Original Article

Current concepts of surgical methods to increase mucosal thickness during dental implantation

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ABSTRACT

The importance of soft tissues for the maintenance of peri-implant tissue health is one of the most discussed topics in dental implantology. Numerous studies confirm that the presence of soft tissues affects the aesthetic result and the long-term survival of dental implants. It was suggested that surgical procedures aimed to increase peri-implant mucosa improve outcomes of implant treatment. This literature review aims to make an overview of methods of soft tissue management around dental implants. The analysis of available publications, which consider surgical methods to achieve soft-tissue volume gain during dental implantation showed that recently more and more data on the successful use of collagen matrices in mucogingival surgery are accumulated. However, there are no fundamental investigations related to application of substitute materials in various clinical situations. Consequently, it must be admitted that more randomized studies regarding the comparative analysis of various methods of increasing the soft tissue thickness around dental implants are required.

Keywords: Keratinized mucosa, Soft tissue augmentation, Connective tissue graft, Xenogeneic collagen matrix

Introduction

The role of soft tissues in the survival of dental implants is one of the most pressing issues today in modern implantology [1]. Soft tissue deficiency affects not only the aesthetic result but also leads to dysfunction. Correction of this condition around dental implants is more important than in the area of natural teeth since the peri-implant soft tissues have specific anatomical and histological characteristics that lead to less protection against mechanical factors and bacterial invasion [2-4].

Soft tissue parameters, such as the width of the keratinized attached mucosa and its thickness, are of particular importance in the prevention of inflammatory complications after dental implant placement [1, 5].

Numerous studies have been devoted to investigating the keratinized mucosa (KM) width. Although the results are inconsistent, most authors agree that the absence of KM at implant sites increases the vulnerability of soft tissues around implants. It is the presence of a sufficient KM width around the dental implant that is one of the factors of successful implant treatment [1, 6, 7].

Currently, an important aspect for a favorable prognosis for a functioning implant is not only the sufficient width of the KM but also the peri-implant soft tissue thickness. The latter affects both the aesthetic component of the treatment outcome and the marginal bone stability around implants [8].

If the thickness of the soft tissues is less than 2 mm, the mucosa may become grayish in the area of the implant due to the abutment visibility. No changes in soft tissue color are observed with a mucosa thickness of more than 3 mm [9].

Clinicians pay special attention to the question of the impact of soft tissue volume on bone resorption. When the thickness of peri-implant soft tissues is less than 2 mm, bone resorption occurs during biological width establishment [10]. Lots of studies have been devoted to investigating the relationship between the mucosal thickness in the implant area and bone

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resorption. So it was identified that the rates of bone loss level in the group of patients with soft tissue thickness of 2 mm or less were significantly higher than the rate of bone loss level in the group of patients with peri-implant mucosal thickness of more than 2 mm [11]. The soft tissue augmentation procedures significantly reduce the risk of bone resorption. Moreover, it has been proved that platform switching does not preclude marginal bone loss if peri-implant mucosa is thin. With thickened soft tissues, the use of implants, even without platform switching, allows maintaining the bone level with minimal remodeling [12].

Ultrasound assessment of the mucosal thickness around dental implants in the aesthetic zone showed that the minimum soft tissue thickness should be equal to 2.88 [13].

The risk for developing inflammatory complications is increased in the implant area with mucosal thickness less than 2 mm due to the greater accumulation of plaque compared to area where soft tissue thickness is more than 2 mm [14].

Ladwein *et al*. have observed 211 patients with inserted dental implants for 8 years. The authors found that an unsatisfactory level of oral hygiene and bleeding on probing were detected in the implant areas with insufficient mucosa volume. However, there were no statistically significant changes in probing depth and bone level [15].

Over a ten-year observation period, Roccuzzo M. revealed that even in patients who adequately exercising individual oral hygiene. There is a significant plaque accumulation in the implant area, where the KM was less than 2 mm [7].

Thus, today it is commonly accepted that the lack of soft tissue volume around the implant is a predisposing factor for the occurrence of not only an unsatisfactory aesthetic result but also bone loss. However, the number of scientific papers devoted to this topic is limited, so further investigations are required to study this issue.

Materials and Methods

Materials and methods used for writing this article are the analysis of available publications, which consider surgical methods to achieve soft-tissue volume gain during dental implantation.

Results and Discussion

There are various surgical techniques to increase the volume of peri-implant soft tissue. In 1966, Nabers first coined the term "free gingival graft" [16]. This method involves the harvesting of the mucosal strip from the hard palate, and then it is placed on a periosteal recipient site [17]. Depending on the thickness of the donor tissue, 3 types of graft are distinguished: thin (0.5 - 0.8 mm), medium (0.9-1.4 mm), thick (more than 1.5 mm). A thin graft is more suitable for the enlargement of keratinized attached gingiva and it gives a good esthetic result. This graft heals quickly but has the highest percentage of secondary shrinkage (25-30%). When an average-thickness graft is placed, an aesthetically acceptable result is achieved, and the risk of developing recessions is also reduced in comparison with a thin graft. Thick grafts show minimal secondary contraction, but the recipient zone differs from the surrounding tissues in color and thickness after healing [18]. Despite its high efficiency, this technique has several disadvantages, such as additional trauma to the donor site, poor aesthetic outcome after an operation, and limited graft size [5, 18].

Another option for increasing the volume of the soft tissue is the use of a connective tissue graft (CTG) with fixation under the covering flap. Both the hard palate area between the canine and the first molar and the area of the maxillary tuberosity is used for taking CTG. The selection of these regions for obtaining CTG is associated with the presence of lamina propria containing vessels, cells, and fibers. Some studies have also compared the CTG from the hard palate and the maxillary tuberosity. According to histological data the tuberosity donor site contains more connective tissue (lamina propria) and less submucosal tissue (adipose and glandular tissue) [19, 20].

The anatomy of the vascular bed is an important factor for selecting the area for graft harvesting. There are the palatine artery and sufficiently developed network of blood vessels in the hard palate, and vascular damage can cause complications [21].

Several factors should be taken into account to achieve successful outcomes when using CTG. First of all, the best possible blood supply from the recipient site and the covering flap must be achieved to preserve the graft, and the technique of incision and suturing must be correct [19, 22]. Graft formation and graft thickness must be relevant [21].

Despite the high clinical efficiency, the application of connective tissue grafts has several disadvantages, such as increased duration of the surgical procedure, additional trauma to the donor site, the complexity of the surgical protocol, the risk of tissue necrosis in the donor area, the limited graft size, and significant postoperative pain. Many authors also describe the risk of bleeding during graft harvesting, paresthesia of the palate, and the development of a secondary infection in the donor area [23, 24].

Currently, in periodontal plastic surgery, xenogeneic collagen matrices are used more frequently for soft tissue augmentation. Previously, other allogeneic materials, such as lyophilized skin [25], non-cellular dermal matrix, have been used for this purpose in mucogingival surgery. However, some authors have concluded that the use of these materials leads to unsatisfactory clinical results [26].

Modern xenogeneic substitutes have the following characteristics: they are temporary structures (extracellular matrices), which are the basis for the growth and differentiation of new cells; they distribute the loading that occurs during chewing [27]. They are biodegradable, and degrade at such a rate, that when they disintegrate, they were replaced by the patient's newly formed tissue. The use of xenogeneic collagen matrix demonstrates good healing of soft tissues since it has a porous structure that allows a blood clot to be retained.

Xenogeneic collagen matrix maintains long-enough volume stability to ensure a vascularization and fibroblasts producing collagen type I that fills the scaffold pores before its degradation occurs [28].

Thoma *et al*. evaluated the effectiveness of the use of a collagen matrix in comparison with a subepithelial connective tissue graft (SCTG). Twenty patients were entered into the study, soft tissue augmentation was performed single-tooth implant sites with soft tissue volume deficiency, and the thickness was assessed before surgery and up to 90 days after. The average increase in volume in the group where the SCTG was used was 0.5 mm – at the occlusal site, 1.5 mm - at the buccal side, in the second group, where the collagen matrix was used, 1.8 mm - at the occlusal site, 1.0 mm buccally. There was no statistically significant differences between the groups. Medication consumption was slightly increased in the SCTG group up today 3 [29]. The data are consistent with the results in the study by Gargallo-Albiol J. *et al.*, where the researchers also did not find a statistically significant difference between the use of CTG and collagen matrix [24].

However, opposite results have been also presented. According to a randomized controlled trial by Cairo F. *et al.*, the use of CTG to increase the soft tissue volume on the vestibular side is more effective than the use of collagen matrix [30]. Puzio *et al*. evaluated the thickness of KM around implants after the use of CTG and after the use of the collagen matrix. Observations were carried out during the year after soft tissue augmentation in the area of installed implants. The authors concluded that in both cases there was an increase in the soft tissue thickness, but higher values were noted in the group where CTG was used [31]. The CTG regarded as the gold standard has also demonstrated greater efficiency in the early healing phase after surgery [32]. Similar data were obtained by other authors who carried out a comparative analysis of the use of CTG and collagen matrixes to increase the soft tissue volume [30, 33].

However, there is evidence that the application of collagen matrices is as effective as the use of CTG, this conclusion was made by Gargallo-Albiol J. *et al*. as a result of the meta-analysis [24]. The authors also established that the use of a collagen matrix makes it possible to reduce the pain medications intake in the postoperative period. The use of both CTG and collagen matrices prevents marginal bone resorption around implants [8]. According to a meta-analysis of the effectiveness of various soft tissue management techniques, Thoma *et al*. concluded that the use of CTG and collagen matrices is suitable for increase the width of KM and reduce the risk of marginal bone loss [34].

Martin Lissek *et al*. performed a systematic review, which concluded that soft tissue augmentation around dental implants with substitute materials is a safe procedure and results in mucosal thickening [35]. At the same time, the authors noted that SCTG can still be considered as the gold standard, but in some situations, substitute materials may be an acceptable alternative. For example, it may be an alternative for patients with a low pain threshold, people with concomitant pathology, and also, importantly, these materials can be used by a surgeon with insufficient experience in the harvesting of autogenous tissues [35]. The advantages also include greater availability, low cost, and the ability to use in large quantities [36].

Conclusion

Even though recently more and more data on the successful use of collagen matrices in mucogingival surgery are accumulated, it must be admitted that there are no fundamental investigations related to their application in various clinical situations. The importance of the volume of soft tissue around dental implants has been discussed by various authors; however, it is necessary to recognize the lack of randomized studies regarding the comparative analysis of various methods of increasing the soft tissue thickness.

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