Subpedicle Acellular Dermal Matrix Graft and Autogenous Connective Tissue Graft in the Treatment of Gingival Recessions: A Comparative 1-Year Clinical Study

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Background: Many surgical techniques have been proposed for the correction of dental root exposition. Among these, bilaminar techniques (BTs) have been reported as offering the best results in terms of root coverage (RC). However, BTs require a second surgical site to harvest the graft, with discomfort for the patient. The use of an acellular dermal matrix (ADM) avoids the need for a donor site. The aim of this study was to compare the clinical results of 2 BTs by autogenous connective tissue (CT) or ADM.

Methods: In 30 systemically healthy, non-smoking patients aged 34.5 ± 5.2 years, who showed no periodontal pockets >4 mm after a hygienic phase, a Miller’s class I or II gingival recession was treated for root coverage. All patients underwent a BT: in 15 patients, an autogenous connective tissue graft was employed (CT group); in the other 15 subjects, ADM was used as a subepithelial graft (ADM group). Prior to and 1 year after surgical treatment, the following clinical parameters were recorded: gingival recession (GR), probing depth (PD), clinical attachment level (CAL), width of keratinized tissue (KT), and gingival thickness (GT); the percentage of RC (%RC) was also calculated, and the data were statistically analyzed. The number of weeks needed to obtain complete healing with mature tissue appearance was also recorded.

Results: Both groups yielded significant improvements in terms of GR decrease, CAL and KT gain, and GT increase as compared to baseline values. The mean %RCs were 88.80 ± 11.65% and 83.33 ± 11.40% in the CT and ADM groups, respectively. Complete RC was observed in 46.6% of patients from the CT group, and 26.6% of the ADM group patients. No significant differences were observed between the two techniques for GR, CAL, and GT improvements; however, the CT group produced a significantly (P <0.01) greater increase in KT as compared to the ADM group. Complete healing of the surgical procedure was observed 6.20 ± 1.01 and 8.93 ± 1.33 weeks after suture removal in the CT and ADM groups, respectively (P <0.001).

Conclusions: The CT and ADM subepithelial grafts were similarly able to successfully treat gingival recession defects; however, the CT group obtained a significantly greater increase in KT, and showed a quicker complete healing. J Periodontol 2002;73:1299-1307.

KEY WORDS
Gingival recession/surgery; bilaminar technique; gingival recession/therapy; tooth root/surgery; matrix, acellular dermal.
age (RC); conversely, the free gingival graft technique offers a low degree of predictability in the correction of gingival recessions. Comparative studies have demonstrated that BTs show a significantly greater degree of predictability when the aim of the clinician is to obtain complete RC. The rationale of BTs is to enhance the degree of predictability of therapeutic results by increasing the blood supply to the grafted tissue in comparison to the free gingival flap: Langer and Langer suggested covering of the grafted tissue by a coronally replaced gingival flap; Raetzke introduced the envelope flap technique; whereas Nelson associated a laterally sliding flap or a bipapillary technique to the free connective tissue graft.

Currently, BTs are considered to be the surgical procedures offering the most predictable results when the maximum percentage of RC (%RC) represents the main goal. BTs make use of a graft from the palate to increase gingival dimensions, and therefore require a second surgical procedure to harvest the tissue from the donor area; this causes discomfort to the patient because of postsurgical pain and the risk of bleeding from the donor area. The use of a barrier membrane underneath a coronally sliding flap in a GTR procedure has been proposed in order to avoid the need for tissue drawing from the palate. However, it has been observed that although the degree of RC yielded by GTR is similar to BTs, the GTR procedure produces a lower increase in gingival thickness. In this regard, it should be noted that gingival thickness and phenotype probably play an important role in preventing the recurrence of tissue recession and therefore an increase of gingival thickness represents a desirable clinical result.

Recently, an acellular dermal matrix (ADM) has been reported to have a favorable clinical outcome in RC at gingival recession sites. ADM is a freeze-dried, cell-free, dermal matrix with a collagen and elastic fiber extracellular matrix; this allogenic material is human-skin derived, and further treated to remove the antigenic targets of mediated-immunity cells. Originally, ADM was introduced in plastic surgery for the treatment of full-thickness burn wounds. A periodontal plastic surgery procedure using ADM offers the advantage of avoiding the need for a palatal donor site, while offering to the clinician a tissue with a thickness similar to an autogenous connective graft.

The aim of the present study was to compare the results obtained by 2 BTs using CT or ADM grafts to achieve RC and an increase in the gingival thickness (GT) at a 1-year examination after surgical treatment. Furthermore, we investigated the time needed by each surgical technique to obtain a mature tissue appearance. The materials and methods section includes a detailed description of the study population, methodology, and clinical measurements.

**MATERIALS AND METHODS**

**Study Population and Design**

Thirty systemically-healthy patients, all Caucasian (11 males and 19 females) and aged between 29 and 51 (mean age: 34.5 ± 5.2), participated in the study. All patients had asked to be treated for esthetic reasons and/or dentine hypersensitivity by a root coverage surgical procedure. The subjects did not have probing depths (PDs) exceeding 4 mm in the whole dentition, were non-smoking and, at the beginning of the study, each displayed the presence of plaque and bleeding on probing in less than 20% of periodontal sites. All patients selected for the study had at least one gingival recession ≥ 3 mm that was classified as Miller’s class I or II and was considered as the experimental site, in the right side of the mouth for right-handed subjects, and in the left for left-handed patients. This characteristic was chosen in order to examine marginal tissues that could be exposed to the less traumatic forces of oral hygiene measures, yielding more comparable results. If the patient had more than one gingival recession, the more pronounced was chosen for the study. However, all the experimental sites did not present PD values exceeding 3 mm or clinically-appreciable gingival inflammation. Patients received accurate and repeated oral hygiene instructions and were highly motivated towards the maintenance of oral health. They were instructed to avoid a brushing technique which could cause damage to the marginal tissues and not to use a toothbrush with hard bristles or an abrasive toothpaste. These features were maintained and controlled for the entire experimental period.

After having signed their informed consent for participation in the study, each patient was randomly assigned into one of two experimental groups that were both treated for gingival recession by a BT consisting of a partial thickness coronally-positioned pedicle flap. This BT was performed either with an autogenous connective tissue graft from the palate (CT group, 15 patients), or with an ADM§ (ADM group, 15 patients). In all, 3 upper cuspids, 4 upper incisors, and 8 lower incisors were surgically treated in each experimental group.

**Clinical Measurements**

Clinical data were recorded twice, 1 week before the surgical treatment and at a 1-year examination. Full-mouth plaque score (FMPS) and full-mouth bleeding score (FMBS) were recorded as the % of tooth surfaces with the presence of supragingival plaque or bleeding after probing with a 20g controlled force probe. All measurements were made at the experi-

§ Alloderm, Life Cell Corp., Branchburg, NJ and Lifecore Biomedical, Inc., Chaska, MN.

† Vivacare TPS Probe, Vivadent, Schaan, Liechtenstein.
mental sites by a Williams probe\(^\dagger\) accurate to the nearest 0.5 mm.

Gingival recession (GR) was measured as the distance between the cemento-enamel junction (CEJ) and the most apical point of the gingival margin. PDs and clinical attachment levels (CALs) were measured as the distance from the bottom of the pocket to the most apical portion of the gingival margin and CEJ, respectively. The width of keratinized tissue (KT) was measured from the most apical point of the gingival margin to the mucogingival junction. All measurements were performed at the buccal surface of the teeth. The number of recession sites that had undergone complete coverage was recorded in each experimental group. A gingival recession was considered to be completely covered when the root surface was undetectable at the clinical examination.

Gingival thickness (GT) was determined at a mid-buccal location about 1 mm apical to the PD level with a #15 endodontic reamer. The reamer was inserted perpendicularly to the mucosal surface, through the soft tissue with light pressure until a hard surface was felt. The silicon disk stop was then placed in tight contact with the soft tissue surface and fixed by a drop of cyanoacrylic adhesive; after careful removal of the reamer, the penetration depth was measured with a calliper accurate to the nearest 0.1 mm.

**Surgical Procedures**

After induction of local anesthesia, the exposed root surfaces were carefully planed with curets and ultrasonic instruments. The root surfaces were not subjected to any chemical conditioning. The patients were treated as follows: a scalloped intrasulcular incision was made corresponding to the recession, extending to the line angles of both adjacent non-defect teeth. When needed, oblique corono-apical incisions were made, starting at the termination point of the intrasulcular incision, and extending into the alveolar mucosa. A partial thickness pedicle flap was raised by sharp dissection.

In the CT group (Fig. 1), the connective tissue graft was obtained from the palate, in the area corresponding to the bicuspids, by using a 2.5 mm distance, parallel blades scalpel.\(^\dagger\) Alternatively, in the ADM patients (Fig. 2), the ADM was hydrated in sterile saline for 10 minutes according to the manufacturer’s recommendations. The material was trimmed to cover the exposed root area, and extended about 3 mm on the bone surrounding the exposed root surface. The basement membrane side of the material was placed facing up towards the vestibule. In both experimental groups, the pedicle flaps were coronally positioned to cover as much of the autogenous connective graft in CT subjects and the acellular dermal matrix in ADM subjects as possible. A 5-0 silk suture secured the flaps to the grafts and simultaneously to the surface of the neighboring papillae.

All patients underwent the same postsurgical treatment, consisting of the administration of analgesics and the prescription of 0.12% chlorhexidine rinses twice daily for 3 weeks following the surgery. No periodontal dressing was placed. The sutures were removed 15 days after surgery. Home care instructions were given, specifying the use of cotton swabs with chlorhexidine 1% gel until healing had progressed sufficiently to allow gentle brushing and flossing. Professional prophylaxis was done weekly for the first month and at 3-month intervals up to 1 year.

**Healing Evaluation**

To evaluate the time needed by each experimental group to achieve complete healing of the surgically-treated area, the patients were asked to return to the Department of Periodontology of the University of Chieti every week after suture removal until the healing of the treated site was judged complete. The judgment of complete healing with mature tissue appearance was done by a periodontist with 15 years of clinical experience. The clinician was blinded regarding the surgical technique used for each patient, and is an author of the present experimental study. For each subject participating in the study, the number of weeks after suture removal that were needed to obtain a mature tissue appearance was recorded.

**Data Analysis**

A statistical package\(^\#\) was used to perform the data analysis. The balancing of experimental groups by age and gender was tested by the Mann-Whitney U test and \(\chi^2\) analysis, respectively. Descriptive statistics are expressed as means ± standard deviations (SD), while all the hypothesis testings were by non-parametric methods; %RC was calculated as: [(GR baseline – GR 1-year)/GR baseline] × 100.

Analysis of clinical data between the experimental groups was made comparing similar teeth from each group. The Mann-Whitney U test was used to evaluate the differences in the clinical parameters between the experimental groups at baseline and the 1-year examination. Wilcoxon’s test was used to assess the significance of changes of clinical parameters between baseline and 1-year evaluations within each experimental group.

Within each group, the difference in clinical parameters with time were also calculated by subtracting the value obtained at the 1-year examination from those from the beginning of the study for GR, PD, and CAL, and the inverse for KT and GT. The Mann-Whitney U test assessed the statistical significance of the differ-
ences between the experimental groups; the same analysis was used to evaluate the differences in the %RC obtained by the different techniques.

$\chi^2$ analysis was used to assess the statistical significance of differences in the number of gingival recessions undergoing complete coverage in each experimental group. The Mann-Whitney $U$ test was also used to test the difference between the healing time of the two experimental groups, as measured by the number of weeks needed to obtain a judgment of complete healing with mature tissues. A probability of $P < 0.05$ was accepted for rejection of the null hypothesis.

Figure 1.
CT group. A. Miller Class I recessions in the lower incisor area. B. A split-thickness flap is raised. C. Autogenous connective tissue graft is placed under the flap. D. Suture. E. The treated area 1 year after surgery.
RESULTS
The experimental groups were balanced by age ($P > 0.05$) and gender ($P > 0.05$). The clinical results obtained in the present study are summarized in Tables 1, 2, and shown in Figure 3.

The experimental groups did not significantly differ for FMPS and FMBS at either the presurgical or 1-year postsurgical evaluations. Hence, the experimental groups were homogeneous at baseline for marginal health parameters (Table 1). This marginal health condition was maintained throughout the study.

Similarly, and as reported in Table 2, at baseline, the clinical parameters relating to the defects to be treated did not show significant differences between the 2

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**Figure 2.**
ADM group. **A.** Miller Class I recessions in the lower incisor area. **B.** Split-thickness flap is raised. **C.** Acellular dermal matrix is placed on the root surfaces. **D.** The flap is sutured to cover the ADM graft. **E.** Clinical appearance 1 year after surgery.
groups. Conversely, within each group, all the clinical parameters had changed significantly at the 1-year examination, with the exception of PD. At this final examination, GR, PD, CAL, and GT did not show significant differences between the two treatments. Moreover, at this stage, KT was significantly greater in the CT group (Table 2).

Within each group, the differences in clinical parameters between the beginning of the study and the 1-year examination demonstrated an improvement of conditions, and they were similar for the 2 techniques in relation to the GR, PD, and CAL gains (Table 3). The KT increase was significantly greater in the CT group (Table 3). No significant difference was observed in the GT increase between the CT and ADM groups ($P > 0.05$; Table 3).

The %RC was 88.80 ± 11.65 for the CT group and 83.33 ± 11.40 for the ADM group. This clinical parameter did not show any significant difference ($P > 0.05$) between the 2 surgical techniques (Fig. 3). Complete RC (%RC = 100) was observed in 7 subjects (46.6%) from the CT group, and 4 patients (26.6%) from the ADM group, although this difference was not statistically significant ($P > 0.1$).

Finally, complete healing of the surgical procedure was observed 6.20 ± 1.01 and 8.93 ± 1.33 weeks after suture removal in the CT and ADM groups, respectively. This difference was statistically significant ($P < 0.001$).

### DISCUSSION

The main goal of this study was to compare the effectiveness of two BTs, that of a surgical treatment making use of an autogenous CT graft as compared to an ADM group. Our results show that both periodontal plastic surgical treatments were able to significantly improve the clinical parameters evaluated in this research from the baseline to the 1-year examination (Table 2). The only exception was seen for PD, which did not show significant changes at the 1-year examination in either group. This result was expected, because in our patients the baseline PD was compatible with a condition of gingival health, and the patient

Table 1.
Marginal Health Parameters (mean values ± SD) at Baseline and 1-Year Examinations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>CT Group Baseline</th>
<th>Difference 1 Year</th>
<th>ADM Group Baseline</th>
<th>Difference 1 Year</th>
<th>Between Group Difference Baseline 1 Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMPS</td>
<td>13.3 ± 2.2</td>
<td>N.S.</td>
<td>12.8 ± 3.0</td>
<td>12.9 ± 3.2</td>
<td>N.S.</td>
</tr>
<tr>
<td>FMBS</td>
<td>11.1 ± 2.5</td>
<td>N.S.</td>
<td>10.9 ± 2.9</td>
<td>11.5 ± 2.4</td>
<td>N.S.</td>
</tr>
</tbody>
</table>

Table 2.
Mean Values (± SD) of Clinical Parameters at Baseline and 1-Year Examinations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>CT Group Baseline</th>
<th>Difference 1 Year</th>
<th>ADM Group Baseline</th>
<th>Difference 1 Year</th>
<th>Between Group Difference Baseline 1 Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>GR</td>
<td>4.80 ± 1.14</td>
<td>$P &lt; 0.001$</td>
<td>0.53 ± 0.64</td>
<td>4.75 ± 1.20</td>
<td>$P &lt; 0.001$</td>
</tr>
<tr>
<td>PD</td>
<td>1.53 ± 0.51</td>
<td>N.S.</td>
<td>1.33 ± 0.61</td>
<td>1.46 ± 0.51</td>
<td>N.S.</td>
</tr>
<tr>
<td>CAL</td>
<td>6.33 ± 1.39</td>
<td>$P &lt; 0.001$</td>
<td>1.93 ± 0.79</td>
<td>6.26 ± 1.38</td>
<td>$P &lt; 0.001$</td>
</tr>
<tr>
<td>KT</td>
<td>1.80 ± 0.67</td>
<td>$P &lt; 0.001$</td>
<td>3.73 ± 1.22</td>
<td>1.53 ± 0.83</td>
<td>$P &lt; 0.02$</td>
</tr>
<tr>
<td>GT</td>
<td>0.81 ± 0.30</td>
<td>$P &lt; 0.001$</td>
<td>1.96 ± 0.42</td>
<td>0.80 ± 0.36</td>
<td>$P &lt; 0.001$</td>
</tr>
</tbody>
</table>

Figure 3.
Percentages of root coverage following the surgical treatment (mean ± SD).
in comparison with other data from the literature,23 65.9% (ADM). This result may appear less favorable
subepithelial grafts by Aichelmann-Reidy et al.24 These significant differences were reported between CT and ADM
ments (CT: 96.2%; ADM: 95.8%). Similarly, no significant differences were observed in other studies,23,24 which have reported
the study. Hence, our results might differ from those in the literature for CT subepithelial grafts.

table 3.
Mean Changes (± SD) of Clinical Parameters Between Baseline and 1-Year Examinations Within Experimental Groups

<table>
<thead>
<tr>
<th>Group</th>
<th>GR</th>
<th>PD</th>
<th>CAL</th>
<th>KT</th>
<th>GT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT</td>
<td>4.20 ± 0.86</td>
<td>0.20 ± 0.56</td>
<td>4.40 ± 1.05</td>
<td>1.93 ± 1.03</td>
<td>1.14 ± 0.44</td>
</tr>
<tr>
<td>ADM</td>
<td>4.00 ± 1.06</td>
<td>0.13 ± 0.51</td>
<td>4.13 ± 1.18</td>
<td>0.53 ± 0.51</td>
<td>1.03 ± 0.34</td>
</tr>
<tr>
<td>Difference</td>
<td>N.S.</td>
<td>N.S.</td>
<td>N.S.</td>
<td>P &lt;0.01</td>
<td>N.S.</td>
</tr>
</tbody>
</table>

selection criteria expressly excluded experimental sites with PDs exceeding 3 mm.
The GR, CAL, and GT improvements between the baseline and the 1-year examinations were similar in the CT and ADM groups (Table 3). Similarly, a comparable %RC was obtained by the 2 surgical techniques (CT: 88.80%; ADM: 83.33%; P >0.05). These data are similar to those from other studies,23,24 in a comparative study between CT and ADM grafts used in a BT, Harris23 reported comparable %RCs from both treatments (CT: 96.2%; ADM: 95.8%). Similarly, no significant differences were reported between CT and ADM subepithelial grafts by Aichelmann-Reidy et al.24 These authors observed mean %RCs of 74.1% (CT) and 65.9% (ADM). This result may appear less favorable in comparison with other data from the literature,23 although, if two patients who experienced complications are dropped from the data set, the %RCs obtained are comparable with others in the literature23 and with the present study. Case report studies25-31 have also shown %RCs that are very similar to those reported in the literature for CT subepithelial grafts.

In the present study, the CT group achieved a complete resolution of the gingival recession defects (%RC = 100) in 46.6% of cases, whereas only 26.6% of the recessions from the ADM group were completely covered. Even though the former value is almost 2-fold the latter, this difference was not statistically significant (P >0.1); this is probably due to the lack of statistical power, because of the number of subjects included in the study. Hence, our results might differ from those obtained in other studies,23,24 which have reported similar complete RCs between CT- and ADM-treated gingival recession.

Our data show that the CT group experienced a significantly (P <0.01) greater increase in KT, as compared to the ADM group (Table 2). A similar result was obtained by Harris23 in a clinical trial comparing CT and ADM grafts in association with a coronally positioned pedicle flap. In a comparative study on the effectiveness of ADM to increase attached gingiva, Wei et al.32 reported that ADM free grafts produced a lesser extent of attached tissue in comparison with CT free grafts. These authors ascribed this result to the considerable shrinkage of ADM during the healing phase. ADM is a non-vital connective tissue; it is also conceivable that viability of the connective tissue may be essential for a graft to fully express the capability of inducing keratinization of the overlying epithelium. However, other authors do not agree with this hypothesis.33,34 ADM acts as a scaffold for cells from the surrounding tissues, and the original non-vital graft is degraded and completely replaced by the host cells.32 Considering that only the cells from the periodontal ligament and gingival connective tissue are capable of inducing the development of a keratinized epithelium,35 the inductive properties of ADM grafts will depend on the percentage of colonization of the non-vital graft by the host cells deriving from these tissues capable of inducing keratinization. Conversely, CT grafts are entirely made up of tissue that is able to induce keratinization of the epithelium.

An interesting result from our study is that GT did not differ between the two groups at the 1-year examination (Table 2), and that the change in GT was similar in both experimental groups (Table 3). This observation suggests that, when the aim of the clinician is to improve GT, the use of ADM grafts yields similar results, when compared to that of CT grafts, with the advantage of avoiding a second surgical site for tissue drawing. This is very important because the GTR technique, used for RC purposes, does not require a second palatal surgical site. However, although this technique offers similar results in terms of RC, it has been shown not to be able to increase GT in a similar way to the subepithelial CT grafts.20 A good capability of ADM in increasing GT was also noted, although not measured, by Henderson et al.26 Since marginal tissue thickness may be a more critical determinant of future recession than the width of the keratinized gingiva, this clinical property is of paramount importance.26 In this connection, it is important to emphasize that a relevant factor that increases the risk for gingival recession is a thin and delicate gingival phenotype.21,22 In the presence of thin marginal tissues, injuries from inflammatory reactions or traumatic tooth brushing may easily produce gingival recession. Therefore, the aim of a mucogingival surgical procedure should not only be to increase the width of the keratinized tissue, but also its thickness.

A further aim of the present study was to investigate the time needed to obtain a mature tissue appearance using a CT or an ADM graft placed underneath a pedicle flap. Our results show that complete healing is obtained after a significantly shorter period using
CT (6.20 and 8.93 weeks for CT and ADM, respectively). This observation may be explained by the fact that ADM is a non-vital material which needs to be resorbed and substituted by the host tissues. This biological process may thus require an additional period of time, which affects the healing process duration. This has been already noted, although not measured, by Tai and Wei et al. In the latter study, patients treated by ADM were about 2 weeks slower in obtaining complete tissue healing. These data are thus in agreement with our results.

In conclusion, a BT making use of ADM as a subepithelial graft for RC is capable of achieving clinical results comparable to those obtainable with a CT graft. ADM also produces marginal tissue characterized by a similar thickness. Furthermore, the ADM technique offers the advantage of avoiding a second surgical site with a consistent reduction of a patient’s morbidity and the surgical risks. However, when compared with CT grafts, ADM produces a lower increase in KT. Therefore, it should not represent the technique of choice when a maximum increase in KT is the goal of the surgical procedure. Further studies are needed to clarify this clinical aspect.

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