A 2-Year Follow-Up of Root Coverage Using Subpedicle Acellular Dermal Matrix Allografts and Subepithelial Connective Tissue Autografts

A. Hirsch,* M. Goldstein,* J. Goultschin,* B.D. Boyan,†‡ and Z. Schwartz*†‡

Background: Coverage of roots exposed by gingival recession is one of the main objectives of periodontal reconstructive surgery. A large variety of mucogingival grafting procedures are available. However, the long-term effectiveness of this procedure is still not clear. This study compared the effectiveness of subpedicle acellular dermal matrix allografts with subepithelial connective tissue autografts in achieving root coverage 2 years postoperatively.

Methods: One hundred one (101) patients were treated with dermal matrix allografts (mean age, 28.4 ± 0.7 years; mean recession, 4.2 mm) and 65 patients treated with connective tissue graft (mean age, 30.1 ± 1.4 years; mean recession, 4.9 mm). All patients underwent full periodontal evaluation and presurgical preparation, including oral hygiene instruction and scaling and root planing. The exposed roots were thoroughly planed and covered by a graft without any further root treatment or conditioning. There were no differences in the average age, time of follow-up, or gender between the two groups. Patients were evaluated periodically between 1 and 2 years. Residual recession and defect coverage were assessed.

Results: Mean residual root recession after root coverage with acellular dermal matrix allograft was 0.2 ± 0.04 mm, with defect coverage of 95.9% ± 0.9%. Frequency of defect coverage was 82.2%. Root coverage was 98.8% ± 0.2%, resulting in a frequency of root coverage of 100%. Gain in keratinized gingiva was 2.2 ± 0.04 mm and attachment gain was 4.5 ± 0.1 mm per patient. Connective tissue autografts resulted in mean residual root recession of 0.1 ± 0.04 mm, with percent defect coverage of 97.8% ± 0.6% and frequency of defect coverage of 95.4%. Root coverage was 99.1% ± 0.2%, and frequency of root coverage was 100%. Gain in keratinized gingiva was 3.0 ± 0.1 mm and attachment gain was 5.3 ± 0.2 mm per patient. No significant differences in final recession and root coverage between the two treatment methods were found. However, autografts resulted in significant increases in defect coverage, keratinized gingival gain, attachment gain, and residual probing depth. The clinical results were stable for the 2-year follow-up period.

Conclusions: These results indicate that coverage of root by subpedicle acellular dermal matrix allografts or subepithelial connective tissue autografts is a very predictable procedure which is stable for 2 years postoperatively. However, subepithelial connective tissue autografts resulted in significant increases in defect coverage, keratinized gingival gain, attachment gain, and residual probing depth. J Periodontol 2005;76:1323-1328.

KEY WORDS
Follow-up studies; gingival recession/surgery; gingival recession/therapy; grafts, connective tissue; grafts, dermal; grafts, gingival; grafts, subepithelial; grafts, subpedicle; periodontal attachment; periodontal diseases/surgery; tooth root.

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Although gingival recession seldom results in tooth loss, marginal tissue recession is associated with thermal and tactile sensitivity, esthetic complaints, and a tendency toward root caries.1-4 Gingival recession may be due to several etiologic factors including periodontal disease,1,2 mechanical forces such as faulty toothbrushing,3 tooth malposition, and frenum pull,4,5 to mention just a few. Gingival recession is frequently accompanied by a very narrow strip of keratinized mucosa. However, minimal amounts of keratinized gingiva have been demonstrated to be compatible with a healthy periodontal condition, provided that adequate plaque control is performed.6,7 Therefore, coverage of exposed root surfaces is performed not to increase keratinized epithelium but to ameliorate the patient’s esthetic troubles, dentinal hypersensitivity, or root caries.

A variety of highly predictable and esthetically acceptable mucogingival grafting procedures exists for treating exposed roots, whether intact,8 carious, or restored.9 One of the problems with root coverage grafting is the limited supply of donor connective tissue. Multiple sites often need grafting, requiring more than one surgical procedure. The palate is the usual source for connective tissue grafts and there can be significant postoperative morbidity, particularly when large grafts are needed.10

A commercially available acellular dermal matrix allograft (ADMA)§ has been introduced as a substitute for connective tissue in root coverage procedures. The epithelium has been removed from the graft, but the basement membrane has been preserved to facilitate epithelial migration when an overlying flap does not cover the material.10 A specially designed process prevents viral transmission or antigenicity by removing all cells. Thus, the material consists of extracellular matrix underlying connective tissue and the original configuration of the vascular supply, which is conducive to revascularization.11

ADMA has been compared to connective tissue grafts (CTG) in root coverage procedures. Short-term results are esthetically similar and acceptable as well as achieving a similar extent of root coverage.12 At 12 months postoperatively, ADMA results in a similar extent of coverage as CTG, but CTG results in a significantly greater gain of keratinized mucosa.13 A recent report indicates that after 48 to 49 months, only 32% of the cases treated with ADMA improved or remained stable with time.14 The purpose of the present study was to compare the long-term (2 years) effectiveness and predictability of ADMA and CTG in the treatment of relatively severe recessions.

**MATERIALS AND METHODS**

The study was a retrospective study and, as such, did not require approval by the Institutional Review Board.

### Table 1.

**Patient Profile**

<table>
<thead>
<tr>
<th></th>
<th>Connective Tissue Graft</th>
<th>ADMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>30.1 ± 1.4</td>
<td>28.4 ± 0.7</td>
</tr>
<tr>
<td>Male (N)</td>
<td>22</td>
<td>37</td>
</tr>
<tr>
<td>Female (N)</td>
<td>43</td>
<td>64</td>
</tr>
<tr>
<td>Follow-up (months)</td>
<td>25.4 ± 2.3</td>
<td>24.0 ± 0.5</td>
</tr>
<tr>
<td>Smokers (N)</td>
<td>32</td>
<td>48</td>
</tr>
<tr>
<td>Patients (N)</td>
<td>65</td>
<td>101</td>
</tr>
</tbody>
</table>

### ADMA Patients

The ADMA group consisted of 101 patients (37 males and 64 females, mean age 28.4 ± 0.7 years). These patients were treated at the periodontics clinic of the Hebrew University-Hadassah School of Dental Medicine in Jerusalem and private offices. The treatment was done by experienced periodontists who used this method frequently in their practice. The time of follow-up was 24 ± 0.5 months. All patients were otherwise healthy. Forty-eight of the patients were smokers (Table 1).

Miller’s Class I and II gingival recessions were treated for root coverage. The initial recession defect was 4.2 ± 0.1 mm. All patients underwent full periodontal evaluation and presurgical preparation, including oral hygiene instruction and scaling and root planing. The exposed root surfaces were planed using curets and flushed with water. No root conditioning was done. A coronally repositioned flap procedure was performed in all cases. The flaps were split about 3 mm from the osseous crest to facilitate coronal positioning. An effort was made to completely cover the ADMA grafts. The papillae mesial and distal to the recession defects were deepithelialized.

The grafts were fixed by means of 4/0 resorbable sutures and the flaps coronally repositioned by means of sling sutures, where total coverage with the ADMA grafts was the primary goal. A periodontal dressing was used to cover the surgical wound. Amoxicillin (500 mg t.i.d.) and ibuprofen (400 mg × 2) were prescribed. Chlorhexidine gluconate mouthrinses (0.2% b.i.d.) were also prescribed. Sutures were removed after 10 days in most cases. Follow-up visits were every 2 weeks for 6 weeks and then every 3 months for 2 years at which point measurements were taken.

### Connective Tissue Patients

A second group of 65 patients (22 males and 43 females) with a mean age of 30.1 ± 1.4 years (Table 1) was treated using connective tissue grafts. The treatment was done

§ Alloderm, Life Cell, The Woodlands, TX.
by experienced periodontists, who used this method frequently in their practice. Miller’s Class I and II gingival recessions were treated for root coverage. This group had similar recessions although slightly deeper (4.9 mm versus 4.2 in the ADMA group) (Table 2). The subepithelial connective tissue graft procedure was a modification of the method described in detail by Langer and Langer. A connective tissue graft was obtained from the palate and placed under a full-thickness flap with mesial and distal vertical releasing incisions of the recipient site. The flap was then positioned coronally over the graft. Sutures were used to hold the flap in position. A periodontal dressing was used to cover the surgical wound. Amoxicillin (500 mg t.i.d.) and ibuprofen (400 mg × 2) were prescribed. Chlorhexidine gluconate mouthrinses (0.2% b.i.d.) were also prescribed. Sutures were removed after 10 days in most cases. Follow-up visits were held every 2 weeks for 6 weeks and then every 3 months for 2 years at which point measurements were taken.

**Statistical Analysis**

Greenwell et al. proposed a data analysis method to determine predictable root coverage using the average root size. We followed this approach, using root coverage as a parameter to obtain information about the size of the residual recession defect. The statistical significance was determined using Bonferroni’s modification of Student t test. P values of ≤0.05 were considered significant.

**RESULTS**

**Case 1: AMDA**

A 38-year-old woman presented with gingival recessions of 4 and 5 mm, and width of keratinized gingiva of 2 and 3 mm, on teeth #11 and #12, respectively (Fig. 1A). A full-thickness flap was elevated (Fig. 1B). An acellular dermal matrix allograft was placed to cover the exposed roots and was stabilized by sutures. Forty-two month postoperative photograph shows complete defect coverage.

<p>| Table 2. Effectiveness and Predictability of Root Coverage by Treatment |
|---------------------------|-----------------------------|-----------------------------|
| <strong>Recession (mm)</strong> | <strong>Initial Defect Mean (SEM)</strong> | <strong>Final Defect Mean (SEM)</strong> | <strong>Defect Coverage Mean (SEM)</strong> | <strong>Effectiveness % Defect Coverage Mean (SEM)</strong> | <strong>Predictability Frequency ≥90% Defect Coverage Frequency</strong> | <strong>Effectiveness % Root Coverage Mean (SEM)</strong> | <strong>Predictability Frequency ≥90% Root Coverage Frequency</strong> |</p>
<table>
<thead>
<tr>
<th>Treatment</th>
<th>ADMA</th>
<th>CTG</th>
<th>ADMA</th>
<th>CTG</th>
<th>ADMA</th>
<th>CTG</th>
<th>ADMA</th>
<th>CTG</th>
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</thead>
<tbody>
<tr>
<td>Initial Defect</td>
<td>4.2</td>
<td>4.9</td>
<td>(0.1)</td>
<td>(0.2)*</td>
<td>0.2</td>
<td>0.1</td>
<td>(0.04)</td>
<td>(0.04)</td>
</tr>
<tr>
<td>Final Defect</td>
<td>0.2</td>
<td>0.1</td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>4.0</td>
<td>4.8</td>
<td>(0.1)</td>
<td>(0.2)*</td>
</tr>
<tr>
<td>Defect Coverage</td>
<td>4.0</td>
<td>4.8</td>
<td>(0.1)</td>
<td>(0.2)*</td>
<td>95.9</td>
<td>97.8</td>
<td>(0.9)</td>
<td>(0.6)*</td>
</tr>
<tr>
<td>Effectiveness % Defect Coverage</td>
<td>95.9</td>
<td>97.8</td>
<td>(0.9)</td>
<td>(0.6)*</td>
<td>83 of 101</td>
<td>62 of 65</td>
<td>82.2%</td>
<td>95.4%</td>
</tr>
<tr>
<td>Predictability Frequency ≥90% Defect Coverage</td>
<td>83 of 101</td>
<td>62 of 65</td>
<td>82.2%</td>
<td>95.4%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
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</tbody>
</table>

* Significant difference, CTG versus ADMA.
Methods for Root Coverage

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exposed roots and some of the enamel, and was stabilized by sutures (Fig. 1C). The full-thickness flap was then repositioned coronally, completely covering the graft. Sutures were used to hold the flap in position. The 24-month postoperative photograph (Fig. 1D) shows complete defect coverage on the treated teeth.

Case 2: CTG
A 32-year-old woman presented with longstanding gingival recession on the labial aspect of teeth #6 and #5. The gingival recession was 4 mm on each tooth, and the width of the keratinized gingiva was 3 mm and 2 mm, respectively (Fig. 2A). A full-thickness flap was elevated (Fig. 2B). A connective tissue graft that was harvested from the palate was placed to cover the exposed roots and some of the enamel and was stabilized by sutures (Fig. 3C). The full-thickness flap was then repositioned coronally, completely covering the graft. Sutures were used to hold the flap in position. The 25-month postoperative photograph shows a complete defect coverage on the treated teeth (Fig. 2D).

In both cases, full coverage of the recession was found that was stable for 2 years.

Clinical Study
No differences in the average age, time of follow-up, or number of males and females were found between the two groups of patients (Table 1). The mean final root recession after root coverage with ADMA in 101 patients was $0.2 \pm 0.04$ mm, with defect coverage of $95.9\% \pm 0.9\%$ (Tables 2 and 3). The frequency of defect coverage was $82.2\%$. Root coverage was $98.8\% \pm 0.2\%$, resulting in a frequency of root coverage of $100\%$. The gain in keratinized gingiva was $2.2 \pm 0.04$ mm and the attachment gain was $4.5 \pm 0.1$ mm per patient. The mean residual root recession remaining after root coverage with CTG in 65 patients was $0.1 \pm 0.04$ mm, with percent defect coverage of $97.8\% \pm 0.6\%$. The frequency of defect coverage was $95.4\%$. Root coverage was $99.1\% \pm 0.2\%$, and the frequency of root coverage was $100\%$. The gain in keratinized gingiva was $3.0 \pm 0.1$ mm and the attachment gain was $5.3 \pm 0.2$ per patient (Table 2). There were no significant differences in final recession and root coverage between treatments. However, treatment with CTG showed significant increases in defect coverage, keratinized gingival gain, attachment gain and residual probing depth (Tables 2 and 3). There were similar results when the two-treatment modality was examined per tooth (comparison of 262 versus 169 teeth) (Table 3). Non-smokers and smokers also showed similar results when treated with ADMA (Table 4) or CTG (data not shown). The clinical results were stable for the 2-year follow-up period. No further recession or recurrent caries were observed during the follow-up period.

**DISCUSSION**

The results presented here indicate that defect coverage and defect elimination are extremely predictable and sustained over a 2-year period when ADMA is used as a graft material. However, increased keratinized epithelia over the long healing periods required for ADMA were not as achievable as with CTG, as noted previously.\textsuperscript{15,16} Despite this shortcoming, the use of ADMA precludes the need of a second surgical site, thus avoiding postoperative discomfort and risks such as bleeding, although the gain in keratinized gingiva and attachment level is significantly greater in a CTG group.

A recent publication by Harris\textsuperscript{17} deals with a short-term (12 to 13 weeks) and long-term (48 to 49 months) comparison of root coverage with ADMA and a subepithelial graft. His results concur with ours in the short term but dif-

![Figure 2](image-url)
It was very interesting that similar results were found when the data were calculated per patient and per tooth. These results may indicate that in both methods, similar results will be achieved if the treatment is done for coverage of single or multiple teeth.

One of main differences between CTG and ADMA is that increased keratinized epithelia over the long healing periods required for ADMA were not as achievable as with CTG. The reason for this is not clear. However, based on the study by Wei et al.,20 which compared healing histologically after root coverage with both methods, it appears that ADMA lacks the ability to induce the “correct” epithelial/connective tissue interface to produce keratinized tissue. The results of the present study also indicate that smoking did not significantly affect the ability of either treatment modality to provide root coverage. The two treatment groups presented with statistically different initial mean recession values. We think these differences did not clinically influence the results of root coverage by the two methods.

CONCLUSION
Use of both ADMA and CTG produced excellent and similar results in the short and long term (2 years). The main difference was the amount of keratinized gingiva and attachment level that could be achieved, being significantly greater in the CTG group.

REFERENCES

Table 3.
Summary of Results Per Site and Per Patient (mean ± SEM)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Calculation per</th>
<th>Initial Recession (mm)</th>
<th>Final Recession (mm)</th>
<th>Defect Coverage (%)</th>
<th>Root Coverage (%)</th>
<th>Gain in Keratinized Gingiva (mm)</th>
<th>Follow-Up Gain (mm)</th>
<th>Attachment Gain (mm)</th>
<th>Residual Probing Depth (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADMA</td>
<td>Patients (N = 101) 4.2 ± 0.1 0.25 ± 0.04 95.88 ± 0.85 98.80 ± 0.24 2.21 ± 0.04 23.97 ± 0.45 4.53 ± 0.10 0.71 ± 0.07</td>
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<td></td>
<td>Teeth (N = 262) 3.6 ± 0.1 0.25 ± 0.04 94.96 ± 1.03 98.77 ± 0.24 1.94 ± 0.07 23.97 ± 0.45 3.80 ± 0.10 0.94 ± 0.04</td>
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<tr>
<td>CTG</td>
<td>Patients (N = 65) 4.9 ± 0.2 0.13 ± 0.04 97.78 ± 0.60 99.10 ± 0.24 2.98 ± 0.14 25.40 ± 2.34 5.27 ± 0.18 1.10 ± 0.04</td>
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<tr>
<td></td>
<td>Teeth (N = 169) 4.3 ± 0.1 0.07 ± 0.02 94.8 ± 0.36 98.48 ± 0.12 2.44 ± 0.12 25.40 ± 2.34 4.94 ± 0.13 1.07 ± 0.02</td>
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Significant difference, CTG versus ADMA: *P < 0.05; †P < 0.001; ‡P < 0.01.

Table 4.
Summary of Results of Smoker Versus Non-Smoker ADMA Patients (mean ± SEM)

<table>
<thead>
<tr>
<th>Smokers</th>
<th>Patients (N)</th>
<th>Initial Recession (mm)</th>
<th>Final Recession (mm)</th>
<th>Gain in Keratinized Gingiva (mm)</th>
<th>Follow-Up Gain (mm)</th>
<th>Attachment Gain (mm)</th>
<th>Probing Depth (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td>4.2 ± 0.08 0.17 ± 0.04 2.10 ± 0.07 23.02 ± 0.50 4.45 ± 0.12</td>
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<tr>
<td>Non-smokers</td>
<td>52</td>
<td>4.2 ± 0.07 0.19 ± 0.04 2.27 ± 0.06 24.90 ± 0.43 4.51 ± 0.10</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

* Significant difference, smoker versus non-smoker, P < 0.01.


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Accepted for publication January 10, 2005.