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Soft tissue conditioning around teeth and implants

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ABSTRACT

Periodontal diseases encompass a wide variety of conditions, mostly related to biofilm accumulation while others may develop independently of it. Mucogingival deformities and around teeth, and peri-implant soft tissue deficiencies are some of the most common conditions that we need to treat in our daily practice.

1. Introduction

Periodontal diseases encompass a wide variety of conditions, mostly related to biofilm accumulation while others may develop independently of it.

Mucogingival deformities and conditions around teeth, and peri-implant soft tissue deficiencies are some of the most common conditions that we need to treat in our daily practice.

Gingival recession is the term used to describe the apical shift of the marginal gingiva beyond the cementoenamel junction with exposure of the root surface. This root exposure is frequently associated with dental hypersensitivity, difficulty in achieving optimal plaque control and esthetic concerns. Different surgical techniques and modifications have been described in the literature over time for the treatment of gingival recessions around teeth.

Classically, the success of implant therapy was defined as implant survival over time. However, nowadays can be defined by maintenance of peri-implant health, with low inflammatory indices, stable marginal bone level and peri-implant soft tissue dimensions.

Peri-implant soft tissue plays a crucial role in the maintenance of peri-implant health. In this sense, soft tissue grafting around implants might help in the prevention of peri-implant biological complications.

The aim of this narrative review is to provide an overview of the existing evidence regarding different mucogingival procedures to improve soft tissue condition around teeth and implants.

2. Soft tissue conditioning around teeth

Gingival recession (GR) is defined as the apical migration of the gingival margin in relation to the cementoenamel junction (CEJ) [1]. Anatomic factors, trauma from brushing, periodontal disease and tooth malposition are the main risk factors for the development of these periodontal defects. Gingival recession is often associated with esthetic problems and dentinal hypersensitivity [2]. Irregularities of gingival margin contour may also pose difficulty for patients to perform adequate oral hygiene, leading to accumulation of plaque and gingival inflammation. Sites with gingival recession also have increased susceptibility to future gingival recession [3]. The negative consequences associated with gingival recession provide a rationale for the treatment of certain gingival recession defects.

Mucogingival deformities and conditions around teeth englobe a group of clinical scenarios such as reduction of vestibular depth, lack of keratinized tissue, presence of aberrant frenum, and may not be directly associated with pathology.

There is evidence that GR do not lead to tooth loss and in presence of adequate hygiene control, do not compromise gingival health [4]. However, there is a longitudinal tendency to increase in size. A recent systematic review evaluating 1650 untreated gingival recessions reported that 78 % of them increased in depth, 7 % diminished and 15 % remained stable over time [5].

In most of the cases GR do not represent a significant clinical problem, but they can be perceived as an esthetic problem by patients (especially the ones affecting the anterior maxilla), they can difficult the maintenance of an adequate plaque control, or be related with dentin hypersensitivity, root caries or non-carious cervical lesions (NCCL) [6].

The presence of a minimal dimension of keratinized gingiva has not been demonstrated to be a prerequisite to avoid clinical attachment loss, in the presence of optimal plaque control and thus, absence of inflammation [7].

However, in the presence of inflammation due to an inadequate plaque control at least 2 mm of keratinized gingiva and 1 mm of those being attached are suggested in order to maintain gingival health [8].

Observational studies have shown that sites with minimal attached gingiva and intrasulcular restorations tend to develop inflammation and

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consequently gingival recessions [7,8].

There is an association between orthodontic treatment and gingival recessions, with up to 47 % of prevalence in some retrospective studies [9]. Risk factors in the development of those recessions are the direction of orthodontic movement and the gingival phenotype [7]. In presence of a thin phenotype (gingival thickness < 1 mm) or minimal amount of attached gingiva (<1 mm), expansive orthodontic movements or buccal tilting of teeth might result in gingival recession defects [10].

In this clinical scenario, in presence of a thin phenotype, it is suggested to treat the gingival recessions prior to orthodontic therapy. However, when the expected movement is lingual, an existing recession will be reduced or even disappear after the orthodontic phase. So, in this other situation it is suggested to wait until the end of the orthodontic therapy to evaluate if mucogingival therapy is needed [11].

The presence of non-carious cervical lesions (NCCL) is associated with higher prevalence of gingival recessions [12].

2.1. Diagnostic considerations

To date, Miller's classification [13] has been one of the most widely used for the diagnosis of gingival recessions. However, due to some limitations and difficulties when using it, the last Workshop on the Classification of Periodontal Diseases [8] determined the use of Cairo's classification [14] as the reference classification for gingival recession defects. It is based on interproximal attachment loss as the reference, and as the key prognostic factor for the achievement of root coverage. There are three types of recession:

- Recession type 1 (RT1): When the apical displacement of the gingival margin presents with no loss of interproximal clinical attachment, maintaining the interdental papillae unharmed. As a result, interproximal CEJ is not visible.
- Recession type 2 (RT2): When the gingival recession is associated with loss of interproximal attachment, although this is less than or equal to the attachment loss at the buccal (measured from the CEJ to the gingival margin).
- Recession type 3 (RT3): When the interproximal bone loss is greater than the dimension of the gingival recession.

It is also important to identify the prognostic factors that can influence our decision on the type of surgical intervention for the treatment of the gingival recessions.

- Depth of gingival recession: Distance in millimeters measured with a periodontal probe from the CEJ to the gingival margin. According to a systematic review by Chambrone et al. the greater the depth of gingival recession, the lesser the probability of achieving complete root coverage (CRC) [15].
- Gingival phenotype: A thin gingival phenotype is considered less than or equal to 1 mm, while a thick phenotype is greater than 1 mm. A colored periodontal probe can be used to determine this parameter [10]. Thin gingival phenotypes are associated with less percentage of root coverage [16].
- Width of keratinized gingiva: Distance in millimeters measured with a periodontal probe from the gingival margin to the mucogingival junction. It can range between 2.75 mm and 5.44 mm for fine phenotypes and between 5.09 mm and 6.65 mm in thick phenotypes [1].
- Loss of tooth substance: NCCL can affect enamel's surface creating some concavities or steps in the root contour. Pini-Prato [17] reported that 50 % of 1000 evaluated gingival recessions presented modifications of the root surface. As mentioned before, they are associated with less percentage of root coverage [18]. Pini-Prato [17] proposed a classification as a mean to describe the presence of cervical lesions affecting the integrity of the CEJ. (*A* = detectable CEJ; *B* = non detectable CEJ) and the presence of a detectable cervical step ("+" indicates the presence of a step > 0.5 mm; "-" indicates the absence of a cervical step > 0.5 mm).
- Vestibular depth: Distance in mm from the gingival margin to the point of greatest concavity of the mucosal fold. Shallow vestibular depth is associated with less percentage of root coverage [40]. A clinical situation that is often found around mandibular incisors.
- High frenulum insertion and labial muscular pull may influence negatively in the outcome of root coverage procedures [19]

All these clinical parameters must be evaluated and taken into consideration prior to selecting the most adequate surgical approach for the treatment of gingival recessions.

2.2. Treatment of gingival recessions

Root-coverage procedures are surgical interventions performed to treat gingival recessions and re-establish the location of the free gingival margin to its physiological position.

The term mucogingival surgery was defined by Friedman in 1957 as the surgical procedures designed to preserve gingiva, remove aberrant frenulum, or muscle attachments and increase the depth of vestibule [20].

Later in 1993, Miller proposed the term periodontal plastic surgery, considering that mucogingival surgery had moved beyond the traditional treatment to also include correction of ridge form and soft tissue esthetics. In the proceedings of the 1996 World Workshop in Periodontics, the definition of periodontal plastic surgery was consolidated as surgical procedures performed to prevent or correct anatomic, developmental, traumatic or disease induced defects of the gingiva, alveolar mucosa, or bone [11].

Classically, the introduction of surgical procedures for gingival augmentation was based on the opinion that the presence of a wide band of keratinized and attached mucosa around teeth was critical for maintaining gingival health and preventing attachment loss and soft tissue recession. According to Friedman and Ochsenbein, the presence of a wide band of keratinized tissue was critical to maintain periodontal health [20,21].

Then, one of the first studies in which attempts were made to evaluate the significance of the gingival zone for maintenance of periodontal health was carried out by Lang and Loe in 1972 [22]. It was concluded, based on clinical and visual examination, that even though tooth surfaces were free from plaque, all sites with less than 2 mm of attached gingiva exhibited persistent clinical signs of inflammation. Thus, the authors suggested that 2 mm of attached gingiva is an adequate width for maintaining gingival health.

Subsequent clinical trials by Miyasato et.al showed that in the presence of oral hygiene measures, it is possible to maintain clinically healthy gingival margin tissues even in areas with less than 1 mm of attached gingiva. They also showed that the rate of plaque accumulation was similar in areas that had minimal and appreciable width of keratinized gingiva [23].

The question whether a firmly attached portion of gingiva is critical for the protection of the periodontium proper was addressed by Wennstrom and Lindhe in 1983 [24] using the beagle dog model. With mechanical plaque control measures performed daily, the gingival units could be maintained free from clinical as well as histological signs of inflammation irrespective of the presence or absence of attached portion of gingiva. However, when bacterial plaque was allowed to accumulate for 40 days, the clinical signs of inflammation were more pronounced in tooth regions than those with mobile gingiva. Curiously, the finding that the clinical signs of gingival inflammation did not correspond with the size of the inflammatory cell infiltrate, as seen through histology, illustrates the difficulties inherent in the interpretation of data from clinical examinations in areas with varying gingival width. The results of these two studies are in contrast with the data presented by Lang and Loe in 1972. Thus, at this point, the requirement for a wide band of

keratinized tissue was in question.

Dorfman evaluated in 1982 the effectiveness of gingival augmentation in maintaining periodontal attachment [25]. 92 patients with bilateral facial tooth surfaces exhibiting minimal keratinized tissue had a free gingival graft placed on one side while the contralateral side was the untreated control. Both sides received regular SRP maintenance. They concluded that minimizing inflammation is sufficient to maintain attachment levels, despite width. Further support for the conclusion that a minimal zone of gingiva may not compromise periodontal health is available from a few other longitudinal clinical.

Wennstrom et al. 1987 [26] conducted a study where the two central incisors were moved in a labial direction through the alveolar bone envelope and the first premolars were moved in a distal direction into contact with the first molars. Following extensive bodily movement of the incisors in a labial direction through the alveolar bone, most teeth showed a small apical displacement of the soft tissue margin, but no loss of connective tissue attachment. In other words, the apical displacement of the gingival margin was the result of a reduced height of the free gingiva, which in turn may be related to tension "stretching" in the soft tissues during the facial tooth movement and reduced buccolingual tissue thickness. These observations suggest that plaque-induced inflammation and the thickness (volume) of the marginal soft tissue, rather than the apicocoronal width of the keratinized and attached gingiva, are determining factors for the development of gingival recession and attachment loss during orthodontic tooth movement.

Bissada et al. [27] studied the significance of the width of keratinized gingiva in relation to existence of subgingival restorations. They conlcuded that teeth with sub gingival restorations and narrow zones of keratinized gingiva showed statistically significant higher gingival scores than teeth having submarginal restorations with wide zones of keratinized gingiva. Teeth without sub gingival restorations showed no statistical difference between narrow and wide zones of keratinized gingiva.

Recent systematic reviews have reported that coronally advanced flap (CAF) in combination with a connective tissue graft (CTG) is the gold standard for soft tissue augmentation and root coverage [15,28, 37]. Several randomized controlled clinical trials (RCTs) have demonstrated successful recession reduction, clinical attachment level gain and increased zone of keratinized tissue [29,30].

The tunneling procedure for root coverage was introduced in 1994 [31] and defined as supraperiosteal envelope technique and was first applied for multiple gingival recessions in 1999 [32]. A particular characteristic of this mucogingival procedure is that the interdental papillae are left intact, being one of the advantages of the technique the minimally invasive nature of the surgery, which results in minimal postoperative discomfort at the recipient site [33].

The Vestibular Incision Subperiosteal Tunnel Access (VISTA) technique has been developed in an attempt to address the limitations of current techniques. VISTA consists of a vertical incision placed in the vestibule, remote from the treatment area. Through this incision, a subperiosteal tunnel is created using a series of specially designed elevators, extending toward the vestibular depth as well as the ridge crest. This method of tunneling provides an opportunity for tension-free mobilization of the mucoperiosteal complex, which can be relocated and fixated in a coronal direction in order to achieve soft tissue augmentation and coverage of exposed root surface.

Another particular aspect is the suturing technique with sutures anchored to the vestibular surface of the teeth with composite [34].

In a retrospective study [35] multiple gingival recessions were treated by vista, and demonstrated a mean percentage of linear root coverage of 96.2 % and 84.3 % for Miller Class I/II and Class III recessions, respectively.

The techniques mentioned above have shown positive outcomes, especially in cases when there is no loss of the interproximal bone: RT1 recession defects, according to the Cairo Classification [14]. These type of recession defects present with more remaining blood supply adjacent to the defect site when there is intact interproximal bone and periodontal attachment. Subsequently there is a better chance of obtaining complete root coverage, regardless of the technique used. Conversely, in sites with loss of interdental bone and attachment (RT2 and RT3) defects [14] root coverage procedures have reduced efficacy and less predictability [5].

When treating multiple gingival recession defects, the most validated techniques are the envelope-type coronally advanced flap with or without the use of a connective tissue graft, and the tunnel techniques combined with connective tissue grafts [36]

The outcome of root coverage procedures is usually measured by the position of the gingival margin with respect to the cemento-enamel junction (CEJ). In this sense, complete root coverage is achieved when the final position of the gingival margin is located at the CEJ level.

However, the final position of the gingival margin may not be adequate for assessing the overall outcome of the surgical treatment of gingival recessions. Irregularities of the marginal gingiva, inadequate color match, and presence of scar tissue are some of the common consequences after these types of mucogingival procedures [38]. Therefore, a complete coverage of the root surface cannot be considered the only factor for determining success in the treatment of gingival recessions.

2.3. *Factors influencing the outcome of root coverage procedures*

Factors for success can be grouped into 3 categories: patient related factors, site related factors, and technique related factors.

2.3.1. *Patient related factors*

Poor oral hygiene, smoking (Silva et al. 2006) and traumatic toothbrushing [3,39] need to be addressed prior to the treatment for success. Maintenance of optimal plaque control has been reported as a key factor to obtain predictable outcomes [36]. Adequate oral hygiene instructions must be provided to patients in order to prevent application of traumatic brushing techniques. Smoking has been described as a negative factor in the outcome of root coverage procedures, in a dose-dependent manner [36,38].

2.3.2. *Site related factors*

For site related factors, the main factor that will influence the outcome of our therapy is interproximal attachment loss as registered by Miller or Cairo classification. In cases where there is no loss of interproximal attachment, we can anticipate complete root coverage. However, in Miller class III (RT2) gingival recession defects, the mean root coverage can vary from 54.8 % to 85 % [5].

Depth and width of gingival recession are crucial factors that we need to consider, due to the amount of avascular supply present in the site. Deep and wide recessions are more difficult to treat than shallow and narrow ones [40].

Flap thickness has been correlated with predictability of root coverage. Baldi [41] showed that when we perform coronally advanced flaps with no connective tissue graft we need at least a thickness greater than 0.8 mm to achieve complete root coverage.

Similar conclusions were reported in a systematic review by Hwang and Wang [42] with a positive correlation between flap thickness and recession reduction, being 1 mm the threshold to achieve complete root coverage.

A more recent study reported that when using a connective tissue graft or substitutes, initial flap thickness has a limited role in the predictability of root coverage in any of the techniques used [43].

Location of the gingival recession defects plays a role in the outcome of therapy. Cairo et al. studied the percentage of root coverage in maxillary RT2 recession defects using coronally advanced flap with and without connective tissue grafts. What they saw is that when CAL was less than 3 mm, they were able to obtain complete root coverage in more than 80 % of the sites at 6 months and at 63 % of the sites 10 years postoperatively [44,45].

In two studies by Aroca [46,19] also evaluated the treatment of maxillary and mandibular RT2 recession defects using a modified coronally advanced tunnel approach with a connective tissue graft. They concluded that the probability of achieving complete root coverage was higher in the maxilla compared to the mandible. Similar conclusions were reported by Blasi [41].

Even though depth of vestibule is often associated with gingival recessions, evidence about its impact in root coverage is scarce. Blasi et al. [41] showed that in patients receiving a coronally advanced flap with connective tissue graft, the presence of a shallow vestibule was related to less root coverage. They also observed higher percentage of root coverage in the maxilla compared to the mandible, with a mean root coverage of 87 %.

This is an important aspect to consider when selecting the surgical approach for mandibular recessions.

2.3.3. *Technique related factors*

Incision design is an important factor to consider when planning our surgical approach, especially when performing a coronally advanced flap. The use of vertical releasing incisions in the trapezoidal flap design has been correlated with some esthetic complications, such as the presence of keloids [30].

The use of a connective tissue graft or substitute is of great importance in the intrasulcular tunneling approaches, due to the limited amount of coronal advancement of the mucogingival complex. However, in the coronally advanced flap or in VISTA approaches its use is suggested when dealing with RT2 and RT3 recessions, or in presence of unfavorable local anatomical factors, minimal amount of keratinized gingiva and thin phenotypes [47].

The use of connective tissue graft in the treatment of RT2 recession defects was also supported by Cairo [48]. The use of an adjunctive connective tissue graft resulted in higher percentage of complete root coverage (57 %) compared to the coronally advanced flap alone (29 %).

Minimal flap tension is a key factor during wound healing, mainly to achieve blood clot stability and avoid muscle tension on the gingival margin [36].

Pini-Prato [48] found a statistically significant negative association between flap tension and recession reduction when performing coronally advanced flap.

An association between the position of the gingival margin after suturing and the achievement of complete root coverage was stablished in a study by Pini-Prato [49], where it was shown that placing the gingival margin 2 mm or more coronal to the CEJ resulted in complete root coverage.

This factor might be crucial when using a coronally advanced flap technique with no use of connective tissue graft or substitutes.

Blasi, however showed that positioning the gingival margin only 0.5 mm coronal to the CEJ was enough to achieve complete root coverage in most of the cases when using a connective tissue graft [50].

The use of connective tissue grafts in coronally advanced flap procedures have been suggested in presence of unfavorable local anatomical factors, such as keratinized tissue width < 2 mm, gingival thickness < 1 mm, tooth malposition and presence of non-carious cervical lesions [47].

Biological mediators such as enamel matrix derivatives have been advocated in root coverage procedures due to its biologic properties, being able to stimulate new attachment formation on denuded root surface, improve angiogenesis, and increase the proliferation and migration of T-lymphocytes [51].

Several connective-tissue substitutes have also been introduced to reduce morbidities associated with autogenous soft tissue harvesting. Acellular dermal matrices were the first materials available in the market. This allogenic substitute consists of a freeze-dried connective tissue matrix with no epithelium or cellular components obtained from tissue banks [52].

Cairo et al.[37] concluded that the use of acellular dermal matrix in combination with coronally advanced flap resulted in inferior clinical results compared with the use of a subepithelial connective tissue graft.

Xenogenic collagen matrices can also be used in mucogingival procedures around teeth and implants [53]. They have been shown to promote regeneration of keratinized gingiva and to improve mucosal wound healing.

According to a recent systematic review by Chambrone [54], xenogenic collagen matrices with coronally advanced flap offered better results compared with coronally advanced flap alone.

McGuire and Sheyer [55] evaluated the use of these collagen matrices in the treatment of RT1 recession defects. Better results were obtained when performing coronally advanced flap with connective tissue grafts, however the use of collagen matrices was found to be less invasive and time consuming.

3. Soft tissue conditioning around implants

Peri-implant hard and soft tissues are developed as a result of a wound healing process after implant placement. Formation of a new bone in contact with the implant surface is known as osseointegration. Peri-implant mucosa is comprised of a connective tissue portion which is covered by either keratinized or non-keratinized epithelium.[56].

Peri-implant health is defined by the absence of clinical signs of inflammation, such as redness, bleeding on probing and swelling [57].

Maintenance of this peri-implant health is fundamental for their long-term success [58,59]. However, due to the anatomical aspects of peri-implant soft tissues, with an absence of periodontal ligament and the type of union of the connective tissue around implants, can result in a higher susceptibility of developing progressive inflammatory responses in the presence of plaque and biofilm accumulation.

According to Jung et al.[60] soft tissue deficiencies, which are a common clinical finding, might result in marginal bone loss, inflammation, and mucosal recession around implants. The etiology of these deficiencies is diverse, and many different factors can influence the stability of peri-implant soft tissues.

3.1. *Factors associated with peri-implant soft tissue deficiencies*

The dehiscence of the peri-implant soft tissue can be defined as an apical migration of the soft tissue margin of the implant-supported crown compared to the homologous natural tooth, with or without exposure of the implant surface [61].

3.1.1. *Patient related factors*

Peri-implantitis is a plaque-associated pathological condition that occurs in tissues around dental implants. It is characterized by inflammation in the peri-implant mucosa and loss of supporting bone. Affected sites exhibit clinical signs of inflammation such as bleeding on probing and/or suppuration, increase in probing pocket depth and/or recession of the mucosal margin, as well as radiographic bone loss compared with previous records. This leads to the loss of hard and soft tissue around implants.

There is substantial evidence that poor oral hygiene is associated with peri-implant diseases. Patients with poor plaque control are at higher risk of developing this pathology [62].

History of periodontal disease is another risk factor for peri-implantitis, with strong evidence that supports this association.[63]

However, smoking and diabetes have been reported in some studies to be risk indicators for peri-implantitis.[64].

3.1.2. *Site related factors*

3.1.2.1. Supracrestal tissue height and mucosal width. From several human and animal studies, it is known that peri-implant mucosa is around 3–4 mm high with an epithelium that is about 2 mm long [65].

Some animal studies have reported that a minimal dimension of 2 mm is needed for stability of the tissues. If this dimension is not maintained, it can result in marginal bone resorption [66].

Recent publications have remarked the importance of an adequate soft tissue height to allow the re-establishment of supracrestal tissue attachement. A thick phenotype seems to be related with reduced bone resorption [66,67].

From an esthetic point of view, several studies have suggested a critical threshold value of 2 mm for achieving less discoloring of soft tissues [68,69].

Thin mucosa can result in crestal bone loss after implant placement, and up to one year after placement. If initial mucosal thickness is less than 2.5 mm, there might be bone loss during the first year of function. On the other hand, if the initial mucosal thickness is equal to or more than 2.5 mm, marginal bone loss can be avoided [70].

A thicker mucosa can provide greater stability of the peri-implant mucosal margin compared to thin mucosa, which is fundamental to prevent mucosal recession [71,72].

3.1.2.2. Keratinized mucosa. Keratinized mucosa (KM) describes the masticatory mucosa present at implant sites, which extends from the margin of the peri-implant mucosa to the movable lining mucosa [57]. The need for a minimal amount of KM has also been studied around implants but is still a controversial issue. Wennstrom [73] evaluated the influence of the KM on peri-implant soft tissue conditions and could not find a direct association between lack of a minimal amount of KM and implant mucosal inflammation. On the other hand, some studies reported more inflammation at implant sites with less than 2 mm of KM [74,75].

Data from a systematic review suggested that at least 2 mm of KM is critical to prevent the development of inflammation [76]. However, up to date, the results of the existing clinical trials are not conclusive about the effect on long-term health and maintenance of implants without an adequate band of keratinized mucosa.

Reduced keratinized mucosal width has been reported to be a risk indicator for peri-implant mucositis [77]. In this line, Schwarz et. al [78] concluded that keratinized mucosal width plays a role on the prevention and resolution of peri-implant mucositis.

Several studies have evaluated whether a gingival graft to increase this band of keratinized mucosa is beneficial. Lin [79] observed that the presence of keratinized mucosa with a height of at least 1–2 mm can have a positive influence in reducing biofilm accumulation, and consequently mucosal inflammation, mucosal recession, and loss of clinical attachment.

It has also been reported that an increase in the width of the peri-implant tissues influences the maintenance of peri-implant marginal bone [80].

KM plays a role not only in peri-implant health, but also in esthetics. Thus, absence of KM around implants has been linked to lower patient esthetic satisfaction in recent publications [81,82].

3.1.2.3. Peri-implant bone thickness. A minimum thickness of the buccal plate of 2 mm after implant placement has been suggested in order to maintain an adequate support of the soft tissues and avoid complete resorption of the buccal wall after restoration [83].

Monje et al. suggested that a buccal bone thickness >1.5 mm is necessary to minimize bone resorption after implant installation [84]. However, there is limited clinical evidence to suggest a minimum bone thickness needed to guarantee health of peri-implant soft tissues.

Lack of buccal bone at implants has also been reported to be associated with decreased height of facial soft tissues [85,86].

3.1.3. Technique related factors

3.1.3.1. Surgical and prosthetic considerations. Incorrect three-dimensional position of the implant (generally with an excessive buccal angulation) can result in hard tissue resorption and consequently soft tissue deficiencies during the healing period.

Buser [87] has shown that implant's shoulder position is strongly associated with mucosal recession. This situation is more important in anterior areas, with a significant association between recessions of the peri-implant mucosa and the positioning of the implant towards buccal.

The apico-coronal position of the implant is also a key factor for the maintenance of peri-implant health, allowing an adequate emergence profile of the implant restoration.

3.2. Treatment of peri-implant mucosal deficiencies

The use of soft tissue augmentation procedures around implants with soft tissue deficiencies has been recommended to obtain positive biological, functional and esthetics outcomes [80,88].

Different techniques can be adopted at different time points to improve soft-tissue volumes around implants, including pedicle flaps, connective tissue grafts, and the use of biomaterials. Optimal results can be achieved with the use of autologous subepithelial connective tissue grafts, which are considered the "gold standard" for soft tissue augmentation [80]. The use of an autologous graft has some advantages, including the possibility of increasing the width of the keratinized mucosa and the stability of the results over time [81]. Autogenous soft grafts have also been reported to reduce probing pocket depth, soft tissue dehiscence, plaque index, and marginal bone loss [80,89].

According to the available evidence, the use of a connective tissue around implants results in an improvement in clinical conditions of health. An increase in the thickness and height of the keratinized mucosa results in an improvement of parameters related to inflammation such as bleeding on probing, gingival index and plaque index, and thus, represent a clinical improvement.

Soft tissue substitutes, such as xenogenic (mainly from porcine origin) or allogenic matrices are alternative options for the treatment of mucosal defects, with a reduced morbidity, since a second surgical site is avoided.

Among human-based tissue substitutes, acellular dermal matrix is the graft most employed.

Three-dimensional stable collagen matrices have been used for the correction of soft-tissue dehiscence or to increase peri-implant mucosal thickness. Thoma et al. [80] reported that the use of autogenous connective tissue grafts achieved slightly higher volume gain around implants, but was also related with greater morbidity and longer surgical times compared with xenogenic matrices.

When comparing acellular dermal matrices (ADM) and xenogenic collagen matrices, ADM have shown better performance mostly in the early phases due to ability to mimic the native tissue microenvironment. Three dimensional collagen matrices have lower performance that ADM, but it seems to remain stable over time [90].

When the goal of our therapy is to increase the width of peri-implant KM, a variety of techniques have been proposed such as apically positioned flap alone or in addition to a free gingival graft or a collagen matrix.[53].

Apically positioned flap plus an autogenous free gingival graft resulted in superior clinical outcomes in terms of marginal bone levels compared with apically positioned flap alone or in combination with a collagen matrix [80].

Therefore, when aiming to increase the band of keratinized mucosa around implants, the use of an autogenous free gingival is recommended [91]

4. Conclusions

Absence or reduced width of keratinized mucosa around dental implants may be related with improper plaque control and risk for biological complications. In this sense, soft tissue conditioning around

implants in those mentioned situations is recommended.

Apically positioned flap with a free gingival graft is the best therapeutic approach for keratinized mucosal width augmentation.

Soft tissue grafting around implants aiming to increase vertical and horizontal mucosal width has been shown to reduce marginal bone loss, preventing from biological complications related to the exposure of rough implant surfaces.

Based on the available literature, soft tissue substitutes exhibit promising clinical and biological properties, however future studies are needed in order to evaluate the performance over time.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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