Histometric Evaluation of Periodontal Surgery

III. The Effect of Bone Resection on the Connective Tissue Attachment Level*

Jack Caton,† and Sture Nyman‡

The purpose of this study was to evaluate the effect of surgical elimination of the osseous walls of angular bony defects on the connective tissue attachment and alveolar bone levels. Using a Rhesus monkey model, 36 periodontal pockets in four animals were operated on while the contralateral pockets served as unoperated controls. Plaque control was maintained until the animals were killed 1 year after surgery. Following routine processing, the interdental tissues were analyzed histometrically. Comparing measurements of surgically treated and untreated sites, resection of the osseous walls of interdentally located angular bony defects caused not only a reduction in the height of the alveolar bone but also a significant loss of connective tissue attachment. The procedure also resulted in the elimination of angular bony defects, intrabony pockets, and in addition, reduced the height of the interdental soft tissue.

The periodontal literature contains different viewpoints on the necessity for elimination of osseous deformities and angular bony defects in the surgical management of periodontitis. For example, Schluger, Friedman, Ochsenbein, and Ochsenbein and Ross advocate recontouring and resection of the bone walls of angular defects to prevent the recurrence of periodontal pockets after treatment. Other investigators recommend procedures which include curettage of osseous defects but exclude mechanical removal of bone. These latter procedures would permit a remodeling of alveolar bone and repair of bone within angular defects. In fact, later studies have shown that “bone fill” predictably will occur after surgical debridement of the osseous defects (i.e., removal of plaque, calculus and granulation tissue in combination with root planing), and establishment of optimal postoperative plaque control. Precise information is sparse regarding the effect of these two types of procedures (resective and nonresective bone surgery) on the connective tissue attachment level and the alveolar bone.

A series of studies demonstrating the effect on the connective tissue attachment level of various surgical procedures, without bone resection, have been reported by Caton and co-workers. These investigations were carried out using a nonhuman primate model, in which it is possible to produce periodontal pockets of nearly identical depth and morphology around contralateral teeth, one of which can be subjected to a therapeutic procedure while the other serves as its non-treated control. The results of these studies showed that the connective tissue attachment level remained unchanged when osseous resection was avoided.

The purpose of the present study was to evaluate the effect of surgical elimination of the osseous walls of angular bony defects on the connective tissue attachment and alveolar bone levels using the nonhuman primate model.

**MATERIALS AND METHODS**

Thirty-six contralateral pairs of periodontal pockets were produced on the maxillary and mandibular central incisors and first molars, the maxillary first bicuspids and the mandibular second bicuspids in four young adult male Rhesus monkeys (Macaca mulatta) by the methods described by Caton and Zander and Caton and Kolwański. Three months after pocket production, all test and control teeth were scaled and plaque control was initiated. The plaque control regimen consisted of toothbrushing, interdental flossing and a 3-minute topical application of 2% chlorhexidine gluconate solution three times a week (Monday, Wednesday and Friday). This method of plaque control has been shown previously to eliminate clinical signs of gingivitis in this species.

*After 3 weeks of plaque control, the pockets on one
side of the jaw (randomly selected) were subjected to the following surgical procedure while the other side remained as the unoperated control. Following scalloped reverse bevel incisions, mucoperiosteal flaps were reflected past the mucogingival junction on the facial and oral aspects of the teeth. All soft tissue was removed from the root surfaces and adjacent alveolar bone. The bony walls of the interdentally-located, one, two and three wall angular defects were eliminated with the use of a slow speed round bur under irrigation with sterile saline. Following planing of the exposed root surfaces down to the newly established alveolar crest, the surgical site was again irrigated with sterile saline and the flaps were apically positioned and secured with 4-0 silk interdental sutures. Care was taken to obtain complete coverage of the interdental bone by the soft tissue. A eugenol base periodontal dressing was applied over the wound area and 600,000 units of penicillin G administered intramuscularly once a day for 14 days after surgery. From this point, when the sutures and the surgical pack were removed, the regular plaque control regimen was reinstituted and continued for the remainder of the study. In addition, starting 2 weeks after surgery, all test and control teeth were scaled and polished every 60 days until the animals were killed, 1 year after the surgery.

Analysis

The surgically treated and control sites were prepared for cellloidin embedding and mesio-distal step serial sections cut and analyzed. Using the cemento-enamel junction as a fixed reference point, linear measurements were made along the root surface with a calibrated grid in the eyepiece of a light microscope at X 35 magnification, on at least 10 step serial sections at 196 µ intervals, to the most apical cells of the junctional epithelium and the crest of the interdental bone. The distance between the crest of the interdental gingiva and the apical end of the junctional epithelium was also measured. For the four animals, measurements from 36 sites on the operation side were compared to the corresponding contralateral control sites by the paired sample t test.

In order to determine whether the surgical procedure caused loss of connective tissue attachment and alveolar bone support on the "uninvolved" teeth immediately adjacent to the intrabony pockets, measurements were made as described above and compared by the same statistical method to the corresponding contralateral sites, i.e., control teeth which had intrabony pockets visible in a mesio-distal plane. Twelve such pairs were available for comparison. In addition to the histometric measurements, histological observations of the morphology of the interdental tissues were performed.

All histologic measurements were made by one investigator. Intraexaminer error for histologic measurements was determined before and after analysis by performing three sets of measurements, 72 hours apart, on 10 randomly chosen sections and then calculating the mean for each parameter. The percentage difference from this mean of each set was determined and the intraexaminer error expressed as the average percentage difference. Intraexaminer errors for the histologic measurements ranged from 2.9 to 3.8%.

RESULTS

The statistical analysis of the histological measurements is presented in Table I. The mean connective tissue attachment level apical to the cemento-enamel junction (CEJ-E) on the surgically treated teeth was 3.74 mm and on the control teeth 3.39 mm. The surgical procedure produced a significant loss of connective tissue attachment (P < 0.001) compared to the unoperated side. This was true for the four monkeys as a group, as well as for each individual monkey.

Similarly, surgery resulted in a significant (P < 0.001) loss of interdental crestal bone height. The mean crestal bone height relative to the cemento-enamel junction (CEJ-CR) on the surgically treated teeth was 4.04 mm and on the control teeth 3.43 mm. Again, this was true for the four monkeys as a group as well as for each individual monkey.

The surgery resulted in a loss in height of supracrestal soft tissue. The distance between the crest of the interdental gingiva and the apical end of the junctional epithelium (GMJE) was significantly (P < 0.001) reduced on the surgery side. The mean value of the teeth operated on was 2.28 mm and of the control teeth 3.20 mm.

Twelve of the 36 control pockets had an associated angular bony defect visible in a mesio-distal plane (Fig. 1). The apical end of the junctional epithelium was located apical to the crestal bone in these 12 pockets, and therefore, they could be classified as intrabony pockets. In contrast, there were no angular bony defects or intrabony pockets among the 36 treated teeth (Fig. 2).

In eight of the surgically treated pockets a small amount (< 0.30 mm) of new cementum could be seen on the instrumented root surface, apical to the junctional epithelium (Fig. 3). When this occurred, periodontal fibers were aligned roughly perpendicular to the new cementum.

<table>
<thead>
<tr>
<th>Table I</th>
<th>Histometric Analysis Comparing Operated and Unoperated Pockets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistical Analysis using paired t test. SD = Standard Deviation; δ = Mean difference; CEJ = Cemento-enamel junction; JE = Apical end of junctional epithelium; GM = Crest of interdental gingiva; CR = Crest of interdental bone.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operated</td>
</tr>
<tr>
<td>CEJ-JE</td>
<td>3.74</td>
</tr>
<tr>
<td>CEJ-CR</td>
<td>4.04</td>
</tr>
<tr>
<td>GM-JE</td>
<td>2.28</td>
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</tbody>
</table>

* Measurements in millimeters.
The crestal alveolar bone in both the experimental and control sites displayed neither marked reparative nor resorptive morphology. Enlarged osteoblasts and osteoclasts were rarely encountered on the surface of the crestal bone.

The statistical analysis comparing measurements of the surgically treated and untreated "uninvolved" teeth immediately adjacent to teeth with angular bony defects is presented in Table 2. A significant (P = <0.001) loss of connective tissue attachment and crestal bone height occurred on these teeth whose supporting bone before surgery was the wall of the adjacent angular defect.

**DISCUSSION**

This investigation demonstrated that resection of the osseous walls of interdentally located angular bony defects caused not only a reduction in the height of the alveolar bone, but also a significant loss of connective tissue attachment. This loss of support occurred on teeth with pockets as well as on adjacent "uninvolved" teeth whose supporting bone contributed to the walls of the angular bony defects. These findings are different from the results of "regenerative" procedures evaluated in the Rhesus monkey model, which showed no alteration in the connective tissue attachment level and some repair of alveolar bone.11,12

Several clinical and histological investigations related to osseous surgery have been reported. Clinical attachment levels, measured with a periodontal probe, have been reported following the apically positioned flap with osseous resection.13-17 Interproximal attachment levels were essentially unchanged with the exception of a significant loss in clinical attachment reported by Donnenfeld et al.1 While the histological findings in the present study correspond roughly to the clinical evaluation of Donnenfeld et al., the relationship of clinical attachment level measurements to the histologically determined connective tissue attachment level remains controversial, and therefore, strict comparisons cannot be made. The reported decrease in the interproximal bone height evaluated by re-entry operations and radiographic analysis18,19 agrees with the present histometric findings of a decrease in the height of the interproximal crestal bone.
Other investigators have examined the effect of osseous resection histologically. Thus, Wright and Loé using monkeys and Van Dijk using dogs, reported loss of connective tissue attachment and creetal alveolar bone which agrees with our findings. On the other hand, Caliess et al. using monkeys, found no change in either bone height or connective tissue attachment levels after 72 days.

One of the goals of osseous resective surgery has been the elimination of intrabony pockets and angular bony defects. In the present study, osseous resection resulted in the complete eradication of intrabony pockets, which could be visualized in a mesio-distal plane. The possibility exists that the buccal-lingual component of the intrabony pocket could still be present. The finding of a significant reduction in supracrestal soft tissues in our study is consistent with previous reports that the apically positioned flap procedure is effective in reducing clinical pocket depth.18-22-24

A series of clinical studies in humans have been reported regarding the effect of different surgical modalities (with and without osseous surgery) on the clinical attachment level and the alveolar bone height.19-20-21

Table 2

<table>
<thead>
<tr>
<th></th>
<th>Mean operated*</th>
<th>Mean unoperated*</th>
<th>N</th>
<th>( \Delta )</th>
<th>SD*</th>
<th>t Value</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEJ-JE</td>
<td>2.13</td>
<td>0.83</td>
<td>12</td>
<td>1.34</td>
<td>0.46</td>
<td>9.57</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>CEJ-CR</td>
<td>2.68</td>
<td>1.55</td>
<td>12</td>
<td>1.13</td>
<td>0.30</td>
<td>12.56</td>
<td>&lt;0.001</td>
</tr>
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* Measurements in millimeters.

The results of these studies have demonstrated that the determining factor for success or failure in the treatment of periodontitis is the degree of plaque control which can be accomplished and maintained rather than the method of surgery used. Thus, progression of disease was prevented in patients who were maintained on an optimal level of oral hygiene and the disease recurred in patients where plaque control was insufficient. The technique used for surgical elimination of pockets had little, if any, influence on the eradication of the disease. When these findings are considered in conjunction with the results reported here, osseous surgery, involving resection of the bone walls of angular defects, where these bone walls constitute supporting bone for adjacent teeth, must be carefully planned with respect to the goals of the therapeutic procedure.

REFERENCES


Figure 3. Surgically treated pocket on medial of mandibular second molar tooth. New cementum (N) has been deposited on planed old cementum (O), apical to the junctional epithelium (JE). CR = creetal alveolar bone, mesio-distal section (Original magnification X 200).
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