The Effect of Occlusal Forces on Healing Following Mucogingival Surgery*, **

BY IRVING GLICKMAN, JEROME B. SMULOW, GIORGIO VOGEL*** AND GINO PASSAMONTI, **** BOSTON, MASSACHUSETTS

NUMEROUS EXPERIMENTS have been conducted regarding the healing following various forms of mucogingival surgery.1-6 We were interested in determining whether post-surgical healing would be affected by altered occlusal forces.

PROCEDURE

Nine adult mongrel dogs were used as experimental animals and divided according to occlusal function in the maxillary anterior region as follows: Group I—Unaltered occlusion, 2 animals, Group II—Hyperfunction, 3 animals; Group III—Hypofunction, 3 animals. One animal served as unoperated control. Hyperfunction was created using a cast gold overcontoured splint cemented on the mandibular anterior teeth so as to increase the vertical dimension and create excessive apico-labial forces (Fig. 1). Hypofunction was created by extraction of the mandibular incisors (Fig. 2).

Mucogingival surgery was performed in the maxillary anterior region at the time the occlusion was altered. The maxillary anterior region was divided into two areas, from the midline to the distal of the third incisor. On the right side a gingival flap was reflected from the gingival margin to the fornx of the vestibule, where it was resected. The periosteum was left intact on the bone. A repositioned flap operation was performed on the labial surface on the left side. A mucoperiosteal flap was reflected and then replaced and sutured into position at the level of the bone (Fig. 3). The palatal marginal gingiva was removed by gingivectomy on both sides.

The operated areas were covered with periodontal pack* retained with an acrylic stent for a period of two weeks. The animals were sacrificed after three months, at which time the jaws were removed, fixed in 10 per cent neutral buffered formalin, decalcified, embedded in celloidin and cut in serial section.

MICROSCOPIC FINDINGS

Maxillary Right Side—Resected Gingival Flap Operation—Periosteum Intact on the Bone

Unaltered Occlusion. The gingiva was healed with the sulcus restored at the level of the cemento-enamel junction (Figs. 4 and 5). There was a moderate leukocytic infil-

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Fig. 1. Cast overcontoured splint to create hyperfunction. Notches in teeth are for clinical measurements.

Fig. 2. Hypofunction created by extraction of mandibular anterior teeth. Notches in teeth are for clinical measurements.

Fig. 3. Experimental operative procedure. Animal’s right side—Resected flap operation—periosteum intact on bone. Animal’s left side—Repositioned flap operation.

Fig. 4. Unoperated control animal—survey labio-palatal section of right maxillary incisor showing relationship of the gingiva, periodontal ligament and alveolar bone. Hematoxylin and eosin. Orig. Mag. X9.

Fig. 5. Unaltered occlusion—Resected Gingival Flap Operation—Periosteum Intact on the Bone—survey labio-palatal section of right maxillary incisor three months after operation showing increased length of attached gingiva and slight reduction in height of labial bone. Hematoxylin and eosin. Orig. Mag. X9.
Fig. 6. Unaltered occlusion—detailed view of labial crest shown in Figure 5. Note dense periodontal ligament fiber bundles perpendicular to tooth and bone with bone formation adjacent to periodontal ligament and on external labial surface. Hematoxylin and eosin. Orig. Mag. X90.

tration in the connective tissue at the base of the sulcus. The attached gingiva was well formed and increased in length compared with the unoperated control. There was a slight reduction in the height of the labial bone and bone formation was observed adjacent to the periodontal ligament and on the external surface (Fig. 6). The periodontal ligament was intact with dense fiber bundles perpendicular to the tooth and bone.

Hyperfunction. The gingiva was healed with a well-formed gingival sulcus and attached gingiva which was increased in length (Fig. 7). The gingival attachment was at the cemento-enamel junction, but in some areas it was increased in length. There was a moderate marginal leukocytic infiltration in the gingiva. The periodontal ligament was widened with well-formed fibers with an increased number of dilated blood vessels. The bone surface adjacent to the periodontal ligament presented irregular resorption lines covered with new bone into which new fibers were embedded (Fig. 8). The labial bone was slightly reduced in height compared with the unoperated animal, but not to a greater degree than in the operated animals with unaltered occlusion.

The morphology of the labial plate was markedly altered. In the gingival half it was thinned in contrast with the apical half which presented a thickened bulge (Fig. 7). There was new bone formation in the crestal region of the labial plate with pronounced osteoclasts along the adjacent external surface (Fig. 9). There was incremental bone apposition beneath the periosteum in the apical portion of the labial plate. Partially repaired areas of resorption in the labial root surface extended through the cementum into the dentin (Fig. 10).

Hypofunction. The gingiva was healed with an intact gingival sulcus at the cemento-enamel junction, with moderate underlying
leukocytic infiltration (Figs. 11 and 12). The height of the labial bone was reduced compared with the unoperated control but not to a greater degree than in the operated animals with unaltered occlusion. The fibers of the periodontal ligament were reduced in number. The fiber bundles were less evident and in some areas the fibers were disoriented and parallel to the root. On both the labial and palatal surfaces the alveolar crest fibers were elongated and almost parallel to the root as if the tooth were extruded.

The contour of the labial plate was notably altered. The gingival portion was thinned and tapered with prominent osteoclastic activity along the external surface. The apical half of the labial plate was thickened, and in some areas formed a distinct bulge (Fig. 11).

There were striking differences in the appearance of the palatal surface of the hypo and hyperfunction animals. In the former the alveolar crest fibers extended from the bone to the tooth in long bundles, almost parallel to the tooth surface. A thin zone of surface osteoid was present at the bony crest (Fig. 13). In the hyperfunction animals the crestal fibers were shorter, more nearly perpendicular to the tooth, with evidence of incremental bone apposition at the crest in the direction of the fibers (Fig. 14).

Maxillary Left Side—Repositioned Flap Operation—Periosteum Elevated from the Bone

In Group I (Unaltered occlusion), Group II (Hyperfunction) and Group III (Hypo-function), the findings in terms of gingival healing, location of the gingival sulcus, widened zone of attached gingiva and the appearance of the periodontal ligament, and labial and palatal bone were essentially the same as in their counterparts on the right side.

The labial bone presented similar alterations in contour in the hypo and hyperfunction animals as those observed on the right
The severe abnormal occlusal conditions created in the experiment significantly affected the healing following mucogingival surgery. The effects were manifested in the periodontal ligament and the alveolar bone. The change in occlusal forces apparently did not influence the healing of the gingiva in terms of the formation of a normal gingival sulcus and zone of attached gingiva and the location of the gingival attachment on the root surface.

In the hypofunction animals there was a reorientation in direction of the periodontal ligament fibers and a reduction in fiber density. The alveolar crest fibers were longer than normal and extended from the crest of the alveolar bone to the tooth surface almost parallel to it consistent with extrusion of the teeth.

In the hyperfunction animals the microscopic findings were consistent with the reparative changes one would expect to find three months after the periodontal tissues had been injured by the abrupt increase in force created by the overcontoured crowns. The periodontal ligament was densely fibrous and widened, with increased vascularity. The bone surface adjacent to the periodontal ligament was remodelled as evidenced by new bone and osteoid in previously resorbed areas. On the palatal surface of the teeth in hyperfunction there were well-formed periodontal ligament fibers
Fig. 12. Hypofunction animal—detailed view of crest of labial bone shown in Figure 11. There is a reduction in the number and density of the periodontal ligament fibers. Note resorption of bone on external surface. Hematoxylin and eosin. Orig. Mag. X80.

Fig. 13. Hypofunction animal—detailed view of gingiva and crest of palatal bone shown in Figure 11. The alveolar crest fibers extend in long bundles from crest to root surface almost parallel to tooth surface. Hematoxylin and eosin. Orig. Mag. X60.

Fig. 14. Hyperfunction animal—detailed view of crest of palatal bone shown in Figure 11. The alveolar crest fibers are short and more nearly perpendicular to the root surface. Compare with Figure 13. Hematoxylin and eosin. Orig. Mag. X60.

Fig. 15. Hyperfunction animal—Repositioned Flap Operation—Periosteum Removed, three months after operation showing partially repaired cemental tear on the palatal surface of maxillary left incisor. Hematoxylin and eosin. Orig. Mag. X120.
with new bone increments suggesting a response to tension created by the excessive labially directed forces.

The most striking change created by the abnormal occlusion was the altered contour of the labial plate in the operated areas. Comparable changes in contour occurred with hypo and hyperocclusion and with both types of surgical operation. The changes consisted of a thinning and a tapering of the gingival segment of the labial plate and a bulge-like thickening in the apical portion. The thinning of the bone resulted from increased osteoclasts along the outer surface and the thickening was produced by periosteal bone apposition.

It might be hypothesized that the thickening of the apical portion of the labial bone in the hyperfunction animals represented an attempt to compensate for the thinning in the gingival area in order to stabilize the tooth against displacement by the increased labial force. It is difficult to explain why hypofunction produced comparable changes in bony contour.

The height of the labial plate was not quantitated microscopically, but it appeared that the altered occlusion did not cause reduction in bone height beyond that produced by the experimental surgical procedures. In all operated animals the labial bone height was reduced to a greater degree on the left side (repositioned flap—periosteum elevated from the bone) than on the right side (resected gingival flap—periosteum intact on the bone).

Extreme and abrupt alterations in occlusion affected the healing following the forms of mucogingival surgery performed in this experiment and the effects were microscopically detectable three months after the operation. Less severe and gradual changes in occlusal forces might have been tolerated without affecting post-surgical healing. However, based upon the findings, occlusal forces constitute a variable which could affect the healing following mucogingival surgery. The limits beyond which the occlusion must be altered in order to significantly affect the healing should be determined.

CONCLUSIONS

Artificially created hyperfunction and hypofunction altered the healing following mucogingival surgery operations in which the periosteum was removed from the bone and in which the periosteum was left intact. The altered occlusion produced a change in the contour of the labial bony plate. The healing of the gingiva and location of the gingival margin were not affected. It is suggested that occlusion is one of the variables which affects the outcome of mucogingival surgery.

REFERENCES