Vertical Releasing Incisions for Flap Design: Clinical and Histological Study in Monkeys

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Introduction
Since the work of Portsch in the last century, the use of incisions in oral surgical procedures has been well explored. Several authors have examined numerous incision designs for various purposes. Among them is the use of vertical incisions to facilitate tooth extraction, and to perform periapical or periodontal surgery. Periodontal flap procedures routinely include vertical releasing incisions. Because of improper healing at their marginal ends, delayed restoration of the normal anatomical contour of the gingival margin, or even gingival grooves, may result.

Our purpose was to investigate in monkeys the clinical and histological aspects, including microvascularization, of the healing process of two different vertical releasing incisions: one perpendicular, and one beveled to the underlying alveolar bone.

Material and Methods
Two young adult Rhesus monkeys, with an average weight of 12 lbs., were used for this study. Anesthesia with pentobarbital sodium (Nembutal), 30 mg/kg of body weight, was given. Ten full thickness flaps, using molars and premolars, were carried out with two vertical releasing incisions placed at interproximal areas: one perpendicular and the other beveled to the alveolar bone. They extended from the margin straight down apically to the mucogingival line (Figs. 1 and 2). Each incision was assigned randomly to one or the other design by the toss of a coin. The flaps were reflected and the deno-gingival area was curetted. Afterward, the flaps were replaced and secured by No. 000 sutures. No sutures were placed at the vertical releasing incisions (Figs. 3 and 4).

The monkeys were killed by general anesthesia 9, 14, 21 or 28 days after the procedures. They were exsanguinated via the femoral arteries. A combined solution of Pelkan carbon black and 10% buffered formalin solution was perfused through the exposed and cannulated external carotid arteries to evaluate revascularization of the wound areas. Two blocks for each postoperative time period, including the operated teeth and the surrounding tissues, were obtained and fixed in 10% formalin. After partial decalcification in EDTA, cross-sections about 1 mm thick were obtained from one block and cleared by the Spalteholz method. The other block was dehydrated, embedded in paraffin, and cross-sectioned serially at about 10 µm to be stained with H & E. For evaluation, sections from three different levels were selected: (a) the most coronal part of the marginal area; (b) the middle of the sulcular area; and (c) slightly apically, or at the bottom of the sulcular epithelium (Fig. 1).

Results
Clinical Evaluation
Immediately after the surgery, the full thickness flap was well adapted and the two vertical releasing incisions, perpendicular and beveled, showed no clinical difference. In order to avoid any possible interference with the healing process, no sutures were placed at the level of the vertical incisions (Figs. 3 and 4).
Fig. 1. The design of the surgical procedure performed and the level where the cross-sections were obtained.

Fig. 2 (a) Incision perpendicular to the underlying alveolar bone. (b) Incision beveled to the underlying alveolar bone.

Fig. 3. No sutures were placed at the level of the vertical releasing incisions to avoid any possible interference with the healing process.

At 9 days postoperatively, the marginal tissues associated with the perpendicular incision area showed a groove that could not be observed in the marginal tissues associated with the beveled incision area.

The 14-, 21- and 28-day postoperative samples continued to show, although on a lesser scale, some groove at the marginal tissue associated with the perpendicular incision, while the location of the beveled incisions could not be detected.

**Histological and microvascular aspect**

The 9-day specimen at level (a) has a very thin crevicular epithelium, showing some inflammatory infiltrate along this area. A dense connective tissue is interposed between the crevicular and the oral epithelium, where a rich and well-organized network of vessels can be observed. This becomes less organized, with some dilated vessels and increased cellularity at the two incision sites. The smooth keratinized oral epithelium with regular rete pegs is disrupted at the perpendicular site, where irregular and enlarged rete pegs, almost reaching the crevicular epithelium, are present, interrupting the normal vascular arrangement of the loops (Figs. 1 and 5). At level (b) the appearance is nearly the same, but the inflammatory reaction with increasing vascularization is present, not only at the areas of the incisions, but also within the flap. The perpendicular incision always shows more inflammation than the beveled one.

The soft-tissue groove and the microvascular gap are also quite evident at the perpendicular incision site, while the beveled incision site exhibits only a slight defect (Figs. 1, 6, and 8). At level (c), vascularization of sulcular and oral epithelia are well defined, while the vascular network in between them is less evident (Figs. 1 and 7).

The 14-day specimen shows at level (a) a thin crevicular epithelium along the entire area with a more prominent microvascularization than the one present underneath the oral epithelium. The latter is smoother all over the area, but at the perpendicular incision area, a groove or depression is still present. The capillary loops at this site are shorter and irregular, if compared with the other incision site, but increased cellularity is still present on both incision areas (Figs. 1 and 9). The levels (b) and (c) show the same characteristics, but with reduced intensity (Figs. 1 and 10).

The 21- and 28-day slides show at level (a) some fusion of rete pegs from the crevicular and oral epithelia over the roots. The inflammatory reaction is quite evident. A groove is still present at the perpendicular incision area. The irregularity of the rete
Figs 5-8 Nine days postoperatively.

Fig. 5 Level "a": (a) overall picture, (b) perpendicular, and (c) beveled sites (H&E, original magnification X3 and X14).

Fig. 6 Level "a": (a) overall picture, (b) perpendicular, and (c) beveled sites (H&E, original magnification X3 and X14).

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Fig. 7 Level "c": (a) overall picture, (b) perpendicular, and (c) beveled sides (H&E, original magnification X3 and X16)

Fig. 8 Level "b": (a) overall picture, (b) perpendicular, and (c) beveled sides (clear sections X5 and X100)

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Fig 9: Fourteen days postoperatively, Level "a": (a) Overall picture, (b) Perpendicular, and (c) Beveled sites (clear sections, original magnification X25, X100, and X200).

Fig 10: Fourteen days postoperatively, Level "b": (a) Perpendicular and (b) Beveled sites (H&E, original magnification X160).
Fig. 11 Twenty-one days postoperatively, level "a," (a) overall picture, (b) perpendicular, and (c) beveled sites (H&E, original magnification X3 and X16).

Fig. 12 Twenty-one days postoperatively, level "b," (a) overall picture, (b) perpendicular, and (c) beveled sites (thin section, original magnification X3 and X10).
pegs, at this site, with changes in thickness and width, is more evident than the one observed at the beveled incision area. The differences in capillary loops between the two areas are similar to those observed in the 14-day specimens, but the connective tissue fibers are completely reorganized at the beveled area (Figs. 1 and 11). At levels (b) and (c) the healing process is more advanced (Figs. 1 and 12).

Discussion

Special attention should be taken when vertical releasing incisions are performed as part of the flap design. This study has compared two different types of vertical releasing incisions; one perpendicular, the other beveled to the underlying alveolar bone. Flaps were elevated, the area curetted and flaps repositioned to their former location and sutured. The serial cross-sections obtained have presented in the same specimens the two incisions to be studied and compared. The wider tissue interface, present at the beveled incision site, improved the healing by allowing faster reorganization and avoiding accidents. Wirthlin et al. demonstrated a fused bridge of oral and crevicular epithelia and a slight groove 7 days postoperatively, when a simple vertical incision was performed parallel to the long axis of the tooth in attached gingiva. A soft tissue groove has been shown at the sites of the perpendicular incisions (which matched with those of Wirthlin) throughout the experiment. The difference between the two results might be explained by the fact that no flap reflection was performed by Wirthlin et al., while a full mucoperiosteal flap was raised in our experiment. A slight depression also was seen in some of the beveled incision sites in this study. However, the pattern of healing was not altered around these areas as significantly as it was around perpendicular incisions. It is worth noting that with both incisions, healing was always more advanced in the deeper areas, away from the gingival margin.

In suturing the flaps, sutures were placed away from the incisions to avoid any possible interferences with healing in the areas of the vertical releasing incisions. Neither disruption of vascularization nor alterations in healing that could be ascribed to the sutures was found histologically. It would be interesting to evaluate whether different suturing techniques would interfere differently with revascularization and healing of these patterns of incisions.

Even though sutures are placed, there is always the possibility of some flap displacement, with tissue overlapping on one side and a gap on the other. This one condition alone will delay the healing process: if a perpendicular incision is used, epithelial bridging will take place only after growth of granulation tissue has occurred.

Based on these results, the beveled incision, which is also called "slanted" by Ramfjord, should be advocated for all kinds of techniques involving a full thickness flap when vertical incisions are needed.

Summary

Mucoperiosteal flaps incorporating two different vertical releasing incisions, one perpendicular and another beveled, to the underlying alveolar bone were performed in monkeys to evaluate and compare possible healing variations. The clinical, histological and microvascular aspects of healing were studied from 9-26 days. Healing in the beveled incision was faster, owing to the amount of soft tissue interface. Soft tissue grooves (accidents) were more frequently noted in association with perpendicular incisions.

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References