Ridge Preservation Comparing the Clinical and Histologic Healing of Membrane vs No-Membrane Approach to Buccal Overlay Grafting

Abdullah Alkanan, BDS, MSD
Henry Greenwell, DMD, MSD
Abhishek Patel, BDS, MSD/Margaret Hill, DMD
Brian Shumway, DMD, MS/Jeremy Lowy, DMD, MSD

Twenty-four patients completed this randomized, controlled, blinded clinical trial comparing ridge preservation with a membrane (acellular dermal matrix graft [ADMG]) vs no membrane on buccal overlay graft technique. An intrasocket corticocancellous allograft with a facial overlay xenograft was used for both groups, and an ADMG was used as a membrane with guided bone regeneration in the ADMG group (control group). In the No Membrane group (test group), ADMG was used to cover only the occlusal surface for graft containment, with no membrane on the buccal overlay graft. Final crestal ridge width and vertical ridge height had no significant difference between groups (P > .05). Facial contour was preserved for the ADMG group compared to No Membrane group. Histologic examination showed a high percentage of vital bone for both groups with no significant difference between groups.


Extraction sites often undergo alveolar bone resorption in both horizontal and vertical directions. The majority of postextraction bone loss occurs on the facial aspect of the ridge, often due to loss of the buccal plate. In recent years, esthetics has received a greater emphasis in implant treatment. Adequate architecture of the alveolar bone and soft tissue are needed for both esthetic and functional implant treatment. Ridge preservation procedures aim to preserve edentulous ridge width and height dimensions at the extraction site by preserving alveolar bone and promoting bone fill in the extraction socket. Various commercially available membranes are used to act as a barrier and to promote selective cell population in guided bone regeneration (GBR) procedures. Human studies of extraction alone with no ridge preservation show, when analyzed as a group, a mean loss in ridge width of about 2.9 mm, or 33%. Sites treated with a ridge preservation procedure, on the other hand, show a mean loss of only about 1.3 mm, or 15%. This substantial difference indicates that ridge preservation procedures provide a significant advantage in terms of preserving ridge dimensions and the esthetic contours supported by the underlying bone.

Both resorbable and nonresorbable membranes have been used for...
GBR procedures and have proven to be successful. The acellular dermal matrix GBR membrane (ADMG) is the thinner version of the ADM membrane, which is used for root coverage procedures, and is designed for GBR procedures. ADMG heals by incorporating within the host tissue and has been proven to be an effective barrier membrane that helps preserve soft tissue dimensions.

Poulia et al compared two techniques of ridge preservation: an intrasocket graft alone vs an intrasocket graft plus a buccal overlay xenograft, with a collagen membrane used for both groups. The buccal overlay graft resulted in an almost unchanged ridge width, which is unusual for a ridge preservation study. The successful buccal overlay grafting technique is used in the present study. However, one group will have a barrier membrane on buccal overlay while the other group will not.

The primary aim of this study is to compare the clinical and histologic healing of ridge preservation using intrasocket allograft with xenograft facial overlay between membrane and no-membrane groups.

Materials and Methods

Study Design

A total of 24 patients participated in this 4-month randomized, controlled, blinded, clinical and histologic study of ridge preservation in nonmolar teeth. Using a coin toss, 12 patients were selected for the positive control membrane group (ADMG group) and received an intrasocket mineralized corticocancellous particulate allograft (MinerOss, BioHorizons) plus a facial overlay with a particulate bovine xenograft (MinerOss X, BioHorizons) covered by an ADMG membrane (AlloDerm GBR, BioHorizons) on both the occlusal and buccal graft. The 12 test patients (No Membrane group) received the same socket bone graft and buccal overlay graft as the ADMG group but without the membrane coverage on buccal overlay. Only the exposed intrasocket allograft was covered with ADMG membrane to prevent loss of graft material. The coin toss was done by the mentor (H.G.) immediately prior to the procedure. The operator (A.A.) selected which side of the coin would indicate either test or control treatment for the first patient, and the next patient was automatically assigned to the treatment group opposite the first patient. A new coin toss was performed for the third subject, with the procedure being performed until all patients were assigned a group. Implant placement surgery was performed 4 months after the grafting procedure, and a trephine core was removed from the osteotomy site for histologic analysis. All patients signed an informed consent approved by the University of Louisville Institutional Review Board in October 2016.

Outcome Variables

The primary clinical outcome variable was the crestal horizontal ridge width, and the power analysis was based on this variable. The primary histologic variable was percent vital bone. Other variables evaluated included horizontal ridge width 5 mm apical to the crest, vertical ridge dimension change, soft tissue thickness, and contour.

Inclusion/Exclusion Criteria

Subjects met the eligibility criteria if they were at least 18 years of age and had one nonmolar tooth requiring extraction that would be replaced by a dental implant. Extraction sites were bordered by at least one tooth. Exclusion criteria included: (1) debilitating systemic diseases; (2) head and neck radiation or chemotherapy; (3) known allergy to any material or medication used in the study; (4) history of intravenous or oral bisphosphonate use for more than 3 years; (5) long-term steroid therapy; (6) pregnancy. Patients were excluded posttreatment if they failed to follow the posttreatment protocol/appointments; had an adverse reaction to any of the materials used in the study, such as hypersensitive, allergic, or other immune response; and sloughing or failure of the ADMG.

Clinical Parameters

Horizontal ridge width was measured with a modified digital caliper to the nearest 10⁻² mm at the midsocket crestal level and 5 mm apically. Change in vertical ridge height was determined by measuring the distance from the acrylic stent to the alveolar crest on the mesial and distal sides adjacent to the tooth surface and midridge, which was...
defined as the mesiodistal center of the site. These measurements were taken on the buccal, occlusal, and lingual surfaces using a UNC-15 periodontal probe. Facial contour was subjectively assessed as convex, flat, or concave. Soft tissue thickness was measured at the crest and 5 mm apical to the crest at the initial and final exams and on the occlusal side at 4 months. An endodontic file with a rubber stopper was used, and the distance from file tip to stopper was measured with a digital caliper.

**Surgical Treatment**

For both groups, full-thickness flaps were elevated to expose both the facial and the palatal/lingual aspects of the alveolar ridge. The teeth were extracted with minimal trauma. After complete degranulation, the socket allograft was placed to the level of the alveolar crest, and the facial overlay xenograft was placed over the buccal wall of the extraction socket, from the alveolar crest to about 12 mm apically. For the ADMG group (Fig 1), the membrane was trimmed to completely cover the graft and extended at least 5 mm past the graft margins. For the No Membrane group (Fig 2), the ADMG membrane was trimmed to cover only the occlusal intrasocket graft to prevent loss of graft particles. In both groups, primary closure was not attempted and the membrane overlying the central portion of the socket was left exposed. At 4 months, a 2.7 × 6.0-mm trephine was used with chilled saline irrigation to remove a core from the osteotomy site, and an implant was placed.

**Histologic Analysis**

Fourteen trephine cores (2.7 × 6 mm; seven from each group) were processed for histologic preparation, and 12 to 15 step/serial sections were taken from the center of each longitudinally sectioned core. One sample from each group was excluded due to disintegration of the cores during histologic processing, and six samples per group remained. The sections were stained with hematoxylin and eosin. Percent vital bone, nonvital bone, and trabecular space were determined using an American Optics light microscope at ×150 magnification, with a ×10 objective and a ×5 reticle eyepiece.

**Statistical Analysis**

Means and standard deviations were calculated for all parameters. The data were analyzed using paired t-test to determine the statistical significance of the differences between initial and final data. Unpaired t-test was used to evaluate statistical differences between the test and control groups. The sample size of 12 gave 87% statistical power to detect a difference of 1-mm ridge width between the groups. The mean and standard deviation used for the power calculation were based on data from previous studies.

**Results**

A total of 25 patients were entered into this study. One patient in the No Membrane group did not return due to family medical problems and was excluded. Reasons for extraction of teeth included recurrent periapical infection, non-restorability, vertical root fracture, and Miller Grade 3 mobility. The No Membrane group had 8 females and 4 males with a mean age of 59 ± 16 years, while the ADMG group had 7 females and 5 males with a mean age of 61 ± 13 years. The No Membrane group consisted of four maxillary incisors, one maxillary canine, six maxillary premolars, and one mandibular premolar. The ADMG group consisted of six maxillary incisors, two maxillary premolars, and four mandibular premolars. There were no adverse events during the course of the study.

**Horizontal Ridge Width Changes**

For the No Membrane group, the mean crestal ridge width change was –1.9 ± 1.4 mm while for the ADMG group it was –2.2 ± 1.0. Both groups had a statistically significant mean loss of crestal ridge width (P < .05), and the difference between the two groups was not statistically significant (Table 1).

**Vertical Ridge Height Changes**

On the midbuccal aspect, the No Membrane group had a mean gain of 0.5 ± 6.5 mm (P > .05), while the ADMG group gained 0.6 ± 1.3 mm (P > .05). The difference between the groups was not statistically significant (P > .05).
Facial Contour

At baseline, the No Membrane group had 11 flat contours and 1 convex contour, while the ADMG group had 12 sites with flat contour. At the time of reentry, the No Membrane group had 5 sites with flat contour and 7 with concave contour, while the ADMG group had 12 sites with flat contour.

Fig 1  Mandibular left second premolar of a patient in the ADMG group. (a) Initial presentation. Note that the second premolar is an abutment for a two-unit porcelain-fused-to-metal distal cantilever bridge replacing the first molar. (b) Immediate postextraction socket. (c) The graft is covered on the facial and occlusal sides with AlloDerm GBR (BioHorizons) to provide full membrane coverage of the graft. (d) Healing at 16 weeks with no swelling present. ADMG is completely epithelialized. (e) Reentry at 4 months.
Fig 2  Maxillary left first premolar of a patient in the No Membrane group.  
(a) Initial presentation. The tooth has a full porcelain crown. (b) Immediate postextraction socket. (c) The graft is not covered on the facial side but is covered on the occlusal side with Alloderm GBR (BioHorizons) to prevent loss of graft particles. (d) Healing at 16 weeks with no swelling present. ADMG is completely epithelialized. (e) Reentry at 4 months. (f) Preoperative radiograph showing recurrent periapical infection with previously treated and failed endodontic treatment. (g) Postoperative radiograph after 4 months of graft healing. The socket graft used was mineralized corticocancellous particulate with bovine xenograft buccal overlay. In this group, there was no membrane coverage on the facial overlay graft. (h) Radiograph at implant placement.
Both the No Membrane and ADMG groups had a significant gain of soft tissue thickness at both the buccal crest and 5 mm apical to the crest between initial and final evaluations \((P < .05)\). The difference between the groups was not statistically significant \((P > .05, \text{Table 2})\).

### Soft Tissue Thickness

Both the No Membrane and ADMG groups had a significant gain of soft tissue thickness at both the buccal crest and 5 mm apical to the crest between initial and final evaluations \((P < .05)\). The difference between the groups was not statistically significant \((P > .05, \text{Table 2})\).

### Histologic Evaluation

The No Membrane group consisted of six cores that showed a mean of 37% ± 11% vital bone, 25% ± 15% nonvital bone, and 38% ± 9% trabecular space. The ADMG group had six cores that yielded a mean of 28% ± 17% vital bone, 35% ± 18% nonvital bone, and 36% ± 3% trabecular space. There was no statistically significant difference between groups for vital bone, nonvital bone, and trabecular space \((P > .05)\).

### Discussion

In this 4-month randomized, controlled, blinded clinical trial, the No Membrane group had a mean loss of crestal ridge width of 1.9 ± 1.4 mm (21%), which was similar to the 2.2 ± 1.0 mm (28%) seen with the ADMG group \((P > .05, \text{Table 1})\). The crestal ridge dimensional changes seen in the present study are comparable to previous ridge-preservation studies, in which about 18% crestal ridge width was lost.\(^6,^7^1\) This supports the concept proposed by Wang et al that a slowly resorbing outer layer of grafting material can resist resorption and impact the final result. Those authors proposed that a rapidly resorbing inner graft layer is beneficial since it will be replaced by newly formed vital bone.\(^2^4\) In the present study, the results indicate that the change in osseous dimensions is comparable with or without a membrane. The presence of a slow-resorbing xenograft as buccal overlay may have resulted in similar crestal ridge width results between both groups.

From these results, one question that arises is whether a membrane is needed for a ridge preservation procedure; because using a membrane adds time, cost, and technique sensitivity to the procedure, there should be a valid reason for its use. Site-specific data from previous ridge-preservation studies indicate that maxillary sites tend to have more resorption than mandibular sites, and that maxillary anterior sites tend to have the highest percentage of lost ridge width compared to other sites.\(^6,^1^1,^1^8\) One advantage of using ADMG on buccal overlay graft is the preservation of soft tissue contour in a mesiodistal direction. In this study, the ADMG group was able to maintain soft tissue contour in all cases, which

### Table 1 Mean ± SD (in mm) of Horizontal Ridge Width for ADMG and No Membrane Sites

<table>
<thead>
<tr>
<th></th>
<th>Initial</th>
<th>Final</th>
<th>Change (%)</th>
<th>Range</th>
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<tbody>
<tr>
<td>ADMG at crest</td>
<td>8.0 ± 1.3</td>
<td>5.8 ± 1.5</td>
<td>−2.2 ± 1.0*</td>
<td>(28) −3.8 to −0.5</td>
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<tr>
<td>No membrane at crest</td>
<td>8.8 ± 1.5</td>
<td>6.9 ± 1.8</td>
<td>−1.9 ± 1.4*</td>
<td>(21.4) −3.4 to −1.0</td>
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<td>ADMG at 5 mm</td>
<td>8.6 ± 1.8</td>
<td>7.7 ± 1.6</td>
<td>−0.9 ± 1.0*</td>
<td>(9.4) −2.4 to 0.7</td>
</tr>
<tr>
<td>No membrane at 5 mm</td>
<td>9.2 ± 1.5</td>
<td>8.4 ± 1.7</td>
<td>−0.8 ± 1.3</td>
<td>(8.3) −2.8 to 2.1</td>
</tr>
</tbody>
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Range values refer specifically to the values given for change in ridge width.

SD = standard deviation; ADMG = acellular dermal graft matrix.

*\(P < .05\) for initial and 4-month values.

### Table 2 Mean ± SD (in Index Units) of Soft Tissue Thickness for ADMG and No Membrane Sites

<table>
<thead>
<tr>
<th></th>
<th>Initial</th>
<th>Final</th>
<th>Change</th>
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</thead>
<tbody>
<tr>
<td>Buccal crest</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>ADMG</td>
<td>1.9 ± 0.5</td>
<td>3.0 ± 0.8</td>
<td>1.1 ± 1.0*</td>
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<tr>
<td>No membrane</td>
<td>2.1 ± 0.4</td>
<td>3.0 ± 0.8</td>
<td>0.9 ± 0.8*</td>
</tr>
<tr>
<td>Apical to crest (5 mm)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>ADMG</td>
<td>1.6 ± 0.5</td>
<td>2.8 ± 0.6</td>
<td>1.2 ± 0.7*</td>
</tr>
<tr>
<td>No membrane</td>
<td>1.6 ± 0.5</td>
<td>2.5 ± 0.6</td>
<td>0.9 ± 0.8*</td>
</tr>
<tr>
<td>Occlusal</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>ADMG</td>
<td>2.7 ± 1.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No membrane</td>
<td>2.6 ± 0.8</td>
<td></td>
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</table>

Mean soft tissue thickness was measured to evaluate the effect of the barrier membrane on the overlying soft tissue thickness.

SD = standard deviation; ADMG = acellular dermal graft matrix.

*\(P < .05\) for initial and 4-month values.
is an esthetic advantage, whereas the No Membrane group failed to do so in more than half the cases. This may be because of the inherent property of ADM to heal by incorporating into the host tissue. In both groups, ADM was left exposed over the socket. This increased the zone of keratinized tissue at the future implant site without using an autogenous soft tissue graft. This result is comparable to previous studies using ADM as a barrier membrane.22,23

Another parameter to consider is the soft tissue biotype. A study by Linkevicius et al showed that implant sites with a crestal soft tissue thickness ≤ 2 mm leads to bone loss, even when the microgap is covered supracrestally.25 In the present study, both groups had an initial soft tissue thickness ≤ 2 mm, which changed to a final soft tissue thickness of 3 mm at the crest (Table 2). Therefore, using ADMG in sites with a thin biotype may be beneficial to increasing soft tissue thickness.

Histologic analysis showed a high percentage of vital bone in the midsocket area where the cortico-cancellous allograft was placed. This is comparable to previous histologic studies on ridge preservation.26,27 This indicates that the goal of the layered graft from Wang et al had been achieved and that the implant would be placed in an area with a high percentage of vital bone.24

Conclusions

Both groups had a similar horizontal and vertical ridge dimension change (P > .05). The ADMG group was able to maintain soft tissue contour in all cases, whereas the No Membrane group failed to do so in more than half the cases. Not utilizing a membrane in ridge preservation procedure did not compromise final bone dimensions but did negatively affect ridge contour.

Acknowledgments

The authors declare no conflicts of interest.

References


