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CLINICAL EVALUATION OF CORONALLY ADVANCED FLAP WITH OR WITHOUT ACELLULAR DERMAL MATRIX GRAFT FOR THE TREATMENT OF MULTIPLE GINGIVAL RECESSIONS WITH THIN TISSUE BIOTYPE

PhD Doctoral Thesis

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I. SUMMARY

The objective of this randomized, parallel and controlled study was to assess the clinical effectiveness of acellular dermal matrix graft (ADM) combination with coronally advanced flap (CAF) on complete defect coverage, esthetics and patient satisfaction compared to CAF alone for the treatment of Miller Class I & II multiple buccal recessions with gingival thickness (GT) < 0.8 mm.

A total of 24 patients (12 females and 12 males) with 48 Miller Class I & II multiple recessions ≥3 mm were included and divided into test (CAF+ADM) and control (CAF) groups. At baseline and 12 months after the surgery, plaque index (PI), gingival index (GI), bleeding on probing (BoP), probing depth (PD), clinical attachment level (CAL), recession height (RH), keratinized tissue height (KT), gingival thickness (GT), mean and complete defect coverage were evaluated. Patient satisfaction, root coverage esthetic score (RES) and the correlation between GT and defect coverage were also assessed.

Baseline RH in CAF+ADM and CAF groups was 3.25 ± 0.34 mm and 3.21 ± 0.26 mm, respectively. Intra-group comparisons revealed statistically significant differences at 12 months compared to baseline data for all parameters ($p<0.05$). GT increased from 0.75 ± 0.06 mm to 1.41 ± 0.11 mm in test group, and from 0.71 ± 0.08 mm to 0.77 ± 0.09 mm in control group. Mean and complete defect coverage were 94.84% (RH reduction: 3.08 ± 0.51 mm) and 83.33% in test group, 74.99% (RH reduction: 2.37 ± 0.83 mm) and 50.00% in control group, respectively. Inter-group differences were found to be statistically significant for RH reduction, attachment gain, KT and GT increase, mean defect coverage, RES in favor of test group ($p<0.05$). There was a significant positive correlation between GT and mean defect coverage ($r=0.465$; $p<0.05$).

Better esthetic results and clinical improvements were achieved with ADM combination. Tissue thickness significantly increased with the use of ADM graft. The thicker (≥1.3 mm) the gingival tissue gets with the adjunctive use of ADM, the higher percentage of complete defect coverage is achieved in Miller Class I & II multiple recession defects. ADM can be used as an effective alternative to subepithelial connective tissue graft for the treatment of multiple defects. CAF in association with ADM can be proposed as a valid therapeutic approach for the treatment of multiple gingival recessions with thin tissue biotype.

Key words: Coronally advanced flap, acellular dermal matrix graft, root coverage esthetic score, multiple recessions, gingival thickness

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IV. ABBREVIATIONS

ADM	**Acellular Dermal Matrix Graft**
BoP	**Bleeding on Probing**
CAF	**Coronally Advanced Flap**
CAL	**Clinical Attachment Level**
CRC	**Complete Root Coverage**
GI	**Gingival Index**
GT	**Gingival Thickness**
KT	**Keratinized Tissue Width**
MRC	**Mean Root Coverage**
PD	**Probing Depth**
PI	**Plaque Index**
RES	**Root Coverage Esthetic Score**
RH	**Recession Height**
RW	**Recession Width**
®	**Registered Trademark**

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1. INTRODUCTION and AIM

Gingival recession is defined as the location of the gingival margin apical to the cemento-enamel junction (1). The main indications for root coverage are difficulty in plaque control, prevention and management of root caries and cervical abrasion, root hypersensitivity and undesirable esthetics (2,3). Recent evidence indicates coronally advanced flap (CAF) as an effective periodontal plastic surgical procedure for the treatment of Miller Class I & II multiple gingival recessions with advantages for the patient in terms of optimum root coverage, esthetics and morbidity, obtaining stable long-term results (4-6). CAF has been used alone (4,5,6,7) or in combination with subepithelial connective tissue graft (8,9,10,11,12), enamel matrix proteins (13), platelet-rich fibrin (14), orthodontic button application (15), and in adjunction with low intensity laser therapy (16). Among these techniques, subepithelial connective tissue graft covered by CAF was considered effective and predictable technique for multiple type defects (9), providing significantly greater degree of root coverage, gingival thickness (GT) and keratinized tissue height (KT) increase. Acellular dermal matrix graft (ADM) has been used in in combination with CAF for root coverage procedures (17-59), providing GT (20,23,26,28,35) and KT gain (17,18,20-24,60), as an alternative to subepithelial connective tissue graft in periodontal plastic surgery, eliminating the disadvantages such as the need for a second surgical procedure to harvest donor tissue which caused patient discomfort, the risk of postoperative complications (palatal necrosis, pain and bleeding), difficulty to harvest sufficient donor tissue from shallow or thin palate, a limited amount of donor tissue for multiple recession sites and longer surgical time (18,20,21,23,24,27,32,34,37,42,43,47,49,55,57). ADM is a freeze-dried, cell free, dermal matrix comprised of structurally integrated basement membrane complex and extra cellular matrix, in which collagen bundles and elastic fibers are the main components. The allograft is obtained from human cadavers, from which the cell component is removed and the ultrastructural integrity of the extracellular matrix is maintained. The dermal matrix exibits undamaged collagen and elastin and does not elicit an inflammatory response in the host tissue. By removing all cellular components, the source of disease transmission and immunologic reaction is minimized; leaving a structurally intact connective tissue matrix composed of type I collagen. The collagen matrix functions as a scaffold to allow ingrowth by host tissues, maintaining its structural integrity, and revascularizing via preserved vascular channels. The tissue is, therefore, considered to be acellular and non-immunogenic; healing occurs by repopulation and revascularization rather than through a granulation to limit scarring. These special qualities of ADM make it a suitable dermal transplant (30,61-70).

CRC is considered the true goal of the treatment because only complete coverage assures recovery from the hypersensitivity and esthetic defects associated with recession areas (71). Flap thickness and tissue biotype had been reported as the important clinical factors, affecting the clinical outcomes of root coverage procedures, and the variability of CRC. GT of 0.8-1.2 mm was associated with more predictable prognosis. Initial thickness was found to be the most significant factor and gingival thickness ≥1.2 mm was associated with CRC (72). The thickness <1 mm could harm the achievement of CRC (73). Also, it was concluded that flap thickness might have a greater influence on the final outcome than KT (26). These observations suggested that tissue biotype might be a significant factor influencing esthetic-treatment outcomes. For our best knowledge, there is no study evaluating ADM for the treatment of multiple recessions with thin tissue biotype. Therefore, the aim of this study was to evaluate the clinical effectiveness of ADM combination with CAF on complete defect coverage, esthetics and patient satisfaction compared to CAF alone for the treatment of Miller Class I & II multiple buccal recessions with GT < 0.8 mm.

2. LITERATURE REVIEW

2.1. Gingival Recession and Its Classification

Gingival recession is defined as the location of the gingival margin apical to the cemento-enamel junction. It results clinically in exposed root surface, marginal tissue and attachment loss (1,74). It may affect most of the adult population (75,76). It is a common feature in populations with high standarts of oral hygiene (77-79) and in populations with periodontal disease resulting from poor oral hygiene (80-82).

The most frequent etiological factors associated with gingival recessions are traumatic toothbrushing and increasing brushing frequencies (79,83), factitial injury (84,85), tooth malposition (79), high muscle attachments and abnormal frenum (86), periodontitis (82), and iatrogenic factors related to location of restoration margin and periodontal treatment procedure (87,88).

The main indications for root coverage are difficulty in plaque control, prevention and management of root caries and cervical abrasion, root hypersensitivity and undesirable esthetics (2,3).

Gingival recessions have been classified in four classes, according to the prognosis of root coverage (89):

Class I: Marginal tissue recession not extending to the mucogingival junction, with no loss of interproximal bone or soft tissue.

Class II: Marginal tissue recession extending to or beyond the mucogingival junction, with no loss of interproximal bone or soft tissue.

Class III: Marginal tissue recession extending to or beyond the mucogingival junction, with loss of interproximal bone or soft tissue but coronal to the apical extent of the marginal tissue recession.

Class IV: Marginal tissue recession extending beyond the mucogingival junction, with loss of interproximal bone extending to a level apical to the extent of the marginal tissue recession.

CRC can be achieved in Class I and II defects, only partial coverage may be expected in Class III. Class IV recession defects are not amenable to root coverage. Possible outcome of the root coverage procedure is related to the level of periodontal tissue support at the interproximal surfaces of the tooth.

2.2. Periodontal Plastic Surgery

As first proposed by Miller in 1988, the term periodontal plastic surgery comprises different surgical techniques intended to correct and prevent anatomical, developmental, traumatic or plaque disease-induced defects of the gingiva, alveolar mucosa or bone (90).

Treatment procedures that fall within the definition of periodontal plastic surgery are root coverage procedures, gingival and edentulous ridge augmentation, removing of the aberrant frenulum, prevention of ridge collapse associated with tooth extraction, crown lengthening, gingival preservation at ectopic tooth eruption, correction of mucosal defects at implants, loss of interdental papilla which presents an aesthetic and/or phonetic problem.

One of the most frequent indications of periodontal plastic surgery is the root coverage procedures for the treatment of buccal gingival recessions.

Historically, root coverage procedures originated at the beginning of the 20th century, presented by Younger in 1902, Harlan in 1906 and Rosenthal in 1911 (91) who first described the use of pedicle or free soft tissue grafts to cover denuded root surfaces. However, these techniques were abandoned for a long time.

During recent decades, different surgical procedures such as free gingival grafts (93,94), subepithelial connective tissue grafts (11,81,94-99), CAF (4-7,9,13-16,56,94,97-106,109-128), laterally repositioned flap (110,129-131), semilunar coronally repostioned flap (109,132,133), double papilla flaps (134), tunneling (135,136), or in combination with guided tissue regeneration

(112,113,124-126,137,138), ADM (19,23,26,28,35), enamel matrix proteins (13,103,104,115-118,123), platelet-rich plasma (105,107,139), platelet-rich fibrin (14,140), porcine collagen matrix grafts (47,141-144), recombinant human platelet derived growth factor + beta tricalcium phosphate (145,146), and anorganic bone mineral/peptide-15 (119) have been introduced.

These techniques have been devoloped and improved with various modifications over the years to attain CRC, achieve improvements in RH and CAL reduction, KT with the high predictability of these procedures in Miller Class I & II recession defects (2). Most of these modifications were made to enhance blood supply to the graft, thereby resulting in increased success rates (74,147).

The selection of one instead of the another surgical technique depends on the local anatomic characteristics of the defect site, such as RH, RW, amount of keratinized tissue adjacent to defect, number of adjacent teeth to be treated, the width and height of interdental papilla, GT, amount of connective tissue available from the donor site, location of the recession (maxillary or mandibular), the depth of the vestibulum, presence of frenulum. Also, the number of surgeries and intraoral surgical sites, the need to satisfy the esthetic demands of the patient, which include final color and tissue blend of the grafted area should be considered.

Pedicle grafts (CAF, laterally repositioned flap, semilunar coronally repositioned flap and double papilla flap) have been reported to offer good results in terms of root coverage; conversly, the free gingival graft technique offers a low degree of predictability in the correction of gingival recessions (100,148,149). In recent years, some systematic reviews and meta-analysis were published focusing on the effect of periodontal plastic surgery procedures on the treatment gingival recessions (72,147,150-154).

It was reported that subepithelial connective tissue grafts, CAF alone or in combination with ADM, enamel matrix proteins and subepithelial connective tissue grafts; and guided tissue regeneration may be used as the choice of periodontal plastic surgery for the root coverage procedures. Subepithelial connective tissue grafts procedures had greater gain in root coverage and KT increase compared to guided tissue regeneration (153). It was advised to use subepithelial connective tissue grafts, where both root coverage and KT increase were expected; and ADM in cases where subepithelial connective tissue grafts harvested from the palate were not sufficient to cover the recession defect (147).

2.3. Coronally Advanced Flap

The CAF is the first choise of surgical procedure when there is adequate KT apical to the recession defect. Optimum root coverage results, good color blending of the treated area with respect to adjacent soft tissues, and recuperation of the original morphology of the soft tissue margin can be predictably accomplished using this surgical approach. (94,100)

2.3.1. Coronally Advanced Flap and Combinations (Animal Studies)

Several animal studies (50,51,53,54,56,142,155-158) have been performed in order to evaluate the histologically and histomorphometrically the potential of different periodontal plastic approaches to regenerate periodontium with formation of cementum, bone and periodontal ligament coronal to the baseline position of the gingival margin.

Casati et al. (156) compared histologically and histomorphometrically the healing of bioabsorbable polylactic acid membrane and CAF combination (test group) and CAF procedure alone (control group) in the treatment of 5 mongrel dogs with recession defects (5x7 mm), surgically created on the buccal aspect of the maxillary cuspids. After 3 months of healing, the dogs were sacrified and the blocks were processed. The histometric parameters evaluated included length of sulcular and junctional epithelium, connective tissue adaptation, new cementum, new bone, and defect coverage. The extension of the epithelium, connective tissue adaptation, new cementum, bone formation was 1.9 ± 0.8 mm, 0.1 ± 0.1 mm, 3.8 ± 1.5 mm, 1.1 ± 0.5 mm in the test group; and 3.0 ± 0.9 mm, 0.8 ± 0.5 mm, 2.4 ± 0.3 mm, 1.4 ± 0.2 mm in the control group, respectively (p=0.16, p=0.051, p=0.16, p=0.53). Histologically, MRC observed was similar, 90.5% and 91.9% for the test group and control group, respectively. No statistical differences in any of the parameters could be detected ($p>0.05$). They concluded that both procedures resulted in a favorable healing response with no significant difference between the treatments.

Lee et al. (157) compared clinically, histologically and histomorphometrically the efficacy of collagen membrane and CAF combination (test group) and CAF procedure alone (control group) in the treatment of 8 mongrel dogs with recession defects (5x5 mm), surgically created on the buccal aspect of the maxillary cuspids. After 4 months of healing, the dogs were sacrified and the blocks were processed. The evaluated clinical and histomorphometrical parameters included RH, KT, PD, length of sulcular and junctional epithelium, connective tissue adaptation, new cementum, new bone, and defect coverage. Clinically, both treatments achieved statistically significant ($p<0.05$) root coverage compared to baseline. MRC observed was 66% and 56% for the test group and control group, respectively. KT significantly increased in CAF sites at 16 weeks ($p<0.05$), while no significant differences were found for other clinical parameters between treatments ($p>0.05$). Histomorphometrically, test group showed a statistically significant increase of new attachment and newly formed connective tissue when compared to CAF at 16 weeks. They concluded that within the limits of this preclinical study, both guided tissue regeneration and CAF could be successfully used for the treatment of gingival recession defects.

Rosetti et al. (158) compared histologically and histomorphometrically the healing of collagen membrane + demineralized freeze-dried bone allografts combination with CAF (test group) and CAF procedure alone (control group) in the treatment of 5 dogs with recession defects (7x5 mm), surgically created on the buccal aspect of the maxillary cuspids. After 3 months of healing, the dogs were sacrified and the blocks were processed. The parameters evaluated included cementum and bone formation, epithelial migration and gingival level. The extension of the neoformed cementum, new bone, MRC was 32.72%, 23.20%, 50.69% in the test group; and 18.82%, 9.90%, 59.73% in the control group, respectively with a statistically significant inter-group difference in favor of the test group ($p<0.05$). Epithelial proliferation on the root surface, with means of 15.14% for the test group and 20.34% for the control group showed no statistical difference ($p>0.05$). They concluded that the treatment of gingival recession defects with collagen membrane + demineralized freeze-dried bone allografts, showed better outcomes in terms of a larger extension of neoformed cementum and bone, as well as in terms of a smaller proportion of residual recessions.

Sallum et al. (51) compared histologically and histomorphometrically the healing of enamel matrix proteins and CAF combination (test group) and CAF procedure alone (control group) in the treatment of 5 mongrel dogs with recession defects (5x7 mm), surgically created on the buccal aspect of the maxillary cuspids. After 3 months of healing, the dogs were sacrified and the blocks were processed. The evaluated histometric parameters included RH reduction, length of epithelium, connective tissue adaptation, new cementum, new bone, and defect coverage. Residual RH, extension of the epithelium, new connective tissue attachment, new cementum and bone formation was 0.1 ± 0.2 mm, 1.3 ± 0.7 mm, 1.3 ± 0.7 mm, 0.7 ± 0.6 mm, 0.1 ± 1.8 mm in the test group; and 0.8 ± 1.3 mm, 1.3 ± 0.7 mm, 4.0 ± 1.4 mm, 0.5 ± 0.32 mm, -0.5 ± 1.4 mm in the control group, respectively ($p=0.17$, $p=0.89$, $p=0.22$, $p=0.34$, $p=0.50$). Histologically, MRC observed was similar, 98.2% and 85.8% for the test group and control group, respectively. Both procedures resulted in a favorable healing response with no statistically significant difference between the treatments ($p>0.05$). However, new connective tissue attachment could be achieved more consistently with EMD.

Vignoletti et al. (142) compared clinically, histologically and histomorphometrically the healing of a two-layer porcine-derived collagen matrix graft and CAF combination (test group) and CAF procedure alone (control group) in the treatment of 12 minipigs with recession defects (5x4 mm), surgically created on the buccal aspect of the cuspids. After 3 months of healing, the pigs were sacrified and the blocks were processed. Histometrically, in the test group, there was a shorter junctional epithelial dimension (2.26 ± 0.23 mm) compared with the control (2.79 ± 0.77 mm). On the contrary, the amount of newly formed cementum was larger in the test group (1.08 ± 0.41 mm) than in the control group

(0.75 ± 0.25 mm), although the differences were not statistically significant ($p>0.05$). Both techniques rendered similar clinical outcomes, achieving CRC at the end of the study. Nevertheless, the porcine collagen matrix graft graft attained more tissue regeneration, characterized by a shorter epithelium and a larger new cementum formation. They concluded that the use of a xenogenic porcine collagen matrix graft resulted in the incorporation of the xenograft within the adjacent host connective tissues in the absence of significant inflammation.

In some other animal studies CAF+ADM combination (50,51,54,56) with the addition of enamel matrix proteins (50) or beta-tricalcium phosphate (56) for root coverage procedures was compared with CAF procedure histologically.

Luczyszyn et al. (54) histologically evaluated the healing of CAF+ADM combination in the treatment of 6 mongrel dogs with recession defects (5x4.8 mm), surgically created on the buccal aspect of the cuspids. Each of the two animals was sacrificed after 4, 8, and 12 weeks. At 4 weeks, thick collagen fibers from the ADM were clearly seen in the connective tissue, and some blood vessels were penetrating into the ADM. At 8 weeks, blood vessel penetration was enhanced, and collagen fiber bundles from the ADM were seen sending branches into the connective tissue in all directions. After 12 weeks, the ADM and the connective tissue seemed to be well integrated into a single highly vascularized structure, indicating almost complete incorporation of the ADM. Based on the findings of this study, they concluded that ADM was capable of consistently integrating into host connective tissue.

Sallum et al. (51) compared histologically and histomorphometrically the healing of CAF+ADM combination (test group) and CAF procedure alone (control group) in the treatment of 6 mongrel dogs with recession defects (5x7 mm), surgically created on the buccal aspect of the maxillary cuspids. After 4 months of healing, the dogs were sacrified and the blocks were processed. The histometric parameters evaluated included RH, GT, length of epithelium, connective tissue adaptation, new cementum and bone. Residual RH, GT increase, extension of the epithelium, new connective tissue attachment, new cementum and bone formation was 0.88 ± 1.33 mm, 1.63 ± 0.28 mm, 2.28 ± 0.92 mm, 0.05 ± 0.08 mm, 2.35 ± 1.55 mm, 0.60 ± 1.36 mm in the test group; and 0.21 ± 0.22 mm, 1.16 ± 0.20 mm, 2.10 ± 0.46 mm, 0.06 ± 0.08 mm, 2.90 ± 0.96 mm, 0.35 ± 0.82 mm in the control group, respectively (p=0.21, p=0.002, p=0.74, p=0.36, p=0.53, p=0.53). GT significantly increased in test group (p<0.05), while no significant differences were found for other clinical parameters between treatments (p>0.05). The present study indicated no major differences in the healing pattern between ADM and CAF combination or CAF procedure alone but a superior thickness of the gingival tissues might be obtained with the inclusion of ADM.

De Oliveira et al. (50) compared histologically and histomorphometrically the healing of CAF+ADM combination with enamel matrix proteins (test group) and CAF+ADM combination alone (control group) in the treatment of 6 mongrel dogs with recession defects (7x5 mm), surgically created on the buccal aspect of the maxillary cuspids. The epithelial formation, cementum regeneration, bone regeneration, connective tissue attachment gain and defect extent was 2.15 mm, 0.32 mm, 0.86 mm, 3.11 mm, 5.51 mm in the test group; and 2.88 mm, 0.06 mm, 0.75 mm, 2.15 mm, 4.90 mm in the control group, respectively (p=0.0446, p=0.46, p=0.58, p=0.23, p=0.46). They concluded that enamel matrix proteins did not result in beneficial effects when associated with CAF+ADM.

Okubo et al. (56) compared histologically and histomorphometrically the healing of CAF+ADM combination with the addition of beta-tricalcium phosphate, CAF+ADM combination and CAF alone (control group) in the treatment of 24 beagle dogs with recession defects (6x5 mm), surgically created on the buccal aspect of the maxillary cuspids. Tissues were histologically examined at 4, 8, or 16 weeks following treatment. A greater GT was observed at the sites treated in both CAF+ADM+beta-tricalcium phosphate and CAF+ADM groups than in the CAF alone group. CAF+ADM+beta-tricalcium phosphate group showed a statistically significant increase in both new bone and cementum formations compared to the CAF+ADM group (p<0.05). The results suggested that the combination of beta-tricalcium phosphate with CAF+ADM was more effective in promoting new bone and cementum formations than CAF+ADM alone.

2.3.2. Coronally Advanced Flap and Combinations (Human Studies)

CAF has been used alone (4-7,9,13-16,56,94,97-106,109-128) or in combination with subepithelial connective tissue graft (9,11,81,94,96,97,98,159,160), guided tissue regeneration (112,113,124-126,137,138,156,157,161), enamel matrix proteins (13,103,104,115-118,123,155), ADM (17-59), platelet-rich plasma (105,107), platelet-rich fibrin (14,140), recombinant human platelet derived growth factor (145,146), porcine collagen matrix grafts (47,141-144), anorganic bone mineral/peptide-15 (119), living tissue-engineered human fibroblast-derived dermal substitute (162), button application (15,34), and in adjunction with low intensity laser therapy (16).

The reports about CAF alone were ranging from 53% (59) to 86.7% (104) for MRC, and from 7.7% (35) to 88.9% (110) for CRC (4,5,6,7,9,13-16,26,28,35,39,59,94,97,98,103-106,108-120,122-126,128) with evaluation periods of 6 (4,13-15,26,28,39,59,94,97,98,105,109,110,112-114,116,118-120,122,124-126,128), 12 (4,6,7,9,16,35,94,103,104,106,108,117,122,124), 18 (123), 24 (13,35,94,115,122), 36 months (114), 60 months (5,9,106,108), 72 months (124); also 8 (106) and 14 years (108).

De Sanctis & Zucchelli (114) reported the long-term clinical results following a modification of the CAF (split thickness with releasing vertical incisions) on 40 localised maxillary Miller Class I or II recessions defects ≥2 mm with initial KT ≥1 mm utilizing a split–full–split surgical technique. RH, KT, PD, CAL were evaluated. Baseline RH was 3.82 ± 1.2 mm. MRC was 98.6%, with RH reduction of 3.72 ± 1.0 mm and 96.7% with 3.64 ± 1.1 mm at 1 and 3 year evaluations, respectively. Baseline KT was 1.34 ± 0.6 mm. Mean KT increase between the baseline and 1 year was 0.70 ± 0.20 mm, the baseline and the 3 years was 1.78 ± 0.90 mm, and all these changes were statistically significant. PD remained almost unchanged in the three (baseline, 1 and 3 years) observation periods. A significant difference in terms of CAL was found between the 1- and 3-

year values compared with the baseline value ($p<0.05$); while the loss of attachment occurred during the 3-year observation period (0.05 ± 0.6 mm) was not statistically significant ($p>0.05$). They concluded that the modified CAF technique was effective in the treatment of localised gingival recession in the maxilla, also KT increase was greater in sites with greater initial RH and lower amount of initial KT in 3 years evaluation period.

Pini-Prato et al. (106) evaluated the results of CAF procedures performed for the treatment of 60 patients (11 smokers) with single Miller Class I & II maxillary gingival recessions ≥2 mm in long-term (8-years) case series study, followed for 6 months and 8 years. Baseline RH was 3.2 ± 1.1 mm. RH reduction from baseline to 8 years was 2.3 ± 1.1 mm ($p<0.001$), while RH increased in 53% of the sites between 6 months and 8 years (0.5 ± 0.7 mm; $p<0.001$). MRC was 90.62% at 6 months and 71.87% at 8 years. The percentage of sites with CRC decreased from 55% at 6 months to 35% at 8 years ($p=0.0047$). Fifteen sites with CRC at 6 months showed a recurrent recession at 8 years while 3 patients with residual recession at 6 months showed CRC at 8 years. Baseline KT was 2.7 ± 1.1 mm. The amount of KT tended to decrease from baseline to 8 years (0.6 ± 0.8 mm; $p<0.0001$). The general linear model showed that RH reduction was associated with both baseline RH and KT. Gender, age and smoking were not associated with RH reduction at 8 years. They concluded that the CAF procedure was effective in the treatment of gingival recessions. However, recession relapse and KT reduction occurred during the follow-up period. Also, the baseline KT was a predictive factor for recession reduction when using the CAF technique.

Santana et al. (109) compared the clinical outcomes of CAF (control group) and semilunar coronally repositioned flap (test group) procedure in the treatment of 22 patients with maxillary Miller Class I recession defects ≤5 mm and baseline KT ≥2 mm. RH, KT, PD, CAL were evaluated. Baseline RH in the test group was 2.9 ± 0.4 mm, whereas in control group it was 3.1 ± 0.6 mm. MRC and RH reduction in the test and control groups were 41.38% and 1.2 ± 0.5 mm; 83.87% and 2.6 ± 0.7 mm at 6 months evaluation, respectively. CRC was accomplished in 9.03% (2 out of 22) of the treated cases in the test group and in 63.64% (14 out of

22) in the control group. Baseline KT in the test group was 4.3 ± 0.6 mm, whereas in control group, it was 4.5 ± 0.6 mm. KT increase was 0.9 ± 0.7 mm in the test group, whereas this value decreased in the control group at 6 months evaluation (-0.2 ± 0.9 mm). Inter-group comparisons demonstrated statistically significant RH reduction and attachment gain changes in favor of the CAF procedure, whereas for KT the significance was in favor of the test group ($p<0.05$). Both flap designs were effective in obtaining and maintaining a coronal displacement of the gingival margin. Root coverage obtained in the immediate post-surgical period of test sites, but was not maintained throughout the subsequent evaluations. They concluded that root coverage was significantly better with CAF compared to the semilunar coronally repositioned flap procedure in the treatment of shallow maxillary Miller Class I recession defects in terms of percentage of root coverage and frequency of CRC at 6 months postoperatively.

Santana et al. (110) compared the clinical outcomes of CAF (control group) and laterally repositioned flap technique (test group) in the treatment of 36 patients with maxillary Miller Class I recession defects. RH, KT, PD, CAL were evaluated. Baseline RH in the test group was 3.4 ± 0.6 mm, whereas in the control group it was 3.2 ± 0.5 mm. MRC and RH reduction in the test and control groups were 95.5% and 3.26 ± 0.4 mm; 96.6% and 3.09 ± 0.5 mm at 6 months evaluation, respectively. CRC was accomplished in 83.33% (15 out of 18) of the treated cases in the test and in 88.88% (16 out of 18) in the control groups. MRC and CRC were not statistically significant between the procedures. Baseline KT in test group was 4.3 ± 0.6 mm, whereas in the control group it was 4.5 ± 0.6 mm. KT increase was 2.9 ± 1.7 mm and 0.2 ± 1.7 mm in the test and control groups at 6 months evaluation, respectively. Inter-group comparisons demonstrated statistically significant KT gain in favor of the test group ($p<0.05$). Both flap techniques were effective in treating recession defects resulting in similar improvements for percentage of root coverage and frequency of CRC. The laterally repositioned flap resulted in significantly more KT gains than the CAF. They concluded that the results obtained 6 months after the surgery by CAF in the treatment of Miller Class I maxillary recession defects were clinically similar to the laterally repositioned flap. However, more limited KT gain was obtained with

CAF.

2.3.3. Coronally Advanced Flap in Combination with Subepithelial Connective Tissue Graft

CRC is considered the true goal of the treatment because only complete coverage assures recovery from the hypersensitivity and esthetic defects associated with recession areas (71). The systematic review of the literature indicated that subepithelial connective tissue graft with CAF procedure for root coverage of Miller Class I & II recession defects; enhanced the probability to obtain CRC and improved RH reduction (150). Also, a meta-analysis of the literature indicated that subepithelial connective tissue graft, ADM and enamel matrix proteins in combination with CAF were superior to CAF alone in achieving CRC, but subepithelial connective tissue graft showed the best predictability (154). Subepithelial connective tissue graft covered by CAF was considered the most predictable technique and 'gold standart' procedure for single defects (94,152) and effective and predictable technique for multiple defects (9), providing significantly greater degree of root coverage, GT increase and KT gain.

Wennström & Zucchelli (94) treated 67 patients with 103 Miller Class I recession defects ≥3 mm by CAF (control group) and CAF combined with subepithelial connective tissue graft (test group). RH, KT, PD, CAL were evaluated. Baseline RH in the test group was 4.0 ± 1.0 mm, whereas in the control group it was 4.1 ± 0.9 mm. MRC and RH reduction in the test and control groups were 96.1% and 3.8 ± 0.7 mm; 96.4% and 3.9 ± 0.5 mm at 6 months evaluation, respectively. CRC was observed in 72% of the test and 74% of the control sites. At the 24 months evaluation, MRC was 98.9% in test and 97.1% in control groups. 88% of the teeth in the test group showed CRC compared to 80% for teeth in the control group. Baseline KT in the test group was 0.9 ± 0.5 mm, whereas in the control group it was 1.1 ± 0.5 mm. KT increase was 2.6 ± 0.1 mm and 0.4 ± 0.5 mm at 6 months, and 2.8 ± 0.1 mm and 1.1 ± 0.1 mm in the test and control groups at 24 months evaluation period, respectively. KT was the only variable that showed statistically significant difference between the test and control groups at the follow-up examinations (p<0.05). Both surgical procedures resulted in similar degree of root coverage. They concluded that changes of tooth brushing habits might be of greater importance than increased GT for long-term maintenance of the surgically established position of the gingival margin.

Da Silva et al. (97) compared CAF alone (control group) or in conjunction with a subepithelial connective tissue graft (test group) in the treatment of 11 non-smoking subjects with Miller Class I localised recession defects ≥3 mm. RH, KT, GT, PD, CAL were evaluated. Baseline RH in the test group was 4.20 ± 0.78 mm, whereas in the control group it was 3.98 ± 0.62 mm. MRC and RH reduction in the test and control groups were 75% and 3.16 ± 0.86 mm; 69% and 2.73 ± 0.99 mm at 6 months evaluation, respectively. CRC was observed at 56% of the test and 45% of the control sites. Baseline KT in test group was 2.79 ± 0.93 mm, whereas in the control group it was 3.38 ± 1.23 mm. KT increase in the test and decrease in the control groups at 6 months evaluation period was 0.55 ± 0.91 mm and 0.21 ± 0.63 mm, respectively. Baseline GT in test group was 1.34 ± 0.28 mm, whereas in the control group it was 1.27 ± 0.29 mm. GT increase was 0.44 ± 0.37 mm and 0.01 ± 0.32 mm in the test and control groups at 6 months postoperatively, respectively. Inter-group comparisons demonstrated statistically significant KT and GT gain in favor of test group (p<0.05). They concluded that both surgical approaches were effective in terms of root coverage, although when KT and GT increase are desired outcomes, then CAF in conjunction with subepithelial connective tissue graft should be used.

Cortellini et al. (98) compared the clinical outcomes of CAF alone (control group) or in combination with a subepithelial connective tissue graft (test group) in 85 patients with localised Miller Class I & II gingival recessions ≥2 mm in a parallel-group, multi-centre, double-blind, randomized-controlled clinical trial. RH, KT, PD, CAL, dentine hypersensitivity were evaluated. Baseline RH in the test group was 2.7 ± 0.7 mm, whereas in the control group it was 2.4 ± 0.7 mm. MRC and RH reduction in the test and control groups were 74.1% and 2.0 ± 1.0 mm; 62.5% and 1.5 ± 1.1 mm at 6 months evaluation, respectively. CRC was observed at 60% of the test and 37% of the control sites. Baseline KT in the test group was 2.7 ± 1.2 mm, whereas in the control group it was 3.2 ± 1.3 mm. KT increase and decrease in the test and control groups at 6 months evaluation period was 0.6 ± 1.1 mm and 0.1 ± 1.2 mm, respectively. Even RH reduction was not different between the two groups, significantly greater probability of CRC was observed after CAF + subepithelial connective tissue graft combination (p=0.0033). Both treatments were effective in providing a significant RH reduction and dentine hypersensitivity, with only limited intra-operative and post-operative morbidity and side effects. They concluded that adjunctive application of a subepithelial connective tissue graft under a CAF increased the probability of achieving CRC in maxillary Miller Class I & II defects.

2.3.4. Coronally Advanced Flap in Combination with Guided Tissue Regeneration

Barrier membranes have been proposed and tested by many authors (112-126,137,163). Both animal (156-158,161) and human histology studies (164) demonstrated the potential of this approach to regenerate periodontium with formation of cementum, bone and periodontal ligament coronal to the baseline position of the gingival margin.

Amarante et al. (126) compared the clinical outcomes of CAF alone (control group) or in combination with a bioabsorbable membrane (test group) in 20 patients with bilateral localised Miller Class I or II gingival recessions in cuspids or premolars ≥3 mm. RH, RW, KT, PD, CAL were evaluated. Baseline RH in the test group was 4.1 ± 0.9 mm, whereas in the control group it was 3.6 ± 1.0 mm. MRC and RH reduction in the test and control groups were 56.1% and 2.3 ± 0.5 mm; 69.4% and 2.5 ± 0.3 mm at 6 months evaluation, respectively. CRC was observed at 25% of the test and 50% of the control sites. Baseline KT in test group was 2.4 ± 0.7 mm, whereas in the control group it was 2.6 ± 0.5 mm. KT increase was 0.5 ± 0.1 mm and 0.4 ± 0.1 mm in the test and control groups at 6 months evaluation periods, respectively. At the 6-months evaluation, there was no significant difference between the treatments in terms of the evaluated parameters

($p>0.05$). When patients were grouped as smokers (8) and non-smokers (12), no significant differences were revealed for any of the response variables. CAF offered a predictable, simple, and convenient approach as a root coverage procedure in Miller Class I and II recession defects. They concluded that combining this technique with the placement of a bioabsorbable membrane does not seem to improve the results following surgical treatment of such defects.

Lins et al. (125) compared the clinical outcomes of CAF alone (control group) or in combination with a titanium-reinforced expanded polytetrafluoroethylene barrier membrane (test group) in 10 patients with bilateral localised Miller Class I or II gingival recessions in cuspids or premolars ≥2 mm. RH, RW, KT, PD, CAL, alveolar crest level were evaluated. Baseline RH in the test group was 3.4 ± 0.6 mm, whereas in the control group it was 3.3 ± 0.4 mm. MRC and RH reduction in the test and control groups were 45% and 1.5 ± 0.6 mm; 60% and 2.0 ± 0.3 mm at 6 months evaluation, respectively. Baseline KT in the test group was 2.45 ± 0.7 mm, whereas in the control group it was 3.1 ± 1.0 mm. KT increase was 1.1 ± 0.1 mm and 0.6 ± 0.1 mm in the test and control groups at 6 months evaluation periods, respectively. Alveolar crest level gain was 1.0 ± 0.6 mm and 0.2 ± 0.3 mm in the test and control groups, respectively. After 6 months, there was a significant difference between the treatments in RH reduction in favor of the control group and alveolar crest level gain in favor of the test group ($p<0.05$). They concluded that the amount of root coverage obtained with CAF was greater than that observed with guided tissue regeneration, although it resulted in significantly greater alveolar crest level gain.

Banihashemrad et al. (112) compared the effectiveness of CAF alone (control group) or in combination with a resorbable collagen membrane (test group) in 7 patients with 22 Miller Class I & II gingival recessions ≥3 mm. RH, RW, KT, PD, CAL were evaluated. Baseline RH in the test group was 4.46 ± 0.31 mm, whereas in the control group it was 3.64 ± 0.20 mm. MRC and RH reduction in the test and control groups were 67.88% and 3.00 ± 0.36 mm; 57.42% and 2.00 ± 0.27 mm at 6 months evaluation, respectively. Baseline KT in the test group was 3.73 ± 0.30 mm, whereas in the control group it was 3.91 ± 0.29 mm. KT increase was 0.36 ± 0.28 mm in the test group, whereas a decrease of 0.18 ± 0.23 mm was observed in the control group. After 6 months, there was a significant difference between the treatments in terms of RH and RW reduction, attachment gain in favor of the test group ($p<0.05$). They concluded that Miller Class I & II gingival recessions were amenable to treatment using the guided tissue regeneration with satisfactory outcome.

Cardaropoli & Cardaropoli. (113) compared the results of CAF alone (control group) or in combination with a bioabsorbable membrane and demineralized xenograft in a gel state (test group) in 16 non-smoking patients with 20 Miller Class I or II gingival recessions in maxillary cuspids or premolars ≥2 mm. RH, KT, GT, PD, CAL were evaluated. Baseline RH in the test group was 2.50 ± 0.71 mm, whereas in the control group it was 2.70 ± 0.54 mm. MRC and RH reduction in the test and control groups were 93.33% and 2.35 ± 0.78 mm; 92.49% and 2.50 ± 0.28 mm at 6 months evaluation, respectively. CRC was achieved in 10 test (70%) and 6 control patients (60%). Baseline KT in the test group was 2.45 ± 0.72 mm, whereas in the control group it was 2.60 ± 0.66 mm. KT increase was 0.80 ± 0.54 mm in the test group, whereas a decrease of 0.55 ± 0.55 mm in the control group was observed. Baseline GT in the test group was 0.85 ± 0.17 mm, whereas in the control group it was 0.93 ± 0.21 mm. GT increase was 0.88 ± 0.18 mm and 0.17 ± 0.12 mm in the test and control groups, respectively. After 6 months, there was a significant difference between the treatments in terms of GT in favor of the test group ($p<0.05$). Both procedures offered a predictable, simple, and convenient means of root coverage in Miller Class I & II recession defects. They concluded that the guided tissue regeneration procedure resulted in more KT and GT increase than the CAF alone.

Leknes et al. (124) compared 12 months and 6 years results of CAF alone (control group) or in combination with a biodegradable membrane (test group) in 20 patients with bilateral Miller Class I or II gingival recessions ≥3 mm at cuspids or premolars. RH, RW, KT, GT, PD, CAL were evaluated. Baseline RH in the test group was 4.10 ± 0.90 mm, whereas in the control group it was 3.60 ± 1.00 mm. MRC and RH reduction in the test and control groups were 51.2% and 2.10 ± 0.60

mm; 61.1% and 2.20 ± 0.30 mm at 12 months evaluation, respectively. Baseline KT in the test group was 2.4 ± 0.7 mm, whereas in the control group it was 2.6 ± 0.5 mm. After 12 months, KT increase was 0.60 ± 0.10 mm and 0.40 ± 0.10 mm in the test and control groups, respectively. GT was only measured at the 6-year evaluation. GT increase was 0.89 ± 0.16 mm in the test group, whereas a decrease of 0.80 ± 0.20 mm was observed in the control group. The 6-year evaluation showed a significant gain of root coverage for the control group only ($p<0.05$). No significant inter-group differences were detected for any other treatment variables ($p>0.05$). Compared with baseline, the 6-year results showed that in 7 of the test sites more root coverage was obtained, 3 sites were unchanged and in one site recession was observed in the obtained root coverage. For the 11 control sites, in 8 of the sites more root coverage was obtained, and 3 sites were unchanged. Five test and 10 control sites exhibiting CRC at 6 months were reduced to 2 test and 1 control sites, respectively, at the 6-year evaluation. CAF procedure offered a simple and reliable treatment alternative as a root coverage procedure in Class I & Class II recession type defects. It seems that the placement of a biodegradable membrane underneath the flap did not seem to improve neither the short nor the long-term results, also long-term outcome stability seems to be critically dependent on a continuous follow-up program with re-instruction in non-traumatic brushing habits.

2.3.5. Coronally Advanced Flap in Combination with Enamel Matrix Proteins

Enamel matrix proteins have been extensively studied in animals (165) and humans (166-168), providing evidence of tissue regeneration. This technique has been proposed and tested in several controlled studies in terms of achieving root coverage (103,104,115,117,118,123,169). Enamel matrix proteins mimic the function of proteins secreted by the inner layer of Hertwig's epithelial root sheath on the surface of the new dentin. The material consists of several enamel matrix-derivatives, primarily amelogenin, which is harvested from embryonic porcine teeth.

Modica et al. (118) compared the clinical outcomes of CAF alone (control group) or in combination with enamel matrix proteins (test group) in 12 patients with 28 bilateral Miller Class I & II gingival recessions ≥2 mm in cuspids or premolars. RH, KT, PD, CAL were evaluated. Baseline RH was 3.71 ± 1.68 mm for the test group, and 3.50 ± 1.56 mm for the control group. MRC and RH reduction in the test and control groups were 91.2% and 3.36 ± 1.55 mm; 80.9% and 2.71 ± 1.20 mm at 6 months evaluation, respectively. CRC was achieved in 9 of 14 test (64%) and 7 of 14 control sites (50%). Baseline KT in the test group was 1.71 ± 1.07 mm, whereas in the control group it was 1.36 ± 1.01 mm. KT increase was 0.21 ± 0.70 mm and 0.07 ± 0.83 mm in the test and control groups, respectively. No statistically significant inter-group differences were found at any stage of the study in terms of the evaluated parameters ($p>0.05$). The authors concluded that enamel matrix proteins did not seem to significantly improve the clinical outcomes of gingival recession treated by means of CAF.

Hagewald et al. (117) compared the results of CAF procedure alone (control group) or in combination with enamel matrix proteins (test group) in the treatment of 36 patients with 20 Miller Class I or II gingival recessions ≥3 mm and KT ≥1 mm in maxillary cuspids or premolars in a prospective, split-mouth, placebo-controlled randomised study. Contol site was additionally treated with placebo (propylene glycol alginate). RH, RW, KT, PD, CAL and alveolar bone level were evaluated. Baseline RH was 3.7 ± 1.0 mm for the test group, and 3.9 ± 1.1 mm for the control group. MRC and RH reduction in the test and control groups were 80% and 2.8 ± 0.8 mm; 79% and 2.9 ± 0.9 mm at 6 months evaluation, respectively. Baseline KT in the test group was 2.1 ± 1.0 mm, whereas in the control group it was 2.4 ± 1.0 mm. KT increase was 0.7 ± 0.9 mm and 0.3 ± 0.9 mm in the test and control groups, respectively. After 6 months, there was a significant difference between the treatments in terms of KT in favor of the test group ($p<0.05$). The authors concluded that the additional use of enamel matrix proteins together with CAF procedure for recession coverage showed no difference in the overall clinical outcome, with no clear benefit to combine enamel matrix proteins with this surgical procedure.

Del Pizzo et al. (104) compared the 1- and 2-year follow-up results of CAF procedure alone (control group) or in combination with enamel matrix proteins (test group) in the treatment of 15 patients with bilateral Miller Class I or II gingival recessions ≥3 mm. RH, RW, KT, PD, CAL were evaluated. Baseline RH was 4.07 ± 1.0 mm for the test group, and 4.13 ± 0.74 mm for the control group. MRC and RH reduction in the test and control groups were 90.67% and 3.6 ± 0.83 mm; 86.67% and 3.53 ± 0.83 mm at 24 months evaluation, respectively. From 12 to 24 months, MRC decreased slightly from 93.67% to 90.67% in the test group and from 88.33% to 86.67% in the control group. CRC was achieved in 11 of 15 of patients (73.33%) in the test group, and in 9 of 15 (60%) in the control group. Baseline KT in the test group was 1.47 ± 0.74 mm, whereas in the control group it was 1.67 ± 0.82 mm. KT increase was 1.00 ± 0.76 mm and 0.47 ± 0.64 mm in the test and control groups, respectively. The amount of KT always increased in the test group over the study period, whereas in the control group a decrease in KT was observed between 12 to 24 months. There was no significant difference between the treatments in terms of RH, RW, PD and CAL during evaluation period ($p>0.05$). Root coverage outcomes were similar in both groups and no statistically significant differences were found between the groups. They concluded that the additional use of enamel matrix proteins to CAF is not justified for clinical benefits of root coverage, but as an attempt of achieving periodontal regeneration rather than repair.

Spahr et al. (115) compared the results of CAF procedure alone (control group) or in combination with enamel matrix proteins (test group) in the treatment of 13 patients with bilateral Miller Class I or II gingival recessions ≥3 mm and KT ≥1 mm in a split-mouth, placebo-controlled and randomised study. Contol site was additionally treated with placebo (propylene glycol alginate). RH, RW, KT, PD, CAL and alveolar bone level were evaluated. Baseline RH was 3.59 ± 0.83 mm for the test group, and 3.81 ± 0.84 mm for the control group. MRC and RH reduction in the test and control groups were 84% and 2.8 ± 0.8 mm; 67% and 2.4 ± 0.9 mm at 24 months evaluation, respectively. CRC maintained over 2 years in

53% of the test group sites, and 23% of the control group sites. Baseline KT in the test group was 2.08 ± 0.74 mm, whereas in the control group it was 0.65 ± 0.82 mm. KT increase was 0.7 ± 0.1 mm and 0.3 ± 0.7 mm in the test and control groups, respectively. After 24 months, there was a significant difference between the treatments in terms of RW and PD change in favor of the test group ($p<0.05$). A total of 47% of the treated recessions in the control group deteriorated again in the second year after therapy compared to 22% in the test group. They concluded that enamel matrix proteins seem to provide better long-term results.

Castellanos et al. (103) compared the results of CAF procedure alone (control group) or in combination with enamel matrix proteins (test group) in the treatment of 22 patients with localized Miller Class I or II gingival recessions ≥2 mm. RH, RW, KT, PD and CAL were evaluated. Baseline RH was 2.68 ± 1.63 mm for the test group, and 2.31 ± 1.52 mm for the control group. MRC and RH reduction in the test and control groups were 88.6% and 2.32 ± 1.03 mm; 62.2% and 1.41 ± 0.57 mm at 12 months evaluation, respectively. CRC was 54.4% in the test group, and 36.3% in the control group. Baseline KT in the test group was 3.81 ± 1.95 mm, whereas in the control group it was 3.31 ± 1.81 mm. KT increase and decrease in the test group and control groups was 0.82 ± 0.20 mm and 0.04 ± 0.01 mm, respectively. When both treatments were compared at 12 months, there was a significant difference in RH reduction and KT gain in favor of the test group ($p<0.05$). The histological findings demonstrated that the junctional epithelium ended at a level of coronal to the treated recession as was indicated by the level of instrumentation. The regeneration of periodontal support was evident coronal to this area. CAF alone or with enamel matrix proteins was an effective procedure to cover localized gingival recessions. They concluded that the addition of enamel matrix proteins significantly improves the amount of root coverage.

Cueva et al. (116) compared the results of CAF procedure alone (control group) or in combination with enamel matrix proteins (test group) in the treatment of 17 patients with 58 Miller Class I, II, and III gingival recessions ≥2 mm in randomized, controlled, clinical investigation. RH, RW, KT, PD and CAL were evaluated. Baseline RH was 2.77 ± 0.62 mm for the test group, and 2.68 ± 0.65 mm for the control group. MRC and mean RH reduction in the test and control groups were 92.9% and 2.60; 66.8% and 1.90 mm at 6 months evaluation, respectively. CRC was 36.2% in the test group, and 13.79% in the control group. Baseline KT in the test group was 2.08 ± 1.17 mm, whereas in the control group it was 2.17 ± 0.98 mm. Mean KT increase was 0.60 mm and 0.05 mm in the test and control groups, respectively. When both treatments were compared at 6 months, there was a significant difference in RH and RW reduction, and KT gain in favor of the test group ($p<0.05$). The application of enamel matrix proteins to denuded root surfaces receiving CAF significantly increased the percentage of root coverage compared to CAF without enamel matrix proteins. They concluded that enamel matrix proteins application was accompanied by a significant KT increase in 6 months after surgery.

Pilloni et al. (123) examined the effects of CAF procedure alone (control group) or in combination with enamel matrix proteins (test group) in the treatment of 30 patients with Miller Class I or II gingival recessions on single-rooted teeth. RH, KT, PD and CAL were evaluated. Baseline RH was 2.86 ± 0.64 mm for the test group, and 2.66 ± 0.70 mm for the control group. MRC and RH reduction in the test and control groups were 93.80% and 2.66 ± 0.61 mm; 66.50% and 1.73 ± 0.70 mm mm at 18 months evaluation, respectively. CRC was 81.25% in the test group, and 31.25% in the control group. Baseline KT in the test group was 1.80 ± 0.75 mm, whereas in the control group it was 1.66 ± 0.60 mm. KT increase and decrease in the test group and control groups was 0.13 ± 0.06 mm and 0.06 ± 0.01 mm, respectively. When both treatments were compared at 6 months, there was a significant difference in RH reduction, KT and attachment gain in favor of the test group ($p<0.05$). They concluded that the application of enamel matrix proteins was beneficial in improving the effects of CAF in terms of amount of root coverage, attachment gain, and KT increase.

2.3.6. Coronally Advanced Flap in Combination with Platelet-rich Plasma

Platelet concentrated graft under CAF procedure has been proposed in periodontal plastic surgery. Platelets contain many autogenous growth factors (including platelet-derived growth factor, insulin-like growth factor and transforming growth factor-beta) that regulate several biologic activities at both genetic and cellular levels (170).

Huang et al. (105) evaluated the outcomes of CAF procedure alone (control group) or in combination with platelet-rich plasma (test group) in the treatment of 24 patients with localized Miller Class I gingival recessions ≥2 mm. RH, RW, KT, GT, PD and CAL were evaluated. Baseline RH was 2.8 ± 0.2 mm for the test group, and 2.9 ± 0.5 mm for the control group. MRC and RH reduction in the test and control groups were 81.0% and 2.3 ± 0.9 mm; 83.5% and 2.5 ± 0.8 mm at 12 months evaluation, respectively. CRC was 63.6% in the test group, and 58.3% in the control group. Baseline KT in test group was 2.70 ± 1.2 mm, whereas in control group was 2.7 ± 1.4 mm. KT increased 0.3 ± 0.9 mm and 0.6 ± 0.7 mm in the test group and control groups, respectively. Baseline GT in the test group was 1.1 ± 0.4 mm, whereas in the control group this value was 1.1 ± 0.2 mm. GT increase and decrease in the test and control groups was 0.6 ± 0.4 mm and 0.3 ± 0.4 mm, respectively. When a comparison was performed at 12 months, there was no statistically significant difference between the groups in terms all evaluated parameters ($p>0.05$). They concluded that the application of platelet-rich plasma as an adjunct to CAF root coverage procedure provided no clinically measurable enhancements on the final therapeutic outcomes of CAF in Miller Class I recession defects.

Lafzi et al. (107) evaluated clinical efficiency of CAF procedure alone (control group) or in combination with platelet-rich plasma (test group) in the treatment of 6 non-smoker patients with 20 bilateral Miller Class I gingival recessions ≥2 mm. RH, RW, KT, PD and CAL were evaluated. Baseline RH was 3.3 ± 0.8 mm for the test group, and 3.6 ± 0.9 mm for the control group. MRC and RH reduction in the test and control groups were 61.8% and 2.0 ± 0.1 mm; 65.0% and 1.2 ± 0.7 mm at 3 months evaluation, respectively. Baseline KT in the test group was 2.9 ± 0.9 mm, whereas in the control group it was 2.4 ± 0.7 mm. KT decrease was 0.1 ± 0.1 mm and 0.1 ± 0.2 mm in the test and control groups, respectively. When both treatments were compared at 12 months, there was no statistically significant difference between the groups in terms of all evaluated parameters ($p>0.05$). They concluded that while platelet-rich plasma enhanced the outcomes of CAF especially throughout the first month post-operatively, it offered no clinical advantage over CAF alone during the subsequent 2 months.

The results of these studies suggest that platelet-rich plasma may only affect early wound healing that can be considered as one of the important factors in the prevention of the surgically established gingival margin.

2.3.7. Coronally Advanced Flap in Combination with Anorganic Bone Mineral/Peptide-15

ABM/P-15 was developed as a synthetic bone substitute composed of a peptide component (P-15) adsorbed on an anorganic bone mineral (ABM). P-15 contains amino acids identical to that are found in residues of Type I collagen, a protein uniquely involved in cell adherence, particularly in fibroblasts and osteoblasts. ABM is a natural, microporous, bovine-derived bone mineral occurring in a particulate form that has smooth porous particles of 300-mm mean diameter. ABM/P-15 is commercially available either as a granulate or as flow formulation, based on a gel matrix (171)

Nazareth & Cury (119) evaluated the outcomes of CAF procedure alone (control group) or in combination with anorganic bone mineral/peptide-15 (test group) in the treatment of 15 patients with bilateral Miller Class I gingival recessions ≥2 mm. RH, KT, GT, PD and CAL were evaluated. Baseline RH was 2.60 ± 0.61 mm for the test group, and 2.67 ± 0.69 mm for the control group. MRC and RH reduction in the test and control groups were 85.56% and 2.20 ± 0.54 mm; 90.00% and 2.40 ± 0.80 mm at 6 months evaluation, respectively. CRC was 66.67% in the test group, and 73.33% in the control group. Baseline KT in the test group was 3.07 ± 1.44 mm, whereas in the control group it was 3.13 ± 1.59 mm. KT increase was 0.07 ± 0.25 mm and 0.07 ± 0.44 mm in the test and control groups, respectively. Baseline GT in the test group was 1.18 ± 0.20 mm, whereas in the control group this value was 1.16 ± 0.22 mm. GT increase was 0.00 ± 0.01 mm and 0.03 ± 0.04 mm in the test and control groups, respectively. When both treatments were compared at 6 months, there was a significant difference in GT change in favor of the test group ($p<0.05$). In the test group, a positive correlation was observed between bone height at baseline and the RH reduction ($r=0.56$; $p=0.03$). In the anorganic bone mineral/peptide-15 treated group, a greater reduction in RH was associated with higher bone level at baseline. They concluded that CAF associated with anorganic bone mineral/peptide-15 provided no significant difference in root coverage and attachment gain compared to CAF procedure alone in localised Miller Class I gingival recessions.

2.3.8. Coronally Advanced Flap in Combination with Acellular Dermal Matrix Graft

Although subepithelial connective tissue graft is a valid and succesfull surgical procedure, it has some disadvantageous such as the need for a second surgical procedure to harvest donor tissue which caused patient discomfort, the risk of postoperative complications (palatal necrosis, pain and bleeding), difficulty to harvest sufficient donor tissue from shallow or thin palate, a limited amount of donor tissue for multiple recession sites and longer surgical time. ADM has been used as an alternative to subepithelial connective tissue graft in periodontal plastic surgery, eliminating the disadvantages described above.

ADM is a freeze-dried, cell free, dermal matrix comprised of structurally integrated basement membrane complex and extra cellular matrix, in which collagen bundles and elastic fibers are the main components. The allograft is obtained from human cadavers, from which the cell component is removed and the ultrastructural integrity of the extracellular matrix is maintained. The dermal matrix exhibits undamaged collagen and elastin and does not elicit an inflammatory response in the host tissue. By removing all cellular components, the source of disease transmission and immunologic reaction is minimized; leaving a structurally intact connective tissue matrix composed of type I collagen. The collagen matrix functions as a scaffold to allow ingrowth by host tissues, maintaining its structural integrity, and revascularizing via preserved vascular channels. The tissue is, therefore, considered to be acellular and non-immunogenic; healing occurs by repopulation and revascularization rather than through a granulation to limit scarring. The special qualities of ADM make it a suitable dermal transplant (30,61-70).

ADM has been extensively used in medicine for full-thickness burns (61,62). It has been used for revision of depressed scars, nasal reconstruction, rhytid revision, facial defect repair, septal perforation repair, and paratidectomi defect repair (63-70).

The use of ADM has been recommended in dentistry to increase the zone of attached gingiva around teeth and implants (60,172-177), for root coverage procedures (17-59), to increase GT (20,23,26,28,35) and KT (17,18,20-24,60), soft tissue ridge deformities augmentation (178), eliminate gingival melanin pigmentation (179), as a membrane for guided bone (180-182) and tissue (183) regeneration; and tissue bioengineering (53,159).

The main objective in the usage of this material is to maintain or even exceed the success rate and prominent esthetics demonstrated with the subepithelial connective tissue graft with improved patient acceptance, simple surgical procedure and decreased complications, particularly in the treatment of challenging cases that involved defects of multiple teeth, thin gingival and palatal donor tissue, and limited time period.

Clinically ADM provides a uniform thickness, easy trimmed, well-adaptable material and requires a short time (10 min) to rehydrate before it can be used (17).

Previous studies compared the ADM and subepithelial connective tissue graft for the treatment of gingival recession, demonstrating similar results between both techniques (18,20,21,23,24,27,32,34,37,42,43,47,49,55,57).

Cummings et al. (49) reported the histological results of subepithelial connective tissue graft, ADM, and CAF to cover denuded roots in humans. The study included 4 patients previously treatment planned for extractions of three or more anterior teeth. Three teeth in each patient were selected and randomly designated to receive either a subepithelial connective tissue graft or ADM graft beneath CAF (tests) or CAF alone (control). Six months postoperatively block section extractions were performed and the teeth processed for histologic evaluation with hematoxylin-eosin and Verhoeff's stains. Histologically, both the subepithelial connective tissue graft and ADM were well incorporated within the recipient tissues. New fibroblasts, vascular elements, and collagen were present throughout the ADM, while retention of the transplanted elastic fibers was apparent. No effect on the keratinization or connective tissue organization of the overlying alveolar mucosa was evident with either graft. For both materials, areas of cemental deposition were present within the root notches, the alveolar bone was essentially unaffected, and the attachments to the root surfaces were similar. They concluded that although subepithelial connective tissue graft and ADM have a slightly different histological appearance, both could successfully be used to cover denuded roots with similar attachments and no adverse healing.

Harris (18) compared the clinical efficiency of CAF procedure in combination with ADM (test group) or subepithelial connective tissue graft (control group) in the treatment of 50 patients with 107 Miller Class I, II or III gingival recessions ≥2 mm. RH, KT, PD and CAL were evaluated. Baseline RH was 3.1 ± 0.8 mm for the test group, and 3.4 ± 0.8 mm for the control group. MRC and RH reduction in the test and control groups were 95.8% and 2.9 ± 0.5 mm; 96.2% and 3.2 ± 0.5 mm at 3 months evaluation, respectively. CRC of the patients was 87.7% in the test group, and 81.0% in the control group. Baseline KT in the test group was 1.6 ± 0.9 mm, whereas in the control group it was 1.3 ± 0.8 mm. KT increase was 1.1 ± 0.1 mm and 2.0 ± 0.2 mm in the test and control groups, respectively. When both treatments were compared at 12 months, there was a significant difference only in PD and KT change in favor of the control group ($p<0.05$). The results of procedures defined as both esthetically and clinically acceptable by the patients and the clinician.

Novaes et al. (21) evaluated the clinical outcomes of CAF procedure in combination with ADM (test group) or subepithelial connective tissue graft (control group) in the treatment of 9 patients with 30 Miller Class I or II gingival recessions ≥3 mm. RH, KT, PD and CAL were evaluated. Baseline RH was 3.23 ± 1.08 mm for the test group, and 2.97 ± 0.81 mm for the control group. MRC and RH reduction in the test and control groups were 60.0% and 2.1 ± 1.0 mm; 66.7% and 1.83 ± 0.83 mm at 6 months evaluation, respectively. CRC of the patients was 60% in the test group, and 40% in the control group. Baseline KT in the test group was 1.6 ± 0.9 mm, whereas in the control group it was 1.3 ± 0.8 mm. KT increase was 0.63 ± 0.85 mm and 1.26 ± 0.88 mm in the test and control groups, respectively. The subepithelial connective tissue graft group had a statistically significant KT increase after 3 months compared to the test group ($p<0.05$). Both procedures produced KT increase after 6 months, with no statistically significant difference ($p>0.05$). There was no statistically significant difference between the test and control groups in terms of RH reduction, attachment gain, and PD reduction ($p>0.05$). They concluded that ADM might be a substitute for palatal donor tissue in root coverage procedures.

Paolantonio et al. (23) evaluated the clinical outcomes of CAF procedure in combination with ADM (test group) or subepithelial connective tissue graft (control group) in the treatment of 30 patients with Miller Class I or II gingival recessions ≥3 mm. RH, KT, GT, PD and CAL were evaluated. Baseline RH was 4.75 ± 1.20 mm for the test group, and 4.80 ± 1.14 mm for the control group. MRC and RH reduction in the test and control groups were 83.33% and 4.00 ± 1.06 mm; 88.80 % and 4.20 ± 0.86 mm at 12 months evaluation, respectively. CRC of the patients was 26.6% in the test group, and 46.6% in the control group. Baseline KT in the test group was 1.53 ± 0.83 mm, whereas in the control group it was 1.80 ± 1.67 mm. KT increase was 0.53 ± 0.51 mm and 1.93 ± 1.03 mm in the test and control groups, respectively. Control group demonstrated a significantly greater KT increase and showed quicker and more complete healing ($p<0.05$). Baseline GT in the test group was 0.80 ± 0.36 mm, whereas in the control group it was 0.81 ± 0.30 mm. GT increase was 1.03 ± 0.34 mm and 1.14 ± 0.44 mm in the test and control groups, respectively. When both treatments were compared at 12 months, there was a significant difference only in GT change in favor of the control group ($p<0.05$). Complete healing of the surgical procedure was observed 8.93 ± 1.33 and 6.20 ± 1.01 weeks after suture removal in the test and control groups, respectively. They concluded that the subepithelial connective tissue graft and ADM were similarly able to successfully treat gingival recession defects; however, the subepithelial connective tissue graft group obtained a significantly greater KT increase, and showed a quicker complete healing.

Tal et al. (72) compared the clinical efficiency of CAF procedure in combination with ADM (test group) or subepithelial connective tissue graft (control group) in the treatment of 7 patients with bilateral Miller Class I or II gingival recessions ≥4 mm. RH, KT, PD and CAL were evaluated. Baseline mean RH was 5.14 mm for the test group, and 4.86 mm for the control group. MRC and mean RH reduction in the test and control groups were 89.1% and 4.57 mm; 88.7% and 4.29 mm at 12 months evaluation, respectively. Mean baseline KT in the test group was 2.29 mm, whereas in the control group it was 2.00 mm. KT increase was 0.86 mm and 2.14 mm in the test and control groups, respectively. When both treatments were compared at 12 months, there was a significant difference only in KT change in favor of the control group ($p<0.05$). They demonstrated that recession defects might be covered using ADM or subepithelial connective tissue graft with no practical difference.

Harris et al. (27) evaluated the short-term (mean 12.3 to 13.2 weeks) and long-term (mean 48.1 to 49.2 months) root coverage results obtained with CAF procedure in combination with ADM (test group) or subepithelial connective tissue graft (control group) in the treatment of 25 patients with Miller Class I or II gingival recessions ≥2 mm. MRC obtained in the short-term period for ADM (93.4%) and subepithelial connective tissue graft (96.6%), and long-term period for subepithelial connective tissue graft (97.0%) were statistically similar. These values were statistically greater than MRC obtained in the long-term period for ADM (65.8%). Long-term results revealed that MRC was greater in multiple type defects (70.8%) than single type defect (50.0%). They stated that it seemed as though treating multiple defects with an ADM had an advantage over treating singular defects with an ADM; the mean results with the subepithelial connective tissue graft held up with time better than the mean results with ADM.

Hirsch et al. (32) evaluated 2-year follow-up of CAF procedure in combination with ADM (test group) or subepithelial connective tissue graft (control group) in the treatment of 166 patients with Miller Class I or II gingival recessions. RH, KT, PD and CAL were evaluated. Baseline RH was 4.2 ± 0.1 mm for the test group, and 4.9 ± 0.2 mm for the control group. MRC and RH reduction in the test and control groups were 98.8% and 3.95 ± 0.06 mm; 99.1% and 4.77 ± 0.16 mm at 24 months evaluation, respectively. KT increase was 2.2 ± 0.04 mm and 3.00 ± 0.10 mm in the test and control groups, respectively. They concluded that there were no significant differences in final recession and root coverage between the two treatment methods ($p<0.05$); the coverage of root by ADM or subepithelial connective tissue graft was a very predictable procedure, which was stable for 2 years postoperatively.

Rahmani et al. (34) evaluated the clinical outcomes of CAF procedure in combination with ADM (test group) or subepithelial connective tissue graft (control group) in the treatment of 14 patients with 20 Miller Class I & II gingival recessions. RH, RW, KT, PD and CAL were evaluated. Baseline RH was 4.05 ± 1.04 mm for the test group, and 3.70 ± 0.63 mm for the control group. MRC and RH reduction in the test and control groups were 72.08% and 2.90 ± 0.81 mm; 70.12% and 2.60 ± 0.97 mm at 6 months evaluation, respectively. Baseline KT in the test group was 0.75 ± 0.54 mm, whereas in the control group it was 8.80 ± 0.63 mm. KT increase was 2.95 ± 0.69 mm and 2.50 ± 0.97 mm in the test group and control groups, respectively. When both treatments were compared at 6 months, there was no significant difference in any of the evaluated parameters ($p>0.05$). They concluded that ADM and subepithelial connective tissue graft techniques could produce the same results when used for the successful treatment of gingival recessions, and ADM could be used as an adequate alternative treatment modality for conventional techniques.

Joly et al. (37) compared the clinical findings of CAF procedure in combination with ADM (test group) or subepithelial connective tissue graft (control group) in the treatment of 10 patients with bilateral Miller Class I or II gingival recessions ≥3 mm in the preliminary study. RH, KT, GT, PD and CAL were evaluated. Baseline RH was 4.2 ± 0.9 mm for the test group, and 4.4 ± 1.3 mm for the control group. MRC and RH reduction in the test and control groups were 50% and 2.1 ± 0.9 mm; 79.5% and 3.5 ± 1.2 mm at 6 months evaluation, respectively. Baseline KT in the test group was 2.4 ± 0.8 mm, whereas in the control group it was 3.1 ± 1.3 mm. KT increase was 1.1 ± 1.5 mm and 1.2 ± 0.8 mm in the test and control groups, respectively. Baseline GT in the test group was 0.8 ± 0.4 mm, whereas in the control group it was 0.8 ± 0.3 mm. GT increase was 0.7 ± 0.4 mm and 1.3 ± 0.6 mm in the test and control groups, respectively. When both treatments were compared at 6 months, there was a significant difference in terms of RH, GT, CAL in favor of the control group ($p<0.05$). They concluded that CAF associated with subepithelial connective tissue graft or ADM was effective in root coverage. However, CAF associated with subepithelial connective tissue graft provided a more favorable clinical outcome.

De Souza et al. (42) compared the clinical results of CAF procedure in combination with ADM (test group) or subepithelial connective tissue graft (control group) in the treatment of 7 patients with bilateral Miller Class I or II gingival recessions. RH, KT, PD and CAL were evaluated. Baseline RH was 3.15 ± 1.01 mm for the test group, and 2.93 ± 0.78 mm for the control group. MRC and RH reduction in the test and control groups were 63.5% and 2.00 ± 1.08 mm; 73.4% and 2.15 ± 0.55 mm at 12 months evaluation, respectively. Baseline KT in the test group was 2.68 ± 1.13 mm, whereas in the control group it was 2.37 ± 1.21 mm. KT increase was 0.63 ± 0.85 mm and 1.77 ± 1.01 mm in the test and control groups, respectively. When both treatments were compared after 12 months, there was no significant difference in any of the evaluated parameters ($p>0.05$). They concluded that ADM might be a substitute for palatal donor tissue in root coverage procedures and that the time required for additional KT gain might be greater for the ADM than for subepithelial connective tissue graft procedures.

Haghighati et al. (43) evaluated the effect of interdental papilla dimensions on the outcome of CAF procedure in combination with ADM (test group) or subepithelial connective tissue graft (control group) in the treatment of 16 patients with bilateral Miller Class I or II gingival recessions ≥2 mm. RH, papilla height and width were evaluated. Baseline RH was 2.93 ± 0.93 mm for the test group, and 3.37 ± 1.36 mm for the control group. MRC and RH reduction in the test and control groups were 85.42% and 2.53 ± 1.11 mm; 69.05% and 2.31 ± 1.14 mm at 12 months evaluation, respectively. CRC was 75.0% in the test group, and 31.3% in the control group. Baseline papilla height in the test group was 4.09 ± 1.16 mm, whereas in the control group it was 3.63 ± 0.83 mm. When both treatments were compared at 12 months, there was a significant difference only in CRC change in favor of the test group ($p<0.05$). Significant positive correlations were found between papilla height and papilla width and MRC, and papilla height of at least 5 mm was associated with CRC. They concluded that ADM might be a good substitute for subepithelial connective tissue graft to treat shallow to moderate gingival recessions. In addition, papilla dimensions, can help predict the success of future root coverage.

Mansouri et al. (57) compared the clinical results of CAF procedure in combination with ADM (test group) or subepithelial connective tissue graft (control group) in the treatment of 5 patients with bilateral Miller Class I & II gingival recessions ≥2 mm. RH, RW, KT, PD and CAL were evaluated. Baseline RH was 2.66 ± 1.00 mm for the test group, and 2.66 ± 1.11 mm for the control group. MRC and RH reduction in the test and control groups were 71.1% and 1.77 ± 0.66 mm; 85.7% and 2.22 ± 0.83 mm at 6 months evaluation, respectively. CRC was 44.4% in the test group, and 55.5% in the control group. Baseline KT in the test group was 2.44 ± 1.13 mm, whereas in the control group it was 2.88 ± 0.78 mm. KT increase was 2.00 ± 1.11 mm and 1.44 ± 0.88 mm in the test and control groups, respectively. When both treatments were compared after 6 months, there was no significant difference in any of the evaluated parameters ($p>0.05$). They concluded that ADM might be suggested as an acceptable substitute for subepithelial connective tissue graft considering the root coverage effect and KT increase.

Moslemi et al. (55) reported the long-term results of CAF procedure in combination with ADM (test group) or subepithelial connective tissue graft (control group) in the treatment of 16 patients with bilateral Miller Class I & II gingival recessions ≥2 mm. RH, RW, KT, PD and CAL were evaluated. Baseline RH was 2.87 ± 0.91 mm for the test group, and 3.33 ± 1.39 mm for the control group. MRC and RH reduction in the test and control groups were 85.4% and 2.6 ± 1.1 mm; 69.1% and 2.2 ± 1.1mm at 6 months evaluation, respectively. CRC was 73.3% in the test group, and 26.7% in the control group. Baseline KT in the test group was 1.90 ± 1.31 mm, whereas in the control group it was 1.93 ± 1.28 mm. KT increase was 0.97 ± 1.01 mm and 0.80 ± 1.26 mm in the test and control groups at 6 months evaluation, respectively. When both treatments were compared at 6 months, there was a significant difference in terms of CRC in favor of the test group ($p<0.05$). At 5 years, MRC and RH reduction in the test and control groups were 54.6% and 1.6 ± 1.2 mm; 39.8% and 1.5 ± 1.4 mm, respectively. CRC was 20.0% in the test group, and 13.3% in the control group. Significant relapses were detected in CRC, RH and RW reductions in both groups with no statistically significant difference (p>0.05). Patients practicing horizontal toothbrushing habit showed more relapse (p=0.01). Compared with baseline, KT did not increase in ADM-treated sites over 5 years evaluation period (p=0.903). They concluded that 5-year results of subepithelial connective tissue graft and ADM were similar in terms of CRC and RH reduction. Both techniques showed a significant relapse associated with returning to horizontal toothbrushing habit. KT increase was stable in subepithelial connective tissue graft treated sites, but reached to pre-surgical values in ADM-treated cases.

Griffin et al. (52) compared the frequency of complication occurrence after 75 free gingival grafts, 256 subepithelial connective tissue grafts or 89 ADM procedures and identified possible predictors for these complications. They reported that long surgical procedures and smoking may increase the severity and frequency of certain post-surgical complications after periodontal plastic surgeries. Free gingival graft procedures incured a higher likelihood for postoperative pain or bleeding than subepithelial connective tissue graft procedures, whereas the application of an ADM might significantly reduce the probability of swelling and bleeding.

ADM has been used in combination with CAF (17-59), or with the addition of enamel matrix proteins (36,44,50), autologous gingival fibroblasts by tissue-engineering (53,159), recombinant human platelet derived growth factor (58), and beta-tricalcium phosphate (56).

Santos et al. (30) reported root coverage of 12 clinical cases with 26 Miller Class I & II gingival recessions (range from 1 to 5 mm). MRC was 74%. CRC was achieved in 13 of 26 defects (50%). They reported that the long-term results of the cases were stable, also proposed technique of root coverage with ADM could be a good alternative to soft tissue grafts for root coverage, and it should be part of our periodontal plastic surgery armamentarium.

Harris (22) evaluated the long-term stability of CAF procedure in combination with ADM in the treatment of 20 patients with 47 Miller Class I & II gingival recessions. RH, KT, PD and CAL were evaluated. Baseline RH and KT were 3.1 ± 0.7 and 2.0 ± 1.7 mm, respectively. At 18 months evaluation, RH reduction, KT increase, MRC and CRC were 2.7 ± 0.3 mm, 0.4 ± 0.2 mm, 87.0% and 30%, respectively. The intra-group difference at 18 months was statistically significant in terms of RH reduction and attachment gain ($p<0.05$). The author concluded that the root coverage results obtained with ADM were predictable, esthetic, and stable over time.

Barros et al. (29) compared the clinical results of modified (test group) and conventional (control group) CAF procedure in combination with ADM in the treatment of 14 patients with 32 Miller Class I or II gingival recessions ≥3 mm. In the control group the two releasing incisions were placed on the proximal surfaces of the involved tooth (33), whereas in the test group the incisions were displaced to the mesial and distal line angles of the ad cent teeth, distant from the recession, providing a broader flap. RH, KT, PD and CAL were evaluated. Baseline RH was 3.9 ± 0.87 mm for the test group, and 3.4 ± 0.49 mm for the control group. MRC and RH reduction in the test and control groups were 79% and 3.6 ± 0.64 mm; 63.9% and 2.1 ± 0.97 mm at 6 months evaluation, respectively. Baseline KT in test group was 2.0 ± 1.16 mm, whereas in the control group it was 2.2 ± 1.53 mm. KT increase was 1.0 ± 1.04 mm and 0.8 ± 0.75 mm in the test and control groups at 6 months evaluation, respectively. When both treatments were compared at 6 months, there was a significant difference in terms of RH reduction in favor of the test group ($p<0.05$). They concluded that the modified technique was more suitable for root coverage procedures with the ADM since it had statistically significant better clinical results compared to the conventional technique.

Barros et al. (31) compared the 1-year clinical outcome of the same study (78). MRC, RH reduction, KT increase were 82.5%, 3.2 ± 0.75 mm, 1.3 ± 0.98 mm in the test group, whereas these values were 62.3%, 2.1 ± 0.89 mm, 1.0 ± 0.81 mm in the control group at 12 months evaluation, respectively. When both treatments were compared at 12 months, there was a significant difference in terms of RH reduction in favor of the test group ($p<0.05$). They concluded that the modified technique was also suitable for root coverage when compared with the conventional technique at 1-year evaluation period.

Felipe et al. (38) compared the clinical results of two flap designs of CAF procedure in combination with ADM in the treatment of 15 patients with bilateral Miller Class I or II gingival recessions ≥2 mm. The control group was treated with a broader flap (78) and vertical releasing incisions, whereas the test group was treated with the same flap design but without vertical releasing incisions. RH, KT, GT, PD, CAL, esthetics and pain were evaluated. Baseline RH was 2.88 ± 0.81 mm for the test group, and 2.73 ± 0.76 mm for the control group. MRC and RH reduction in the test and control groups were 68.99% and 2.09 ± 1.23 mm; 84.81% and 2.32 ± 0.90 mm at 6 months evaluation, respectively. CRC was 33.3% in the test group, and 60.0% in the control group. Baseline KT in the test group was 1.94 ± 1.66 mm, whereas in the control group it was 2.73 ± 0.76 mm. KT increase was 0.14 ± 1.28 mm and 0.32 ± 0.81 mm in the test and control groups at 6 months evaluation, respectively. Baseline GT in the test group was 0.48 ± 0.29 mm, whereas in the control group it was 0.55 ± 0.21 mm. GT increase was 0.66 ± 0.44 mm and 0.51 ± 0.31 mm in the test and control groups at 6 months evaluation, respectively. When both treatments were compared at 6 months, there was a significant difference in terms of RH reduction and KT increase in favor of the control group ($p<0.05$). The esthetic result was equivalent between the groups, and all patients tolerated both procedures well. They concluded that both techniques provided significant root coverage, good esthetic results, and similar levels of postoperative discomfort. However, the broader flap with vertical releasing incisions had statistically significantly better results for root coverage of localized gingival recessions. Andrade et al. (91) reported 12 months results of the same study (89). MRC, CRC, RH reduction, KT and GT increase were 74.32%, 40.0%, 2.16 ± 0.16 mm, 0.56 ± 0.15 mm, 0.16 ± 0.65 mm in the test group, whereas these values were 83.28%, 53.3%, 2.27 ± 0.23 mm, 0.60 ± 0.24 mm, 0.41 ± 0.48 mm in the control group at 12 months evaluation, respectively. After 12 months, there was a significant difference only in terms of KT increase in favor of the control group ($p<0.05$). They concluded that both flap designs in combination with ADM, provided significant RH reduction after 12 months, and there was no statistically significant difference between the groups regarding root coverage ($p>0.05$). However, there was a statistically significant difference between the groups after 12 months for the KT, favouring the group with releasing vertical incisions ($p<0.05$).

Henderson et al. (19) compared effectiveness of ADM orientation on the treatment outcome of root coverage used in combination with CAF procedure in the treatment of 10 patients with Miller Class I or II recession defects ≥3 mm. ADM with basement membrane side were placed against the root surface in test group, whereas with connective tissue side against the root surface in the control group. RH, KT, PD and CAL were evaluated. Baseline RH in the test group was 4.20 ± 2.44 mm, whereas in the control group it was 3.70 ± 0.95 mm. MRC, CRC, RH reduction in the test and control groups were 94.9%, 70%, 3.95 ± 2.19 mm and 95.5%, 80%, 3.55 ± 1.07 mm at 12 months evaluation, respectively, with no additional root coverage gained due to creeping attachment between 2 and 12 months. Baseline KT in the test group was 1.80 ± 1.32 mm, whereas in the control group it was 1.60 ± 1.07 mm. KT increase was 0.80 ± 0.92 mm and 0.80 ± 1.14 mm in the test and control groups at 12 months evaluation, respectively. There was no statistically significant difference between the groups in terms of evaluated parameters ($p>0.05$). They determined that the orientation of the graft did not affect the treatment outcome of root coverage procedure after 12 months.

Woodyard et al. (26) compared the results of CAF alone (control group) or in combination with ADM (test group) in the treatment of 24 patients with Miller Class I or II recession defects ≥3 mm. RH, KT, GT, PD, CAL were evaluated. Baseline RH in the test group was 3.46 ± 0.89 mm, whereas in the control group it was 3.27 ± 0.56 mm. MRC, CRC, RH reduction in the test and control groups were 99%, 92%, 2.35 ± 0.78 mm and 67%, 33%, 2.19 ± 0.95 mm at 6 months evaluation, respectively. No additional root coverage was gained due to creeping attachment between 2 and 6 months for either group. Baseline KT in the test group was 1.79 ± 1.27 mm, whereas in the control group it was 1.54 ± 1.16 mm. KT increase was 0.81 ± 0.96 mm in the test group, whereas a decrease of 0.33 ± 1.05 mm in the control group was observed. Baseline GT at sulcus base in the test group was 0.76 ± 0.21 mm, whereas in the control group it was 0.75 ± 0.21 mm. GT increase was 0.40 ± 0.26 mm and 0.03 ± 0.23 mm in the test and control groups, respectively. After 6 months, there was a significant difference between the treatment groups in terms of RH reduction, GT increase and attachment gain in favor of the test group ($p<0.05$). They concluded that treatment with a CAF+ADM combination significantly increased GT when compared with CAF alone and root coverage was significantly improved with the use of ADM.

Cortes et al. (28) compared the results of CAF alone (control group) or in combination with ADM (test group) in the treatment of 13 patients with bilateral localized Miller Class I recession defects ≥3 mm. RH, RW, KT, GT, PD, CAL were evaluated. Baseline RH in the test group was 3.46 ± 0.85 mm, whereas in the control group it was 3.58 ± 0.57 mm. MRC, CRC, RH reduction in the test and control groups were 74.5%, 23%, 2.58 ± 0.67 mm and 69.8%, 23%, 2.50 ± 0.64 mm at 6 months evaluation, respectively. No additional root coverage was gained due to creeping attachment between 2 and 6 months for either group. Baseline KT in the test group was 3.15 ± 0.75 mm, whereas in the control group it was 2.73 ± 0.78 mm. KT increase was 0.69 ± 0.83 mm and 0.46 ± 0.63 mm in the test and control groups, respectively. Baseline GT in the test group was 1.05 ± 0.27 mm, whereas in the control group it was 1.05 ± 0.22 mm. GT increase was 0.71 ± 0.30 mm and 0.24 ± 0.24 mm in the test and control groups, respectively. After 6 months, there was a significant difference between the treatment groups in terms of GT increase in favor of the test group ($p<0.05$). They concluded that both techniques could provide significant root coverage in Miller Class I gingival recessions; however, a greater GT could be expected with ADM.

Côrtes et al. (35) reported 24 months evaluation of the same study (77). After 24 months, MRC and CRC reduced from 76% to 68% and from 23% to 7.7% in test group, whereas the same parameters changed from 71% to 56% and from 23% to 7.7% in the control group, respectively. They concluded that ADM could provide greater GT increase and might reduce the residual RH observed after 24 months in defects treated with CAF procedure alone.

Mahajan et al. (39) compared the effectiveness of CAF procedure alone (control group) or in combination with ADM (test group) in terms of root coverage and patient satisfaction in the treatment of 14 patients with bilateral localized Miller Class I & II recession defects ≥3 mm. RH, KT, PD and patient satisfaction with regard to patient-centered criteria: root coverage attained; relief from dentinal hypersensitivity; color of gums; shape and contour of gums; surgical procedure (pain during surgery and the discomfort experienced related to the duration of the procedure and handling by the surgeon); post-surgical phase (pain, swelling, and postoperative complications); and cost effectiveness (patients were asked whether the treatment justified the time and money spent) were evaluated. Baseline RH in the test group was 4.0 ± 1.0 mm, whereas in the control group it was 3.7 ± 0.7 mm. MRC and RH reduction in the test and control groups were 97.14%, 3.85 ± 0.89 mm and 77.42%, 2.85 ± 0.89 mm at 6 months evaluation, respectively. Baseline KT in the test group was 2.57 ± 0.78 mm, whereas in the control group it was 3.42 ± 4.14 mm. KT increase was 1.14 ± 0.37 mm and 0.71 ± 0.48 mm in the test and control groups, respectively. The difference between the two groups in terms of RH reduction was statistically significant in favor of the test group ($p<0.05$). There was no statistically significant differences between the two groups in the remaining clinical parameters and overall patient satisfaction ($p>0.05$) except in criteria related to patient comfort and cost effectiveness, in which CAF alone produced significantly better results ($p<0.05$). They concluded that ADM was significantly superior with regard to effectiveness and efficiency in the treatment of gingival recession than CAF alone. CAF procedure alone emerges as a better option than CAF + ADM in terms of cost effectiveness and patient comfort.

Jagannathachary et al. (59) compared the results of CAF alone (control group) or in combination with ADM (test group) in the treatment of 10 patients with bilateral maxillary localized Miller Class I recession defects ≥2 mm. RH, RW, KT, GT, PD, CAL were evaluated. Baseline RH in the test group was 2.20 ± 0.35 mm, whereas in the control group it was 2.20 ± 0.95 mm. MRC and RH reduction in the test and control groups were 82.2%, 0.90 ± 0.91 mm and 53%, 0.70 ± 0.67 mm at 6 months evaluation, respectively. Baseline KT in the test group was 3.95 ± 0.93 mm, whereas in the control group it was 3.75 ± 0.79 mm. KT increase was 0.65 ± 0.71 mm and 0.10 ± 1.07 mm in the test and control groups, respectively. Baseline GT in the test group was 1.00 ± 0.00 mm, whereas in the control group it was 1.00 ± 0.24 mm. GT increase in the test and control groups was 1.70 ± 0.26 mm and 0.00 ± 0.00 mm, respectively. After 6 months, there was a significant difference between the groups in terms of GT increase in favor of the test group ($p<0.05$). They concluded that the amount of root coverage obtained with ADM + CAF was superior compared to CAF alone.

Barker et al. (45) compared the results of CAF procedure in combination with Puros Dermis Graft (test group) or ADM (control group) in the treatment of 14 patients with 52 Miller Class I or III recession defects ≥2 mm. RH, KT, PD and CAL were evaluated. Baseline RH in the test group was 3.50 ± 1.47 mm, whereas in the control group it was 3.79 ± 1.47 mm. MRC, RH reduction were 81.4%, 2.83 ± 0.48 mm and 83.4%, 3.13 ± 0.71 mm in the test and control groups at 6 months evaluation, respectively. Baseline KT in test group was 2.60 ± 1.13 mm, whereas in the control group it was 2.83 ± 1.17 mm. KT increase was 0.25 ± 0.30 mm and 0.11 ± 0.32 mm in the test and control groups, respectively. There was no statistical or clinical difference in terms of evaluated parameters in CAF for root coverage with either of ADM or Puros Dermis Graft ($p>0.05$). They concluded that both materials were successful in achieving root coverage.

Papageorgakopoulos et al. (41) compared the results of tunneling (test group) or CAF (control group) procedures in combination with ADM in the treatment of 24 patients with Miller Class I or II recession deffects ≥3 mm. RH, KT, GT, PD and CAL were evaluated. Baseline RH in the test group was 3.1 ± 0.3 mm, whereas in the control group it was 3.4 ± 0.8 mm. MRC, CRC, RH reduction were 78%, 50%, 2.4 ± 1.0 mm and 95%, 83%, 3.2 ± 0.9 mm in the test and control groups at 4 months evaluation, respectively. Baseline KT in the test group was 1.2 ± 0.8 mm, whereas in the control group it was 1.0 ± 0.5 mm. KT increase was 0.6 ± 0.5 mm and 0.8 ± 0.7 mm in the test and control groups, respectively. Baseline GT at sulcus base in test group was 0.7 ± 0.2 mm, whereas in the control group it was 0.6 ± 0.1 mm. GT increase was 0.1 ± 0.2 mm and 0.5 ± 0.2 mm in the test and control groups, respectively. They concluded that the difference between the groups was considered clinically significant but was not statistically ($p>0.05$).

Also, some other studies reported CAF+ADM combination with the addition of enamel matrix proteins (36,44) and recombinant human platelet derived growth factor (58) in an attempt to improve the clinical outcomes in the root coverage procedures.

Shin et al. (36) compared the results of CAF+ADM combination with enamel matrix proteins (test group) and CAF+ADM combination alone (control group) in the treatment of of 14 patients with Miller Class I or III localized and multiple recession defects ≥2 mm. RH, RW, KT, PD and CAL were evaluated. Baseline RH in the test group was 3.58 ± 0.48 mm, whereas in the control group it was 3.74 ± 0.60 mm. MRC, RH reduction were 79.4%, 2.05 ± 1.00 mm and 73.4%, 1.93 ± 1.32 mm in the test and control groups at 6 months evaluation, respectively. Baseline KT in the test group was 3.68 ± 1.68 mm, whereas in the control group it was 3.65 ± 1.61 mm. KT increase was 0.89 ± 0.66 mm and 0.52 ± 0.56 mm in the test and control groups, respectively. After 6 months, there was a significant difference between the groups in terms of KT increase in favor of the test group ($p<0.05$). They concluded that the use of enamel matrix proteins in conjunction with ADM resulted with a statistically significant effect on KT increase, but no significant effects on attachment gain or percentage of root coverage was observed.

Pourabbas et al. (44) compared the clinical outcomes of CAF+ADM combination with enamel matrix proteins (test group) and CAF+ADM combination alone (control group) in the treatment of 15 patients with 36 Miller Class I or II recession deffects ≥2 mm. RH, RW, KT, PD and CAL were evaluated. Baseline mean RH in the test group was 5.13 mm, whereas in the control group it was 5.11 mm. MRC, RH reduction were 84.9%, 2.04 mm and 89.5%, 2.14 mm in the test and control groups at 6 months evaluation, respectively. Baseline mean KT in the test group was 2.11 mm, whereas in the control group it was 2.16 mm. KT increase was 0.80 mm and 1.03 mm in the test and control groups, respectively. There was no significant difference in terms of the evaluated parameters between the groups ($p>0.05$). They concluded that application of enamel matrix proteins did not improve the clinical efficacy of ADM in combination with CAF in root coverage procedures.

Carney et al. (58) compared the clinical outcomes of CAF+ADM combination with recombinant human platelet derived growth factor (test group) and CAF+ADM combination alone (control group) in the treatment of 17 patients with 40 Miller Class I, II and III recession deffects ≥2 mm. RH, RW, KT, PD, CAL, papillary height and width were evaluated. Baseline RH in the test group was 2.98 ± 1.00 mm, whereas in the control group it was 3.04 ± 1.10 mm. MRC, RH reduction was 69%, 2.33 ± 0.24 mm and 76.7%, 2.28 ± 0.26 mm in the test and control groups at 6 months evaluation, respectively. Baseline KT in the test group was 2.16 ± 1.23 mm, whereas in the control group it was 2.19 ± 1.07 mm. KT increase was 0.00 ± 0.05 mm and 0.14 ± 0.05 mm in the test and control groups, respectively. They concluded that were no statistically or clinically significant differences in terms of the evaluated parameters between the groups with a CAF and ADM with and without recombinant human platelet derived growth factor for the treatment of recession defects (p>0.05).

2.3.9. Coronally Advanced Flap For The Treatment of Multiple Recession Defects

CAF has been also documented as an effective surgical technique for the treatment of multiple gingival recessions with advantages for the patient in terms of esthetics and morbidity (4-7), obtaining stable long-term results, with MRC ranging from 74.91% (16) to 97.1% (4), and CRC from 24% (13) to 73% (4) (4,5,6,7,13-16).

Zucchelli & De Sanctis (4) evaluated the effectiveness of CAF with no vertical releasing incisions for the treatment 73 maxillary Miller Class I or II multiple recession defects ≥2 mm in 22 patients with esthetic demands. The mean number of recessions treated in each patient was 3.4 (range 2 to 5). RH, KT, PD, CAL were evaluated. Baseline RH was 2.8 ± 1.1 mm. RH reduction was 2.7 ± 0.8 mm at 12 months evaluation. Twelve months after the surgery, RH reduction and

MRC were 2.7 ± 0.8 mm and 97%, respectively with 64 defects having CRC (88.6%). CRC in all recessions was achieved in 16 out of 22 patients (73%). No statistically significant relationship was found between the root coverage results and the number of recession defects treated in each patient. Baseline KT was 1.8 ± 0.9 mm. A statistically significant KT increase (0.6 ± 0.1 mm) was observed after 1 year; this increase was inversely correlated ($p<0.001$) with the amount of presurgical KT. The intra-group difference at 6 months was statistically significant in terms of RH, KT and CAL ($p<0.05$). The multiple regression analysis showed that the final result, in terms of root coverage, was significantly affected by the initial RH ($p<0.001$) and KT ($p<0.01$). Also, greater RH reductions were observed in the cases with worse initial conditions and with lesser KT amount. They reported that the proposed surgical technique was very effective for the treatment of multiple gingival recessions in esthetic areas and successful root coverage could be achieved irrespective to both the number of recessions simultaneously treated and the presence of preoperative minimal KT amount.

Zucchelli & De Sanctis (5) reported 60 months stability of clinical outcomes of the same study (27). At the 5 years evaluation, MRC was 94%, with 85% of CRC. CRC in all recessions was maintained in 15 out of 22 patients (68%). The long-term stability of the gingival margin in the treated sites was significantly influenced by the patient's regular participation in the recall program and the susceptibility to gingival recession in other areas of the mouth. A statistically significant KT increase of 0.80 ± 0.64 mm was observed between the 1 and 5 years evaluations, the increase between the baseline and the 5 years follow-up was 1.38 ± 0.90 mm ($p<0.05$). This was significantly affected by the baseline KT and RH: in particular, increase in KT amount was greater in sites with a greater preoperative RH and lower KT at 5 years. They reported that CAF for multiple recession defects were well maintained over the 4 years evaluation period. Negative patient habits such as a lack of compliance with a supportive care program and individual susceptibility to gingival recession were significantly associated with the recurrence in gingival recession. Also, KT increase that followed the CAF procedure may be attributed to the tendency of the mucogingival junction line to regain its genetically determined position.

Zucchelli & De Sanctis (7) evaluated the clinical efficacy of the CAF modification for the upper anterior teeth. They treated 25 Miller Class I or II multiple recession defects ≥2 mm in maxillary incisors and canines in 6 patients with aesthetic demands. RH, KT, PD, CAL were evaluated. Baseline RH was 2.84 ± 1.0 mm. The mean number of gingival recessions treated in each patient was 4.1 (range 3 to 5). At 12 months evaluation, RH reduction, MRC, CRC were 2.72 ± 0.9 mm, 97%, 67%, respectively. Baseline KT was 1.76 ± 0.6 mm. A statistically significant KT increase (0.64 ± 0.6 mm) was observed after 1 year. The intra-group difference at 12 months was significant in terms of RH reduction, KT and attachment gain ($p<0.05$). They concluded that the modification of the flap design was effective for the treatment of multiple gingival recessions affecting the anterior teeth in patients with aesthetic demands, and these results were successful both in terms of root coverage and keratinized tissue width increase.

Zucchelli et al. (6) compared root coverage and esthetic outcomes of CAF with (control group) and without (test group) vertical releasing incisions in 32 patients with esthetic complaints due to the exposure of 92 maxillary Miller Class I & II multiple recession defects ≥1 mm. RH, KT, PD, CAL, patient satisfaction with esthetics were evaluated. Baseline RH in the test group was 2.59 ± 1.03 mm, whereas in the control group it was 2.55 ± 0.92 mm. The mean number of recessions treated in each patient was 2.92 (range 2 to 4) and 2.78 (range 2 to 4) in test and control groups, respectively. MRC and RH reduction in the test and control groups were 97.27% and 2.49 ± 0.93 mm; 92.64% and 2.33 ± 0.85 mm at 12 months evaluation, respectively. CRC was accomplished in 89.3% (42 out of 47) of the treated defects in the test and 77.7% (35 out of 45) of the defects in the control groups. CRC was achieved in 12 test (75%) and 7 control patients (43.7%). Baseline KT in the test group was 1.70 ± 0.50 mm, whereas in the control group it was 1.6 ± 0.49 mm. KT increase was 0.68 ± 0.51 mm and 0.44 ± 0.50 mm in the test and control groups at 12 months evaluation, respectively. Both CAF techniques were effective in reducing RH. The surgical time was significantly shorter in test group with no statistically significant difference between the two groups in terms of RH reduction and attachment gain. Keloid formation along the vertical releasing incisions was responsible for the worst esthetic evaluation made by an independent expert periodontist. Patient satisfaction with esthetics was very high in both treatment groups, with no statistically significant differences between them ($p>0.05$). They concluded that a statistically greater probability of CRC ($p<0.05$), greater KT increase, better postoperative course and esthetic results were observed in patients treated by the CAF without vertical releasing incisions.

2.3.10. Coronally Advanced Flap and Different Combinations For The Treatment of Multiple Recession Defects

Subepithelial connective tissue graft covered by CAF was considered effective and predictable technique for multiple defects (8-12), providing significantly greater degree of root coverage, GT increase and KT gain.

Cetiner et al. (12) evaluated the effectiveness and the predictability of expanded mesh connective tissue graft covered by CAF in the treatment of 10 patients with 52 multiple Miller Class I & II multiple recession defects ≥3 mm. Palatal graft was expanded to cover the recipient bed, which was 1.5 times larger than the graft. RH, KT, RW, PD, CAL were evaluated. Baseline RH was 3.11 ± 0.80 mm. Twelve months after the surgery, RH reduction and MRC were 3.0 ± 0.53 mm and 96.1%, respectively. CRC was achieved in 12 out of 15 treated sites (80%). Baseline KT was 3.93 ± 0.72 mm. A statistically significant KT increase (1.18 ± 0.35 mm) was observed after 12 months. The intra-group difference at 6 months was statistically significant in terms of RH and RW reduction, KT and attachment gain ($p<0.05$). They demonstrated that the expanded mesh connective tissue graft covered by CAF was an effective and highly predictable procedure for the treatment of multiple gingival recessions in terms of root coverage and KT increase.

Chambrone & Chambrone (11) evaluated the results obtained with subepithelial connective tissue graft covered by CAF for the treatment of 28 patients with 69 multiple Miller Class I or II multiple recession defects ≥3 mm. RH, KT, PD, CAL were evaluated. Baseline RH was 3.84 ± 1.50 mm. Six months after the surgery, RH reduction and MRC were 3.7 ± 1.27 mm and 96.35%, respectively. CRC was achieved in 20 of the 28 defects (71%). Baseline KT was 1.66 ± 1.09 mm. A statistically significant KT increase (2.16 ± 0.18 mm) was observed after 6 months. The intra-group difference at 6 months was statistically significant in terms of RH and RW reduction, KT and attachment gain ($p<0.05$). Patients with maxillary recessions revealed statistically superior outcomes than patients with mandibular recessions. They concluded that subepithelial connective tissue graft with CAF was an effective procedure to cover multiple gingival recessions, especially in defects localized in the maxillary arch.

Carvalho et al. (10) evaluated the effectiveness and the predictability of CAF without vertical releasing incisions in combination with subepithelial connective tissue graft procedure for the treatment of 10 non-smoking patients with 29 Miller Class I or II multiple recessions ≥1 mm. RH, KT, PD, CAL were evaluated. Baseline RH was 2.10 ± 0.82 mm. Six months after the surgery, RH reduction and MRC were 2.03 ± 0.78 mm and 96.7%, respectively. CRC of the defects was 93.1%. Nine of the 10 patients (90% of the patients) experienced CRC. Baseline KT was 2.34 ± 1.47 mm. KT increased to 1.31 ± 1.23 mm after 6 months. The intra-group difference at 6 months was statistically significant in terms of RH reduction, KT and attachment gain ($p<0.05$). They concluded that CAF without vertical releasing incisions in combination with subepithelial connective tissue graft was effective and predictable to produce root coverage of multiple defects associated with KT increase.

De Sanctis et al (8) evaluated CAF in combination with subepithelial connective tissue graft for the treatment of 10 patients with 26 Miller Class I or II multiple recessions ≥2 mm in the posterior mandibular area in a case series study. RH, KT, PD, CAL were evaluated. Baseline RH was 3.40 ± 0.83 mm. Twelve months after the surgery, RH reduction and MRC were 2.12 ± 0.50 mm and 91.2%, respectively. Greater RH reductions were observed in cases where the initial conditions were worse. CRC of the defects was 50%. One of the 10 patients (10% of the patients) experienced CRC. Baseline KT was 0.57 ± 0.46 mm. A statistically significant KT increase (2.52 ± 0.25 mm) was observed after 12 months. The intra-group difference at 12 months was statistically significant in terms of RH reduction, KT and attachment gain ($p<0.05$). They conluded that CAF in association with subepithelial connective tissue graft could be proposed as a valid therapeutic approach for multiple recession defects in mandibular posterior areas.

Long-term clinical outcomes of CAF plus subepithelial connective tissue graft (test group) and CAF alone (control group) were compared by Pini-Prato et al. (9) and evaluated in the treatment of 13 patients with 93 maxillary Miller Class I, II & III bilateral multiple recession defects. RH and CRC were evaluated. Baseline RH in the test group was 3.6 ± 1.3 mm, whereas in the control group it was 2.9 ± 1.3 mm. MRC and RH reduction in the test and control groups were 89.65% and 3.0 ± 1.3 mm; 83.33% and 2.6 ± 1.3 mm at 6 months evaluation, respectively. CRC was 34% of the treated cases in the test group and in 57% in the control group. There was no statistically significant difference between groups in terms of RH reduction and CRC at 6 months ($p>0.05$). At the 5-year follow-up, test group showed a higher percentage of sites with CRC (52%) than CAF alone group (35%) ($p=0.0239$). The marginal relapse was observed in the control group, while a coronal improvement of the margin was noted in the test group between the 6-month and the 5-year follow-up. They concluded that CAF in combination with subepithelial connective tissue graft provided better CRC than CAF alone in the treatment of multiple gingival recessions at the 5-year follow-up.

Aroca et al. (14) determined whether the addition of platelet-rich fibrin to a modified CAF (test group) would improve the clinical outcome compared to CAF alone (control group) for the treatment 20 patients with 67 Miller Class I & II multiple recession defects. After repositioning, CAF was stabilized at the contact points with horizontal suspensory sutures. RH, KT, GT, RW, PD, CAL were evaluated. Baseline RH was 2.9 ± 1.1 mm and 2.5 ± 0.9 mm in the test and control groups, respectively. RH reduction in the test and control groups were 2.3 ± 0.5 mm and 2.3 ± 0.5 mm at 6 months evaluation, respectively. MRC after 1 month were 81.0 ± 16.6% and 86.7 ± 16.6%, in the test and control groups, respectively. At 6 months, MRC decreased to 80.7 ± 14.7% and increased to 91.5 ± 11.4% in test and control groups, respectively. At 6 months, CRC of the defects was 52.2% in the test group, whereas this value was 74.6% in the control group. Baseline KT in the test group was 2.78 ± 1.08 mm, whereas in the control group it was 2.85 ± 1.23 mm. KT decreased 0.24 ± 0.23 mm and 0.48 ± 0.34 mm in test and control groups at 6 months evaluation, respectively. Baseline GT in the test group was 1.1 ± 0.4 mm, whereas in the control group it was 1.1 ± 0.3 mm. GT increased to 0.3 ± 0.1 mm and remained unchanged in test and control groups at 6 months evaluation, respectively. The difference between the groups at 6 months was statistically significant in terms of MRC, GT and attachment gain, and RW reduction ($p<0.05$). They concluded that modified CAF was a predictable treatment for multiple defects, whereas combination of a platelet-rich fibrin membrane positioned under the modified CAF did not provide an additional effect on the root coverage but did an additional GT increase compared to CAF alone at 6 months.

Ozcelik et al. (15) evaluated the effectiveness of CAF alone (control group) or in combination with orthodontic button application (test group) for the treatment of 41 patients with aesthetic demands, presenting 155 maxillary Miller Class I or II multiple gingival recessions ≥2 mm and GT ≥0.8 mm. RH, KT, GT, RW, PD, CAL were evaluated. The esthetic evaluation according to the root coverage esthetic score (RES) system and patient evaluation of post-operative discomfort and esthetics visual analog scale were also performed. Baseline RH was 4.3 ± 1.1 mm and 4.4 ± 1.1 mm in the test and control groups, respectively. RH reduction in the test and control groups were 3.89 ± 0.98 mm and 4.65 ± 0.99 mm at 6 months evaluation, respectively. At 6 months, MRC was 96.2% and 89.1%, in the test and control groups, respectively. CRC was 84.6% (66 of the 77 defects) in the test group, whereas this value was 61.0% (47 of the 78 defects) in the control group. Baseline KT in the test group was 2.4 ± 1.1 mm, whereas in the control group it was 2.4 ± 1.1 mm. KT increase was 0.66 ± 0.95 mm and 0.48 ± 0.97 mm in the test and control groups at 6 months evaluation, respectively. The difference between the groups at 6 months was statistically significant in terms of RH reduction, MRC, CRC, attachment gain, RES and patient satisfaction ($p<0.05$). They concluded that 6 months results revealed that the CAF + orthodontic button approach was effective for the treatment of multiple gingival recessions in patients with aesthetic demands.

Ozturan et al. (16) assessed the effectiveness of CAF alone (control group) or in combination with low intensity laser therapy application (test group) for the treatment of 10 patients with aesthetic demands, presenting 74 Miller Class I or II multiple gingival recessions. Diode laser (588 nm) was applied to the test sites before and immediately after surgery, and for 5 min. daily for 7 days post-operatively. RH, KT, PD, CAL were evaluated. Statistically significant differences were observed between test and control sites in terms of RH and RW reduction, KT and attachment gain after 1 year (p=0.014, p=0.015, p=0.009 and p=0.018, respectively). The test group presented greater CRC (n = 7.70%) compared with the control group (n = 3.30%) after treatment. They concluded that low intensity laser therapy might improve the predictability of CAF in multiple recessions.

Cordaro et al. (13) evaluated the effectiveness of CAF alone (control group) and enamel matrix proteins + CAF with vertical releasing incisions (test group) for the treatment of 10 patients with 58 maxillary Miller Class I & II multiple gingival recessions ≥2 mm at 6- and 24-month follow-up periods. RH, KT, PD, CAL were evaluated. Baseline RH was 3.12 ± 1.11 mm and 2.93 ± 0.83 mm in the test and control groups, respectively. RH reduction in the test and control groups was 2.50 ± 0.73 mm and 2.29 ± 0.62 mm, respectively at 6 months evaluation. MRC was 82.8 ± 14% and 80.7 ± 20%, in the test and control groups, respectively. CRC was 31% (9 of the 29 defects) in the test group, whereas this value was 45% (13 of the 29 defects) in the control group. After 24 months, RH reduction in the test and control groups was 2.31 ± 0.87 mm and 2.03 ± 0.69 mm at 24 months evaluation, respectively. MRC was 74.8% ± 16% and 71.0 ± 22%, in the test and control groups, respectively. CRC was 17% (5 of the 29 defects) in the test group, whereas 24% (7 of the 29 defects) in the control group. Baseline KT in the test group was 2.72 ± 0.61 mm, whereas in the control group it was 2.78 ± 0.65 mm. KT increase was 0.28 ± 0.41 mm and 0.31 ± 0.51 mm in the test and control groups at 6 months evaluation, respectively. At 24-months, KT increase from baseline was 0.41 ± 0.42 mm and 0.36 ± 0.44 mm in the test and control groups respectively. No statistically significant differences were found at any stage of the study in terms of MRC, CRC, RH reduction, KT and attachment gain, and PD change ($p>0.05$). They concluded that the use of enamel matrix proteins did not seem to significantly improve the results of the CAF procedure for root coverage in the treatment of multiple recessions.

2.4. Factors Affecting the Success of the Coronally Advanced Flap Therapy

Many factors have been reported that could influence the clinical outcomes of root coverage procedures and the variability of MRC and CRC. Patient related factors: smoking (122,128,184), poor oral hygiene, and traumatic toothbrushing (5)); surgery related factors: clinical experience (72), postsurgical marginal position (185), flap design (6,7,29,31,38,40), flap tension (186), root surface preparation techniques (72,111,187-190); site related factors: anatomical (89), defect configurations (4,72,163), papilla dimension (191), flap thickness and tissue biotype (6,72,192-194), the location of the tooth (72) demonstrated different levels of impact.

Silva et al. (128) evaluated the influence of cigarette smoking on the outcome of CAF procedure in 10 current smokers (≥10 cigarettes daily for at least 5 years, test group) and 10 non-smokers (never smoked, control group) with Miller Class I maxillary canine or bicuspids defects ≥2 mm. RH, KT, PD and CAL were evaluated. Baseline RH was 2.74 ± 0.28 mm and 2.54 ± 0.42 mm in the test and control groups, respectively. RH reduction in the test and control groups were 1.90 ± 0.45 mm and 2.32 ± 0.60 mm at 6 months evaluation, respectively. MRC was 69.3% and 91.3%, in the test and control groups, respectively. At 6 months, CRC was not obtained in any patient in the test group, whereas 50% of the patients revealed CRC in the control group. The achieved CRC was 50% less in the smokers ($p<0.05$). Baseline KT was 2.88 ± 0.90 mm and 2.78 ± 0.62 mm in the test and control groups, respectively. KT decrease was 0.72 ± 0.73 mm in the test group, whereas the value was increased to 0.14 ± 0.14 mm in the control group at 6 months. Intragroup analysis showed that CAF was able to reduce RH and improve clinical attachment level in both groups ($p<0.05$), whereas intergroup analysis demonstrated that smokers presented greater residual RH at 6 months and lower percentage of root coverage (69.3% versus 91.3%; $p<0.05$). They concluded that CAF provided benefits for both smokers and non-smokers in terms of root coverage of shallow Miller Class I defects, however, cigarette smoking negatively impacted the clinical outcomes, specifically residual RH, percentage of root coverage, and frequency of CRC.

Later on, Silva et al. (122) published the long-term results of the same study (129). RH significantly increased in test (0.44 ± 0.09 mm) and control groups (0.28 ± 0.12 mm) between 6 and 24 months. Also 50% of smokers and 10% of non-smokers lost between 0.5 and 1.0 mm of root coverage in the same period. At 24 months, MRC was 53.8% and 78.7% in the test and control groups, respectively. CRC was 20% in the control group. KT decrease was 0.16 ± 0.01 mm and 0.28 ± 0.05 mm in the test and control groups at the same period, respectively. Intragroup analysis showed that CAF at 6 and 24 months, failed to maintain the gingival margin at the initially achieved position. Intergroup analysis showed that smokers had significantly greater residual RH ($p=0.001$) at 24 months. Both smokers and non-smokers had attachment lost and experienced KT decreases. They concluded that the long-term stability of CAF outcomes was less than desirable, particularly in smokers. Two years after CAF procedure, smokers had significantly greater residual RH compared to non-smokers both statistically and clinically.

Pini Prato et al. (185) evaluated the influence of the post-surgical location of gingival margin relative to CEJ on RH reduction and CRC after CAF procedure. They treated 60 patients with Miller Class I maxillary defects ≥2 mm. RH, KT, PD, CAL, dental hypersensitivity, distance between the incisal margin and postoperative gingival margin were evaluated. Baseline RH was 3.18 ± 1.06 mm. Six months after the surgery, RH reduction and MRC were 2.86 ± 0.99 mm and 89.93%, respectively. CRC was 55%. Baseline KT was 2.74 ± 1.08 mm. KT decrease was 0.37 ± 0.55 mm after 6 months. The expected percentage of cases ending with CRC was about 17% if the flap margin was positioned at the cementoenamel junction level, while the probability of CRC approaches 100% when the margin is displaced to an extremely coronal location (2.5 mm) postsurgically. Baseline RH and the location of the margin after suturing were positively correlated to RH reduction; also seemed to affect CRC. They concluded that more coronal the level of the gingival margin after suturing, the greater the probability of CRC.

Pini-Prato et al. (186) evaluated the impact of flap tension on CAF procedure and compared RH reduction achieved in flaps with tension (test group) and without tension (control group) in the treatment of 11 patients with bilateral Miller Class I maxillary defects ≥2 mm 3 months after surgery. RH, KT, PD, CAL, flap tension were evaluated. Before suturing, the residual tension of both right and left flaps was measured with a dynamometer. In the test group, baseline RH was 2.82 ± 0.64 mm and mean tension was 6.5 g, while in the control group, the baseline RH was 2.68 ± 0.81 mm and mean tension was 0.4 g. Three months later, the test group showed RH reduction of 2.18 ± 0.60 mm, with MRC of 78 ± 15%, and CRC was achieved on 2 teeth (18%). In the control group the RH reduction was 2.32 ± 0.81 mm, with MRC of 87 ± 13%. CRC was obtained on 5 teeth (45%). The difference of recession reduction between the test and control groups was not statistically significant (p=0.3911). In the test group, linear regression analysis showed a statistically significant association between RH reduction and both RH at baseline (p=0.0001) and mean of the tensions recorded on the test side (p=0.0009). They concluded that minimal flap tension did not influence recession reduction after 3 months when shallow recessions were treated by CAF, also in the test group, the statistical analysis suggested that the higher the flap tension, the lower RH reduction was achieved.

Saletta et al. (191) evaluated the impact of the dimension of the interdental papilla as a prognostic factor for the clinical outcome of CAF in the treatment of 33 patients with localised Miller Class I recessions defects ≥2 mm. Baseline RH was 2.77 ± 0.76 mm. Three months after the surgery, RH reduction and MRC were 2.27 ± 0.20 mm and 83.72%, respectively. CRC was achieved in 13 of the 33 defects (39%). Baseline papilla height and area was 4.55 ± 0.89 mm and 12.34 ± 3.50 mm, respectively. Baseline KT was 2.95 ± 0.98 mm. KT increase (0.05 ± 0.01 mm) was observed after 3 months. MRC was not significantly correlated to the papilla area (p=0.3692) or to papilla height (p=0.0968). The CRC was not correlated to the papilla area (p=0.3181), but it was correlated to papilla height (p=0.0499). They concluded that the root coverage following CAF procedure was not significantly correlated to papilla dimension. However, CRC was significantly more frequent in sites with lower height of the adjacent papilla.

Pini-Prato et al. (187) evaluated the outcomes of root surface preparation techniques in terms of root surface polishing at slow speed with a rubber cup and prophylaxis paste for 60 seconds (test group) versus root planning with sharp curet (control group) used in combination with CAF for the treatment of 10 patients with bilateral localized Miller Class I or II maxillary recessions ≥2 mm. Baseline RH was 3.1 ± 1.1 mm and 2.9 ± 1.0 mm in the test and control groups, respectively. Three months after the surgery, the test group showed RH reduction of 2.6 ± 0.6 mm; with MRC of 89 ± 14%. In the control group, RH reduction was 2.3 ± 0.7 mm and MRC was 83 ± 16%. The difference between the test and control groups in terms of MRC was not statistically significant (p=0.1405), even though the test group showed slightly better clinical results in terms of root coverage. CRC was obtained on 5 teeth (50%) and on 4 teeth (40%) in the test and control groups, respectively. Baseline KT in the test group was 3.1 ± 1.3 mm, whereas in the control group it was 2.7 ± 1.2 mm. KT decrease was 0.7 ± 0.8 mm and 0.2 ± 1.1 mm in the test and control groups at 3 months evaluation, respectively. It was reported that mechanical instrumentation of the exposed root surfaces was not necessary when shallow recessions caused by traumatic toothbrushing are treated in patients with high levels of oral hygiene.

Later on, Pini-Prato et al. (108) reported the long-term results of the same study (187). Both groups showed similar outcomes in terms of RH reduction after 14 years. Residual RH was 0.9 ± 1.2 mm and 0.9 ± 0.9 mm in the test and control groups, respectively. CRC was quite stable over time in both groups. Five defects in the test and 3 defects in the control group, showed CRC at 14 years. On the other hand, one site in the control group showing CRC at 3 months developed a new recession at 14 years while 1 site in the test and 1 site in the control groups that showed a recession at 3 months developed a CRC at 14 years. The amount of KT decreased slightly over time in both sides. Considering the baseline KT, polishing seemed to be more indicated than root planing in cases of KT >3 mm, while root planing appears to be more appropriate with KT <3 mm. The authors reported that during the long-term follow-up period, gingival recession recurred in 39% of the treated sites following the CAF procedure.

Zucchelli et al. (111) evaluated the effectiveness of ultrasonic piezoelectric devices (test group) and hand instrumentation using curets (control group) for the treatment of root surfaces in combination with a CAF in the treatment of 11 subjects with bilateral Miller Class I localised recession ≥3 mm. Baseline RH was 3.82 ± 0.60 mm and 3.64 ± 0.80 mm in the test and the control groups, respectively. Six months after the surgery, the test group showed RH reduction of 3.18 ± 0.75 mm; with MRC of 84.2%. In the control group, RH reduction was 3.54 ± 0.82 mm and MRC was 95.4%. The difference between the test and control groups in terms of MRC was not statistically significant (p>0.05), even though the control group showed slightly better clinical results in terms of root coverage. CRC was obtained on 6 teeth (55%) and on 9 teeth (82%) in the test and control groups, respectively. Baseline KT in the test group was 1.72 ± 0.64 mm, whereas in the control group it was 1.63 ± 0.67 mm. KT increase was 0.36 ± 0.67 mm and 0.55 ± 1.1 mm in the test and control groups at 12 months evaluation, respectively. The study failed to demonstrate any superiority for hand instruments over ultrasonic treatment of the root surface in combination with CAF at 6 months after the surgery in terms of root coverage.

Huang et al (72) analyzed the factors that may affect the results of CAF procedure in 23 patients with localised Miller Class I recession defects ≥3 mm. RH, RW, KT, PD, CAL, GT were evaluated. Baseline RH, KT, and GT was 2.9 ± 0.4 mm (range 2.5 to 4); 2.7 ± 1.3 mm (range 1 to 5.8); 1.1 ± 0.3 mm (range 0.5 to 2), respectively. Six months after surgery, mean gain of these values was 2.4 ± 0.3 mm; 0.5 ± 0.4 mm and 0.4 ± 0.2 mm. MRC and CRC was 82.3 ± 24.7 % and 60.86%, respectively. From baseline to the 6-month follow-up, RH, RW, KT, GT, and CAL changes revealed a statistical significance (p<0.05). The 6-month post surgical RH reduction and root coverage was investigated by multiple regression analysis to explore the impact of specific factors: patient age, tooth location, initial GT, RH, RW, and the surgeon’s experience. The RH reduction was positively correlated to baseline RH and tooth location. Baseline GT ≥1.2 ± 0.3

mm was associated with CRC at the 6-month follow-up ($p<0.05$). They concluded that CAF was a predictable procedure to treat Miller Class I recession defects and initial gingival thickness was the most significant factor associated with CRC.

Flap thickness and tissue biotype had been reported as the important clinical factors, affecting the clinical outcomes of root coverage procedures (6,72,192-194). GT can be evaluated by direct measurements, probe transparency, ultrasonic devices, and cone-beam computed tomography. The tissue thickness was defined as thin, when gingival thickness <1.5 mm, and as thick one when having a gingival thickness ≥2 mm. It was suggested that gingival or periodontal diseases were more likely to occur in patients with a thin gingival biotype, injuries from inflammatory reactions or traumatic tooth brushing may easily produce gingival recessions (195,196). Although it has been admitted that a minimal amount of gingival tissue can be compatible with a healthy periodontal condition (197), the marginal gingival thickness is a critical determinant of future recession areas (198). In root coverage procedures, gingival thickness of 0.8-1.2 mm was associated with more predictable prognosis (72,192,194). Initial thickness was found to be the most significant factor and gingival thickness ≥1.2 mm was associated with CRC (72). It was reported that CAF alone were strongly associated with flap thickness. Also, GT ≥ 0.8 mm achieved CRC (192). The thickness <1 mm could harm the achievement of CRC (73). Also, it was concluded that flap margin thickness might have a greater influence on the final outcome than KT (26). These observations suggested that tissue biotype might be a significant factor influencing esthetic-treatment outcomes. For our best knowledge, there is no study evaluating ADM for the treatment of multiple recessions with thin tissue biotype. Therefore, the aim of this study was to evaluate the clinical effectiveness of ADM combination with CAF on complete defect coverage, esthetics and patient satisfaction compared to CAF alone for the treatment of Miller Class I & II multiple buccal recessions with GT < 0.8 mm.

3. MATERIAL AND METHODS

3.1. Study Population

The patients were selected from the pool of patients seeking treatment at Yeditepe University Faculty of Dentistry and Dental Hospital for gingival recession defects. All the risks and the benefits involved in the procedures were explained to the patients before they signed an informed consent form. The study population included 24 patients (12 females and 12 males) with Miller Class I & II multiple buccal gingival recession defects ≥3 mm.

The study was designed as a randomized, parallel and controlled clinical investigation. Patients were assigned to one of the two treatment groups using a computer-generated randomization table. Each patient in the study had at least two recession defects affecting adjacent teeth of the upper jaw. Twelve patients were treated by the combination of CAF with ADM as a test group (CAF+ADM), whereas the other 12 patients were treated by CAF alone (CAF).

3.2. Patient Selection

Patient inclusion criteria were as follows:

1) Miller Class I & II multiple buccal recession defects ≥ 3 mm on maxillary incisors, canines or premolars
2) PD <3 mm
3) Free of systemic complications and without a history of allergies
4) No use of antibiotics over the previous 3 months prior to treatment
5) Non-smoker
6) No pregnancy
7) Absence of endodontically treated teeth
8) Absence of bruxism and occlusal trauma
9) Absence of previous root coverage procedure

3.3. Study Design

Each patient received a comprehensive periodontal examination and evaluation of toothbrushing technique and habits. Presurgical preparation included detailed oral hygiene instructions, scaling and root planning under local anesthesia using ultrasonic devices[1] and Gracey curettes[2], and occlusal adjustment, if indicated. The patients were instructed to perform a non-traumatic brushing technique (roll) using an ultra soft toothbrush in combination with interdental flossing twice a day. Patients were revaluated 8 weeks after initial therapy and only the patients with PD and GI scores <1 were included (199). Individual acrylic occlusal stents were prepeared for the clinical measurements. Baseline full mouth periapical radiographs were taken to evaluate interproximal alveolar bone level to assist in gingival recession classification of teeth exhibiting recession defects. Preoperative intraoral photographs and clinical measurements were performed at baseline and 12 months after surgery. The study design was explained in Figure 1.

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[1] **Piezon® OEM built-in kit**, EMS, SWITZERLAND.
[2] **Gracey** SG ¾, $^{5}/_{6,}$ $^{7}/_{8,}$ **Mini-Five** SAS ¾, Hu-Friedy, USA.

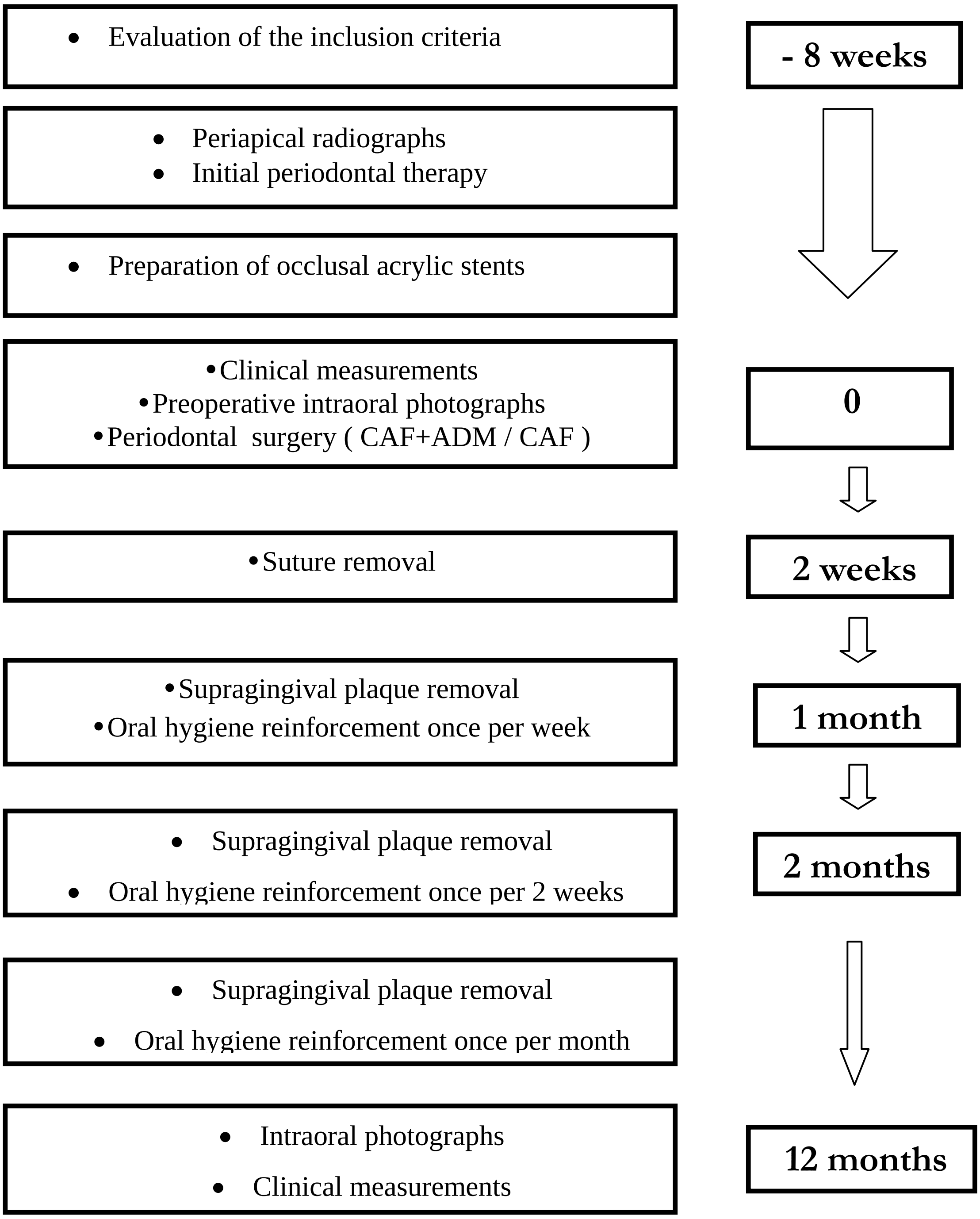


Figure 1. Study Design.

3.4. Clinical Parameters and Measurements

All measurements were performed at baseline and 12 months after surgery and recorded by the same calibrated examiner using a 0.4 mm diameter 15 mm calibrated periodontal probe[3]. Individually prepared acrylic occlusal stents were used and served as the constant points in order to align the probe properly and reduce the errors associated with probe placement at different time intervals. The occlusal stent was made to cover the occlusal surfaces of the all teeth being treated in maxilla. It was also extended apically on the buccal and lingual surfaces to cover the coronal third of the teeth. Six grooves were placed so that the postsurgical measurements could be made at the same position and angulation as those made prior to surgery.

The following indices and measurements were used:

3.4.1. Plaque Index

Teeth were isolated by cotton rolls and after drying by air syringe, the microbial dental plaque was evaluated by the explorer from 4 tooth surfaces (mesio-buccal, mid-buccal, disto-buccal and mid-palatinal) and scores between 0-3 were given for each point (200).

Scoring was made as follows:

0 – No microbial dental plaque in the gingival area

1 – A film of microbial dental plaque adhering to the free gingival margin and adjacent area of the tooth, recognized only by running a probe across the tooth surfaces.

2 – Moderate accumulation of soft deposits within the gingival pocket and on the gingival margin and/or adjacent tooth surfaces that can be seen by the naked eye.

[3] **PCP 15 UNC**, Hu-Friedy, USA.

3 – Abundance of soft matter within the gingival pocket and/or on the gingival margin and adjacent tooth surface.

3.4.2. Gingival Index

The periodontal probe was used to assess the bleeding potential of the tissues from 4 tooth surfaces (mesio-buccal papilla, mid-buccal margin, disto-buccal papilla and mid-palatinal margin) and scores between 0 - 3 were given for each point (201).

Scoring was made as follows:

0 – Normal gingiva

1 – Mild inflammation, slight change in color, slight edema; no bleeding on probing (BoP)

2 – Moderate inflammation, redness, edema, and glazing; bleeding on probing

3 – Severe inflammation, marked redness and edema, ulcerations; tendency to spontaneous bleeding.

3.4.3. Bleeding on Probing

The periodontal probe was used to assess bleeding after probing from 4 tooth surfaces (mesio-buccal papilla, mid-buccal margin, disto-buccal papilla and mid- palatinal margin) and scored as positive (+) or negative (-) bleeding for each point (202).

3.4.4. Probing Depth

PD of the recession defect was measured by the periodontal probe at the mid buccal surface of the related tooth as the distance between the gingival margin and the bottom of the gingival sulcus (Figure 2).

3.4.5. Clinical Attachment Level

CAL of the recession defect was measured by the periodontal probe at the mid-buccal surface of the related tooth and it was defined as the distance between the cemento-enamel junction and the bottom of the gingival sulcus (Figure 2).

3.4.6. Recession Height

RH was measured by the periodontal probe at the mid-buccal surface of the related tooth as the distance between the cemento-enamel junction and the most apical point of the gingival margin (Figure 2).

3.4.7. Recession Width

RW of the defect was measured by the periodontal probe as the horizontal distance from one border of the recession to another in mesio-distal direction at the level of the cemento-enamel junction (Figure 2).

3.4.8. Keratinized Tissue Height

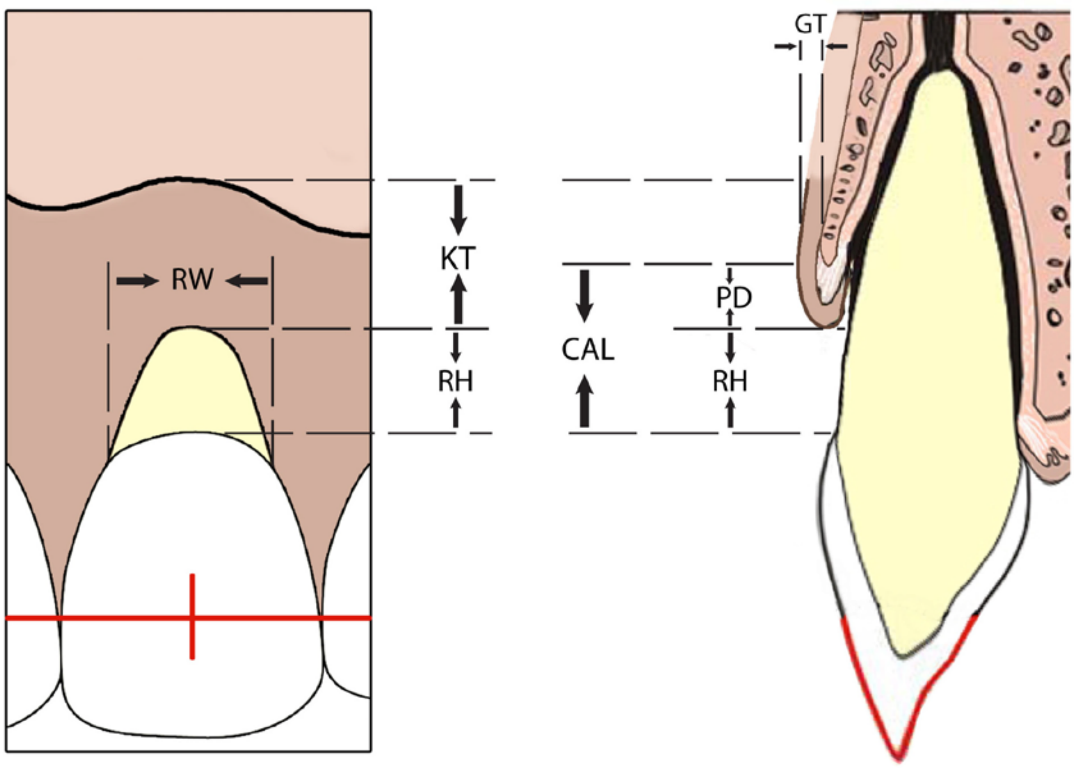
KT of the recession defect was measured by the periodontal probe at the same point as the probing depth, clinical attachment level and RH (Figure 2).

3.4.9. Gingival Thickness

GT was measured at the mid-point location between the gingival margin and mucogingival junction (Figure 2), using an #25 endodontic spreader[4] (Figure 3). Under the local anesthesia, the spreader was pierced perpendiculary to the mucosal surface, through the soft tissue with light pressure until hard surface was felt. The silicone disk stop was placed in tight contact with the external soft tissue surface. After carefully removing the spreader, penetration depth was measured with a digital caliper[5] with 0.05 resolution (28) (Figure 4).

All measurements were recorded in the personal data sheets prepared for the research (Figure 5, 6).

[4] **Endodontic Spreader #25 25 mm,** MANI, JAPAN.
[5] **Stainless Steel Digital Caliper 75 mm,** SHAN, CHINA.



PD	Probing Depth
CAL	Clinical Attachment Level
RH	Recession Height
RW	Recession Width
KT	Keratinized Tissue Height
GT	Gingival Thickness

Figure 2. Schematic drawing representing clinical indices and measurements.

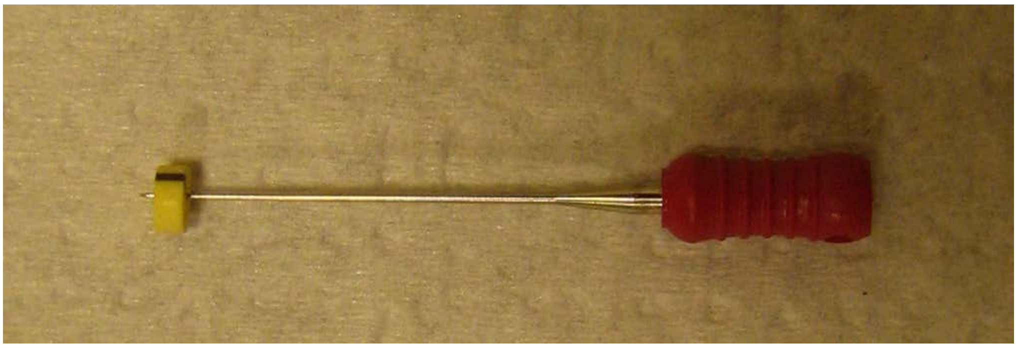
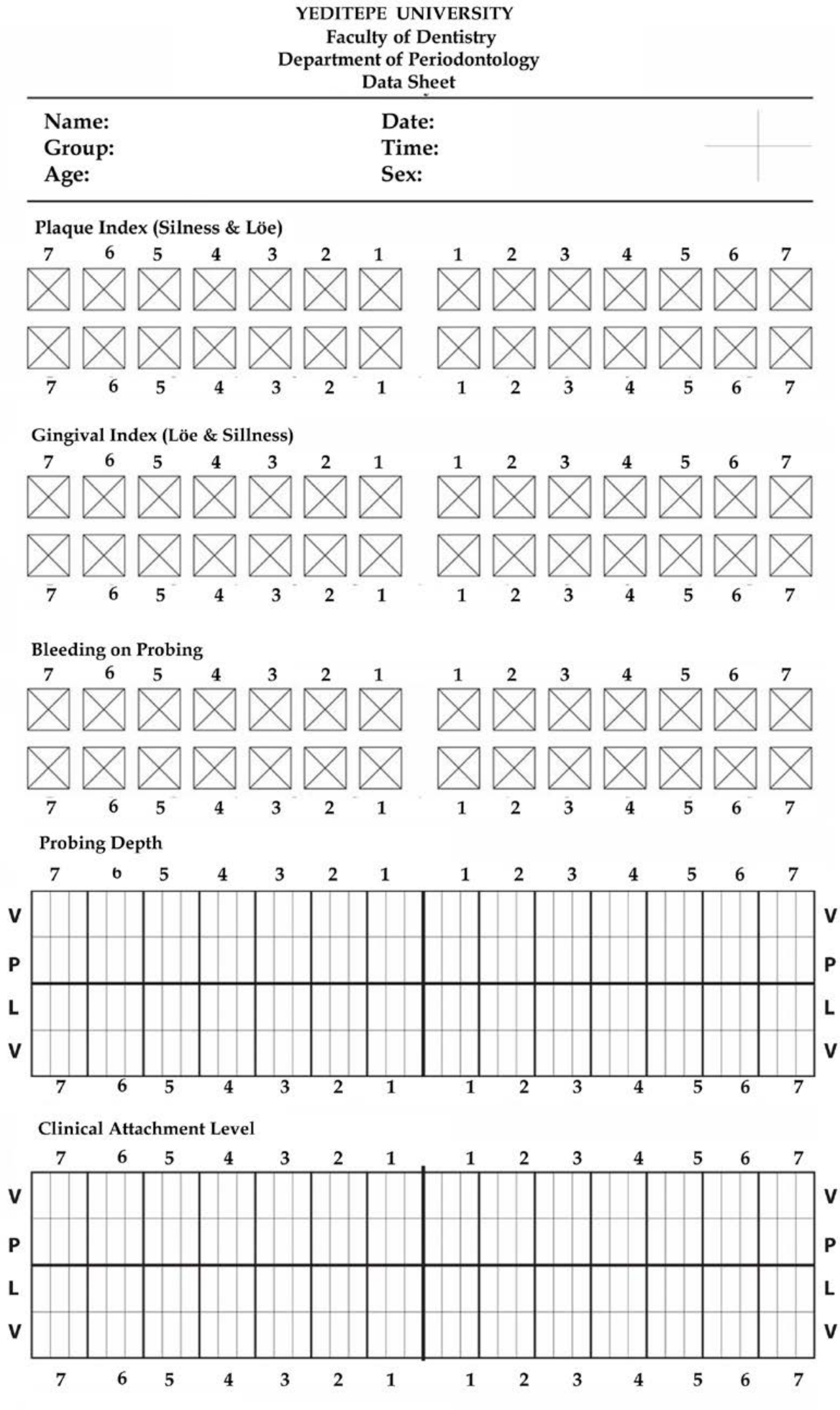


Figure 3. Endodontic Spreader.

Figure 4. Digital Caliper.



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Data Sheet

Name: Date:
Group: Time:
Age: Sex:

Plaque Index (Silness & Löe)

7 6 5 4 3 2 1 1 2 3 4 5 6 7

7 6 5 4 3 2 1 1 2 3 4 5 6 7

Gingival Index (Löe & Sillness)

7 6 5 4 3 2 1 1 2 3 4 5 6 7

7 6 5 4 3 2 1 1 2 3 4 5 6 7

Bleeding on Probing

7 6 5 4 3 2 1 1 2 3 4 5 6 7

7 6 5 4 3 2 1 1 2 3 4 5 6 7

Probing Depth

7 6 5 4 3 2 1 1 2 3 4 5 6 7

V P L V

7 6 5 4 3 2 1 1 2 3 4 5 6 7

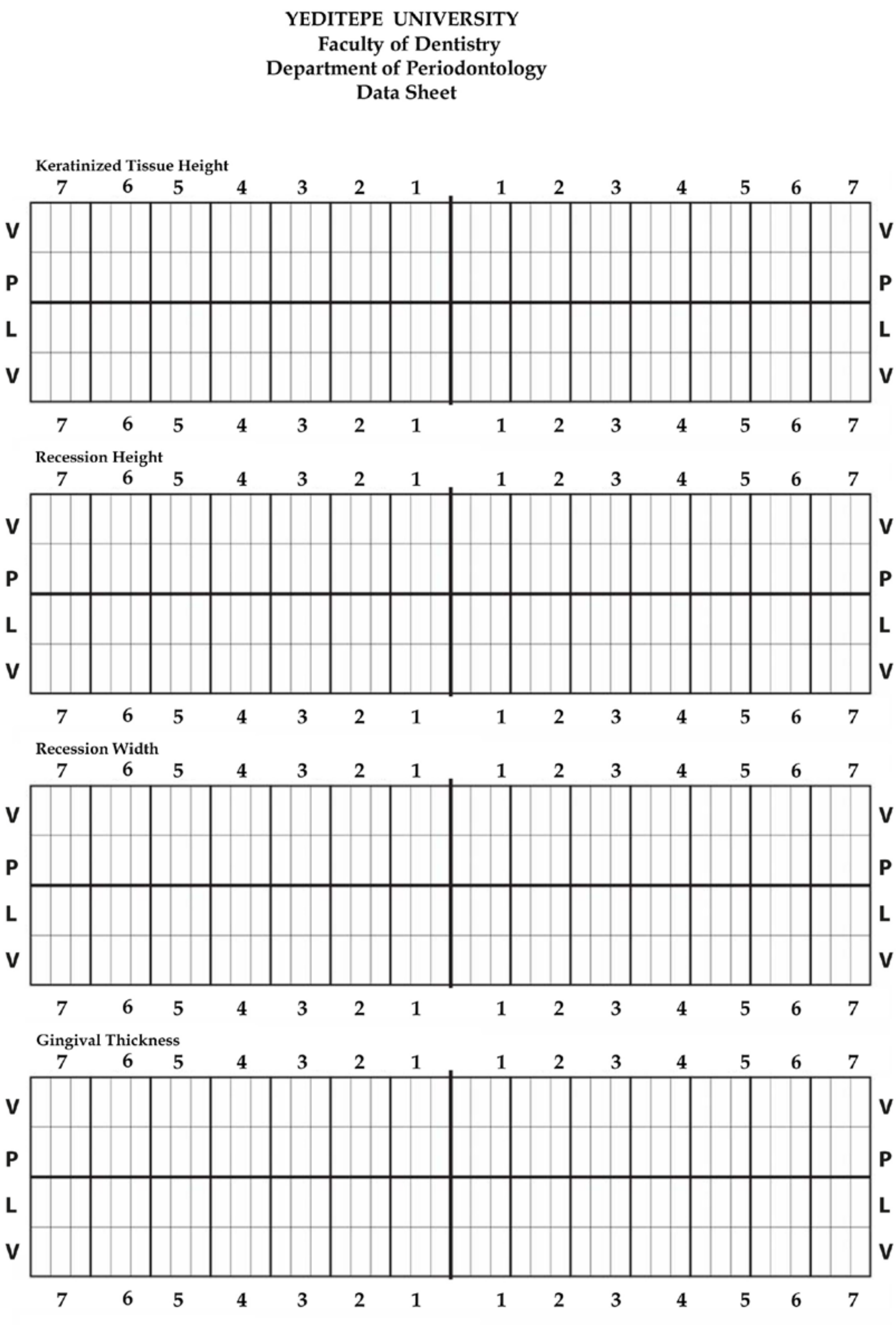
Clinical Attachment Level

7 6 5 4 3 2 1 1 2 3 4 5 6 7

V P L V

7 6 5 4 3 2 1 1 2 3 4 5 6 7

Figure 5. Data Sheet I.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Data Sheet

Keratinized Tissue Height

7 6 5 4 3 2 1 1 2 3 4 5 6 7

V P L V | V P L V

7 6 5 4 3 2 1 1 2 3 4 5 6 7

Recession Height

7 6 5 4 3 2 1 1 2 3 4 5 6 7

V P L V | V P L V

7 6 5 4 3 2 1 1 2 3 4 5 6 7

Recession Width

7 6 5 4 3 2 1 1 2 3 4 5 6 7

V P L V | V P L V

7 6 5 4 3 2 1 1 2 3 4 5 6 7

Gingival Thickness

7 6 5 4 3 2 1 1 2 3 4 5 6 7

V P L V | V P L V

7 6 5 4 3 2 1 1 2 3 4 5 6 7

Figure 6. Data Sheet II.

3.4.10. Defect Coverage

Mean defect coverage percentage was calculated as follows:
$[(RH_{baseline} - RH_{12\ months})/RH_{baseline}] \times 100\%$.

Complete defect coverage was calculated as the percentage of patients with defects having complete coverage achieved as the gingival margin at cemento-enamel junction or coronal level.

3.4.11. Patient Satisfaction Score

Each patient was questioned about his/her satisfaction with regard to the folowing patient-centered criteria:

Root coverage attained, relief from dentinal hypersensitivity, color of gums, shape and contour of gums, surgical procedure in terms of pain during surgery and the discomfort experienced related to the duration of the procedure and handling by the operatör, post surgical phase in terms of the pain, swelling, and postoperative complications; and cost effectiveness in terms of the time and money spent for the treatment (39).

Patient satisfaction was assesed using a three-point rating scale: fully satisfied (3 points); satisfied (2 points); and unsatisfied (1 point).

3.4.12. Root Coverage Esthetic Score

Root coverage esthetic score **(**RES) was used as a scoring system to assess the esthetic outcomes following root coverage procedures on Miller Class I & II gingival recession defects through the
evaluation of clinical cases. Gingival margin level**,** marginal tissue contour**,** soft tissue texture**,** mucogingival junction alignment and gingival color were evaluated without magnification (203). Zero, 3 and 6 points were used for the evaluation of the position of the gingival margin, whereas a score 0 or 1 point was used for each of the other variables (Table 1).

The ideal score was 10 points. If the final position of gingival margin was equal or apical to the previous recession depth (failure of root coverage procedure), irrespective of color, the presence of scar, marginal tissue contour, or mucogingival junction, or a partial or total loss of interproximal papilla (black triangle) occurred following the treatment, 0 points was assigned.

Table 1. RES variables and definitions.

Gingival Margin Level	**0**	Failure of root coverage (Gingival margin apical or equal to the baseline recession)
	3	Partial root coverage
	6	CRC
Marginal Tissue Contour	**0**	Irregular gingival margin (does not follow cemento-enamel junction)
	1	Proper marginal contour/scalloped gingival margin (follows cemento-enamel junction)
Soft Tissue Texture	**0**	Scar formation and/or kelloid like appereance
	1	Absence of scar or kelloid formation
Mucogingival Junction Alignment	**0**	Mucogingival junction not aligned with the junction of adjacent teeth
	1	Mucogingival junction aligned with the junction of adjacent teeth
Gingival Color	**0**	Color of tissues varies from gingival colours at adjacent teeth
	1	Normal color and integration with the adjacent soft tissues

3.5. Acellular Dermal Matrix Graft Preparation Protocol

When preparing to use the ADM[6] (Figure 7) before surgery, the rehydration procedure should begin early enough to allow for adequate rehydration prior to application. Two dishes were used for the rehydration procedure. The allograft was placed with the attached backing in the first dish in the sterile field (Figure 8). Then the dish was filled with at least 50 ml of saline to submerge and soak the allograft for 5 minutes. Next, the allograft was aseptically transferred to the second dish, which was filled with 50 ml saline, submerged completely, and allowed to soak for five minutes. Then the material was removed and used for the procedure (Figure 9).

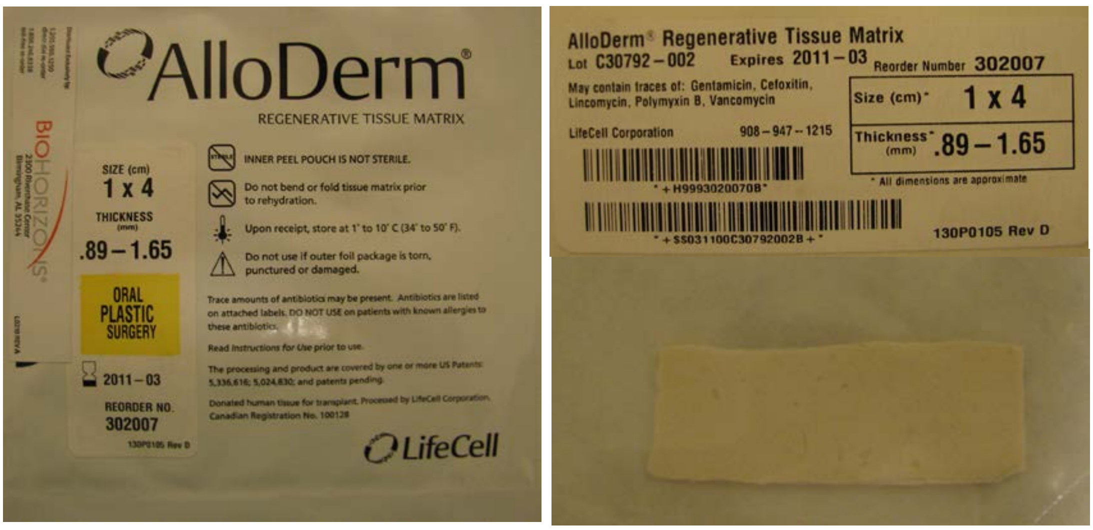

Figure 7. ADM graft.

[6] **AlloDerm® Regenerative Tissue Matrix**, BioHorizons, USA.

Figure 8. ADM rehydration procedure.

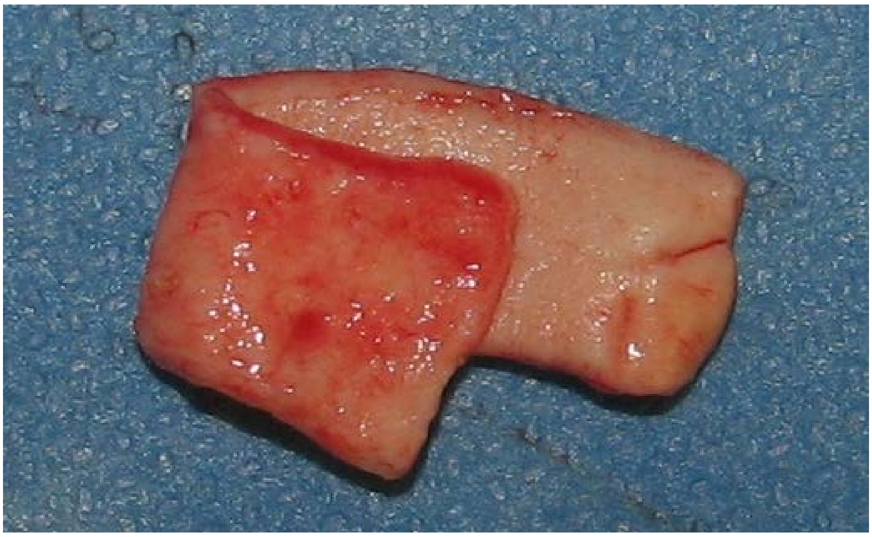

Figure 9. Fully rehydrated ADM. After both sides are saturated with blood, basement side does not retain blood, whereas the connective tissue side remains red.

3.6. Surgical Procedure

All treatment procedures were performed by the same operator. After the local anesthesia[7], an intra-sulcular incision using 15C blade[8] was made at the buccal aspect of the involved teeth being treated. Horizontal incisions were made at the level of cementoenamel junction of the interdental papillae, without interfering with the gingival margin of the neighboring teeth. Two vertical incisions were extended at the distal ends of the horizontal incisions across the mucogingival line reaching the alveolar mucosa. A split-full-split thickness flap was elevated to expose at least 3 mm of the marginal bone apical to the dehiscence area. Releasing incisions was made to allow for a tension-free coronal repositioning of the flap. Papillas were deepithelialized for better vascularization of the tissue bed. The exposed root surface was thoroughly planed by hand instruments to obtain a smooth and hard surface and washed with saline solution. Then the surfaces were conditioned with EDTA 24%, pH 6,7[9] for 2 minutes to remove the smear layer. Afterwards, surfaces were thoroughly rinsed with saline and kept free of saliva. In CAF +ADM group, the ADM was adapted to cover the root surface to the level of cementoenamel junction. The lateral borders were extended at least 3 mm beyond the ossesous dehiscence margins. The basement membrane side was placed adjacent to bone and tooth, and the connective tissue side was placed facing the flap (Figure 9). ADM was sutured using double sling suture technique with 5–0 resorbable polyglyconate monofilament sutures.[10] The flap was coronally positioned at the level of coronal to cementoenamel junction and sutured to completely cover the ADM using double sling suture technique with 5–0 non-resorbable polypropylene monofilament sutures.[11] The releasing incisions were closed with interrupted sutures. Gentle pressure was applied to achieve hemostasis and a close adaptation of the flap to the underlying surface. No surgical dressing was used. In CAF group, the surgical procedures were identical except for the placement of the graft. The surgical procedures were

[7] **Ultracain DS Fort 2 ml** , Aventis Pharma Turkey, TURKEY.
[8] **Scalpel Blade 15C,** KLS Martin Group, GERMANY.
[9] **PrefGel 0.6 ml gel,** Straumann®, SWITZERLAND.
[10] **Coated Vicryl 5-0 sutures, Ethicon,** Johnson&Johnson, USA.
[11] **Prolene 5-0 sutures, Ethicon,** Johnson&Johnson, USA.

documented with clinical photographs. During the surgery, microsurgical instruments[12] were used (Figure 10).

Figure 10. Microsurgical instruments.

3.7. Post-Surgical Medication and Care

Post surgical care was directed to the maintenance of wound stability, pain and infection control. Patients were given written and oral postoperative instructions, which outlined home care and dosing of medications. The patients received postoperative systemic antibiotic therapy for a period of 5 days (2x1000 mg amoxicillin clavulanate/day)[13]. Oral analgesics (naproxen sodium 550 mg tablets every 8 hours as necessary)[14] were also prescribed. In addition, all patients

[12] **Microsurgical Instruments,** Kohler**,** GERMANY.
[13] **Augmentin BID 1000 mg**; GlaxoSmithKline Pharmaceuticals Turkey, TURKEY.
[14] **Apranax Forte Tablets 550 mg**; Abdi Ibrahim, TURKEY.

were advised to avoid hard chewing in the surgical areas and to rinse twice daily with a 0,12% solution of chlorhexidine digluconate[15] for 4 weeks .

After a healing period of 2 weeks, sutures were removed. All patients were allowed to initiate mechanical plaque control using an ultra soft toothbrush and a roll technique 4 weeks after the operation. The patients were recalled for a supragingival plaque removal and oral hygiene reinforcement once a week during first month, twice per month until the third month, and once a month until the end of the study. During the 12-month follow-up period, neither subgingival instrumentation nor probing of the operated areas was performed. At the end of the 12-month evaluation period, the same clinical measurements were obtained.

3.8. Data Analysis

The statistical analysis was performed using statistical package.16 For all statistical evaluations the patient was maintained as the unit of measurement. All the parameters were measured at baseline and 12 months after the surgery. Data analysis was done for full mouth for PI, GI and BoP, whereas defect site measurements were used for PD, CAL, RH, GT and KT. The balancing of groups by age and gender was tested by Student's t-test and Chi-square test, respectively. Quantitative data was recorded as the mean value ± standard deviation. Parameters with normal distribution for the comparison of quantitative data were evaluated using Student's t-test and Paired Sample t test, whereas parameters, which did not have a normal distribution, were evaluated using Mann Whitney U-test and Wilcoxon sign test. The Paired Sample t and Wilcoxon sign tests were used to evaluate the intragroup differences, whereas the Student's t and Mann-Whitney U tests were used to evaluate the intergroup differences. Power analysis indicated that with minimum 9 patients in each group, the study would have 80% statistical power to detect a difference of 1 mm defect coverage between the groups (a:0.05) (26,97). The correlation between tissue thickness and defect

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[15] **Klorhex Oral Rinse % 0,2;** Drogsan Pharmaceuticals, TURKEY.
[16] **NCSS 2007&PASS 2008** Statistical Software, USA.

coverage was evaluted by the Spearman's rho test. The value of $p<0.05$ was considered as the level of significance.

4. RESULTS

4.1. Demographic Results / Recession Location

Twenty four patients aged between 22-40 years (mean age of 29.20 ± 5.03) with 48 Miller I & II buccal gingival recession defects ≥3 mm fulfilling the selection criteria were included in this study. The recessions were located in 17 incisors, 13 cuspids and 18 bicuspids. Age and gender of the patients, and recession location are presented in Tables 2 & 3, respectively.

Table 2. Age and gender distribution of the patients.

		CAF + ADM	**CAF**	***p***
Age		28.67 ± 4.35	29.75 ± 5.77	0.609 [+]
Gender	**Male**	5 (% 41.7)	7 (% 58.3)	0.414 [++]
	Female	7 (% 58.3)	5 (% 41.7)	

[+] Student's t-test, [++] Chi-square test, $p<0.05$

Table 3. Location of the recession defects.

CAF + ADM	**Incisors**	**Cuspids**	**Bicuspids**
	9	7	8
CAF	**Incisors**	**Cuspids**	**Bicuspids**
	8	6	10

4.2. Clinical Results

Healing was uneventful in all patients and none was excluded from the study. Intraoral pictures of one representative case from each group are documented in Figures 11 a-h and 12 a-g.

4.2.1. Baseline Parameters

Baseline paremeters were similar in both groups ($p>0.05$) (Table 4).

Table 4. Comparison of baseline parameters of CAF + ADM and CAF groups.

	CAF + ADM	**CAF**	***p***
PI	0.48 ± 0.11	0.49 ± 0.07	0.864^{+}
GI	0.50 ± 0.08	0.51 ± 0.09	0.945^{+}
BoP (%)	8.83 ± 1.27	8.91 ± 1.44	0.882^{+}
PD (mm)	1.17 ± 0.24	1.14 ± 0.22	0.889^{++}
CAL (mm)	4.41 ± 0.42	4.35 ± 0.34	0.757^{++}
RH (mm)	3.25 ± 0.34	3.21 ± 0.26	0.868^{++}
RW (mm)	3.46 ± 0.50	3.33 ± 0.49	0.376^{++}
GT (mm)	0.75 ± 0.06	0.71 ± 0.08	0.198^{++}
KT (mm)	2.48 ± 0.50	2.58 ± 0.71	0.683^{+}

$^{+}$ Student's t-test, $^{++}$ Mann Whitney U test, $p<0.05$

4.2.2. Plaque Index

The mean values and standard deviations of PI scores at baseline and after 12 months, and intra-group comparisons are presented in Table 5. Intra-group comparisons revealed statistically significant differences in plaque index values in both groups at 12 months ($p<0.05$).

Table 5. Mean values and standard deviations of PI at baseline and 12 months after treatment, and intra-group comparisons.

		CAF+ADM	**CAF**
PI	**Baseline**	0.48 ± 0.11	0.49 ± 0.07
	12 months	0.42 ± 0.09	0.41 ± 0.07
	$^{+}$***p***	**0.001**	**0.001**

$^{+}$Paired Sample t-test, $p<0.05$

4.2.3. Gingival Index

The mean values and standard deviations of GI scores at baseline and after 12 months, and intra-group comparisons are presented in Table 6. Intra-group comparisons revealed statistically significant differences in GI values in both groups at 12 months ($p<0.05$).

Table 6. Mean values and standard deviations of GI at baseline and 12 months after treatment, and intra-group comparisons.

		CAF+ADM	**CAF**
GI	**Baseline**	0.50 ± 0.08	0.51 ± 0.09
	12 months	0.45 ± 0.08	0.46 ± 0.08
	$^{+}$***p***	**0.002**	**0.001**

$^{+}$Paired Sample t-test, $p<0.05$

4.2.4. Bleeding on Probing

The mean values and standard deviations of BoP scores at baseline and after 12 months, and intra-group comparisons are presented in Table 7. Intra-group comparisons revealed statistically significant differences in BoP values in both groups at 12 months (p<0.05).

Table 7. Mean values and standard deviations of BoP at baseline and 12 months after treatment, and intra-group comparisons.

		CAF+ADM	CAF
BoP (%)	**Baseline**	8.83 ± 1.27	8.91 ± 1.44
	12 months	7.91 ± 1.44	7.87 ± 1.65
	$^{+}$***p***	**0.002**	**0.001**

$^{+}$Paired Sample t-test, p<0.05

4.2.5. Probing Depth

The mean values and standard deviations of PD scores at baseline and after 12 months, and intra-group comparisons are presented in Table 8. There was a statistically significant increase in PD scores in both groups at 12 months (p<0.05).

Table 8. Mean values and standard deviations of PD at baseline and 12 months after treatment, and intra-group comparisons.

		CAF+ADM	CAF
PD (mm)	**Baseline**	1.17 ± 0.24	1.14 ± 0.22
	12 months	1.50 ± 0.42	1.35 ± 0.22
	$^{++}$***p***	**0.011**	**0.025**

$^{++}$Wilcoxon sign test, p<0.05

4.2.6. Clinical Attachment Level

The mean values and standard deviations of CAL scores at baseline and after 12 months, and intra-group comparisons are presented in Table 9. There was a statistically significant decrease in CAL scores, revealing attachment gain, in both groups at 12 months ($p<0.05$).

Table 9. Mean values and standard deviations of CAL measurement at baseline and 12 months after treatment, and intra-group comparisons.

		CAF+ADM	CAF
CAL (mm)	**Baseline**	4.41 ± 0.42	4.35 ± 0.34
	12 months	1.67 ± 0.65	2.18 ± 0.86
	$^{++}$***p***	**0.002**	**0.002**

$^{++}$Wilcoxon sign test, $p<0.05$

4.2.7. Recession Height

The mean values and standard deviations of RH scores at baseline and after 12 months, and intra-group comparisons are presented in Table 10. RH reduction was statistically significant in both groups at 12 months ($p<0.05$). In the CAF+ADM group baseline RH was 3.25 ± 0.34 mm. This value reduced to 0.17 ± 0.39. In the CAF group baseline RH was 3.21 ± 0.26 mm, which reduced to 0.83 ± 0.94.

Table 10. Mean values and standard deviations of RH measurement at baseline and 12 months after treatment, and intra-group comparisons.

		CAF+ADM	CAF
RH (mm)	**Baseline**	3.25 ± 0.34	3.21 ± 0.26
	12 months	0.17 ± 0.39	0.83 ± 0.94
	$^{++}$***p***	**0.002**	**0.002**

$^{++}$Wilcoxon sign test , $p<0.05$

4.2.8. Keratinized Tissue Height

The mean values and standard deviations of KT scores at baseline and after 12 months, and intra-group comparisons are presented in Table 11. KT increased significantly at 12 months in both groups ($p<0.05$).

Table 11. Mean values and standard deviations of KT measurements at baseline and 12 months after treatment, and intra-group comparisons.

		CAF+ADM	CAF
KT (mm)	**Baseline**	2.48 ± 0.50	2.58 ± 0.71
	12 months	3.69 ± 0.54	3.19 ± 0.92
	$^{+}$***p***	**0.001**	**0.001**

$^{+}$Paired Sample t-test, $p<0.05$

4.2.9. Gingival Thickness

The mean values and standard deviations of GT scores at baseline and after 12 months, and intra-group comparisons are presented in Table 12. GT increased significantly at 12 months in both groups ($p<0.05$). In the CAF+ADM group baseline GT was 0.75 ± 0.06 mm. This value increased to 1.41 ± 0.11 at 12 months. In the CAF group baseline GT was 0.71 ± 0.08 mm, which increased to 0.77 ± 0.09 at 12 months.

Table 12. Mean values and standard deviations of GT measurements of the recession defect at baseline and 12 months after treatment, and intra-group comparisons.

		CAF+ADM	CAF
GT (mm)	**Baseline**	0.75 ± 0.06	0.71 ± 0.08
	12 months	1.41 ± 0.11	0.77 ± 0.09
	$^{+}$***p***	**0.002**	**0.005**

$^{+}$Paired Sample t-test, $p<0.05$

4.2.10. Inter-group Comparisons of Clinical Parameters

Inter-group comparisons of all measurements are presented in Table 13. Inter-group differences were found to be statistically significant for RH reduction, attachment, KT and GT gain ($p<0.05$), and insignificant for PI, GI, BoP, PD change ($p>0.05$).

Table 13. Inter-group comparisons of all measurements at 12 months after treatment.

	CAF+ADM	CAF	+*p*
PI	0.06 ± 0.05	0.08 ± 0.04	0.271
GI	0.06 ± 0.03	0.05 ± 0.02	0.815
BoP (%)	0.92 ± 0.99	1.04 ± 0.75	0.564
PD Change (mm)	-0.33 ± 0.32	-0.21 ± 0.25	0.343
Attachment Gain (mm)	2.75 ± 0.54	2.17 ± 0.81	**0.049**
RH Reduction (mm)	3.08 ± 0.51	2.37 ± 0.83	**0.030**
GT Gain (mm)	0.69 ± 0.10	0.07 ± 0.04	**0.001**
KT Gain (mm)	1.21 ± 0.23	0.60 ± 0.36	**0.001**

+Mann Whitney U test, $p<0.05$

4.2.11 Defect Coverage

Mean, complete and frequency of defect coverage in both groups are presented in Tables 14-18. Mean and complete defect coverage were 94.84 % and 83.33 % in CAF+ADM group, whereas these values were 74.99 % and 50.00 % in CAF group, respectively. Inter-group comparisons revealed statistically significant differences for mean defect coverage in favor of CAF+ADM group ($p<0.05$).

Table 14. Mean and complete defect coverage percentage in CAF+ADM group.

Patient (n)	**RH** Baseline (mean, mm)	**RH** 12 months (mean, mm)	**Difference** (mm)	**Mean Defect Coverage** (%)	**Complete Defect Coverage** (%)
1	3.00	0.00	3.00	**100**	+
2	3.00	0.00	3.00	**100**	+
3	3.00	1.00	2.00	**66.67**	**-**
4	3.50	0.00	3.50	**100**	+
5	4.00	0.00	4.00	**100**	+
6	3.00	0.00	3.00	**100**	+
7	3.00	0.00	3.00	**100**	+
8	3.50	1.00	2.50	**71.43**	**-**
9	3.50	0.00	3.50	**100**	+
10	3.50	0.00	3.50	**100**	+
11	3.00	0.00	3.00	**100**	+
12	3.00	0.00	3.00	**100**	+
	3.25 ± 0.34	**0.17 ± 0.39**	**3.08 ± 0.51**	**94.84 ± 12.09**	**83.33**

Table 15. Mean and complete defect coverage percentage in CAF group.

Patient (n)	**RH** Baseline (mean, mm)	**RH** 12 months (mean, mm)	**Difference** (mm)	**Mean Defect Coverage** (%)	**Complete Defect Coverage** (%)
1	3.00	1.00	2.00	**66.67**	**-**
2	3.00	0.00	3.00	**100**	+
3	3.00	0.00	3.00	**100**	+
4	3.50	1.00	2.50	**71.42**	**-**
5	3.00	0.00	3.00	**100**	+
6	3.50	2.00	1.50	**42.85**	**-**
7	3.50	0.00	3.50	**100**	+
8	3.00	0.00	3.00	**100**	+
9	3.50	2.00	1.50	**42.85**	**-**
10	3.00	2.00	1.00	**33.33**	**-**
11	3.50	2.00	1.50	**42.85**	**-**
12	3.00	0.00	3.00	**100**	+
	3.21 ± 0.26	**0.83 ± 0.94**	**2.37 ± 0.83**	**74.99 ± 28.07**	**50.00**

Tablo 16. Inter-group comparison of mean defect coverage.

	Mean Defect Coverage (%)	$^{+}\boldsymbol{p}$
CAF+ADM	94.84 ± 12.09	**0.049**
CAF	74.99 ± 28.07	

$^{+}$Mann Whitney U test, , $p<0.05$

Tablo 17. Inter-group comparison of complete defect coverage.

	Complete Defect Coverage (%)		$^{++}$***p***
CAF+ADM	10 (12)	83.33	0.193
CAF	6 (12)	50.00	

$^{++}$Chi-square test, $p<0.05$

Table 18. Frequency of defect coverage.

	100 %	**50-99 %**	**0-49 %**
CAF +ADM	10	2	0
CAF	6	2	4

4.2.12 Patient Satisfaction Score

Detailed information related to the patient satisfaction score in CAF+ADM and CAF groups and the results of comparisons are presented in Tables 19 & 20.

Table 19. Number of patients related to the patient satisfaction evaluation in CAF+ADM and CAF groups.

Patient centered outcome (Points)	CAF+ADM Patient (n): 12			CAF Patient (n): 12		
	Fully satisfied	Satisfied	Unsatisfied	Fully satisfied	Satisfied	Unsatisfied
Root coverage	10	2	0	3	6	3
Dentin hypersensitivity	11	1	0	3	5	4
Gum color	11	1	0	10	2	0
Gum shape and contour	10	2	0	4	5	3
Surgical procedure	5	7	0	9	3	0
Post surgical phase	5	7	0	8	4	0
Cost effectiveness	6	6	0	12	0	0

Table 20. Inter-group comparison of patient satisfaction scores.

	Patient Satisfaction Score	^{+}p
CAF+ADM	18.83 ± 1.75	0.174
CAF	17.33 ± 3.25	

$^{+}$Student's t-test, $p<0.05$

Intergroup comparisons revealed that overall patient satisfaction was similar in both groups (p>0.05). Patients rated both treatments equally in all aspects, except the comfort during and after the surgical procedure and the cost effectiveness in CAF+ADM group.

4.2.13. Root Coverage Esthetic Score

The results of root coverage esthetic scores (RES) in both groups are presented in Tables 21-23. RES was siginificantly higher in CAF+ADM group ($p<0.05$).

Table 21. RES evaluation in CAF + ADM group.

Patient (n)	**Gingival Margin Level** (Points)	**Marginal Tissue Contour** (Points)	**Soft Tissue Texture** (Points)	**Mucogingival junction alignment** (Points)	**Gingival Color** (Points)	**Total Score** (Points)
1	6	1	1	1	1	**10**
2	6	0	1	1	1	**9**
3	3	0	1	1	1	**6**
4	6	1	1	1	1	**10**
5	6	1	1	1	1	**10**
6	6	1	1	1	1	**10**
7	6	1	1	1	1	**10**
8	3	1	1	1	1	**7**
9	6	1	1	1	1	**10**
10	6	1	0	0	0	**7**
11	6	1	1	1	1	**10**
12	6	1	1	1	1	**10**
						9.08 ± 1.50

Table 22. RES evaluation in CAF group.

Patient (n)	**Gingival Margin Level** (Points)	**Marginal Tissue Contour** (Points)	**Soft Tissue Texture** (Points)	**Mucogingival junction alignment** (Points)	**Gingival Color** (Points)	**Total Score** (Points)
1	3	1	1	1	1	**7**
2	6	1	1	1	1	**10**
3	6	1	1	1	1	**10**
4	3	0	1	1	1	**6**
5	6	0	1	1	1	**9**
6	3	0	1	1	1	**6**
7	6	0	1	1	1	**9**
8	6	0	0	1	1	**8**
9	3	0	1	1	1	**6**
10	3	0	0	0	1	**4**
11	3	0	1	1	1	**6**
12	6	1	1	1	1	**10**
						7.58 ± 2.02

Table 23. Inter-group comparison of RES.

	Root Coverage Esthetic Score	^{+}p
CAF+ADM	9.08 ± 1.50	**0.038**
CAF	7.58 ± 2.02	

$^{+}$Mann Whitney U test, $p<0.05$

RES was siginificantly higher in CAF+ADM group (p<0.05).

4.2.14. Correlation of Gingival Thickness with Mean Defect Coverage Percentage

There was a significant positive correlation between GT and mean defect coverage percentage at 12 months (n=48) ($p<0.05$). Data related to correlation is presented in Table 24.

Table 24. Correlation of GT with mean defect coverage percentage at 12 months.

	r	^{+}p
GT - Mean Defect Coverage Correlation (12 months)	0.465	**0.022**

$^{+}$Spearman's rho test, $p<0.05$

Figure 11a. CAF+ADM group, Preoperative clinical view.

Figure 11b. Flap design and incisions.

Figure 11c. Flap elevation; conditioning with 24% EDTA, 2 min.

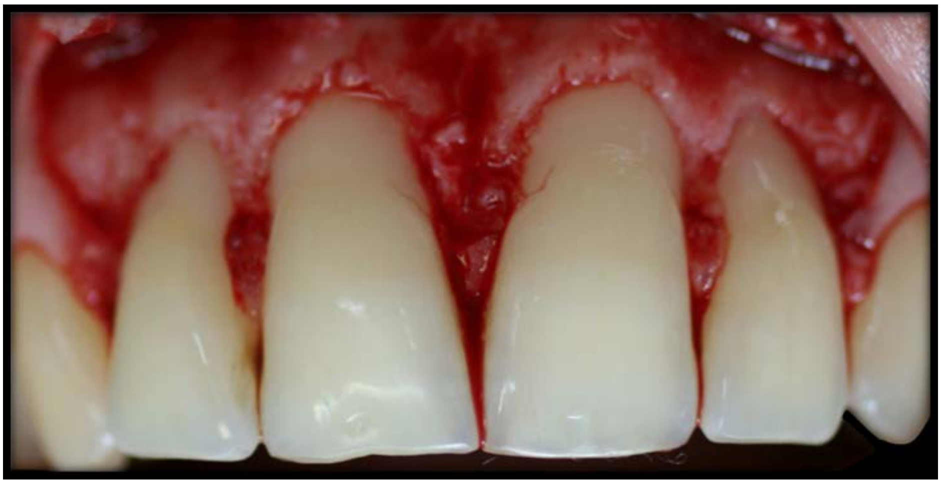

Figure 11d. Rinsing with saline.

Figure 11e. ADM stabilization with 5-0 resorbable sutures.

Figure 11f. Suturing with 5-0 non-resorbable sutures.

Figure 11g. Postoperative view (12 months).

Figure 12a. CAF group, Preoperative clinical view.

Figure 12b. Flap design and incisions.

Figure 12c. Flap elevation; conditioning with 24% EDTA, 2 min.

Figure 12d. Rinsing with saline.

Figure 12e. Suturing with 5-0 non-resorbable sutures.

Figure 12f. Postoperative view (12 months).

5. DISCUSSION

The 12 months results of the present randomized controlled clinical study demonstrated that CAF+ADM and CAF procedures provides benefits for the patients in terms of RH reduction, KT and GT gain, mean and complete defect coverage, patient satisfaction, and RES compared with baseline. However better esthetical results and clinical improvements were achieved with ADM graft combination.

Since Miller I & II multiple recession defects are defined predictable for CRC, only these type of defects were included in the study (89).

In patients with high esthetic expectations, CAF is the first choice when there is adequate KT apical to the recession defects (4,5,101,114). With this approach, the soft tissue used to cover the root exposure is similar in color, texture, and thickness to that originally present at the buccal aspect of the tooth with the recession defect; thus, the esthetic result is more satisfactory. Multiple gingival recessions, affecting esthetic areas of the mouth, were successfully treated with CAF and its modifications (4,5-7). Therefore in this study CAF was used to treat multiple gingival recessions. As the main goal was to obtain complete defect coverage, ADM was used in combination with CAF for the treatment of Miller Class I & II recessions with gingival thickness <0.8 mm.

ADM has been used as an alternative to subepithelial connective tissue graft in periodontal plastic surgery, eliminating the disadvantages such as the need for a second surgical procedure to harvest donor tissue which caused patient discomfort, the risk of postoperative complications (palatal necrosis, pain and bleeding), difficulty to harvest sufficient donor tissue from shallow or thin palate, a limited amount of donor tissue for multiple recession sites and longer surgical time (18,20,21,23,24,27,32,34,37,42,43,47,49,55,57). The main objective in the usage of this material was to maintain or even exceed the success rate and prominent esthetics demonstrated after the subepithelial connective tissue graft with simple surgical procedure and decreased complications, particularly in the treatment of challenging cases that involved defects of multiple teeth, thin palatal donor tissue; and in patients with low discomfort threshold and limited time period.

Previous studies in the literature for the treatment of single recession defects reported results for ADM+CAF, ranging from 50% (37) to 99% (26) for MRC; and from 7.7% (35) to 91.6% (26) for CRC (19-24,26-32,34-40,43-45,55,57-59) with evaluation periods of 6 (20,21,26,28,29,34,36-39,43-45,55,57,58,59), 12 (19,23,24,31,35,40), 18 (22), 24 (32,35), 48 (27), 60 months (55) and 10 years (46).

The reports about CAF for the treatment of single defects were ranging from 53% (59) to 86.7% (104) for MRC, and from 7.7% (35) to 88.9% (110) for CRC (26,28,35,39,59,94,97,98,103-106,108-120,122-126,128) with evaluation periods of 6 (26,28,39,59,94,97,98,105,109-113,116,118,119,120,122,124-126,128), 12 (35,94,103,104,106,108,114,117,122,124), 18 (114,123), 24 (35,94,115,122) and 60 months (106,108,124); also 8 (106) and 14 years (108).

In multiple defects treated with CAF, MRC was reported in a range from 74.91% (16) to 97.1% (4), and CRC in a range from 24% (13) to 73% (4) (4-7,9,13-16).

In the present study, 12 months after the surgery mean and complete defect coverage were 94.84% and 83.33%; 74.99% and 50.00%, in CAF+ADM and CAF groups, respectively. Inter-group differences were found to be statistically significant only for mean defect coverage, in favor of CAF+ADM group ($p<0.05$). These findings are in accordance with the previous results reported in the literature about the use of ADM graft in combination with CAF, or CAF alone.

The results achieved in this study for CAF+ADM group in terms of mean (94.84%) and complete (83.33%) defect coverage were also similar to CAF + subepithelial connective tissue graft application (MRC-96.7%, 96%, 86%, 96%; CRC-90%, 71%, 45%, 80%) (9-12), CAF + button application (MRC-96.2%, CRC-84.6%) (15) and CAF + low intensity laser therapy (MRC-90.82%, CRC-

70%) (16); and better than CAF + platelet-rich fibrin (MRC-80.7%, CRC-52.23%) (14), and CAF + enamel matrix proteins (MRC-82.8%, CRC-31%) (13) procedures, recently reported for the treatment of multiple gingival recession defects.

Woodyard et al. (26) treated 24 patients with 24 Miller Class I or II recessions ≥3 mm treated with CAF+ADM or CAF alone. After 6 months, MRC and CRC were 98.85 % and 91.67 %; 66.97 % and 33.33 %, in CAF+ADM and CAF groups, respectively. No additional root coverage gained due to creeping attachment between 2 and 6 months for either group. They concluded that treatment with CAF+ADM significantly increased GT when compared with CAF alone and root coverage was significantly improved with the use of ADM.

Cortes et al. (28) evaluated 13 patients with comparable bilateral Miller Class I localised gingival recessions ≥3 mm by CAF+ADM or CAF alone. After 6 months, both treatments resulted in significant root coverage ($p<0.01$), MRC and CRC were 76 % and 23 %; 71 % and 23 %, in CAF+ADM and CAF groups, respectively; with no significant difference between the groups They concluded that both techniques could provide significant root coverage in Miller Class I gingival recessions; however, a greater GT can be expected with ADM application. De Queiroz Côrtes et al. (35) reported 24 months evaluation of the previous study (28). After 24 months, MRC and CRC was reduced from 76% to 68%, and from 23% to 7.7% for CAF+ADM group; from 71% to 56%, and from 23% to 7.7% for CAF group, respectively. They concluded that ADM could provide greater GT and may reduce the residual RH observed after 24 months in defects treated with CAF.

Mahajan et al. (39) treated 14 patients with Miller Class I & II localised recessions ≥3 mm. After 6 months, both treatments resulted in significant root coverage ($p<0.01$), MRC were 97.14% and 77.42% in CAF+ADM and CAF, respectively; with statistically significant difference between the groups ($p<0.05$). They concluded that CAF+ADM was significantly superior with regard to effectiveness and efficiency in the treatment of gingival recession than CAF alone.

Jagannathachary et al. (59) treated 10 patients with bilateral Miller Class II maxillary localised recession defects ≥2 mm by CAF+ADM and CAF. After 6 months, both treatments resulted in significant root coverage ($p<0.01$), MRC were 82.2% and 53%, in CAF+ADM and CAF groups, respectively; with statistically significant difference between the groups ($p<0.05$). They concluded that the amount of root coverage obtained with ADM + CAF was superior compared to CAF alone.

Harris et al. (27) reported the short-term (mean 12.3 to 13.2 weeks) and long-term (mean 48.1 to 49.2 months) root coverage results obtained with CAF procedure in combination with ADM, in the treatment of 25 patients with Miller Class I or II gingival recessions ≥2 mm. They demonstrated that MRC obtained in the short-term for ADM application (93.4%), was statistically greater than the results obtained in the long-term ADM (65.8%). However, MRC (70.8%) for multiple sites treated with CAF+ADM was greater than that (50.0%) of single-defect sites treated with CAF+ADM, and 32.0% of cases treated with ADM demonstrated stability or improvement even in the long-term period. They stated that it seemed as though treating multiple defects with an ADM had an advantage over treating singular defects with an ADM.

A statistically significant root coverage (94.84%) associated with the CAF+ADM in thin gingival tissue might be due to the presence of collagen, which forms a major portion of the ADM graft extracellular matrix. It was found that collagen stimulates platelet attachment, enhances fibrin linkage, and is chemotactic for fibroblasts. Collagen, also inhibits the apical migration of epithelium, allowing undifferentiated mesenchymal cells to repopulate the space and promote regeneration resulting in a stable attachment of the covering flap to the previously denuded root surface, thus preventing “subsidence of epithelium.” Futhermore, during healing period, the ADM graft might have acted as a shock absorber, deflecting the undue forces that otherwise would be transmitted to the fragile maturing fibrin clot on the root surface, therefore may facilitate better tissue maturation and root coverage (39).

Many factors have been reported that could influence the clinical outcomes of root coverage procedures and the variability of MRC and CRC. Patient related factors: smoking (122,128,184), poor oral hygiene, and traumatic toothbrushing (5)); surgery related factors: clinical experience (72), postsurgical marginal position (186), flap design (5-7,29,31,38,40), flap tension (186), root surface preparation techniques (72,111,187-190); site related factors: anatomical (89), defect configurations (4,72,163), papilla dimension (191), flap thickness and tissue biotype (6,72,192-194), the location of the tooth (72) demonstrated different levels of impact.

Multiple gingival recessions, affecting esthetic areas of the mouth, were successfully treated with an envelope (without vertical releasing incisions) (5) and trapezoidal type of CAF (6). Trapezoidal CAF design was used in this study to reduce flap tension and to provide more coronal repositioning of the flap. Zucchelli et al. (6) compared the root coverage of CAF with and without vertical releasing incisions for the treatment of Miller Class I & II multiple recession defects ≥1 mm. At 12 months, both techniques were effective with no statistically significant difference between the two groups in terms of RH reduction and attachment gain, but with statistically greater probability of CRC with envelope type of CAF. MRC and CRC in CAF group with vertical releasing incisions were 92.64±14.25% and 43.7%, respectively, whereas in CAF group without vertical releasing incisions MRC and CRC were 97.27±8.08% and 75%, respectively. Andrade et al. (40) compared two surgical techniques (with and without releasing vertical incisions) in combination with ADM for the treatment of single defects. After 12 months, MRC and CRC was 83.28% and 53.34% (with vertical incisions) ; 74.32% and 50% (without vertical incisions), respectively; with no statistically significant difference between the groups regarding root coverage. Barros et al. (31) compared the clinical results of conventional and a modified technique with broader flap for the treatment of localised recessions ≥3 mm with CAF+ADM. After 12 months, MRC was 82.5% for the modified group and 62.3% for the conventional group, respectively. They concluded that the modified technique was more suitable for root coverage procedures in localised defects with the ADM, with superior clinical and statistically significant results compared to the traditional technique.

The results of these studies revealed that although there is not always a statistically significant difference between the two flap designs in terms of MRC and CRC, therefore both flap designs could be used. In this study, flap design with vertical releasing incisions as applied in this study has more chance to obtain better root coverage.

Orientation of ADM graft was also considered in the research. Henderson et al. (19) determined that the orientation of the graft did not affect the treatment outcome of root coverage procedure. In this study, ADM graft was oriented with the basement membrane side against the bone and root as suggested by the manufacturer.

Root surface biomodification is another important factor considered in the studies by researchers. The issue is controversial. The results of some studies have demonstrated that the conditioned root surfaces had a higher CRC compared with sites not treated with root conditioning agents (204-206). Conversely, however, the results of other studies have shown no significant clinical benefit from root conditioning in conjunction with root coverage procedures (190,207-209).

Mechanical instrumentation (scaling and root planing) may leave a smear layer, which inhibits cell re-attachment and may serve as a reservoir for microbial growth (189). Therefore, chemical conditioning of the roots was performed in order to detoxify, decontaminate, and demineralize the root surface, thereby removing the smear layer and to improve their biocompatibility. After the removal of the smear layer, the collagenous matrix of dentin and cement is exposed and these collagen fibers supposedly serve as chemo-attractants for periodontal fibroblasts (189,190,204-208,210-212). Various adjunctive agents have been proposed for this purpose. These include chemical root conditioners such as citric acid (204-208,210), tetracycline HCI (208), EDTA (189,190), phosphoric acid (212), and dentin bonding agents (213). In addition to chemical conditioning, the applicability of different laser systems such as CO_2 (214-217), Nd:YAG (217-

221), diode (222) and Er:YAG (209,217,222-225) laser in the removal of the smear layer have been demonstrated. Nd:YAG and Er:YAG lasers were used as root surface biomodifier for treatment of gingival recessions with subepithelial connective tissue graft (209,221). The use of Nd:YAG laser as a root surface biomodifier negatively affected the outcome of root coverage with the subepithelial connective tissue graft (221), and the application of the Er:YAG laser for removing the smear layer from the root surfaces did not enhance the results (209).

The present study, chemical treatment of the instrumented root consisted of 24% EDTA gel maintained on the root surface for 2 minutes, which was done to eliminate the smear layer from the dentine tubules and to improve coagulum adhesion to the root surface (104). EDTA is a chelating agent that could enhance the attachment of connective tissue to the root surface by exposing collagen (189). The material works at neutral pH, and this property has been reported to preserve adjacent tissue vitality (226).

Previous studies in the literature for the treatment of recession defects reported that GT might have a greater influence on the final outcome than the width of KT (23,26). It was stated that GT <1 mm can harm the achievement of CRC (73). GT increase could help to prevent future recessions in sites with a thin periodontal tissue phenotype (23).

In the present study, GT increase was 0.69 mm, from 0.75 mm to 1.41 mm in CAF+ADM group; and 0.07 mm from 0.71 mm to 0.77 mm in CAF group, with significant difference between the groups ($p<0.05$).

Studies in the literature reported, GT gain for ADM+CAF group, in a range from 0.32 mm (26) to 1.03 mm (23) with initial thickness from 0.55 mm (38,40) to 1.05 mm (28,35) (23,26,28,35,37,38,40,59); achieving MRC between 50% (37) and 98.58% (26) and CRC between 30% (23) and 91.67% (26).

Whereas results for GT gain for CAF group was reported in a range from -0.05 (120) to 0.24 (28) with initial thickness from 0.75 mm (26) to 1.27 mm (97) (14,26,28,35,59,97,105,113,119,120,128), achieving MRC between 53% (59) and 92.49% (113) and CRC between 7.7% (35) and 73% (119).

The significant increase in GT in combined therapy group might be due to integration of the membrane with the overlying flap.

In the study of Woodyard et al. (26), six months after treatment of Miller Class I or II defects ≥3 mm with CAF+ADM and CAF, GT increased from 0.76 mm to 1.15 mm in test group; and 0.75 mm to 0.77 mm in control group, with significant difference between the groups. MRC and CRC were 98.58% and 91.67%; 66.92% and 33.34%, in test and control groups, respectively. They concluded that treatment with CAF+ADM significantly increased GT when compared with CAF alone and root coverage was significantly improved with the use of ADM. De Queiroz et al. (35) published 24 months results of the same study, and reported that ADM could provide greater GT and might reduce the residual RH observed after 24 months in defects treated with CAF.

Review of the literatüre reveals that GT between 0.8 and 1.2 mm was associated with more predictable prognosis (72,192,194). Initial thickness was found to be the most significant factor and GT ≥ 1.2 mm was associated with CRC (72).

In this study, there was a significant positive correlation between GT and mean defect coverage in both groups ($r=0.465$; $p<0.05$). When GT ≥1.3 mm, higher percentage of complete defect coverage was achieved. These observations suggested that tissue biotype is a significant factor influencing esthetic-treatment outcomes of root coverage procedures (23).

In the present study, the mean baseline RH in CAF+ADM and CAF groups were 3.25±0.34 mm and 3.21±0.26 mm, respectively. These findings are in accordance with the previous studies in the literature. Intra and intergroup comparisons revealed statistically significant differences for RH reduction ($p<0.05$). RH reductions were 3.08±0.51 mm and 2.37±0.83 mm, in test and control groups, respectively, When the mean baseline RH ≥3 mm, RH reductions for ADM+CAF was reported in a range from 2.1 (21) to 4.57 mm (24) (19,21,22-24,26-29,31,32,34-37,39,44,45,58). For CAF, the reported range was between 2 mm (112) to 4 mm (94) (15,16,26,28,35,39,94,97,104,106,109-115,117,118,124-126).

In the present study, KT increase was 1.21 mm, from 2.48 mm to 3.69 mm in ADM group; and 0.60 mm from 2.58 mm to 3.19 mm in CAF group, with significant difference between the groups ($p<0.05$).

KT increase for ADM+CAF therapy was reported in a range of 0.11 (45) to 2.95 mm (34) (19,20,22-24,26-29,31,32,34-40,44,45,55,57-59,128). For CAF, the reported range was between -0.48 (14) to 1.2 mm (94) (4,6,7,13-16,26,28,35,39,59,94,97,98,103-106,109-120,122-126,128).

It is still unknown exactly how an increase in the KT can occur in recessions treated with CAF+ADM combinations. Considering that it is a non vital graft and that only the cells from the periodontal ligament and gingival connective tissue are capable of inducing the development of a keratinized epithelium, Paolantonio et al. (23) suggested that the inductive properties of the ADM depend on the percentage of colonization of the non vital graft by host cells deriving from tissues capable of inducing keratinization. However, further studies are needed to clarify the dynamics of the cellular healing process. In addition, differences in the ADM orientation (basement membrane side in contact with the flap or with the periosteum) may influence the cellular healing dynamics of this material in terms of keratinization of the overlying epithelium. It was also hypothesized that KT increase after CAF could be explained as the tendency for the mucogingival junction line to regain its ‘‘genetically determined’’ original position after repositioning (227), or the capability of the connective tissue, deriving from the periodontal ligament, to participate in the healing processes taking place at the dento-gingival interface (228).

In the present study, baseline PD in CAF+ADM and CAF groups were 1.17 mm and 1.14, respectively. Probing depth increase was 0.33 mm and 0.21 mm, in test and control groups, respectively, without statistically significant differences between the groups ($p<0.05$). These findings are in accordance with the previous studies in the literature for the treatment of recession defects that reported PD changes for ADM+CAF group, ranging from -0.6 mm (31) to 0.54 mm (35) (19,20,21,22-24,26-29,31,34-40,44,45,55,57-59) and for CAF, from -0.53 mm (123) to 0.58 mm (28) (4,6,7,13-15,16,26,28,35,39,59,94,97,98,103-106,109-120,122-125,126,128). The small increase observed in the PD should not be considered to be clinically relevant because all patients had a healthy sulcus with no bleeding on probing after 12 months. Attachment gain occurred parallel to the amount of RH reduction without a substantial clinical change in PD.

In our study, attachment gain in CAF+ADM and CAF groups were 2.75 mm and 2.17, respectively, with statistically significant difference between the groups ($p<0.05$).

These findings are in accordance with the previous studies in the literature, reporting attachment gains for ADM+CAF group, ranging from 0.81 mm (21) to 4.53 mm (32) (19,21-24,26-29,31,32,34-37,39,44,45,58), and for CAF, from 1.50 mm (124) to 3.93 mm (15) (15,16,26,28,35,39,94,97,104,106,109-112,114,115,117,118,124-126). The type of healing obtained between the soft tissue and previously denuded root surface can only be speculated on, since we did not perform histological evaluation. The gain in our study probably represents a combination of new connective tissue and an epithelium attachment. Cummings et al. (49) demonstrated histologically in humans a combination of long junctional epithelium and connective tissue adhesion after the use of the CAF+ADM combination for root coverage.

Even if the achievement of the CRC is the main treatment outcome for the treatment of single and multiple gingival recessions (150), this variable may be restrictive and unable to describe the final esthetic outcome of the surgery, in terms of complete soft tissue integration. Although the esthetic concern is an important parameter, only a few studies in the periodontal literature (20,38,211,229-234) attempted to evaluate the esthetic outcomes of root coverage procedures.

More recently, RES system was reported as a reliable method for assessing the esthetic outcomes of root coverage procedures (231). The rationale for the RES was the observation that the achievement of CRC per se cannot be considered a full esthetic success. Level and tissue contour of the gingival margin, texture of the soft tissue, mucogingival line alignment and color of the gingiva were evaluated without magnification by the RES system (203).

In the present study, the mean RES in CAF+ADM and CAF groups were 9.08 ± 1.50 and 7.58 ± 2.02, respectively, with statistically significant difference between the groups ($p<0.05$). Maximal RES of 10 points were achieved only in 8 from 10 patients in test group; and in 3 from 6 patients in control group, respectively. These findings are in accordance with the esthetic outcomes of previous clinical trials.

Cairo et al. (203) evaluated the esthetic outcomes with RES system following root coverage surgery of 31 patients with Miller Class I & II single defects ≥2 mm treated with different type of root-coverage procedures (CAF, CAF + connective tissue graft, double papilla flap + connective tissue graft, and a free gingival graft). The mean RES for single CAF and CAF + connective tissue graft treated sites was 8.07 and 9.00 points, respectively. The mean RES was 7.8. CRC was 77% at 6 months. Five of 24 cases of CRC achieved score of 10 points, in one case, score was 0 points.

Pini-Prato et al. (235) used RES system to evaluate 100 patients with 195 single or multiple recessions, treated using different root coverage procedures

(CAF, CAF + connective tissue graft, and a free gingival graft). Multiple recessions were treated by means of CAF and CAF + connective tissue graft. After 12 months, only 21 of 195 (11%) treated recessions obtained the maximum RES score 10 points, while 68 recessions (35%) showing CRC obtained lower scores. The mean RES for single and multiple recessions treated with CAF was 6.7 and 7.3 points, respectively. CAF combination with subepithelial connective tissue graft RES was 6.3 and 7.0 points for single and multiple defects, respectively. Free gingival graft showed the lowest RES of 4.1 points.

Ozcelik et al. (15) evaluated the effectiveness of CAF procedure combined with orthodontic button application (CAF+B) for the treatment of 41 patients with aesthetic demands presenting 155 Miller Class I or II multiple recession defects ≥2 mm. The mean RES in CAF+B and CAF groups were 8.65±1.47 and 7.43±1.56 points, respectively, with statistically significant difference between the groups ($p<0.05$). Six months results showed that the CAF+B approach was effective for the treatment of multiple gingival recessions in patients with aesthetic demands.

Jhaveri et al. (159) used RES system for the assessment of the esthetic outcome of CAF+ADM seeded with autologous gingival fibroblasts (test group) and CAF + subepithelial connective tissue graft (control groups) applications. After 6 months, the mean RES for the test group was 8.1, and 7.9 points for the control group. Overall, 13 cases (seven of the test group and six of the control groups) achieved CRC; only seven of these cases achieved RES of 10 points.

Although 6 months period was considered adequate to provide soft tissue maturity and stability as reported in systematic reviews dealing with root-coverage procedures (71,150), it was shown that the length of follow-up was a positive predictive factor in terms of aesthetics and the follow-up period should not be less than 12 months (230). The evaluation period used in our study was 12 months. A longer period of evaluation is probably necessary to assess whether these initial positive results are modified with time.

In our study, we questioned all the patients about their satisfaction with regard to the folowing patient-centered criteria: root coverage; dentinal hypersensitivity; color, shape and contour of gums; pain, discomfort and handling during surgery; post surgical pain, swelling and complications; cost effectiveness in terms of time and money spent for the surgery (39).

Satisfaction was assesed using a three-point rating scale: fully satisfied (3 points); satisfied (2 points); and unsatisfied (1 point). Overall patient satisfaction results for both CAF+ADM and CAF therapies were similar ($p>0.05$). Patients rated the test and control groups equally in all aspects, except the comfort during and after the surgical procedure and the cost effectiveness in CAF+ADM group. Also, more postoperative swelling and pain was encountered by the patients who were treated with the ADM graft. The reason might be the initial reaction of the body to a foreign graft material. Some patients were unhappy about the soft tissue bulge produced after the graft placement. The patients in CAF group had no such complaints; however, it should be noted that none of the patients in the ADM group had a score <2 points. Conversely, 3 patients rated in CAF group ‘‘unsatisfactory’’ in terms of root coverage, 4 patients rated ‘‘unsatisfactory’’ in terms of relief from dentinal hypersensitivity, 3 patients rated ‘‘unsatisfactory’’ in terms of shape and contour of gums. The reason could be partial root coverage, thin tissue biotype and high patient expectations. Therefore, from a clinician’s point of view, within the limits of this study ADM combination with CAF seems to be superior in the treatment of multiple gingival recessions compared to CAF procedure alone. However, when patient-centered criteria are to be fulfilled, CAF procedure emerges as a better option because it supersedes the ADM in terms of cost effectiveness and patient comfort.

In addition, the use of microsurgical instruments with magnification may lead to more sophisticated soft tissue handling, thereby enhancing the final esthetic outcomes (203,236)

There is a need for multicenter, clinical and histological trials using the CAF+ADM combination for the treatment of multiple defects with long-term follow-up to validate the results and for further insight into the use of ADM for root coverage.

It can be concluded that better esthetic results and clinical improvements were achieved with ADM combination. Tissue thickness significantly increased with the use of ADM graft. The thicker (≥1.3 mm) the gingival tissue gets with the adjunctive use of ADM, the higher percentage of complete defect coverage is achieved in Miller Class I & II multiple recession defects. ADM can be used as an effective alternative to subepithelial connective tissue graft for the treatment of multiple defects. CAF in association with ADM can be proposed as a valid therapeutic approach for the treatment of multiple gingival recessions with thin tissue biotype.

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7. CIRRICULUM VITAE

Cavid Ahmedbeyli was born on 14 October 1983 in Baku, Azerbaijan.

He graduated from the Yeditepe University Faculty of Dentistry (Istanbul) in 2005.

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