Original Article

Treatment of Multiple Adjacent Class I and Class II Gingival Recessions by Modified Microsurgical Tunnel Technique and Modified Coronally Advanced Flap Using Connective Tissue Graft: A Randomized Mono-center Clinical Trial

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Abstract

Background: Complete and uneventful recession coverage should be the aim of gingival recession treatment. Systematic reviews have said that coronally advanced flap with connective tissue graft (CTG) is the gold standard for gingival recession treatment. Minimally invasive procedures with optical magnification allow minimal tissue manipulation and precise adaptation of wound edges helping in faster and uneventful healing, thus bringing about a satisfactory clinical and patient outcome. Thus, the following study compares the clinical- and patient-related outcomes of modified microsurgical tunnel technique (MMTT) and modified coronally advanced flap (MCAF) using CTG in the coverage of multiple adjacent Miller's class I and II gingival recessions. **Materials and Methods:** Gingival recession patients were selected and were assigned randomly to either MMTT+CTG or MCAF+CTG. Clinical parameters were evaluated at 1, 3, and 6 months. Patient's satisfaction level was assessed by measuring root coverage esthetic score, hypersensitivity, and morbidity. The statistical analysis was performed using commercially available software SPSS version 14. Descriptive statistics were expressed as mean±standard deviation for each parameter. Intragroup comparison was done by using the paired *T*-test. Intergroup comparison was done using the independent Student's *T*-test. The significance level was set at $P = 0.05$. **Results:** MMTT+CTG showed a statistically significant greater clinical- and patient-related outcome. **Conclusion:** MMTT+CTG, being a closed procedure, preserves the blood supply, helps in faster healing, and does not compromise the esthetics. All these lead to decreased morbidity and increased patient satisfaction which makes MMTT a superior technique than the conventional procedure in gingival recession treatment.

Keywords: *Connective tissue graft, esthetics, gingival recession, mucogingival surgery, periodontal regeneration*

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Introduction

Gingival recession is defined as the migration of the gingival margin apical to the cementoenamel junction[1] and may affect single or multiple root surfaces. It may lead to either dental hypersensitivity, caries and non-carious cervical lesions (NCCLs), or

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loss of esthetics. Complete coverage of recession defects should be the end goal of any root coverage procedure. Evidence reports of multiple root coverage procedures include varying manipulations of patients' gingival tissues facilitating their augmentation, thus covering the denuded root surface. In many cases, these surgical techniques performed to treat gingival recession also enhance the esthetic appearance of the tissue.[2] As esthetic concerns are also one of the main indications for root coverage, selection of the most appropriate soft tissue grafting procedure must be done carefully.

Successful treatment of gingival recession is based on the use of clinically predictable root coverage procedures, most common being coronally advanced flap with connective tissue grafts (CTGs).[3-7] Maintenance of papillary integrity is paramount for optimum vascular supply leading to rapid wound healing.[8] Reflection of a full thickness flap has been shown to cause resorption of alveolar bone.[9] Usage of minimally invasive procedures like tunneling techniques with optical magnification allows minimal tissue manipulation and precise adaptation of wound edges helps in faster and uneventful healing, thus bringing about a satisfactory clinical and patient outcome.

Although a few comparative clinical studies have assessed the tunneling technique for root coverage outcomes when combined with various biomaterials,[10-13] the direct comparison between tunneling technique and coronally advanced flap with CTG has been subject to limited investigation.[14] Given the inconsistent available results, the priority ascribed to aesthetic and patient-centered outcomes,[3] further investigations are needed.

Thus, the aim of the present study is to compare the clinical, esthetic, and patient-related outcomes of a modified microsurgical tunnel technique (MMTT) with modified coronally advanced flap (MCAF) using a CTG in the treatment of multiple adjacent Miller's class I and class II gingival recessions.

Materials and Methods

Experimental design

This is a mono-center, randomized, double blind, parallel design, prospective, interventional clinical trial performed over a period of 6 months. In this study, clinical- and patient-related outcomes of MMTT and MCAF using CTG in the coverage of multiple adjacent Miller's class I and II gingival recessions were compared. The study protocol was approved by the Institutional Ethics Committee (protocol no. 15114) and registered with the Clinical Trial Registry of India (CTRI no. CTRI/2018/03/012460). Written informed consent was obtained from all participants before enrollment, and all procedures were performed in accordance with the Declaration of Helsinki of 1975, revised in 2000.

Study participants

Ten consecutive patients visiting the Outpatient Department were checked for the following criteria.

Inclusion criteria

(1) Age ≥18 years;
(2) Presence of two or more adjacent Miller class I and class II gingival recessions on esthetic zones of the maxillary and mandibular arch with an apico-coronal extension (i.e., recession depth) 2–4 mm;
(3) Probing pocket depth less than 3 mm;
(4) Full mouth plaque index score (Sillness and Löe) <20% and full mouth modified sulcular bleeding index score (Muhlemann and Son) <20%;
(5) Gingival thickness ≥ 0.8 mm;
(6) Properly aligned teeth in the arch without any malposition.

Exclusion criteria

(1) Patients with systemically compromised health;
(2) Periodontal surgical treatment during the previous 24 months in the involved site;
(3) Pregnant or lactating mothers;
(4) Smokers;
(5) Non-compliant patients;
(6) Restored teeth;
(7) Non-carious cervical lesion.

Sample size calculation and randomization

Sample size of 10 gives a confidence interval of 95% and achieves a power of 98% with a mean of paired differences of 2.5 with an estimated standard deviation of differences of 1.0 and with a significance level of 0.05000.

Block randomization was carried out. Opaque envelopes which were opened immediately before surgery were used as the method of concealment.

Operator

A single operator carried out all surgeries. An examiner who is a different person recorded the parameters.

Interventions

MMTT is assigned the test group, whereas MCAF+CTG is the control group.

Data collection

Clinical measurements and digital pictures were taken at baseline, 1, 3, and 6 months post-surgery.

Clinical measurements

Measurements were performed by a single examiner using an explorer, William's periodontal probe, and a reamer:

(1) Plaque index by Sillness and Löe[15]:

(2) Sulcular bleeding index by Muhlemann and Son[16];
(3) Recession depth (RD);
(4) Probing depth (PD);
(5) Clinical attachment level (CAL);
(6) Keratinized tissue width (KTW);
7) Gingival biotype (GB).

Mean root coverage (MRC) and complete root coverage (CRC) were calculated eventually.

Dentinal hypersensitivity

At baseline, 1, 3, and 6 months post-surgery, patients were provided with questionnaires to subjectively evaluate their dentinal hypersensitivity. Quantitative evaluation was done using a visual analog scale (VAS).[17]

Patient morbidity

It was assessed by subjective evaluation from the patient regarding pain, bleeding, and swelling 7 days after the surgery. Quantitative evaluation was done using VAS.[17]

Esthetic evaluation

The esthetic evaluation was done using the Root Coverage Esthetic Score[18] by comparing the digital images taken at baseline and 6 months by the operator.

Pre-surgical procedure

Every patient received initial therapy consisting of oral hygiene instructions, scaling and root planning and tooth polishing using a rubber cup, and a low abrasive polishing paste. Coronoplasty was performed for buccal prominences if trauma from occlusion was present. A modified Stillman's brushing technique was prescribed for teeth with recession-type defects in order to minimize tooth brushing trauma.

Surgical procedure

Immediately prior to surgical procedure, the patient was instructed to rinse with 0.2% chlorhexidine gluconate for 1 min. A complete asepsis and infection control were maintained. Local anesthesia was administered by infiltration at the donor and recipient sites (2% lidocaine, epinephrine 1: 100,000).

Harvesting of CTG

Bouchard *et al.*[19] had demonstrated in a randomized clinical trial that the CTG harvested using the "trap-door technique"[20] with its epithelial collar removed showed better esthetic results than in those cases in which the epithelial collar was retained. Byun *et al.*[21] in a randomized controlled trial compared the significance of epithelial collar in predictable and successful root coverage and concluded that a retained epithelial collar provided no significant benefit. Thus a "modified trap door" as showed by Zuchelli[22] was used to harvest CTG.

A horizontal incision is placed 1–2 mm away from the gingival margin. The length of this incision is 1 mm more than the total width of the teeth with gingival recession at each end. Two vertical incisions are placed at each end of the horizontal incision with the length being again 1 mm more than the maximum depth of the recession defect [Figure 1].

The primary flap is raised in a split-thickness manner with the blade held parallel to the external mucosal plane, moving it "blind" outward toward the vertical incisions.

The horizontal graft incision is made along the same primary flap incision. This incision is made perpendicular to the bone plane until the thickness chosen for the graft is achieved. At this point, the blade is tuned to cut parallel to the external surface. As with primary flap, the blade is moved "blind" outward toward the vertical incisions [Figure 2].

The connective tissue for the graft is made completely free and lifted both apicocoronally and mesiodistally. An apical incision is made almost perpendicular to the bone plane to detach the graft [Figures 3 and 4].

The primary flap is repositioned and simple interrupted sutures are placed joining the primary flap to the adjacent soft tissues [Figure 5].

Modified microsurgical tunnel technique

MMTT was performed according to Zuhr *et al.*[23] Crevicular incisions in a split thickness manner were made on the facial surfaces of the teeth affected by gingival recession [Figure 6]. The split thickness dissection was extended apically to the mucogingival junction (MGJ) with tunneling knives 1 and 2. These were again used for splitting of the alveologingival

Figure 1: A horizontal incision is placed 1-2 mm away from the gingival margin and two vertical incisions are placed at each end of the horizontal incision

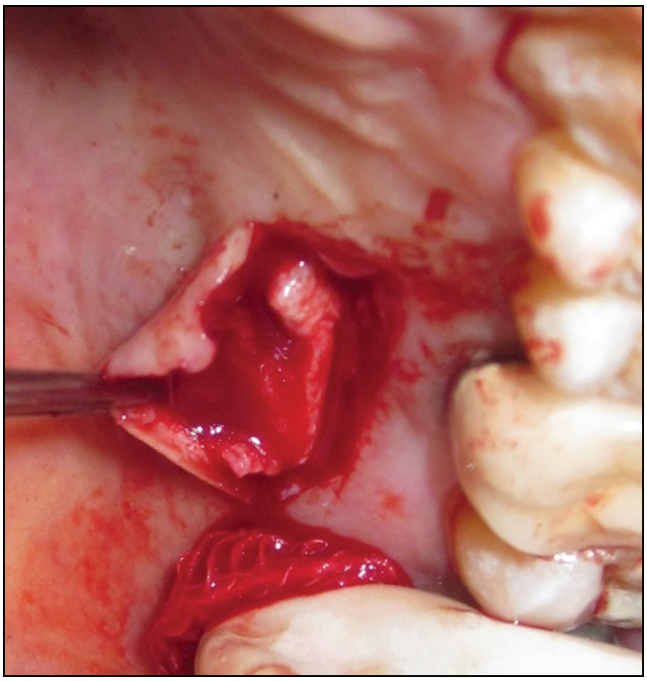

Figure 2: The primary flap is raised in a split-thickness manner, moving it "blind" outwards towards the vertical incisions. The horizontal graft incision is made perpendicular to the bone plane

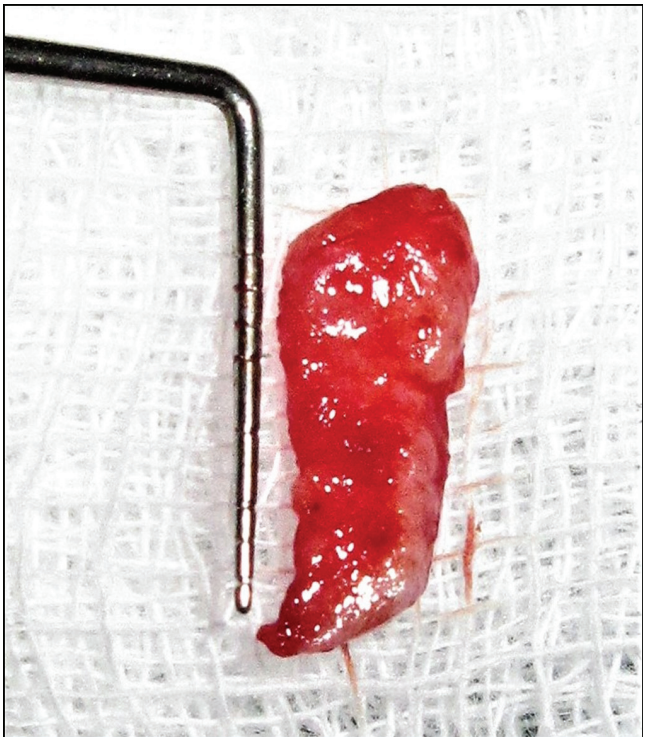

Figure 3: Graft 1 mm longer than the total width of recession affected teeth

fibers at the crest of the interdental bone [Figure 7]. This allowed for adequate coronal flap advancement [Figure 8]. Extreme caution was exercised as not to split the interdental papilla as maintenance of papillary integrity is the hallmark of MMTT. Care was taken to

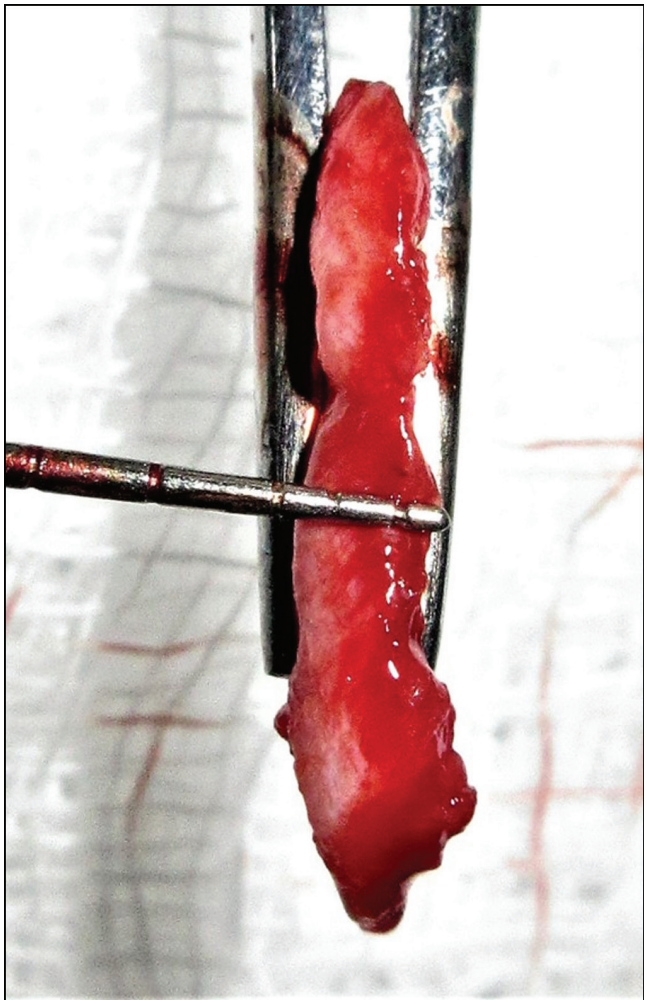

Figure 4: Adequate graft thickness

Figure 5: The primary flap is repositioned and simple interrupted sutures are placed joining the primary flap to the adjacent soft tissues

not raise the papilla in the lingual or palatal aspect in order to prevent shrinkage of tissue while healing, thus leading to the formation of black triangles.

The CTG was harvested as described before and trimmed. The 5-0 suture (Mersilk, Ethicon) was guided through the "tunnel" created from one end and exited through the other. The suture was engaged to one end of the CTG. The suture was then again guided back through the "tunnel" exiting through the end from which it had initially entered. The graft was inserted into the "tunnel" by gently tugging at the suture ends while at the same time pushing it with a blunt instrument. Light digital pressure was used to position the CTG in the tunnel. Stabilization of the graft and coronal advancement of the gingivopapillary unit were accomplished by vertical mattress sutures (5-0, Mersilk, Ethicon). Care was taken to engage the lingual or palatal aspect at a much more apical level than the facial aspect. This helped in coronal displacement as well as stabilization [Figure 9]. Periodontal dressing was applied.

Figure 6: Crevicular incisions in a split thickness manner were made on the facial surfaces of the teeth affected by gingival recession

Figure 7: Split thickness dissection extending apically to the mucogingival junction followed by splitting of the alveologingival fibers at the crest of the interdental bone

MCAF with CTG

MCAF was performed according to Zuchelli and De Sanctis.[24] An intrasulcular incision was performed involving at least one tooth mesial and at least one tooth distal to the teeth with gingival recessions [Figure 10]. Oblique incisions were traced at the interdental soft tissue level to achieve a coronal rotation of the surgical papilla [Figure 11]. The flap was then raised up to the MGJ with a periosteal elevator and mobilized with a

Figure 8: Adequate coronal advancement of flap

Figure 9: Vertical mattress sutures placed with care being taken to engage the lingual or palatal aspect at a much more apical level than the facial aspect

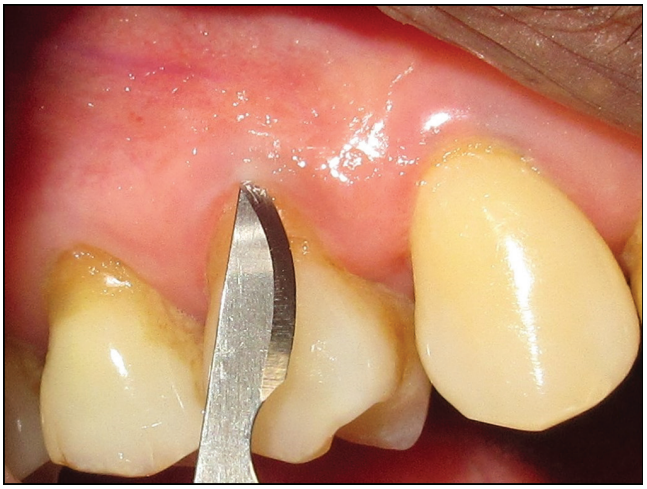

Figure 10: Intrasulcular incision

Figure 11: Interdental oblique incisions to achieve surgical rotation of papillae

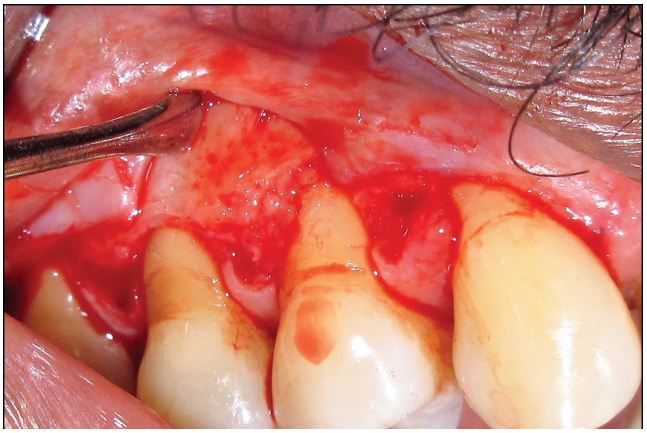

Figure 12: Flap raised in a split-full-split manner beyond the mucogingival junction

sharp horizontal periosteal incision beyond the MGJ [Figure 12]. Any muscular tension was relieved to allow passive coronal flap advancement [Figure 13]. Exposed root surfaces were carefully treated with gentle root planing. The CTG was harvested as described before,

Figure 13: Passive coronal advancement of flap

was trimmed, and adapted to cover each exposed root about 1 mm beyond the CEJ. The anatomic papillae were de-epithelialized by surgical blade. The graft was sutured with the anatomic papillae using a simple interrupted 4-0 resorbable suture (Vicryl, Ethicon). The flap was passively positioned 2 mm coronal to the CEJ completely covering the graft[25] [Figure 14]. Continuous sling sutures using non-resorbable 5-0 sutures were used to stabilize the flap (Mersilk, Ethicon) [Figure 15]. Periodontal dressing (Coe Pak, GC) was applied.

Post-operative care

Immediately after surgery, periodontal dressing (Coe Pak, GC) was placed on the surgical site. External ice pack application was done for 30 min on and off and patients were instructed to continue regular oral hygiene at home for the first 24 h. A non-steroidal anti-inflammatory tablet was prescribed and advised to be taken depending on pain on an individual basis. The patients were instructed to continue their regular home hygiene care, except in the operated area, in which tooth brushing was discontinued for the first 2–3 weeks after surgery and plaque control was maintained by means of 0.2% chlorhexidine gluconate mouth wash. Patients were instructed not to brush on the surgical site and advised to continue mouthwash and later on to use a soft toothbrush with Charters' method of tooth brushing. The patients were recalled at 1, 3, and 6 months following surgical treatment, and oral prophylaxis was performed. Clinical measurements recorded pre-operatively were repeated at 1, 3, and 6 months post-operatively.

Statistical analysis

The results obtained were subjected to statistical analysis. The statistical analysis was performed using commercially available software SPSS version 14, IBM. CAL and KTW were the primary outcome variables,

Figure 14: Connective tissue graft placed under the primary flap

Figure 15: Continuous sling sutures placed

whereas all others were secondary outcome variables. Descriptive statistics were expressed as mean±standard deviation for each parameter. Intragroup comparison was done by using the paired *T*-test. Intergroup comparison was done using the independent Student's *T*-test. The significance level of 0.05 was employed in the comparisons.

Results

Patient characteristics

A total of 10 patients met the inclusion criteria and were enrolled in the study. They were randomized and were equally allocated in the test and control groups. All patients completed the study with no dropouts and no adverse effects were reported in the follow-up period. The mean age of the study population was 44.4±9.31 years (range 33–60 years), with test group having 42.6±8.961 years and control group having 46.2±10.33 years. Independent Student's *T*-test revealed that *t*-value was −0.589 and was statistically non-significant with a *P*-value of 0.572.

Figure 16: Pre-operative status of teeth to be treated by modified microsurgical tunnel technique

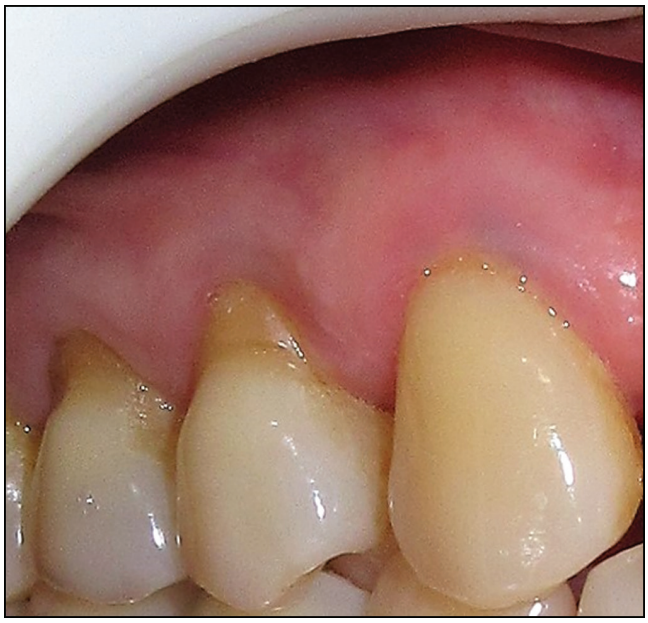

Figure 17: Pre-operative view of teeth to be treated by modified coronally advanced flap with connective tissue graft

Baseline characteristics

A total of 29 recession defects (test group: 15; control group: 14) were treated. Central incisors included 17.24% of total defects (MMTT: 20%; MCAF: 14.28%). Lateral incisors included 24.13% of all defects (MMTT: 26.66%; MCAF: 21.42%). Canines also made up 24.13% of all defects (MMTT: 26.66%; MCAF: 21.42%). First premolar included 20.68% of defects (MMTT: 13.33%; MCAF: 28.57%). Second premolar comprised 17.24% of all defects (MMTT: 13.33%; MCAF: 21.42%).

The mean baseline CAL in the test group was 5.068±0.723 mm and in the control group was

4.832±0.646 mm (*P*=0.601). The mean baseline KTW in the test group was 3.0±0.784 mm and in the control group was 3.134±0.505 mm (*P*=0.756). Further baseline characteristics are presented in Table 1 [Figures 16 and 17].

Clinical evaluation at 6 months

At 6 months, the mean CAL was 0.4±0.548 mm (test group) and 1.466±0.869 mm (control group) (*P*=0.049). MRC and CRC for the test group were 92.01%; 80% (*P*=0.703) and for the control group were 87.39%; 60% (*P*=0.545).

At 6 months, the mean KTW was 4.532±0.505 mm (test group) and 3.8±0.447 mm (control group) (*P*=0.041) [Figures 18 and 19].

Further clinical outcomes representing the changes in the clinical parameters measured at 6 months are presented in Table 2.

Figure 18: Six months post-operative view after treatment by modified microsurgical tunnel technique

Aesthetic outcomes

The results of the assessment of the final aesthetic values are presented in Table 3.

In both the groups, the final aesthetic outcomes (RES scores) revealed no difference between the two groups. Both treatments showed high aesthetic results.

Patient-centered outcomes

The changes in dentinal hypersensitivity from baseline up to 6 months are presented in Table 4.

Both the treatment groups showed an appreciable decrease in levels of dentinal hypersensitivity from baseline up to 6 months but with no significant difference between them.

Regarding patient morbidity levels, both the groups reported of some palatal pain. The control group saw patients complaining of some pain and bleeding from the recipient area also along with some post-operative swelling, whereas the test group reported none. Table 5 describes the patient morbidity level comparison.

Discussion

In this study, both the test and control groups showed excellent clinical and patient-related outcome. However, statistically significant differences exist between the two in favor of the test group.

There was a statistically significant decrease in PI of both the test and control groups while the intergroup comparison showed no significant differences. This can be attributed to the "Hawthorne effect" in patients as demonstrated by Feil *et al.*[26] who found that the subjects who were presented with a situation that

Table 1: Baseline characteristics of test and control groups

Parameters	Groups	*N*	Mean	Standard deviation (SD)	*P*-value*
Age (years)	Test	5	42.6	8.96	0.572 (NS)
	Control	5	46.2	10.33	
PI-B	Test	5	0.43	0.14	0.773 (NS)
	Control	5	0.33	0.19	
SBI-B	Test	5	0.4	0.18	0.784 (NS)
	Control	5	0.37	0.04	
RD-B	Test	5	3.4	0.64	0.201 (NS)
	Control	5	2.83	0.65	
PD-B	Test	5	1.47	0.51	0.078 (NS)
	Control	5	2	0	
KTW-B	Test	5	3	0.78	0.756 (NS)
	Control	5	3.13	0.50	
CAL-B	Test	5	5.07	0.72	0.601 (NS)
	Control	5	4.83	0.65	
GB-B	Test	5	1.53	0.38	0.781 (NS)
	Control	5	1.60	0.37	

PI= plaque index; SBI =sulcular bleeding index; RD= recession depth; PD = pocket depth, KTW-keratinized tissue width; CAL= clinical attachment level; GB = gingival biotype

**P*=0.05

Table 2: Clinical outcomes at 6 months

Parameters	Groups	*N*	Mean	Standard deviation (SD)	*P*-value*
PI-6	Test	5	0.76	0.18	0.374 (NS)
	Control	5	0.8	0.26	
SBI-6	Test	5	0.32	0.10	0.883 (NS)
	Control	5	0.31	0.05	
RD-6	Test	5	0.27	0.59	0.846 (NS)
	Control	5	0.33	0.47	
PD-6	Test	5	1.67	0.47	0.843 (NS)
	Control	5	1.6	0.55	
KTW-6	Test	5	4.53	0.51	0.041 (S)
	Control	5	3.8	0.45	
CAL-6	Test	5	0.4	0.55	0.049 (S)
	Control	5	1.47	0.87	
GB-6	Test	5	2.07	0.68	0.581 (NS)
	Control	5	2.27	0.37	

PI = plaque index; SBI = sulcular bleeding index; RD = recession depth; PD = pocket depth; KTW-keratinized tissue width; CAL= clinical attachment level; GB = gingival biotype

**P*=0.05

Table 3: Final aesthetic outcome

Res	Test	Control	*P*-value
	8.4±1.341	8.266±0.435	0.837 (NS)

**P*=0.05

Table 4: Dentinal hypersensitivity

Sensitivity	Test	Control	*P*-value
Baseline	4.4±0.893	3.8±0.837	0.305 (NS)
6 months	1.8±0.837	2.4±1.342	0.421 (NS)
	P<0.001 (S)	0.025 (S)	

**P*=0.05

Table 5: Patient morbidity levels

Group	Patient morbidity	*P*-value
Test	1.44±0.541	0.05 (S)
Control	2.04±0.288	

**P*=0.05

simulated participation in an experiment showed statistically significant reduction in plaque levels than the ones who had no knowledge of study participation.

The SBI correlates with PI scores with significant differences at baseline and end of the study period, but no difference whatsoever between the test and control groups. The findings are in accordance to a study conducted by Sulewska *et al.*[27] in which a statistical significant reduction was observed from baseline to 6 months.

The intergroup comparison of KTW at 6 months was statistically significant ($P = 0.041$). The results are in accordance to a study conducted by Azaripour *et al.*[14] comparing MMTT+CTG and MCAG+CTG. Both the groups showed an increase in KTW. The difference in KTW between the two groups at 6 months was statistically significant ($P = 0.039$).

The results can be substantiated by the fact that the MGJ tends to regain its genetically pre-determined position following coronal positioning of the gingivopapillary unit.[28] The granulation tissue contains periodontal ligament cells which have the potential to induce keratinization.[28] It is also believed that connective tissue holds the key for tissue specificity and tissue from alveolar mucosa forms a non-keratinized epithelium, whereas periodontal ligament cells form a keratinized gingival epithelium.[29]

Intergroup comparison of CAL at 6 months was shown to be statistically significant ($P = 0.049$) in favor of the MMTT+CTG group. This study is a first of its kind to record the CAL level across its study groups and to check for its clinical significance.

The decrease in CAL loss can be correlated to the decrease in RD and to the more or less stable or a mild increase in PD. Different types of attachment after the use of CTGs have been reported in literatures. Histologic data retrieved ≥5 months after surgery showed the following: (1) some degree of periodontal regeneration at the base of the recession defect (i.e., formation of new bone,[30,31] cementum,[30-32] and periodontal ligament[30,33]) and (2) major portions of the root covered by connective tissue attachment (mostly parallel to the root surface)[30,32,34] and/or long junctional epithelium.[30,31,33,35] It has also been suggested that the formation of new attachment may be associated with the use of subepithelial connective tissue grafts (SCTGs), including the palatal periosteum, and its potential "barrier effect" when the graft is placed with periosteum facing the root surface.[32] A similar assumption was already proposed by another case report.[33] Histologic

Figure 19: Six months post-operative view of teeth treated by modified coronally advanced flap with connective tissue graft

evidence of root coverage above the original free gingival margin was found associated with the use of SCTG.[35]

The intergroup comparison of patient morbidity gives a statistically significant difference between the test and control groups (P = 0.05) with the results in favor of MMTT+CTG. This may be attributed that MMTT is a minimally invasive surgery which causes less post-operative pain, bleeding, and swelling when compared with conventional surgeries. The results are, however, not in accordance to a similar study conducted by Azaripour *et al.*[14]

Since the stability of the KTW warrants a longer observation period, the 6-month follow-up period in our study is a limitation. Systematic reviews deciding the efficacy of tunneling techniques need to be carried out to enhance our current understanding regarding its superiority.

Conclusion

Thus, to conclude, both techniques showed a satisfactory root coverage, supporting their use in the treatment of multiple adjacent gingival recessions over a period of 6 months. Based on patient's perspective, MMTT was considered a better root coverage procedure as it resulted in better esthetics and low morbidity. MMTT showed a greater gain in CAL and KTW when compared with MCAF+CTG. As increase in CAL and KTW are desired outcomes in root coverage procedures, MMTT was considered to be a superior technique.

Future scope/clinical significance

In keeping up with present times where patients demand quick resolution of mucogingival problems along with minimal morbidity, minimally invasive techniques with magnification are going to become the mainstay. This article explores clinical- as well as patient-related outcomes which have been positive and will help clinicians with necessary data to provide the best to their patients.

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Conflicts of interest

The authors report no conflict of interest.

Authors contributions

Not applicable.

Ethical policy and institutional review board statement

This study is approved by the Institutional Ethics Committee (protocol no. 15114).

Patient declaration of consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Data availability statement

All data are provided.

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