

Surgical alternatives for increasing gingival thickness in anterior implants

Alternativas cirúrgicas para aumento de espessura gengival em implantes anteriores

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ABSTRACT

Oral rehabilitation with dental implants is a well-established practice that combines aesthetics and functionality. The success of implants is not limited to osseointegration but also involves the health of the surrounding soft tissues, particularly in areas of high aesthetic demand. Gingival tissue quality is crucial for peri-implant stability,

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and periodontal biotypes – categorized as “thin,” “intermediate,” and “thick” – play a significant role in case planning and management to achieve an aesthetic and functional outcome. Current approaches to increasing tissue thickness involve connective tissue graft surgical techniques, which are widely used to enhance thickness and keratinized mucosa and are considered the gold standard due to their predictability and durability. Alternatives, such as xenogenic collagen matrices, offer reduced morbidity and greater patient comfort but still show inferior results in terms of long-term tissue stability. Although promising, collagen matrices require further studies to determine whether they can effectively replace autogenous grafts with comparable outcomes. Therefore, the choice of technique should consider gingival biotype, implant location, donor site assessment, operator technique, and patient preferences. Further research is needed to evaluate the benefits of alternative materials in the context of long-term treatments.

Indexing terms: Dental Implants. Esthetics, dental. Osseointegration.

RESUMO

A reabilitação oral com implantes dentários é uma prática consolidada, combinando estética e funcionalidade. O sucesso dos implantes não se limita apenas a osseointegração, mas também envolve a saúde dos tecidos moles circundantes, especialmente em áreas de alta demanda estética. A qualidade do tecido gengival é crucial para a estabilidade peri-implantar e os biótipos periodontais, categorizados em “fino”, “intermediário” e “espesso”, desempenham um papel importante para o planejamento e condução do caso para alcançar um resultado estético e funcional. As perspectivas atuais para o aumento de espessura do tecido envolvem técnicas cirúrgicas de enxerto de tecido conjuntivo, que são amplamente utilizadas para aumentar a espessura e mucosa queratinizada e são consideradas o padrão-ouro pela previsibilidade e durabilidade. Alternativas, como as matrizes de colágeno xenogénico, oferecem menor morbidade e maior conforto para o paciente, mas ainda mostram resultados inferiores em termos de estabilidade tecidual a longo prazo. Embora promissoras, as matrizes de colágeno necessitam de mais estudos para determinar se podem substituir o enxerto autógeno com eficácia comparável. Assim, a escolha da técnica deve considerar: o biotipo gengival, a localização do implante e avaliação da área doadora, técnica do operador e as preferências do paciente. Mais pesquisas são necessárias para avaliar as vantagens dos materiais alternativos no contexto de tratamentos de longo prazo.

Termos de indexação: Implantes dentários. Estética dentária. Osseointegração.

INTRODUCTION

Oral rehabilitation with dental implants has become a well-established and successful practice in modern dentistry, offering an effective and long-lasting solution for patients with tooth loss. However, the success of these treatments extends beyond mere implant osseointegration and requires a multidisciplinary approach involving implantology, periodontology, and dental prosthetics to achieve aesthetic and functional outcomes. The aesthetic factor, especially in the anterior region where aesthetic demands are higher, is crucial for patient satisfaction. The restoration of both hard and soft tissues represents a challenging and decisive task, particularly when considering the contouring of soft tissues around the implant [1-3].

To meet the increasing aesthetic expectations of patients, peri-implant plastic surgeries have gained prominence in implantology. These involve surgical procedures aimed at improving the aesthetics and function of the tissues surrounding the implant. Such procedures include filling bone defects, increasing gingival tissue volume, augmenting keratinized gingiva, and surgically modifying the gingival phenotype [4,5].

The thickness of gingival tissue has been identified as a critical factor for peri-implant stability. Determining the gingival phenotype has been established as an influential factor in treatment predictability and success. Differences in bone and gingival architecture, characterizing each biotype, can influence and alter the final aesthetic result of a rehabilitative treatment [6].

Various elements play a crucial role in defining periodontal biotype characteristics. According to a group of authors, some properties include bone architecture, gingival thickness, the amount of keratinized mucosa, and dental crown configuration [7]. Researchers propose the existence of three distinct biotypes: “Thin” Biotype, characterized by interproximal contacts near the incisal edge, a narrow band of adjacent keratinized mucosa, clinically delicate and thin gingiva, slender triangular crowns with little cervical convexity, and relatively thin alveolar bone; “Intermediate” Biotype, features fibrous and thick gingiva, elongated triangular crowns, a narrow band of keratinized mucosa, and a highly beveled and regular gingival arch; “Thick” Biotype, marked by pronounced cervical convexity, larger interproximal contacts positioned apically, a broad band of adjacent keratinized mucosa, fibrous and relatively thicker gingiva, rounded gingival arch margins, and quadrangular dental crowns. Understanding these biotypes is crucial for the personalized planning of dental procedures to optimize aesthetic and functional outcomes according to each patient’s individual characteristics.

Periodontal biotypes classified as “thin” are associated with gingival recession, bone dehiscence, and fenestration, leading to the exposure of implant components. They also exhibit lower resistance to trauma during brushing. This results in less predictable post-surgical tissue levels, compromising the aesthetic and functional outcomes of treatment. Conversely, “thick” biotypes are considered more advantageous for achieving more stable aesthetic results. They also demonstrate greater resistance to brushing trauma compared to the “thin” biotype. Although they are more prone to pocket formation during inflammatory processes, thick biotypes offer better predictability in the healing of soft and hard tissues post-surgery and are associated with the formation of papillae adjacent to immediate implants [8-10].

Among the most common techniques for increasing gingival thickness, connective tissue grafts stand out as the gold standard approach. Connective tissue grafts, which utilize tissue harvested from the patient’s own palatal mucosa, provide predictable and long-lasting results. However, with the development of new biocompatible materials, such as xenogeneic collagen matrices, less invasive alternatives have been explored, offering potential benefits such as reduced morbidity at the donor site and increased patient comfort [3,11].

Autografts of connective tissue are excellent for repairing soft tissue defects. The extracellular matrix of connective tissue acts as a support and guidance structure for the newly infiltrating fibroblasts, ensuring smooth integration with the surrounding tissues. Fibroblasts are transferred with the connective tissue autograft. Most of these cells are well-nourished by the blood supply from plasma circulation in the initial period and by vascularization in the subsequent period after transplantation. Consequently, they exhibit a favorable prognosis [12].

Several studies have highlighted the importance of keratinized tissue around implants, showing that a band of keratinized mucosa less than 2 mm may promote biofilm accumulation, peri-implant bleeding, and soft tissue recession [13]. Conversely, adequate tissue presence offers advantages such as facilitating rehabilitative procedures, reducing the likelihood of tissue collapse, promoting aesthetics, and allowing for the maintenance of oral hygiene without irritation or discomfort for the patient [14,15].

Given the importance of gingival thickness in maintaining the aesthetics and functionality of dental implants in the anterior region, this study aims to review and analyze the different surgical techniques used

to increase gingival thickness, focusing on clinical outcomes, associated complications, and implications for clinical practice.

METHODS

This study consists of an integrative literature review aimed at identifying, analyzing, and synthesizing recent scientific articles published on surgical techniques for increasing gingival thickness in anterior dental implants.

The research strategy was carried out using online bibliographic databases, specifically PubMed, where articles published in the last 10 years in English and Portuguese were selected. The search strategy was outlined using MeSH descriptors, with the following terms defined for the search: “Oral Surgical Procedures”, “Surgical Techniques”, “Dental Implants”, “Prostheses and Implants”, “Gingiva”, “Gingivoplasty”, “Mouth Mucosa”, “Dental Esthetics”, “Dental Aesthetics”, “Connective Tissue Graft”. The descriptors were combined with Boolean operators to broaden and refine the results.

The search strategies were implemented using search filters and following the inclusion criteria: meta-analysis studies, randomized clinical trials, or systematic reviews, and studies involving surgical procedures aimed at increasing gingival thickness in anterior teeth. The exclusion criteria were: studies involving patients with comorbidities, parafunctional habits, smokers, or motor disabilities that hinder oral hygiene; and laboratory or animal studies.

RESULTS

The bibliographic research conducted in the PubMed database, according to the described methodology, resulted in a series of studies. Their available titles and abstracts were reviewed, and seven articles meeting the inclusion and exclusion criteria were selected to be part of this literature review. This group includes publications from 2015 to 2024, all in English, consisting of literature reviews, systematic reviews, and observational studies (Chart1).

Chart 1. Summary of articles found after literature review.

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Author	Year	Title	Study Type	Considerations
Bassetti et al. [17]	2015	Soft tissue grafting to improve the attached mucosa at dental implants: A review of the literature and proposal of a decision tree.	Literature Review	Discusses the importance of keratinized mucosa around implants for health maintenance and proposes a decision tree for graft use.
Zucchelli et al. [16]	2020	Autogenous soft tissue grafting for periodontal and peri-implant plastic surgical reconstruction.	Literature Review	Presents the latest evidence and the current state of autogenous soft tissue grafting for tissue augmentation and recession coverage on teeth and dental implants.

Chart 1. Summary of articles found after literature review.

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Author	Year	Title	Study Type	Considerations
Huang et al. [27]	2021	Clinical evaluation of xenogeneic collagen matrix versus free gingival grafts for keratinized mucosa augmentation around dental implants: a randomized controlled clinical trial.	Randomized Clinical Trial	Evaluates the use of autogenous and xenogeneic grafts. Results show better width gain with autogenous grafts but highlight other characteristics without statistical differences.
Ashurko et al. [20]	2023	Comparative analysis of xenogeneic collagen matrix and autogenous subepithelial connective tissue graft to increase soft tissue volume around dental implants: a systematic review and meta-analysis.	Literature Review; Meta-Analysis	Compares the use of autogenous and xenogeneic grafts around implants. Shows greater efficacy with autogenous grafts but indicates alternative uses for xenogeneic grafts.
Hadzik et al. [28]	2023	Soft-tissue augmentation around dental implants with a connective tissue graft (CTG) and xenogeneic collagen matrix (CMX)-5-year follow-up.	Randomized Clinical Trial	Evaluates the quality of timing for autogenous and xenogeneic grafts. Demonstrates better results with autogenous grafts when surgery is performed before implant placement.
Thoma et al. [29]	2023	Soft tissue augmentation with a volume-stable collagen matrix or an autogenous connective tissue graft at implant sites: five-year results of a randomized controlled trial post implant loading.	Randomized Clinical Trial	Compares the use of autogenous and xenogeneic grafts around implants. No significant differences were observed between the two methods in terms of clinical and radiographic results over five years.
Atieh et al. [21]	2024	Xenogeneic collagen matrix versus free gingival graft for augmenting Peri-implant keratinized mucosa around dental implants: a systematic review and meta-analysis.	Literature Review; Meta-Analysis	Reviews observational studies comparing certain criteria after using autogenous and xenogeneic grafts around implants. Positions autogenous grafts as more stable in the long term.

The analysis encompassed current articles on the importance of gingival thickness for implant longevity, the surgical methods used to increase gingival volume, including surgical techniques and types of grafts employed, as well as the aesthetic and functional impact of these techniques.

DISCUSSION

A review aimed at demonstrating the most recent evidence and the current state of the use of autogenous soft tissue grafts shows that one of the current methods employed for grafting is the technique of free gingival grafts. This involves harvesting tissue with epithelium, which is generally combined with an apically positioned flap or vestibuloplasty to increase the width of keratinized mucosa. The technique offers high predictability but is also associated with certain risks, such as significant graft shrinkage during the healing process and the potential for color mismatch with the surrounding tissue. Connective tissue grafts have also become a viable alternative. These are performed using a coronally advanced flap or the tunneling technique, especially for their superior aesthetic outcomes and greater suitability for increasing the tissue volume around teeth and implants [16].

Another study highlights the importance of soft tissue grafts for improving keratinized mucosa around implants. This research emphasizes the significance of an adequate width of keratinized mucosa (at least 2 mm) around dental implants to facilitate oral hygiene, prevent peri-implant inflammation, and avoid biological complications such as mucositis and peri-implantitis. The presence of keratinized mucosa is associated with better clinical outcomes and long-term stability of the tissues surrounding implants. The article also notes that its absence may increase susceptibility to inflammation and tissue recession around implants [17].

The presence of keratinized and thick tissue around implants is further discussed in other studies, which support these findings by demonstrating benefits for peri-implant health and maintenance, as well as case aesthetics. Research indicates that increasing the soft tissue around implants reduces inflammation and enhances patient comfort, making oral hygiene easier [18,19].

The same study that highlights the importance of soft tissue grafts for improving keratinized mucosa around implants also suggests that the timing and necessity of soft tissue grafting should be carefully evaluated. Interventions can be performed at different stages of treatment: before implant placement, during implant placement surgery, after initial healing (two-stage surgery), or after implant exposure and loading. However, when the implant is already exposed and under load, the procedure may become more complex and less predictable, especially if biological complications such as mucositis are already present [17].

Some of the selected studies compare the use of autogenous grafts, still considered the gold standard, with xenogeneic grafts for increasing gingival thickness, presenting a highly current systematic review on the subject.

The first systematic review on this topic aimed to evaluate the effectiveness of xenogeneic collagen matrices compared to subepithelial connective tissue grafts [20]. Eight randomized clinical trials were selected for analysis, and the results revealed that xenogeneic collagen matrices are less effective than subepithelial connective tissue grafts in increasing peri-implant soft tissue thickness.

Another study [21], also a systematic review, brought a similar comparison, evaluating six studies with similar results. It provided an interesting analysis showing that while both graft types initially yielded satisfactory results, xenogeneic grafts exhibited greater shrinkage in width and thickness over time, demonstrating that autogenous grafts offer greater stability over the long term. In terms of patient satisfaction and changes in the contour and texture of augmented areas, results were comparable between the two groups.

Similar findings are reported by other authors in these comparisons, showing that autogenous grafts still yield more satisfactory results compared to xenogeneic grafts [22,23]. However, other studies [24-26] have found comparable results between autogenous and xenogeneic grafts, highlighting some advantages of xenogeneic grafts: easier and more reproducible surgical techniques, consistently adequate graft size, reduced surgical time and morbidity, no need for a secondary surgical site as a donor area, less postoperative discomfort, and fewer complications such as bleeding and necrosis. These factors can influence patient perception of the treatment, enabling a less invasive procedure with faster and more tolerable postoperative recovery. In summary, collagen matrices represent a valid alternative in certain cases.

It is worth noting that most studies cite the use of the xenogeneic collagen matrix Mucograft (Geistlich Pharma AG, Wolhusen, Switzerland) and the stable volume collagen matrix Fibro-Gide (Geistlich Pharma AG, Wolhusen, Switzerland) as the most widely used and effective substitutes [23-25].

Another important consideration, although underexplored in most studies, is the integration of the graft with adjacent soft tissues for aesthetic evaluation. When evaluating this variable, favorable results were found in both groups. These studies stated that favorable outcomes were obtained in both groups and that when evaluated blindly, neither procedure could be distinguished in terms of color or aesthetic results. This contrasts with free gingival grafts, where collagen matrices produce superior results. One disadvantage of free gingival grafts is the discrepancy in tissue color between the graft and the surrounding tissue [23].

Further comparisons between autogenous and xenogeneic grafts were evaluated in three clinical studies to demonstrate their results:

A randomized clinical study involving 26 patients compared two methods of increasing keratinized mucosa around dental implants: xenogeneic collagen matrices and free gingival grafts [27]. Results showed that autogenous grafts achieved better outcomes, with an increase of about 4.1 mm in keratinized mucosa width compared to 1.8 mm with xenogeneic grafts. However, both methods maintained similar peri-implant health. Regarding surgical duration and postoperative pain, the group receiving xenogeneic grafts experienced better results, with a shorter procedure and less discomfort. Patient satisfaction showed no significant difference between the groups.

Another randomized clinical study with a 5-year follow-up compared Connective Tissue Grafts (CTG) and xenogeneic collagen matrices (CMX) [28]. The study involved 67 patients divided into three groups: Group 1 – no tissue augmentation; Group 2 – tissue augmentation before implant placement; Group 3 – tissue augmentation after implant placement. Results confirmed autogenous grafts as the most effective method for peri-implant tissue augmentation, providing better bone stability and tissue thickness over time. Xenogeneic grafts were also effective but showed inferior results in tissue thickness compared to autogenous grafts. Tissue augmentation performed before implant placement proved more beneficial for soft tissue stability, reinforcing the importance of soft tissue augmentation for long-term peri-implant health and aesthetic outcomes.

The final analysis involved a randomized study in which the authors evaluated methods for soft tissue augmentation around implants and their long-term efficacy with autogenous and xenogeneic grafts [29]. The study included 20 patients who underwent surgeries and clinical and radiographic evaluations over five years, measuring mucosal thickness, marginal bone levels, and crest contour changes. Results showed no significant differences in any of the analyzed aspects, including mucosal thickness, crest contour changes, peri-implant health, marginal bone levels, aesthetics, and patient-reported outcomes.

Through the analysis of these studies, it can be observed that although autogenous grafts remain the gold standard for soft tissue augmentation, xenogeneic grafts have proven to be an effective alternative,

offering the advantage of lower morbidity and comparable aesthetic results. This makes them an attractive option, especially for patients with limited availability for graft harvesting or those who prefer less invasive procedures.

CONCLUSION

The results obtained in this study allowed for an understanding of the importance of surgical techniques for increasing gingival thickness in maintaining peri-implant health and achieving satisfactory aesthetic outcomes around implants. Adequate gingival thickness was identified as a critical factor in preventing gingival recession and promoting the long-term stability and aesthetics of dental implants. Connective tissue grafts were shown to be the most effective and well-documented technique for this purpose, providing superior clinical results in terms of increased thickness and soft tissue stability around implants.

The analysis of the studies demonstrated that, although alternative materials such as xenogeneic collagen matrices offer advantages in terms of reduced morbidity and greater patient comfort, connective tissue grafts remain the method of choice due to their predictability and long-term durability. The choice of surgical technique should, therefore, be carefully considered, taking into account the patient's gingival biotype, the location of the implant, and individual preferences.

Finally, it is essential that more long-term clinical studies be conducted, particularly with alternative materials such as xenogeneic collagen matrices, to evaluate whether they may eventually replace connective tissue grafts in terms of clinical efficacy and predictability.

Conflict of interest: The authors declare that there are no conflicts of interest.

Collaborators

N Gonçalves, conceptualization, formal analysis, investigation, project administration, validation, visualization, writing – original draft. M Paes, supervision. VCS Borges, supervision. JO Araújo, supervision. LB Maia, supervision. BM Carvalho, methodology, writing – review & editing.

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