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BILAMINAR TECHNIQUE IN THE TREATMENT OF MILLER I-II GINGIVAL RECESSION DEFECTS USING ER:YAG LASER FOR THE ROOT SURFACE BIOMODIFICATION

PhD Thesis

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DECLARATION

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree except where due acknowledgement has been made in the text.

Ece Deniz Yarımoğlu

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ABBREVIATIONS

®	Registered Trademark
ADM	Acellular Dermal Matrix
BMP	Bone Morphogenetic Proteins
CEJ	Cemento-enamel Junction
CAF	Coronally Advanced Flap
CAL	Clinical Attachment Level
CC	Complete Coverage
CHX	Chlorhexidine
CM	Collagen Matrix
CTG	Connective Tissue Graft
DFDBA	Demineralized Freeze-dried Bone Allograft
DGG	De-epithelized Gingival Graft
EMD	Enamel Matrix Derivatives
ePTFE	Expanded Polytetrafluorethylen
Er, Cr: YSSG	Erbium,chromium: yttrium
Er:YAG	Erbium: yttrium-garnet
FGG	Free Gingival Graft
FMBS	Full Mouth Bleeding Score
FMPS	Full Mouth Plaque Score
GI	Gingival Index
GM	Gingival Margin
GNT	Gingiva of the Natural Tooth
GT	Gingival Thickness

GTR	Guided Tissue Regeneration
KT	Keratinized Tissue
MDC	Mean Defect Coverage
MRC	Mean Root Coverage
MGJ	Mucogingival Junction
Nd:YAG	Neodymium yttrium-garnet
NT	Natural Tooth
PD	Probing Depth
PI	Plaque Index
PRF	Platelet Rich Fibrin
PRP	Platelet Rich Plasma
RG	Receding Gingival Margin
RH	Recession Height
RT	Recession Type
RW	Recession Width

ABSTRACT

YARIMOĞLU, ED (2021) Bilaminar Technique in The Treatment of Miller I-II Gingival Recession Defects Using Er:YAG Laser for the Root Surface Biomodification. Yeditepe University Health Sciences, Periodontology Department. Doctorate Thesis.

In the treatment of the gingival recessions, Er:YAG laser is considered to be used for removing the smear layer and biomodifying the root surface due to its tissue friendly mechanism of action and safety. Exposing the collagen fibers of the root surface, this procedure may lead to enhanced wound healing. The aim of this randomized controlled clinical study was to evaluate the clinical outcomes of coronally advanced flap (CAF) + connective tissue graft (CTG) combined with an Er:YAG laser or an ultrasonic device instrumentation for root surface biomodification. Twenty patients with single Miller I gingival recessions were treated with CAF+ CTG combined with the root surface application of Er:YAG laser (test) (30Hz, 50Mj, under water irrigation) or ultrasonic device (control) with 2 different tips (designed for supragingival scaling and root planing). Plaque and gingival indices, probing depth, clinical attachment level, recession height, gingival thickness and keratinized tissue were evaluated at baseline and 6 months after the surgical procedure, as well as final complete and mean defect coverages. At 6-month follow-up, significant clinical improvements were detected in the evaluated parameters within both treatment groups ($p<0.05$). However, no significant differences were detected between the groups in any of the evaluated parameters ($p>0.05$). Within the limits of this study, no significant advantages were obtained for Er:YAG laser over ultrasonic treatment of the root surface in combination with CAF+ CTG. Further long-term studies on larger sample size, accompanied with histological evaluation, are required to provide support and evidence for the clinical and biologic aspects of laser biomodification.

Key Words: Coronally Advanced Flap, Gingival Recession, Root Coverage, Er:YAG Laser, Connective Tissue Graft

ÖZET

YARIMOĞLU, ED (2021). Er:YAG Lazer ile Kök Yüzeyi Modifiye Edilmiş Tekli Dişeti Çekilmelerinin Kuronale Konumlandırılan Flap ile Tedavi Etkinliğinin İncelenmesi. Yeditepe Üniversitesi Sağlık Bilimleri Enstitüsü, Periodontoloji ABD. Doktora Tezi

Dişeti çekilmelerinin tedavisinde, kök yüzeyi biomodifikasyonu ve smear tabakasının kaldırılması amacıyla Er:YAG lazerlerin kullanımı doku dostu çalışma mekanizması ve güvenli olması nedeniyle tercih edilebilir. Kök yüzeyindeki kolajen fibrillerin açığa çıkması yara iyileşmesi üzerinde olumlu etki yaratabilmektedir. Bu randomize kontrollü klinik çalışmanın amacı bağ dokusu ile kuronale kaydırılan flep operasyonu sırasında kök yüzeyi biomodifikasyonu amacıyla kullanılan Er:YAG lazer ile ultrasonik aletin etkinliğinin klinik parametreler ile değerlendirilmesidir. Tekli Miller I dişeti çekilmesi bulunan 20 hastanın tedavisinde bağ dokusu ile kuronale kaydırılan flap operasyonu operasyonu sırasında kök yüzeyi biyomodifikasyonu amacıyla test grubunda Er:YAG lazer (30Hz, 50Mj), kontrol grubunda ise 2 özel uca sahip ultrasonik alet kullanılmıştır. Plak ve gingival indeksler, cep derinliği, klinik ataşman seviyesi, çekilme derinliği, dişeti kalınlığı, keratinize doku miktarı başlangıç ve operasyon sonrası 6. ayda değerlendirilmiştir. Operasyonlar sonrası 6. Ayda değerlendirilen parametreler açısından her iki grupta istatistiksel olarak anlamlı sonuçlar alınmıştır ($p<0.05$). Ancak gruplar arasında değerlendirilen klinik parametreler arasında istatistiksel olarak anlamlı farklılık bulunmamıştır ($p>0.05$). Bu çalışmanın limitleri dahilinde, kök yüzeyi biomodifikasyonunda Er:YAG lazerin ultrasonik aletlere göre üstünlüğü bulunamamıştır. Uzun dönem takipli, örnek sayısı artmış ve histolojik değerlendirmelerin yapıldığı çalışmalara ihtiyaç bulunmaktadır.

Anahtar Kelimeler: Kuronale Kaydırılan Flep, Dişeti Çekilmesi, Kök Yüzeyi Kapama, Er:YAG Lazer, Bağ Dokusu

1. INTRODUCTION and PURPOSE

Gingival recession is an apical shift of the gingival margin from the physiologic position with exposure of the root surface to the oral cavity[1]. Although microbial dental plaque and inflammation are the key factors for all periodontal defects, the etiology of the gingival recession is more complex[2]. Etiological factors can be grouped under the headings of anatomical, physiological, pathological factors leading to gingival recessions[3–5]. The main indications for the treatment of recessions are dentin hypersensitivity, pain, esthetic concerns, difficulty in the removal of dental plaque biofilm, hard-tissue abrasions/cavities and fear of tooth loss[6].

Treatment of the gingival recessions is one of the most popular topic among researchers and clinicians as a part of periodontal plastic surgery. The literature has thoroughly documented that gingival recessions can be treated using several surgical techniques and the selection of the surgical technique depends on many factors to be evaluated for decision making. Among all these techniques, the main and most frequent used ones to treat single gingival recessions are pedicle soft tissue procedures and free soft tissue procedures and regenerative procedures as well[7].

Coronally advanced flap (CAF) is widely used and the most predictable technique for the treatment of Miller Class I and II recession defects, with high success rate and esthetic results[8–10]**.** However, CAF alone has some disadvantages when the thickness of the flap is equal or less than 1mm. The bilaminar technique using connective tissue graft (CTG) along with CAF is the most predictable surgical procedure for root coverage according to the recent literature[11–14].

The healing pattern of CAF+CTG procedure is explained by a long junctional epithelial attachment extending beyond the original gingival margin and in some areas neighboring to the original bone level with minimal connective tissue. Only small portions of new cementum-like tissue formation, observed at the apical portion of the recession in some studies. The use of CAF combined with CTG achieves root coverage with satisfying clinical results, but histologically with minimal connective tissue attachment and true regeneration is not observed[15–18].

One of the fundamental steps considered in root coverage procedures, is the root surface modification. The purposes of root surface biomodification are removal of the smear layer, elimination of bacterial substance and exposition of fibers on the dentin and cementum[19–21].

The aim of the present study is to compare the effects of two different biomodification approaches, as Er:YAG laser and ultrasonic device, on the clinical treatment outcomes of single gingival recessions treated by CAF+ CTG.

2. LITERATURE REVIEW

2.1. Gingival Recessions and Classification

The gingival margin is clinically represented by a scalloped line that follows the outline of the cemento-enamel junction (CEJ) or 1-2 mm coronal to it. Gingival recession is an apical shift of the gingival margin from the physiologic position with exposure of the root surface to the oral cavity[1].

In the literature, there are many classification systems for gingival recessions. Among the others, Miller's classification system is one of the most widely used classification system. This classification aims the diagnosis of the severity of gingival recessions and the prognostic evaluation of the treatments. Gingival recessions have been classified into four groups based on the level of gingival margin with respect to the mucogingival junction and the underlying alveolar mucosa by Miller[22].

- Miller I Gingival Recession; recession does not extend to the mucogingival line and there is no interdental attachment loss.
- Miller II Gingival Recession; gingival margin reaches to mucogingival line and there is no interdental attachment loss.
- Miller III Gingival Recession; defect is located at or beyond to the mucogingival line with interproximal attachment and bone loss.
- Miller IV Gingival Recession; interproximal attachment loss is severe and/or there is malpositioning of the teeth.

However, after many years, on the basis of an exact classification on the use of more complicated mucogingival surgical approaches, new classification systems have been revealed.

Pini-Prato et. al[23] (2010) have classified dental surface and exposed root surfaces with a new system. This system is based on the presence/visibility of CEJ (A) or absence of CEJ (B), and presence (+) or absence (-) of abrasions on the dental surface. Then, four possible classes have been identified (A+, A-, B+, B-).

More recently, Cairo et al. [24] (2011) proposed a new classification system which detailed the severity of interproximal bone loss. According to this classification system;

- Recession type I (RT1); defects include gingival recession with no interproximal bone loss.
- Recession type II (RT2); defects consist of interproximal attachment loss less than or equal to the buccal site.
- Recession type III (RT3); defects with more interproximal bone loss than buccal site.

2.2.Etiology of Gingival Recessions

Although microbial dental plaque and inflammation are the key factors for all periodontal defects, the etiology of the gingival recessions is more complex[2]. Etiological factors can be grouped under the headings of anatomical, physiological, pathological factors leading to gingival recessions.

2.2.1. Anatomical factors

Dehiscence and fenestration of the alveolar bone is one of the most widely seen etiological factor that may lead to gingival recession. Additionally, the abnormal tooth position in the arch and the shape of the tooth can also be considered as predisposing factors for gingival recessions[5].

2.2.2. Physiological factors

Orthodontic treatment, fingernail biting, sucking objects like pen, pencil or toothpicks are the physiological etiologic factors that may lead to gingival recessions[4,25]

2.2.3. Pathological factors

Faulty toothbrushing is commonly associated with gingival recession and partly explains low plaque levels found at sites of gingival recession[26]. Soft-tissue ulcers and hard-tissue cervical abrasions are clinical signs of gingival recessions caused by traumatic toothbrushing [27].

Incorrect flossing techniques, peri-oral and intra-oral piercings, direct trauma associated with malocclusion, partial denture/restorative therapy, periodontal disease, bacterial plaque and herpes simplex can be listed as the other pathological etiologic factors[27].

2.3. Pathogenesis of Gingival Recessions

There is limited source of knowledge in the literature investigating the pathogenesis of gingival recession. The most rationally related study to pathogenesis has been proposed by Baker and Seymour[28] in 1976, which reports histological findings associated with inflammatory gingival recession in Wistar rats. Baker and Seymour has introduced that gingival recession occurs with the presence of inflammation affecting epithelial and connective tissues. Proliferation of the epithelial cells into the connective tissue brings about a subsidence of the epithelial surface, which is manifested clinically as a gingival recession.

Three recognizable zones have been described during the experimental gingival recession formation that can be simulated to human gingival recessions[28]. (Figure1)

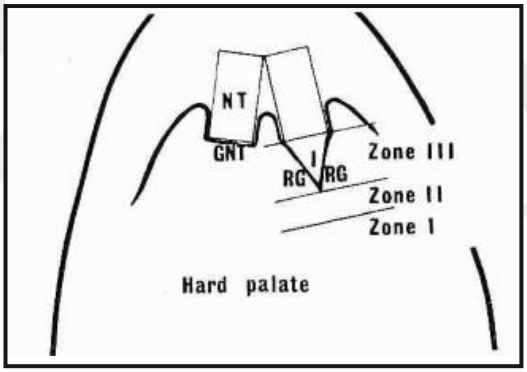

Figure 1. Diagram of the zones in the gingival recession process from which sections are taken vertically, parallel to the zone line. (NT: Natural tooth, GNT: Gingiva of Natural Tooth, RG: Receding Gingival Margin)

Appearance of Unaffected Tissues (Zone I)

This zone is described as the control zone. Tissue between epithelial layer of the periodontal pocket and palate is thick but does not contain alveolar bone. The rete pegs of the oral epithelium and pocket-lining epithelium are in normal configuration and not elongated into the intervening connective tissue [28].

Hyperplasia of Rete Pegs (Zone II)

Reduced thickness of the epithelial layer of the pocket and palate is observed. Lengthening of the rete pegs is noticeable. In the connective tissue, rete pegs are surrounded by the mononuclear cell infiltration. Section from a more advanced stage; the

mesial and distal basal layers have produced a common granular layer, which has begun to split where a common keratinized layer has differentiated [28].

Separation of the Mesial and Distal Components of Receding Gingival Margin (Zone III)

Keratinized layers are separated and a narrow cleft formation is observed.

2.4. Indications for root coverage surgical procedures:

- Dentin hypersensitivity, pain
- Esthetic concerns
- Accumulation of microbial dental plaque biofilm enhancing difficulty in the removal of inflammation.
- Hard-tissue abrasions/cavities
- Fear of tooth loss[6].

Dentin hypersensitivity is characterized by a short-term sharp pain occurred with chemical, thermal and osmotic stimulus. The widely accepted mechanism of the dentin hypersensitivity is hydrodynamic theory of pain, where the movement of the dentinal fluid in the dentinal tubules triggers sensory nerve fibers in the inner dentine and dentino-pulpal junction.

The most widely concern among the patients with gingival recession in the anterior area is esthetics. Root substance is usually different in color than the crown and the contour of the gingiva may lead to asymmetric appearance.

Gingival recession areas may often clinically be a site of plaque retention. This situation can be explained with two reasons; dentin hypersensitivity that creates pain during brushing and change of the anatomic conditions which makes the cleaning difficult in the gingival recession area [29].

2.5. Treatment of Gingival Recessions

The term mucogingival surgery was first proposed by Friedman[30] (1957), which included surgical procedures conserving gingival tissue, removing muscle attachments and frenulum and increasing the depth of vestibule.

Later on, in 1993, Miller[31] has proposed the new term ‘‘Periodontal Plastic Surgery’’. This term includes surgical procedures performed to conserve or correct developmental, anatomic, traumatic or disease-induced defects of the gingiva, alveolar mucosa or supportive bone around teeth and also implants.

Treatment of the gingival recessions is one of the most popular topic among researchers and clinicians as a part of periodontal plastic surgery. The literature has thoroughly documented that gingival recessions can be treated using several surgical techniques and the selection of the surgical technique depends on many factors to be evaluated for decision making[32] (Figure 2).

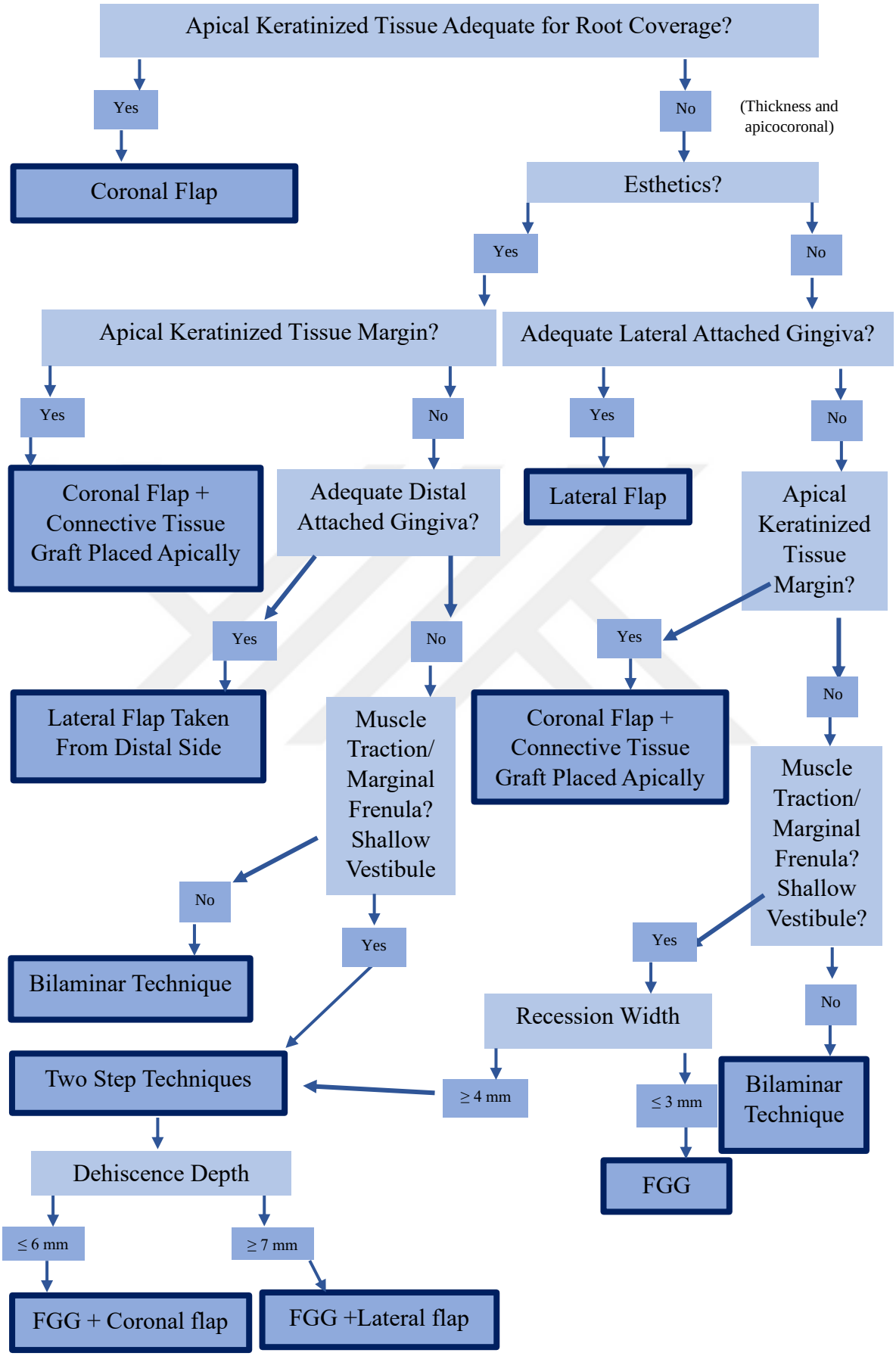

Figure 2. Decision making criteria for the choice of surgical technique for single gingival recession defects[32]

Among all these techniques, the main and most frequent used ones to treat isolated/single gingival recessions and their features are listed below.

2.5.1. Pedicle Soft Tissue Graft Procedures

2.5.1.1. Rotational Flap Procedures

Grupe & Warren[33] are the first reporting the sliding flap as a technique to treat single gingival recessions. They have described the technique as the elevation of a full-thickness flap adjacent to the recession and then its rotation to cover the recession.

2.5.1.1.a. Laterally Repositioned (Rotational) Flap

In a laterally repositioned flap, the soft tissue mesial or distal to the exposed root surface is used for coverage[33]. Laterally repositioned flap is recommended when there is a contraindication for coronally advancement of the flap; absence or deficient keratinized tissue apical to the recession, presence of frenulum or muscle attachments into the gingival margin, white clefts extending to the alveolar mucosa, a shallow fornix or the presence of deep root abrasions, requiring greater soft tissue thickness to allow restoration of a correct tooth emergence profile. This is a predictable root coverage technique when donor site (mesial or distal to recession area) has the following criteria: Mesiodistal extension of the donor site should be at least 6mm or more than the width of the recession. At least 1mm of keratinized tissue is needed to be conserved to protect the gingival margin of the adjacent tooth and also at least 2 mm of keratinized tissue in the mesio-distal section of the pedicle and a tissue thickness of at least 1mm around the related teeth should be present. Scar formation in the area of healing by secondary intention may be considered as disadvantage of this technique in patients with high esthetic expectations[27].

2.5.1.1.b. Double Papilla Flap

Cohen and Ross[34] has introduced the technique in 1968 in which bilateral interdental papilla around recession are used as donor tissue for single gingival recessions. They have also reported that, there is less chance of flap necrosis together with easy suturing because interdental papillae are thicker and wider than labial gingiva. Although they reported 85% of success in root coverage, the degree of success varies between the studies [35].

However, Sculean et al. [36] in 2018, have improved the surgical outcome modifying the surgical principle. The aim of this laterally closed tunnel technique is to achieve a predictable root coverage of the deep isolated gingival recessions in the mandibular area and minimize the risk of postoperative complications caused by unfavorable anatomical conditions. Beveled intrasulcular incisions are made by using microsurgical blades and mucoperiosteal pouch is prepared. The pouch is then mobilized apically beyond the mucogingival line and extended mesially and distally from the recession defect by undermining the facial surface of the interdental papillae. Muscle and collagen fibers are further released at the inner surface of the pouch. As a result of this, the margins of the pouch can cover completely or greater part of the exposed root surface mesially and distally without tension. The margins of the pouch are pulled together over the connective tissue graft (CTG) which is obtained from the palate and sutured with interrupted sutures. This technique is further extended to be used with hyaluronic acid in 2020[37].

2.5.1.1.c. Oblique Rotational Flap

This procedure is a modification of horizontally repositioned flaps and other gingival repositioned flap procedures. It is first introduced by Pennel et al. [38] in 1965. They have advocated that this technique not only provides a consistent method for establishing an adequate zone of attached gingiva but also eliminates abnormal frenal attachment and labial periodontal pockets.

2.5.1.2. Advanced Flap Procedures

2.5.1.2.a. Coronally Advanced Flap

Coronally advanced flap (CAF) and its modifications involve a coronal shift of the soft tissue located apically to the recession to cover the exposed roots surface [39]. In 1926, Norberg[40] has first mentioned this technique but in 1975 Bernimoulin et al.[41], are the first to describe the technique at both single and multiple gingival recessions.

Within time, various modifications have been done by the researchers and today it is a very commonly used approach for the treatment of gingival recessions. The following criteria are required to perform this technique; sufficient keratinized tissue height apical to the root exposure (1mm for shallow, 2mm for recessions ≥5mm) and thickness. The main contraindications for CAF are the absence of keratinized tissue apical to the recession, presence of gingival clefts extending into the alveolar mucosa, high frenulum

pull at the soft-tissue margin, shallow vestibule depth and abnormal tooth position (prominant root) [27]. The technique includes vertical incisions lateral to the recession area beginning at a point apical to the papilla tip and extending into alveolar mucosa. The alveolar mucosa between 2 vertical incisions are then undermined by sharp dissection with going well into the vestibule while keeping the position parallel to the surface. Next, a sulcular incision is made to reflect the coronal portion of the flap by sharp dissection close to the periosteum until reaching the split thickness incision previously made in alveolar mucosa. De-epithelization for each papilla is then performed. Suturing the 2 vertical incisions are done before suturing the papillae. The final suture is a sling suture anchored to the tooth's palatal cingulum, pressing the papilla and ensuring a good fit between the keratinized tissue of the flap and tooth's anatomical crown convexity[27].

A modified CAF has been presented by De Sanctis[42] in 2007 which provides some clinical and biologic advantages over the previous ones. The split-thickness flap elevation is suggested at the level of surgical papilla to provide blood supply to the interproximal areas. Moreover, the partial thickness of the surgical papillae has promoted the nutritional exchanges with each other and the underlying de-epithelialized anatomical papillae and increased the blending of the surgical area in terms of color and thickness. At the middle portion of the flap, full thickness flap performance has facilitated to achieve root coverage with the help of more thicker flap tissue and some periosteum. The more apical split-thickness flap elevation has promoted the easier coronal displacement of the flap. Another important modification of this technique is that the coronal advancement of the flap not obtained by periosteal incisions, but by cutting the muscle insertions included in the thickness of the flap.

Many studies and systematic reviews conclude that, CAF is a predictable and safe root coverage procedure for the treatment of single gingival recessions [43,10,44,8,45–47].

2.5.1.2.b. Semilunar Coronally Advanced Flap

Semilunar coronally advanced flap has been proposed by Tarnow[48] in 1986. The technique involves a semilunar incision made parallel to the free gingival margin of the facial tissue, and thereafter coronally positioning of this tissue over the recession area. Advantages of this technique are reported as; no tension on the flap, no shortening of the vestibule, and no interference with the existing papillae.

2.5.2 Free Soft-tissue Graft Procedures

2.5.2.1. Epithelized Graft (Free Gingival Graft)

The term free gingival graft (FGG) refers to the harvesting of keratinized epithelial connective tissue from its original site and its placement at the target recipient site[49]. The FGG is the most common procedure for increasing the keratinized tissue height. However; authors have reported unpredictable results in terms of the root coverage [27]. In the literature, percentage of root coverage ranges from 11 to 100 [50,51,52,53].

White scar formation of the grafted tissue that contrasts the adjacent soft tissue is another disadvantage for this technique for the patients with high esthetic expectations. The FGG is contraindicated in patients with deep and wide gingival recessions and in the presence of deep facial probing pockets associated with gingival recession. FGG can be confidently used when the main target of the surgical procedure is to increase the height and thickness of keratinized tissue and vestibulum depth [27].

2.5.2.2. Gingival Unit Grafts

A modified FGG as gingival unit grafts is described by Kuru & Yıldırım[54] in 2013. The modification is the involvement of marginal gingiva and papillary tissue in the palatal graft whose vascular configuration matches more closely in size and number to those of the recipient site of recession. The presence of marginal gingiva and papillary tissue in the gingival unit is expected to provide an alternative approach for the prospective synergism between recipient and donor tissues. They have indicated that the involvement of gingival margin and papillary tissue in the conventional palatal graft may provide additional benefits in clinical parameters in terms of defect coverage. Gingival unit grafting results in imperceptible differences in color and texture with adjacent tissues, and the margins of the graft are found to be more coronal than the margins of the adjacent gingiva in most of the patients. Providing better clinical and esthetic improvements in Miller I and II types of single gingival recession defects compared with FGG have revealed the additional benefits of gingival unit grafts.

2.5.2.3. Connective Tissue Graft

The bilaminar technique using CTG subepithelially along with CAF first introduced by Langer & Langer[55], is the most predictable surgical procedure for root coverage according to the recent literature [11–13,56–59].

The biological explanation for the success is increased blood supply and stability for the CTG, enhancing the survival of the graft on the avascular root surface. Esthetic outcomes are increased accordingly by hiding the white scar appearance of the surgical area [58]. The indications of this technique are the presence of a recession defect in the esthetic zone, where CAF alone is contraindicated due to inadequate keratinized tissue, gingival recession with deep abrasion, root prominence and gingival recession associated with prosthetic crown and implants [27].

The technique is described as the following: CTG is harvested from the palate. The graft is then placed on the recipient area to cover the bone dehiscence and is sutured slightly apical to the CEJ. The papillae coronal to the graft are de-epithelized and provide anchorage to the surgical papillae of the covering flap. The trapezoidal flap is coronally advanced to completely cover the graft. The sling coronal suture is anchored to the palatal cingulum to permit precise adaptation between the keratinized tissue of the flap and the convexity of the tooth crown [27].

During the last two decades, clinicians have introduced several modifications to the original bilaminar technique. These modifications are related to the type of the graft harvested from palate, the localization for the placement of the graft with regards to CEJ[60], to the design of the flap with the use of envelope approach[61,62] or vertical releasing incisions[63,64]. More recently in a study by Zucchelli et al.[65], another modified approach regarding the use of de-epithelized gingival graft (DGG) is recommended to improve the esthetic results of bilaminar technique.

In the literature many different CTG harvesting procedures have been described and the most common ones are; the envelope technique with single [66] or double incisions [67] and the trap-door technique [68]. In all of these techniques; a split-thickness flap elevation is performed and the withdrawal of CTG and closure of the palatal wound are done with the access flap. Primary closure of the wound and primary intention provide reduction in patient morbidity. However, acceptable palatal fibro-mucosa thickness is of critical importance to avert desquamation of the undermined superficial flap as a result of compromised vascularization [42,68,69]. In addition to these techniques, modified FGG as DGG technique is thereafter used for connective tissue harvesting by de-epithelizing FGG from the palate[65]. In this technique surgical wound heals by secondary intention within 2-4 weeks and may be associated with some discomfort for the patient as a result of

postoperative pain and/or bleeding. However, this technique is easy to perform, has less morbidity and can be performed even in the presence of a thin palatal tissue [27,65].

Another surgical approach in a case series report, described by Sculean et al.[70] as modified coronally tunnel technique, is used in combination with enamel matrix derivate (EMD) + CTG for the treatment of single mandibular gingival recessions. Intrasulcular incisions are done using microsurgical blades and mucoperiosteal flap is elevated with specifically designed tunneling knives beyond the mucogingival line leaving the interdental papilla intact. Mucoperiosteal tunnel is extended by full thickness preparation laterally from the recession utilizing the same tunneling knives. Thereafter, the tunneled flap can be mobilized and advanced coronally without tension. Finally, for the complete mobilization, the interdental papillae are gently undermined. After the application of EMD, the CTG is pulled in the tunnel by means of single or mattress sutures and fixed in the inner site of the tunnel flap. CTG is fixed at the CEJ or 1 mm below by sling suture. Finally, the flap is moved coronally to completely cover CTG and the recession area by means of a sliding suture.

In some patient-related conditions, in which obtaining CTG is unfavorable, soft tissue augmentation biomaterials can be an alternative for CTG. Although the origin of the biomaterials can vary and may have some disadvantages, it is suggested that they have a good tissue integration with surrounding connective tissues and the biomaterials may function as a basis for soft tissue regeneration[17,71–74]. However, their shrinkage tendency is well known and in a meta-analysis for example, comparing the effectiveness of a collagen matrix (CM) biomaterial versus CTG in combination with CAF, it has been concluded that CAF+CM is not superior to CAF + CTG in terms of clinical parameters but CM can improve the clinical efficacy when compared to CAF alone[75].

2.5.3. Regenerative Procedures

Guided tissue regeneration (GTR) with resorbable and non- resorbable membranes has been used for the treatment of gingival recessions. In the literature, there are studies indicating that GTR is predictable surgical modality for root coverage [76–78]. Especially in deep gingival recessions, GTR induces the regeneration of new connective tissue attachment and the bone. The percentage of the root coverage obtained by the use of membranes ranges from 54 to 87 (with a mean of 74). Nonetheless, there may be several

complications with the use of membranes, such as, membrane exposure and contamination, difficulties in placing the membrane and new tissue damage during removal of the non-resorbable membranes[27].

Ideally, the aim of the root coverage procedures is not only a complete root coverage but also periodontal regeneration for ensuring physiological probing depth and long-term stability [79]. EMD has been first proposed in 1977 by Schonfeld [80] as a tissue healing modulator to mimic events that occur during embryonic period. To date, EMD is known as an effective agent for stimulating periodontal regeneration, characterized by formation of periodontal ligament, alveolar bone and cementum [81–86]. EMD in combination with CAF, aims to achieve the objectives of enhancing root coverage results and inducing periodontal regeneration [17,81]. In the literature there are many studies revealing that EMD when combined with CAF, improves the percentage of root coverage, increases keratinized gingival tissue height and provides better reduction of recession[9,87–90].

Current literature reports, regarding root coverage procedures, are given in Table 1 including the use of different surgical approaches such as CAF, CAF + CTG, CAF + EMD, CAF + GTR, CAF + GTR + bone grafts, CAF + Acellular Dermal Matrix (ADM), CAF + CM, CAF + platelet rich fibrin (PRF), CAF + Platelet Rich Plasma (PRP) etc.

Table 1: Root coverage outcomes for single gingival recessions. CC: Complete Coverage (%), MRC: Mean Root Coverage (%), EMD: Enamel matrix derivate, CAF: Coronally Advanced Flap, CTG: Connective Tissue Graft, ADM: Acellular Dermal Matrix, GTR: Guided Tissue Regeneration, XCM: Xenogeneic Collagen Matrix, Platelet Rich Fibrin: PRF, Platelet Rich Plasma: PRP, FGG: free gingival graft, DFDBA: demineralized freeze-dried bone allograft, ePTFE: expanded polytetrafluorethylen)

Study	Intervention	CC	MRC
Abolfazli et al.[91]	EMD + CAF (12 months) CTG + CAF (12 months) EMD + CAF (24 months) CTG + CAF (24 months)	- - 25.0 66.6	77.7 83.4 76.9 93.1
Alves et al.[92]	ADM + EMD + CAF (6 months) ADM + CAF (6 months) ADM + EMD + CAF (12 months) ADM + CAF (12 months)	15.8 5.3	55.4 44.0 59.7 52.8
Amarante et al.[93]	GTR (polylactide membrane - Guidor) (6 months) + CAF CAF (6 months) GTR (polylactide membrane - Guidor) (12 months) + CAF CAF (12 months) GTR (polylactide membrane - Guidor) (72 months) + CAF CAF (72 months)	25.0 50.0 20.0 30.0 18.2 9.1	51.2 63.8 51.2 61.1 35.0 34.2
Ayub et al.[94]	ADM + CAF	26.6 0	88.4 65.8
Babu et al.[95]	ADM + CAF GTR (collagen membrane) + CAF CTG + CAF	- -	84.0 84.8
Barros et al.[96]	ADM + CAF CTG + CAF	- -	80.7 78.7
Bouchard et al.[97]	CTG + CAF + citric acid (graft without epithelial collar) CTG (graft with epithelial collar)	20.0 33.3	69.7 64.7
Bouchard et al.[98]	CTG + CAF + tetracycline hydrochloride CTG + CAF + citric acid	40.0 53.3	79.3 84.0
da Silva et al.[99]	CTG + CAF CAF	18.1 9.0	75.3 68.8

de Queiroz Cortes et al.[100]	ADM + CAF (6 months) CAF (6 months) ADM + CAF (12 months) CAF (12 months) ADM + CAF (24 months) CAF (24 months)	23.0 23.0 15.3 15.3 7.7 7.7	76.0 71.0 71.0 66.7 68.4 55.9
Del Pizzo et al.[9]	EMD + CAF CAF	73.3 60.0	90.7 86.7
Dodge et al.[101]	GTR (polylactide membrane - Guidor) + tetracycline hydrochloride + DFDBA + CAF GTR (polylactide membrane - Guidor) + tetracycline hydrochloride + CAF	50.0 33.3	89.9 73.7
Hägewald et al.[102]	EMD + CAF (6 months) Placebo (propylene glycol alginate) + CAF (6 months) EMD + CAF (12 months) Placebo (propylene glycol alginate) + CAF (12 months) EMD + CAF (24 months) Placebo (propylene glycol alginate) + CAF (24 months)	- - - - 53.0 23.0	80.0 79.0 80.0 79.0 84.0 67.0
Henderson et al.[103]	ADM (basement membrane side against the tooth) + CAF ADM (connective tissue side against the tooth) + CAF	70.0 80.0	94.9 95.5
Jankovic et al.[104]	PRF + CAF EMD + CAF	60.0 65.0	72.1 70.5
Jepsen et al.[105]	XCM + CAF CAF	82.8 48.6	72.0 66.2
Joly et al.[106]	ADM + CAF (without vertical incisions) CTG + CAF (without vertical incisions)	- -	50.0 79.5
Keceli et al.[107]	CTG + PRP+ CAF CTG + CAF	35.3 42.1	86.4 86.4
Keceli et al.[108]	CTG + platelet-rich fibrin + CAF CTG + CAF	55.0 35.0	89.6 79.9
Kuru & Yıldırım [54]	Gingival Unit Graft FGG	50 0	91.62 68.97
Matarasso et al.[109]	GTR (polylactide membrane - Guidor) + double papilla flap GTR (polylactide membrane - Guidor) + CAF	- -	73.9 62.5
McGuire et al.[88]	EMD + CAF (6 months) CTG + CAF (6 months) EMD + CAF (10 years) CTG + CAF (10 years)	89.5 79.0 55.6 77.8	95.1 93.8 83.3 89.8

Paolantonio et al. [110]	GTR (polylactide membrane - Guidor) + CAF GTR (polylactic acid membrane - Paroguide) + hydroxyapatite/collagen/chondroitinsulphate graft + CAF CTG + double papilla flap	40.0 53.3 60.0	81.0 87.1 90.0
Paolantonio et al. [111]	CTG + double papilla flap FGG	48.6 8.6	85.2 53.2
Pendor et al.[112]	CTG + double papilla flap CTG + CAF	60.0 60.0	88.0 84.7
Pilloni et al.[113]	CTG + Hyaluronic acid	80 33.3	93.8 73.1
Rasperini et al.[114]	CTG + EMD + CAF CTG + CAF	61.5 46.6	90.7 76.6
Reino et al.[115]	CTG + CAF (extended flap) CTG + CAF	10.0 0	44.5 43.2
Reino et al.[116]	XCM + CAF (extended flap) XCM + CAF	- -	81.9 62.8
Roccuzzo et al.[117]	GTR (polylactic acid membrane - Guidor) + CAF GTR (ePTFE membrane - Gore-Tex) + CAF	41.6 41.6	82.4 82.4
Rosetti et al.[118]	GTR (collagen membrane) + tetracycline hydrochloride + DFDBA + CAF (18 months) CTG + tetracycline hydrochloride (18 months) GTR (collagen membrane) + tetracycline hydrochloride + DFDBA + CAF (30 months) CTG + tetracycline hydrochloride (30 months)	- - - -	84.2 95.6 87.0 95.5
Rocha Dos Santos et al.[119]	XCM + CAF EMD + CAF XCM + EMD + CAF CAF	52.9 70.6 58.8 23.5	87.2 88.8 91.6 68.0
Shori et al.[120]	ADM + CAF CTG + CAF	- -	86.9 84.7
Tozum et al.[121]	CTG + modified tunnel procedure CTG + CAF	- -	96.4 77.1

Trombeli et al.[122]	CAF + fibrin glue + tetracycline hydrochloride CAF + tetracycline hydrochloride	9.1 18.2	63.1 52.9
Wang et al.[123]	GTR (reabsorbable double thickness collagen membrane - Sulzer Dental Inc) + CAF CTG + CAF	43.8 43.8	73.0 84.0
Woodyard et al.[124]	ADM + CAF CAF	91.6 33.3	96.0 67.0
Zucchelli et al.[60]	CTG (graft size equal to the bone dehiscence) + CAF CTG (graft size 3 mm greater than the bone dehiscence) + CAF	86.7 80.0	97.3 94.7
Zucchelli et al.[125]	Ultrasonic scaling + CAF Manual/hand scaling + CAF	54.5 81.8	84.2 95.4

2.6. Healing After Root Coverage Procedures

Healing process of root coverage procedures have been investigated in animal studies and also in human histologic case reports [62,110-123,127-132].

There are various animal studies in the literature using CAF alone or with many combinations[15,18,126–128]. Similar histological findings have been reported in these studies; connective tissue attachment to the bone and cementum is found in the most apical portion of the root, and long junctional epithelium is observed in the most coronal portion of the root surface[15,18,126–128].

Regarding the human studies, a human histologic case study with CAF + CTG has performed by Harris et al.[129]. They explained the healing pattern by a long junctional epithelial attachment extending beyond the original gingival margin and in some areas nearly to the original bone level with minimal connective tissue. No new bone or cementum is detected in any section. The use of this technique that combines CTG with a pedicle graft is achieved root coverage with satisfying clinical results but histologically true regeneration is not observed.

Majzoub et al. [130] have also published a case report aiming to clarify the histological nature of the attachment of CTG to the root surface. They have shown that healing has occurred with a long junctional epithelium almost all over the previously exposed root area, including only small portions of new cementum-like tissue formation, observed at

the apical portion of the recession. No root resorption and ankylosis are identified in any of the sections.

Healing following the CAF + ADM is evaluated by both animal and human studies[131,132]. An animal study by Luczyszyn et al.[131] has evaluated the healing of CAF in combination with ADM. After 12 weeks following operation, the ADM and the connective tissue seem to be well integrated into highly vascularized single structure, indicating almost complete incorporation of ADM.

A human histologic study evaluating the healing of ADM alone is published by Scarano et al.[132]. In this study, connective and epithelial tissue formation are observed after 10 weeks without any inflammatory cells and macrophages in the specimen. In another human histologic study evaluating the healing of CAF + ADM published by Cummings et al. reported that, new fibroblasts, vascular elements, and collagen are present throughout the ADM at 6-month block section extractions. Areas of cemental deposition are present within the root notches and the attachments to the root surfaces are similar to CAF + CTG group.

In regenerative procedures healing is also achieved by means of mainly long junctional epithelium and connective tissue attachment, only with some new bone, new cementum at the apical part of the recession area [62,117-119,133,134,127-132].

Root coverage by using GTR, using biocompatible barrier membranes can achieve reestablishment of soft tissue loss over gingival recession defects with clinical attachment gain and keratinized gingiva[118,135–137]. However, histologic evaluation illustrates limited true regeneration by means of new bone and new cementum with Sharpey fibers attached on the surface [133,134,138–140]. Healing following the use of GTR is evaluated histologically in an animal study by Al Hezaimi et al.[133]. They have performed a histological evaluation by block biopsies at post-operative 3 months following CAF + resorbable membrane application used to treat gingival recession defects on baboons. Although, CAF is found clinically effective for the treatment of gingival recessions, minimal alveolar bone and connective tissue replacing the membrane are obtained.

The human case study by Harris[134] has evaluated the healing of CAF+ resorbable membrane on 4 teeth. Only one of these teeth have revealed new bone, cementum and connective tissue attachment. However, because newly formed bone, cementum and

connective tissue are not found coronal to the original gingival margin of the recession defect, the results cannot be classified as true regeneration on the previously exposed recession surface.

Healing following the use of EMD is also evaluated by histological studies both on animals and humans, revealing an inductive property of the biomaterial for the improvement of surgical clinical results[17,141–146]. An animal study by Shirikata et al. [17] has evaluated the healing of CAF alone or in combination with EMD, ADM, EMD+ADM. The height of the new bone is found the greatest and new cementum with periodontal ligament like-tissue is only detected in the presence of EMD. EMD is found to induce the formation of new cementum. These findings are supported by the results of other related animal studies[119,130,131].

The human case study using CAF+ EMD have shown the presence of a junctional epithelium approximately 2 mm in the coronal portion[145]. Apical to the junctional epithelium, connective tissue fibers are seen in close proximity to the root surface but in general, no insertion of these fibers into the root surface is observed. In one of the 6-month specimens, new cementum and bone formation are observed in the apical portion of the grafted area. These findings are supported by the results of other related animal studies[143,146].

As seen in the aforementioned histological studies, there is still a long way to the ideal new attachment system where we need further improvements. In the literature, it has been proposed that the use of root surface biomodification with different agents may improve the connective tissue attachment, thereby the predictability of root coverage procedures [147]. Biomodification may remove smear layer, exposing fibers on the dentin and eliminating bacterial substances that inhibit gingival fibroblast growth [148].

2.7. Root Surface Biomodification

It has been postulated that it is necessary to rehabilitate the root surface for cell attachment and fiber insertion since exposed root surface may display a hyper-mineralized surface layer and endotoxin contamination. In vitro and in vivo studies have used root surface conditioners or instrumentations in order to detoxify, decontaminate and demineralize the root surface, thereby removing the smear layer and exposing the

collagenous matrix of dentin and cementum to support proper healing[19,20,155,156,21,125,149–154].

2.7.1. Classification of Root Surface Biomodification

There are many different agents for root surface biomodification in the literature. They can be categorized into 3 groups as chemical agents, biostimulation agents and mechanical agents presented in Table 2 [157].

Table 2: Classification of Root Surface Biomodification Agents.

Chemical Agents
Citric Acid, Hydrochloric Acid, Lactic Acid, Phosphoric Acid, Trichloroacteic Acid, Formic Acid, Polyacrylic Acid, Tetracycline HCL, Doxycycline, Minocycline, EDTA, Fibronectin, Laminin, Formalin, Chlorhexidine, Hydrogen Peroxide, Sodium Hypochlorite, Chondroitin Sulfate, Zinco, Pyridinium Chloride and Sodyum-Lauril Suplhate, Sodium Deoxycholate and Cohn's Factors Enzymes, Stannous Fluoride
Biostimulation Agents
Enamel Matrix Derivative, Platelet Rich Plasma, Recombinant Human Growth Hormone, Hyaluronic Acid
Mechanical Agents
Hand instruments, Ultrasonic devices, Lasers

2.7.1.1. Chemical Agents

The purpose of using chemical agents is to remove the surface smear layer that accumulates in the dentin tubules after root planing. Smear layer removal exposes the collagen fibrils contained within the dentin tubules, thus allowing them to interact with the fibrin network of the clot formed between the root and soft tissue. This ensures blood clot adhesion to the root surface, which is the first essential step of the wound healing [7].

In vitro and in vivo studies using root surface conditioners such as; EDTA, tetracycline or citric acid have been performed to detoxify, decontaminate and demineralize the root surface, thereby removing the smear layer and exposing the collagenous matrix of dentin and cementum [19–21,150,158].

1.7.1.2. Biostimulation Agents

Currently, different biomaterials are used for root surface biomodification such as, bone morphogenetic proteins (BMP), growth hormones and PRP. In dogs, root surface biomodification has been done with BMP leading to the stimulation of cementum-like tissue formation and inhibition of epithelial downgrowth. Good results are also achieved with platelet-derived growth factor that provided high root surface biocompatibility and positive effect on adhesion. However, randomized controlled clinical trials are required to confirm benefits of these agents in terms of root surface biomodification [159].

2.7.1.3. Mechanical Agents

Mechanical instrumentation of root surface consists of mainly root planing. The aim of root planing is to eliminate microbial deposits and softened demineralized tissue, leaving a smooth hard surface conducive to soft tissue attachment. Generally, root planing is performed with curettes, however, today, aggressive root planing is no longer justified [158]. This fact has aroused clinicians' interest in the idea of performing mechanical root instrumentation with ultrasonic devices. Ultrasonic devices are not only easier and faster to use but also cause less trauma to the soft tissue and root surface[160,161].

Root biomodification procedures associated with mucogingival surgery can be performed pre-surgically or during surgical procedures both of which have advantages and drawbacks. The advantages of presurgical planing are the preservation of radicular cementum integrity in the anatomical bone dehiscence area and the performance in a blood-free environment. Its disadvantages are soft tissue trauma and the risk of inadequate planing of the root surface on the facial aspect. An insufficient removal of the infected and softened tissue layer affects the outcome of the surgery and/or causes an increase in probing depth. Presurgical root planing is recommended in cases when remaining soft tissue apical to recession is not used in root coverage technique (gingival grafts, laterally sliding flap) and in cases of gingival recessions in association with PD ≤ 1mm and high/thick band of keratinized tissue apical to the recession. The advantage of open-flap scaling is the easy performance due to the soft tissue being out of harm's way. The potential disadvantage is the risk of shaving off an area of healthy radicular cementum. Intraoperative root planing is indicated in all clinical situations other than above and for the gingival recessions in association with carious or demineralized root surface [7].

In addition to mechanical conditioning by hand and ultrasonic devices, the application of different laser systems for removing the smear-layer, exposing dentin tubules and collagen fibers on root surface have been demonstrated. Lasers considered as high technologic devices, take up huge space in periodontal treatment attempts in many aspects including root surface biomodification according to recent systematic reviews[162,163,164,165].

There are many different types of lasers recommended for different dental treatments.

- Argon Laser; tooth bleaching and advanced curing lights.
- Carbondioxide (CO_2) Lasers; Gingivectomy/Gingivoplasty, second stage implant exposure, periodontal curretage, removal of oral mucosal lesions.
- Diode Lasers; Gingivectomy/Gingivoplasty, oral medicine uses, second stage implant exposure, periodontal curretage, removal of oral mucosal lesions.
- Neodymium yttrium-garnet (Nd:YAG) Lasers; Gingivectomy/Gingivoplasty, oral medicine uses, second stage implant exposure, periodontal curretage, removal of oral mucosal lesions.
- Erbium: yttrium-garnet (Er:YAG) Lasers ; Gingivectomy/Gingivoplasty, second stage implant exposure, periodontal curretage, removal of hard tissues, removal of oral mucosal lesions.
- Erbium,chromium: yttrium (Er, Cr: YSSG) Lasers ; Gingivectomy/Gingivoplasty, second stage implant exposure, periodontal curretage, removal of hard tissues, removal of oral mucosal lesions.

In periodontology, lasers have potential applications in three main areas; surgical procedures (gingivectomy, crown lengthening, frenectomy), scaling and root planing and the management of pathological changes resulting from periodontal disease. However, there is still paucity of information and lack of randomized controlled clinical studies requiring further research[166].

Er:YAG laser is first presented by Zharikov et al. in 1975[167] . Its wavelength of 2940 nm coincides with absorption peak of water. Er:YAG laser is well absorbed by all biological tissues which contain water and can be used for the treatment of both hard and

soft tissues in periodontology. With its tissue friendly mechanism of action, Er:YAG laser seems encouraging since it has the capacity to remove smear layer efficiently and establish a biocompatible root surface[144,148,152,164,165,170–172,169,170].

2.7.2. Er:YAG Laser Biomodification Studies in the Literature

Theodoro et. al[151] have studied the extracted human teeth irradiated with Er:YAG laser (47 mJ and 83 mJ) after scaling and root planing and evaluated the root surface morphology by using scanning electron microscopy (SEM). They have shown that the usage of Er:YAG laser with 83 mJ enpowers the removal of the smear-layer and exposes the dentin tubules without creating fissures, cracks or carbonized areas.

Feist et. al[173] have cultured human gingival fibroblasts on dental root fragments after calculus removal followed by Er:YAG irridiation at 2 different energy densities (60 and 100 mJ/ pulse). The best cell adhesion and proliferation are observed with the pulse of 60 mJ. This energy density creates a homegenous roughness similar to micro-excavations of the same depth and is distributed uniformly along the fragments. Both energy densities of the Er:YAG laser are found more effective compared to the diode laser.

Theodoro et al. [174] have studied the biocompatibility of root surfaces treated by Er: YAG laser. Root fragments of human teeth extracted due to severe periodontitis are divided into 3 groups. In the first group; root planing is done with Gracey curettes, in the second group; irradiation is performed with Er:YAG laser (60 mJ/pulse, 10 Hz; 10" each with 10-second interval, 3 J/cm2), in the third group irradiation is done with Er:YAG laser (100 mJ/pulse, 10 Hz; 10" each with 10-second interval, 5 J/cm^2). Then, cells are seeded on the top of each fragment. One, 2, and 3 days after seeding, the specimens are prepared for SEM analysis. The surfaces treated with 60 mJ/pulse Er:YAG laser irradiation promoted faster cell adhesion and growth.

We have also in vitro studies on this very subject evaluating the surface morphology after different biomodification approaches. Although, Er:YAG laser ends up with surface roughness in comparison to the other root surface instrumentation tools, it also demonstrates the highest success in the exposition of collagen fibers and removal of the smear layer[170–172].

Based on the encouraging results of Er:YAG laser for root surface biomodification, removal of the smear layer and increasing the growth and adhesion of the cells, the aim of the present study is to compare the effects of two different biomodification approaches, as Er:YAG laser and ultrasonic device, on the clinical treatment outcomes of single gingival recessions treated by CAF + CTG.

3. MATERIALS and METHODS

3.1. Study Population

Study population consisted of 20 patients; aged between 28 to 52 who were referred to Yeditepe University Faculty of Dentistry, Periodontology Department, Istanbul, Turkey. Study protocol was approved by Yeditepe University Ethical Committee (Appendix 1). All the complications and prosperities of the procedures were explained and an informed consent form was obtained from each patient prior to the study.

3.2. Patient Selection

Patients were selected based on the following inclusion criteria:

- Periodontally and systemically healthy patients,
- Presence of Miller Class I and II maxillary canine and premolar teeth with gingival recessions ≥ 2 mm,
- Presence of identifiable CEJ,
- Full mouth plaque score (FMPS) <20%,
- Full mouth bleeding score (FMBS) <20%,
- Non-smoker.

Exclusion criteria for the participation of the study were as follows:

- Patients who received periodontal surgery previously on the affected-recession sites,
- Pregnant and nursing individuals, and systemically compromised patients,
- Prosthetic restorations at the experimental teeth.

3.3. Study Design

The study was designed as a parallel, randomized, controlled clinical trial. Flowchart of the study is shown in Figure 3. At baseline, patients received periodontal and radiographic examination. Baseline intraoral photographs were also taken. Initial

periodontal treatment was performed with ultrasonic devices[a] and Gracey curettes[b]. Patients were instructed to brush their teeth with roll technique [175] using a soft-bristled brush to eliminate the negative impact of improper brushing at least 2 months prior to surgery.

All surgical procedures were performed by the same investigator (E.Y.) in the same clinic. 10 patients of each group were treated by a combination of CAF with CTG. Test and control groups were randomly assigned by B.K. according to computer-generated randomization table (www.randomizer.org). During the surgical procedure, Er:YAG[c] laser was used for root biomodification in the test group, while ultrasonic device with 2 different tips (universal tip designed for supragingival scaling and H3 tip for root planing) was used for the same purpose in the control group. Each patient contributed with one gingival recession.

3.4. Sample Size Calculation

Sample size was calculated based on Francetti et al. [176]. The amount of vertical recession was used as primary outcome. The power analysis results indicate that, 9 subjects in each group defined at 80% statistical power and significance level (alpha) of 0.05 to detect mean paired of differences of 1.35 with a standard deviation (SD) of 0.7. 10 patients were treated in each group considering 10% drop-out.

[a] Newtron® P5 B.LED, Acteon, Merignac, France.
[b] Gracey SG 5/6, 7/8, Hu-Friedy®, Chicago, USA.
[c] Er:YAG laser, Hoya ConBio, Fremont, USA

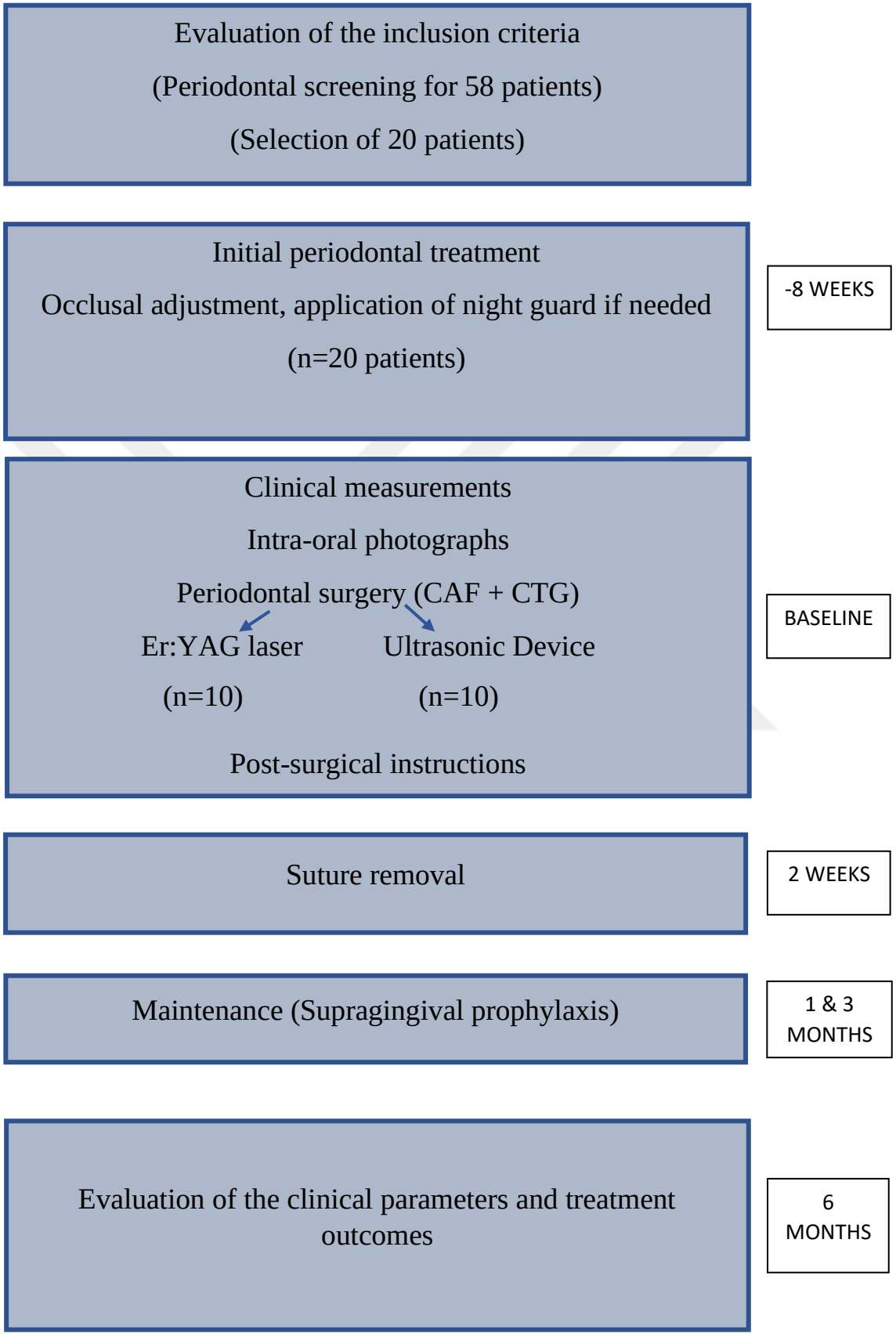

Figure 3. Flowchart of the study.

3.5. Clinical Indices and Measurements

Clinical indices and measurements including FMPS, FMBS, Plaque Index (PI), Gingival Index (GI), Probing Depth (PD), Recession Height (RH), Recession Width (RW), Clinical Attachment Level (CAL), and Keratinized Tissue (KT) were recorded before the surgical procedure and at 6-month follow up by the same blinded examiner (H.G.) with a manual periodontal probe[d]. Gingival Thickness (GT) was measured with a digital caliber[e]. Schematic illustration of the clinical measurements is shown in Figure 4.

3.5.1. Full Mouth Plaque Score

FMPS was recorded as the percentage of total tooth surfaces (mesiobuccal, buccal, distobuccal and palatal) that revealed the presence of plaque detected by the use of a periodontal probe [177].

3.5.2. Full Mouth Bleeding Score

Bleeding on probing was assessed dichotomously with a periodontal probe and FMBS was calculated as the percentage of total surfaces (mesiobuccal, buccal, distobuccal and palatal) with bleeding on probing[178].

3.5.3. Plaque Index

PI was used to determine the thickness of plaque along the gingival margin. Teeth were dried with air and dental plaque biofilm was evaluated with the probe at four sites for each experimental tooth (mesio-buccal, mid-buccal, disto-buccal and mid-palatinal). The scoring system had 4 grades as follows [179]:

Grade 0: No plaque at the gingival margin.

Grade 1: Thin plaque layer at the gingival margin, only detectable by scraping with a probe.

Grade 2: Moderate layer of plaque along the gingival margin, visible to the naked eye.

Grade 3: Abundant plaque along the gingival margin, interdental spaces filled with plaque.

[d] 15 UNC Color-Coded Probe, Hu-Friedy®, Chicago, USA.
[e] SHAN 75mm Stainless Steel Digital Caliper, Cincinnati, USA.

3.5.4. Gingival Index

GI was evaluated with periodontal probe to assess the bleeding potential of the gingival tissues from 4 surfaces of each experimental tooth (mesio-buccal papilla, mid-buccal margin, disto-buccal papilla and mid-lingual margin).

The scoring system had 3 grades as follows [180]:

Grade 0: Normal gingiva, no inflammation, no bleeding.

Grade 1: Mild inflammation, slight erythema, no bleeding.

Grade 2: Moderate inflammation, bleeding on probing.

Grade 3: Severe inflammation, severe erythema and swelling, tendency to spontaneous bleeding, possible ulceration.

3.5.5. Probing Depth (mm)

PD was measured at mid-buccal surface of the related teeth with a periodontal probe as the distance between the gingival margin and the bottom of the gingival sulcus.

3.5.6. Clinical Attachment Level (mm)

CAL was measured at mid-buccal surface of the related teeth with a periodontal probe as the distance between CEJ and bottom of the gingival sulcus.

3.5.7. Recession Height (mm)

RH was measured at the mid-buccal point of the recession as the distance between CEJ and margin of the gingiva.

3.5.8. Recession Width (mm)

RW was measured for the initial evaluation of the defect as the horizontal distance in mesio-distal direction at the level of CEJ [181].

3.5.9. Gingival Thickness (mm)

GT was measured 1 mm below the gingival margin at the mid-buccal gingival surface with #25 endodontic spreader under the local anesthesia. The spreader was positioned to puncture the gingiva, then the silicon stopper was placed carefully and thickness was measured with digital caliber [182].

3.5.10. Keratinized Tissue (mm)

KT was measured at the mid-buccal surface as the distance between the mucogingival junction and to the gingival margin [182].

3.5.11. Mean Defect Coverage (%)

Mean defect coverage (MDC) was calculated as,

[(RH baseline – RH 6 months) / RH baseline] x 100% [54].

3.5.12. Complete Coverage (%):

Complete coverage (CC) was calculated as the percentage of the experimental teeth which have the gingival margin at the CEJ or coronal to it at 6-month post-operatively.

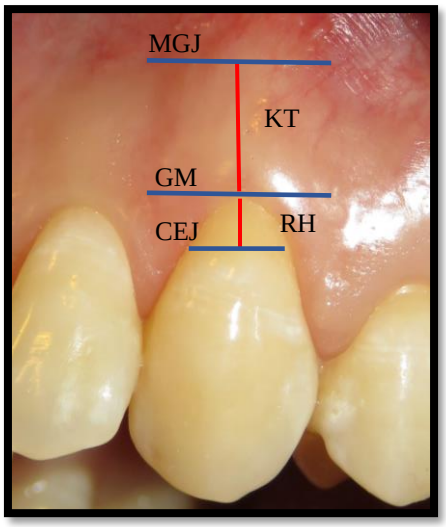

Figure 4. Clinical measurements of the defect area. (MGJ: Mucogingival Line, KT: Keratinized Tissue, GM: Gingival Margin, RH: Recession Height, CEJ: Cemento-enamel junction)

3.5.13. Esthetic Evaluation

Esthetic outcomes were assessed using the root coverage esthetic score (RES) at 6 months after surgery by an expert periodontist (H.G.) who is blinded to the treatment groups. The total score evaluates five variables, level of the gingival margin, marginal tissue contour, soft tissue texture, mucogingival junction alignment, and gingival color [183].

The evaluation of 'level of the gingival margin' score is like the following; 0 point for failure of root coverage, 3 points for partial root coverage and 6 points for complete root coverage.

'Marginal tissue contour' was evaluated as irregular gingival margin (0 point) or proper marginal contour (1 point).

For the 'soft tissue texture', 0 point refer to scar formation or keloid-like appearance whereas 1 point for MGJ aligned harmonically with the MGJ of the adjacent teeth.

'Gingival color' was evaluated as color of the gingival tissue not integrated with the color at adjacent tissues (0 point) or integration with the adjacent soft tissues (1 point).

Patient satisfaction in terms of esthetics was also evaluated at 6 months. Patients were asked to express their satisfaction for the treatment outcomes. Color match, overall satisfaction and complete root coverage parameters were evaluated by the patients from excellent to good, fair and poor [183].

3.6. Surgical Technique

Both test and control groups were treated with the same surgical technique as CAF + CTG described by Zucchelli et al[60,65]. After application of the infiltration anesthesia[f], two horizontal incisions extending 3 mm each in the mesial and distal direction were performed at a distance from the vertex of the anatomic papilla equal to the depth of the recession and two beveled vertical-releasing incisions extending into the alveolar mucosa. A split-full-split thickness flap was elevated and all muscle insertions were eliminated to relieve its coronal displacement[60] (Figure 5).

In the control group root surface biomodification was performed with an ultrasonic device with two sequentially used specifically-designed tips[g] until clean and hard root surface was obtained by sweeping motion (Figure 6), while in the test group the root surface biomodification was performed with Er:YAG laser (Figure 7). Root surfaces were irradiated with a laser beam of 30 Hz, 50 Mj, 1.5 W with a sweeping motion under water irrigation. During laser irradiation, protective glasses with appropriate optical density was used by the operator.

[f] Ultracain DS Fort 2 ml, Aventis Pharma Istanbul, Turkey.
[g] Newtron® P5 B.LED, Acteon, Merignac, France.

CTG was harvested from the palate with the DGG technique[65]. An epithelized FGG was taken from the palate and de-epithelized with a sharp 15c blade[h]. Two horizontal incisions of which the coronal one was performed 1-1.5 mm apical to the soft tissue margin and two vertical incisions uniting these two horizontal incisions were made to outline the graft borders to be harvested. The graft is harvested in a split-thickness fashion obtaining a FGG of approximately 1.5 mm thickness. De-epitelization was done until all epithelium was removed. The graft was sutured at the level of the CEJ with two interrupted sutures[i]. Then the flap was advanced 1-2 mm coronal to CEJ in order to cover the CTG completely. A sling suture was anchored behind the palatal cingulum of the tooth with the recession defect to compress the surgical papillae against the corresponding de-epithelized anatomical papillae. Non-absorbable monofilament interrupted sutures[j] were placed on the releasing incisions with an apico-coronal direction. Final double horizontal mattress suture[k] was placed at the base of the buccal fornix to eliminate the forces of the muscle insertions as well as to restore the vertical dimension of the vestibule.

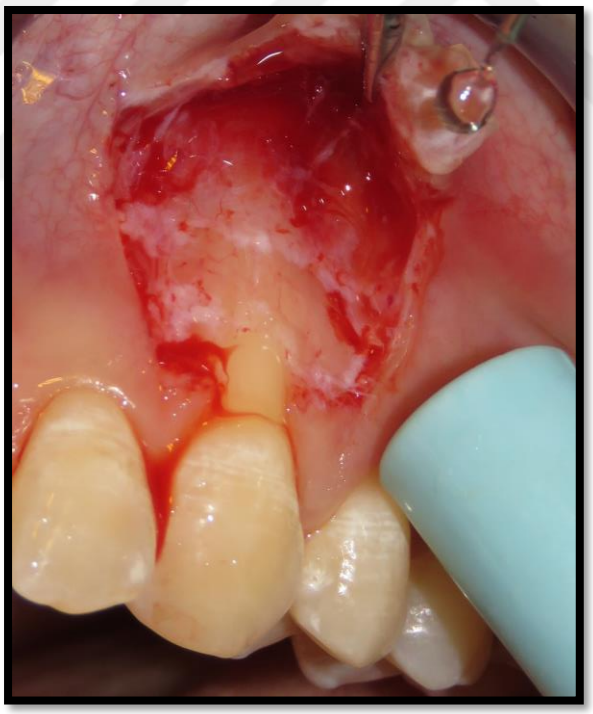

Figure 5. Split-full-split flap design.

[h] Galena 15 Blade, Istanbul, Turkey.
[i] Vycril, 6-0, Pegelak®, Doğsan, Trabzon, Turkey.
[j] Polyproplene,6-0, Propilen®, Doğsan, Trabzon, Turkey.
[k] Vycril, 3-0, Pegelak®, Doğsan, Trabzon, Turkey.

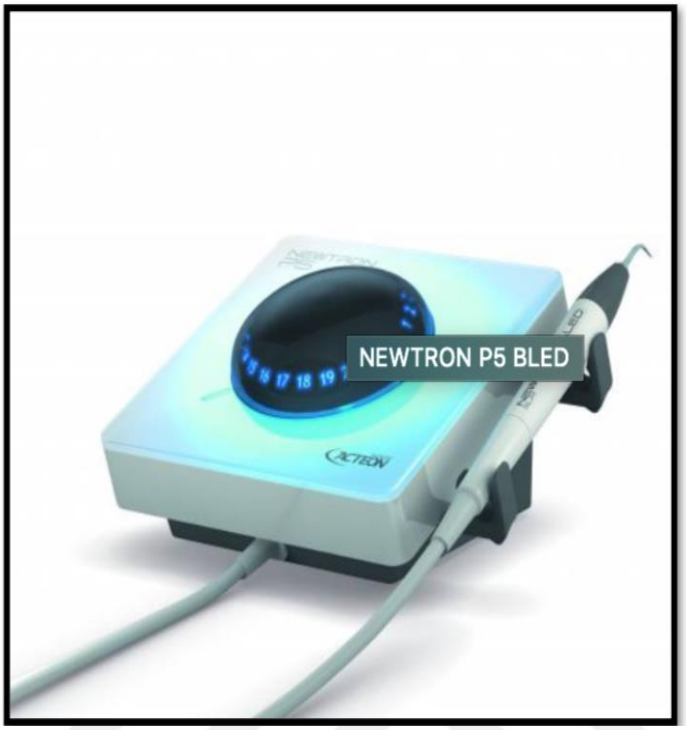

Figure 6. Ultrasonic Device

Figure 7. Er:YAG Laser

3.7. Postsurgical Medication, Oral Hygiene, Diet, and other Precautions

Post-operative instructions regarding the infection control and home care were given in written form by hand-outs. Naproxen sodium[l] (550 mg) was prescribed every 12 hours for 5 days to prevent pain and edema. Patients were instructed to rinse with chlorhexidine (CHX) solution[m] (0.2%) twice daily for 1 minute commencing the day after procedure and continuing for 14 days after suture removal. Patients were advised not to brush the surgical area for 2 weeks and to apply an ice pack for 24 hours, intermittently. Lukewarm or cold semiliquid diet on the day of procedure was recommended. During the days following the surgery, semiliquid diet and easy-to-chew soft food with no sharp edges were recommended for 2 weeks. Patients were also instructed not to pull their lips, not to consume any hot beverages, avoid heavy chewing and any physical activity for the following 2 weeks.

At two weeks following the operation, sutures were removed, plaque control of the surgical area was maintained with the 0.2% CHX solution for the additional 14 days. Therefore, starting from the third week after surgery, patients were instructed to start tooth brushing with a soft-bristled toothbrush using the roll technique without a toothpaste[184]. Regular tooth brushing including interdental cleaning was resumed at 4 weeks postoperatively[185]. At 3-month follow-up appointment, the use of soft brush was changed to a medium toothbrush[186].

All the patients were recalled at 1, 3and 6 month follow-ups after the surgical procedures for the professional supragingival prophylaxis and at 6 months for clinical measurements.

3.8. Data Analysis

The statistical analysis was performed by a commercially available software (IBM SPSS Statistics 22). Mean & standard deviations (mean ± SD) and median values for the clinical parameters were calculated. Age, gender and location of the gingival recession defects were tested via Student's t-test and Continuity (Yates) correction. Esthetic evaluation and patient satisfaction data were tested via Fisher's exact test. Data analysis was done full mouth for plaque accumulation and bleeding scores (FMPS, FMBS) whereas PI, GI, PD, CAL, RH, GT and KT were evaluated site specific for the

[l] Apranax Forte Tablets 550 mg; Abdi Ibrahim, Istanbul, Turkey.
[m] Klorhex Oral Rinse % 0,2; Drogsan Pharmaceuticals, Istanbul, Turkey.

experimental teeth. All the parameters were measured at baseline and at 6 months. Kolmogorov-Smirnov test was used for the evaluation of the distribution of parameters. Parameters without normal distribution were evaluated using the Mann Whitney U-test for the inter-group and the Wilcoxon sign test for the intra-group comparisons. The primary outcome variable was RH. The other parameters were considered as secondary outcome variables. The value of $p<0.05$ was considered to be the level of significance.

4.RESULTS

20 patients aged between 28 to 52 years with Miller I buccal single gingival recession defects ≥ 2 mm, were treated in the study. The recessions were located at 12 canines and 8 premolars. Age, gender and recession locations of the test and control groups are presented in Table 3. All patients completed the study and none of them were excluded from the study.

One representative case from each group are presented in Figures 8 to 19.

Table 3. Demographic data and recession locations.

		CONTROL	TEST	p
Age (Mean ± SD)		35.6±2.1	33.9±2.5	0.086[1]
Gender (n)/%	Female	(4)/40	(4)/40	1.000[2]
	Male	(6)/60	(6)/60	
Recession Location (n)/%	Canine	(6)/60.0	(6)/60.0	1.000[2]
	Premolar	(4)/40.0	(4)/40.0	

[1]*Student T test,* [2]*Continuity (Yates) test,* p>0.05.

4.1. Baseline Clinical Parameters

Baseline clinical parameters regarding FMPS (%), FMBS (%), PI, GI, PD (mm), RH (mm), RW (mm), GT (mm), KT (mm) are presented in Table 4. No statistically significant differences were detected between the test and control groups at baseline in terms of all evaluated clinical parameters (p>0.05).

Table 4. Inter-group comparison of the baseline clinical parameters.

	CONTROL Mean ± SD (Median)	TEST Mean ± SD (Median)	p
FMPS (%)	13.21±0.49 (13)	12.71±1.29 (12.5)	0.219
FMBS (%)	12.04±0.98 (12)	12.43±1.21 (12.5)	0.366
PI	0.48±0.33 (0.33)	0.62±0.23 (0.67)	0.340
GI	0.52±0.26 (0.33)	0.67±0.27 (0.67)	0.304
PD (mm)	1.38±0.23 (1.33)	1.28±0.23 (1.33)	0.431
RH (mm)	2.57±0.65 (2.5)	2.82±0.6 (3)	0.297
RW (mm)	2.50±0.5 (2.5)	2.57±0.45 (2.5)	0.784
GT (mm)	1.00±0.41 (1)	1.07±0.35 (1)	0.728
KT (mm)	3.14±0.48 (3)	3.64±0.48 (4)	0.076

Mann Whitney U test, $p<0.05$.

4.2. Full Mouth Plaque Score (%)

The mean ± standard deviations, and median values of FMPS at baseline and 6 months are presented in Table 5. The percentages of FMPS were detected 13.21±0.49 and 12.71±1.29 at baseline; 12.50±1.15 and 12.00±1.29 at 6 months, in control and test

groups, respectively. Intra- and inter-group comparisons of FMPS were not statistically significant both at baseline and 6 months (p>0.05).

Table 5. Intra- and inter-group comparisons of FMPS at baseline and 6 months.

		CONTROL Mean ± SD (Median)	TEST Mean ± SD (Median)	p[1]
FMPS (%)	Baseline	13.21±0.49 (13)	12.71±1.29 (12.5)	0.219
	6 Months	12.50±1.15 (13)	12.00±1.29 (11.5)	0.477
	p[2]	0.180	0.059	

[1]*Mann Whitney U test,* [2]*Wilcoxon sign test,* p<0.05.

4.3. Full Mouth Bleeding Score (%)

The mean ± standard deviations and median values of FMBS at baseline and 6 months, intra and inter-group comparisons are presented in Table 6. The percentages of FMBS were detected 12.04±0.98 and 12.43±1.21 at baseline; 10.61±1.46 and 11.50±12.9 at 6 months in control and test groups, respectively. Intra-group comparisons revealed statistically significant differences in FMBS in both groups at 6 months (p=0.041, p=0.017)). Inter-group differences were not statistically significant at baseline and 6 months (p>0.05).

Table 6. Intra- and inter-group comparisons of FMBS (%) at baseline and 6 months.

		CONTROL Mean ± SD (Median)	TEST Mean ± SD (Median)	p[1]
FMBS (%)	Baseline	12.04±0.98 (12)	12.43±1.21 (12.5)	0.366
	6 Months	10.61±1.46 (10.5)	11.50±1.29 (11.5)	0.222
	p[2]	**0.041**	**0.017**	

[1]*Mann Whitney U test,* [2]*Wilcoxon sign test,* p<0.05.

4.4. Plaque Index

The mean ± standard deviations, and median values of PI scores of experimental teeth at baseline and 6 months are presented in Table 7. PI scores were detected 0.48±0.33 and 0.62±0.23 at baseline; and 0.14±0.18 and 0.19±0.26 at 6 months, in control and test groups, respectively. Intra-group comparisons revealed statistically significant differences in PI scores in both groups at 6 months (p=0.047, p=0.049). Inter-group comparisons of PI scores were not found statistically significant both at baseline and 6 months (p>0.05).

Table 7. Intra- and inter-group comparisons of PI scores at baseline and 6 months.

		CONTROL Mean ± SD (Median)	TEST Mean ± SD (Median)	p[1]
PI	Baseline	0.48±0.33 (0.33)	0.62±0.23 (0.67)	0.340
	6 Months	0.14±0.18 (0)	0.19±0.26 (0)	0.827
	p[2]	**0.047**	**0.049**	

[1]*Mann Whitney U test,* [2]*Wilcoxon sign test,* p<0.05.

4.5. Gingival Index

The mean ± standard deviations and median values of GI scores of the experimental teeth at baseline and 6 months, intra- and inter-group comparisons are presented in Table 8. GI scores were detected 0.52±0.26 and 0.67±0.27 at baseline; 0.19±0.18 and 0.19±0.26 at 6 months in control and test groups, respectively. Intra-group comparisons revealed statistically significant differences in GI values in both groups at 6 months (p=0.041, p=0.039). Inter-group differences were not statistically significant for GI scores at baseline and 6 months (p>0.05).

Table 8. Intra and inter-group comparisons of GI at baseline and 6 months.

		CONTROL Mean ± SD (Median)	TEST Mean ± SD (Median)	p[1]
GI	Baseline	0.52±0.26 (0.33)	0.67±0.27 (0.67)	0.304
	6 Months	0.19±0.18 (0.33)	0.19±0.26 (0)	0.830
	p[2]	**0.041**	**0.039**	

[1]*Mann Whitney U test,* [2]*Wilcoxon sign test,* p<0.05.

4.6. Probing Depth (mm)

The mean ± standard deviations, and median values of PD of the experimental teeth at baseline and 6 months, intra-and inter-group comparisons are presented in Table 9. PD values were detected 1.38±0.23 and 1.28±0.23 at baseline; and 1.48±0.18 and 1.38±0.23 at 6 months, in control and test groups, respectively. Intra- and inter-group comparisons of PD values were not statistically significant both at baseline and 6 months (p>0.05).

Table 9. Intra- and inter-group comparisons of PD (mm) at baseline and 6 months.

		CONTROL Mean ± SD (Median)	TEST Mean ± SD (Median)	p[1]
PD (mm)	Baseline	1.38±0.23 (1.33)	1.28±0.23 (1.33)	0.431
	6 Months	1.48±0.18 (1.33)	1.38±0.23 (1.33)	0.424
	p[2]	0.450	0.453	

[1]*Mann Whitney U test,* [2]*Wilcoxon sign test,* p<0.05.

4.7. Clinical Attachment Level (mm)

The mean ± standard deviations and median values of CAL at baseline and 6 months, intra- and inter-group comparisons are presented in Table 10. CAL values were 3.95±0.49 and 4.10±0.48 at baseline; 1.69±0.39 and 1.65±0.60 at 6 months, in control and test groups, respectively. Intra-group comparisons revealed statistically significant differences in CAL as attachment gain in both control and test groups at 6 months (p=0.015, p=0.017). Inter-group differences were not statistically significant for CAL at baseline and 6 months (p>0.05).

Table 10. Intra- and inter-group comparisons of CAL (mm) at baseline and 6 months.

		CONTROL Mean ± SD (Median)	TEST Mean ± SD (Median)	p^1
CAL (mm)	Baseline	3.95±0.49 (4)	4.1±0.48 (4)	0.583
	6 Months	1.69±0.39 (2)	1.65±0.37 (2)	0.797
	p^2	**0.015**	**0.017**	

[1]*Mann Whitney U test*, [2]*Wilcoxon sign test*, p<0.05.

4.8. Recession Height (mm)

The mean ± standard deviations and median values of RH at baseline and 6 months, intra- and inter-group comparisons are presented in Table 11. RH values were 2.57±0.65 and 2.82±0.60 at baseline; and 0.21±0.58 and 0.27±0.65 at 6 months, in control and test groups, respectively. Intra-group comparisons revealed statistically significant differences in both test and control groups at 6 months (p=0.001, p=0.003). Inter-group differences were not statistically significant at baseline and 6 months (p>0.05)

Table 11. Intra- and inter-group comparisons of RH (mm) at baseline and 6 months.

		CONTROL Mean ± SD (Median)	TEST Mean ± SD (Median)	p[1]
RH (mm)	Baseline	2.57±0.65 (2.5)	2.82±0.60 (3)	0.297
	6 Months	0.21±0.58 (0)	0.27±0.65 (0)	0.797
	p[2]	**0.001**	**0.003**	

[1]*Mann Whitney U test,* [2]*Wilcoxon sign test,* p<0.05.

4.9. Gingival Thickness (mm)

The mean ± standard deviations and median values of GT at baseline and 6 months, intra- and inter-group comparisons are presented in Table 12. Intra-group comparisons of GT values revealed statistically significant differences in both test and control groups at 6 months (p=0.015, p=0.016). Inter-group differences were not statistically significant at baseline and 6 months (p>0.05).

Table 12. Intra- and inter-group comparisons of GT (mm) at baseline and 6 months.

		CONTROL Mean ± SD (Median)	TEST Mean ± SD (Median)	p[1]
GT (mm)	Baseline	1.00±0.41 (1)	1.07±0.35 (1)	0.728
	6 Months	2.21±0.39 (2)	2.32±0.51 (2.5)	0.583
	p[2]	**0.015**	**0.016**	

[1]*Mann Whitney U test,* [2]*Wilcoxon sign test,* p<0.05.

4.10. Keratinized Tissue (mm)

The mean ± standard deviations and median values of KT at baseline and 6 months, intra- and inter-group comparisons are presented in Table 13. KT values were 3.14±0.48 and 3.64±0.48 at baseline; 4.43±0.35 and 4.79±0.64 at 6 months, in control and test

groups, respectively. Intra-group comparisons revealed statistically significant differences in KT in both control and test groups at 6 months (p=0.017, p=0.014). Inter-group differences were not statistically significant for KT at baseline and 6 months (p>0.05)

Table 13. Intra- and inter-group comparisons of KT (mm) at baseline and 6 months.

		CONTROL Mean ± SD (Median)	TEST Mean ± SD (Median)	p^1
KT (mm)	Baseline	3.14±0.48 (3)	3.64±0.48 (4)	0.076
	6 Months	4.43±0.35 (4.5)	4.79±0.64 (5)	0.258
	p^2	**0.017**	**0.014**	

[1]*Mann Whitney U test*, [2]*Wilcoxon sign test*, p<0.05.

4.11. Clinical Parameters at 6 Months

Inter-group comparisons of the intra-group changes of the evaluated clinical parameters as PD change, CAL gain, RH reduction, KT gain as well as percentages of MDC and CC were not found statistically significant (p>0.05) (Table 14).

Table 14. Inter-group comparisons of the mean differences of the clinical parameters between baseline and 6 months.

	CONTROL Mean ± SD (Median)	TEST Mean ± SD (Median)	p
PD change (mm)	-0.1±0.26 (0)	-0.1±0.32 (0.33)	0.948[1]
CAL gain (mm)	2.26±0.76 (2.5)	2.45±0.82 (2.5)	0.250[1]
RH reduction (mm)	2.36±0.55 (2)	2.55±0.65 (2)	0.797[1]
KT gain	1.29±0.49 (1,5)	1.14±0.24 (1)	0.441[1]
MDC (%)	92.14±7.26 (100)	93.36±8.09 (100)	0.796[1]
CC (%) / n	80 / 8	80 / 8	1.000[2]

[1]Mann Whitney U test, [2]Fisher's Exact Test, p<0.05

4.12. Esthetic evaluation

Professional evaluation of the color match, contour, consistency, contiguity and degree of the keloid formation is presented in Table 15. No significant differences were found between the two groups (p>0.05).

Table 15. Evaluation of the color match, contour, consistency, contiguity and degree of the keloid formation.

	CONTROL n/%	TEST n/%	p
Color match			
Excellent	5/50	6/60	
Good	5/50	4/40	0.850
Adequte	0/0	0/0	
Unsatisfactory	0/0	0/0	
Contour			
Good	10/100	10/100	1.000
Poor	0/0	0/0	
Irregular	0/0	0/0	
Consistency			
Firm	10/100	10/100	
Spongy	0/0	0/0	1.000
Contiguity			
Yes	10/100	10/100	1.000
No	0/0	0/0	
Keloid Formation			
Absent	10/100	10/100	1.000
Present	0/0	0/0	

Fisher's exact test ($p<0.05$).

4.13. Patient Satisfaction with Esthetics

Patient satisfaction score evaluated in terms of color match, overall satisfaction and amount of root coverage is presented in Table 16. No significant differences were found between the groups ($p>0.05$).

Table 16. Patient satisfaction with color match, overall satisfaction and amount of root coverage.

	CONTROL n/%	TEST n/%	p
Color match			
Excellent	5/50	5/50	
Good	5/50	5/50	0.850
Fair	0/0	0/0	
Poor	0/0	0/0	
Overall Satisfaction			
Excellent	10/100	10/100	
Good	0/0	0/0	1.000
Fair	0/0	0/0	
Poor	0/0	0/0	
Amount of Root Coverage			
Excellent	8/80	8/80	1.000
Good	2/20	2/20	
Fair	0/0	0/0	
Poor	0/0	0/0	

Fisher's exact test ($p<0.05$).

4.14. Representative Case of the Control Group (Figures 8-13)

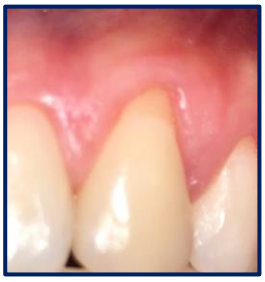

Figure 8: Pre-operative clinical view

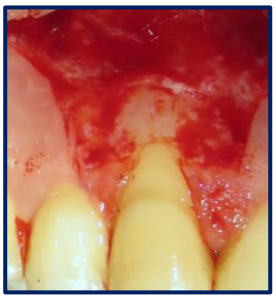

Figure 9: Split-full-split thickness flap elevation

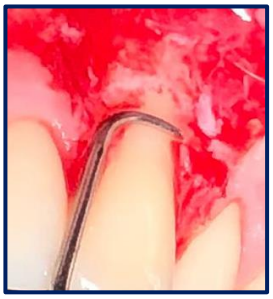

Figure 10: Biomodification with ultrasonic device

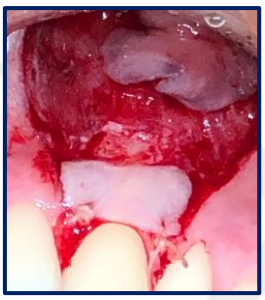

Figure 11: CTG sutured with 4.0 absorbable suture

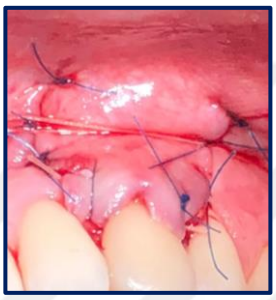

Figure 12: Final closure of the flap

Figure 13: Post-operative view at 6 months.

4.15. Representative Case of the Test Group (Figures 14-19)

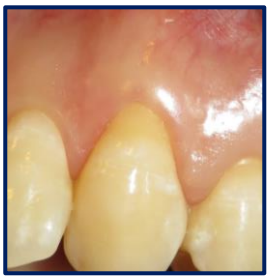

Figure 14: Pre-operative clinical view

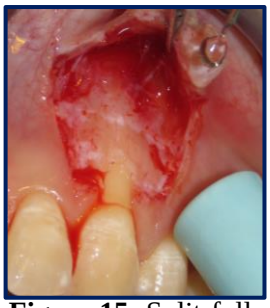

Figure 15: Split-full-split thickness flap elevation

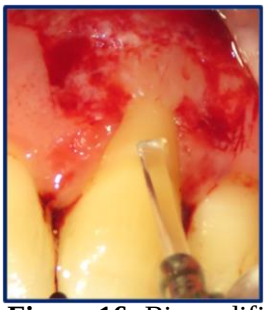

Figure 16: Biomodification with Er:YAG laser

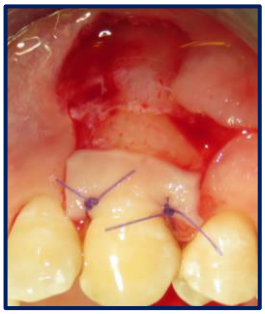

Figure 17: CTG sutured with 4.0 absorbable suture

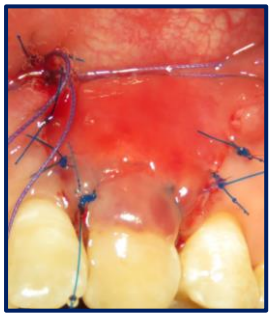

Figure 18: Final closure of the flap

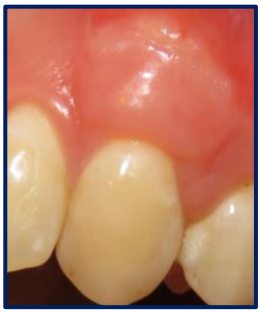

Figure 19: Post-operative view at 6 months.

5. DISCUSSION and CONCLUSION

The aim of this randomized controlled clinical study was to evaluate the clinical outcomes of CAF + CTG combined with an Er:YAG laser or an ultrasonic device instrumentation for root surface biomodification. No significant differences were found in terms of defect coverage outcomes between the groups treated with Er:YAG laser or ultrasonic device, however, both groups ended up with clinically significant improvements.

It is important to evaluate the gingival recession cases for decision making before the surgery[32]. The right indications and the concomitance with the present clinical situation lead to success in the treatment. The amount of the keratinized gingival tissue apical or lateral to the gingival recession is of critical importance. In the present study, the mean height of the keratinized gingival tissue apical to the recession defect was 3.14±0.48 mm in the control and 3.64±0.48 mm in the test groups, respectively. However, the initial gingival thickness was approximately 1.00 mm in the control and test groups, that justified the use of CTG.

A recent systematic review has revealed that CAF procedure is a safe and predictable root coverage surgical technique for the treatment of single-type gingival recessions[187]. However, CAF alone has some disadvantages when the thickness of the flap is equal to less than 1mm. Therefore, CAF + CTG combination as the bilaminar technique was used in this study as proposed by Zucchelli[60].

The main indications for the bilaminar technique are high esthetic demands and a flap thickness equal or less than 1mm. Bilaminar technique, combining CAF + CTG, provides an additional blood supply to the CTG. Furthermore, the esthetic results are better through hiding the white scare appearance of the graft and masking the irregular outline of the mucogingival junction that are frequently seen after FGG procedure[158].

During the last two decades, clinicians have introduced several modifications to the original bilaminar technique. These modifications are related to the type of the graft harvested from palate, to the design of the flap with the use of envelope approach[61,62] or vertical releasing incisions[63,64]. More recently in a study by Zucchelli et al[65]., another modified approach is recommended to improve the esthetic results of bilaminar technique. These modifications this time are related to the harvesting technique, size,

thickness and the positioning of the CTG in relation to CEJ. According to Zucchelli et al.[65] the obtained CTG should be less than 1mm thickness and be placed apical to the CEJ at a distance equal to the height of the keratinized tissue.

In the present study, the thickness of the CTG was less than 1mm obtained by DGG and was placed apical to the CEJ at a distance equal to the height of the existing keratinized tissue. The literature has reported different CTG harvesting techniques. The most common are trapdoor[68] and the envelope techniques with single[56,188] or double incisions[67]. The split thickness flap elevation has been performed during these procedures with a primary closure. However, in the presence of a thin palatal mucosa, DGG harvesting procedure presents advantages. The studies which evaluate the patient-based results after usage of CTG and DGG for root coverage approaches have revealed minimal differences [65,188,189]. Although the higher amount of postoperative pain has been reported after the DGG operations due to secondary healing compared to the CTG procedures, Zucchelli et. al. reported no statistically significant difference between the two harvesting techniques in terms of painkiller consumption, post-operative discomfort and bleeding[65]. Other advantages of the usage of the DGG are greater stability of the graft and less shrinkage compared to the deeper connective tissue harvested using the trap-door approach[65]. Considering these advantages, DGG technique for harvesting CTG was prefered along with the CAF procedure in the present study.

One of the fundamental steps considered in root coverage procedures, is the mechanical root surface modification, suggested by most of the authors for different purposes, such as smoothing irregularities or grooves of the root surface, removing root caries lesions, reducing the convexity of the root or mesio-distal distance and minimizing cementum toxicity[158,159]. A trial by Pini Prato et al. [148] have shown that while vigorous root planing does not significantly modify root curvature, it only reduces mesio-distal root dimension by 3%. Furthermore, flattening the root surface reduces the number of dentin tubules available for clot attachment which is the first healing event in periodontal wound healing. Today, therefore, agressive root planing is no longer justified and this fact have aroused much more clinical interest in the idea of performing mechanical root instrumentation with ultrasonic scalers[125]. In the present study, the specifically designed ultrasonic tips were used. Ultrasonic instruments are not only easier and faster to use in comparison to curettes, but also cause less trauma to soft tissues when used subgingivally and cause less root tissue loss[190]. A recent trail by Zucchelli et al. [125] have found similar

results in terms of root coverage or CAL gain between the root surface biomodification instrumentation with curettes or ultrasonic devices in conjunction with CAF. In order to eliminate the detrimental effects of post-mechanical smear layer presented on the root surface, compromising the cell reattachment and process of regeneration, several authors have also suggested the use of different chemical agents, such as citric acid, tetracycline, HCI and sodium hypochlorite combined with scaling and root planing[150,158,159]. These agents have been used to remove the smear layer produced by mechanical root instrumentation, expose the collagen fibrils of the dentin matrix that facilitate the formation of the new connective tissue attachment and remove cytopathic substances that inhibit human gingival fibroblast growth from infected cementum. However, a systematic review has shown that results from controlled clinical trials in humans do not show significant differences in terms of root coverage between sites treated with root planing alone or with a combined treatment[158]. For today, chemical root surface conditioning cannot be considered as an adjunctive or a key element to provide better root coverage during the treatment of gingival recessions defects.

Recently, prominence has been given to the use of lasers for this purpose. Er:YAG laser has drawn attention due to its tissue friendly mechanism of action, safety and bactericidal effects as well as the capacity to remove bacterial endotoxins. Ablation occurs without producing a smear layer when Er:YAG lasers are used[163].

Due to the excellent ablation effect on both soft and hard tissues, Er:YAG laser can be used safely during the periodontal treatment procedures[162]. Periodontal connective tissue attachment on to the Er:YAG-lased root surface has not yet been fully studied. Along with our in vitro studies [170–172] evaluating the root surface changes of different agents and instrumentations, considered as a reliable basis for constructing the aim of the present study, we evaluated the use of Er:YAG laser for root surface biomodification compared to gentle mechanical surface preparation with novel tips of an ultrasonic device. However, we found no significant differences between the study groups on the clinical outcomes of the treatment of single maxillary gingival recessions.

There are only 3 studies in the literature aiming the same objectives for the evaluation of root surface biomodification in patients with Miller I and II single gingival recession defects[125,153,154]. Two of them are directly related with the present study in terms of test and control root surface applications as well as the surgical treatment method of CAF+CTG[153,154].

Dilsiz et al. evaluated the efficiency of Er:YAG laser for the root surface biomodification during the treatment of gingival recessions with CAF+CTG technique[154]. In this split-mouth, randomized clinical trial, 24 teeth with approximately 3mm of RH in 12 patients presenting Miller class I and II gingival recessions were divided into 2 groups as test and control. Only in the test group root surface biomodification was performed using Er:YAG laser (2 Hz, 60 mJ=pulse, 40 s, with air spray). CAL, RH and PD were measured at baseline and 6 months postsurgery. RH values were 3.08±0.57 mm and 3.00±0.71 mm at the baseline and 0.58±1.02 and 0.46±0.75 mm at 6 months in the test and control group, respectively. CAL values were 4.54±0.90 and 4.67±0.94 mm at baseline and 2.04±0.59 and 2.08±0.49 mm at 6 months in the test and control groups, respectively ($p>0.05$). PD values were 1.46±0.43 mm and 1.58±0.49 mm at the baseline and 1.46±0.66 mm and 1.63±0.68 mm at 6 months in the test and control group ($p>0.05$). For test and control groups, the MRC was 80% and 86% ($p>0.05$) and complete root coverage was 75% and 67%, respectively ($p>0.05$). No significant differences were found between the test and control groups in terms of all the evaluated parameters ($p>0.05$). However, significant MRC and CAL gain values were obtained within both groups. This study showed that root surface conditioning with an Er:YAG laser did not enhance the clinical results achieved by CAF+ CTG.

Poormoradi et al. evaluated the root surface biomodification by Er,Cr:YSGG laser (2780 nm wavelength, 20 Hz repetition rate, 0.75 W power) versus curette instrumentation[153]. In this split-mouth, randomized clinical trial, 30 patients presenting Miller I and II gingival recessions with ≥2mm of RH, were treated using CAF+CTG technique. Clinical parameters (RH, CAL and PD) were collected at baseline, at 2 and 6 months postoperatively. At baseline, RH was 3.27±0.70 mm in the test group and 3.20±0.77 mm in the control group. At 6 months RH was 0.40±0.63 mm in the test group and 0,73±0,96 mm in the control group ($p>0.05$). CAL values were 4.80±1.20 mm and 4.67±1.11 mm in the test and control groups at baseline. After 6 months, CAL was 1.33±0.97 mm in the test group and 1.80±1.32 mm in the control group ($p>0.05$). At baseline PD was 1.53±0.64 mm in the test group and 1.47±0.64 mm in the control group. At 6 months PD was 1.13±0.35 mm in the test group and 1.27±0.45 mm in the control group, respectively ($p>0.05$). MRC was 87% for the test and 80% for the control groups ($p>0.05$), and for CC, it was 66% and 60%, respectively ($p>0.05$). There were no significant differences between the two groups in terms of all evaluated parameters

($p>0.05$). In conclusion, although root surface biomodification by Er,Cr:YSGG laser improved MRC and CC percentages, these changes were not found statistically significant.

In the third, more or less similar study by Zucchelli et al., CAF alone was used as the surgical technique[125]. The matching test group in this study was ultrasonic mechanical biomodification with the aim of comparing the effectiveness versus curette instrumentation. This split mouth randomized clinical trial on 11 subjects with bilateral gingival recession defects presenting ≥3mm of RH, evaluated the clinical parameters of FMPS and FMBS, RH, CAL and KT. The results revealed high percentages of MRC (95.4% in the control group and 84.2% in the test group) and CC (82% in the control group and 55% in the test), with no statistically significant difference between them. CAL gains were clinically significant within both groups (3.36±0.92 mm in the control group and 2.90±0.70 mm in the test group), again without statistically significant difference between them. The increase in KT was statistically significant within both groups without any significant difference in between (0.55±0.52 mm in the control group and 0.36±0.67 mm in the test group). In conclusion, similar results were reported in terms of root coverage outcomes when hand and ultrasonic root instrumentation were used as root surface biomodification treatments.

In the present study, baseline PD was 1.38±0.23 mm in the control and 1.28±0.23 mm in the test groups, respectively. A minor negative change of PD at 6 months was 0.1±0.26 mm in the control and 0.1±0.32 mm in the test groups. Baseline CAL was 3.95±0.49 mm in the control, 4.1±0.48 mm in the test groups, respectively. CAL gain at 6 months was 2.26±0.76 mm in the control group while it was 2.45±0.82 mm in the test group. Baseline GT was 1±0.41 mm in the control and 1.07± 0.35 mm in the test groups, respectively. After 6 months, GT was 2.21 ±0.39 mm in the control and 2.32±0.51 mm in the test groups. At baseline KT was 3.14±0.48 mm in the control and 3.64±0.48 mm in the test groups. At 6 months they were 4.43±0.35 mm in the control and 4.79±0.64 mm in the test groups. RH was 2.57±0.65 mm in the control and 2.82±0.60 mm in the test groups. At 6 months, RH reduction was 2.36±0.55 mm in the control and 2.55±0.65 mm in the test groups, respectively. The MDC in the test and control groups at 6 months was 93% and 92%, respectively and CC was detected as 80% in both groups. None of the evaluated parameters revealed significant differences between the two groups.

When the differences between the baseline and 6 months measurements of the clinical parameters as well as MDC and CC percentages were evaluated all together in comparison with the similar articles in the current literature, similar improvements were obtained within the groups of Er:YAG laser and ultrasonic root biomodification methods. However, the differences did not reach to a significant level between the groups of this and the related aforementioned studies, suggesting the failure of demonstrating any better results in root coverage supported by the use of different root surface treatment techniques. On the other hand, CAF+CTG as the surgical method, achieved clinically significant improvements in root coverage and is confirmed as one of the most predictable root coverage surgery. The impact of root instrumentation during root coverage surgery may not be reflected to the clinical outcomes or may be overshadowed by the clinical success of the applied surgical technique. Furthermore, it may be speculated that root surface biomodification is not a key factor for the overall clinical success which needs further investigation of other contributing factors. Histological findings are of high importance for a final decision on the adjunctive effects of root surface biomodification methods.

Improvement in esthetics together with a comfortable postoperative period is one of the major goals of periodontal plastic surgery. There is limited data in the literature respecting patient's perceptions and opinions because of the difference in primary criteria of evaluation between patients and professionals[183]. Patient centered assessments can be made by questioning them for the levels of esthetic outcomes and are beneficial for the overall feedback. In both of our groups, a satisfactory color and tissue blend were obtained in the recipient area together with the improved clinical parameters in this study. According to the patient reported outcomes none of the patients declared dissatisfaction concerning esthetic parameters.

Within the limits of this study, we concluded with statistically insignificant differences in terms of RH, CAL gain, MDC and CC, during the root surface treatment with Er:YAG laser. Studies on a larger group of patients and additional histological studies are required to provide support and evidence for the clinical and biologic aspects of laser biomodification.

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T.C. YEDİTEPE ÜNİVERSİTESİ

Sayı : 37068608-6100-15- 1923 **13/08/2020**
Konu: Klinik Araştırmalar
Etik Kurul Başvurusu hk.

İlgili Makama (Ece Deniz Yarımoğlu)

Yeditepe Üniversitesi Diş Hekimliği Fakültesi Periodontoloji AD. Prof. Dr. Bahar Eren Kuru'nun sorumlu araştırmacı olduğu **"Er – YAG Lazer İle Kök Yüzeyi Modifiye Edilmiş Tekli Dişeti Çekilmelerinin Kuronale Konumlandırılan Flap İle Tedavi Etkinliğinin İncelenmesi"** isimli araştırma projesine ait Klinik Araştırmalar Etik Kurulu (KAEK) Başvuru Dosyası **(1922)** kayıtlı Numaralı KAEK Başvuru Dosyası, Yeditepe Üniversitesi Klinik Araştırmalar Etik Kurulu tarafından **12.08.2020** tarihli toplantıda incelenmiştir.

Kurul tarafından yapılan inceleme sonucu, yukarıdaki isim belirtilen çalışmanın yapılmasının etik ve bilimsel açıdan uygun olduğuna karar verilmiştir

(KAEK Karar No:1255)

Prof. Dr. Turgay Çelik

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Klinik Araştırmalar Etik Kurul Başkanı

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YEDİTEPE ÜNİVERSİTESİ KLİNİK ARAŞTIRMALAR ETİK KURULU KARAR FORMU

Araştırmanın Açık Adı	"Er - YAG Lazer İle Kök Yüzeyi Modifiye Edilmiş Tekli Dişeti Çekilmelerinin Kuronale Konumlandırılan Flap İle Tedavi Etkinliğinin İncelenmesi"
VARSA ARAŞTIRMANIN PROTOKOL KODU	

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BAŞVURU BİLGİLERİ	KOORDİNATÖR/SORUMLU ARAŞTIRMACI UNVANI/ADI/SOYADI	Prof. Dr. Bahar Eren Kuru / Dt. Ece Deniz Yarımoğlu
	KOORDİNATÖR/SORUMLU ARAŞTIRMACININ UZMANLIK ALANI	Diş Hekimliği Fakültesi – Pedodonti A.D.
	KOORDİNATÖR/SORUMLU ARAŞTIRMACININ BULUNDUĞU MERKEZ	Yeditepe Üniversitesi
	VARSA İDARİ SORUMLU UNVANI/ADI/SOYADI	
	DESTEKLEYİCİ	
	PROJE YÜRÜTÜCÜSÜ UNVANI/ADI/SOYADI (TÜBİTAK vb. gibi kaynaklardan destek alanlar için)	
	DESTEKLEYİCİNİN YASAL TEMSİLCİSİ	
	ARAŞTIRMANIN FAZI VE TÜRÜ	FAZ 1 ☐
		FAZ 2
		FAZ 3
		FAZ 4 ☐
		Gözlemsel ilaç çalışması ☐
		Tıbbi cihaz klinik araştırması ☒
		İn vitro tıbbi tanı cihazları ile yapılan performans değerlendirme çalışmaları ☐
		İlaç dışı klinik araştırma ☐
		Diğer ise belirtiniz ☐
	ARAŞTIRMAYA KATILAN MERKEZLER	TEK MERKEZ ☒ / ÇOK MERKEZLİ ☐ / ULUSAL ☒ / ULUSLARARASI ☐

18.08.2020
ASLI GİBİDİR

Prof. Dr. Turgay ÇELİK
Yeditepe Üniversitesi KAEK Başkanı

YEDİTEPE ÜNİVERSİTESİ KLİNİK ARAŞTIRMALAR ETİK KURULU KARAR FORMU

Araştırmanın Açık Adı	"Er - YAG Lazer İle Kök Yüzeyi Modifiye Edilmiş Tekli Dişeti Çekilmelerinin Kuronale Konumlandırılan Flap İle Tedavi Etkinliğinin İncelenmesi"
VARSA ARAŞTIRMANIN PROTOKOL KODU	

KLİNİK ARAŞTIRMALAR ETİK KURULU	
ETİK KURULUN ÇALIŞMA ESASI	İlaç ve Biyolojik Ürünlerin Klinik Araştırmaları Hakkında Yönetmelik, İyi Klinik Uygulamaları Kılavuzu
BAŞKANIN UNVANI / ADI / SOYADI:	Prof. Dr. Turgay Çelik

Unvanı/Adı/Soyadı	Uzmanlık Alanı	Kurumu	Cinsiyet		Araştırma ile ilişki		Katılım *	
Prof. Dr. Turgay Çelik (Etik Kurul Başkanı)	Tıbbi Farmakoloji	Y.Ü. Eczacılık Fakültesi	E ☒	K ☐	E ☐	H ☒	E ☒	H ☐
Prof. Dr. Ferda Özkan	Patoloji	Y.Ü. Tıp Fakültesi	E ☐	K ☒	E ☐	H ☒	E ☒	H ☐
Prof. Dr. Pelin Yazgan	Fiziksel Tıp ve Rehabilitasyon	Okan Üniversitesi Hastanesi	E ☐	K ☒	E ☐	H ☐	E ☐	H ☐
Prof. Dr. Esra Can	Diş Hekimi	Y.Ü. Diş Hekimliği Fakültesi	E ☐	K ☒	E ☐	H ☒	E ☒	H ☐
Prof. Dr. Hasan Aydın	Endokrinoloji	Y.Ü. Tıp Fakültesi	E ☒	K ☐	E ☐	H ☒	E ☒	H ☐
Hasan Erdem	Hukuk (Av.)	Serbest Meslek	E ☒	K ☐	E ☐	H ☐	E ☐	H ☐
Dr. Öğr. Üyesi Gökhan Ertaş	Biyo Medikal	Y.Ü. Mühendislik Fakültesi	E ☒	K ☐	E ☐	H ☒	E ☒	H ☐
Buket Dirgen	Sivil Üye	Acıbadem Hastanesi	E ☐	K ☒	E ☐	H ☐	E ☐	H ☐
Prof. Dr. Recep Erol Sezer	Halk Sağlığı	Y.Ü. Tıp Fakültesi	E ☒	K ☐	E ☐	H ☒	E ☒	H ☐
Prof. Dr. Arzu Tatlıpınar	KBB	Y.Ü. Tıp Fakültesi	E ☐	K ☒	E ☐	H ☒	E ☐	H ☐
Doç. Dr. Muhammed Hamitoğlu	Eczacı	Y.Ü. Eczacılık Fakültesi	E ☒	K ☐	E ☐	H ☒	E ☒	H ☐
Dr. Öğr. Üyesi F. Ferda Kartufan	Anesteziyoloji ve Reanimasyon	Y.Ü. Tıp Fakültesi	E ☒	K ☒	E ☐	H ☒	E ☐	H ☐

*:Toplantıda Bulunma

26.06.2020 ASL gerekli

Prof. Dr. Turgay ÇELİK
Yeditepe Üniversitesi KAEK Başkanı

YEDİTEPE ÜNİVERSİTESİ KLİNİK ARAŞTIRMALAR ETİK KURULU KARAR FORMU

Araştırmanın Açık Adı	**"Er - YAG Lazer İle Kök Yüzeyi Modifiye Edilmiş Tekli Dişeti Çekilmelerinin Kuronale Konumlandırılan Flap İle Tedavi Etkinliğinin İncelenmesi"**
VARSA ARAŞTIRMANIN PROTOKOL KODU	

	Belge Adı	Tarihi	Versiyon Numarası	Dili
DEĞERLENDİRİLEN BELGELER	ARAŞTIRMA PROTOKOLÜ	12.08.2020	2	Türkçe ☒ İngilizce ☐ Diğer ☐
	BİLGİLENDİRİLMİŞ GÖNÜLLÜ OLUR FORMU	12.08.2020	2	Türkçe ☒ İngilizce ☐ Diğer ☐
	OLGU RAPOR FORMU	12.08.2020	2	Türkçe ☒ İngilizce ☐ Diğer ☐
	ARAŞTIRMA BÜTÇESİ	12.08.2020	2	Türkçe ☒ İngilizce ☐ Diğer ☐

	Belge Adı		Açıklama
DEĞERLENDİRİLEN DİĞER BELGELER	KLİNİK ARAŞTIRMA BAŞVURU FORMU GÖZLEMSEL RETROSPEKTİF	☒ ☐ ☐	
	TIBBİ CİHAZ TC KLİNİK ARAŞTIRMA (AKADEMİK) TC GÖZLEMSEL KLİNİK ARAŞTIRMA TC İN VİTRO KLİNİK ARAŞTIRMA	☐ ☐ ☐ ☐	
	SİGORTA	☐	
	ARAŞTIRMA BÜTÇESİ	☒	
	BİYOLOJİK MATERYEL TRANSFER FORMU	☐	
	ÖZGEÇMİŞLER	☒	
	HELSİNKİ BİLDİRGESİ	☒	
	ÇIKAR İLİŞKİSİ BELGESİ	☐	
	KURUM İZNİ	☒	
	ARŞİV FORMU	☐	
	CİDDİ ADVERS OLAY (CAO) BİLDİRİMİ	☒	
	KURUM DIŞI ARAŞTIRMACI BAŞVURU FORMU	☐	
	İTHALAT FORMU	☐	
	DEPO BAŞVURU FORMU	☐	
	CD	☒	
	SONLANIM BİLDİRİMİ BAŞVURU FORMU	☒	

KARAR BİLGİLERİ	**Karar No:1255**	**Tarih: : 12.08.2020**

Yukarıda bilgileri verilen **"Er - YAG Lazer İle Kök Yüzeyi Modifiye Edilmiş Tekli Dişeti Çekilmelerinin Kuronale Konumlandırılan Flap İle Tedavi Etkinliğinin İncelenmesi"** klinik araştırmanın başvuru dosyası ile ilgili belgeler araştırmanın /çalışmanın gerekçe, amaç, yaklaşım ve yöntemleri dikkate alınarak incelenmiş ve uygun bulunmuş olup araştırmanın/çalışmanın başvuru dosyasında belirtilen merkezlerde gerçekleştirilmesinde etik ve bilimsel yönden yeterli bulunduğuna toplantıya katılan etik kurul üye tam sayısının salt çoğunluğu ile karar verilmiştir.
İlaç ve Biyolojik Ürünlerin Klinik Araştırmaları Hakkında Yönetmelik kapsamında yer alan araştırmalar/çalışmalar için Türkiye İlaç ve Tıbbi Cihaz Kurumu'ndan izin alınması gerekmektedir.

18. 08. 2020
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T.C.
SAĞLIK BAKANLIĞI
Türkiye İlaç ve Tıbbi Cihaz Kurumu

NORMAL
15.03.2021

Sayı : E-68869993-511.06-369789
Konu : 2019-058

Prof. Dr. Bahar EREN KURU
Yeditepe Üniversitesi Diş Hekimliği Fakültesi
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Kadıköy/İstanbul

İlgi : Kurum evrak kayıt 10.03.2021 tarihli ve E.761831 sayılı başvurunuz.

Sorumlu araştırmacısı olduğunuz, aşağıdaki tabloda bilgileri verilen ilgi klinik araştırma başvuru dosyası ve belgeler; araştırmanın gerekçe, amaç, yaklaşım ve yöntemleri dikkate alınarak 06.09.2014 tarihli ve 29111 sayılı Resmî Gazete 'de yayımlanan Tıbbi Cihaz Klinik Araştırmaları Yönetmeliği gereğince incelenmiş olup Uzmanlık Tezleri ve/veya Akademik Amaçlı Yapılacak Tıbbi Cihaz Klinik Araştırmaları Başvuru Formunda belirtilen merkezde araştırmanın başlaması uygun bulunmuştur.

Araştırmanın Adı	Er-YAG Lazer İle Kök Yüzeyi Modifiye Edilmiş Tekli Dişeti Çekilmelerinin Kuronale Konumlandırılan Flap İle Tedavi Etkinliğinin İncelenmesi
Koordinatör Merkez	Yeditepe Üniversitesi Diş Hekimliği Fakültesi
Koordinatör / Sorumlu Araştırmacı	Prof. Dr. Bahar EREN KURU
Protokol tarihi / versiyon no	12.08.2020/2
BGOF tarihi / versiyon no	12.08.2020/2
ORF tarihi / versiyon no	12.08.2020/2
Araştırma Broşürü tarihi / versiyon no	-
Proje Yürütücüsü	-

Bu kapsamda yukarıda ayrıntıları verilen çalışma ile ilgili olarak;

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- Araştırmanın başlamaması, iptali veya sonlandırılması halinde tarafımıza bilgi verilmesi,
- Araştırma süresince ortaya çıkan advers olayların/etkilerin tarafımıza bildirilmesi,
- Araştırmanın Helsinki Bildirgesi'nin son metni, İyi Klinik Uygulamalar İlkeleri ve ilgili mevzuata uygun olarak yürütülmesi,
- Araştırmada kullanılan her türlü araştırma ürününün ve ürünlerin kullanılmasına mahsus her türlü malzeme ile muayene, tetkik, tahlil ve tedavilerin bedeli için gönüllüden herhangi bir ücret talep edilmemesi,

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T.C.
SAĞLIK BAKANLIĞI
Türkiye İlaç ve Tıbbi Cihaz Kurumu

- Araştırmaya ait yıllık bildirim formunun düzenli olarak Kurumumuza gönderilmesi,
- Sorumlu araştırmacı olarak yazımızın bir örneğinin ilgili etik kurula iletilmesi hususlarında bilgilerinizi ve gereğini rica ederim.

Dr. Asım HOCAOĞLU
Kurum Başkanı a.
Daire Başkanı

Cirriculum Vitae

Personal Information

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Education

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University	Diş Hekimliği	Yeditepe Üniversitesi	2015
High School	-	Adana Anadolu Lisesi	2009

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English	60 (YDS)

Scientific Works

SCI, SSCI, AHCI indekslerine giren dergilerde yayınlanan makaleler

Evaluation of the effects of Er:YAG laser for the de-epithelization of the palatal graft in the treatment of multiple gingival recessions: A randomized clinical trial, Photobiomodulation, Photomedicine and Laser Surgery,2019
Implant mucosal tunnel may be critical modifier for peri-implant health (Digest), Journal of clinical periodontology, 2019
Clinical efficacy of coronally advanced flap with or without connective tissue graft for the treatment of multiple adjacent gingival recessions in the aesthetic area: a randomized controlled clinical trial, Journal of clinical periodontology (Digest), 2017