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# Root coverage surgeries using modified tunneling technique of xenogenic collagen matrix versus autologous connective tissue graft as a treatment of Miller class II gingival recession (RCT study)

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## Abstract

**Background** Recently, there is increased demand for periodontal plastic surgery and development of new surgical approaches for aesthetic purposes. Gingival recession (GR) is the exposure of the root surfaces leading to esthetic problems, hypersensitivity, caries of the roots and teeth loss. Coronally advanced flap is considered a predictable treatment of GR but it needs a filler like subperiosteal connective tissue graft (CTG) which is considered as the gold standard treatment approach. The aim of the present study is to compare the clinical benefits and effectiveness of a xenogenic collagen matrix (mucoderm, botiss, dental, Berlin, Germany) to CTG for treatment of GR.

**Results** Regarding clinical parameters, mean preoperative values for attached gingiva, probing depth, clinical attachment loss and gingival recession for group I were (1.8 ± 0.7 mm, 1.2 ± 0.3 mm, 6.6 ± 0.4 mm and 5.4 ± 0.2 mm) respectively. While mean postoperative values were (2.3 ± 0.9 mm, 1.1 ± 0.4 mm, 3.4 ± 0.5 mm and 2.7 ± 0.7 mm) For group two preoperative mean values were (1.9 ± 0.3 mm, 1.1 ± 0.5 mm, 6.8 ± 0.5 mm and 5.4 ± 0.2 mm) respectively. While mean for postoperative values of attached gingiva, probing depth, clinical attachment loss and gingival recession for group tow were (2.5 ± 0.6 mm, 0.8 ± 0.3 mm, 3.7 ± 0.2 mm and 3.1 ± 0.3 mm) respectively All of the clinical parameters measured showed a significant difference between pre ad postoperative measurements while there was no significant differences between the two groups (test and control group). Regarding the patients satisfaction the percentage was greater in test group but the difference was not statistically significant.

**Conclusions** In general, all of the parameters measured showed a significant difference between pre and postoperative measurements for each group but there is no significant difference between the two groups using (two treatment approaches. Both treatment procedures are considered efficient in increasing zone of attached gingiva and decreasing its clinical attachment loss. Mucoderm is considered as an efficient alternative to CTG for treatment of gingival recession.

**Keywords** Mucoderm, CTG, Gingival recession

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## 1 Background

Recently, there is increased demand for aesthetic procedures leading to an increased interest in periodontal plastic surgery and result in the development of new surgical techniques and concepts. Gingival recession (GR) is the exposure of the root surfaces due to apical migration of the dentogingival junction; the gingival margin migrates apically to the cemento enamel junction (CEJ) and is usually associated with esthetic problems [1]. This may lead to hypersensitivity of the roots, root caries and teeth loss [2]. These findings are correlated with vigorous tooth brushing and thin gingival biotype [3]. Treatment of gingival recession should be started with phase one treatment represented by the removal of the etiologic factors that may lead to periodontal destruction, then periodontal debridement and commitment to proper oral hygiene measures followed by evaluation ahead before the corrective surgical phase to cover the exposed roots [4].

The goals of root coverage surgeries are to cover the root with integrated tissues and restore satisfactory color and form [5].

Root coverage surgeries started in the past by increasing the zone of the attached gingiva by using free gingival grafts then modified to use pedicle grafts or bilaminar techniques with coronally or laterally positioned flaps or using guided tissue regeneration techniques [6].

Tunneling technique steps were described by (Zabalegui 1999) then modified by (Zuhr et al. 2007) by coronal positioning [10, 11].

Coronally advanced flap (CAF) therapy has been proposed together with a connective tissue graft, barrier membrane, enamel matrix derivative, acellular dermal matrix, platelet concentrated graft, or living tissue-engineered human fibroblast-derived dermal substitute [7].

On the other hand, connective tissue grafting showing some operative difficulties like connective tissue harvesting, the possibility of bleeding, technique sensitivity in addition to postoperative complications like bleeding from the donor site, pain, and delayed wound healing [9]. So, an alternative treatment approach by using xenogenic collagen matrix is compared to autologous connective tissue as a filler with coronally advanced flap to reduce gingival recession, probing depth, attachment loss in addition to increasing zone of attached gingiva together with obtaining better patient satisfaction with fewer postoperative complications.

To overcome these complications, allogenic and porcine acellular collagen matrices have been introduced and developed. Therefore, the aim of the present study is to compare the clinical benefits and effectiveness of a xenogenic collagen matrix (mucoderm, botiss dental, Berlin, Germany) to the subperiosteal connective tissue graft (CTG) for treatment of gingival recession.

In 2011, Cairo et al. classified gingival recession (GR) based on the assessment of CAL at both buccal and interproximal sites to three types: Recession Type 1 (RT1): showed gingival recession with no loss of interproximal attachment., Recession Type 2 (RT2) showed GR associated with interproximal CAL less than or equal to the buccal CAL. Recession Type 3 (RT3): GR associated with interproximal CAL greater than the buccal CAL.[24]

## 2 Methods

### 2.1 Study design

This study was designed as a prospective, randomized controlled clinical trial with a parallel design to investigate and compare the outcomes and efficiency of two approaches of root coverage surgeries using tunneling technique of xenogenic collagen matrix (test group) versus autologous connective tissue (control group) as a treatment of Miller class II gingival recession. The following parameters were measured preoperatively and six months postoperatively; the zone of attached gingiva, periodontal probing depth, clinical attachment loss, gingival recession, and patient satisfaction. Two types of root coverage surgeries were used: applying mucoderm or autologous connective tissue graft. This randomized controlled trial was conducted under the ethical principles for medical research involving human subjects, and was approved by Research Ethics Committee, Faculty of Dentistry, Beni-Suef University (FDBSU-REC) with approval number: #FDBSUREC/08042021/FA.

FDBSU-REC is organized and operated according to Enhancing Research Ethics Committees in Egypt, Guidelines for Standard Operating Procedures, Monitor 2006, Guidelines of the Declaration of Helsinki, International Conference of Harmonization (ICH), and United States Codes of Federal Regulations and registered in the office of Human Research Protection under the IORG #: IORG0010018.

### 2.2 Sample size and characteristics of patients selection

Twenty four [8, 16] patients; free from any systemic disorders, were selected from the outpatient's clinics of the Periodontology Department, Faculty of Dentistry, Assiut University, Egypt. The study was conducted at the same department and the patients were randomly divided into two groups; Group 1 (test group): treated by coronally advanced flaps and modified tunneling of collagen matrix (mucoderm, botiss dental, Berlin, Germany) and Group 2 (control group): treated by coronally advanced flaps and modified tunneling of subepithelial connective tissue grafts harvested from the patient's palate.

### 2.3 Inclusion criteria

The selected patients for this study are non-smokers, aged 18–60 years with multiple gingival recession (Miller class I, or II.) for more than two adjacent affected teeth with plaque score less than 10%. [27]

### 2.4 Exclusion criteria

Patients with systemic conditions, psychological problems, parafunctional habits, or patients presented with mal-posed teeth, hypermobile teeth, teeth with Miller class III gingival recession were excluded from this study.

### 2.5 Pre-surgical preparations

All patients underwent non-surgical phase including proper teeth cleaning, scaling, periodontal debridement using manual instrumentation, ultrasonic debridement, and reevaluation before the surgical phase; patient with plaque score more than 20% revised phase one treatment and instructed for oral hygiene measures, patients with plaque score less than 20% were good candidates for the corrective surgical phase.

### 2.6 Randomization

The participating patients were randomized by using computer-generated random numbers ([www.randomizer.org](http://www.randomizer.org)). Patients were randomized into two groups: group 1 (test group): treated by coronally advanced flaps and modified tunneling of collagen matrix barrier, group 2 (control): treated by coronally advanced flaps and modified tunneling of subepithelial connective tissue graft.

All cases photographed before and 6 months after the surgeries to measure the outcomes of each surgical approach.

#### 2.6.1 Test group material

mucoderm is a xenogenic matrix produced by botiss that offers a valid alternative to autologous soft tissue grafts (Fig. 1. A). According to the manufacturer, mucoderm is a natural, non-cross-linked tissue matrix, consisting of collagen type I and III, which strongly resembles the native structure of the human dermis. In a natural enzymatic process, mucoderm is integrated into the surrounding tissue and replaced by the patient's own connective



**Fig. 1** for group 1 (test group) showing; preoperative photograph for the gingival recession (A), Photograph showing the application of mucoderm (collagen graft) with modified tunneling technique (B), Photograph showing suturing of tissues. (C) and Photograph showing follow up with root coverage and postoperative healing (D)

tissue. The natural collagen network of mucoderm that results from the multistep purification process act as a scaffold for soft tissue cells and blood vessels. During the healing process, mucoderm is vascularized and integrated into the surrounding tissue. For a broad range of indications, mucoderm serves as a safe alternative to autologous connective tissue grafts. It has a natural, three-dimensional collagen structure and is made of pure porcine collagen without any artificial/chemical cross-linking. Scanning electron microscopic pictures of mucoderm show its rough surface and open-porous collagen network that acts as a guiding structure for soft tissue cells and blood vessels [8]. Mucoderm characterized by native collagen matrix, the compact collagen structure of mucoderm, fast vascularization, and integration, rapid hydration, easy handling and complete remodeling into patient's own tissue in about six month.

## 2.7 Steps of handling of mucoderm

### 2.7.1 Hydration

Sufficiently long hydration of mucoderm before the application is necessary. Hydration should be performed in sterile saline solution or blood for 5 to 20 min, depending on the technique used and the desired flexibility of the matrix, the flexibility of the mucoderm increases with hydration time.

### 2.7.2 Trimming

The size and shape of the matrix should be adapted to the size of the defect. After hydration, mucoderm can be easily trimmed to the desired size with a scalpel or a pair of scissors. Rounding off the edges following brief hydration of the matrix can prevent perforation of the gingival tissue during flap closure. For the coverage of multi-recession defects, the surface of mucoderm can be extended by cutting the matrix on alternating sides (mesh-graft technique) and pulling it.

### 2.7.3 Exposure

Mucoderm should only be left for open healing if a revitalization from the surrounding or underlying wound bed is ensured. Exposure should always be avoided when used for recession coverage. Open healing is feasible in the case of a vestibuloplasty if mucoderm is sutured to the periosteum.

### 2.7.4 Fixation

When a split-thickness flap is used, close contact between the periosteal wound bed and the immobilized mucoderm matrix should be ensured by suturing the matrix to the intact periosteum using single-interrupted or crossed sutures.

## 2.8 Blinding and Surgical procedures

After local anesthesia administration, intrasulcular envelope was made including the recessed teeth and the adjacent mesial and distal teeth [7]. The mucoperiosteum is then carefully elevated by a sharp modified tunnel elevator without vertical releasing incisions. Proper subgingival periodontal debridement: the meticulous subgingival debridement of the exposed root surfaces was performed using hand instruments (Gracey Curettes, Hu-Friedy, Chicago, IL, USA). Appropriate mobilization of the full thickness flaps to reach the mucogingival junctions and checked to be repositioned coronally to cover the cemento-enamel junctions.

After that, a closed the envelope was opened to the operator (AA) to know which group.

For group one, the prepared parts of the collagen matrix (mucoderm, botiss, dental, Berlin, Germany) were placed through the modified tunnelling technique (Fig. 1).

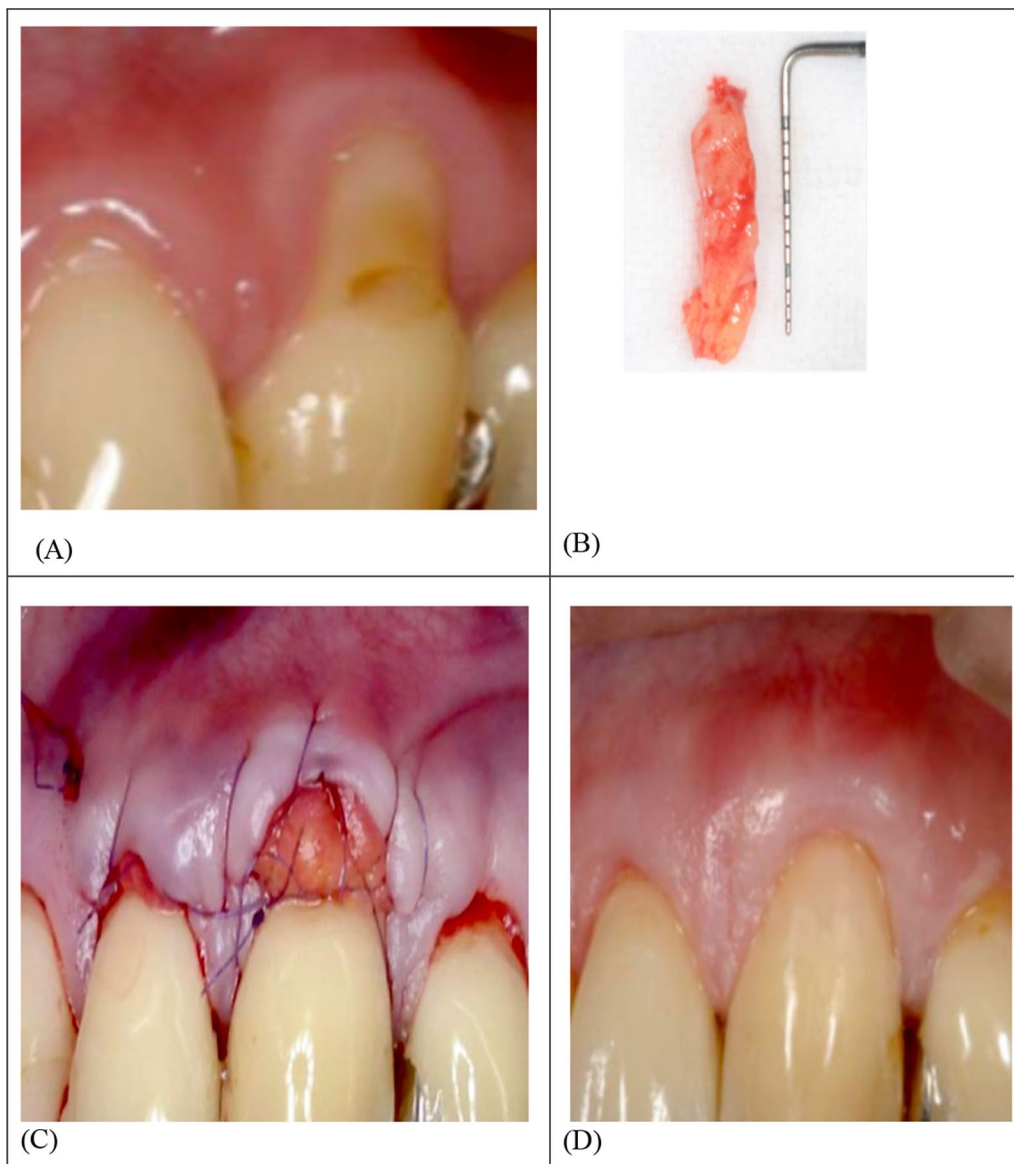
For group 2; The palatal donor site was anesthetized with 0.001% adrenalin (Alexandria Company for Pharmaceutical & Chemical Industries, Alexandria, Egypt) then the connective tissues were harvested from the palate by a single incision [11], or by trap door [12] according to the anatomical variations of the palate. The ideal thickness of the connective tissue is 1–1.5mm so in some cases further thinning of the graft was performed extra orally. The donor sites were closed immediately by the cross mattress suturing technique.

Then the graft should be large enough to cover the recession over the cemento-enamel junction then placed through the modified tunnel made by two vertical incisions mesial and distal to the recessed teeth. Starting from the alveolar mucosa ending at the mucogingival junction if the modified tunneling of the graft was inaccessible through the pouch of the gingiva. Suturing of the graft is then done using resorbable sutures. (Fig. 2).

## 2.9 Postsurgical care

Antibiotics (Augmentin 2 gm tab per day/one ever 12 h), or Clindamycin 900 mg per day for penicillin-allergic patients each 12 h for 5 days, analgesics every 8 h (500 mg paracetamol) were prescribed for the patients for 5 days. Chlorohexidine mouth wash 2% was prescribed for two weeks as a substitute for tooth brushing which stopped for the first two weeks after the surgeries. Suture removal of the outer non-resorbable sutures were performed after two weeks.

Patients recall was done after 1, 3, and 6 months after the surgeries to measure the recession and to record the results in charts for comparison with baseline records (Fig. 1.D and Fig. 2. D).



**Fig. 2** for control group Showing Pre-operative photograph of the gingival recession (A), Connective tissue graft harvested from the palate by a single incision flap (B), Tunneling of the graft, coronally advancement of the flap and suturing of the flap (C) and follow up for healing after 6 months (D)

### 3 Results

The following parameters were measured and compared between the baseline time; before the surgeries and the results after six months postoperatively:

1. The zone of attached gingiva: the distance from the tip of the papilla to the mucogingival junction minus the probing depth measured in millimeters (mm).
2. Periodontal probing depth: measured from the gingival margin to the depth of the gingival sulcus in six sites per tooth and measured in mm.
3. Clinical attachment loss: measured from the cemento-enamel junction to the depth of the sulcus in six sites per tooth and measured in mm.

4. Gingival recession: the depth measured from the gingival margin to the cementoenamel junction in mm.
5. Patient satisfaction: at the suture removal time, the patients were asked about their feedback regarding the duration of each surgery, the postoperative complications which filled in questionnaires.

### 3.1 Statistical Analysis

Numerical data were examined for normality by checking the data distribution and using tests of normality (Kolmogorov–Smirnov and Shapiro–Wilk tests).

Qualitative data were presented as frequencies and percentages of the sample. The Chi-square test was used for comparisons of qualitative data.

For parametric data; Independent-Samples T-test and Paired-Samples T-test were used to compare between the two groups.

The significance level was  $P < 0.05$ . *IBM SPSS* (version 20) was used for statistical analysis.

### 3.2 Demographic data

There was no statistically significant difference between mean age values in the two groups (Fig. 3). There was also no statistically significant difference between gender distributions between the groups (Fig. 4).

\*Significant at  $P < 0.05$

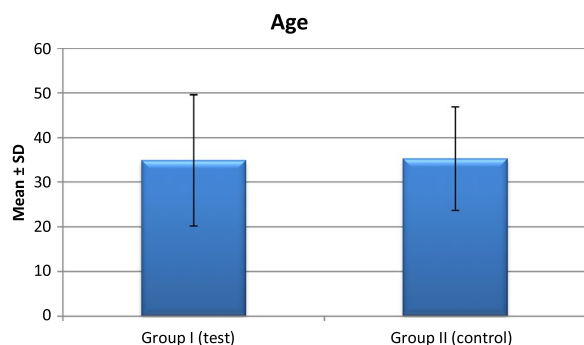
*The measured parameters:*

The zone of attached gingiva mean.

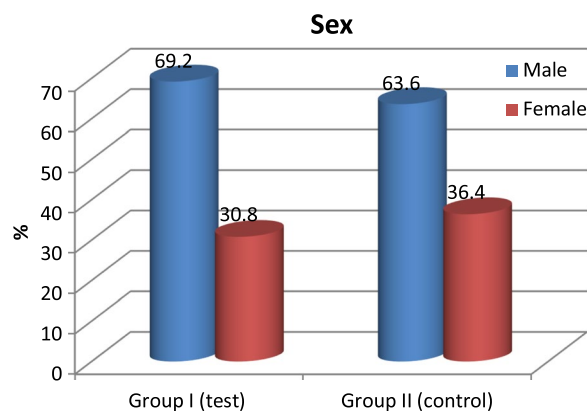
There was a statistically significant difference ( $< 0.005$ ) between Pre-operative and Post-operative (after 6 months) of the zone of attached gingiva mean in the two groups (Table 1).

Periodontal probing depth mean.

There was a statistically significant difference ( $< 0.005$ ) between Pre-operative and Post-operative (after 6



**Fig. 3** Column chart representing distributions age in the two groups



**Fig. 4** Cylinder chart representing distributions gender in the two groups

months) of pocket depth mean in group I (test) but there was no statistically significant difference between Pre-operative and Post-operative (after 6 months) of pocket depth mean in group II (control) (Table 2).

Clinical attachment loss CAL mean.

There was a statistically significant difference ( $< 0.005$ ) between Pre-operative and Post-operative (after 6 months) of clinical attachment loss mean in the two groups. (Table 3).

The Gingival recession (GR) measurement mean.

There was statistically significant difference ( $< 0.005$ ) between Pre and Post-operative (after 6 months) of gingival recession mean in the two groups (Table 4).

Patient satisfaction.

There was no statistically significant difference between patients' satisfaction in the two groups (Fig. 5).

Visual Analog Scale (VAS).

There was no statistically significant difference between VAS in the two groups (Fig. 6).

**Table 1** Descriptive statistics and results of paired-samples T-test for comparison between pre and post-operative in each group as well as t- test results between the two different groups as regards the zone of attached gingiva

Zone of attached gingiva mean	Group I (test) (n = 96)	Group II (control) (n = 82)	Significance between Groups
Pre-operative Mean ± SD	1.8 ± 0.7	1.9 ± 0.3	$P > 0.05$
Post-operative Mean ± SD	2.3 ± 0.9	2.5 ± 0.6	$P > 0.05$
P-value	$P < 0.01^{**}$	$P < 0.01^{**}$	

\* Significant at  $P < 0.05$

\*\* Significant at  $P < 0.01$

**Table 2** Descriptive statistics and results of paired-samples T-test for comparison between pre and post operative in each group, as well as t- test results between the two different groups as regards the pocket depth

Pocket depth mean	Group I (test)	Group II (control)	Significance between Groups
	(n = 96)	(n = 82)	
Pre-operative			
Mean ±SD	1.2 ±0.3	1.1 ±0.5	P >0.05
Post-operative			
Mean ±SD	1.1 ±0.4	0.8 ±0.3	P >0.05
P-value	P <0.01**	P <0.01**	

\* Significant at P <0.05

\*\*Significant at P <0.01

**Table 3** Descriptive statistics and results of paired-samples T-test for comparison between pre and post operative in each group, as well as t- test results between the two different groups as regards CAL

CAL mean	Group I (test)	Group II (control)	Significance between Groups
	(n = 96)	(n = 82)	
Pre-operative			
Mean ±SD	6.6 ±0.4	6.8 ±0.5	P >0.05
Post-operative			
Mean ±SD	3.4 ±0.5	3.7 ±0.2	P >0.05
P-value	P <0.01**	P <0.01**	

\* Significant at P <0.05

\*\*Significant at P <0.01

**Table 4** Descriptive statistics and results of paired-samples T-test for comparison between pre and post-operative in each group, as well as t- test results between the two different groups as regards GR

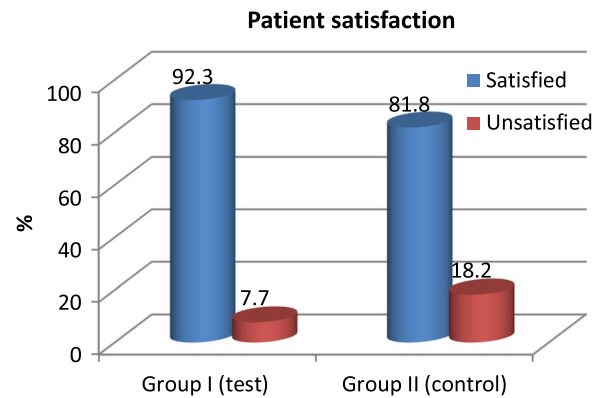
GR mean	Group I (test)	Group II (control)	Significance between Groups
	(n = 96)	(n = 82)	
Pre-operative			
Mean ±SD	5.4 ±0.2	5.4 ±0.5	P >0.05
Post-operative			
Mean ±SD	2.7 ±0.7	3.1 ±0.3	P >0.05
P-value	P <0.01**	P <0.01**	

\* Significant at P <0.05

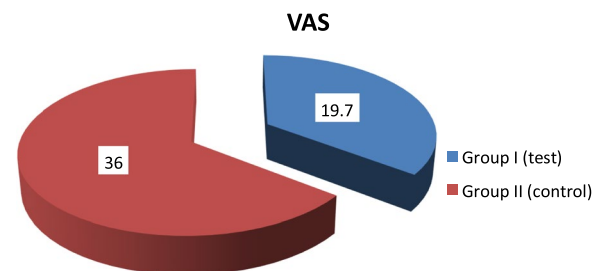
\*\*Significant at P <0.01

#### 4 Discussion

The increased interest in periodontal plastic surgery has resulted in the development of new surgical techniques and approaches [24]. Gingival recessions or the reduced



**Fig. 5** Column chart representing comparison between Pre-operative & Post-operative of patient satisfaction in groups



**Fig. 6** Pie chart representing comparison between VAS in groups

width of the attached gingiva may have a significant impact on the patient’s smile and potential teeth sensitivity [25]. Besides aesthetic reasons, several indications mandate the treatment of soft tissue deficiencies. Recently, modern techniques of plastic-aesthetic periodontal surgery allows a satisfactory regeneration of soft tissue deficiencies in the majority of cases. Subepithelial connective tissue grafts harvested from the palate are commonly used. Despite their clinical success, some disadvantages may be associated with their use. For example, when harvesting autologous tissue a second surgical site is created, which may result in increased post-operative pain and a higher risk of infections and complications. Moreover, the quality of the harvested tissue varies from patient to patient and its limited availability may become a problem, particularly for the correction of larger soft tissue defects or multiple recessions.

Studies are still debating if a reduction in the width of the attached gingiva is associated with an increased risk of infections, loss of attachment, and higher plaque accumulation. The present study is evaluating the use of two different fillers; the autogenous connective tissue graft obtained from the patient’s palate vs. the xenogenic grafts modified tunneling combined with coronally positioned

flaps, both treatments showed significant results concerning the recession coverage, increasing the zone of attached gingiva and clinical attachment gain compared to the baseline records which corresponded with a systematic review that evaluated the outcomes of various surgical approaches for the treatment of miller class one and two; the findings of the review concluded that the use of coronally positioned flap either with filler or not gave predictable results regarding the complete root coverage [13].

Regarding the flap, the technique was very atraumatic and conservative; modified tunneling of the autogenous connective tissue or the xenogenic filler without any vertically releasing incisions gave the maximum benefits of revascularization of both graft and flaps which coronally repositioned above the cemento enamel junction (CEJ) to cover receded gingiva of Miller class one and two and maintained in this position by mattress sutures [14], but some of the patients of control groups complained from harvesting of autogenous connective tissues from their palates that were explained by doing two surgeries one for covering the roots and another for the donor sites.

Both treatments of this study gave statistically significant results regarding increasing the zone of attached gingiva compared to the baseline data which may be explained by the tendency of the mucogingival junction to regain its original position [15].

The gain of attachment was observed for the two groups, statistically significant compared with the baseline condition could be explained by the creeping effect of the attachment and maybe also influenced by thicker gingiva formation after placement of the filler underneath the flaps either autogenous or xenogenic type [16].

Root coverage surgeries compared coronally advanced flap only versus coronally advanced flap with subepithelial connective tissue graft revealed apical shrinkage of the gingival margins for the first group in contrast to a coronal shift of the gingival margins for the second group after five years follow up which was explained by the creeping of the attachment [16] and the apical shift of the gingival margins due to a decreased thickness of the attached tissues. So the present study was designed to use the subepithelial connective tissue graft as a comparative group [5].

In the present study; shallower probing depths and clinical attachment gain were observed in the both groups after 6 months follow up and it was attributed to graft attachment either the autogenous or the xenogenic ones to the root surface by down growth of both epithelial and connective tissue attachments [14, 17].

The flap design used in the present study for both groups was maintaining homogeneous blood supply to the underneath graft without vertical releasing incisions

and with careful consideration of other factors that increase the success rate like flap thickness and tension-free suturing [18, 19].

Although that CAF with connective tissue graft considered the gold slandered approach for the root coverage of localized or generalized gingival recession with predictable results especially Miller class I and II but still the drawbacks of donor site morbidity, pain, and bleeding possibilities could not be avoided; so the need for another atraumatic graft like the collagen xenogenic matrix considered a solution and good alternative to the connective tissue grafts [20–22].

According to a split-mouth, comparative study between CAF with CTG versus CAF with collagen matrix; even both increased the attached gingiva and decrease the periodontal probing; the first group resulted in  $90\% \pm 18\%$  root coverage means and complete root coverage was founded in 85% of the sites, but the second group resulted in  $71\% \pm 21\%$  root coverage mean, and complete root coverage was founded in 42% of the total sites (23).

## 5 Conclusions

1. Both treatment procedures are considered efficient in increasing zone of attached gingiva and decreasing its clinical attachment loss around the recessed gingiva.
2. Mucoderm is considered as an efficient alternative to CTG for treatment of gingival recession.
3. In general, all of the parameters measured showed a significant difference between pre and postoperative measurements for each group but there is no significant difference between the two groups using( two treatment approaches.

## Abbreviations

CTG	Connective tissue graft
ICH	International Conference of Harmonization
mm	Millimeters
GR	Gingival recession
CEJ	Cemento enamel junction
CAF	Coronally advanced flap
CAL	Clinical attachment loss
FDBSU-REC	Research Ethics Committee, Faculty of Dentistry, Beni-Suef University
VAS	Visual Analog Scale

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## Author contributions

The corresponding author AA contributed to Conceived and designed the idea of the experiment, conducted the clinical part of the experiment, interpreting the results and drafted the manuscript. The co-authors, Prof. Dr.



WA and Dr. MA participated in data and statistical analysis then edited the final version of the manuscript. All authors read, revised and approved the final manuscript.

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#### Availability of data and materials

The data sets used and analyzed during the current study are available from the corresponding author on reasonable request.

#### Declarations

##### Ethics approval and consent to participate

This randomized controlled trial titled: "Root coverage surgeries using tunneling technique of xenogenic collagen matrix versus autologous connective tissue graft as a treatment of Miller class two gingival recession (RCT study) was conducted following the ethical principles for medical research involving human subjects, and was approved by the Research Ethics Committee (FDBSU-REC), Faculty of Dentistry, Beni-Suef University (Approval number: #FDBSUREC/08042021/FA). FDBSU-REC is organized and operated according to Enhancing Research Ethics Committees in Egypt, Guidelines for Standard Operating Procedures, Monitor 2006, Guidelines of the Declaration of Helsinki, International Conference of Harmonization ICH, and United States Codes of Federal Regulations and registered in the office of Human Research Protection under the IORG #: IORG0010018. Informed consent of participation was obtained from all individual participants included in the study (attached next page).

##### Competing interests

The authors declare that they have no competing interests.

##### Consent for publication

Not applicable.

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#### References

- Kavitha J, Navarasu M, Srikanth V (2014) Treatment of gingival recession using coronally advanced flap-case reports. *Int J Dental Sci Res* 2(1):1–4. <https://doi.org/10.12691/ijdsr-2-1-1>
- Serino G, Wennström JL, Lindhe J, Eneroth L (1994) The prevalence and distribution of gingival recession in subjects with a high standard of oral hygiene. *J Clin Periodontol* 21(1):57–63. <https://doi.org/10.1111/j.1600-051x.1994.tb00278.x>
- Sangnes G, Gjermo P (1976) Prevalence of oral soft and hard tissue lesions related to mechanical tooth cleaning procedures. *Community Dent Oral Epidemiol* 4(2):77–83. <https://doi.org/10.1111/j.1600-0528.1976.tb01607.x>
- Zucchelli G, De Sanctis M (2013) Modified two-stage procedures for the treatment of gingival recession. *Eur J Esthet Dent* 8(1):24–42
- Cairo F, Pagliaro U, Nieri M (2008) Treatment of gingival recession with coronally advanced flap procedures: a systematic review. *J Clin Periodontol* 35(8):136–162. <https://doi.org/10.1111/j.1600-051x.2008.01267x>
- Clauser C, Nieri M, Franceschi D, Pagliaro U, Pini-Prato G (2003) Evidence-based mucogingival therapy. Part 2: Ordinary and individual patient data meta-analyses of surgical treatment of recession using complete root coverage as the outcome variable. *J Periodontol* 74(5):741–756. <https://doi.org/10.1902/jop.2003.74.5.741>
- Zucchelli G, De Sanctis M (2000) Treatment of multiple recession-type defects in patients with esthetic demands. *J Periodontol* 71(9):1506–1514. <https://doi.org/10.1902/jop.2000.71.9.1506>
- Pabst AM, Müller WEG, Ackermann M (2017) Three-dimensional scanning electron microscopy of maxillofacial biomaterials. *Br J Oral Maxillofac Surg* 55(7):736–739. <https://doi.org/10.1016/j.bjoms.2017.05.010>
- Buff LR, Bürklin T, Eickholz P, Mönning JS, Ratka-Krüger P (2009) Does harvesting connective tissue grafts from the palate cause persistent sensory dysfunction? A pilot study. *Quintessence Int* 40(6):479–489
- Zabalegui I, Sicilia A, Cambra J, Gil J, Sanz M (1999) Treatment of multiple adjacent gingival recessions with the tunnel subepithelial connective tissue graft: a clinical report. *Int J Periodontics Restorative Dent* 19(2):199–206
- Zuhr O, Fickl S, Wachtel H, Bolz W, Hürzeler MB (2007) Covering of gingival recessions with a modified microsurgical tunnel technique: case report. *Int J Periodontics Restorative Dent* 27(5):457–463
- Langer B, Langer L (1985) Subepithelial connective tissue graft technique for root coverage. *J Periodontol* 56(12):715–720. <https://doi.org/10.1902/jop.1985.56.12.715>
- Hofmänner P, Alessandri R, Laugisch O, Aroca S, Salvi GE, Stavropoulos A, Sculean A (2012) Predictability of surgical techniques used for coverage of multiple adjacent gingival recessions—a systematic review. *Quintessence Int* 43(7):545–554
- Guiha R, El Khodairy S, Mota L, Caffesse R (2001) Histological evaluation of healing and revascularization of the subepithelial connective tissue graft. *J Periodontol* 72(4):470–478. <https://doi.org/10.1902/jop.2001.72.4.470>
- Zucchelli G, Mele M, Mazzotti C, Marzadori M, Montebugnoli L, De Sanctis M (2009) Coronally advanced flap with and without vertical releasing incisions for the treatment of multiple gingival recessions: a comparative controlled randomized clinical trial. *J Periodontol* 80(7):1083–1094. <https://doi.org/10.1902/jop.2009.090041>
- Wan W, Zhong H, Wang J (2020) Creeping attachment: a literature review. *J Esthet Restor Dent* 32(8):776–782. <https://doi.org/10.1111/jerd.12648>
- Goldstein M, Boyan BD, Cochran DL, Schwartz Z (2001) Human histology of new attachment after root coverage using a subepithelial connective tissue graft. *J Clin Periodontol* 28(7):657–662. <https://doi.org/10.1034/j.1600-051x.2001.028007657.x>
- Harris RJ (2002) Root coverage with connective tissue grafts: an evaluation of short- and long-term results. *J Periodontol* 73(9):1054–1059. <https://doi.org/10.1902/jop.2002.73.9.1054>
- Raetzke PB (1985) Covering localized areas of root exposure employing the "envelope" technique. *J Periodontol* 56(7):397–402. <https://doi.org/10.1902/jop.1985.56.7.397>
- Cardaropoli D, Tamagnone L, Roffredo A, Gaveglia L (2012) Treatment of gingival recession defects using a coronally advanced flap with a porcine collagen matrix compared to coronally advanced flap with connective tissue graft: a randomized controlled clinical trial. *J Periodontol* 83(3):321–328. <https://doi.org/10.1902/jop.2011.110215>
- Jepsen K, Jepsen S, Zucchelli G, Stefanini M, de Sanctis M, Baldini N, Greven B, Heinz B, Wennström J, Cassel B, Vignoletti F, Sanz M (2013) Treatment of gingival recession defects with a coronally advanced flap and a xenogenic collagen matrix: a multicenter randomized clinical trial. *J Clin Periodontol* 40(1):82–89. <https://doi.org/10.1111/jcpe.12019>
- Rotundo R, Pini-Prato G (2012) Use of a new collagen matrix (mucograft) for the treatment of multiple gingival recessions: case reports. *Int J Periodontics Restorative Dent* 32(4):413–419
- Aroca S, Molnár B, Windisch P, Gera I, Salvi GE, Nikolidakis D, Sculean A (2013) Treatment of multiple adjacent Miller class I and II gingival recessions with a Modified coronally advanced tunnel (MCAT) technique and a collagen matrix or palatal connective tissue graft: a randomized, controlled clinical trial. *J Clin Periodontol* 40(7):713–720. <https://doi.org/10.1111/jcpe.12112>
- Cairo F, Nieri M, Cincinelli S, Mervelt J, Pagliaro U (2011) The interproximal clinical attachment level to classify gingival recessions and predict root coverage outcomes: an explorative and reliability study. *J Clin Periodontol* 38:661–666. <https://doi.org/10.1111/j.1600-051x.2011.01732.x>
- Cairo F, Graziani F, Franchi L, Defraia E, Pini-Prato GP (2012) Periodontal plastic surgery to improve aesthetics in patients with altered passive eruption/gummy smile: a case series study. *Int J Dent* 2012:837658. <https://doi.org/10.1155/2012/837658>

26. Imber JC, Kasaj A (2021) Treatment of Gingival Recession: When and How? *Int Dent J* 71(3):178–187. <https://doi.org/10.1111/idj.12617>
27. Thamaraiselvan M, Elavarasu S, Thangakumaran S, Gadagi JS, Arthie T (2015) Comparative clinical evaluation of coronally advanced flap with or without platelet rich fibrin membrane in the treatment of isolated gingival recession. *J Indian Soc Periodontol*. 19(1):66–71. <https://doi.org/10.4103/0972-124X.145790>

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