BMC Oral Health

RESEARCH

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Comparison of conventional and modified sling suture techniques in free gingival graft operations-a randomized controlled clinical trial

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Abstract

Background The aim of this study was to investigate the effects of conventional suture (CS) and modified sling suture (MSS) techniques, applied in free gingival graft (FGG) surgery using gingival unit graft (GUT) and conventional graft (CG) techniques, on clinical parameters and graft dimensions.

Methods 52 individuals having Cairo Type 2 (RT2) and Type 3 (RT3) gingival recessions in mandibular anterior were divided into four groups as (a) GUT + MSS ($n = 13$), (b) GUT + CS ($n = 13$), (c) CG + MSS ($n = 13$) and (d) CG + CS ($n = 13$). Keratinized tissue width (KTW), relative gingival recession height (rGRH), and relative vestibule depth (rVD) measurements were recorded using a digital caliper and UNC 15 periodontal probe. Dimensional changes (Δ) of the graft surface area (GSA) was determined by ImageJ software. All measurements were done at baseline, 1st and 3rd months.

Results It was determined that the increase in KTW in the 1st and 3rd months in GUT + CS group was significantly higher than GUT + MSS group ($p < 0.05$). There was no statistically significant difference in Δ rVD and Δ rGRH values between the groups. When ΔGSA (mm2) values were compared between the groups, the decrease in the 1st and 3rd months in the CG + MSS group was found to be significantly higher than the GUT + MSS and GUT + CS groups ($p < 0.05$).

Conclusion Within the limits of this study, it can be concluded that keratinized tissue can be obtained successfully with both GUT or CG techniques in FGG surgery, on the other hand, regardless of the suture technique, GUT showed less graft shrinkage than CG.

Trial registration The study was retrospectively registered at ClinicalTrials (Registration number: NCT06197893; Date of registration: 11 January 2024).

Keywords Autograft, Gingival recession, Gingival unit transfer, Free gingival graft, Mucogingival surgery, Sling suture, Shrinkage

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Introduction

Gingival recession is characterized by the exposure of the root surface due to the apical displacement of the gingival margin. This condition can result from various factors, including periodontal disease, traumatic tooth brushing, improper tooth positioning, poorly designed prosthetic restorations, unfavorable occlusal relationships, or a thin periodontal phenotype [1–4]. An inadequate mucogingival complex can hinder effective oral hygiene, potentially leading to localized inflammation and further progression of gingival recession. Treatment may be indicated when patients experience site-specific difficulty maintaining adequate plaque control due to the deep, narrow nature of the recession defect or the absence of keratinized tissue [5].

The Cairo classification is commonly used to assess the predictability of success in treating gingival recession [6]. According to this system, complete root coverage is achievable in RT1 gingival recessions. However, in RT2 recessions, interproximal attachment loss may limit root coverage, resulting in only partial coverage. In a study by Cairo et al., RT3 recession defects were treated with free gingival grafts (FGGs) to achieve gingival augmentation, without aiming for root coverage [7] The free gingival graft (FGG) is one of the most commonly used periodontal plastic surgery techniques for increasing keratinized tissue. Adequate blood supply from adjacent tissues, interproximal gingival texture, and incision characteristics are crucial for graft survival on the avascular root surface [6, 8]. The technique offers several advantages, including its autogenous nature, ability to augment keratinized gingiva, predictable surgical outcomes, ease of application, and the capacity to treat multiple teeth simultaneously. However, it also has limitations, such as aesthetic incompatibility, potential misalignment of the mucogingival junction, and a bulky appearance [9, 10].

Allen and Cohen modified the conventional FGG and termed this technique as gingival unit transfer [11]. This technique includes the marginal and interdental gingiva from the donor area, ensuring surface-to-surface contact with the marginal gingiva and interdental papillae of the recipient bed to optimize blood supply. This allows for better graft adaptation to the recipient bed and minimizes the risk of partial necrosis that may occur on avascular surfaces.

The most important disadvantage of FGG surgery is the dimensional shrinkage of the graft during healing period. Various clinical studies have reported a wide range of graft shrinkage percentages, from 12 to 58% [12–15]. Factors that disrupt vascular continuity play a critical role in graft shrinkage. For instance, increasing the number of sutures for graft stabilization and bleeding control can damage the periosteum and connective tissue in the surgical area. This may result in increased inflammation, impaired wound healing, and negatively impact graft revascularization [16]. The literature recommends minimizing the number of sutures, as excessive suturing can lead to localized hematomas under the graft, which may contribute to graft shrinkage [15, 17–19]. Nowadays, different applications and techniques are defined for aiming to reduce dimensional changes of the graft such as; microsurgery, cyanoacrylate application [20, 21] low level laser therapy [22, 23], hyaluronic acid [24–26] and PRF [27].

In light of this information, a novel suture technique, termed the modified sling suture (MSS)—a modification of the sling suture that incorporates the lingual papilla—may be less invasive than conventional sutures and could result in smaller dimensional changes in the graft during the healing period. Therefore, the null hypothesis of this study posits that the MSS will not lead to less shrinkage in both conventional grafts and gingival unit transfer grafts (GUT) compared to the conventional suture (CS). Accordingly, the aim of this randomized controlled parallel-design clinical study is to evaluate the effect of the MSS technique on graft shrinkage and keratinized tissue gain in FGG surgery. Additionally, we aim to compare these outcomes between GUT and conventional graft (CG) techniques.

The primary outcome was the dimensional changes (Δ) of the graft surface area (GSA). The secondary outcomes included keratinized tissue width (KTW), relative gingival recession height, and relative vestibular depth.

Methodology

Study design

This randomized, controlled parallel design clinical study was conducted at Bezmialem Vakıf University, Faculty of Dentistry, Department of Periodontology between March 2022- December 2022. This study was approved by the human subjects ethics board of Bezmialem Vakıf University, Faculty of Medicine, Clinical Research Ethics Committee (decision date: 15.03.2022 and number: 54757) and was conducted in accordance with the Helsinki Declaration of 1975, as revised in 2013. The study was retrospectively registered at ClinicalTrials (NCT06197893). Before the study, all participants were informed verbally about the clinical procedure and their written informed consent was obtained. The flowchart of the study protocol was summarized in Fig. 1.

Patient sample

A total of 92 patients were initially examined, and those who met the inclusion criteria were simultaneously

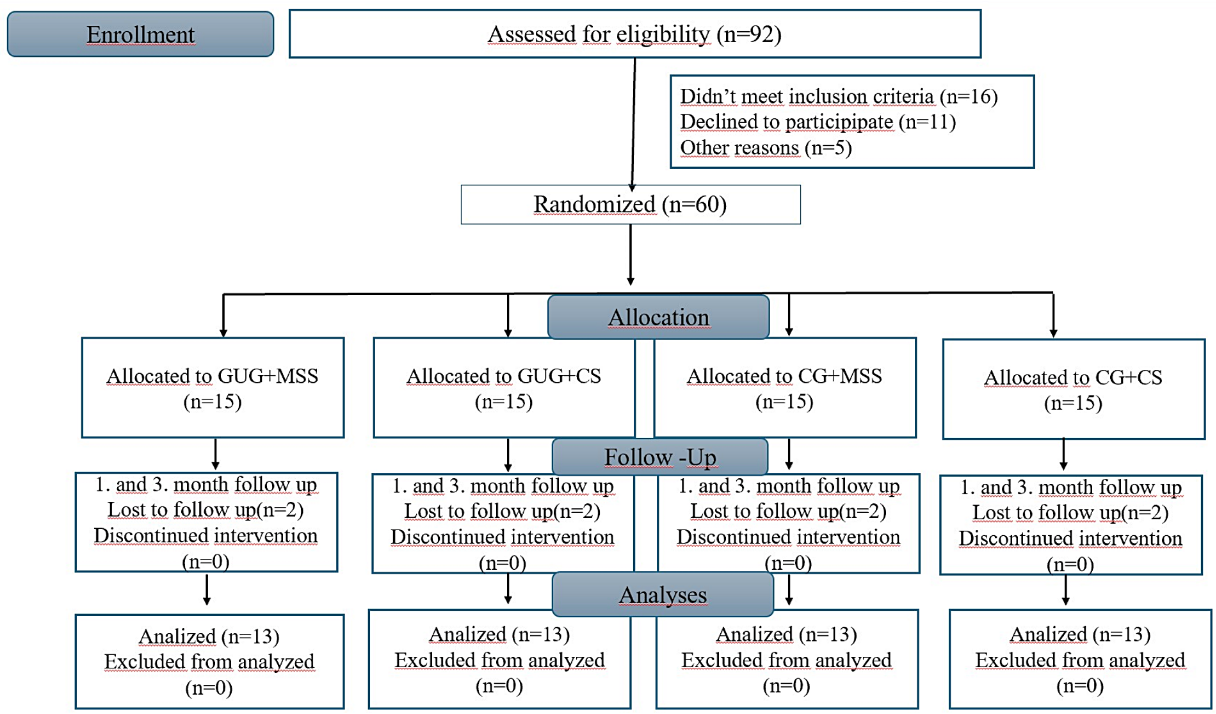

Fig. 1 The flowchart of the study

enrolled in the study. Among them, 60 subjects with gingival recession defects (RT2 and RT3) on 95 mandibular incisors were included.

Inclusion criteria were (1) systemically healthy individuals with less than 1 mm of attached gingiva on their mandibular incisors, (2) PI and GI scores < 1 [1] and, (3) only individuals who had not undergone surgical procedures in the mandibular anterior area were included in the study.

The exclusion criteria were: (1) pregnant or lactating women; (2) patients younger than 18 years of age; (3) patients who smoked more than 10 cigarettes per day; (4) malpositioned restorations and/or endodontic issues; and (5) probing depth ≥ 3 mm at the teeth including the surgical site.

Clinical procedures

All patients who agreed to participate received phase I periodontal treatment and oral hygiene motivation at baseline. After that, surgical appointments were arranged for the patients who had good oral hygiene.

Individuals participating in the study were randomly divided into 4 groups:

Group 1: GUT + MSS (gingival unit transfer + modified sling suture).

Group 2: GUT + CS (gingival unit transfer + conventional suture).

Group 3: CG + MSS (conventional graft + modified sling suture).

Group 4: CG + CS (conventional graft + conventional suture).

Randomizations of the study groups were accomplished in two stages. Just before the operation, suture technique (MSS/CS) to be used in the surgical procedure was determined by a coin toss. Subsequently, graft technique (GUT/CG) for that patient was concluded in the same manner and recorded by one of the authors (DS).

Surgical therapy

Local anesthesia was applied to the mandibular incisor region using the infiltrative technique. In the recipient area, a horizontal incision was made along the mucogingival junction (MGJ), extending one tooth in each direction. Two vertical releasing incisions were then made in the apical-coronal direction at the ends of the horizontal incisions. The incision sites were deepithelialized using a scalpel and scissors, and the root surface was prepared with periodontal curettes. The alveolar mucosa was left unsutured and sterile gauze was placed on the bed for bleeding control until the graft was obtained. All surgical procedures were conducted by one experienced periodontist (SS).

Gingival unit transfer (GUT)

The GUT was harvested from the maxillary premolar area. Following infiltrative anesthesia, a piece of aluminum foil of the desired size was placed in the recipient area of the maxilla. A sulcular incision, including the marginal gingival tissue, and two vertical incisions, encompassing the distal and mesial papillae, were made on the palatal side of the premolars. The incision lines were then connected, and a graft with a thickness of 1–1.5 mm was carefully dissected. A hemorrhagic sponge (spongostan) was placed on the wound site, and a protective prefabricated acrylic stent (palatal plate) was positioned in the donor area.

Conventional graft (CG)

Aluminum foil was placed on the palatal aspect of the maxillary premolars to determine the dimensions of the conventional graft. At least 2 mm from the free gingival margin of the adjacent teeth, the outer edges of the foil were marked with a scalpel, and a 1–1.5 mm thick graft was harvested from the donor area. The maxillary donor site was then covered in the same manner as the GUTG technique.

The clinical photographs of both GUT and CG techniques were given in figure S4.

Modified sling suture (MSS)

The MSS technique was used to fix the dissected graft to the recipient bed and the graft stabilized with 5/0 polypropylene suture. In this technique, the needle first passes through the graft apical to the mesial papilla on the buccal surface, and exits the flap in the lingual papilla region (Fig. 2a, b). Then, on the distal side, the needle was directed through the lingual papilla to the buccal side (Fig. 2c) and passed through the graft apical part of the distal papilla (Fig. 1d) and was removed from the lingual papilla again (Fig. 2e). It was then knotted on the buccal side of the graft by returning to the buccal starting point (Fig. 2e).

The illustration of the MSS technique in GUTsurgery was shown in figure S1.

Conventional suture (CS)

In the conventional suture technique, the coronal portion of the graft was secured with a horizontal mattress suture, followed by two simple sutures along the vertical incision lines on the mesial and distal sides.

Post-surgical care

After the operation, patients were instructed to avoid lip and cheek movements that may affect graft stabilization and patients were given a spare sterile gauze in case of bleeding in the palatal region.

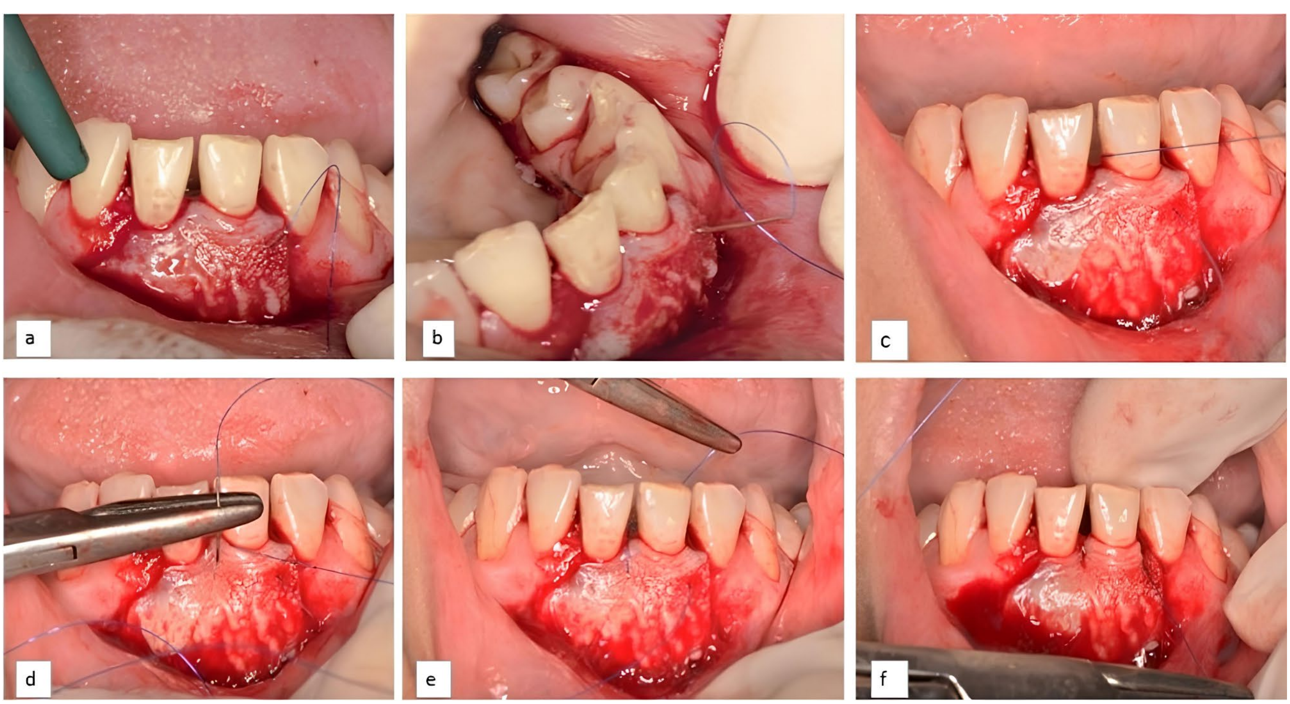

Fig. 2 Clinical photographs of modified sling suture technique used in gingival unit transfer surgery

After surgery, all patients received a nonsteroidal anti-inflammatory drug (NSAID)[1] twice a day for a week and allowed to use it as needed. Patients were instructed to rinse using 0.12% chlorhexidine digluconate[2] for 10 days, twice a daystarting the day after surgery. The patient was allowed to brush 1 week after the operation except the surgical area, and the surgical area can be brushed 2 weeks after the operation.

Clinical measurements

Before the study start, investigator calibration was conducted on 10 patients with gingival recession who were not included in the study. Gingival recession (GR) and keratinized tissue width (KTW) measurements were repeated at one-week intervals using UNC 15 periodontal probe (Hu Friedy, Chicago, IL, USA). Accordingly, intraclass correlation coefficient ranged from 0.817 to 0.989 for GR and, 0.832 to 0.912 for KTW indicating that investigator repeatability was at a sufficient level. All clinical parameters were measured by a single investigator (S.S), and the results were recorded on a data collection form. Periodontal measurements were performed at the same day before surgery and at 1and 3 months post-surgery.

Clinical parameters including keratinized tissue width (KTW) (mm), relative gingival recession height (rGRH), relative vestibule depth (rVD), and graft surface area (GSA) were recorded. An acrylic stent covering the mandibular canine-canine teeth of the patients was prepared using an alginate impression. Reference points on the stent were designated as the intersections of horizontal and vertical grooves created in three regions to encompass the graft area. A UNC 15 periodontal probe with a rubber stopper was employed to measure the distance from the stent's reference point to both the free gingival margin and the mucobuccal fold. The stopper was placed at the reference point, and the distance from the probe tip to the stopper was recorded using a digital caliper. Measurements were summarized as below:

1. The distance between the reference point on the stent and the free gingival margin was considered as the rGRH (mm) and the distance from the reference point on the stent to the mucobuccal fold was considered as the relative vestibule depth (rVD) (mm) (See in figure S2).
2. KTW was measured as the distance from the buccal midpoint of the free gingival margin to the mucogingival junction.

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Determination of the graft surface area (GSA)

The graft dimensions were calculated using ImageJ software. To measure the graft surface area, the reference point of the UNC 15 periodontal probe (5 mm) on the acrylic stent was used for calibration. After calibration, the borders of the graft were outlined and measured in mm^2. The measurements were repeated three times, and the arithmetic mean of the obtained values was calculated as the graft surface area (mm^2), as proposed by Hatipoğlu et al. (2007). (See in figure S3).

Graft shrinkage(GS) was assessed by means of the formula as= [(Preoperative area-postoperative area)/ (Preoperative area)] x 100 and depicted as percent.

Sample size calculation

Prior to the start of the study, the minimum required number of participants in each group was determined through power analysis. Based on this analysis, with a difference between proportions set at 0.44 for KTW, a 95% confidence level and 80% power, the minimum sample size for each group was calculated to be 13 [28–30]. To account for potential participant dropouts, a total of 60 participants were included in the study.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics 22. The normality of the parameters was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Descriptive statistics (mean, standard deviation, and frequency) were calculated. For parameters with normal distribution, One-Way ANOVA followed by Tukey's HSD test was used to compare quantitative data between groups. For non-normally distributed parameters, the Kruskal-Wallis test with Dunn's post hoc analysis was applied. Analysis of Variance for Repeated Measures was used for intra-group comparisons of normally distributed parameters, with the Bonferroni test applied as a post hoc analysis. The Fisher-Freeman-Halton Exact Chi-Square test was used to compare qualitative data. Spearman's rho correlation analysis was conducted to assess relationships between the variables.

Results

This prospective clinical study included 60 patients. On the other hand, 5 patients didn't come to the 1st month control and 3 patients didn't come to the 3rd month control appointments. Therefore, 52 patients completed the study.

Demographic data of study groups was given in Table 1. Accordingly, there was no statistically significant difference between the groups in terms of age and gender ($p > 0.05$). Furthermore, the type of recession included in the study population did not differ between the study groups ($p > 0.05$).

Table 1 Demographic and clinical variables in the study groups

	GUG + MSS (n = 13)	GUG + CS (n = 13)	CG + MSS (n = 13)	CG + CS (n = 13)	p
Age (years)	33,46 ± 7,12	35,38 ± 8,99	36,61 ± 7,27	32,61 ± 8,18	[1]0,568
Gender n(%)					
Female Male	11 (%84,6) 2 (%15,4)	13 (%100) 0 (%0)	12 (%92,3) 1 (%7,7)	11 (%84,6) 2 (%15,4)	[2]0,736
Type of recession		9(%53,8)/4(%30,7)	6(%46,1)/7(%53,8)	6(%46,1)/7(%53,8)	[2]0,603
RT2/RT3	7(%53,8)/6(%46,1)				

Abbreviations: GUG, gingival unit graft; CG, conventional graft; MSS, modified sling suture; CS, conventional suture; RT, recession type

[1]Oneway ANOVA Test[2]Fisher Freeman Halton Exact Test *$p < 0.05$

Clinical measurements

The alterations in KTW, rGRH, and rVD are summarized in Table 2. The change in KTW measurements at the 1st and 3rd months in the GUT + CS group was statistically higher than in the GUT + MSS group ($p < 0.05$). However, KTW alterations over the evaluated time periods were not significantly different between the other groups ($p > 0.05$). In both groups, GRH decreased over time, but intragroup comparison revealed that this change was only significant in the GUT + MSS group ($p < 0.05$). When comparing the change in GRH measurements among the groups, no significant differences were observed ($p > 0.05$). Similarly, alterations in VD measurements did not differ significantly between the groups ($p > 0.05$) (Table 2).

Photogrammetric analysis of the graft area

Dimensional changes of the graft at the evaluated time points are presented in Table 2. The measurements at the 1st and 3rd months showed that GSA decreased in all groups compared to baseline values ($p < 0.05$). When comparing the dimensional changes of the grafts between the groups, it was found that the CG + MSS group exhibited greater dimensional change (mm^2) and graft shrinkage at all evaluated time points compared to the GUT + MSS and GUT + CS groups ($p < 0.05$). However, no significant difference was observed between the other groups ($p > 0.05$).

Correlation analysis showed that no significant relationship was observed between the change in graft dimensions and baseline clinical measurements ($p > 0.05$) (Table 3).

The clinical healing of both groups in all evaluated time periods was illustrated in Fig. 3.

Discussion

This three-month follow-up randomized controlled parallel design clinical study evaluated the effect of MSS and CS techniques on clinical parameters and dimensional changes in FGG operations. According to the data from our study, when the gingival unit graft was fixed to the recipient bed using conventional sutures, a greater increase in the width of keratinized tissue was observed. The depth of the vestibular sulcus increased successfully in all groups, although this difference was not statistically significant. and he rGRH values decreased at similar levels in all groups. Graft shrinkage in the study population ranged from 21 to 46% by the end of the three-month healing period and was statistically significantly higher in the CG + MSS group compared to the GUT + MSS and GUT + CS groups. Although the amount of graft shrinkage was lower in the GUT + MSS group compared to other groups, this difference did not reached significance. To the best of our knowledge, this is the first clinical study that investigates the effect of both graft and suture technique modifications on clinical measurements during the healing period in FGG surgery.

The presence of an adequate width of attached gingiva protects the periodontium from external factors, ensures the immobility of the marginal gingiva, and plays a vital role in maintaining gingival health. Several studies suggest that at least 2 mm of keratinized gingiva, including 1 mm of attached gingiva, is necessary to preserve gingival health [6, 22]. One of the key objectives of the present study was to evaluate the gain in KTW. In the study by Kuru and Yildirim, CG and GUT surgeries were compared in 17 patients with Miller class I and II gingival recessions. The researchers reported a greater decrease in gingival recession (GR) and an increase in clinical attachment level (CAL) and KTW in the GUT group compared to the CG group at the 8-month follow-up [31]. Similarly, Sriwil et al. observed a significant increase in KTW gain in the GUT group, recorded only in the first month [32]. In a comparable study conducted by Jenabien et al., a significant increase in KTW gain was noted in the GUT group at the 6-month follow-up [33]. In current study, when comparing the change in KTW between the groups, no significant difference was found between the CG and GUT groups. However, the increase in KTW in the GUT + CS group at the 1st and 3rd months, compared to the initial values, was significantly higher than that in the GUT + MSS group. This discrepancy may be due to potential differences in the initial length of the grafts in the CG and GUT groups. Although the initial dimensions of the grafts were assessed using photogrammetric analysis, the length and width of the grafts were

Table 2 Changes of clinical (mm), GSA (mm^2) and GSR(%) measurements in both groups during the evaluation period.

KTW	GUG+MSS (n=13)	GUG+CS (n=13)	CG+MSS (n=13)	CG+CS (n=13)	P
T0	1,63±0,52	1,57±0,67	2,05±0,84	1,78±0,86	0,363$^{\Omega}$
T1	5,10±1,55^{a}	7,34±1,25^{aa}	6,85±2,06^{aa}	6,34±1,24^{a}	**0,005**$^{*\Omega}$
T2	5,49±1,32 ^{a}	7,32±1,23^{aa}	6,99±2,05^{aa}	6,24±1,27^{a}	**0,016**$^{*\Omega}$
p$^{£}$	**0,001***	**0,001***	**0,001***	**0,001***	
T0-T1	3,47±1,77 (3,4)	5,77±1,63 (6,1)^{a}	4,80±2,14 (5,1)	4,55±1,41 (4,8)	**0,020**$^{*¥}$
T0-T2	3,86±1,49 (3,8)	5,75±1,58 (5,9)^{a}	4,94±2,22 (4,6)	4,45±1,48 (4,5)	**0,034**$^{*¥}$
rGRH					
T0	8,51±1,19	6,64±1,84	6,92±1,74	7,75±0,85	0,098 $^{\Omega}$
T1	8,13±1,01	6,14±1,32	6,99±1,90	7,43±1,38	0,076 $^{\Omega}$
T2	7,44±1,47$^{a\beta}$	6,17±1,24	6,64±1,81	7,00±0,88	0,384 $^{\Omega}$
p$^{£}$	**0,033***	0,312	0,442	0,403	
T0-T1	-0,37±0,53 (-0,2)	-0,5±0,79 (-0,2)	0,07±1,05 (-0,3)	-0,33±0,78 (-0,1)	0,892$^{¥}$
T0-T2	-1,07±0,82 (-1,2)	-0,47±0,83 (-0,2)	-0,28±0,35 (-0,3)	-0,76±0,75 (-0,8)	0,342$^{¥}$
rVD					
T0	13,60±1,71	12,54±1,17	12,98±2,38	12,72±1,50	0,647 $^{\Omega}$
T1	15,46±1,44^{a}	15,54±1,35^{a}	15,02±2,28^{a}	16,06±1,22	0,652 $^{\Omega}$
T2	15,85±1,64^{a}	15,73±1,40^{a}	15,83±2,63^{a}	15,92±1,15	0,997 $^{\Omega}$
p$^{£}$	**0,019***	**0,005***	**0,001***	**0,004***	
T0-T1	1,86±1,25 (1,4)	3,00±1,5 (3,3)	2,04±1,06 (2,2)	2,24±0,87 (2,4)	0,445$^{¥}$
T0-T2	2,25±1,51 (1,5)	3,19±1,71 (3,6)	2,85±1,14 (3,1)	1,91±0,95 (1,8)	0,474$^{¥}$
GSA	**GUG+MSS (n=13)**	**GUG+CS (n=13)**	**CG+MSS (n=13)**	**CG+CS (n=13)**	
T0	115,51±40,89	101,44±25,54	114,01±45,67	100,45±30,96	0,605 $^{\Omega}$
T1	60,51±18,97^{a}	70,88±21,90^{a}	68,95±26,17^{a}	72,01±19,62^{a}	0,534 $^{\Omega}$
T2	59,73±16,87^{a}	76,28±21,66^{a}	75,98±52,55^{a}	71,53±22,85^{a}	0,515 $^{\Omega}$
p$^{£}$	**0,001***	**0,024***	**0,002***	**0,002***	
T0-T1	-19,09±18,73 (-13,2)	-29,46±21,92 (-33,5)	-64,3±31,79 (-46,4)^{ab}	-46,21±35,52 (-37,7)	**0,001**$^{*¥}$
T0-T2	-19,55±18,8 (-12,6)	-27,92±23,47 (-20,3)	-56,83±36,58 (-51,8)^{ab}	-43,6±34,46 (-34,9)	**0,016**$^{*¥}$
GSR(%)					
T0-T1	-0,21±0,16 (-0,2)	-0,27±0,19 (-0,3)	-0,46±0,18 (-0,4)^{ab}	-0,39±0,19 (-0,4)	**0,006**$^{*¥}$
T0-T2	-0,22±0,17 (-0,2)	-0,26±0,21 (-0,2)	-0,42±0,24 (-0,5)^{ab}	-0,38±0,19 (-0,4)	**0,050**$^{*¥}$

Abbreviations: KTW, keratinized gingival width; rGRH, relative gingival recession height; rVD, relative vestibule depth; GSA, graft surface area; GSR, graft shrinkage rate; GUG, gingival unit graft; CG, conventional graft; MSS, modified sling suture; CS, conventional suture; T0, Baseline; T1, 1.month; T2, 3.month

[a]Difference compared to baseline, intragroup comparison;[ß]Difference compared to 1st month, intragroup comparison;[a]Difference according to GUG+MSS group, intergroup comparison;[b]Difference compared to GUG+CS group, intergroup comparison

[Ω]Oneway ANOVA test, intergroup comparison

[£]Repeated Measures ANOVA, intragroup comparison

*[¥]Kruskal Wallis test, comparison of alterations between groups *$p < 0.05$*

Graft shrinkage(GS) was assessed by means of the formula as= [(Preoperative area-postoperative area)/ (Preoperative area)] x 100 and depicted as percent

Table 3 Evaluation of the correlation between graft surface area changes and clinical parameters

		GSA (T0-T2)	KTW (T0)	rGRH (T0)	rVD (T0)
GSA T0-T2	r	1,000	-,016	,096	,236
	p	.	,909	,597	,194
KTW (T0)	r	-,016	1,000	-,019	,068
	p	,909	.	,916	,712
rGRH (T0)	r	,096	-,019	1,000	,201
	p	,597	,916	.	,271
rVD (T0)	r	,236	,068	,201	1,000
	p	,194	,712	,271	.

Abbreviations: GSA, graft surface area; KTW, keratinized tissue width; rGRH, relative gingival recession height; rVD, relative vestibule depth; T0, Baseline; T2, 3.month

Spearman's Rho Correlation Analysis

*correlation coefficient (r), *p* < 0.05

not measured clinically. Additionally, the greater success of CS compared to MSS in enhancing KTW in the GUT application may be explained by the graft's increased immobility over a larger area of connective tissue.

In the literature, GRH values have been reported to be an important variable measured to evaluate the amount of creeping attachment and root surface coverage [34].T Since the follow-up period in our study was short, creeping attachment was not assessed. However, it was found that rGRH values decreased at varying rates in all groups, and this decrease was statistically significant only in the GUT + MSS group. This outcome might be due to the fact that, fixation of the GUT with MSS increased the compatibility of the graft with the recipient bed and better adaptation of the marginal gingiva and papillary region to the recipient site.

The literature suggests that the placement of a free gingival graft on bone or periosteal tissue in the recipient bed can influence the graft shrinkage rate [14]. Grafts placed directly on exposed alveolar bone may receive faster blood circulation, enhancing graft nutrition and providing a more stable, immobile recipient bed [35]. Conversely, the presence of a thin residual connective tissue layer on the periosteum is also crucial for graft nutrition [36, 37]. In our study, the periosteum and a thin layer of connective tissue were preserved in all groups, with careful preparation of similar recipient beds. Additionally, an increase in vestibular depth was observed in all groups at both the 1- and 3-month evaluations compared to baseline, with no significant differences between groups. This result might be due to the immobile fixation of the free gingival grafts placed in the recipient

Fig. 3 Clinical healing of the gingival transfer in both groups

bed, ensuring that the periosteal blood supply was not impaired. This result is likely due to the fact that the initial surface areas of the free gingival grafts placed in the recipient bed were similar, and the periosteal blood supply remained intact, even though the initial graft heights were not measured.

Tissue shrinkage and dimensional alterations of the free gingival graft (FGG) during the healing period can negatively impact treatment outcomes [38–40]. One factor influencing these changes is the suture technique used to stabilize the FGG. Improper suturing can damage the graft and periosteum, leading to inflammation at the recipient site and impaired wound healing [16]. In a study by Amir Shammas et al., the effects of apical tension and horizontal continuous sutures on graft shrinkage were examined for the first time, with the researchers concluding that this suture technique did not significantly reduce graft shrinkage [15]. In the current study, precious care was taken to avoid tension on both the graft and the surgical area across all groups. While the intention was to minimize the number of sutures and prevent excessive coronal positioning of the graft by utilizing the MSS, the results of the photogrammetric analysis did not support this hypothesis when CG was preferred in FGG surgery. Conversely, when the graft was obtained using the GUT technique, MSS resulted in less shrinkage compared to the CS technique. These findings were consistent when analyzing the percentage of dimensional change, which may be attributed to better adaptation of the GUT with MSS, resulting in less trauma to the avascular plasmatic circulation.

The literature reports various amounts of graft shrinkage. For instance, James and McFall [35] observed a dimensional decrease of 40% at the 3-month follow-up and 49% at the 6-month follow-up. Additionally, Hatipoğlu et al. [14] reported graft shrinkage of 25% at 3 weeks and 35% at 6 months. In both studies, graft dimensions were measured linearly using a periodontal probe. Silva et al. [38] used digital calipers to measure graft sizes and calculated the graft area with computer software, finding approximately 37% shrinkage at 1 month and 44% at 6 months. In our study, graft shrinkage rates ranged from 21 to 46% at 1 month and from 22 to 42% at 3 months. Although the changes in graft dimensions are generally consistent with the literature, the GUT technique demonstrated less shrinkage than the CG technique and these discrepancies may be attributed to methodological differences among the studies [32, 33].

Although randomized controlled studies comparing the use of GUT and FGG have reported superior clinical and aesthetic outcomes for GUT [31, 33], they have not specifically adressed graft shrinkage comparisons. According to the data from our study, GUT demonstrated less shrinkage compared to CG. This finding, as with other clinical parameter results, can be attributed to the better vascularization of the gingival unit graft in the recipient bed, leading to a reduced risk of necrosis. Unlike the CG, GUT includes the papilla, enabling better adaptation to the recipient bed when using MSS. However, since the conventional graft does not include the interdental papilla and relies on plasmatic circulation on the avascular root surface, it may achieve better stabilization with CS compared to MSS.

Complications such as bone denudation and primary palatal flap necrosis at the recipient site are less likely to occur with the GUT technique compared to laterally positioned flaps and subepithelial connective tissue grafts [41]. In this study, the authors did not observe complications related to the donor area such as gingival recession or root surface sensitivity in patients undergoing the GUT technique, unlike those receiving the conventional graft technique. Healing was uneventful in both groups, with complications minimized due to precise and careful tissue manipulation. Furthermore, teeth with gingival recession, a thin gingival phenotype, and/or prosthetic restorations in the palatal region of the maxillary premolars were excluded from this study, which further reduced the risk of potential complications.

Although the results of this study are valuable in highlighting the clinical significance of suture and graft modifications, it has several methodological limitations. One limitation is that, although the surgical recipient areas were managed by a single trained periodontist, the baseline phenotype of the recipient bed was not measured. Another key limitation is the short-term follow-up period. Additionally, the small sample size, lack of patient-reported outcome measures, absence of RES assessment, and retrospective registration in ClinicalTrials are other limitations to consider. This study, primarily focused on achieving keratinized tissue in the lower anterior teeth. Since RT3 cases were included and aesthetics were not the main concern, root surface coverage was neither targeted nor measured. However, future randomized controlled clinical studies should address factors such as the altered mucogingival junction, coverage of residual recessions, and particularly improvements in the color of the grafted area.

Conclusion

In this trial, we evaluated the effect of different suture and graft techniques on graft shrinkage and formation of keratinized gingiva in FGG surgery. Keratinized gingiva was successfully obtained in all patients. Graft shrinkage was less when the GUT was secured to the recipient bed using the MSS technique, compared to other groups. However greater shrinkage was occurred when the MSS technique was applied in the CG groups. In conclusion, within the limitations of this study, MSS should be recommended when the GUT technique is used. However, MSS did not demonstrate superiority over CS when applied to CG. The results of this research should be further explored in long-term randomized controlled clinical trials with individuals having insufficient keratinized tissue, where the recipient phenotypes are standardized. Additionally, the volumetric alteration of the grafts should be analyzed using three-dimensional analysis to strengthen the findings of this study.

Abbreviations

FGG	Free gingival graft
GUT	Gingival unit transfer
MSS	Modified sling suture
CS	Conventional suture
KTW	Keratinized tissue width
rGRH	Relative gingival recession height
rVD	Relative vestibule depth
RT2	Cairo Type 2
RT3	Cairo Type 3
Δ	Dimensional changes
GSA	Graft surface area
PI	Plague index
GI	Gingival index
MGJ	Mucogingival junction
NSAID	Nonsteroidal anti-inflammatory drug
GS	Graft shrinkage
GR	Gingival recession
CAL	Clinical attachment level

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12903-025-05456-x.

Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

Supplementary Material 4

Supplementary Material 5

Acknowledgements
The authors are grateful to the study participants for taking the time to participate in this study.

Author contributions
Sanubar Shakiliyeva: conceptualization, data collection, data interpretation and writing original draft; Demet Sahin: conceptualization, data collection, data interpretation, writing, review and editing; Sadiye Gunpinar: conceptualization, methodology, data interpretation, writing, review and editing, supervision of the study, Mihtikar Gursel: conceptualization, data collection, data interpretation, writing, review and editing.

Funding
The authors funded the study themselves.

Data availability
The data of this study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
This prospective study was approved by the Ethics Committee of the Medical Faculty of Bezmialem Vakıf University (decision date: 15.03.2022 and number: 54757). Before the study, all participants were informed verbally about the clinical procedure and their written informed consent was obtained.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 29 August 2024 / Accepted: 9 January 2025
Published online: 21 February 2025

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