Predictable correction of gingival recession defects remains a challenge for clinical periodontics. Several techniques developed over the years, including the laterally positioned pedicle graft, coronally advanced flap, free gingival graft, and subepithelial connective tissue graft, have yielded promising results.1–5 These techniques do have drawbacks, such as the need for a second surgical site, morbidity linked with harvesting donor grafts, post-surgical bleeding, patient discomfort, poor color match between donor tissue and recipient site, limited quantity of donor tissue, and frequent need for multiple procedures to achieve optimal results. In addition, the type of healing observed following these procedures is usually a long junctional epithelium with a minimal amount of new connective tissue attachment.6,7 Investigators have reported successful root coverage using surgical techniques based on the principles of guided tissue regeneration (GTR).8–14 They employed a variety of nonabsorbable (eg, expanded polytetrafluoroethylene [e-PTFE])

Use of Bone Grafts for the Enhancement of a GTR-Based Root Coverage Procedure: A Pilot Case Study

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The use of guided tissue regeneration (GTR) procedures for the treatment of gingival recession has shown encouraging results and is gaining clinical acceptance. However, attaining space maintenance beneath the membrane remains a problem for clinicians. Hence, the purpose of this pilot case study was to evaluate the effect of adjunctive demineralized freeze-dried bone allograft (DFDBA) placement during collagen membrane GTR-based root coverage procedures. Five patients with Miller Class I or II defects were treated with a combination of DFDBA and collagen membrane. Clinical parameters monitored include recession depth, probing attachment level, probing depth, width of keratinized gingiva, and recession width. Measurements were taken at baseline and 6 months. A statistically significant reduction in recession depth (3.1 ± 0.7 mm) was observed at 6 months, representing 93.4% total attainable root coverage. A significant reduction of recession width (3.5 ± 1.2 mm) after 6 months was also noted. Clinically, a statistically significant mean gain of 3.3 ± 0.6 mm in clinical attachment and 0.8 ± 0.9 mm in keratinized gingiva were obtained at 6 months. No statistically significant difference was found in probing depth between baseline and 6 months postoperative. Plaque and gingival indices remained low and showed no statistically significant change throughout the study period. Results from this pilot case study indicate that use of DFDBA during collagen membrane GTR-based root coverage could be beneficial. (Int J Periodontics Restorative Dent 2002;22:118–127.)

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and absorbable (eg, collagen, polylactide, or polyglycolide polymer) occlusive membranes.\textsuperscript{10–13} GTR-based techniques yield results similar to those achieved by traditional root coverage procedures.\textsuperscript{15–18} GTR-based root coverage, however, offers the additional potential benefit of new attachment formation (bone, cementum, periodontal ligament, and connective tissue) along the previously denuded root surface.\textsuperscript{19} Furthermore, it offers an unlimited supply of materials and eliminates the need for a second surgical site. When a nonabsorbable barrier membrane is used, a second surgical procedure is needed to remove it, which may jeopardize healing and clinical outcomes. Therefore, absorbable barrier membranes are generally preferred. Collagen is a natural material that is well-tolerated by the host tissue. It is physiologically absorbable and it behaves similarly to subepithelial connective tissue grafts by providing a collagenous scaffold for tissue repair. It may secondarily augment the volume of gingival tissues following in vivo expansion, enzyme degradation, and eventual replacement by the surrounding connective tissue.\textsuperscript{20} The chemotactic property of the material encourages host connective tissue and epithelial cells to attach and migrate over its surface. It may secondarily augment the volume of gingival tissues following in vivo expansion, enzyme degradation, and eventual replacement by the surrounding connective tissue.\textsuperscript{20} The chemotactic property of the material encourages host connective tissue and epithelial cells to attach and migrate over its surface. This may reduce the incidence of membrane exposure and bacterial contamination that often inhibits tissue regeneration.\textsuperscript{21} Because it is hemostatic, collagen may promote initial clot formation and stability that is essential for wound healing.\textsuperscript{22} The authors have shown successful root coverage using collagen as a graft material after 6 months of healing.\textsuperscript{12,23,24} Others found mean root coverage of 82.2\% after 2 years using collagen membranes.\textsuperscript{25} The creation and maintenance of a space between the root surface and the overlying GTR barrier is considered critical to the success of all GTR procedures, including those aimed at achieving root coverage.\textsuperscript{26–28} This space is believed necessary to provide a channel for the migration of progenitor cells toward and onto the detoxified root surface, where differentiation of cementoblasts and formation of new cementum and periodontal ligament are desired. Unfortunately, space preservation in recession defects is often difficult to achieve, as the morphology of the dehiscence tends to allow collapse of the membrane against the root surface. A variety of techniques aimed at creating and maintaining space along dehisced or exposed root surfaces have been tried. These methods include grinding the root surface to a concave shape, bending or everting the membrane with sutures,\textsuperscript{29} injecting a thick film of fibrin-fibronectin sealant between the root surface and the membrane,\textsuperscript{8–10} and using titanium-reinforced e-PTFE membranes.\textsuperscript{30} Allografts have been used successfully in periodontics since the early 1970s, primarily to treat intrabony periodontal defects, with more than 60\% of intrabony defects healing with greater than 50\% bone fill.\textsuperscript{31–33} Demineralized freeze-dried bone allograft (DFDBA) is the most commonly used autograft material today. DFDBA has osteoinductive activity\textsuperscript{31,34} and the ability to create and maintain space; therefore, it may be an ideal material to use with GTR-based root coverage procedures. Recently, Duval et al\textsuperscript{35} reported successful root coverage using polylactic acid barriers with or without DFDBA. They reported a trend toward better results in the DFDBA group; however, they found no statistical difference between groups because of inadequate power. There is only limited information available concerning the use of a combination of collagen membranes and DFDBA to treat human gingival recession defects. Therefore, it was the purpose of this pilot case study to determine the feasibility of using DFDBA as an adjunct to collagen membranes in GTR-based root coverage procedures.

**Method and materials**

**Subjects**

Five systemically healthy patients with gingival recession defects measuring ≥ 3 mm (three men and two women, mean age 42.8 years) were selected from the patient pool of the graduate periodontics clinic at the University of Michigan School of Dentistry. All subjects met the following inclusion criteria: (1) one facial Miller Class I or II\textsuperscript{28} recession defect measuring ≥ 3.0 mm on a nonmolar tooth; (2) tissue thickness estimated to be ≥ 0.5 mm at a level
3 mm apical to the free gingival margin; (3) radiographic evidence of sufficient interdental bone height (≤2 mm between crestal bone and cementoenamel junction [CEJ]); and (4) surgery to repair recession defect clinically indicated or requested by the patient. Each participant received initial therapy consisting of oral hygiene instruction, scaling and root planing, coronal polishing, and occlusal adjustment as needed prior to entry into the study. Patients were excluded from the study for any of the following reasons: (1) potential medical complications; (2) known allergy to bovine products; (3) history of anaphylactoid reaction; (4) pregnant or attempting to become pregnant; (5) evidence of clinically significant (as defined by the investigators) renal, hepatic, cardiac, endocrine, hematologic, autoimmune, or any systemic disease that may make interpretation of the protocol or results difficult; (6) previously considered uncooperative; (7) unable to provide informed consent; or (8) participated in another clinical trial using an investigational new drug or device within 30 days of entrance into this study. Oral and written informed consent was obtained from each participant prior to initiation of the study. All patients agreed to have one recession defect treated. The study protocol was approved by the University of Michigan institutional review board concerning human subject research.

**Clinical measurements**

Clinical data were collected at each visit and included preoperative periapical radiographs, color photographs at 1:1 magnification, periodontal indices, and charting of the area. All clinical measures were made to the nearest 0.5 mm with a standard University of North Carolina manual probe. Prior to the study, the examiner was calibrated to reduce intraexaminer error (kappa > .75).

At baseline and postsurgery at 1 week, 2 weeks, 4 weeks, 3 months, and 6 months, Plaque Index36 and modified gingival index37 were recorded for each subject. In addition, at baseline and 6 months postsurgical, the following clinical measurements were recorded: recession depth (RD), recession width (RW), width of keratinized gingiva (KG), clinical attachment level (CAL), and sulcular probing depth (PD). RD and CAL were recorded relative to the CEJ. RD was measured at the midfacial aspect of the tooth, from CEJ to free gingival margin. RW was measured 1 mm apical to the CEJ. KG was determined by subtracting RD from the CEJ-to–mucogingival junction (MGJ) measurement. At 6 months posttreatment, the percentage of root coverage was calculated.

**Surgical protocol**

One surgeon performed all surgeries (Fig 1). Recession sites were prepared according to the standard root coverage procedure described previously.12,14 After achieving profound local anesthesia, the accessible root surface was planed smooth with a combination of hand instruments and burs to eliminate any surface contamination. A sulcular incision was made from the mesiofacial line angle to the distofacial line angle of the tooth. The sulcular incision was extended horizontally into each adjacent papilla, at a level just coronal to the CEJ, to within 1 mm of the adjacent teeth. Starting at the terminal ends of the horizontal incision, two vertical incisions were extended apically well beyond the MGJ to allow adequate flap mobilization. The vertical incisions diverged significantly while progressing apically to preserve blood supply to the flap. The trapezoidal pedicle flap was initially elevated split thickness in the papillary gingiva, then progressed full thickness from the osseous crest to the MGJ, and, finally, split thickness again apical to the MGJ. Split-thickness dissection in the apical portion severed the periosteum to allow tension-free coronal positioning of the flap. Next, papillae adjacent to the recipient tooth were deepithelialized with a 15 c scalpel, leaving 1 mm of epithelium undisturbed next to the adjacent teeth. Following flap reflection, intra–bone marrow perforations were made with a 1/2 round bur in the interproximal areas mesial and distal to the recipient tooth root.
Fig 1a  GTR-based root coverage surgical procedure using DFDBA and a collagen membrane: initial buccal gingival recession.

Fig 1b  Root instrumentation using various instruments (eg, ultrasonic scalers, hand instruments, and burs) prior to flap elevation.

Fig 1c  Two diverging vertical incisions are made on the distal and mesial papillae of the tooth, extending beyond the mucogingival junction. An intrasulcular incision is then made to connect the two vertical releasing incisions.

Fig 1d  Trapezoidal full-thickness mucoperiosteal flap is reflected above the MGJ. Sharp dissection is used beyond the MGJ to free the flap from tension. The epithelium of the interproximal papillae is removed by sharp dissection to provide a bleeding connective tissue bed. The exposed bone is then perforated with a 1/2 round bur.

Fig 1e  Collagen membrane is custom trimmed, with a curve cut in the CEJ area and positioned over the root surface to extend 2 to 3 mm beyond the bony margin. The barrier is secured in position with 5-0 Vicryl sutures.

Fig 1f  Approximately 1 mm of DFDBA is placed evenly over the root surface.

Fig 1g (left)  Membrane is positioned over the graft, and flap is relieved of any tension.

Fig 1h (right)  Flap is coronally positioned to cover the membrane and secured with 5-0 Vicryl sling-tag sutures at the mesial and distal angles. The vertical releasing incisions are then sutured to their new coronal position.
A bovine collagen membrane (BioMend, Calcitek) was trimmed to cover 2 to 3 mm of bone surrounding the exposed root surface. In addition, the cervical portion of the membrane was trimmed in a semilunar shape to allow adaptation to the root. The membrane was secured to the tooth at the level of the CEJ with one 5-0 Vicryl (Ethicon/Johnson & Johnson) sling-tag suture engaging both membrane and papillae. The apical part of the collagen membrane was then lifted off the tooth to allow graft placement under the membrane. A 1-mm-thick layer of DFDBA (LifeNet) was placed, covering the root surface to the CEJ and 2 mm of adjacent bone. The membrane was repositioned to cover the DFDBA. Finally, the pedicle flap was coronally positioned to cover the membrane and secured to the adjacent papillae with interrupted 5-0 Vicryl sutures. Interrupted Vicryl sutures were then used to close the vertical incisions. Care was taken to ensure tension-free flap closure. No periodontal dressing was used.

After surgery, routine postoperative instructions were given. A nonsteroidal antiinflammatory analgesic was prescribed. No antibiotics were prescribed. Postoperative home care instructions included refraining from any mechanical cleaning of the surgical areas for 4 weeks. Warm salt-water rinses and topical warm salt-water application with a cotton tip were used for the first 2 weeks. Patients were then instructed to rinse twice daily with a 0.12% chlorhexidine gluconate mouthrinse for the next 2 weeks. After 4 weeks, patients resumed gentle toothbrushing and flossing.

Results

Five consecutive patients with buccal gingival recession defects measuring ≥3.0 mm were treated. No adverse patient events occurred during the course of the study. GTR surgery with DFDBA reduced mean recession an average of 3.1 ± 0.7 mm, corresponding to a mean root coverage of 93% ± 15% (Table 1). The improvement was statistically significant. Figures 2 and 3 illustrate the treatment procedures and outcome obtained for patients 3 and 4.

There was statistically significant improvement in RW at 6 months when compared to baseline (Table 2). A significant increase of KG was also noted after treatment. CALs were significantly decreased at 6 months, from 5.2 ± 0.3 mm to 1.9 ± 0.5 mm. However, there was no change in PD. In addition, there was no significant change in gingival, plaque, and bleeding indices at 0, 3, and 6 months.

### Table 1

<table>
<thead>
<tr>
<th>Patient</th>
<th>Baseline</th>
<th>6 mo</th>
<th>Baseline to 6 mo improvement</th>
<th>% root coverage</th>
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<tr>
<td>1</td>
<td>3.0</td>
<td>1.0</td>
<td>2.0</td>
<td>67</td>
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<tr>
<td>2</td>
<td>4.0</td>
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<td>5</td>
<td>3.0</td>
<td>0.0</td>
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<td>100</td>
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<td>Mean ± SD</td>
<td>3.3 ± 0.4</td>
<td>0.2 ± 0.4</td>
<td>3.1 ± 0.7*</td>
<td>93 ± 15*</td>
</tr>
</tbody>
</table>

*Significant change from baseline (P < .05).
SD = standard deviation.
Fig 2a  Patient 3 presurgery: 3.0 mm of buccal gingival recession (mandibular left first premolar).

Fig 2b  Two divergent vertical releasing incisions are made.

Fig 2c  Full-thickness flap is raised, and root surface is debrided.

Fig 2d  DFDBA and collagen membrane are placed, and membrane is secured with 5-0 Vicryl suture.

Fig 2e  Flap is coronally advanced and sutured.

Fig 2f  Healing at 6 months shows 100% root coverage.

Fig 3a (left)  Patient 4 presurgery: 3.5 mm of buccal gingival recession (mandibular left canine).

Fig 3b (right)  Full-thickness flap is raised, and root surface is debrided with intra–bone marrow penetration.

Fig 3c (left)  DFDBA and collagen membrane are placed, and membrane is secured with 5-0 Vicryl suture.

Fig 3d (right)  Healing at 6 months shows 100% root coverage.
Discussion

The purpose of this case study was to determine the feasibility of adding bone grafts, in particular DFDBA, to the protocol for collagen membrane–based GTR root coverage procedures. Our results indicate that DFDBA plus a collagen barrier could be used to successfully treat gingival recession defects. The addition of DFDBA may create and maintain extra space that is needed for new attachment formation. Studies have demonstrated the importance of maintaining an adequate space underneath GTR membranes to promote periodontal/bone regeneration. Furthermore, DFDBA has also been shown to possess osteoinductive and/or osteogenic properties that may promote new attachment and bone formation. Therefore, the combination of DFDBA and collagen barrier for root coverage may offer several advantages over traditional periodontal plastic surgery.

In this study, GTR-based surgery using a combination of a collagen membrane and DFDBA yielded significant improvement in RD and percentage of root coverage after 6 months. The percentage of root coverage achieved in this study is higher than we reported in a previous study that used double-thickness collagen membranes. Harris achieved 95.9% root coverage with GTR-based procedures when tissue was ≥0.5 mm thick, compared to 26.7% root coverage when tissue was <5 mm thick. Others recommended that tissues be at least 1 mm thick when attempting root coverage with coronally positioned flaps. The amount of root coverage obtained with DFDBA plus collagen barriers in the present study is comparable to that reported for both bioabsorbable and nonabsorbable membranes.

Furthermore, we modified the enrollment criteria for this study, selecting only those sites with tissue thickness ≥0.5 mm at a point 3 mm apical to the free gingival margin. There was a 3.3-mm gain of CAL after surgery in this study. This was statistically significant and accompanied by almost no change in PD, in agreement with previous studies. The gain in clinical probing attachment with no change in PD suggests that a new attachment formed. However, because of lack of histologic evidence, it is impossible to determine whether this gain in attachment resulted from formation of a long junctional epithelium, a new connective tissue attachment, or a combination of both types of healing. Nevertheless, several studies have reported a formation of a new fibrous periodontal attachment when GTR-based root coverage is performed.

Table 2

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Baseline (mm)</th>
<th>6 mo (mm)</th>
<th>Baseline to 6 mo difference (mm)</th>
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<tr>
<td>Recession width</td>
<td>4.1 ± 0.7</td>
<td>0.7 ± 1.6</td>
<td>3.5 ± 1.2*</td>
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<tr>
<td>Keratinized gingiva</td>
<td>2.1 ± 0.7</td>
<td>2.9 ± 0.7</td>
<td>0.8 ± 0.9*</td>
</tr>
<tr>
<td>Attachment level</td>
<td>5.2 ± 0.3</td>
<td>1.9 ± 0.5</td>
<td>3.3 ± 0.6*</td>
</tr>
<tr>
<td>Probing depth</td>
<td>1.8 ± 0.4</td>
<td>1.7 ± 0.4</td>
<td>0.1 ± 0.2</td>
</tr>
</tbody>
</table>

*Significant difference at P < .05 level. SD = standard deviation.

Furthermore, we modified the enrollment criteria for this study, selecting only those sites with tissue thickness ≥0.5 mm at a point 3 mm apical to the free gingival margin. Harris achieved 95.9% root coverage with GTR-based procedures when tissue was ≥0.5 mm thick, compared to 26.7% root coverage when tissue was <5 mm thick. Others recommended that tissues be at least 1 mm thick when attempting root coverage with coronally positioned flaps. The amount of root coverage obtained with DFDBA plus collagen barriers in the present study is comparable to that reported for both bioabsorbable and nonabsorbable membranes.

The finding that KG increased by an average of 0.8 mm is in line with previous studies. This also agrees with our previous study, in which we observed a gain of 0.9 mm in KG width after GTR-based root coverage with collagen membranes. The increase of KG may be due to a potential space created by DFDBA and by the collagen membrane itself. Pitaru et al reported that collagen membranes prevent apical migration and further support new connective tissue attachment. This often results in increased overlying flap thickness. In addition, the regenerative capacity of DFDBA further enhances new attachment formation.

There was a 3.3-mm gain of CAL after surgery in this study. This was statistically significant and accompanied by almost no change in PD, in agreement with previous studies. The gain in clinical probing attachment with no change in PD suggests that a new attachment formed. However, because of lack of histologic evidence, it is impossible to determine whether this gain in attachment resulted from formation of a long junctional epithelium, a new connective tissue attachment, or a combination of both types of healing. Nevertheless, several studies have reported a formation of a new fibrous periodontal attachment when GTR-based root coverage is performed.
It is important to note that this was a pilot case study with a limited sample size and no control group; therefore, the results reported herein must be interpreted with caution. A randomized controlled trial comparing collagen membranes with and without DFDBA is needed to evaluate the clinical efficacy of this combination approach. Results from this pilot study indicate that use of DFDBA during collagen membrane GTR-based root coverage could be beneficial in promoting favorable clinical results.

Acknowledgments

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References


