A Clinical and Histological Evaluation for Healing of Dehiscence Defects Filled with an Absorbable Atelocollagen Sponge in Dogs

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Abstract: The objective of this study was to evaluate the effect of absorbable atelocollagen sponge on healing of hard tissue of buccal dehiscence defects in mongrel dogs. The mandibular second and fourth premolars of 12 dogs were extracted. Group 1 and Group 2 consisted of dogs without and with an inserted atelocollagen sponge after extraction with buccal plate preservation; Group 3 and Group 4 consisted of dogs without and with an inserted atelocollagen sponge after removing two thirds of the buccal wall. At 0 weeks, Group 4 presented a significantly greater increase in the height of the alveolar bone crest than that of Group 3. Histologically, Group 2 and Group 4 showed better new bone formation ability than Groups 1, 3 at 0 weeks after extraction. The new bone formation ability of Group 3 was the poorest at 10 weeks. The results showed that the transplantation of absorbable atelocollagen sponge in the extraction socket can promote new bone formation and compensate marginal ridge reconstruction.

Key words: atelocollagen sponge, extraction socket, dehiscence defect

1. Introduction

When a tooth is extracted because of dental caries, periodontal disease, trauma or other reasons, the extraction socket is cured through a healing mechanism without specific problems. The extraction socket is completely filled with bone after 16 weeks of healing.\textsuperscript{1} However, Johnson reported that the resorption of the extraction socket occurs after 16 weeks.\textsuperscript{2} Moreover, the alveolar bone of the edentulous site is quantitatively and qualitatively reduced.\textsuperscript{3-5} In particular, this change is observed most dramatically during the first year, and on average, 40-60% of the height and width of the alveolar bone are resorbed.\textsuperscript{4} In the anterior maxilla, the buccal plate of the extraction socket is thin and fragile to allow the alveolar bone to be continually resorbed after tooth extraction.\textsuperscript{6} Araújo and Lindhe revealed that buccal/lingual plate resorption of the extraction socket occurred at an overlapping time of 2 phases: phase 1 (the resorption of the bundle bone and the replacement to the woven bone) and phase 2 (the resorption of the outer surface on both sides of the bone wall).\textsuperscript{7} Araújo et al. experimentally studied changes of the ridge by placing an implant immediately after the extraction\textsuperscript{7} and concluded that the buccal plate rather than the lingual plate showed more severe vertical resorption, suggesting that this pattern of bone resorption after extraction should be considered when an implant is instantly inserted after extraction.

The supporting bone should be preserved during extraction and can be increased when various regenerative materials are used for implant placement. Nevins et al. revealed that the use of grafts during extraction had considerable advantages for the buccal plate of the extraction socket of teeth with prominent roots.\textsuperscript{10} To prevent bone resorption after extraction, many materials and techniques, including various bone grafts and/or barrier membranes, have been evaluated.\textsuperscript{11}

Artzi et al. found that porous bovine bone minerals were not resorbed in the human extraction socket, even after 9 months.\textsuperscript{12}
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Froum et al. showed that bioglass produced a positive effect on healing the extraction socket 6-8 months after tooth extraction. In particular, deproteinized bovine cancellous bone mineral (Bio-Oss, Geistlich, Switzerland) has been widely used to treat defects, such as in sinus floor elevation procedures or the extraction socket. Botticelli et al. reported that although a high rate of contact between Bio-Oss particles and newly formed bone occurred for 4 months, it did not enhance bone formation or the defect closure. In some human and animal experiments, socket preservation techniques were very successful, while other research has reported that the strong points of some preservation techniques were unclear. Therefore, previous bone graft techniques must be improved to be more easily conducted by an operator, leading to a faster substitution for the host bone.

Collagen is a material that has been utilized in various applications, and cross-linked compacted solids or lattice-like collagen gels can be prepared. The resorbable form of collagen has been used for the wound closure of a graft and the extraction socket as well as the intra-oral wound dressing. As mentioned above, many materials and techniques have been studied for preventing bone resorption after extraction. Nevertheless there was less studies for the buccal dehiscence defect at extraction sockets. The present study aimed to evaluate the effect of an absorbable atelocollagen sponge (Teruplug™, Terumo, Japan) on healing the hard tissue of the dehiscence defects in mongrel dogs.

2. Materials and Methods

2.1 Experimental Subjects

Twelve dogs aged 1-2 years, maturing in the same circumstances, were included in this study. Six dogs and another 6 were used to assess changes in hard tissue and the histological assessment after tooth extraction, respectively. The changes of hard tissues were investigated in 2 dogs 4, 6 and 10 weeks after extraction. The histological assessment was conducted in 2 dogs 4, 6 and 10 weeks after extraction. The protocol was approved by Institutional committee at the Chosun University Dental Hospital.

2.2 Methods

Each dog was anesthetized with Zoletil 50® (0.05 mg/kg, Verbac Lab, France) and xylazine HCl (Rompun® 0.15 mg/kg, Bayer, Korea). The second and fourth premolars were then cut vertically after elevating the flap and carefully extracted with forceps (Fig 1). To determine an index point to evaluate the hard tissue, a notch was formed on the third premolar using a bur (Fig 1D). After examining the depth of the extraction socket, two-thirds of the buccal wall of the right mandibular premolar extraction socket were removed (Fig 1A). For comparing the healing process in the buccal dehiscence defect and in the sound buccal wall, dogs without an inserted atelocollagen sponge after extraction with buccal plate preservation, with inserted atelocollagen sponge with buccal plate preservation, without an inserted atelocollagen sponge after removing the buccal wall and with an inserted atelocollagen sponge after removing the buccal wall were designated as Groups 1, 2, 3 and 4, respectively (Table 1) (Fig 1A and 1C). Primary closure was achieved, and the suture material was removed after 1 week. Gentamicin® (0.1 ml/kg, IM) was administered to all experimental dogs after surgery.

2.3 Estimation

2.3.1 Hard Tissue Estimation

To examine changes in hard tissue, the height of the buccal alveolar bone was examined with the previously formed notch by opening the flap 4, 6 and 10 weeks after surgery (Fig 1D).

2.3.2 Histological Estimation

Two dogs were sacrificed by intravenously administering phenobarbital (100 mg/kg) 4, 6 and 10 weeks after surgery.

Table 1. Experimental design.

<table>
<thead>
<tr>
<th>Group</th>
<th>Buccal dehiscence defect</th>
<th>Atelocollagen sponge</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>2</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>3</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>4</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
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Figure 1. Clinical procedure: (A) Reduction of the buccal wall with 1/3 of the apical remaining (Groups 3 and 4); (B) Atelocollagen sponge; (C) View of the insertion of Teruplug to the extraction socket (Groups 2 and 4); (D) Measurement of the buccal bone height of the extraction socket.