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Review article

COMPARATIVE REVIEW OF THE EFFECTIVENESS OF DIFFERENT SURGICAL TECHNIQUES IN THE MANAGEMENT OF GINGIVAL RECESSION

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Abstract: Mucogingival anomalies arise from anatomical and morphological irregularities within the mucogingival complex of periodontal tissues, representing deviations from the normal dimensions and morphology of the gingiva-alveolar mucosa relationship. According to the American Academy of Periodontology glossary, gingival recessions are defined as the exposure of the tooth root surface caused by the apical displacement of the gingiva relative to the cemento-enamel junction.

In addition to aesthetic concerns, gingival recessions lead to increased sensitivity and ineffective plaque control, which can ultimately result in tooth loss. To address these issues, procedures are performed to cover exposed roots and restore the normal function and appearance of the mucogingival complex. The treatment for gingival recessions is primarily surgical, aiming for complete root coverage with long-term stability. Various methods are available, but the gold standard involves using a connective tissue graft in combination with a coronally advanced flap.

This paper compares three treatment methods: the coronally advanced flap (CAF), CAF combined with a connective tissue graft, and CAF with porcine collagen matrix application. The primary objective is to identify which surgical method yields the best clinical outcomes.

Nine studies involving 303 patients demonstrated that the highest root coverage is achieved with CAF combined with a connective tissue graft, showing a reduction in recession depth of 2.64 mm, an increase in the keratinized gingival zone of 1.05 mm, and a reduction in pocket depth of 0.36 mm. CAF combined with porcine collagen matrix provided slightly lower results, while CAF alone yielded the lowest outcomes.

Keywords: mucogingival complex, mucogingival anomalies, gingival recessions, connective tissue graft, coronally advanced flap.

INTRODUCTION

Gingival recession is a mucogingival anomaly defined as the apical displacement of the gingival margin relative to the cemento-enamel border (1). Mucogingival anomalies are the result of anatomical and morphological irregularities in the mucogingival complex of periodontal tissues. This complex consists of the keratinized gingiva (free and attached), alveolar mucosa, and the mucogingival border line (2).

It has been established that there is a mutual relationship between the occurrence of gingival recessions and aging (3, 4). Research shows that 88% of people over 65 years of age and 50% of participants between the ages of 18 and 64 have had at least one gingival recession in their mouths (4). Considering the frequency of gingival recessions, particularly in younger patients, solving this problem is a big challenge.

Advancements in measurement techniques have improved the assessment of recession depth. Digital methods, such as scanners, provide greater accuracy and reliability compared to traditional periodontal probes. Instruments like ultrasound biometers further enhance the precision of these measurements, reducing variability and increasing validity.

Restoring the structure of the mucogingival complex is considered the fundamental and ideal method for treating gingival recession. The goal of gingival recession therapy is to cover the tooth root while satisfying aesthetic parameters and achieving a stable result for a longer period of time.

Indications for treating gingival recessions

The surgical treatment procedure using grafts aims to correct disturbances within the mucogingival complex. The main goal of gingival recession therapy is to cover the exposed tooth root with healthy tissue and bone, achieving appropriate aesthetic results (5). Miyamoto et al. (6) showed that gingiva could remain healthy even in areas where attached gingiva is minimal or absent, as long as proper oral hygiene is maintained and plaque accumulation is prevented. On the other hand, Lang et al (7) suggest that a minimum width of 2 mm is necessary for gingival health. According to their report, areas with 1 mm or less of attached gingiva often show clinical signs of inflammation.

Aesthetic concerns, root hypersensitivity, prevention of root caries, non-carious cervical lesions, and patient discomfort during oral hygiene are primary indications for root coverage procedures (8). The clinical goal of gingival recession surgery is to achieve complete root coverage without visible inflammation (9). However, an adequately positioned gingival margin may not guarantee favorable aesthetic results, as poor aesthetics can arise from uneven contours, poor color match, or scar tissue (10).

At the site of recession, dentin hypersensitivity can develop due to cementum damage and dentin exposure. As a consequence, the patient may experience discomfort, and maintaining good oral hygiene may become challenging (11). Cortellini et al. (12) conducted a multicenter study with 85 participants to demonstrate the benefits of root coverage procedures in reducing tooth sensitivity. Approximately 40% of participants cited root sensitivity as the reason for seeking treatment. Six months after undergoing a coronally advanced flap procedure, with or without connective tissue grafting, the prevalence of root sensitivity decreased to approximately 10%.

In treating gingival recessions, the primary challenge lies in repairing and regenerating the periodontal tissues in the affected area. Soft tissue autografts have become a common procedure because, in addition to covering the exposed tooth root, they can also increase the width of keratinized gingiva. Autogenous grafting methods include free gingival grafts and connective tissue grafts, where soft tissues are transplanted from a distant region to cover the defect. For good therapeutic results, the recipient region must meet the following criteria: it must support rapid revascularization of the free graft, allow the formation of a new vascular network, and enable effective nutrient diffusion.

Free gingival graft

The free gingival graft was first described by Nabers in 1966 and systematized by Sullivan et al (13). A free gingival graft is an epithelialized, keratinized soft tissue, most commonly taken from the palatal mucosa in the area of canines and premolars to avoid injury to the palatine artery. A horizontal incision, approximately 1 mm thick, is made parallel to the dental arch. The shape and size of the graft are chosen based on the availability of tissue and the size of the defect that needs to be covered. The graft is harvested from the palate once the specific shape and size are achieved. It is important that the graft is 1 mm thick, containing a subepithelial connective tissue layer, which is then transplanted into the region of the gingival recession (14). This procedure can address the problem of a narrow zone of keratinized gingiva in a single surgical act and eliminate isolated gingival recession (14).

Connective tissue graft

The most significant progress in autogenous grafting procedures occurred in 1985 with the introduction of the connective tissue graft, which not only provides excellent aesthetic results but also promotes the formation of new connective tissue (15). The histological compatibility of the hard palate mucosa and gingiva led to the idea of using a subepithelial connective tissue graft from the palate for treating recessions. The connective tissue graft has become the gold standard for covering recessions (14). The main advantages of this graft are its dual blood supply from both the periosteum and the graft itself, as well as its perfect integration and optimal aesthetic outcome (16). Since the success of the therapy is determined by the survival of the graft, it is recommended that the flap covering the graft should cover most of the graft to ensure adequate blood supply (9). After four weeks, the tissue closely resembles the surrounding tissue, which is a key aspect of rapid graft survival and biointegration, significantly influencing the effectiveness of the treatment (17).

The connective tissue graft is most commonly harvested from the palate. To prevent the development of palatal recessions, tissue approximately 2 mm from the gingival margin should remain intact. A horizontal incision is made around 3 mm apical to the gingival margin in the premolar region. A second vertical incision determines the width of the graft. A raspatorium is used to release the graft after the vertical incision, both mesially and distally.

Non-autogenous gingival graft

Despite the potential advantages of autogenous tissue grafting, there are also significant drawbacks

and limitations, such as morbidity, pain associated with the secondary surgical site, and the limited dimensions of donor tissue (18). The development of connective tissue substitutes of xenogenic, allogenic, or synthetic origin has gained increasing importance to overcome the inadequacies of autogenous connective tissue. These biomaterials can reduce the duration of the surgical procedure, patient morbidity, and recovery time, but they must also have good biocompatibility, allowing for remodeling and stability of the graft volume over time (18, 19).

Acellular dermal matrix of allogenic (human) origin is frequently used in the United States. Alloderm® (LifeCell, Bridgewater, USA) is an artificial acellular dermal matrix from which the epidermis and cells that could potentially lead to failure in periodontal surgery have been removed. In a meta-analysis conducted by Gapski et al (20), no statistically significant differences were found in the degree of recession coverage between acellular dermal matrix and free connective tissue grafts. On the other hand, the coronally advanced flap with acellular dermal matrix had better aesthetic outcomes, as reported by both clinicians and patients, compared to the coronally advanced flap with a free connective tissue graft, even though it showed a lower degree of root coverage (21). In support of free connective tissue grafts, which remained stable even after four years, Harris (22) showed that recession coverage with human-derived acellular dermal matrix decreased from 93% to 66% after four years (22).

Xenogenic (animal-derived) materials are now also used as alternatives to free connective tissue grafts and human acellular dermal matrices (20). For the European market, the main representative of xenogenic material from pig tissue is Mucograft® (Geistlich Biomaterials, Switzerland). It consists of a compact layer that contributes to stability and a thick, porous layer that serves as a base into which the host's connective tissue grows. Its advantages (according to the manufacturer) include unlimited material availability, shortened procedure time, faster healing, reduced postoperative pain, and better patient acceptance. In comparison to the coronally advanced flap alone, histological studies have shown that the porcine matrix was able to stimulate the formation of new cementum in experimental recessions in an animal model (23). Mucograft® is indicated for covering implants in the immediate or late stages of implantation, localized gingival augmentation to increase keratinized tissue around teeth and implants, alveolar ridge reconstruction for prosthetic treatment, and surgical treatment of gingival recessions. Contraindications include the presence of symptomatic infections, collagen allergies, and it should be used with caution in patients with autoimmune diseases, uncontrolled diabetes, thyroid disorders, and in cases of prolonged corticosteroid therapy or head and neck radiotherapy.

OBJECTIVES

The primary objective of this study is to evaluate the effectiveness of three different surgical methods: coronally advanced flap, coronally advanced flap with connective tissue graft, and coronally advanced flap with porcine collagen matrix. The parameters for recession depth, width of keratinized gingiva, and pocket depth will serve as measures of the effectiveness and success of the therapeutic procedure. All these values were recorded in millimeters before the treatment and six months after the surgery.

Nine studies with a total of 303 patients were analyzed in this research. All studies used as research material are from the period between 2009 and 2022. A detailed literature search was performed in the PubMed database, which included all available studies related to the surgical treatment of gingival recessions. The search criteria included the keywords: gingival recessions, gingival graft, coronally advanced flap, and collagen matrix. For the purposes of the preliminary literature review, the titles and abstracts of all published studies found as a result of the search were reviewed to identify studies that met the inclusion criteria. Publications were included in the research only if they contained data on the performed intervention, the result of the therapy, and a comparison of the outcomes.

CORONALLY ADVANCED FLAP

This therapeutic procedure involves the use of the coronally advanced flap alone, without the use of any type of graft. A total of 86 patients were included in this group across five studies. The study by Mathias-Santamaria et al. (24), which included the largest number of patients (31), was compared to smaller studies such as those by Kanmaz et al. (25) and Rotundo et al. (26), which involved only 12 patients.

Kanmaz et al. (25) reported an average reduction in recession depth of 2.68 mm, whereas Rasperini et al. (27) reported a reduction of 1.7 mm. An increase in the width of the keratinized gingiva was observed in four out of five studies, with the highest result achieved in the study by Rasperini et al. (27). On the other hand, Rotundo et al. (26) found a reduction of 0.9 mm. The probing depth was reduced by an average of 0.14 mm in all five studies. Jepsen et al. (28) reported the largest reduction in probing depth, with a decrease of 0.31 mm, while Kanmaz et al. (25) and Mathias-Santama-

***Table 1**. Comparison of results for Coronary Advanced Flap*

Study	Number of patients	Depth of recession	Width of keratinized gingiva	Probing depth
Rasperini et al., (27)	13	1.7	0.7	0.1
Jepsen et al., (28)	18	2.54	0.61	0.31
Kanmaz et al., (25)	12	2.68	0.46	0
Mathias-Santamaria et al., (24)	31	2	0.4	0
Rotundo et al., (26)	12	2.1	-0.9	0.3
	86	**2.20**	**0.25**	**0.14**

***Table 2.** Comparison of results for Coronary Advanced Flap with Connective Tissue Graft*

Study	Number of patients	Depth of recession	Width of keratinized gingival	Probing depth
Rasperini et al., (27)	12	1.6	0.4	0.2
Nahas et al., (29)	15	2.5	1.2	0.4
Barakat, Dayoub and Alarkan (30)	10	3.19	1.42	0.17
McGuire et al., (31)	30	3.35	1.3	0.6
Maluta et al., (32)	15	2.54	0.91	0.41
	82	**2.64**	**1.05**	**0.36**

ria et al. (24) did not record a significant reduction in probing depth (Table 1).

CORONALLY ADVANCED FLAP WITH CONNECTIVE TISSUE GRAFT

In this group, five studies used the coronally advanced flap with a connective tissue graft (27, 29, 30-32). The average number of patients in these studies was 16.4, with the study by McGuire et al. (31) including the highest number of patients, 30. In contrast, the lowest number of patients was reported in the 2009 study by Barakat et al (30).

Based on the data extracted, McGuire et al. (31) reported the largest average reduction in recession depth, followed by Barakat et al (30) and Maluta et al. (32) with reductions of 3.35, 3.19, and 2.54 mm, respectively. On the other hand, the studies by Rasperini et al. (27) and Nahas et al. (29) had the lowest recession depth reductions, both reporting a reduction of 2.5 mm. The overall average reduction in recession depth for all five studies was 2.64 mm.

The increase in the width of keratinized gingiva was measured in each of the five studies. In one of the two studies (Rasperini et al. (27) and Maluta et al. (32)), the width of the keratinized gingiva was found to be smaller, while three other studies (Nahas et al. (29), McGuire et al. (31), and Barakat et al (30)) reported a greater width, with an average increase of 1.05 mm across all five studies.

All five studies reported a reduction in probing depth, with an average reduction of 0.36 mm. Several factors may influence these results, including gingival phenotype, lack of adequate bone support for the gingival graft, and excessive tooth brushing. During the studies, it was difficult to control all external variables that may impact the outcomes (Table 2).

CORONALLY ADVANCED FLAP WITH THE USE OF XENOGENEIC GRAFT

This group includes data from a total of seven studies that used a coronally advanced flap in combination with a xenogeneic graft. The sum of all seven studies includes a total of 135 patients, with an average of 19.28 patients per study. The largest number of patients was included in two studies, one published in 2022 by Mathias-Santamaria et al. (24) and the oth-

***Table 3**. Comparison of results obtained with Coronary Advanced Flap and Xenogeneic Graft*

Study	Number of patients	Depth of recession	Width of keratinized gingival	Probing depth
Jepsen et al., (28)	22	2.86	1.42	0.22
Mathias-Santamaria et al., (24)	31	2	0.6	-0.1
Nahas et al., (29)	15	2	0.4	0.1
Barakat, et al (30)	10	3.06	1.58	0.14
McGuire et al., (31)	30	2.55	0.7	0.6
Maluta et al., (32)	15	2.43	0.74	0.34
Rotundo et al., (26)	12	2	-0.5	0
	135	**2.41**	**0.71**	**0.19**

er in 2021 by McGuire et al. (31), with a total of 31 and 30 participants, respectively. On the other hand, Barakat et al (30) conducted a study with the smallest number of participants, which included 10 patients. All studies achieved results that were greater than or equal to 2, with the study by Barakat et al (30) showing a reduction in recession depth of up to 3.06 mm. The average reduction in recession depth across these seven studies was 2.41 mm, and all studies achieved results greater than or equal to 2. Additionally, the largest increase in the width of the keratinized gingiva was observed in the study by Barakat et al (30), with a result of 1.56 mm, while four out of the seven studies reported an increase of less than 1 mm. Conversely, Rotundo et al. (26) reported a loss of 0.5 mm. When all data were considered, the average gain in keratinized gingiva width was 0.71 mm. Five studies showed a reduction in probing depth, with an average reduction of 0.19 mm across all seven studies. On the other hand, Mathias-Santamaria et al. (24) observed an increase in probing depth by 0.1 mm. Furthermore, Rotundo et al. (26) did not observe any significant change in probing depth, but Maluta et al. (32) in 2021 reported the largest percentage decrease in probing depth, which amounted to 0.34 mm (Table 3).

CONCLUSION

These clinical results were chosen because they are objective, measurable criteria that can be compared. In the treatment of gingival recessions, the coronally advanced flap is most commonly used. Of the 303 patients, 86 were treated with the coronally advanced flap alone. The average recession depth was 2.20 mm, the gain in the width of the keratinized gingiva was 0.25 mm, and the probing depth was 0.14 mm. A study examining long-term stability concluded that this method alone does not appear to be completely stable in the long term. However, the 2018 study had the highest average width of keratinized gingiva, which was 0.7 mm. On the other hand, of all the studies, only the study by Rotundo et al. showed a negative result for the width of the keratinized gingiva, with a decrease of 0.9 mm. This was attributed to reduced blood flow to the flap during the initial healing phase. In mucogingival surgery, the use of free connective tissue grafts is considered the gold standard for covering gingival recession.

We conclude that significant coverage of defects can be achieved using the coronally advanced flap, either alone or with the use of grafts: connective tissue and porcine collagen. The coronally advanced flap combined with a connective tissue graft is the most effective procedure and the gold standard method for root coverage. The effectiveness of the porcine collagen matrix is lower than that of the connective tissue graft, but porcine collagen can be considered an alternative to the connective tissue graft. The use of porcine collagen and connective tissue grafts, in combination with the coronally advanced flap, gives superior results when compared to the use of the coronally advanced flap alone.

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Note: Artificial intelligence was not utilized as a tool in this study.

Sažetak

UPOREDNI PREGLED EFIKASNOSTI RAZLIČITIH HIRURŠKIH TEHNIKA U MENADŽMENTU RECESIJA GINGIVE

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Mukogingivalne anomalije se ispoljavaju kao posledica anatomomorfoloških nepravilnosti u mukogingivalnom kompleksu parodontalnih tkiva i predstavljaju odstupanje od normalne dimenzije i morfologije u međusobnom odnosu gingive i alveolarne mukoze. Prema rečniku pojmova koji je objavila Američka akademija za parodontologiju, recesije se definišu kao izlaganje površine korena zuba koje je prozrokovano apikalnim pomeranjem gingive u odnosu na cementno-gleđnu granicu.

Pored estetskih problema, recesije gingive su takođe i uzrok preosteljivosti zuba i neefikasne kontrole plaka što na kraju može dovestii do gubitka zuba. Iz tog razloga sprovode se procedure koje za cilj imaju pokrivanje korena zuba i vraćanje normalne funkcije i izgleda mukogingivalnog kompleksa. Terapija gingivalnih recesija je hirurška sa ciljem komplentnog prekrivanja površine korena zuba koje bi bilo stabilno u značajnom vremenskom periodu. Mogu se tretirati na više različitih načina, a primena transplantata vezivnog tkiva u kombinciji sa koronarno pomerenim režnjem predstavlja zlatni standard.

Koronarno pomereni režanj, koronarno pomereni režanj sa primenom grafta vezivnog tkiva i koronarno pomereni režanj u kombinaciji sa matriksom svinjskog kolagena su tri metode lečenja koje će biti prikazane i upoređene. Primarni cilj ovog istraživanja je da se otkrije koja od tri hirurške metode lečenja recesija gingive daje najbolje kliničke rezultate.

Devet studija sa ukupno 303 pacijenta pokazalo je da najveću pokrivenost korena daje koronarno pomereni režanj uz primenu transplantata vezivnog tkiva sa smanjenjem dubine recesije od 2,64 mm i dobijenom zonom keretinizovane gingive od 1,05 mm i smanjenjem dubine džepa od 0,36 mm. Nešto niže rezultate dao je koronarno pomereni režanj uz primenu svinjskog kolagena dok je samo koronarno pomereni režanj dao najniže rezultate.

***Ključne re**či:* mukogingivalni komleks, mukogingivalne anomalije, gingivalne recesije, transplantat vezivnog tkiva, koronarno pomeren režanj.

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