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<td>Author(s)</td>
<td>Fujita, T; Yamamoto, S; Ota, M; Shibukawa, Y; Yamada, S</td>
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Coverage of Gingival Recession Defects Using Guided Tissue Regeneration With and Without Adjunctive Enamel Matrix Derivative in a Dog Model

Takahisa Fujita, DDS*/Shigeki Yamamoto, DDS, PhD**
Mikio Ota, DDS, PhD***/Yoshihiro Shibukawa, DDS, PhD***
Satoru Yamada, DDS, PhD****

The goal of periodontal therapy is to restore supportive tissues destroyed by periodontal disease, as well as to prevent the progression of the disease itself.1 Esthetics are another important matter that must be considered.2 Buccal gingival recession of the maxillary dentition is one of the most important concerns for periodontists. Recently, a variety of techniques have been developed to attain complete root coverage with predictability.3–9 Nevertheless, histometric analyses of the results have demonstrated that the relationship between the flap and the root surface is characterized only by connective attachment at the most apical part of the lesion. Conversely, the coronal part of the interface between the root and flap consists of junctional epithelium.10–12

Guided tissue regeneration (GTR) is used in the treatment of gingival recession to attain both root coverage and new connective tissue attachment.13,14 Clinical results have been promising.15–17 GTR is effective in attaining root coverage, improving clinical attachment levels, and increasing the width of

The aim of this study was to clarify the adjunctive effect of enamel matrix derivative (EMD) on expanded polytetrafluoroethylene membrane guided tissue regeneration (GTR)–based root coverage by creating gingival recessions in beagle dogs. Recessions were treated with GTR + EMD, GTR alone, or neither GTR nor EMD (control). The control group was characterized by long junctional epithelium and little bone formation. The GTR + EMD group showed a statistically significant increase (P < .01) in new bone and cementum formation compared with the GTR group. The results of the present investigation suggest that the adjunctive use of EMD with GTR promotes formation of new bone and cementum without root resorption in recession-type defects in dogs. (Int J Periodontics Restorative Dent 2011;31:247–253.)

*Graduate Student, Department of Periodontology, Tokyo Dental College, Chiba, Japan.
**Instructor, Department of Periodontology, Tokyo Dental College, Chiba, Japan.
***Associate Professor, Department of Periodontology, Tokyo Dental College, Chiba, Japan.
****Chairman and Professor, Department of Periodontology, Tokyo Dental College, Chiba, Japan.

Correspondence to: Dr Takahisa Fujita, Department of Periodontology, Tokyo Dental College, 1-2-2 Masago, Mihama-ku, Chiba-shi 261-8502, Japan; fax: 181-43-270-3955; email: ryamada@tdc.ac.jp.

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keratinized gingiva. However, various problems have occurred with techniques employing membranes. When GTR is applied to wide or deep periodontal defects resulting from gingival recession, root coverage ranges from 64% to 95.2%, which is problematically low for clinical use.

Emdogain (Biora) was developed as an enamel matrix derivative (EMD) for use in clinical treatment to promote periodontal regeneration. The role of EMD in the regeneration of intrabony defects and, more recently, gingival recessions has been studied in view of its potential. The efficacy of EMD in root coverage procedures has been evaluated, and successful root coverage with healthy, thick keratinized tissue has been reported. The problems associated with GTR may be solved by its concomitant use with EMD, since EMD stimulates the biologic processes that lead to the regeneration of periodontal tissue. Limited information is available, however, concerning the effects of EMD on GTR-based root coverage with concomitant use of expanded polytetrafluoroethylene (e-PTFE) membranes. Therefore, the objective of this study was to clarify the effect of the adjunctive use of EMD on e-PTFE membrane GTR-based root coverage.

Method and materials

Adult beagle dogs (n = 24) were used in this study. Gingival recession defects (6 × 5 mm) were created surgically in the maxillary canines bilaterally. A metallic matrix was placed over each defect and left in place for 12 weeks. Two weeks after placement, full-thickness flaps were raised and root surfaces were scaled and planed (Fig 1). The apical notch was placed at the obtained defect (bone level), and the coronal notch was placed at the cementoenamel junction. Defects were assigned to one of the following treatment groups randomly: control (coronally advanced flap), GTR alone (root instrumentation and placement of e-PTFE membrane covering the defect and stabilization with sling sutures), or GTR + EMD (Emdogain application and covering of the defect with e-PTFE membrane) (Fig 2). The animals were euthanized at 2, 4, or 8 weeks.

Semiserial histologic sections were stained using hematoxylin-eosin. The following distances were measured: epithelial length (A), cementum formation (B), bone formation (C), defect extension (D), and gingival level (E) (Fig 3). These measurements were statistically analyzed using the Scheffé test (n = 5) to determine whether the different treatments had any significant effect on the tested histometric parameters.

Results

The gingiva adjacent to all treated teeth exhibited only minute clinical signs of inflammation (Fig 4).
Histologic observations

The control group showed development of long junctional epithelium (Fig 5). To varying degrees, a continuous layer of new cementum had formed coronally from the apical notch.

At 2 weeks postsurgery, no new bone or cementum formation was observed in either the GTR + EMD or GTR groups. In both groups, newly formed connective tissue was seen on the root surface, extending to a level corresponding to the coronal defect.
Fig 8a  GTR + EMD group 4 weeks postsurgery. New bone and cementum were seen on the root surface (hemotoxylin-eosin; magnification ×50).

Fig 8b  Higher magnification view of Fig 8a. The dentin surface underneath the new cementum showed no surface resorption (hemotoxylin-eosin; magnification ×100).

Fig 9  GTR group 4 weeks postsurgery. The dentin surface underneath the new cementum showed surface resorption (hemotoxylin-eosin; magnification ×100).

Table 1  Histometric parameters (mean and standard deviation) for each surgical treatment (mm)

<table>
<thead>
<tr>
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<th>GTR + EMD (n = 5)</th>
<th>GTR (n = 5)</th>
<th>Control (n = 5)</th>
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<tr>
<td>Gingival level</td>
<td>4.22 ± 0.50</td>
<td>3.89 ± 0.10</td>
<td>1.09 ± 0.10</td>
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<tr>
<td>Epithelium</td>
<td>0.19 ± 0.01</td>
<td>0.21 ± 0.02</td>
<td>4.34 ± 0.50</td>
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<tr>
<td>New cementum</td>
<td>6.21 ± 0.10</td>
<td>4.27 ± 0.04</td>
<td>1.25 ± 0.50</td>
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<tr>
<td>New bone</td>
<td>4.70 ± 0.20</td>
<td>2.67 ± 0.20</td>
<td>0.44 ± 0.20</td>
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<tr>
<td>Defect extension</td>
<td>6.36 ± 0.04</td>
<td>6.33 ± 0.03</td>
<td>6.06 ± 0.04</td>
</tr>
</tbody>
</table>

NS = not significant.
*Statistically significant (P < .01, Scheffé test).
notch (Fig 6). No irregularities or surface resorption was seen in the dentin surface in the GTR + EMD group. In the GTR group, the dentin surface presented irregularities or surface resorption (Fig 7). Four weeks after surgery, the GTR + EMD group showed a greater area of new bone formation than the GTR group (Fig 8a), and the dentin surface exhibited a thin layer of cementum (Fig 8b). On the other hand, in the GTR group, the dentin surface underneath the new cementum showed marked new attachment between the periodontal ligament and the new cementum surface, with no preceding resorption (Fig 10b). In the GTR group, the dentin surface underneath the new cementum showed irregularities or surface resorption (Fig 11).

The apical extension of the dentogingival epithelium terminated at the coronal border of the matrix barrier (Fig 10a). The dentin surface underneath the new cementum showed no surface resorption. Eight weeks postsurgery, new bone and cementum formation had occurred in the GTR + EMD and GTR groups, as summarized in Table 1. In the former, new bone and cementum gains were 4.70 and 6.21 mm, respectively.
Discussion

This study compared the healing processes obtained with GTR using e-PTFE membranes and a combination of GTR and EMD. Pathologic examination revealed that the amount of cementum and bone formed at the sites of gingival recession were significantly greater after combination therapy with EMD + GTR than with GTR alone (P < .01). These findings are in agreement with those of an earlier study, suggesting the possibility that combined therapy with EMD + GTR promotes cementum and bone formation. Therefore, whether EMD acted as a matrix between the e-PTFE membrane and the root surface in GTR was investigated. According to the hypothesis that GTR induces accumulation of periodontal cells at the treatment site, the matrix is very important for successful GTR-based tissue regeneration. Guiha et al. reported that periodontal tissue responded to EMD at an early stage of healing. The findings of this study suggest that EMD may also serve as a matrix, allowing clots to extend from periodontal tissue to areas around gingival recessions under the protection of the membrane. Other studies have shown that EMD stimulates periodontal ligament cells and increases cell proliferation. The concomitant use of EMD as a matrix with GTR may stimulate the biologic processes that induce periodontal tissue regeneration.

An interesting finding is that the dentin surface immediately under the new cementum showed irregularities or surface resorption after GTR treatment, but that the intact dentin surface without resorption formed an attachment with the new cementum after treatment with GTR + EMD. Previous studies have described the characteristic resorption of dentin surfaces with GTR. Resorption is usually observed at the root surface, where it attaches to gingival granulation tissue. The authors found that GTR resulted in resorption defects despite sufficient adaptation of the membranes to the covered defects. This suggests that such resorption is a natural step in the healing process of large defects, irrespective of denudation or bacterial contamination. The hypothesis that GTR induced accumulation of periodontal cells is supported by the finding that a layer of new cementum was formed over such typical resorption lacunae, as well as the observation reported by Frank et al. that resorption precedes cementum deposition. The findings that cementum formed by the combined use of EMD and GTR was similar to that obtained with EMD alone suggests that EMD is advantageous, since it induces new attachment without preceding resorption. Treatment using EMD induced the formation of cementum that was attached firmly to the root surface, without preceding resorption. Hunt reported that cells wedged their way through reduced enamel epithelium and that acellular cementogenesis began when the cells reached the enamel surface. It is possible that combined use of GTR + EMD induces acellular hard tissue formation on root surfaces without root surface resorption by exposing periodontal tissue cells to the enamel matrix on the root surface in a manner similar to that in the development of coronal cementum.

Further research is required to determine whether the same results are obtainable in humans. However, the results of this study suggest that GTR-based root coverage using EMD + e-PTFE membrane offers a promising approach for attaining defect coverage in gingival recessions.

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References