Surgical Endodontics

Endodontic flap design

1984 Lubow et al Endodontic flap design: analysis and recommendations for current usage

Most important factor in flap design is blood supply – therefore widest at the base. Then consider regional anatomy – BVs and nerves. Incisions should not be over defects. Then closure - Flap should be replaced so as to cover all surgically exposed sites.

Relieving incisions at least one tooth mesial or distal to the surgical site to cover the surgical area.

6 flap designs – semilunar, triangular, rectangular, trapezoidal, vertical incision and Luebke-Oschsenbein – all full thickness

- Semilunar – contraindicated when a fenestration or dehiscence is present along incision line – often leads to scarring.
- Triangular flap – useful for short roots. Horizontal incision in gingival sulcus, with vertical relieving incision extending to alveolar mucosa interproximally.
- Trapezoidal and rectangular – horizontal incision in gingival sulcus with vertical relieving incisions. Relieving incision are not placed directly over a root or bony prominence which may have an inadequate supply.
- Luebke-Oschsenbein – horizontal incision placed a minimum of 2mm from the depth of the gingival sulcus, the incision line then curves gently to form the vertical components of the flap. Give excellent access and vision and adequate blood supply, not interfere with the aesthetics at the gingival margin. Disadvantage – 2mm of attached gingiva should be present coronal to the line of incision, minimal attached gingiva at the surgical site, unpredictable scar formation

Authors recommend - Full-thickness dissection with easily recognizable landmarks and straight-line incisions. A bevelled horizontal incision is designed to incorporate the maximum amount of facial keratinised tissue into the body of the flap, while leaving the interproximal tissues untouched. Starts in the sulcus – bevelled and cuts across papillae leaving intact. The resultant flap is easily replaced with interrupted sutures to the stable interproximal papillae.

Disadvantages – full thickness may lead to dehiscences/fenestrations. May have gingival aesthetic probs.

1984 Kramper et al Comparative study of the wound healing of 3 types of flap design (on dogs)

Semilunar, submarginal – incision in the attached gingivae, intrasulcular. – submarginal better except in the development of scar formation. Inflammatory changes persisted longer in the semilunar and intrasulcular incisions and retarded wound healing. Loss of alveolar bone occurred in the submarginal and semilunar incisions

Intrasulcular – led to healing by second intention (granulation) due to problems with reapproximation of the wound edges. Loss of alveolar bone and gingival recession. But no scarring visible

Submarginal – easy to replace and primary intention healing. Tensile strength of the submarginal incision wound will be greater at 60 days than the semilunar and intrasulcular incision wounds.Scar tissue present

Semilunar – due to greater vascularity in alveolar mucosa, incision likely to lead to increased hemorrhage. Often leads to overextension or damage to the wound margins for access and visibility.

The requirement of a minimum of 2mm of attached gingiva is of great important in the prevention of mucogingival problems. Triangular flap designs are acceptable if adequate access can be achieved without trauma to the wound margins. Trapezoidal flap designs are not necessary as blood supply should be good enough.

Choice between intrasulcular and submarginal must be first based on the anatomical location of the pathological lesion. The only requisite is that a fibrin clot be established and maintained into which the tissue elements are able to migrate. However, since postop trauma cannot always be avoided, it is prudent to place the incision over healthy bone so the intact periosteum can provide a firm base for suturing the surgical flap into place.

Retraction of a full thickness flap will expose alveolar crestal bone, causing some loss of that bone, possible recession of the marginal gingiva, or at least lengthening of the epithelial attachment.

1995 Moiseiwitsch – Avoiding the mental foramen during periapical surgery

3 steps during presurgical diagnosis, flap design and surgery are presented.

- Preop diagnosis – PA and panoramic. Or vertically placed standard periapical and standard view.
- Flap design – Place single relieving incision distally as access created without stretching mental neurovascular bundle. Could cut groove into bone to prevent retractor slipping.
- Surgical technique – nerve damage often by strectching or crushing of bundle with retractor. Try to stop retractor from slipping.

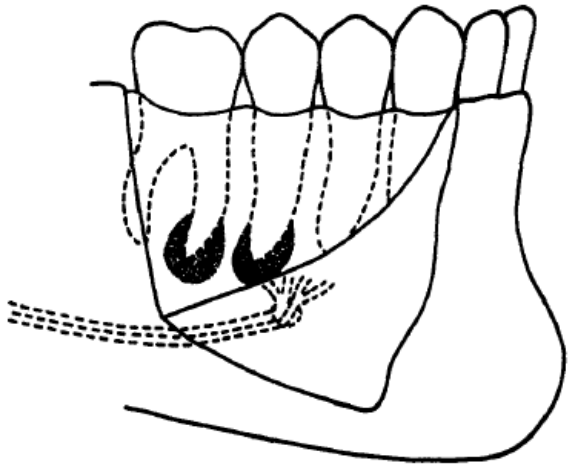


FIG 4. If the releasing incision is placed distal to the surgical site, excellent access can be achieve without stretching the mental neurovascular bundle.

is available of the vertical distance of the mental foramen from the tooth apex.

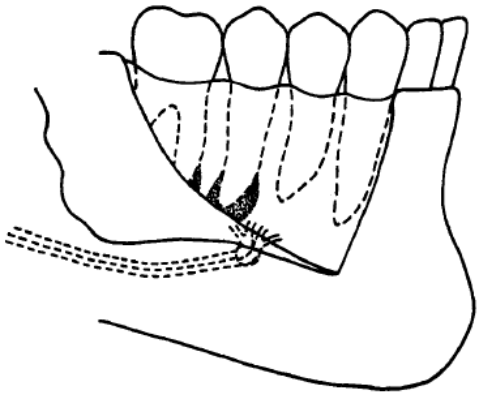


FIG 3. Usually the vertical releasing incision is placed mesial to the surgical site for posterior mandibular surgery. However, when working distal to the mental foramen the mental nerve must often be stretched to gain sufficient access for periapical surgery.

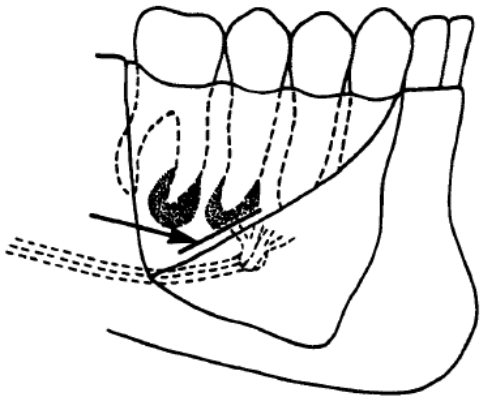


FIG 5. To prevent the retractor slipping during surgery, and perhaps crushing the mental nerve, a groove may be placed in the cortical bone to provide a firm, positive stop for retractor positioning. *Arrow* indicates the groove.

approach, when carrying out apical surgery on a tooth posterior to

2002 Velvart - Papilla base incision: a new approach to recession-free healing of the interdental papilla after endodontic surgery

To evaluate a new incision technique: the papilla base incision.

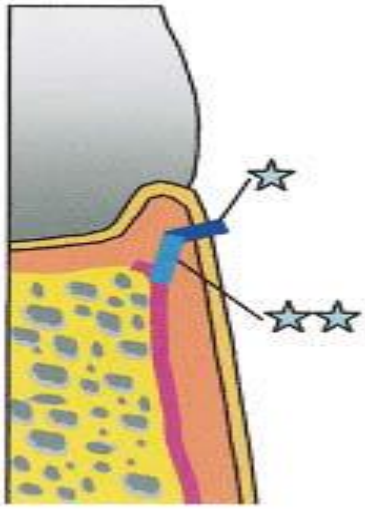
The papilla base flap, consisting of the papilla base incision and two releasing incisions, was used to expose the bone. The papilla base incision consisted of a shallow first incision at the base of the papilla and a second incision directed to the crestal bone, creating a split thickness flap in the area of the papilla base. Further apically a full thickness flap was raised.

In patients with healthy marginal periodontal conditions the papilla base incision allows rapid and predictable recession-free healing following marginal surgical exposure of the soft

tissues. One month postoperatively the majority of the incisions were completely or partially invisible. No noticeable space was created beneath the contact point area.

When the distance from the contact point to the bone was 5 mm or less, the papilla was present almost 100% of the time. With a distance of 6 mm, the papilla was present 56% of the time, and when the distance measured 7 mm or more, the papilla was present 27% of the time or less.

Intro - Endodontic surgery requires exposure of the bone covering the root(s) and the apices. To achieve access, a full thickness flap must be raised, which consists of gingival and mucosal tissue as well as periosteum. To mobilize the flap, various modes of incisions can be selected including horizontal incisions (sulcular and submarginal) and vertical releasing incisions (Gutmann & Harrison 1991a).



The papilla base incision (above) required two different incisions at the base of the papilla.

1 The first shallow incision severed the epithelium and connective tissue to the depth of 1.5 mm from the surface of the gingiva. The incision was placed at the level of the lower third of the papilla in a slight curved line going from one side of the papilla to the other (Fig. 1). The incision started and ended in a 90 degree angle between the border of the tooth and the gingiva (see lines in Fig. 1 above).

2 The scalpel was then placed to the base of the previously created shallow incision at the base of the papilla and subsequently inclined apically, almost parallel to the long axis of the tooth, aiming at the crestal bone margin. With this second incision a split thickness flap was prepared in the apical third of the base of the papilla. The incision ended at the crestal bone level, where the periosteum was separated from the bone (Fig. 2). From there on the preparation continued in a full thickness muco periosteal flap. Buccally over the tooth the vertical incision and papilla base incision were joined by an intrasulcular incision. The scalpel was moved within the sulcus, dissecting the gingiva to the crestal bone. The sulcular incision reached from the releasing incision to the start of the papilla base incision,

or from one papilla to the next papilla. The flap was mobilized and retracted, during the root-end resection and filling.

The flap closure was initiated from the releasing incisions. For the vertical incisions 6/0 (Supramid, B. Braun, Neuhausen, Switzerland) interrupted polyamide sutures were used. The papilla base incision was sutured with two or three polypropylene 7/0 (Prolene, Ethicon, Norderstedt, Germany) interrupted sutures depending on the width of the papilla.

It is of utmost importance to preserve epithelial and connective tissue attachment at its original level and traumatize the attachment apparatus as little as possible during the incision in order to obtain rapid healing through primary intention. This can be obtained by:

1 complete and sharp incision of the tissues;
2 avoiding crushing of the tissues;
3 preventing drying of the tissues during the procedure; and
4 perfect adaptation of wound edges upon closure
(Gutmann & Harrison 1991b).

The wound edges are perfectly reapproximated without tension on the suture. Tension will compromise blood circulation on both the papilla and the split flap and cause delayed healing. It was shown by Pini Prato *et al*. (2000) that greater tension reduced root coverage in coronally advanced flaps.

a) Wound closure of the papilla base incision with three polypropylene sutures; (b) sutures removed after 4 days.

A minimum of two sutures is required, one at each side of the papilla base incision for perfect reapproximation of the wound edges.

The key point of the Papilla base incision is to avoid thinning of the split flap. The epithelium of the partial thickness portion of the flap needs support by underlying connective tissue, which has to be thick enough to maintain vitality through sufficient blood supply. If this goal cannot be obtained, the tissue will necrotize, resulting in a tissue defect, followed by scar formation. On the other hand, excessive thickness of the connective tissue layer of the split flap portion could compromise the survival of the unreflected buccal papilla. The ideal thickness of a partial thickness flap is unknown.

2005 Velvart and Peters - Soft Tissue Management in Endodontic Surgery

Complete, recession-free and predictable healing of gingival tissue is one important goal of endodontic surgical treatment.

Several studies have identified factors that influence the prognosis of endodontic surgery (4 –11). According to Friedman (12) they can be divided into preoperative-, operative-, and postoperative factors. Success rates vary between 25% and 98% depending on the study (13, 14).

An important anatomical consideration during endodontic surgery is the course of blood vessels supplying alveolar mucosa and gingiva. Four interconnected pathways of blood supply exist:

- the subepithelial capillaries of the gingiva and alveolar mucosa,
- the vascular network within the periosteum,
- the intraseptal arteries in the bone marrow and
- the plexus of the periodontium.

Accessing the apical pathology - an evaluation of the size and position of the expected periradicular pathology in relation to the root, neurovascular structures and the sinus has to take place, including assessment of the local blood supply to the soft tissues in and around the designated flap area.

Triangular Flap

This type of surgical flap comprises a horizontal incision extending at least one tooth mesially and distally to the involved area combined with one releasing vertical incision forms a triangular flap (Fig. 4). Usually, the releasing incision is performed on the mesial part of the flap.

The triangular flap is mainly indicated for correction of problems in the cervical and mid-root portions, such as in cases with cervical root resorptions, perforations and in resections of very short roots. The main advantages of this flap design are minimal disruption of the blood supply to the mobilized tissues and easy repositioning of the wound edges. As in all intrasulcular horizontal incisions, recession may result after the healing process.

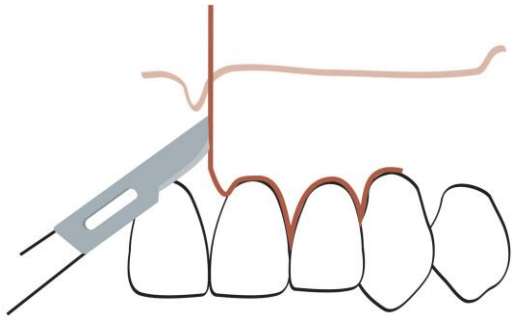
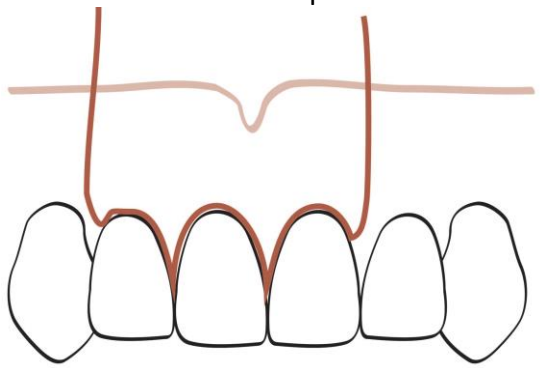


Fig 4

Rectangular and Trapezoidal Flap

Rectangular and trapezoidal flaps are an extension of the triangular flap with a second vertical releasing incision. Most frequesntly used flaps. As the blood vessels run mostly parallel to the long axis of the teeth from the apical to the coronal direction, one consideration is to disrupt the least number of vascular structures.

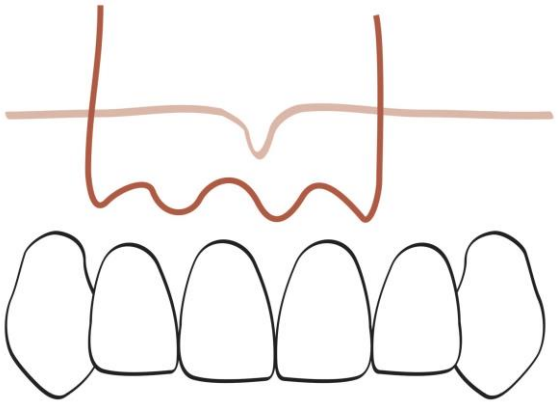


The longer the flap length the more important is the ratio between the length and width of the flap (54). Several authors advocate a length-width ratio of 2:1

Submarginal Flap

The most popular submarginal flap is the flap design by Ochsenbein and Luebke (56). Two releasing vertical incisions are connected by a scalloped horizontal incision. The submarginal flap is only to be used, when there is a broad zone of attached gingiva with a minimum of 2 mm.

Advantage of leaving the marginal gingiva untouched and it does not expose any restoration margins. As crestal bone is not denuded, the risk of attachment loss is minimized. In rare situations, because of insufficient treatment planning and poor surgical technique, necrosis of the unreflected tissue might occur because of deprivation of blood supply to this area. The recession resulting from such tissue breakdown can have devastating effects on the esthetic outcome of surgical treatment. Possible scar tissue formation is another disadvantage of the submarginal flap.



Semilunar Flap

Placing either a straight or a curved horizontal incision in the alveolar mucosa that extends all the way to the bone creates a semilunar flap. The only advantage of this flap design is the fact that the marginal tissue remains untouched and thus no recession will occur. On the other hand, many disadvantages accompany its use. A semilunar flap will provide only limited access to the surgical area. Additionally, placement of the incision over the bony

defect means that the wound cannot be closed over sound bone structure. Furthermore, the content of elastic fibers and muscle attachments of alveolar mucosa is high, both of which exert pulling forces on the reapproximated surgical wound margins

SURGICAL SITE CLOSURE

After irrigation with saline solution to remove debris, the wound edges are reapproximated carefully to allow primary intention healing (52).

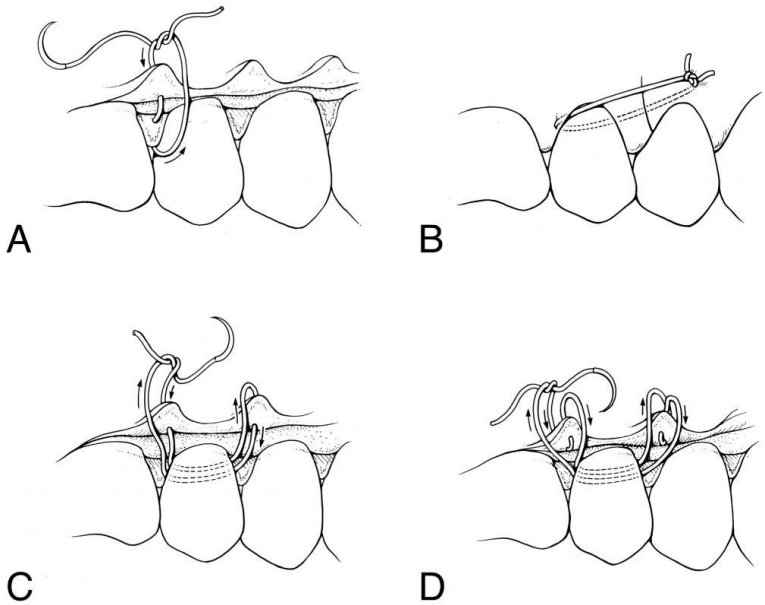
Compression of the repositioned flap with a saline-moistened piece of gauze is necessary to create a thin fibrin layer between flapped tissue and cortical bone (53, 58, 59). Replacement of a thin blood clot with parallel fibrin fibers by new fibrous tissue results in collagen adhesion (58).

SUTURES: TECHNIQUES AND MATERIALS

Bacterial colonization is an important factor leading to tissue reactions to intraoral sutures. When comparing histological tissue response of different suture materials, monofilament sutures (e.g. nylon, gut, steel, and chromic gut) produced smaller inflammatory reaction than multifilament materials (e.g. silk, siliconized silk, polyester, teflonized polyester, cotton, or linen)

In general, monofilament synthetic sutures are least traumatic, allow less bacterial migration and are the materials of choice. Sutures should not act as ligatures and tension created by sutures should be minimal (45). Tension can be reduced by using a greater number of sutures and by choosing fine microsurgical materials (28).

While full flaps are best secured using vertical mattress sutures and anchor sutures, limited flaps are best retained using interrupted, fine-diameter sutures.



Examples of commonly employed suture techniques. (*A*) interrupted suture, (*B*) anchor suture, (*C*) sling suture, and (*D*) vertical mattress suture Reprinted with permission from (102).

SUTURE REMOVAL

A perisutural epithelial sleeve develops at 3 days and can enrobe the entire suture track after 7 days (66). An intense inflammatory response to suture materials and the trauma of suture placement is visible after 3 days (66). As resealing of epithelium at the wound margin is evident within 2 days, suture removal can take place after 48 h but should take place no longer than 96 h after placement.

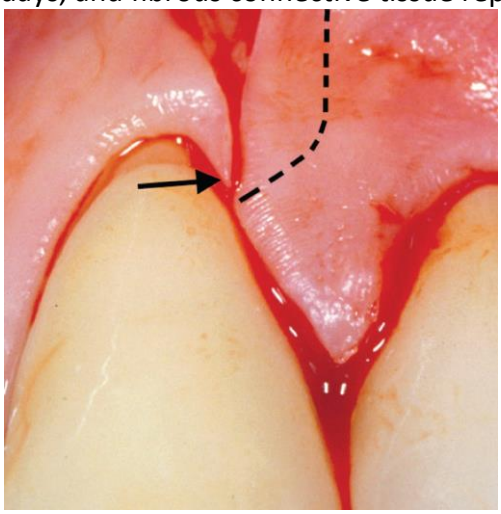
CRITICAL REVIEW OF SOFT TISSUE HEALING

Healing Process

Healing takes place in several phases that overlap and coexist:

- wounding,
- clotting and inflammation,
- epithelial healing,
- connective tissue healing,
- proliferation,
- maturation, and
- remodelling

Within 24 h, polymorphonuclear leukocytes and macrophages start migrating into a blood clot. Stimulated macrophages play a central role in angiogenesis and new collagen synthesis. After 4 days an epithelial barrier has formed. Healing and reattachment of an elevated flap to cortical bone is a slower procedure, the periosteum does not survive reflection (58). Granulation tissue replaces the thin fibrin clot between the flap and cortical bone after 4 days, and fibrous connective tissue replaces granulation tissue by 14 days.



Vertical releasing incision that creates a compromised tissue area (arrow). The proximal, unreflected tissue portion will most probably necrotize because of insufficient blood supply. A dashed line indicates the desired incision course, beginning in a 90-degree angle to the gingival marginal. Keeping the flap moist at all times helps avoids shrinkage and dehydration

Patient Related Factors

Both the type of tissue involved and the type of surgical wound determine the healing process (78). Patients with a “thick” tissue biotype tend to display coronal soft tissue regrowth to the former level in crown lengthening procedures, whereas patients with a thin tissue biotype do not. The integrity and thickness of underlying bone plays a role in mucogingival stability.

Among other principles (incision and flap design, atraumatic and gentle tissue management), a passive and tension-free wound closure is fundamental for proper wound healing and for a successful functional and esthetic outcome.

Changing the size of the suture material and accordingly the size of the needle as in microsuturing is much less traumatic.

Papilla Preservation/Protection

Sulcular full thickness flap is used in periradicular surgery. In this flap technique the buccal papilla is mobilized and becomes part of the flap (89). Ideally, the sulcular incision should dissect the buccal from the lingual papilla. The conventional sulcular flap results in considerable retraction of papilla height after 1 month and 3 months postsurgically.

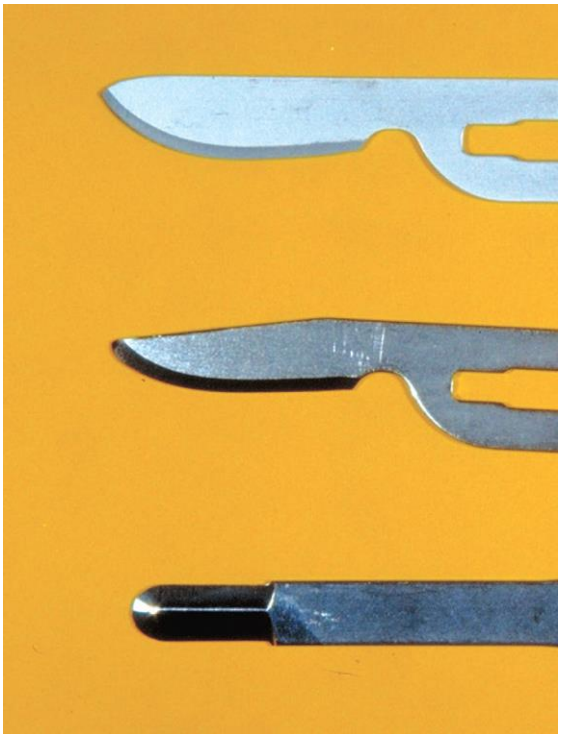
Straight-line incisions during endodontic surgery, without mobilization or inclusion of the papilla into the buccal flap, lead to a clear indentation line where the incision was placed. No longer acceptable.

Depending on the incision site, the following materials have been used:

- Vertical incisions should be sutured with 6/0 sutures, because of close proximity to inserting muscles in the mucosa, which might exert some tension to the wound during mastication and speech. As nylon monofilament materials are somewhat stiff in size 6/0, softer material, such as polyamide (Supramid®) was preferred. This material is a multifilament suture, with a coating providing monofilamentous appearance with a smooth surface.

- For closure of the horizontal incision and the delicate area of the papillae, we recommend polypropylene interrupted sutures with a size of 7/0 or smaller (Fig. 21). As the wound edges should be perfectly adapted to each other, depending on the dimensions of the papilla two or three interrupted sutures are needed. Suture removal performed after 3 to 5 days promoted rapid healing. The critical area for suture removal after 2 to 3 days is the apical portion of the vertical releasing incision—the mucosal wound, in particular in the region with muscle tension, which might require 24 to 48 h longer to initiate healing.

Papilla base flaps have allowed virtually recession free healing after endodontic surgery.



Comparison of different sizes of scalpel blades. Top is the regular blade size #15, middle blade represents the smaller #15C and bottom shows the microblade with double sided cutting edges.