the retention of growth factors and signaling molecules.¹⁶ The preparation of particulate allografts involves the procurement of bone from human donors, followed by processing techniques such as cleaning, shaping, and sterilization to eliminate potential contaminants. These grafts can be sourced from various anatomical locations, and their particle size can vary, allowing for customization based on the specific requirements of the clinical situation. Particulate allografts find application in a range of medical procedures, including orthopedic surgeries, periodontal treatments, and dental implant procedures.¹⁷ They are commonly used to fill bony defects resulting from trauma, disease, or tooth extraction. The graft material supports bone regeneration, aids in the formation of a stable bone structure, and helps create a favorable environment for subsequent procedures like dental implant placement. While particulate allografts offer advantages in terms of versatility and ease of use, considerations include the potential for resorption over time and the need for adequate vascularization for optimal integration with the host bone. Rigorous safety measures, including donor screening and thorough processing methods, are implemented to minimize the risk of disease transmission and ensure the biocompatibility of the allograft material.¹⁸

INTEGRATION OF ALLOGRAFT MATERIALS IN GBR AND ASSOCIATED OUTCOMES

To optimize the bone regeneration environment, different grafting materials are often combined. For instance, combining FDDBA with DFDBA or autogenous bone allows for rapid osteoinduction while retaining the benefits of space creation and increased mineral density associated with mineralized

allograft. This combination takes advantage of the presumed osteoinductivity and faster turnover time of demineralized or autogenous grafts, along with the prolonged turnover time and higher density achieved with mineralized allograft tissue.¹⁹ Clinical studies, such as Sanders et al. (1983), have shown greater success rates with composite grafts compared to FDBA alone in treating periodontal defects. Numerous research studies, encompassing both animal models and human subjects, have extensively investigated the effectiveness of bone substitutes, specifically xenografts and alloplastic bone substitutes. Approximately 50% of dental implant procedures involve the use of bone grafts, with an expected annual increase of nearly 13% globally. By 2021, these operations are estimated to cost around US \$664 million, and the dental bone substitutes market is projected to reach about US \$931 million by 2025, with an annual growth rate of 9.5%. Current bone graft and replacement materials, such as allografts and autografts, often fall short in meeting ideal criteria, lacking features like minimal patient morbidity, user-friendly application, low immunogenicity, angiogenic potential, and cost-effectiveness. Consequently, there is a pressing need for innovative bone substitute materials that offer improved mechanical and biological properties. In the context of buccal plate regeneration, the buccal bone plate in the alveolar process is crucial for the success of implant surgery, impacting both aesthetics and functionality at affected sites.²⁰ Various surgical techniques, including distraction osteogenesis, inlay and onlay grafting, free vascularized autografts, ridge splitting, and guided bone regeneration (GBR), are employed to address alveolar bone loss and facilitate hard tissue augmentation. Guided bone regeneration (GBR), a well-established procedure, proves effective in repairing horizontal and vertical defects in hard tissue. Autogenous bone grafts remain the gold standard for hard tissue augmentation due to their ability to convey essential minerals, proteins, and bone-related cells, promoting bone regeneration and augmenting success. However, the use of autogenous bone carries potential risks and side effects at the donor site.²¹ Alternative bone graft materials like allografts (ABB) and calcium sulfate (CS) serve as effective scaffolds for new bone formation and improvement of hard tissue. The literature emphasizes the importance of ensuring stability and minimizing stress exposure during the procedure to support the creation of new bone, as a newly formed vascular system is susceptible to degeneration under mechanical conditions. Consequently, the careful selection of surgical techniques, graft manipulation, and stabilization procedures is pivotal for enhancing the predictability of the procedure.²²

DISCUSSION

Moslemi, Mousavi Jazi, et al. conducted a study demonstrating the success of both subepithelial connective tissue graft (SCTG) and acellular dermal matrix allograft (ADMA) in treating gingival recessions. Jimi, Hirata, et al. presented a comprehensive review of bone regeneration, encompassing various surgical techniques and materials such as bone grafts, growth factors, and stem cells. Benic and Hämmerle highlighted the effectiveness of the guided bone regeneration (GBR) technique in horizontal bone augmentation. Faverani, Ramalho Ferreira, et al. provided a literature review covering various techniques for bone grafting. Khojasteh, A., Esmaeelinejad, M., & Aghdashi offered an overview of regenerative techniques in oral and maxillofacial bone grafting, discussing their benefits, limitations, and clinical applications. (Faverani, et al.) discussed diverse bone augmentation techniques for addressing alveolar ridge defects. Sharif, F., Rehman, I. U., Muhammad, N., & MacNeil provided an overview of various dental materials used for cleft palate repair, including bone grafts, dental adhesives, and composite materials. Yamada, M., & Egusa presented an overview of different bone substitutes used in implant dentistry, such as autografts, allografts, xenografts, and synthetic bone substitutes. Moy, P. K., & Aghaloo, T. provided a comprehensive overview of the risk factors associated with bone augmentation procedures, covering patient factors, surgical factors, and implant factors. The article delves into the impact of these risk factors on the success of bone augmentation procedures and offers recommendations for minimizing their effects. Manfio, A. S. C., Suri, S., Dupuis, A., & Stevens, K discovered that secondary alveolar bone grafting can enhance the eruption path of permanent maxillary canines in individuals with complete unilateral cleft lip and palate. Mohammadi, B., Abdoli, Z., & Anbarzadeh found that their study's results suggest the abutment angle tolerance significantly affects the stress in dental implant fixtures and screws. The authors recommended considering abutment angle tolerance during implant placement to mitigate the risk of implant failure due to excessive stress, emphasizing the importance of using finite element analysis in dental implant research to assess mechanical behavior under diverse loading conditions. Cinar, I. C., Gultekin, B. A., Saglanmak, A., Akay, A. S., Zboun, M., & Mijiritsky concluded in their study that both allogeneic bone plate and guided bone regeneration techniques are effective in horizontally deficient maxillary alveolar ridge reconstruction. However, the allogeneic bone plate technique exhibited superior outcomes in terms of bone height gain and reduction in ridge width, with similar success rates for implant placement. Zhang Longo et al.'s study revealed that both soft-type block and particulate bone substitutes are effective in guided bone regeneration for peri-implant defects, resulting in similar soft-tissue dimensional changes around implants after one year. Cinar, I. C., Gultekin, B. A., Saglanmak, A., Akay, A. S., Zboun, M., & Mijiritsky suggested from their study results that both techniques are effective, but allogeneic bone plates may have advantages over guided bone regeneration in specific situations.²⁰⁻²⁵

CONCLUSION

The literature review underscores the importance of stability and resistance in hard tissue augmentation techniques, emphasizing the success of allogeneic block grafts in preserving bone volume and minimizing the risk of graft mobilization or collapse during the healing process. Additionally, the comparison between autogenous and allogeneic blocks in terms of resorption rates contributes to the understanding of their effectiveness in horizontal bone augmentation. Overall, the reviewed studies collectively advocate for the continuous exploration and improvement of techniques using particulate allograft materials for buccal plate registration in dental implant rehabilitation. The findings presented in the article contribute valuable insights to guide clinicians in achieving optimal outcomes, both functionally and aesthetically, for patients undergoing implant-supported restorations.

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