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# A Randomized comparative clinical study of two surgical procedures to improve root coverage with the acellular dermal matrix graft

**Lauro G. Ayub, Umberto D. Ramos, Danilo M. Reino, Márcio F. M. Grisi, Mário Taba Jr, Sérgio L. S. Souza, Daniela B. Palioto and Arthur B. Novaes Jr**

Department of Bucco-Maxillo-Facial Surgery and Traumatology and Periodontology, School of Dentistry of Ribeirao Preto, University of Sao Paulo, Ribeirão Preto, Brazil

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***Abstract***

**Aim:** This randomized, controlled, clinical study compared two surgical techniques for root coverage with the acellular dermal matrix graft (ADMG) to evaluate which procedure could provide better root coverage and greater amounts of keratinized tissue.

**Materials and Methods:** Fifteen pairs of bilateral Miller Class I or II gingival recessions were treated and assigned randomly to the test group, and the contralateral recessions were assigned to the control group. The ADMG was used in both groups. In the control group, the graft and flap were positioned at the level of the cemento-enamel junction (CEJ), and in the test group, the graft was positioned 1 mm apical to the CEJ and the flap 1 mm coronal to the CEJ. The clinical parameters were taken before the surgeries and after 6 months. The gingival recession area, a new parameter, was measured in standardized photographs through a special device and software.

**Results:** There were statistically significant differences favouring the proposed technique for all parameters except for the amount of keratinized tissue at 6 months.

**Conclusions:** The proposed test technique is more suitable for root coverage procedures with ADMG, and the new parameter evaluated appears valuable for root coverage analysis. (Clinicaltrials.gov Identifier: NCT01175720).

Key words: acellular dermal matrix; comparison studies; dental aesthetics; gingival recession; root coverage

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**Conflict of interest and source of funding statement**

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Gingival recession is commonly defined as the apical migration of the gingival margin over the cemento-enamel junction (CEJ) with exposure of the root surface (Oates et al. 2003). This feature can be found in populations with high standards of oral hygiene (Wilson 1983, Serino et al. 1994), as well as in populations with poor oral hygiene (Baelum et al. 1986, Löe et al. 1992), reaching prevalence around 51% among subjects (Susin et al. 2004). Gingival anatomic factors, chronic trauma, periodontitis and tooth alignment are the main conditions leading to the development of these defects through inflammation process

(Novaes et al. 1975, Yoneyama et al. 1988, Khocht et al. 1993).

Although many dental conditions may be undetected by the patients, they frequently notice gingival recessions and seek treatment. In this context, the coverage of exposed root surfaces has become an important therapeutic issue due to patients' increasing demands, such as aesthetic problems, dentinal hypersensitivity, root caries or whenever it hampers proper plaque removal (Paolantonio et al. 2002). Different surgical techniques have been used for root coverage (Cohen & Ross 1968, Sullivan & Atkins 1968, Guinard & Caffesse 1978, Langer & Langer 1985, Tarnow 1986, Allen & Miller 1989, Pini-Prato et al. 2000, Cordioli et al. 2001, Del Pizzo et al. 2005, Trombelli et al. 2005, Pilloni et al. 2006), and subepithelial connective tissue graft (SCTG) plus coronally advanced flaps (CAF) are considered the reference therapy. Thus, alternative procedures are usually compared with SCTG+CAF according to their predictability to reduce gingival recession and increase keratinized tissue (Academy Report 2005).

The acellular dermal matrix graft (ADMG), which is obtained from human skin, has been widely used as a substitute for autogenous grafts in mucogingival surgeries (Harris 1998). This allograft has been recommended for the treatment of alveolar ridge deformities (Batista et al. 2001), to increase the width of keratinized tissue around teeth and implants (Wei et al. 2000, 2002, Yan et al. 2006), for root coverage procedures (Aichelmann-Reidy et al. 2001, Novaes Jr et al. 2001, de Queiroz Côrtes et al. 2006, Felipe et al. 2007) and to eliminate gingival melanin pigmentation (Novaes Jr et al. 2002), avoiding the disadvantages presented for the autogenous connective tissue. The ADMG has also been used for guided bone regeneration (Novaes Jr & Souza 2001, Fernandes et al. 2011), besides, membrane for guided tissue regeneration of mandibular Class II furcation defects in dogs (Andrade et al. 2007).

Previous studies comparing the ADMG and SCTG in root coverage procedures have shown similar results regardless of the choice (Aichelmann-Reidy et al. 2001, Novaes Jr et al. 2001). At the same time, these grafts exhibit different healing processes. However, the SCTG maintains some vessels and cells, basing its healing and vascularization on the anastomosis between the vessels of the receptor site and the graft's vessels (Guiha et al. 2001). In case of the ADMG, the resulting structure after its use provides a scaffold for the proliferation of fibroblasts, blood vessels and epithelial cells from the host recipient tissues. Therefore, this matrix is a non-vital allograft, which contains mainly collagen bundles and elastic fibres, and macromolecules of extracellular matrix like glycosaminoglycans and glycoproteins (Luczyszyn et al. 2007). Despite a previous systematic review showed no clinical benefit in adding ADMG underneath the CAF (Cairo et al. 2008), in some cases, the graft use is indicated due to the tissue thickness, acting as substitute to SCTG in the therapy for root coverage. Many studies have reported a representative gingival augmentation with the use of ADMG plus CAF (Harris 2002, de Queiroz Côrtes et al. 2006, Núñez et al. 2009, Scarano et al. 2009). In this context, Barros et al. (2004) demonstrated a beneficial effect of an extended flap, in which the releasing incisions were displaced to the adjacent teeth to provide a larger blood supply. This surgical technique for root coverage of localized gingival recessions favoured the incorporation of the allograft due to more blood nutrition and better source of cells offered by the extended flap. Moreover, this procedure had better results than an approach without vertical incisions for root coverage of localized gingival recessions (Felipe et al. 2007).

However, in some cases of root coverage, the primary soft tissue shrinkage can lead to exposure of the grafts. This fact may be very harmful when the ADMG is used because the exposed part, without nutrition, most of the times, disintegrates, damaging the desired result (Tal 1999).

Thus, the graft and flap positioning at the level of CEJ might favour the exposure of the ADMG, making it impossible to achieve completed root coverage. Based on this statement, a distance between the ADMG and the gingival margin seems to be suitable.

Accordingly, the aim of this study was to compare, clinically in humans, two surgical procedures for root coverage with the ADMG, in which the positioning of the allograft and the flap are different from the technique proposed by Barros et al. (2004) Furthermore, the area of gingival recessions, a new parameter of analysis, was measured to evaluate the results of both procedures.

## Materials and Methods

### Experimental population and study design

This study is a split-mouth, randomized, controlled clinical trial designed to compare the outcomes of two surgical procedures for root coverage. The study was conducted, according to the principles outlined in the Declaration of Helsinki on experimentation involving human subjects, after the approval of the Institution's Human Research Committee (protocol 2009.1.1429.58.2). Fifteen patients aged 20–56 complaining of aesthetic problems or dentinal hypersensitivity were selected by a single operator (L.G.A.) for the study at the Department of Periodontology, School of Dentistry of Ribeirao Preto, University of Sao Paulo. The entry criteria were: (1) non-compromised systemic health and no contraindications for periodontal surgery; (2) no previous periodontal surgical treatment on the involved sites; (3) non-smokers; (4) non-pregnants; (5) CEJ without damage; and (6) large bilateral Miller Class I or II $\geq 3$ mm maxillary or mandibular gingival recessions on homologous teeth. Radiographs were taken to exclude the possibility of a Class III recession on the selected teeth. Thirty recessions were treated. All patients agreed to participate and provided informed consent after explanation of all risks and benefits involved in the procedures and were blinded about the technique held in each side. The study flow chart is outlined in Fig. 1.

The patients initially completed a plaque control program, including oral hygiene instructions to eliminate habits related to the aetiology of the recession, scaling and root

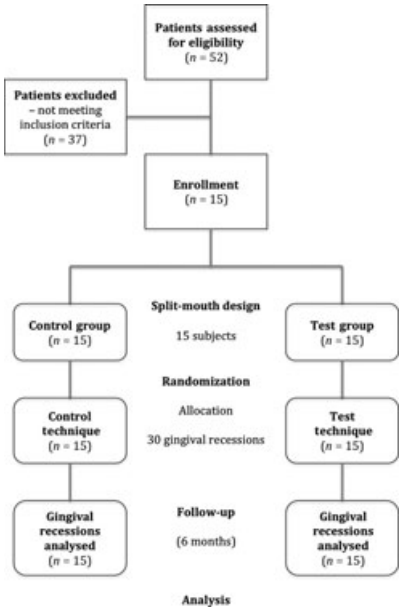


*Fig. 1.* Consort flowchart of the study.

planning, crown polishing and occlusal adjustment, if indicated. The surgical procedures were only carried out after a <20% plaque index was obtained.

Both groups were treated with the ADMG (AlloDerm; LifeCell, Branchburg, NJ, USA), with standardized size (10 mm × 10 mm), as a subepithelial graft and with the same incision design (Fig. 2). In the control group (CG), this allograft was used with the technique developed by Barros et al. (2004) (Fig. 3); whereas in the test group (TG), the technique proposes a distance of 1 mm between the ADMG and CEJ, to avoid its exposure; and 1 mm coronally advanced flap from the CEJ, compensating the primary soft tissue shrinkage (Fig. 4). These standardized distances were achieved with the aid of a millimetre probe.

#### Randomization procedure

The randomized allocation was performed by a single examiner (U.D.R.) using a software program (SPSS Inc., Chicago, IL, USA) by a computer-generated randomly permuted block. Allocation was concealed with opaque envelopes until immediately before surgery to determine which gingival recessions would receive the control or test procedure (Cortellini et al. 2011).

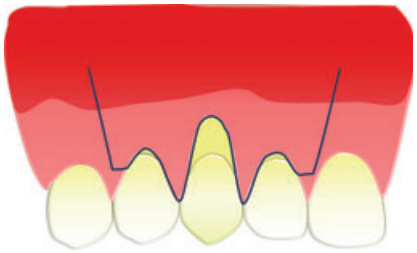

*Fig. 2.* Schematic drawing of incision design.

The randomization process resulted in comparable mean values of all investigated clinical parameters at baseline in both groups.

#### Clinical parameters

The clinical measurements evaluated were: probing depth (PD); relative clinical attachment level (RCAL); gingival recession height (GR); width of keratinized tissue (KT); thickness of keratinized tissue (TKT); and gingival recession area (GRA). All clinical assessments were recorded by the same calibrated experienced periodontist (L.G.A.) at the mid-buccal point of teeth scheduled for surgery at baseline and after 6 months with the aid of an acrylic stent to determine the exact measurement site.

The PD, RCAL and GR were assessed using an automated periodontal probe (Florida Probe, Gainesville, FL, USA). The KT was measured using a periodontal probe after gingival tissue was stained with Schiller's iodine solution at baseline and 6 months post-operatively to determine the width of KT. The TKT was assessed using an anaesthesia needle attached to a silicone disc stop. The needle was placed in an orifice held in the acrylic stent, perpendicular to the mucosa surface through the soft tissue with light pressure, until a hard surface was felt. Then the silicone disc stop was placed in tight contact with the external soft tissue surface. After carefully removing the needle, the penetration depth was measured using a digital calliper with 0.05 mm resolution.

The GRA was calculated through the *gingivomorphometry* method (Weinländer et al. 2009). This technique for the collection and measurement of standardized and reproducible data in oral photography, allows acquiring photographs with standardized enlargement, exposure and aperture. Moreover, visual distortions, such as enlargement or reduction resulting from different camera-object distances and changes of angulations can be excluded by controlling with the equipment: the position of the patient and the position of the camera. The morphometrical part is accomplished using image processing software (OsiriX 3.9.4, OsiriX Imaging Software, www.osirix-viewer.com). The acquired data files are saved as JPEG files and imported into image processing software. The program in pixel values immediately displays the measure of selected GRA. In this case, the unit used seems to be suitable, considering the relative change over time is the real goal.

#### Surgical procedures

A single experienced operator (L.G.A.) performed all surgical procedures, and each pair of recessions was treated in the same surgical session (Figs 3 and 4). After local anaesthesia, the flaps were designed to accommodate the ADMG subepithelially. In the CG and TG, the two releasing incisions were displaced to the mesial and distal line angles of the adjacent teeth, distant from the recession and providing a broader flap. These incisions were united with a sulcular incision, and the papillae were included in the flap. A partial-thickness flap was reflected as close to the periosteum as possible by mesio-distal and apical sharp dissection parallel to the mucosa, beyond the mucogingival junction (MGJ), to release residual muscle tension and to facilitate the passive CAF over the defects.

After flap elevation, the exposed root surfaces were gently planed with sharp curettes (Hu-Friedy, Chicago, IL, USA) and conditioned with 24% EDTA gel preparation for 2 min. with subsequent rinsing with sterile saline. The ADMGs were aseptically re-hydrated in sterile saline according to the manufacturer's instructions and trimmed to a shape and size designed to cover only the exposed root surface of the involved teeth and their surrounding tissue. In the CG, the ADMG was

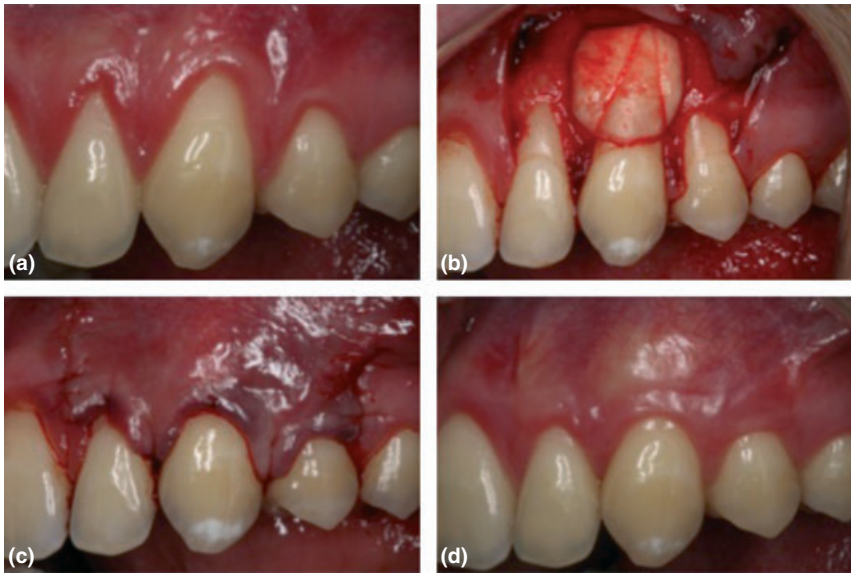


*Fig. 3.* Clinical sequence of the control group. (a) Pre-operative gingival recession on a maxillary left canine. (b) Flap elevated with a partial-thickness dissection and the acellular dermal matrix graft sutured at the level of cemento-enamel junction. (c) Flap sutured at the level of cement-enamel junction covering the entire graft. (d) Post-operative image of the treated area after 6 months.

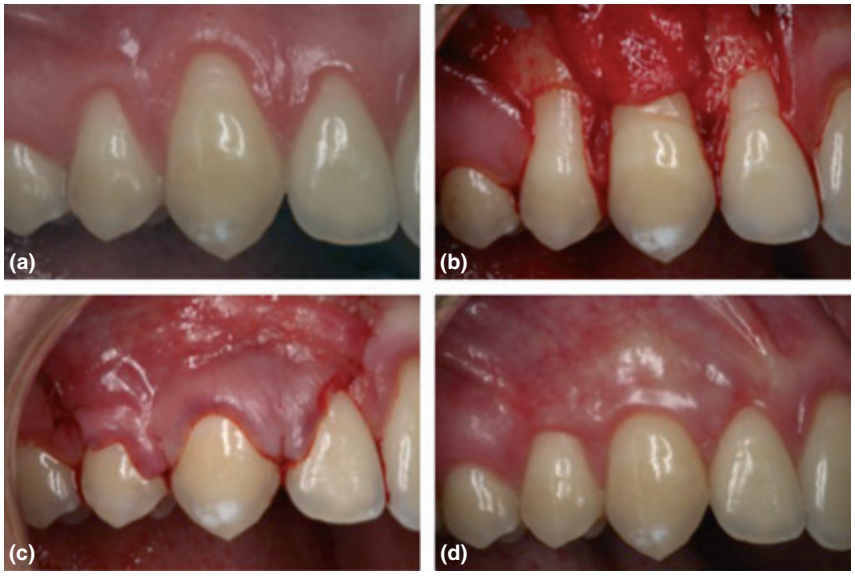


*Fig. 4.* Clinical sequence of the test group. (a) Pre-operative gingival recession on the maxillary right canine. (b) Flap elevated with partial-thickness dissection and the acellular dermal matrix graft sutured 1 mm apical of cemento-enamel junction. (c) Flap sutured 1 mm coronal of cemento-enamel junction. (d) Post-operative image of the treated area after 6 months.

positioned at the level of CEJ, and the basement membrane side was placed facing the flap, whereas the connective tissue side was placed in contact with the subjacent connective tissue and the root surface (Fig. 3b). In the TG, the ADMG was positioned 1 mm apical of CEJ to avoid a possible exposure and increasing the subjacent connective tissue nutrition (Fig. 4b). The allografts were held over the defects with periosteal sutures, using 6-0 bioabsorbable sutures.

The previously reflected partial-thickness flaps were coronally positioned to cover the entire grafts and sutured without tension with sling sutures, also with 6-0 bioabsorbable sutures. However, in the CG, the flap was positioned at the level of CEJ (Fig. 3c), whereas in the TG, the flap was stabilized 1 mm coronal to the CEJ (Fig. 4c). In both groups, interrupted sutures were used in the releasing incisions. No periodontal dressing was applied.

#### Post-surgical care

All patients were instructed to interrupt toothbrushing at the surgical sites, to avoid trauma, for a 14-day period. A 0.12% chlorhexidine digluconate solution rinse twice a day for the first 15 days; amoxicillin (500 mg, t.i.d.) three times a day for 7 days, starting 24 h before surgery; and paracetamol (750 mg) four times a day for 2 days, for control of post-operative pain, were prescribed.

The sutures were removed after 15 days and the patients were instructed to clean the surgical area with a cotton pellet soaked in a 0.12% chlorhexidine digluconate solution twice a day for 15 days. All patients were re-called for control and prophylaxis after 1, 2, 3 and 4 weeks and, subsequently, once a month until the final examination (6 months), maintaining a <20% plaque index over time (Figs 3d and 4d).

#### Statistical analysis

Quantitative data were recorded as mean and standard deviations. To verify the normality of the data, the kurtosis and skewness curves were used. As all data were considered to be normal for the parameters analysed, the ANOVA two-way test was used for intra-group (baseline × 6 months) and inter-group (CG × TG) comparisons. In case of significance, the Bonferroni test was utilized as multiple comparison test. The *t*-test was used for comparisons between groups of mean gains for all parameters. A significance level of 0.05 was used in all statistical comparisons. Initially, a statistical power analysis was not performed for sample size determination, but an initial sample of 15 volunteers was included in the trial ($n = 15$). The $n = 15$ was estimated in clinical studies, which

have used a similar methodology in the treatment of gingival recession areas (Del Pizzo et al. 2005, de Queiroz Côrtes et al. 2006, Andrade et al. 2008). The percentage of root coverage was calculated after 6 months as follows: baseline GR – 6 months GR/baseline GR × 100. For the given sample size of 15 defects per group, a power of 84% detecting 0.5 mm differences between CG and TG averages was obtained (Power and Precision, Biostat, Eaglewood, NJ, USA) . For the power analysis, a standard normal distribution was assumed.

## Results

All patients participated for the entire length of the study and attended all their appointments in accordance with the established protocol. Two cases of ADMG spontaneous exposure were detected in the CG, 7 days after surgery, being the undesired events noted only. All patients reported satisfaction with the results and no discomfort or dental hypersensitivity after the first month.

The Miller Class I or II gingival recessions ($n = 15$ patients, CG: 15 sites and TG: 15 sites) were located on 14 canines (12 maxillary and two mandibular) and 16 pre-molars (eight maxillary and eight mandibular).

There were no statistically significant differences between the two groups at baseline in the mean PD, RCAL, GR, KT, TKT and GRA. At 6 months, there was a statistically significant reduction in GR and GRA, a gain in RCAL, and an increase in KT and TKT between baseline and the 6-month post-operative analysis for both groups, whereas the change in the PD was not statistically significant after 6 months (Table 1).

There was no statistically significant difference between the two groups for KT and TKT. There was a statistically significant difference between the CG and TG in GR and GRA, favouring the TG after 6 months. At baseline, the GR in the CG was 3.32 ± 0.34 mm and was 3.30 ± 0.29 mm [$p$ = non-significant (NS)] in the TG; however, at 6 months, the GR in the CG was 1.14 ± 0.30 mm, and 0.38 ± 0.25 mm ($p \leq 0.01$) in the TG. The GRA, at baseline, in the CG was 38048.66 ± 10920.76 pixel$^2$ (pix$^2$) and was 38919.46 ± 9238.05 pix$^2$ ($p$ = NS) in the TG; however, at 6 months, the GRA in the CG was 20996.82 ± 5926.06 pix$^2$ and was 11118.46 ± 6293.45 pix$^2$ ($p = < 0.05$) in the TG. Moreover, there was a statistically difference at 6 months between the groups in PD and RCAL (Table 2).

The mean gains for all parameters are shown in Table 3 and the comparison between groups revealed a significant superiority of the TG in RCAL, GR and GRA. Besides, the percentage of root coverage was 65.85% for the CG and 88.37% for the TG; this difference was statistically significant. In the CG, all cases had root coverage between 99–50%; whereas in the TG, there was root coverage of 100% in four sites and 99–50% in 11 sites.

## Discussion

In this randomized, controlled, clinical study, the use of ADMG as a subepithelial graft using different surgical techniques for root coverage was compared and evaluated 6 months post-operatively. Although Miller's classification presents considerable limitations, recently discussed (Pini-Prato 2011), it was adopted because it is the most used for root coverage analysis. The study aimed to assess which procedure could provide better root coverage and greater amounts of keratinized tissue. The CG was treated with the technique proposed by Barros et al. (2004), while in the TG, a modification in the graft and flap position was proposed to prevent ADMG exposure and to compensate the primary soft tissue shrinkage. This technique was superior in the root coverage; however, the procedures resulted in similar amounts of keratinized tissue.

The broader flap suggested by Barros et al. (2004) may provide better nutrition to the non-vital allograft. In addition, the displacement of vertical incisions to the mesial and distal line angles of the adjacent teeth was clinically and statistically superior to the conventional technique (Langer & Langer 1985) when using this allograft. Another study demonstrated that the absence of releasing incisions, to favour the blood supply to the ADMG, was not significantly superior to the technique proposed by Barros et al. (2004), considering root coverage after 12 months (Andrade et al. 2008). Although comparisons between the extended flap techniques (Barros et al. 2004) with others may have limited value, as few studies using similar methodology have been published (Barros et al. 2004, Felipe et al. 2007, Andrade et al. 2008), its use as a control procedure seems adequate.

The primary flap shrinkage is a constant concern in root coverage procedures, either for recidivism of root surface exposure or graft exposure. This consideration is especially relevant to a non-vital allograft. In this context, Pini-Prato et al. (2005) introduced the concept of overcorrecting recession defects with the primary flap to enhance the predictability of root coverage. Nonetheless, that study did not evaluate the graft use, especially a non-vital allograft and a suitable position for it and selected smaller defects ($\geq 2$ mm). In addition, different positions for the stabilization of the gingival margin were adopted, varying between 1.5 and 2.5 mm from the CEJ. de Sanctis & Zucchelli (2007), suggested in a case-series study, a modification in the coronally advanced flap procedure for the treatment of isolated recession-type defects to compensate the soft tissue shrinkage. The coronal advancement of the flap to the CEJ was passively obtained and allowed the elimination of lip tension. However, in this case of overcorrect, is not easy to established 1 mm coronal for all cases, but this distance was considered suitable (Pini-Prato et al. 2005). It is important to be aware that slight variations may occur in the flap positioning, even in the present study. This fact can affect the results and could be seen in part as a limitation of the study. In addition, the satisfactory measure of overcompensation in the flap management needed to be confirmed for other studies. In this study, the percentage of root coverage was 88.37% for the TG with root coverage of 100% in four sites and 6585% for the CG with no case with complete root

*Table 1.* Clinical parameters (mean value ± SD) at baseline and 6 months – intra-group comparison

| Parameters | Control | | | Test | | |
|---|---|---|---|---|---|---|
| | Baseline | 6 months | *p*-value | Baseline | 6 months | *p*-value |
| PD (mm) | 1.80 ± 0.57 | 1.97 ± 0.32 | NS | 1.55 ± 0.46 | 1.37 ± 0.34 | NS |
| RCAL (mm) | 5.12 ± 0.59 | 3.11 ± 0.59 | <0.01* | 4.85 ± 0.62 | 1.78 ± 0.42 | <0.01* |
| GR (mm) | 3.32 ± 0.34 | 1.14 ± 0.30 | <0.01* | 3.30 ± 0.29 | 0.38 ± 0.25 | <0.01* |
| KT (mm) | 2.34 ± 1.23 | 3.27 ± 0.62 | <0.01* | 2.63 ± 1.03 | 3.71 ± 0.77 | <0.01* |
| TKT (mm) | 0.91 ± 0.30 | 1.36 ± 0.31 | <0.01* | 0.76 ± 0.28 | 1.28 ± 0.27 | <0.05* |
| GRA ($pix^2$) | 38048.66 ± 10920.76 | 20996.82 ± 5926.06 | <0.01* | 38919.46 ± 9238.05 | 11118.46 ± 6293.45 | <0.01* |

*Statistically significant difference at $p \leq 0.05$.
PD, probing depth; RCAL, relative clinical attachment level; GR, gingival recession height; KT, width of keratinized tissue; TKT, thickness of keratinized tissue; GRA, gingival recession area; mm, millimetre; $pix^2$, $pixel^2$; NS, not significant.

*Table 2.* Clinical parameters (mean values ± SD) at baseline and 6 months – inter-group comparison

| Parameters | Control Baseline | Test Baseline | *p*-value | Control 6 months | Test 6 months | *p*-value |
|---|---|---|---|---|---|---|
| PD (mm) | 1.80 ± 0.57 | 1.55 ± 0.46 | NS | 1.97 ± 0.32 | 1.37 ± 0.34 | <0.01* |
| RCAL (mm) | 5.12 ± 0.59 | 4.85 ± 0.62 | NS | 3.11 ± 0.59 | 1.78 ± 0.42 | <0.01* |
| GR (mm) | 3.32 ± 0.34 | 3.30 ± 0.29 | NS | 1.14 ± 0.30 | 0.38 ± 0.25 | <0.01* |
| KT (mm) | 2.34 ± 1.23 | 2.63 ± 1.03 | NS | 3.27 ± 0.62 | 3.71 ± 0.77 | NS |
| TKT (mm) | 0.91 ± 0.30 | 0.76 ± 0.28 | NS | 1.36 ± 0.31 | 1.28 ± 0.27 | NS |
| GRA ($pix^2$) | 38048.66 ± 10920.76 | 38919.46 ± 9238.05 | NS | 20996.82 ± 5926.06 | 11118.46 ± 6293.45 | <0.05* |

*Statistically significant difference at $p \leq 0.05$.
PD, probing depth; RCAL, relative clinical attachment level; GR, gingival recession height; KT, width of keratinized tissue; TKT, thickness of keratinized tissue; GRA, gingival recession area; mm, millimetre; $pix^2$, $pixel^2$; NS, not significant.

*Table 3.* Mean gains ± SD of clinical parameters between baseline and 6-month analysis

| | Parameters | | | | | |
|---|---|---|---|---|---|---|
| | PD (mm) | RCAL (mm) | GR (mm) | KT (mm) | TKT (mm) | GRA ($pix^2$) |
| Control | −0.17 ± 0.47 | 2.01 ± 0.55 | 2.18 ± 0.35 | −0.93 ± 0.67 | −0.45 ± 0.15 | 17051.84 ± 6089.22 |
| Test | 0.19 ± 0.53 | 3.07 ± 0.74 | 2.92 ± 0.37 | −1.07 ± 0.49 | −0.52 ± 0.19 | 27800.98 ± 7334.70 |
| *p*-value | 0.0191 | <0.0001* | 0.0031* | 0.1642 | 1 | <0.0001* |

*Statistically significant difference at $p \leq 0.05$.
PD, probing depth; RCAL, relative clinical attachment level; GR, gingival recession height; KT, width of keratinized tissue; TKT, thickness of keratinized tissue; GRA, gingival recession area; mm, millimetre; $pix^2$, $pixel^2$.

coverage. The results for the CG may be lower than reported in some studies, but the comparison is difficult because it is a different patient' population, different operator and large recessions. In addition, this result is in accordance with the mean root coverage with ADMG reported by Chambrone et al. (2010) in a recent systematic review and it is more consistent when considering large gingival recessions ($\geq 3$ mm). Moreover, the superiority shown for the TG was statistically significant for all parameters analysed with the exception of KT and TKT after 6 months. However, a more adhered fibrous tissue with lighter colour made it distinguishable from the alveolar mucosa after 6 months. It remains unknown exactly how an increase in the KT can occur in sites treated with ADMGs. Moreover, it is important to consider that the time required for additional gain in the amount of keratinized tissue is greater for the ADMG than for the SCTG (Novaes et al. 2001). Nonetheless, it is reasonable to suppose that the connective tissue from the alveolar mucosa may not have the inductive properties of keratinization attributed to gingival connective tissue (Karring et al. 1975). In this case, the part of the allograft in contact with the connective tissue from the alveolar mucosa may not develop a keratinized layer. Additional studies are needed to clarify the dynamics of the cellular healing process.

In both groups, a significant increase in the TKT was observed. The relevance of gingival thickness in periodontal cleft formation has described by Novaes et al. (1975) in a clinical and histopathologic study. Thus, it has been considered that a thin and delicate gingival phenotype is a relevant factor that increases the risk for gingival recession. Therefore, the increase in this clinical parameter provided by the ADMG, could aid to prevent future recessions in sites

with a thin periodontal phenotype (Paolantonio et al. 2002).

No aesthetic outcome index was adopted in this study because the incision design was the same for both groups. However, despite the incision design for both techniques comprise vertical releasing incision; these did not result in displeasing scars. Actually, these incisions were bevelled in such a way that the bone and periosteal tissue were not included in the superficial incisions, and thus did not participate to the healing process (de Sanctis & Zucchelli 2007).

A suitable nutrition to the allograft is indispensable; hence, the graft displacement 1 mm apical to the CEJ increases the bilaminar nutrition (Zucchelli et al. 2003) and may avoid spontaneous exposure due to the primary soft tissue shrinkage. In study, two cases of graft exposure were detected after 7 days in the CG. This undesired fact delays the healing process and, consequently, a satisfactory aesthetic result.

There was a statistically significant gain in the RCAL in the two groups and the TG was superior to the CG in this parameter after 6 months. A combination of long junctional epithelium and connective tissue attachment after the use of ADMGs for root coverage has been demonstrated histologically in humans by Cummings et al. (2005) and can be expected in this case. As in the GR, the TG was significantly superior to the CG for the GRA. The measurement of GRA through standardized photographs might represent a reproducible way to measure the area of the exposed root surface, thus this new parameter may be useful for the analysis of area of root coverage.

Both surgical techniques include the adjacent teeth in the flap design, but the variation in the clinical parameters was not assessed in this study. However, previous studies with this incision design reported that the techniques did not negatively affect the adjacent teeth (Barros et al. 2004, Felipe et al. 2007, Andrade et al. 2008).

In conclusion, in spite that both surgical procedures provided significant improvement in all parameters analysed, with the exception of PD, the test technique produced significantly greater mean defect coverage. In addition, the GRA, a new parameter adopted for the evaluation of the results, seems to be appropriate to assess root coverage.

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Address:
*Arthur B. Novaes Jr*
*School of Dentistry of Ribeirao Preto*
University of Sao Paulo
*Av. do Café, S/N*
*Ribeirão Preto*
*SP 14040-904*
*Brazil*
E-mail: novaesjr@forp.usp.br

**Clinical Relevance**

*Scientific rationale for the study*: The increasing aesthetic demands by patients are unquestionable and the treatment of gingival recessions is included in this context. This study compared, with a new parameter presented, two surgical techniques with ADMG to assess which procedure could provide better root coverage. The graft and flap position are the differences between the techniques.

*Principal findings*: At 6 months, the proposed technique was statistically better in all parameters except for the amount of keratinized tissue.

*Practical implications*: The new procedure was found to be more efficient for root coverage with ADMG.