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Exploring the Gingival Recession Surgical Treatment Modalities: A Literature Review

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Abstract

Gingival recessions present complex soft tissue pathology, with a multiple aetiology and a high prevalence which increases with age. They are defined as an exposure of the root surface of the teeth as a result of the apical migration of the gingival margin beyond the cementum-enamel junction, causing functional and aesthetic disturbances to the affected individuals. Aiming to ensure complete root coverage and satisfying aesthetic outcomes, a wide range of surgical techniques have been proposed through the decades for the treatment of the gingival recessions. The following literature review attempts to provide a comprehensive, structured and up-to-date summary of the relevant literature regarding these surgical techniques, aiming to emphasise for each technique its indications, its long-term success and predictability, its advantages and disadvantages about each other.

Introduction

Gingival recessions present one of the most common aesthetic and functional problems of the periodontium, but also one of the most complexes regarding the aetiology and the treatment modalities. They are defined as an exposure of the root surface of the teeth as a result of the apical migration of the gingival margin beyond the cementum-enamel junction [1] [2] [3]. It is very common: 50% of subjects in the populations studied have at least one or more sites of 1 mm of root exposure or more[1] [4] [5] [6]; it affectspatients with both good and poor oral hygiene [7] but with a higher prevalence in males [8] and in older ages [7]. It may be localized or generalized and it can affect one or more tooth surfaces, with the buccal ones being most frequently affected [7].

Besides aesthetic shortcomings [7] [8], gingival recessions have a high predisposition to be associated with functional problems related to root exposure, such as dentinal hypersensitivity [9] [10] [11], plaque retention, gingival inflammation, root caries [12] [13] [14] [15] [16], alveolar bone loss and eventually tooth loss [16] [17].

Like in many other periodontal conditions, the aetiology of gingival recessions is multifactorial and complex, with its exact mechanism not fully understood yet. It intertwines predisposing anatomic risk factors-such as bone dehiscence [18], gingival width and thickness insufficiency, tooth malposition

[19] [20], aberrant attachment of the labial frenulum [1] [21] [22] with precipitating factors such as inflammation related to plaque, improper tooth brushinghabits [6] [21] [22] [23] [24], smoking [10], chronic trauma because of traumatic incisor relationship and iatrogenic factors related to improper restorative, prosthetic, orthodontic and periodontal procedures [25] [26].

Considering the high prevalence of this condition, the aesthetic and functional problems related to it and the challenges its treatment presents, a thorough understanding of the disease and its treatment modalities is of crucial importance, to manage it successfully and with predictable long-term outcomes.

Many attempts have been made by different authors [27] [28] [29] to provide a comprehensive classification system regarding gingival recessions. Miller [28] proposed useful recession defect classification based on the height of the interproximal papillae and interdental bone adjacent to the defect area, and the relation of the gingival margin to the mucogingival junction. This classification is useful when deciding on treatment options [30]. Nowadays, it is the most widely used.

Class I: Marginal tissue recession not extending to the mucogingival junction (MGJ). No loss of interdental bone or soft tissue

Class II: Marginal recession extending to or beyond the MGJ. No loss of interdental bone or soft tissue

Class III: Marginal tissue recession extends to or beyond the MGJ. Loss of interdental bone or soft tissue is apical to the CEJ but coronal to the apical extent of the marginal tissue recession.

Class IV: Marginal tissue recession extends to or beyond the MGJ. Loss of interdental bone extends to a level apical to the extent of the marginal tissue recession.

The key factors which determine the successful management of gingival recessions are the identification of its etiologic agents and their elimination, the assessment of the degree of tissue involvement and last but not least, the selection and the careful implementation of the appropriate surgical procedure in order to achieve optimal root coverage, improved soft tissue aesthetics and reduced sensitivity.

The selection of the surgical technique is influenced by some important factors related to the anatomy of the defect such as the size of the defect, the width of the keratinized gingiva apical to the recession, the thickness of the flap, the level of the interdental papilla and the alveolar bone, the vestibular depth and the position of the labial frenulum.

Evidence shows that the size of the initial recession defect will determine the amount of root coverage achieved [31]. Miller class I defects can achieve complete root coverage in 100% of cases, whereas in class II defects complete root coverage is seen in 88% of cases [28]. Larger recession defects rarely achieve full coverage. One study showed recession defects of 3-5 mm only managed to attain 80.6% coverage and recessions[32] greater than 5 mm only attained 76.6% root coverage with free gingival grafts. Nelson[33]reported 100% root coverage in recession defects less than 3 mm, 92% root coverage in recession defects of 4-6 mm and 88% in recession defects of 7-10 mm. Overall better results regarding the percentage of complete and mean root coverage can be achieved if defects are less than 4 mm [31].

Since 1960, a wide range of surgical techniques have been proposed for the treatment of the gingival recessions such as: the free gingival epithelialized graft [27]or free partially epithelialized graft [34], pedicle flaps such double papilla rotational flap [35] laterally repositioned "stimulated" osteoperiosteal pedicle [36], laterally advanced flap [37] [38], coronally advanced flap [39] [40] [41], subepithelial connective tissuegraft [42] (the so-called envelope technique)and their modifications [43] [44]. Other authors have also combined some of the above-mentioned techniques, especially the coronally advanced flap technique, with enamel matrix derivative [45] [46], non-resorbable membranes [47] [48], resorbable membranes [49] [50], acellular dermal matrix allografts [51], xenogeneic collagen matrix [52] [53], platelet-rich plasma [54] [55] and living tissue-engineered human fibroblast-derived dermal substitute [56].

In general, the surgical procedures can be broadly classified in pedicle flap procedures, free graft procedures and guided tissue regeneration procedures either with resorbable or non-resorbable membranes [25]. Several modifications to the conventional techniques have been developed in an attempt to obtain optimal root coverage and better aesthetics.

The pedicle flap was the first periodontal plastic surgery procedure proposed in 1956 for root coverage [37]. This procedure consists in the repositioning of the donor tissue from an area adjacent to the recession defect to cover the exposed root surface. Since the flap remains attached at the base, it retains its blood supply, facilitating the revascularisation with the recipient site. Pedicle flap procedures involve:

a) Rotational flap procedures, which include a laterally positioned flap and the double papillae flap.

b) Flap advancement procedures such as the coronally advanced flap.

Pedicle flap surgical techniques offer long-term predictability and satisfying aesthetic results in cases of relatively shallow single or multiple recession defects (< 5 mm) and if there is adequate keratinised tissue close to the recession defect. They are contraindicated in cases with an inadequate width of the keratinised gingiva, in subjects with a shallow vestibulum, or with a high insertion of the frenulum.

The laterally positioned flap procedure was the first pedicle graft procedure that was used for the treatment of gingival recessions [37]. It was first introduced by Grupe and Warren in 1956 [37] and later modified by Grupe [57]. It was a full-thickness flap prepared from the adjacent site on the side of the recession and repositioned to cover the defect. This was later modified by Hattler [58] who used a split-thickness flap repositioned in a similar way to cover multiple exposed root *surfaces*. Pfeifer and Heller [59] advocated the use of this split-thickness flap to minimise the potential risk for development of dehiscence at the donor's tooth.

The success rate reported for this technique was 69%- 72% [60]. Literature findings suggest that several factors contribute to the success of the procedure. Factors such as the existence of a shallow recession defect [60] the adequate height and width of the keratinized tissue lateral to the recession [25], the wide dimensions of the pedicle and the adequate tissue thickness of the flap [55] are critical in order to achieve predictable root coverage and good aesthetic results. The main advantages of the laterally positioned pedicle graft that it is relatively easy and not time-consuming, it produces excellent aesthetic results and avoids the need for a second surgical site [61]. The disadvantages, however, include the fact that it is applicable only for single-site recession, that there is a possible risk of gingival recession, dehiscence, or fenestration at the adjacent donor site, and that an adequate amount of keratinised tissue at the neighbouring donor site and a deep vestibule are needed.

Double papillae flap (DPF) procedures

This procedure was introduced by Cohen and Ross [35] to overcome the limitations presented by the laterally positioned flap regarding adequate width and height of keratinised gingiva. Since the procedure consists in the coverage of the exposed root by the interproximal papillae of both sides, it can be used in cases where there is insufficient keratinised gingiva on any one side of the recession defect. The excellent aesthetic result thanks to the perfect colour matching of the donor tissue with the recipient is the main advantage of this technique. Anyway, the procedure presents some major drawbacks such as its limitation to single recession defects and its poor predictability [62].

Coronally advanced flap (CAF) procedures

This procedure was first presented by Bernimoulin et al., [41] and it involves the coronal repositioning of the gingival tissue that lies apical to the recession defect. In cases representing shallow recession defects, a thick gingival biotype and a sufficient amount of keratinised gingiva, it can be performed as a one-stage procedure [40]. In other cases, when the thickness and/or amount of the keratinised gingival tissue are an issue, there is the need first to increase the thickness and the amount of the gingiva using a free gingival graft, a connective tissue graft or a resorbable/non-resorbable membrane (guided tissue regeneration). At a second stage, after three months of healing, the tissue can be coronally advanced to cover the recession defects. Since the soft tissue used to cover the root exposure is similar in colour, texture and thickness and blends perfectly with the in-situ gingiva, the coronally advanced flap procedures provides great aesthetic results [63], as long as some critical criteria-such as the presence of adequate keratinized tissue apical to the root exposure, the presence of adequate sulcular depth and no interproximal bone loss- are met [55].

The coronally advanced flap can be used with great reliability and predictability for the treatment of Miller Class I and II recession defects [25] [40] [64]. Zuchelli and de Sanctis [65] have also proposed a modified approach for the treatment of multiple recession defects in cases with high aesthetic demands.

The mean root coverage achieved with a single stage coronally repositioned flap varies between 55-99% and complete root coverage ranges from 24-95% of sites [25] [66]. According to Huang et al., [55], several factors such as the height of the interdental papilla, the amount of keratinised gingiva, the presence of gingival cleft extending in the alveolar mucosa, the deep cervical wear, the frenulum attachment, and the vestibular depth-might have an impact in the outcome.

Pini-Prato et al., [67] concluded that to achieve 100% root coverage with a coronally repositioned flap, the flap should be overcompensated by 2-2.5 mm and sutured tension-free. However, this may be difficult in cases where there are a large recession defect and a shallow sulcus depth. The coronally advanced flap is often used together with a subepithelial connective tissue graft and has proven to be the standard golden treatment in the treatment of

recession defects [68]. In Miller's Class I defects, this combination has been shown to provide complete root coverage of the recession defect [69].

Newer approaches that involve the combination of CAF with acellular dermal matrix graft, enamel matrix derivative, platelet rich fibrin, or collagenous membrane are described further in this article.

Free graft procedures consist in the harvesting of soft tissue from the palatal mucosa, the maxillary tuberosity area or an edentulous ridge and placing it over a recession defect. This technique presents several differences compared to pedicle grafts such as the need of two surgical sites, the lack of the graft's blood supply, making it reliant on the vascularisation offered by the recipient site. For this to occur, there needs to be an adequate overlap of the graft tissue with the soft tissue around the recession defect at the recipient site. Immobilization of the graft at the recipient site is also essential. The success of this technique depends on the thickness of the graft tissue obtained. Therefore, the thickness and volume of the tissue to be grafted from the donor site are important factors in determining the appropriate treatment method and for predicting the prognosis [70] [71].

The commonly used free graft techniques include an epithelialized free gingival graft and a subepithelial connective tissue graft placed either with a pedicle flap, an envelope technique or a tunnelling technique.

The free gingival graft was first described by Bjorn in 1963 [72], and Sullivan and Atkins in 1968 [27] and it was initially used to increase the amount of the attached gingiva and extend the vestibular depth. Later it was used to cover exposed root surfaces.

Free gingival grafts can be used in either one stage procedure, where the graft is placed directly over the root surface, or in a two-stage procedure when the gingival biotype is thin at the recipient site. In this case, the graft is placed apical to the recession defect, and following healing, a pedicle flap is raised and moved coronally to cover the exposed root surface.

Wennstrom [25] reports that the success of free gingival grafts in root coverage is lower compared to other surgical procedures. The mean root coverage achieved with an epithelialized free gingival graft has been shown to vary between 9-87%, and complete root coverage varies between 9-72% of sites [66].

Several factors such as the adequate blood supply from tissues adjacent to the graft bed, the dimensions, border characteristics, thickness and the immobilization of the graft [73] and also the smoking habits of the patient (more than 10 cigarettes/day) [74] have been reported to influence the success of the procedure.

Besides of offering several advantages such as the simplicity of the technique, the possibility to be used in situations that need an increase of the amount of the attached gingiva, this procedure comprises several disadvantages as well, such as the colour mismatch between the donor and recipient tissues, the increased discomfort and the potential for post-operative bleeding from the donor area because of the large wound that heals by secondary intention [75].

The subepithelial connective tissue graft is a bilaminar procedure designed to maximise the supraperiosteal and gingival blood supply of the grafted tissue. The subepithelial connective tissue graft that is usually harvested from the palate is placed over the recession area, while nutrients and revascularisation are derived from the recipient bed, the interdental papillae, and the overlying flap. This method is suitable for covering recessions of both single and multiple adjacent teeth and is especially indicated when aesthetics is the primary consideration. As well as providing root coverage, the subepithelial connective tissue graft can also be used to increase the thickness of the gingival tissues in areas of the gingival recession to reduce the risk of further recession in the future.

Subepithelial connective tissue grafts were first introduced by Langer and Calagna in 1980 [76] and further described in detail by Langer and Langer in 1985 [43]. It was presented as an alternative that overcame the limitations of the free gingival graft since it provided great aesthetic results, lower morbidity of the donor site because of its healing by primary intention and most importantly it offered excellent predictability of the results. For any given site, Nelson reported mean root coverage of 88% [33] while both Levine [77] and Harris [78] reported ~97% root coverage, whereas Tozum et al., [79] reported 96.4%. According to a study focused on the long-term results (27.5 months) of the subepithelial connective tissue grafts, these graft have been shown effective in obtaining a mean of 98.4%root coverage in 100 patients with 146 Miller class I or II recession defects [80]. Other studies on the subepithelial connective tissue graft have considered it to be a predictable method to obtain root coverage in recession defects on molars [81] and on other sites [51]. Chambrone et al., [82], conducted a systematic review and the results showed that the subepithelial connective tissue grafts provided significant root coverage and significant clinical attachment and keratinised tissue gain. Overall comparisons allow us to consider the subepithelial connective graft in combination with the overlying flap as the golden standard procedure in the treatment of recession-type defects [82].

Various modifications of the original technique have been proposed, including connective tissue graft with or without an epithelial collar, partially or covered by a pedicle flap, with an envelope or tunnel design preparation [83] [84].

The main advantages of this procedure are that: it maintains a blood supply to the graft and therefore has good predictability; it provides good aesthetics with preservation of the original flap tissue; the donor site wound is less haemorrhagic and painful and can be healed by primary intention; it is simultaneously applied to both single and multiple recessions. However, the main disadvantage is the fact that this technique is technically demanding and more time-consuming.

Table 1: Comparison of different root coverage techniques in terms of advantages, disadvantages and success rate

Technique	Advantages	Disadvantages	Success rate
LPF [19] [25] [37] [38] [57] [58] [60] [61]	Easy and not time-consuming. No need for a second surgical site. Good aesthetic results.	Applicable only for single-site recessions. Possible risk of gingival recession, dehiscence, or fenestration at the adjacent donor site. An adequate amount of keratinised tissue at the neighbouring donor site and a deep vestibule are needed.	69-72%
DPF [35] [62]	Perfect colour matching of the donor tissue with the recipient. Excellent aesthetic result.	Applicable only for single-site recessions. Poor predictability.	34-82%
CAF [25] [40] [41] [55] [63] [64] [66] [68] [69]	Effective. Excellent aesthetic results. Applicable for single- site and multiple- site recessions.	Presence of adequate keratinised tissue apical to the root exposure, adequate sulcular depth and no interproximal bone loss are needed.	55-99%
FGG [25] [27] [66] [72] [73] [74] [75]	Simplicity of the technique. Can be used in situations that need an increase in the amount of the attached gingiva.	Need of two surgical sites. Lack of the graft's blood supply, relying on the vascularisation offered by the recipient site. Increased discomfort for the patient. The potential for post-operative bleeding. Lower success rate. Colour mismatch.	9-72%
SCTG [43] [51] [76] [77] [78] [79] [80] [81] [82] [83] [84]	Applicable for single- site and multiple- site recessions. Great predictability. Excellent aesthetic results. Lower morbidity of the donor site compared to FGG thanks to the healing by primary closure.	Need of two surgical sites. A limited quantity of graft that can be harvested. Technically demanding. Time-consuming.	88-97%
GTR [85] [86] [87] [88] [89] [90] [91]	Good aesthetics. No need for a second donor site.	No added clinical benefit for the patient treatment in comparison to other traditional root coverage techniques. Need of a second surgical stage when non-resorbable membrane are used. High postoperative membrane exposure rate with potential infection and difficulties with wound closure. Applicable only to single-site recession defects.	45-81%
CAF +ADMA [51] [93] [94] [95] [96] [97] [98]	Unlimited availability. No need for a second donor site. Similar results as SCTG regarding the mean root coverage and the aesthetic outcome Lower postoperative discomfort for the patient. Applicable for single- site and multiple- site recessions.	Not as effective as the SCTG technique in increasing the width of the attached gingiva.	88.7-97 %
CAF+ EMD [45] [69] [99] [100] [101] [102] [103] [104] [105]	Unlimited availability. No need for a second donor site. Similar results as SCTG regarding the mean root coverage and the aesthetic outcome Lower postoperative discomfort for the patient. Applicable for single- site and multiple- site recessions.	Significant variation in the clinical outcomes.	62-89%
CAF+ PRF [106] [107] [108] [109] [110] [111] [112] [113] [114]	Unlimited availability. No need for a second donor site. Lower postoperative discomfort for the patient. Healing biomaterial with great potential for bone and soft tissue regeneration. Enhanced wound healing. Similar clinical results in solving gingival recession problems	More extensive studies are needed to prove its predictability.	72.1-92.7%
CAF + CM [52] [53] [115] [116] [117] [118] [119]	Unlimited availability. No need for a second donor site. Lower postoperative discomfort for the patient. Increases gingival thickness and the width of the keratinised gingiva.	More extensive studies are needed to prove its predictability.	88.5-94.32

The guided tissue regeneration technique consists in the placement of a non-resorbable or resorbable membrane between the recession defect and the exposed bone on one side and the coronally advanced flap on the other, with the aim to allow the selective repopulation of the root surface by periodontal ligament cells that can form new connective tissue attachment between the root surface and the alveolar bone. The first authors that have studied the use of guided regeneration techniques in the treatment of gingival recessions were Tinti and collaborators [85] [86] [87] [88].

In spite of providing several advantages, such as good aesthetics, the absence of the need for a second donor site, a realistic opportunity for true regeneration of the lost periodontal attachment, this technique also has some major drawbacks. Several literature reviews [89] [90] have concluded that GTR doesn't provide an added clinical benefit for the patient treatment in comparison to other traditional root coverage techniques such as the connective tissue graft or the coronally advanced flap procedure. Moreover, two meta-analyses conducted by Al-Hamdan et al., [90] and Clauser et al., [91], concluded that conventional mucogingival surgery resulted in statistically better root coverage, the width of keratinised gingiva, and complete root coverage compared to GTR. Other disadvantages are also the need of a second surgical stage when non-resorbable membrane are used, and the high postoperative membrane exposure rate is resulting in colonisation by oral microbiota [92], potential infection and difficulties with wound closure [89] [90]. Furthermore, the application of this technique is still restricted to single recession defects due to limitations concerning the membrane design, the properties of the membrane material, and the possibility mentioned above of membrane exposure.

Even though the combination of CAF with connective tissue grafts has been demonstrated to be the golden standard in the achievement of predictable root coverage of the recession defects, there are several limitations related to the harvesting of soft tissue autografts, such as the postoperative discomfort associated with an extra surgical site and the limited quantity of soft tissue that can be harvested. To overcome these limitations, Silverstein and Callan [93] advocated the use of an acellular dermal matrix allograft as a substitute for soft tissue autografts. The acellular dermal matrix allograft is biocompatible, safe and non-immunogenic since it is prepared by the removing of the cell components from the human donor skin and the preservation of the ultrastructural integrity.

Many clinical studies revealed the effectiveness of ADMA in the treatment of gingival recession defects [51] [94] [95] [96] [97] both in the short-term and in the long term. The use of the acellular dermal matrix produced a thicker marginal tissue and yielded a higher percentage of root coverage than a CAF alone [95]. Compared to CAF+ SCTG several authors [51] [96] demonstrated that there was no statistically significant difference in the

mean root coverage obtained between the two procedures and that they were both aesthetically acceptable to the patients. A meta-analysis comparing the efficacy of ADM-allografts to other methods concluded that ADM-based root coverage therapy could be used successfully to repair gingival recession defects and to increase the width of the keratinised gingiva [98].

Thus, recession defects might be successfully covered using either an ADMA or SCTG, with no practical difference in the root coverage results or the aesthetics and with the advantage that ADMA offers unlimited availability of donor tissue, making it possible to treat many sites in one single surgical procedure, which improves patient case acceptance and reduces postoperative discomfort. The only drawback of the procedure is the fact that in spite of similar root coverage rates, AMDA technique is not as effective as the SCTG technique in increasing the width of the attached gingiva[51].

Enamel matrix derivative is an extract of the enamel matrix and contains amelogenins of various molecular weight, which according to several authors, are considered to play a particular role not only in enamel formation, but also in the formation of the cementum, periodontal ligament and alveolar bone [99] [100] [101].

Studies have shown that EMD enhances the proliferation and protein production by human periodontal ligament cells in vitro. Moreover, two histological studies showed the formation of new cementum, organising PDL fibres and newly formed bone after treating recession with SCTG+EMD or CPF+EMD [45] [102]. A randomised controlled trial that compared the treatment of Miller Class I and II defects with either EMD+CAF or SCTG+CAF revealed that at the 10-year follow-up evaluation, both techniques provided stable, clinically effective results and that they were similar to each other on all measured parameters [103].

Also, a review article from Cairo et al., [69] concluded that SCTG or EMD in conjunction with CAF enhances the probability of obtaining complete root coverage in Miller Class I and II single gingival recessions.

According to many recent studies, the combination of EMD with CAF produces similar results as the combination of SCGT with CAF regarding the predictability of the treatment of gingival recessions [104] [105].

A recent innovation in dentistry is the preparation and use of platelet-rich fibrin, an autologous leukocyte-platelet-rich fibrin matrix prepared from centrifuged blood without any addition of anticoagulant and bovine thrombin [106].

PRF was first developed in France by Choukroun et al., [107] for special use in oral and maxillofacial surgery.

These growth factors are involved in wound healing and act as promoters of tissue regeneration.A number of studies have confirmed that the specific dense three-dimensional (3D) structure of the fibrin gel in PRF and the action of cytokines and growth factors trapped in the mesh fibrin matrix upregulate cellular activity, promote neoangiogenesis [108] [109], bone growth and maturation and periodontal regeneration in vivo [110]. Some studies have demonstrated that PRF is a healing biomaterial with great potential for bone and soft tissue regeneration, without inflammatory reactions and may be used alone or in combination with bone grafts [111] [112]. Moreover, PRF used in the treatment of gingival recession problems provides several advantages related to the avoidance of a donor site surgical procedure, advanced tissue healing for the first 2 weeks post-surgery, and a major decrease in patient discomfort during the early wound healing period.

Moreover, studies that evaluated the clinical efficacy of PRF in comparison to SCTG concluded that both procedures provided similar clinical results in solving gingival recession problems. No difference could be found between PRF and SCTG procedures in gingival recession therapy, except for a greater gain in keratinised tissue width obtained in the SCTG group and enhanced wound healing associated with the PRF group [113] [114].

The need to avoid palatal donor sites and to have unlimited material availability has inspired researchers to search for alternative options to treat gingival recessions. One of these new approaches is the use of a xenogeneic collagen matrix (CM) of porcine origin (Mucograft®, Geistlich, Wolhusen, Switzerland) in combination with the coronally advanced flap. Structurally, it is composed by two functional layers: an outer compact collagen layer which contributes to structure integrity, protection against infections and allows for better control during suturing, and an inner spongious layer which provides a suitable environment for early vascularisation and promotion of cellular recruitment.

Several studies have concluded that the collagen matrix of porcine origin has proven to be as effective and predictable as the connective tissue graft for increasing the width of KG and to be associated with significantly lower patient morbidity [52] [115] [116] [117].

In 2009, Sanz et al., [115] conducted a randomised retrospective clinical trial consisting of 20 patients followed for 1, 3 and 6 months about keratinised tissue gained through SCTG vs CM augmentation. They found a statistically significant amount of keratinised tissue achieved with both grafting materials (2.6 mm and 2.5 mm respectively) and lower patient morbidity associated with the collagen matrix. Similarly, in one of the first clinical

studies that have compared CM to SCTG, McGuire et al., [52] found that for both techniques, parameters such as the mean clinical attachment level, the periodontal depth and the keratinised gingiva width, improved significantly compared to baseline. All parameters tested for differences between treatment groups also showed equivalence, and at 6 months, no difference could be made in regards to colour or texture.

Another study by Cardaropoli et al., [53] comparing the CM+CAF technique and the SCTG+ CAF technique, demonstrated that both these methods provided a significant reduction of the recession depth after 12 months and that there was no significant difference between them regarding all the clinical parameters that were investigated. The authors concluded that CM could deservedly be considered a substitute for the subepithelial connective tissue graft regarding the treatment of gingival recessions.

Anyway, a study by Jepsen et al., [118] which has compared the CM+CAF technique with CAF technique alone, has found that CM+CAF combination is not superior to the other technique regarding root coverage, but it improves the gingival thickness and the width of the keratinised gingiva significantly.

A more recent multicentre clinical trial concerning the treatment of isolated recessions proved that the combination of CM+CAF significantly increased the marginal soft tissue thickness and the patient satisfaction compared to coronally advanced flaps alone [119].

However, since the CM+CAF technique is relatively new, more studies are needed to determine its effectivity. If it proves to be as effective as the SCTG in providing adequate root coverage, adequate recession reduction and increased width of the keratinised gingiva, then it will undoubtedly be a priceless asset to the clinician in the treatment of gingival recessions.

In conclusion, gingival recessions present challenging soft tissue pathology, with multiple aetiology and a high prevalence which increases with age. Its successful surgical management is closely related to the identification and the elimination of its etiologic factors, the careful selection of the surgical technique and its correct implementation because the procedure is very technique-sensitive. A wide range of surgical techniques has been proposed for the treatment of the gingival recessions, each with its advantages and disadvantages. To provide predictable and long-term results, it is of paramount importance that the surgical technique is individually selected, taking into account several crucial factors such as the size of the defect, the width of the keratinised gingiva apical to the defect and the thickness of the flap. So far, the combination of the subgingival connective tissue graft with the coronally advanced flap represents the gold standard in the treatment of the gingival recessions. More recent techniques such as the combination of CAF with enamel matrix derivative, or with platelet-rich fibrin or with xenogeneic collagen membrane, need further evaluation through more extensive studies.

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