

FLAP DESIGNS IN ENDODONTIC SURGERY

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ABSTRACT: In Surgical Endodontics we face complex situations that require the knowlflap and application of both principles of endodontics (cleansing shaping and filling) in the root management, and the principles of surgery (asepsis, non harmfulness and hemostasis) in the phase of access to the root. Among the factors of surgical relevance that for which have been proposed with the largest number of alternatives is the design of access flap. That clearly indicates that not only one flap design can be ideal in all clinical situations. In this article all proposed access flap designs are evaluated in the light of their degree of compliance with ideal requirements in different circumstances. A clear pattern in the decision-making criteria for the selection of access flaps is proposed.

Keywords: Endodontics, Surgical, Flap

INTRODUCTION:

During the last 20 years, endodontics has seen a dramatic shift in the application of periradicular surgery and the part it plays in the delivery of endodontic services. Previously, periradicular surgery was commonly considered the treatment of choice when nonsurgical treatment had failed or if existing restorative or prosthetic treatment would be endangered by orthograde treatment.(1) Now a widely held principle of endodontic diagnosis and treatment planning is that the primary modality for endodontic treatment failure should be nonsurgical endodontic re-treatment whenever possible.(1-8)

The establishment of good surgical access, both visual and operative, is a requirement for all surgical procedures. Visual access enables the endodontic surgeon to see the entire surgical field. Operative access allows the surgeon to perform the needed surgical procedure(s) with the highest quality and in the shortest amount of time. This will result in the least amount of surgical trauma and a reduction in postsurgical morbidity.

All surgical procedures require the intentional wounding of specific tissues, and the subsequent wound healing depends on the type of tissues wounded and the type of wound inflicted. The surgeon's goal must always be to minimize trauma to both the soft and hard tissues involved in the surgical procedure. Most periradicular surgical procedures require the raising of a mucoperiosteal flap and then revealing the root end(s). To access the bone, a full thickness flap must be raised. This comprises a soft tissue flap, which consists of gingival and mucosal tissue as well as periosteum.

The wide variety of flap designs reflects the number of variables to be considered before choosing an appropriate flap. As conditions vary with each individual patient and specific situation, there will always be a need to select the best flap design for every single case such as marginal mucoperiosteal flaps with one (triangular flap) or two (trapezoidal or rectangular flap) releasing vertical incisions, submarginal mucoperiosteal flaps with the horizontal incision within the attached gingiva and its modification and semi lunar flaps.(9-13)The design of the surgical flap greatly influences the healing process.

The dentist has to decide the design of the flap keeping in mind certain factors like number of teeth involved, extent of the lesion, sulcular depth, location and size of frenum and muscle attachments, approximating anatomic structures and the width of attached gingiva.

PRINCIPLES AND GUIDELINES FOR FLAP DESIGN:

Regardless of the design of the surgical flap, there are a number of principles and guidelines that apply to the location and extent of incisions and will ensure that the flapped soft tissues will closely fit in their original position and will properly cover the osseous wound site and provide an adequate vascular bed for healing:

1. Avoid horizontal and severely angled vertical incisions.

The gingival blood supply is primarily from the same vessels supplying the alveolar mucosa. As these vessels enter into the gingiva, they assume a vertical course parallel to the long axis of the teeth and are positioned in the reticular layer superficial to the periosteum. They are known as the suprapariosteal vessels.(14,15)

They are arterioles with a diameter of about 100 µm and are the terminal branches of the buccal, lingual, greater palatine, inferior alveolar, and superior alveolar arteries.(16)

The collagen fibers of the gingiva and alveolar mucosa provide structural strength to these tissues. The collagen fibers that attach to the periosteum course over the crestal radicular bone in a direction parallel to the long axis of the teeth.(17)

Horizontal and severely angled incisions, such as used in semilunar flaps and in broad-based rectangular flaps, shrink excessively during surgery as a result of contraction of the cut collagen fibers that run perpendicular to the line of incision. As a result of this shrinkage, it is often difficult to return the flap edges to their original position without placing excessive tension on the soft tissues. This often results in tearing out of the sutures and subsequent scar formation from healing by secondary intention.

2. Avoid incisions over radicular eminences.

Radicular eminences, such as the canine, maxillary first premolar, and first molar mesiobuccal root prominences, often fenestrate through the cortical bone or are covered by very thin bone with a poor blood supply. These bony defects may lead to soft-tissue fenestrations if incisions are made over them. Vertical (releasing) incisions should be made parallel to the long axis of the teeth and placed between the adjacent teeth over solid interdental bone, never over radicular bone.

3. Incisions should be placed and flaps repositioned over solid bone.

Incisions should never be placed over areas of periodontal bone loss or periradicular lesions. Without good solid bone to support the repositioned edges of the mucoperiosteal flap, inadequate blood supply results in necrosis and sloughing of the soft tissue. The endodontic surgeon must take into consideration the extent of osseous bone removal necessary to accomplish the intended periradicular surgery when designing the flap so that the repositioned flap margins will be supported by solid bone. Hooley and Whitacre suggest that a minimum of 5 mm of bone should exist between the edge of a bony defect and the incision line.⁽¹⁸⁾

4. Avoid incisions across major muscle attachments.

Incisions across major muscle attachments (frena) make repositioning of the flap and subsequent healing much more difficult. Healing and scar tissue formation by secondary intention healing often results. This can be circumvented by laterally extending the horizontal incision so that the vertical incision bypasses the muscle attachment and it is included within the flap.

5. Tissue retractor should rest on solid bone.

The extension of the vertical incision should be sufficient to allow the tissue retractor to seat on solid bone, thereby leaving the root apex well exposed. If the vertical incisions are not adequately extended, there will be a tendency for the retractor to traumatize the mucosal tissue in the fold at the base of the flap. This may affect the blood supply to these tissues and will result in increased post-surgical morbidity.

6. Extent of the horizontal incision should be adequate to provide visual and operative access with minimal soft-tissue trauma.

In general, the horizontal incision for mucoperiosteal flaps in periradicular surgery should extend at least one to two teeth lateral to the tooth to be treated. This will allow for adequate surgical access and minimize tension and stretching of the soft tissue. A time-tested axiom regarding the length of an incision is that more trauma results from too short an incision rather than too long, and incisions heal from side to side, not from end to end.

7. The junction of the horizontal sulcular and vertical incisions should either include or exclude the involved interdental papilla.

Vertical releasing incisions should be made parallel to the long axis of the teeth and placed between the adjacent teeth over solid interdental bone, never over radicular bone. The vertical incision should intersect the horizontal incision and terminate in the intrasulcular area at the mesial or distal line angle of the tooth. The involved interdental papilla should never be split by the vertical incision or intersect the horizontal incision in the midroot area.

8. The flap should include the complete mucoperiosteum (full thickness).

The flap should include the entire mucoperiosteum (marginal, interdental and attached gingiva, alveolar mucosa, and periosteum). Full-thickness flaps result in less surgical trauma to the soft tissues and better surgical hemostasis than do split-thickness flaps. The major advantages of full-thickness flaps are derived from the maintenance of the suprapariosteal blood vessels that supply these tissues.

FLAP DESIGNS:

According to Gutmann and Harrison, the two major categories of periradicular surgical flaps are the full mucoperiosteal flaps and the limited mucoperiosteal flaps. (2) The location of the horizontal component of the incision is the distinguishing characteristic between the two categories of surgical flaps. All full mucoperiosteal flaps involve an intrasulcular horizontal incision with reflection of the marginal and interdental (papillary) gingival tissues as part of the flap. Limited mucoperiosteal flaps have a submarginal (subsulcular) horizontal or horizontally oriented incision, and the flap does not include the marginal or interdental tissues.⁽²⁾ The addition of plane geometric terms to describe flap designs, as suggested by Luebke and Ingle, provides for an easily identifiable classification of periradicular surgical flap designs. Surgical flaps on the basis of horizontal incision can be classified into two major types (2) i.e.

1. Full mucoperiosteal flaps:
 - a. Triangular (one vertical releasing incision).
 - b. Rectangular (two vertical releasing incision).
 - c. Trapezoidal (broad based rectangular).
 - d. Horizontal (no vertical releasing incision)
2. Limited mucoperiosteal flaps:
 - a. Submarginal curved (Semilunar)
 - b. Submarginal scalloped (Ochsenbein- Luebke)

FULL MUCOPERIOSTEAL FLAPS:

Triangular Flap: The triangular flap is formed by a horizontal, intrasulcular incision and one vertical releasing incision. The primary advantages of this flap design are that it affords good wound healing, which is a result of a minimal disruption of the vascular supply to the flapped tissue, and ease of flap reapproximation, with a minimal number of sutures required. The major disadvantage of this flap design is the somewhat limited surgical access it provides because of the single vertical releasing incision. This limited surgical access often makes it difficult to expose the root apices of long teeth (eg, maxillary cuspids) and mandibular anterior teeth.

A primary incision is made in the gingival sulcus and follows the contours of the tooth. Sufficient space must be provided of any intrabony pathology to prevent the relieving incision lying over the defect and potentially affecting healing. The relieving incision is started at the gingival margins and extends to the attached gingiva. The incision should be made with a firm continuous stroke and the blade not lifted from the bone until the incision is complete. This prevents jagged edges which is difficult to suture. Extension deep into the sulcus not required and can lead to increased bleeding in the operative site. Normally the papilla is preserved.

In posterior surgery, both maxillary and mandibular, the vertical releasing incision is always placed at the mesial extent of the horizontal incision, never the distal. This affords the surgeon maximum visual and operative access with minimum soft-tissue trauma. For anterior surgery, the vertical releasing incision should be placed at the extent of the horizontal incision that is closest to the surgeon and is therefore dependent on the surgeon's position to the right or left of the patient.

After reflecting a triangular flap, sometimes the surgeon may find it necessary to obtain additional access. This can be easily obtained by placement of a distal relaxing incision. A relaxing incision is a short vertical incision placed in the marginal and attached gingiva and located at the extent of the horizontal incision opposite the vertical releasing incision. This incision is also good for relieving flap retraction tension while achieving adequate surgical access.

As a result of the excellent wound-healing potential of this flap design and the generally favourable surgical access it provides, use of the triangular mucoperiosteal flap is recommended whenever possible. It is recommended for maxillary incisors and posterior teeth. It is the only recommended flap design for mandibular posterior teeth because of anatomic structures contraindicating other flap designs.(2)

Rectangular Flap: The rectangular flap is formed by an intrasulcular, horizontal incision and two vertical releasing incisions. The major advantage of this flap design is increased surgical access to the root apex. This flap design is especially useful for mandibular anterior teeth, multiple teeth, and teeth with long roots, such as maxillary canines.

The major disadvantage of the rectangular flap design is the difficulty in reapproximation of the flap margins and wound closure. Postsurgical stabilization is also more difficult with this design than with the triangular flap. This is primarily due to the fact that the flapped tissues are held in position solely by the sutures. This results in a greater potential for postsurgical flap dislodgment. This flap design is not recommended for posterior teeth.

Trapezoidal Flap: The trapezoidal flap is similar to the rectangular flap with the exception that the two vertical releasing incisions intersect the horizontal, intrasulcular incision at an obtuse angle. The angled vertical releasing incisions are designed to create a broad-based flap with the vestibular portion being wider than the sulcular portion. The desirability of this flap design is predicated on the assumption that it will provide a better blood supply to the flapped tissues. Although this concept is valid in other tissues, such as the skin, its application is unfounded in periradicular surgery.(19)

Since the blood vessels and collagen fibers in the mucoperiosteal tissues are oriented in a vertical direction, the angled vertical releasing incisions will sever more of these vital structures. This will result in more bleeding, a disruption of the vascular supply to the unflapped tissues, and shrinkage of the flapped tissues. The trapezoidal flap is contraindicated in periradicular surgery. (19,20)

Horizontal Flap: The horizontal, or envelope, flap is created by a horizontal, intrasulcular incision with no vertical releasing incision(s). The scalpel blade is held as near to vertical as possible and interdentially the papilla is severed at the midcol position. A no.12 blade is very useful in this area. A no.15 scalpel blade can be used around the tooth margins. The horizontal flap can be used for the investigation of the root surface- eg. When looking for root fractures but gives restricted access to the root tip. In this a vertical relieving incision will then be required and the flap then becomes triangular (one relieving incision) or rectangular (two relieving incisions). This flap design has very limited application in periradicular surgery because of the limited surgical access it provides. Its major applications in endodontic surgery are limited to repair of cervical defects (root perforations, resorption, caries, etc) and hemisections and root amputations.

LIMITED MUCOPERIOSTEAL FLAP:

Submarginal Curved (Semilunar) Flap: The submarginal or semilunar flap is formed by a curved incision in the alveolar mucosa and the attached gingiva. The incision begins in the alveolar mucosa extending into the attached gingiva and then curves back into the alveolar mucosa. There are no advantages to this flap design and its disadvantages are many, including poor surgical access and poor wound healing, which results in scarring. This flap design is not recommended for periradicular surgery.

Submarginal Scalloped Rectangular (Luebke- Ochsenein) Flap: The submarginal scalloped rectangular flap is a modification of the rectangular flap in that the horizontal incision is not placed in the gingival sulcus but in the buccal or labial attached gingiva. The horizontal incision is scalloped and follows the contour of the marginal gingiva above the free gingival groove. The major advantages of this flap design are that it does not involve the marginal or interdental gingiva and the crestal bone is not exposed. The primary disadvantages are that the vertically oriented blood vessels and collagen fibers are severed, resulting in more bleeding and a greater potential for flap shrinkage, delayed healing, and scar formation.

When considering the use of this flap design, the endodontic surgeon must keep in mind that the horizontal, scalloped incision must be placed and the flap repositioned over solid bone. Careful evaluation of any buccal or labial periodontal pockets must also be made to minimize the possibility of leaving unflapped gingival tissue without bony support.

The importance of properly angled diagnostic radiographs cannot be overemphasized when considering the use of this flap design. The size and position of any periradicular inflammatory bone loss must also be considered when placing the horizontal incision to ensure that the margins of the flap, when reapproximated, will be adequately supported by solid bone.

Proponents of this flap design stress the importance of not involving the marginal gingiva and the gingival sulcus in the horizontal incision, which may result in an alteration of the soft-tissue attachment and crestal bone levels. It has been reported, however, that, with proper reapproximation of the reflected tissues and good soft-tissue management, the gingival attachment level is minimally altered or unchanged when full mucoperiosteal flaps are used.

CONCLUSION:

The key element in preventing loss of the soft-tissue attachment level is ensuring that the root-attached tissues are not damaged or removed during surgery.(19,21) It has also been reported that crestal bone loss is minimal (about 0.5 mm) when full mucoperiosteal flaps are used in periodontic surgery. These procedures may involve apical positioning of flaps, excision of marginal gingiva, and root planing that must rely on new attachment of soft tissue to cementum. Unlike periodontal surgery, endodontic surgery can accomplish reattachment that results in little or no crestal bone loss.(22) Harrison and Jurosky reported that crestal bone showed complete osseous repair of resorptive defects and no alteration of crestal height following periradicular surgery using a triangular (full mucoperiosteal) flap.(23) In the absence of periodontal disease, a complete return to anatomic and functional normalcy can be expected, following periradicular surgery using triangular or rectangular flap designs.(2)

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