Tunnel technique versus coronally advanced flap with acellular dermal matrix graft in the treatment of multiple gingival recessions


Abstract

Aim: The aim of this randomized controlled clinical study was to evaluate the outcomes of acellular dermal matrix (ADM) graft in combination with tunnel technique (TUN) on root coverage, aesthetics, and patient satisfaction and to compare with coronally advanced flap (CAF)+ADM in the treatment of multiple gingival recessions.

Material and Methods: A total of 20 patients with 58 Miller Class I multiple recessions ≥ 3 mm were included and divided into TUN+ADM and CAF+ADM groups. At baseline and 12 months, probing depth (PD), clinical attachment level (CAL), recession height (RH) and width (RW), keratinized tissue height (KT), gingival thickness, and complete and mean root coverage (CRC, MRC) were evaluated. Patient satisfaction and root coverage aesthetic scores (RES) were also assessed.

Results: Mean root coverage was 75.72% in TUN+ADM and 93.81% in CAF+ADM. Intragroup comparisons revealed significant differences at 12 months for all parameters in both groups (p < 0.05). Intergroup differences were found to be statistically significant for RH and RW reduction, KT increase, CAL gain, MRC, CRC, and RES in favour of CAF+ADM group (p < 0.05).

Conclusion: Both techniques were effective in root coverage of multiple recessions; however, better clinical results were achieved with CAF and ADM combination.

Many techniques have been proposed for the treatment of multiple Miller Class I and II recessions aiming to restore patient’s comfort and aesthetics (Grupe & Warren 1956, Cohen & Ross 1968, Langer & Calagna 1980, Tarnow 1986, Allen 1994, Zabalegui et al. 1999, Zucchelli & De Sanctis 2000, Aroca et al. 2010). The complete coverage of multiple exposed roots is more challenging with a wider area of root exposure, more extensive avascular surface, differences in recession depth and width, and tooth position (Hofmänner et al. 2012, Graziani et al. 2014). Successful results have been achieved in the treatment of multiple gingival recessions with coronally advanced flap (CAF), modified CAF with or without grafting, and tunnel technique (TUN) (Zucchelli & De Sanctis 2000,
Zucchelli et al. 2009, Pini-Prato et al. 2010, Aroca et al. 2013). In a recent systematic review, it has been pointed out that the probability of being the best treatment in terms of recession reduction is associated with the usage of CAF and a grafting procedure, such as acellular dermal matrix (ADM) graft in multiple recessions (Graziani et al. 2014). Although connective tissue graft (CTG) is a gold standard, its harvesting is often associated with increased patient morbidity, prolonged surgical time, and possibility of postoperative complications (Harris et al. 2005). In some cases with thin palatal tissues, harvesting sufficient donor tissue can be a challenging issue for the clinician (Zucchelli et al. 2014). Very few studies evaluated the clinical and patient-related outcomes related to the ADM application in multiple recessions as an alternative to CTG and reported that CAF+ADM is an effective procedure for the treatment of multiple recessions (Thombre et al. 2013, Ahmedbeyli et al. 2014).

The TUN is proposed as minimally invasive, safe, and predictable technique that preserves the intermediate papillae and may accelerate the initial wound healing and causes less scarring with minimal trauma (Zabalegui et al. 1999). A few studies evaluated the clinical outcomes of ADM in combination with TUN in single and multiple recessions (Papageorgakopoulos et al. 2008, Modaressi & Wang 2009, Mahn 2010). Papageorgakopoulos et al. (2008) compared the clinical outcomes of TUN and CAF procedures in combination with ADM in single Miller Class I or II recessions and found no significant difference between the groups related to recession height reduction (RecRed), mean root coverage (MRC), and complete root coverage (CRC). Modaressi & Wang (2009) proposed TUN+ADM as a successful alternative to traditional techniques, especially for multiple recession defects in maxillary premolar and anterior teeth.

The available data seem to suggest that CAF+ADM and TUN+ADM might represent a successful approach in multiple gingival recession treatment. However, no randomized controlled trial has been yet published comparing the TUN with CAF procedure in multiple recession defects using the ADM over a 12-month follow-up period. Therefore, the aim of this randomized controlled clinical study was to evaluate clinical effectiveness of ADM in combination with TUN on defect coverage, aesthetics, and patient satisfaction compared with CAF+ADM for the treatment of multiple gingival recessions.

**Material and Methods**

The present clinical study was conducted according to the guidelines of Helsinki. The study protocol and consent form were approved by the University Institutional Review Board.

Twenty patients, who participated in this study, were referred to the Yeditepe University Faculty of Dentistry, Department of Periodontology, for the treatment of gingival recession defects. All risks and benefits involved in the procedures were explained to the patients before they signed an informed consent form.

**Sample size calculation**

According to the results of power analysis, the sample size of nine subjects for each group was defined for 80% statistical power $\beta = 0.20$ and $\alpha = 0.05$ to detect $\Delta = 1$, standard deviation (SD): 0.7 (Woodyard et al. 2004).

**Study population and design**

This study was designed as parallel, randomized, controlled clinical trial. A total of 20 patients were enrolled. Ten patients were treated with TUN+ADM, and 10 patients were treated with CAF+ADM. Patients were randomly assigned to treatment groups with the use of coin toss. First, flipping was performed for assigning the treatment groups. The side of the coin determined the assignment of each treatment (head: TUN, tails: CAF). Subsequently, another flipping was performed for the distribution of the patients to the groups.

The patients were selected according to the following inclusion criteria:

- Miller Class I multiple recessions $\geq 3$ mm on maxillary or mandibular incisors, canines, or premolars (Figs 1a and 2a),
- Probing depth (PD) $< 3$ mm,
- Absence of non-vital teeth, carries, advanced non-caries lesions or restorations on cervical areas, occlusal trauma, and previous root coverage procedure.
- When cementoenamel junction (CEJ) is not identifiable, CEJ was determined according to Zucchelli et al. (2006) (If the facial CEJ cannot be found, interdental soft tissue was raised gently with a probe to observe the CEJ point angle, where the CEJ gets into the interdental papilla),
- Non-smoker,
- No pregnancy,
- No systemic diseases that could influence the outcome of the therapy.

Each patient received a full diagnostic workup, including full-mouth periapical radiographs, study casts, and intraoral photographs. After diagnostic workup, supragingival scaling and polishing were performed and detailed oral hygiene instructions were given. The patients were instructed to perform a non-traumatic (roll) brushing technique with a soft toothbrush. Patients were re-evaluated 8 weeks after initial therapy and only patients with plaque index (PI) (Silness & Löe 1964) and gingival index (GI) (Löe & Silness 1963) <1 were qualified for the operation.

**Investigator calibration**

A calibration exercise was performed to determine the acceptable intra-examiner reproducibility. Five patients not enrolled in the study who exhibited at least two teeth with a recession height (RH) of $>3$ mm were evaluated by the examiner on two occasions at 48-h intervals. RH, recession width (RW), clinical attachment level (CAL), PD, keratinized tissue height (KT), and gingival thickness (GT) were measured. The examiner was accepted as calibrated if measurements at baseline and at 48 h were similar to the mm at $\geq90\%$.

**Clinical measurements**

All clinical measurements were performed by the same calibrated blinded examiner at baseline and at

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12 months (IO). Individual acrylic occlusal stents were prepared for probe positioning to record PD, RH, CAL, and KT. All measurements were taken with 0.4 mm diameter 15 mm calibrated periodontal probe (PCP 15 UNC; Hu-Friedy, Chicago, IL, USA), and measurements were rounded to the nearest millimetre, except GT was measured with a digital caliper (Stainless Steel Digital Caliper 75 mm; Shan, Guilin, China). PI, GI, and bleeding on probing (BoP) (Ainamo & Bay 1975) evaluated for oral hygiene status and gingival health. CAL, RH, and KT were measured at the mid-buccal surface of the related tooth as the distance between the CEJ and the bottom of the gingival sulcus, as the distance from the CEJ to the most apical point of the gingival margin, and as the distance from the mucogingival junction to the gingival margin, respectively. RW was measured at the level of CEJ as the horizontal distance from one border of the gingival recession margin to another, and GT was measured at the mid-point location between the gingival margin and mucogingival junction, using an endodontic spreader (Endodontic spreader #25 25 mm; Mani, Tochigi, Japan) (Ahmedbeyli et al. 2014).

Patient satisfaction was evaluated considering Mahajan et al.’s (2007) criteria. Aesthetic outcomes of the root coverage procedures were assessed by the root coverage aesthetic score (RES) (Cairo et al. 2009).

Surgical procedure
All surgeries were performed between September 2011 and October 2012. The surgical procedure in TUN + ADM group was based on the tunnel procedure without any vertical incisions, and ADM is then placed and secured through this tunnel (Aroca et al. 2013). After local anaesthesia, root planing of the exposed root surfaces was performed. An intrasulcular incision was made through each recession area by using 15C blade without damaging interdental papilla, and mucoperiosteal flap dissection was made with a tunnel elevator instrument (Fig. 1b) and extended under each papilla till the mucogingival junction. Then, the undermined dissection was performed far beyond the mucogingival junction so that the flap could be moved in a coronal direction without tension. The ADM graft was placed into the tunnel to cover the root surfaces and positioned at the CEJ level (Fig. 1c). The flap margin was positioned coronal to the CEJ to completely cover the defect and ADM and sutured with double sling suture technique with 5-0 non-resorbable polypropylene sutures. The surgical procedure performed in CAF + ADM group was the same technique described in detail in a previous study (Ahmedbeyli et al. 2014) (Fig. 2b, 2c). No surgical dressing was used in both groups.

Post-surgical care
Patients were informed to avoid hard chewing, brushing, or flossing in the operated areas for 14 days. The patients received postoperative systemic antibiotic therapy for a period of 5 days (2 × 1000 mg, amoxicillin clavulanate, Augmentin BID; GlaxoSmithKline Pharmaceuticals, Istanbul, Turkey), oral analgesics for a period of every 8 h as necessary (550 mg, naproxen sodium, Apranax Forte 550 mg; Abdi Ibrahim, Istanbul, Turkey), and oral rinse twice a day for 4 weeks (0.2% chlorhexidine gluconate, Klorhex Oral Rinse; Drogsan Pharmaceuticals, Istanbul, Turkey).

After 2 weeks, sutures were removed and all patients were seen weekly for 1 month. Four weeks after surgery, all patients were re-instructed in mechanical tooth cleaning with a soft toothbrush and a roll technique. For 2 months, all
patients were recalled once per 2 weeks, and once a month until the end of the study for supragingival plaque removal, polishing, and oral hygiene reinforcement. At the end of the 12-month evaluation period, all clinical measurements and photographs were repeated (Figs 1d, 2d).

Statistical analysis

The statistical analysis was performed using commercially available software (IBM SPSS Statistics 22; IBM, North Castle, NY, USA). A subject-level analysis was performed for each parameter except CRC. Mean values and standard deviations (mean ± SD) for the clinical parameters were calculated. Data analysis was done for full mouth for PI, GI, and BoP, whereas defect site measurements were used for PD, CAL, RH, GT, and KT. All the parameters were measured at baseline and 12 months. The balancing of groups by age and gender was tested by Student’s t-test and Fisher’s exact test, respectively. Parameters with normal distribution and Fisher’s exact test, respectively.

The value of p considered as secondary outcome variable. The comparison of baseline parameters of TUN+ADM and CAF+ADM groups revealed statistically significant differences for CRC (Tözüm et al. 2005, Dembowska & Drozdzik 2007, Georges et al. 2009, Aroca et al. 2013, Zuur et al. 2014). The reports about TUN+ADM were ranging from 70% (Shepherd et al. 2009) to 78% (Papageorgakopoulos et al. 2008) for MRC and from 33% (Shepherd et al. 2009) to 50% (Papageorgakopoulos et al. 2008) for CRC with evaluation periods of 4 months. In the literature, there is limited number of study evaluating the defect coverage after CAF+ADM application in multiple recessions ranging from 90% (Thombre et al. 2013) to 94.8% (Ahmedbeyli et al. 2014) for MRC and CRC in a range from 24% (Thombre et al. 2013) to 83.3% (Ahmedbeyli et al. 2014). The results obtained in this study in terms of MRC and CRC are in accordance with the literature in both groups.

Discussion

In this study, significant defect coverage was observed with both treatment approaches at 12 months; however, better clinical improvements and aesthetic results were achieved with CAF+ADM combination.

Mean root coverage was 75.7% and 93.8% in TUN+ADM and CAF+ADM groups, respectively, at 12 months. CRC was assessed on tooth level and was found 37.3% and 85% in TUN+ADM and CAF+ADM groups, respectively. When TUN is considered, randomized controlled trials in combination with CTG reported MRC ranging from 81% to 98.4% and from 33.3% to 85% for CRC (Tözüm et al. 2005, Dembowska & Drozdzik 2007, Georges et al. 2009, Aroca et al. 2013, Zuur et al. 2014). The results obtained in this study in terms of MRC and CRC are in accordance with the literature in both groups.

Table 1. Comparison of baseline parameters of TUN+ADM and CAF+ADM groups

<table>
<thead>
<tr>
<th>Parameter</th>
<th>TUN+ADM Mean ± SD (median)</th>
<th>CAF+ADM Mean ± SD (median)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>PI</td>
<td>0.50 ± 0.04</td>
<td>0.47 ± 0.09</td>
<td>0.313*</td>
</tr>
<tr>
<td>GI</td>
<td>0.51 ± 0.02</td>
<td>0.51 ± 0.09</td>
<td>0.847*</td>
</tr>
<tr>
<td>BoP (%)</td>
<td>9.00 ± 0.62 (8.85)</td>
<td>8.80 ± 1.31 (9)</td>
<td>0.879*</td>
</tr>
<tr>
<td>PD (mm)</td>
<td>1.15 ± 0.25 (1)</td>
<td>1.10 ± 0.21 (1)</td>
<td>0.618*</td>
</tr>
<tr>
<td>CAL (mm)</td>
<td>4.33 ± 0.35 (4.30)</td>
<td>4.40 ± 0.46 (4.25)</td>
<td>0.842*</td>
</tr>
<tr>
<td>RH (mm)</td>
<td>3.23 ± 0.28 (3.14)</td>
<td>3.30 ± 0.35 (3.25)</td>
<td>0.712*</td>
</tr>
<tr>
<td>RW (mm)</td>
<td>3.21 ± 0.50 (3.37)</td>
<td>3.50 ± 0.53 (3.5)</td>
<td>0.175*</td>
</tr>
<tr>
<td>GT (mm)</td>
<td>0.82 ± 0.06 (0.82)</td>
<td>0.76 ± 0.06 (0.72)</td>
<td>0.055*</td>
</tr>
<tr>
<td>KT (mm)</td>
<td>2.34 ± 0.66 (2.1)</td>
<td>2.47 ± 0.51 (2.5)</td>
<td>0.563*</td>
</tr>
</tbody>
</table>

ADM, acellular dermal matrix; BoP, bleeding on probing; CAF, coronally advanced flap; CAL, clinical attachment level; GI, gingival index; GT, gingival thickness; KT, keratinized tissue height; PD, probing depth; PI, plaque index; RH, recession height; RW, recession width; TUN, tunnel technique.

*Student’s t-test, †Mann-Whitney U-test, p < 0.05.
At 12 months, CAF+ADM provides better MRC and CRC rather than TUN+ADM. This result can be attributed to coupled factors. TUN has clinical limitations. First, in this study, multiple adjacent defects with different RH ranged between 3 and 6 mm were treated that increases the surgical difficulty and the risk of failure when compared with similar RHs. The limited flap mobility and coronal advancement caused by missing vertical incisions and intact papilla might lead to an uncovered graft in such heterogeneous defects. If the graft material is ADM, then it might not work as desirable since it has been reported that if ADM is left uncovered, a resorption takes place and the material works best when vertical incisions are performed (Felipe et al. 2007). Previous studies indicate that releasing incisions are an advantage when coronal positioning is needed and modifications to TUN may increase the level of predictability (Papageorgakopoulos et al. 2008, Mahn 2010). Thus, the limitation of coronal positioning the gingival margin following a TUN procedure may affect its predictability when ADM is used as a graft. In this study, although ADM is thoroughly covered, during the healing period, the stabilization of the tissues might be more challenging in TUN procedure rather than CAF. On the other hand, when TUN is combined with CTG, even if small part of the CTG left uncovered, it survives and successful results are obtained (Zabalegui et al. 1999, Zuhr et al. 2014). In this study, CAF technique was applied with vertical incisions. Even though it has been suggested that better clinical outcomes can be achieved due to improved vascularization (Allen 1994, Zabalegui et al. 1999, Zucchelli et al. 2009), there is not enough evidence to avoid vertical incisions. Zucchelli et al. (2009) compared the clinical and aesthetic outcomes of the CAF with and without vertical incisions in the treatment of multiple gingival recessions. Although both techniques resulted in a very high percentage of root coverage, the CAF technique without vertical incisions increased the probability of achieving CRC. On the other hand, Felipe et al. (2007) compared a CAF with releasing incisions to an envelope flap without releasing incisions when using ADM for both procedures. The procedure with releasing incisions achieved 85% MRC, whereas the procedure without releasing incisions resulted in 69% MRC. It has been reported that the main blood supply of the gingiva is directed from vestibule to gingival margin might providing that more blood vessels, nutrients, and source cells can provide better integration of the ADM into the host’s tissues (Felipe et al. 2007). Andrade et al. (2008) evaluated the treatment outcomes of CAF+ADM with or without vertical incisions. MRC and CRC were 74.32% and 40.0% without vertical incisions and 83.28% and 53.36% with vertical incisions at 12 months, respectively. They concluded that both surgical techniques in combination with ADM resulted in significant RecRed after 12 months (p > 0.05), but the group with vertical incisions led to significant difference in KT increase (p < 0.05) (Andrade et al. 2008). It has been suggested that additional grafting may provide a scaffold to support wound healing with increasing the thickness of the wound area (Baldi et al. 1999, Graziani et al. 2014). Mainly, CTG is the choice of the clinicians. Although systematic reviews reported variable results with CAF+ADM combination, the use of ADM as an alterna-

### Table 2. Intrigroup comparison of differences for all measurements at 12 months compared with baseline data

<table>
<thead>
<tr>
<th>Variable</th>
<th>TUN+ADM Mean ± SD (median)</th>
<th>CAF+ADM Mean ± SD (median)</th>
<th>TUN+ADM Mean ± SD (median)</th>
<th>CAF+ADM Mean ± SD (median)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PI</td>
<td>0.50 ± 0.04 0.001</td>
<td>0.47 ± 0.09 0.001</td>
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<tr>
<td>GI</td>
<td>0.51 ± 0.02 0.001</td>
<td>0.51 ± 0.09 0.001</td>
<td></td>
<td></td>
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<tr>
<td>BoP (%)</td>
<td>9.00 ± 0.62 (8.85) 0.005</td>
<td>8.80 ± 1.31 (9) 0.005</td>
<td></td>
<td></td>
</tr>
<tr>
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ADM, acellular dermal matrix; BoP, bleeding on probing; CAF, coronally advanced flap; CAL, clinical attachment level; GI, gingival index; GT, gingival thickness; KT, keratinized tissue height; PD, probing depth; PI, plaque index; RH, recession height; RW, recession width; TUN, tunnel technique.

*Paired sample t-test, †Wilcoxon sign test, p < 0.05.
tive to the gold standard CTG is very popular among clinicians (Novaes et al. 2001, Harris 2004, Moslemi et al. 2011, Graziani et al. 2014).

Several reviews suggested that Miller Class I and II recessions can predictably be treated with various plastic surgical procedures (Chamberone et al. 2009, Hofmann et al. 2012, Buti et al. 2013, Graziani et al. 2014, Chamberonne & Tatakis 2015). However, the best treatment outcome in terms of CRC and RecRed is obtained when there is adequate KT apical to recession (Zucchelli & De Sanctis 2000, 2005); therefore, only Miller I recession defects were included in this study. The evaluation period used in this study was 12 months, which is a positive predictive factor especially in terms of aesthetics. To our knowledge, no randomized controlled trial has been yet published comparing the TUN with CAF in multiple recessions using ADM and reported the results at 12 months. In this aspect, the results will contribute to the literature.

In this study, simple randomization was used. This technique maintains complete randomness of the assignment of a person to a particular group (Schulz & Grimes 2002). However, randomization results could be problematic in small sample size clinical trials, resulting in an unequal number of participants among groups. In this study, the patients were consecutively treated by random allocation to the two treatment groups until 10 patients belonging either of the groups were operated. Then, the rest of the patients were allocated to the other group in order to achieve groups of equal size. This occurred in consecutively treated patient number 17, belonging to CAF+ADM (i.e., patients number 18–20 treated with TUN+ADM).

In our study, aesthetic outcome of the treatments was evaluated with RES system, because just the achievement of CRC cannot be considered as full success without aesthetics (Cairo et al. 2009). In this study, the mean RES in TUN+ADM and CAF+ADM groups was 7.30 ± 1.25 and 8.90 ± 1.60, respectively, with significant difference between the groups (p < 0.05). RES considered CRC as the main goal; therefore, the level of gingival margin contributes 60% of the total RES value, whereas other variables affect 40%. After 12 months, CAF+ADM combination achieved better clinical outcomes; therefore, better RES values were observed. These findings are in accordance with the aesthetic outcomes of previous studies that reported mean RES with a range between 7.30 and 7.58 for multiple recessions treated with CAF (Pini-Prato et al. 2011, Ahmedbeyli et al. 2014), 7.0 for multiple recessions treated with CAF+CTG (Pini-Prato et al. 2011), 8.10 and 9.8 for single and multiple recessions treated with CAF+ADM (Jhaveri et al. 2010, Ahmedbeyli et al. 2014), and 9.6 for single or multiple recessions treated with TUN+CTG (Zuhr et al. 2014). It is important to mention that when the parameter related to the gingival marginal level was excluded; similar results were obtained for mucogingival junction alignment and gingival colour. Soft-tissue texture was better in TUN+ADM group, whereas marginal tissue contour was better in CAF+ADM group.

In our study, all patients were questioned about their satisfaction with regard to the patient-centred criteria. Patient satisfactions were similar for both groups (p > 0.05), but in the TUN+ADM group, patients were unsatisfied about root coverage attained, whereas in the CAF+ADM group, patients complained about the comfort after surgery. The reason could be flap design and vertical incisions in CAF+ADM group, and for the TUN+ADM group, it could be partial root coverage and high patient expectations. Also in the study by Papageorgakopoulos et al. (2008), patients generally reported no significant postoperative complications and minimal discomfort with TUN approach. Modaressi and Wang (2009) assessed pain and aesthetics after TUN+ADM procedure, and an evaluation of postoperative discomfort showed that patients had minimal discomfort and healed uneventfully. Although a significant difference was not observed between the groups for overall satisfaction, with minimal surgical trauma, TUN+ADM seems to be a better approach to reduce discomfort; however, CAF+ADM procedure produced better aesthetic results.

Within the limits of this study, it can be concluded that both TUN+ADM and CAF+ADM procedures were effective in root coverage of multiple recession defects; however, better aesthetic results and clinical improvements were achieved with CAF+ADM. On the other hand, TUN+ADM resulted in less patient discomfort with minimal surgical trauma. Although TUN is a valuable technique, modifications in the technique may improve its efficacy when it is combined with ADM. Therefore, further studies with different flap designs will provide insight to the clinician.

References


Clinical Relevance

Scientific rationale for the study: The most preferred techniques in the treatment of multiple gingival recessions are coronally advanced flap (CAF), modified CAF with or without grafting, and tunnel technique (TUN). At present, there are limited data evaluating acellular dermal matrix graft (ADM) combination on complete root coverage, aesthetics, and patient satisfaction with TUN for the treatment of multiple recessions.

Principal findings: Both TUN+ADM and CAF+ADM were effective in root coverage of multiple recessions; however, better aesthetic and clinical results were achieved with CAF and ADM combination.

Practical implications: Although TUN+ADM resulted in less patient discomfort with minimal surgical trauma, CAF+ADM resulted with better clinical outcomes with more postoperative complaints.