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A Novel Vertical Y-shaped Tunnel Approach Versus Modified Coronally Advanced Tunnel Technique, for The Treatment of Miller Class I Gingival Recession: A Randomized Clinical Trial

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Abstract:

Objectives: to compare a novel vertical Y-shaped tunnel approach (YST) with modified coronally advanced tunnel technique (MCAT), both with connective tissue graft (CTG), in the treatment of single gingival recession (GR).

Materials and Methods: Patients with Miller's Class I GR defects in the esthetic zone were selected and randomly allocated to MCAT +CTG (group I, n =16 sites): and YST+CTG (group II, n =16 sites). The following measurements were recorded at baseline, 1, 3 and 6 months post-surgically; percentage of root coverage (primary outcome), complete root coverage (CRC), recession Depth (RD), recession width (RW), width of the keratinized tissue (KTW), plaque index (PI), and gingival index (GI). Probing depth (PD), clinical attachment level (CAL) and gingival thickness (GT) were measured at baseline and after 6 months. Professional esthetic evaluation (EE), patient-reported satisfaction, pain index and duration of the surgical procedures were also recorded.

Results: Six months after surgery, five patients (MCAT) and none (YST) obtained CRC, RC% was 81.04 ±9.32% (MCAT) and 59.48 ±7.79% (YST). MCAT achieved significantly better reduction in RD and RW and better CAL and KTW gain ($p<0.05$). No intergroup significant difference was recorded regarding PI, GI, PD, and GT ($P>0.05$). Regarding EE, a significant intergroup difference was reported in favor of MCAT ($p<0.05$). The study failed to find significant differences related to patient-centred outcomes.

Conclusion: Notable superior results were obtained, in most of studied parameters, in favour of MCAT when compared with YST. Comparable results were only obtained regarding GT.

Clinical relevance: Although MCAT showed superior RC% in comparison to YST, both techniques yielded comparable clinical improvements in GT. YST showed promising outcomes regarding gingival phenotype modification.

Keywords: gingival recession; modified coronally advanced tunnel; root coverage; minimally invasive; connective tissue graft.

Introduction

The desire for improved esthetics has increased over the last years. Periodontal plastic surgery deals with regenerative procedures designed to restore function, form, and enhance esthetics. These procedures are performed to correct or eliminate anatomic, developmental or traumatic deformities of the gingiva or alveolar mucosa **[1]**.

GR is defined as the displacement of the gingival margin (GM) apical to the cementoenamel junction (CEJ) with the loss of periodontal connective tissue fibers along with root cementum and alveolar bone **[2]**. Recession may be associated with increased root surface sensitivity, increased root caries susceptibility, and development of cervical abrasions. It can also impede proper plaque control **[3]**. Various surgical techniques and materials have been described for management of recession defects such as pedicle soft tissue graft **[4, 5]**, free gingival graft **[6, 7]**, subepithelial connective tissue graft (SCTG) **[7, 8]**, acellular dermal matrix allograft (ADM) **[9, 10]**, and guided tissue regeneration (GTR) **[11]**.

The tunnel techniques are approaches that optimize esthetics and predictability because of its ability to avoid releasing critical papillae and maintaining a high level of vascularity at the surgical site to support the inserted grafts **[12]**. The tunnel technique has a minimally invasive nature since the interdental papillae are left intact and vertical incisions are not performed which

results in better esthetics. This technique entailed the placement of a connective tissue graft (CTG) in the tunnel. Complete graft coverage is not mandatory if the graft dimensions are sufficient to ensure its survival. Avoiding detachment of the highly fragile interdental soft tissue can minimize the risk of losing papilla height in critical esthetic areas, avoid scar formation, maximize the papillary and lateral blood supply to the underlying graft and better stabilize the graft for optimal wound healing **[12, 13].**

Modified coronally advanced tunnel (MCAT) is a tunnelling technique with the advantage of covering a large portion of the underlying graft with the intention to avoid graft necrosis and achieve a more predictable root coverage result. MCAT was applied to treat Miller class I, II, and III multiple recession defects **[14]**. To further minimize trauma, protect the blood supply, and improve wound healing, **Zuhr et al. [13]** fine-tuned the tunnelling procedure introducing a micro-surgical concept and appropriate instrumentation.

With the advocation of newer techniques, there is an increase in the treatment options for the treatment of GR. Currently, a shift from the extensive surgical procedures to minimally invasive techniques has been seen. The advantages of these techniques include reduction in surgical time and increased patient comfort. New minimally invasive techniques, such as vestibular incision subperiosteal tunnel access (VISTA) have been suggested **[15, 16]**. Another technique was proposed by **Chao [17]**. These procedures did complete justice with the patients' demands of esthetics along with minimal discomfort and saved operators' time. However, technical skill is required for these procedures; moreover, this technique is less predictable for Millers Class III as well as Class IV type of recession. This merits further research and trials in this direction.

Recent plastic procedures have provided satisfactory results in the treatment of GR but there is, presently, a greater need for procedure that cause less surgical morbidity with improved results. In the current study we propose a novel vertical tunnel technique as a minimally invasive approach (Vertical Y-shaped Tunnel Approach; YST) and evaluate clinical results in comparison to MCAT, both using CTG. The novel technique was intended to allow stability of the graft, maximum coronal vascularity and minimum soft tissue reflection.

Patients and methods Study design and compliance with ethical standards

The present study is a human, prospective, single centre, single blind, controlled parallel RCT for the treatment of Miller's Class I GR (ClinicalTrials.gov ID: NCT06453369). The trial was performed in accordance with the Declaration of Helsinki in 1975 as revised in Tokyo in 2004 and reported according to the Consolidated Standards of Reporting Trials (CONSORT) criteria, 2010. The trial was reviewed and approved by the institutional ethics committee (RECO6U/14-2022). Patients were informed about the surgical procedure including objectives, study visits, risks, and benefits, and informed consent were obtained.

Sample size calculation and study population

Considering that %RC is the primary outcome variable and based on the data indicating that standard deviation (SD) of the differences in the paired measurements would not surpass 30%, the sample size for paired continuous data was calculated to be 14 subjects per treatment group (80% power which is equal $\beta = 0.20$ type II error level with 5% type I error level which is equal $\alpha = 0.05$ probability level). This provided 80% power to disclose a true difference of 20% points between test and control. However, considering that some patients might be lost during follow-up, 16 patients were recruited **[18]** .

From August 2022 to November 2023, thirty-two patients were selected at the Periodontology Clinic of Faculty of Dentistry, October 6 University using the following eligibility criteria: age above 18 years old, the presence of Miller's class I GR on maxillary and mandibular incisors, canines, or premolars, absence of a history of periodontal surgery at the

involved sites in the last 12 months, history of compliance with oral hygiene instructions and periodontal recall, sufficient palatal donor tissue thickness (>2mm) and clearly identifiable CEJ. Patients were excluded if having any systemic illness known to affect the outcome of periodontal therapy, including diabetes, immune deficiencies, etc. Pregnant, lactating women and current use of any form of tobacco were also excluded.

To determine if patients met the inclusion/exclusion criteria, they were screened by a single calibrated examiner (the primary investigator). Six non-study patients with at least one tooth with GR were enrolled for the calibration exercise. The examiner made measurements twice at an interval of 48 h. Calibration was accepted when ≥ 90% of the recordings were repeated within a difference of ≤ 1.0 mm.

The screening visit included review of medical and dental history, physical examination with comprehensive periodontal examination. Periapical radiographic analysis of the selected recession sites was performed to confirm the class of recession. The initial therapy consisted of phase I therapy, including scaling, root planing, oral hygiene instructions, correction of the recession etiological factors, and dental prophylaxis as needed. One month evaluation of adequate oral hygiene and control of gingival inflammation (PI and GI<15%) is carried out before surgical procedures.

Randomization, allocation concealment, and blinding

Using a block randomization list prepared by a statistician not involved in the study, patients were randomly allocated to one of the two treatment approaches: group I (n=16 sites): modified coronally advanced tunnel technique +CTG (MCAT), group II (n =16 sites): vertical Y-shaped tunnel + CTG (YST). No information on treatment allocation was given to the patients. **Clinical measurements**

All clinical measurements were recorded by a single examiner (the primary investigator) utilizing a William`s graduated periodontal probe and rounded off to the nearest 0.5 mm. The following parameters were recorded: (1) Complete root coverage (CRC): The number of sites that resulted in 100% root coverage; (2) RD: distance from CEJ to the gingival margin at midbuccal aspect of the tooth; (3) RW: horizontal distance between the bilateral gingival margins at the height of the CEJ; (4) Percentage of root coverage (%RC): calculated as ([RD preoperative - RD postoperative]/RD preoperative) × 100%. (5) probing depth (PD): distance from the gingival margin to the bottom of the gingival sulcus at mid-buccal point of the tooth; (6) clinical attachment level (CAL): distance from CEJ to the bottom of the gingival sulcus at mid-buccal point of the tooth; (7) Width of the keratinized tissue (KTW): distance between the gingival margin and the muco-gingival junction in the mid-buccal aspect of the tooth; (8) GT: measured at the mid-buccal aspect of the gingiva 2 mm apical the gingival margin at the attached gingiva or the alveolar mucosa using endodontic reamer with a silicon disk stop; (9) PI and gingival index (GI) **[19]**; and (10) Professional aesthetic evaluation (EE): assessed by an independent second examiner, who is blinded to the treatment assignment, in accordance with root coverage esthetic score, the evaluation was based on comparing digital photographs taken at baseline and after 6 months **[20]**.

All measurements were recorded, by the same examiner, at baseline, 1, 3 and 6 months postsurgically except for PD, CAL, and GT which were recorded at baseline and at post-surgically.

Duration of the surgical procedures (TO) was recorded in minutes.

Patient-reported outcome measures

Pain index (PN): Pain is recorded on a horizontal pain scale of 0-10 at 9 am, 3pm, and 9 pm from the day of the surgery for 3 days post-treatment **[21]** . Additionally, At the 6-month followup examination, questionnaires were given to the patients for subjective evaluation of

aesthetics and overall satisfaction. Questions were designed in a dichotomous fashion (yes or no). **The Surgical interventions**

Both surgical techniques required achieving local anesthesia using 4% articaine hydrochloride with adrenaline (1:100,000). All recession defects were debrided using Gracey Curettes (HuFriedy, USA) and any root surface deposit, soft cementum, root prominence, or irregularities were eliminated. For both groups, a CTG was harvested from the palate, the first incision is perpendicular to the 2nd premolar and 1st molar and is 1.5-2 mm apical to their GM and as wide as the distance between the two mid-buccal points of adjacent tooth bilaterally, followed by a second incision parallel to the fore mentioned teeth and is 1-2 mm apical to the first incision, then the CTG was raised and released from apical and lateral attachment .The graft was then prepared to have a homogenous thickness of 1.5-2 mm. The dimension of the graft was based on at least 3 × RW and at least 1 × RD **[22]**.

Surgical protocol for MCAT with CTG (Group I): (Figure 1)

The tunnel was prepared with a full-thickness sulcular incision up to MGJ and as a split-thickness flap beyond MGJ. Care was taken to undermine the tissue beyond the MGJ using the tunnelling instruments to obtain a tension-free tunnel, allowing coronal passive movement. Interdental papillae were gently undermined, without detaching its tip, to prepare the bed for CTG placement. The adjacent papillae of the neighbouring teeth were also involved in the preparation to ensure a coronal positioning of the tunnel flap. The exposed root surfaces were then planed. The graft was then inserted into the tunnel and stabilized to the underlying CT interproximally using 5.0 sutures. Finally, the mobilized buccal flap was advanced coronally to fully cover CTG and secured with 5/0 resorbable sling sutures **[13]**.

Surgical protocol for YST with CTG (Group I): (Figure 2)

Sulcular incision was performed using 15c blade. Micro-periosteal elevator was used to elevate vertical full thickness tunnel starting coronally from the gingival sulcus and directed apically. Micro periosteal elevator was used to elevate the buccal aspect of both mesial and distal papillae of the affected tooth (figure 2 a). CTG was prepared and inserted into the coronal tunnel aperture using suture tied with the graft and blunt instrument to facilitate intrusion of graft into tunnel. CTG was inserted into the tunnel up to the apical level leaving a coronal part to completely cover the defect (figure 2 b). Finally single interrupted suture was used to secure the coronal exposed part of the CTG followed by sling suture fixation of the flap with that of CTG. The donor CTG was stabilized to the underlying CT interproximally using 5.0 sutures (figure 2 c).

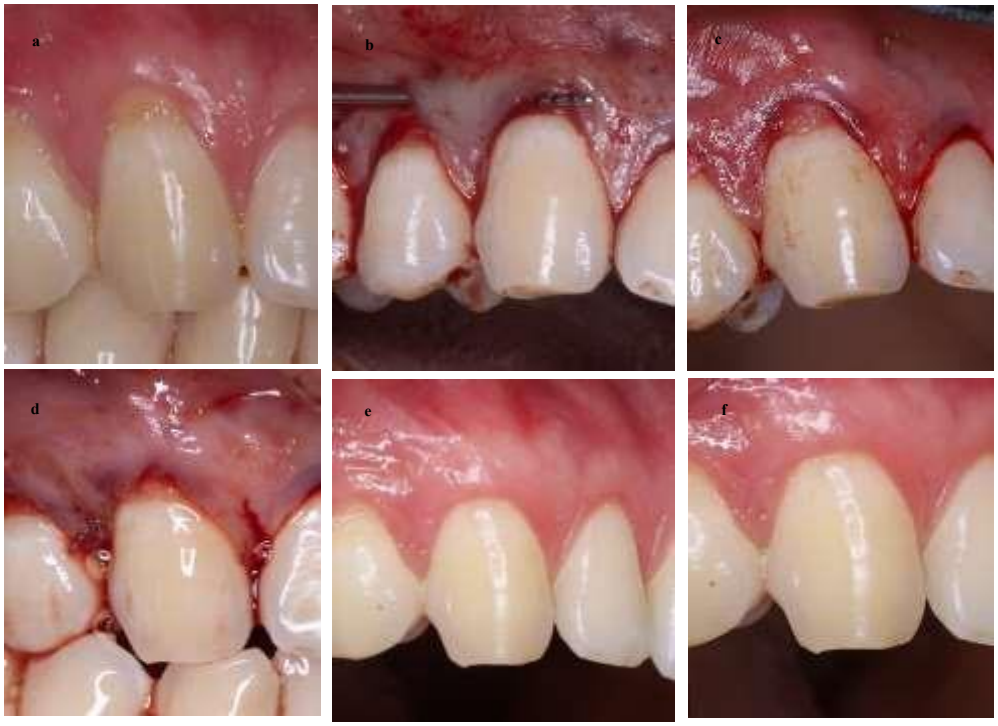

Figure 1. Representative clinical case of MCAT group (control). (a) Baseline view. (b) Tunnel preparation. (c) CTG insertion and adaptation. (d) Suturing. (e) 3-month followup (f) 6-month followup.

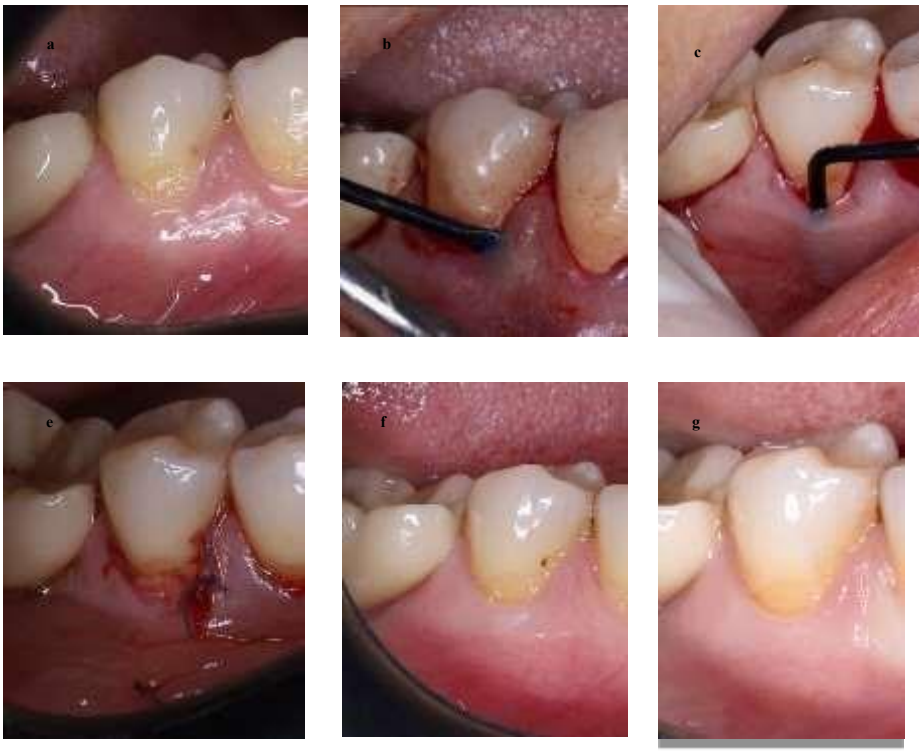

Figure 2: Representative clinical case of YST (test). (a) baseline view. (b) proximal releasing. (c) vertical tunnel preparation. (d) graft insertion using suture. (e) suturing. (f) 3-month follow up. (g) 6-month follow up.

Postoperative care

Post-surgical medications included amoxicillin (500 mg) three times daily for 5 days and diclofenac (50 mg) twice daily as an analgesic until pain is recessed. The patients were instructed to clean the surgical sites with a cotton pellet soaked in 0.12% chlorhexidine solution for 1 month. Sutures were removed two weeks after the surgery for donor site. Six weeks after the surgery, the patients resumed mechanical tooth cleaning in the operated areas using a postoperative soft brush and received professional prophylaxis teeth cleaning. Patients were asked to record the pain index (PN) on daily basis for the first 3 days after the surgery. All patients were seen for professional prophylaxis, plaque control, and healing evaluation once a week during the 1st month, bimonthly until the third month, and monthly until the final assessment 6 months post surgically.

Data Analysis

All data calculated, tabulated, and statistically analyzed using suitable statistical tests as follows. A normality test (Shapiro-Wilk) was done to check the normal distribution of the samples. Descriptive statistics were calculated in the form of Mean ± Standard deviation (SD). Chi square test was used to compare groups for CRC. Paired sample T test was used to compare between different TO for each group. Independent T test was used to compare between different groups. One way ANOVA (Analysis of variance) was used to compare between more than two times intervals. Bonferroni post hoc test was performed for pair wise comparisons among the groups. P value ≤ 0.05 is considered statistically significant. Statistical analysis was performed using the computer program SPSS software for windows version 26.0 (Statistical Package for Social Science, Armonk, NY: IBM Corp) at significant levels<0.05 (P- Value). **Results**

A total of 16 patients, 10 females and 6 males ranging in age from 22 to 50 (mean 37. 4 years), with 32 recession sites were evaluated clinically in this study. All patients were complaining of either receding gums or elongation of teeth which appeared unaesthetic to them.

At 6 months, the CRC was achieved in 5 patients (37.5%) in group I and none in group II. For group I, there was a significant reduction (P<0.001) in mean values of RD from 2.22 ±0.48 at baseline to 0.63±0.43, 0.41 ±0.0.42 and 0.41 ±0.27 at 1, 3 and 6 months respectively. For group II, the mean values of RD significantly decreased (P<0.001) from 2.50 ±0.45 at baseline to 1.26±0.26, 1.00 ±0.36 and 0.97 ±0.26 at 1, 3 and 6 months respectively. There was statistically significant difference between group I and group II for RD at all evaluation periods (P<0.001). The mean RD reduction was higher in group I than in group II at all evaluation periods (Table 1) (Figure 1, 2).

For group I, there was a significant reduction (P<0.001) in mean values of RW from 2.81 ±1.18 at baseline to 1.50 ±1.00, 1.03 ±1.09 and 1.00 ±0.73 at 1, 3 and 6 months respectively (average 64.41% reduction). For group II, there was no significant reduction in mean value of RW measured at different evaluation periods when compared with baseline (P>0.05). There was statistically significant difference between group I and group II, in favor for group I, for RW at all evaluation periods (P<0. 05). (Table1).

There was statistically significant difference between group I and group II for %RC at all evaluation periods (P<0.001). For group I, the mean %RC was 73.23 ±8.24 at 1 month. This value increased to 82.23 ±10.41 at 3 months then slightly decreases to 81.04 ±9.32at the end of the study. For group II, the mean %RC was 48.44 ±5.74 at 1 month. This value increased to 58.65 ±8.62 and 59.48 ±7.79 at 3 and 6 months respectively.

Intergroup analysis showed that PD was not significantly different either initially (P=0.24) or at the 6-month evaluation (P=0.74). For both groups there was no significant difference in mean value of PD measured at the end of study compared with baseline (P>0.05). For both groups, there was significant gain in the mean values of CAL measured at 6 months (P<0.001). There was statistically significant difference between group I and group II, in favor of group I,

for CAL after 6M (P<0.001). For group I, the mean value of CAL was improved from in 4.03 ±0.94 at baseline to 2.06±0.51 at 6 month with gain 48.9%. For group II the mean CAL value was improved from 4.06 ±0.83 at baseline to 2.69 ±0.54 at 6 months with gain 33.7% (Table 1).

There was no statistically significant difference between group I and group II for KTW at different times (P>0.05). For group I, there was a significant increase in mean value of KTW from 2.94 ±1.31 at baseline to 4.13 ±1.52, 4.75 ±1.03, and 4.75 ±1.05 at 1m 3 and 6 months respectively. For group II, mean value of KTW increased from 3.41 ±1.81 at baseline to 4.53 ±1.90, 4.91 ±1.96, and 4.94 ±1.02. However, this increase was statistically insignificant (P=0.132).

There was no statistically significant difference between group I and group II for GT at baseline (P=0.35) and at the end of the 6 months of follow-up (P=0.41). For both groups, there was significant increase in mean value of GT measured at the 6 months follow-up compared with baseline (P<0.001). GT increased from 0.95 ±0.16 to 1.30 ±0.21 for group I and from 0.89±0.20 to 1.23±0.21 for group II with percent change 36.8% and 38.2% respectively.

Both groups demonstrated a statistical increase in PI at 1 month follow up then decreased at 3- and 6-months evaluation periods. When compared with group I, PI values of group II showed a statistically significant difference (P<0.05). Similarly, all treatment modalities demonstrated a significant increase in mean values of GI at 1 month follow up, then decreased at 3- and 6-months evaluation periods. When compared with group I, GI values of group II showed a statistically significant difference (P<0.05).

Statistical analysis showed no significant difference between group I and II regarding the mean value of TO and PN (P=0.06) (Table 1). For both groups, there was significant difference in mean value of PN measured at after 2 and 3 days (P<0.001) compared with 1 day. The pain recorded at day 1 was 7.50 ±0.1.03 and 7.56±0.81, for group I and II respectively, and gradually decreased after 3 and 6 days (Table 1). EE outcomes were significantly better in the MCAT group (9.31 ±0.79 versus 8.50±0.50, P<0.001). **Table 1. Clinical Outcomes:**

Parameter		**(Group I) MCAT**	**(Group II) YST**	***p*-value intergroup**
CRC	1 month 3 months 6 months	2 (12.5%) 7 (43.8%) 5 (37.5%)	0 0 0	———
RD	Base line 1 month 3 months 6 months	2.22±0.48 0.63±0.43† 0.41±0.42† 0.41±0.27†	2.50±0.45 1.26±0.26† 1.00±0.36† 0.97±0.26†	0.097 <0.001** <0.001** <0.001**
RW	Base line 1 month 3 months 6 months	2.81±1.18 1.50±1.00† 1.03±1.09† 1.00±0.73†	3.16±1.27 2.47±1.04 2.31±1.17 2.13±0.90	0.435 0.012** 0.003** 0.001**
%RC	1 month 3 months 6 months	73.23±8.24 82.23±10.41† 81.04±9.32†	48.44±5.74 58.65±8.62† 59.48±7.79†	<0.001** 0.001** <0.001**
PD	Base line 6 months	1.81±0.68 1.66±0.65	1.56±0.48 1.72±0.36	0.24 0.74
CAL	Base line 6 months	4.03±0,94 2.06±0.51†	4.06±0.83 2.69±0.54†	0.92 <0.001**

KTW	Base line 1 month 3 months 6 months	2.94±1.31 4.13±1.52† 4.75±1.03† 4.75±1.05†	3.41±1.81 4.53±1.90 4.91±1.96 4.94±1.02	0.41 0.52 0.53 0.52
GT	Base line 6 months	0.95±0.16 1.30±0.21†	0.89±0.20 1.23±0.21†	0.35 0.41
PI	Base line 1 month 3 months 6 months	0.61±0.30 1.09±0.13† 0.60±0.12 0.40±0.12	0.73±0.32 1.25±0.44† 0.81±0.51 0.61±0.62	0.084 0.04* 0.03* 0.04*
GI	Base line	0.63±0.29	0.79±0.12	0.783
	1 month 3 months 6 months	1.11±0.34† 0.64±0.20 0.42±0.10†	1.34±0.26† 0.92±0.24 0.71±0.15	0.04 * 0.04 * 0.04 *
TO		52.94±4.01	59.31±5.18	0.06
PN	1 day 2 days 3 days	7.50±1.03 5.63±0.72† 2.56±0.81†	7.56±0.81 5.19±0.83† 2.13±0.72†	0.850 0.122 0.231
EE	6 months	9.31±0.79	8.50±0.52	<0.001**

† Significantly different from baseline using paired t test
***Significant intergroup difference; $p<0.05$**
****Significant intergroup difference; $p<0.001$**

Discussion

Over the last years, with the direction to use minimally invasive approaches, tunnel techniques have become a valuable contribution. The rationale for a sulcular tunnel access techniques includes the reduction of vascular disruption and preservation of the papilla which provides lateral blood supply that contribute to gingival tissue perfusion **[23].** Moreover, the abstention from releasing incisions leads to achieving a stable wound and maintaining its integrity during the healing process. The ideal technique to treat GR defects would be simple, minimally invasive, and predictable for optimal clinical, aesthetic and patient-centered outcomes. This is especially true for single recession defects in the aesthetic zone.

The published literature provides substantial evidence that the combined approach with the additional use of SCTG is the most effective surgical procedure for RC. MCAT, in particular, showed superior results. Nevertheless, it still indicated mainly in multiple defects and relatively invasive to be used in single defect as it needs extending flap to adjacent teeth and apically to MGJ to allow good coronal repositioning to cover the graft **[27-33]**. Thus, regarding treatment of deep single recession-type defects, other novel techniques may yet be needed. Hence, the main goal of this clinical trial was to obtain comparable results with less invasiveness compared to MCAT using the same graft approach. This prospective, randomized, controlled clinical trial tried to determine the differences in clinical outcomes as well as patient-centered outcomes and practitioner-assessed esthetic outcomes between a novel YST technique and MCAT technique in treating Miller's Class I single recession defects in the esthetic zone.

The YST technique is a simplified method. It creates a Y -shaped subperiosteal tunnel. The technique begins by sulcular incision then micro-periosteal elevator was used to elevate vertical full thickness tunnel starting coronally from the gingival sulcus and directed apically. Micro periosteal elevator was used to elevate the buccal aspect of both mesial and distal papillae of the affected tooth. CTG was prepared and inserted into the coronal tunnel aperture using suture tied with the graft and blunt instrument to facilitate intrusion of graft into tunnel. CTG was inserted into the tunnel up to the apical level leaving a coronal part to completely cover the

recession defect. This technique was intended to achieve several advantages including gentler soft tissue manipulation, improving primary closure and mechanical stability of the wound. The techniques of the tested approaches mainly differed in their incisional placement, along with the type of tunnel (vertical vs horizontal) and method of CTG insertion. Using SCTG in both treatment groups allow having comparable results and less variables.

The main objective of the surgical interventions is to achieve CRC which has been accepted as the best indicator of success **[35].** In the current study, CRC was obtained in 37.5% in MCAT group and none in YST group. The corresponding values for % RC were 81.04% and 59.48%, respectively. Both the tested approaches achieved a statistically significant recession reduction (1.81mm for MCAT, 1.53 mm for YST) (Table 1). However, the difference between the two groups was significant, in favour for MCAT group. Nevertheless, for YST group, RC increased throughout the evaluation periods which indicates the occurrence of creeping attachment on teeth treated with this surgical technique. Teeth treated with MCAT showed significant increase of % RC at 3 months, but mild decrease occurred at the end of the study (73%, 82%, 81% at 1, 3 and 6 months respectively).

As the YST technique is novel, there are currently no available studies that compare its clinical outcomes compared to other RC techniques. For the MCAT technique, a comparable percentage of CRC to what obtained in the current study was reported by **Aroca et al. [13]** who reported CRC of 22% for the same technique. **Tavelli et al. [37]** in a systematic review and meta-analysis evaluated the efficacy of tunneling technique in the treatment of localised and multiple gingival recessions. The mean percentage of RC and CRC of tunneling for single recession was 82.75 ± 19.7% and 47.15% respectively. The results of the present study in terms of RC and CRC (81.04 ±9.32% and 37.5%) compare well with that of Tavelli's review.

In contrary, the currently reported values are less than those reported by **Salhi et al. [38]** who treated single Miller class I recessions with a pouch technique, similar to MCAT, and compared to CAF. Authors reported 91% RC in the pouch group and 96% in the CAF group after 6 months. However, only single Miller class I recessions in the upper jaw were included, whereas in the current trial, single gingival recessions in the upper and lower jaw were included. This is relevant since it is possible that RC is more demanding and difficult in the lower jaw **[38].**

Regarding RW, the comparison between the two groups was also statistically significant (p=0.012, 0.003 and 0.001) with MCAT showing improved RW reduction. Reduction of about 1.81mm in RW was seen in the MCAT group from baseline to 6 months compared to about 1.03mm in the YST group. The MCAT group were relatively less than the earlier studies by **Pietruska et al. [39]** and **Yilmaz et al. [40]**. Wherein 2.15 mm and 2.67 mm reduction in RW was noted respectively.

As good oral hygiene is a must before surgical procedures and through the study period. We evaluated PI and GI. This also allow us to include oral hygiene as a factor in cases of inferior results. Both treatment modalities demonstrated a statistical increase in PI at 1 month follow up. The increase in plaque index at 1 month follow up is most probably attributed to instructing the patients to abstain from brushing and flossing the operated area for 3 weeks post-surgical. After reinstitution of oral hygiene practices, all treatment modalities showed a return to optimal PI. When compared with group I, PI values of group II showed a statistically significant difference ($P<0.05$), however, all values are within accepted range. Similarly, all treatment modalities demonstrated a significant increase in mean values of GI at 1 month follow up. Then all treatment modalities showed a return to optimal GI. When compared with group I, GI values of group II showed a statistically significant difference ($P<0.05$).

To ensure that we can gain a firm new attachment with low risk of further recession, PD and CAL were also monitored. PD and CAL were evaluated on baseline and at the end of the 6

months of follow-up. as these parameters need tissue penetration which may affect the healing process. In both treatment groups, no statistically significant changes in mean PD occurred following root coverage surgery (p> 0.5). This result was expected, because in the patients selected, the baseline PD was compatible with a condition of gingival health and the patient selection criteria included only patients with Miller Class I GR. Both groups demonstrated a significant reduction in CAL following the surgical treatment, but intergroup analyses showed statistically significant difference favoring group I.

As both techniques involves the use of CTG, measuring the difference in KTW and GT was another concern. KT provides fibrotic collar and attachment around the tooth that increase the capacity of the periodontium to withstand the masticatory forces. When it becomes inadequate, it impacts the aesthetic appearance and oral hygiene maintenance specifically on the previously exposed root surface. Soft tissue phenotype modifications including an increase in GT to achieve at least 1.46 mm have been associated with GM stability over time **[41, 42].**
Interestingly, the results from the present study indicate that both surgical interventions were of similar efficacy in terms of increasing GT (p=0.41). A significant increase in GT of approximately 0.35 mm was obtained in both groups (p<0.001). The final GT values were consistent with those found in the literature **[40, 43]**. Regarding KTW gain, the current study compares well to that of **Pietruska et al. [39]** . For MCAT, mean KTW increased significantly from 2.94 ± 1.31 mm at baseline to 4.75± 1.05 after 6 months (P= 0.031). For YST, KTW was also increased but the difference was statistically insignificant when compared to baseline (p=0.132). Although higher values were reported for the MCAF, there was no statistically significant difference between the study groups at different evaluation periods. It may be speculated that the higher increase in KTW in relation to sites treated with MCAT may be due to the secondary keratinization of the CTG left exposed. The significant increase in GT and KTW in this study is mainly explained by the additional use of CTG which is consistently associated with an increased keratinized tissue gain.

Self-reported patient perception of pain after interventions were evaluated using pain index (VAS). The patients were instructed to use a postoperative diary during the first 3 days to collect postoperative pain by filling the VAS scale. At the 6-month follow-up examination, another questionnaire was given to the patients for subjective evaluation of esthetics and overall satisfaction. Questions were designed in a dichotomous fashion (yes or no). In this study, no major adverse events were reported after the surgical procedures. Post-operative pain VAS values were lower for the test group, although patients' perception of the outcomes was satisfactory for both groups.

We measured duration of the surgical procedures in minutes to compare chair time between the two procedures. YST demonstrated a shorter surgery duration (about 3 minutes difference, p=0.039). This is the only clinical outcome in favor of the YST group.

At the end of the study period (after 6 months), the esthetic outcome was professionally assessed by an independent examiner, who was blinded to the treatment groups. Both groups resulted in high average scores (out of 10). A significant intergroup difference was reported in favor of group I as the esthetic score was about 9.3 while it is about 8.5 for group 2 (P<0.001).

To sum up, the current results indicate notable superior results, in most of studied parameters, in favour of MCAT when compared with YST. Comparable results were only obtained regarding GT, and better results in favour of YST were obtained when evaluating the duration of the surgical procedures.

To more in depth explain the current results and the superiority of the MCAT, especially regarding CRC, we suggest that one of the main reasons could be the decreased initial access which limits release and decrease visibility to underlying alveolar bone and any potential root dehiscence. This may lead to more residual flap tension with the YST technique. A controlled

clinical study, designed to evaluate the effect of residual flap tension on the amount of root coverage, showed that applied flap tensions <1 g are compatible with complete coverages while a residual mean tension of 6.5 g lowered the probability for a complete root coverage **[44]**. Additionally, decreased initial access make the technique sensitive and need more skills especially to enter the graft through tunnel and fixating it.

Another reason is the lower portion of graft-to-flap coverage that increases risk of graft necrosis and decreases predictability. The survival of the part of the graft that is placed over the avascular root surface depends on the graft nature, diffusion of plasma, and subsequent revascularization. The YST technique involves subperiosteal (full thickness) tunneling that allows the creation of a pouch from the gingival margin to the apex. Compared to the supraperiosteal (partial thickness) flap elevation, the initial revascularization of the CTG during the early healing phase may be jeopardized because the initial resorption at the denuded cortical bone may delay vascular proliferation during the early healing phase. The is evidenced by partial graft necrosis associated with some cases in the exposed part of CTG in the YST technique, in contrary to complete coronally repositioning of the flap and covering all of the graft in MCAT which allow not only protection from infection by oral bacteria, but also fixation of graft and vascularity during healing process beside giving more stable and firm attachment with tooth surface. The risk of graft necrosis may be decreased by enlarging the flap or decreasing the exposed part, but in the first case it would lose its main goal "being minimally invasive", and in the second it would be only limited to mild recession cases.

Some limitations should be considered, most importantly, although autogenous CTG remains the gold standard for RC and increasing KTW around teeth. This procedure, however, requires a secondary donor site, which can lead to increased pain and morbidity. Alternatives that have been investigated to overcome these limitations showed less equality regarding most of the studied parameters. Accordingly, trying to encompass all the positive benefits of minimally invasive and biologically enhanced soft-tissue procedures, less invasive and more patient friendly techniques or alternatives should be introduced. Furthermore, longer followup periods with higher number of patients could reveal more details about factors associated with the prognosis and indications of the novel YST technique. Within the limitations of this randomized controlled trial, it can be concluded that MCAT was superior in root coverage percentage, however both techniques were successful in terms of the modification of gingival phenotype.

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Ethical Regulations:

a) The research, therapies, and any possible adverse effects were fully explained to the patients.

b) The patients signed an informed consent. Moreover, a verbal approval was obtained for the patient.

Declarations

Ethics approval and consent to participate:

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee

Informed consent: Informed consent was obtained from all individual participants included in the study.

Conflict of interest: The authors declare no competing interests.

Clinical trial registration: ClinicalTrials.gov PRS platform

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