SOFT TISSUE MANAGEMENT TECHNIQUES FOR IMPLANT DENTISTRY: A CLINICAL GUIDE

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Establishing nontension primary closure over implant and bone-grafted sites begins with proper soft tissue management. This paper will demonstrate the various soft tissue flap designs required to optimize postsurgical wound healing. Simple and advanced flap management techniques are described in a step-by-step manner utilizing drawings to show each step-by-step surgical procedure. Management of postoperative soft tissue complications will also be addressed.

INTRODUCTION

Proper manipulation of oral tissues is a prerequisite for successful surgical results. Zola states five basic points to consider in the design of a soft tissue flap for intraoral surgery: (1) anatomy, (2) access, (3) replacement, (4) closure, and (5) blood supply. He states, “Soft tissue surgery has as its basic tenet the preservation of anatomy. This is achieved by delicate and knowledgeable handling of the tissues.” Understanding the underlying anatomy is a prerequisite for any surgery.Extending a flap beyond the immediate surgical boundary may be required to establish adequate visual and working access. Rateitschak and Shanaman demonstrate periodontal surgery flaps designed to use vertical relieving incisions to gain better visualization of the surgery site. Hupp shows similar vertical incisions with a wide apical tissue base of oral surgery procedures. Careful, firm reflection of periosteum off of the bone creates an appropriate environment for tissue replacement. Readaptation of a tissue flap is best accomplished over healthy, bleeding bone. Establishing nontension primary closure over a bone-grafted site can require significant tissue manipulation. Adequate blood supply is maintained when tissues are closed without tension. In addition, wound margins placed in tension can result in sutures pulling through the tissue during normal postoperative swelling.

Fugazzotto classified tissue flap closure into six categories based on the minimal-to-severe buccal-lingual ridge atrophy with or without an apical-occlusal component. Fugazzotto urges the clinician to “keep the flap design as simple as possible to accomplish the therapeutic end result of treatment in any of his classifications.” If more aggressive flap designs must be used, then Fugazzotto urges the use of “long releasing incisions well up into the buccal fold, being placed mesial and distal to the edentulous space.” Alignment of minor or aggressive tissue flaps must be placed and sutured in such a manner as to ensure the attainment of passive primary soft tissue closure. Tarnow et al described bone and
soft tissue deficiencies as a result of loss of teeth and bone support over a period of time. Congenitally missing teeth can result in an edentulous area that is inadequate labiobuccally and possibly mesiodistally. Tarnow et al\textsuperscript{b} also classified absence of bone from minor to major deficiencies and stated that “major bone loss could require several soft tissue operations to accomplish a good aesthetic result.” Lauer et al\textsuperscript{f} and Hughes et al\textsuperscript{g} described using a vestibuloplasty on the facial side of an atrophic mandible as well as transalveolar fixation of lingual soft tissue due to high muscle attachment after resorption. Cranin et al\textsuperscript{h} showed different healing patterns depending on the location and design of the surgical incision used to expose the surgical site. Tarnow et al\textsuperscript{b} and Adriaenssens et al\textsuperscript{i} describe the importance of stage 2 tissue design to help keep desirable aesthetics.

This paper will describe soft tissue management techniques for the following: bone onlay grafting, soft tissue tunneling, chin grafting (donor and receptor sites), and postoperative complications. Both simple and advanced closure techniques will be addressed. Adherence to the techniques outlined in this article will result in improved tissue adaptation over a grafted and/or implanted site and increased success rates. This article assumes that the operator adheres to appropriate pharmacological support and sterile environmental conditions as described by Rosen et al\textsuperscript{b} and Heller.\textsuperscript{j}

**Importance of Adequate Tissue Closure**

Obtaining adequate tissue closure begins with proper soft tissue flap design. Intraoral flaps should resemble the shape of a trapezoid (Fig 1). The wider base of the trapezoid is that portion of the flap still attached to the adjacent soft tissues and underlying periosteum. Blood circulation and lymphatic drainage are maintained through this attached tissue base. To ensure proper flap continuity, scalpel penetration should contact bone, penetrating the underlying periosteum and bisecting available attached gingivae.

Wound closure is enhanced when the suture needle penetrates attached gingivae on both sides of the incision line. Single interrupted and/or continuous locking sutures are used to secure the approximated surgical flaps. Full thickness flaps should be reflected cleanly, with few periosteal tissue tags remaining on the bone. Tissue flap margins should passively approximate with adequate bleeding surfaces. Tension of a sutured site increases the probability of suture material pulling through the edge of the surgical flaps with normal postoperative swelling. A trapezoidal design allows the operator to surgically fillet (Fig 2) the underlying periosteum with a scalpel blade in a horizontal direction, thereby increasing flap mobility 10–15% and reducing tension at the wound margin. Occasionally, muscle fiber resection is also required to obtain the tissue flexibility required for nontension flap approximation.

**FOUR-TIE TECHNIQUE FOR SECURE KNOT TYING**

It is very important to use a knot tying technique that eliminates unraveling of 3-0 vicryl (Johnson and Johnson) suture knots during the first 14 days of healing.\textsuperscript{k} Figures 3–7 demonstrate this four-tie technique. Vicryl suture is composed of polygalactic acid, which resorbs in 3–4 weeks. The manufacturer recommends that the suture be removed in 10–14 days. Practicing this technique with silk suture and a towel prior to intraoral use gives the operator a feel for knot continuance and security. Using four ties of the suture material ensures a secure knot is formed that will not come loose with swelling tissue or a mechanical trauma to the knot during the healing period.

The first part of the knot is two forward loops with gentle pulling of the knot to snug closely against the tissue with little or no bunching of suture material (Fig 3). The second part of the knot is one forward loop, causing a granny knot between the first and second tie (Fig 4). The third part of the knot is one reverse loop, causing a square knot with the previous tie (Fig 5). This part of the knot can be pulled with greater force, as all it will do is tighten the square knot and not allow the suture material to bunch up. The fourth part of the knot is a single forward loop, which causes another granny knot with the underlying square knot (Fig 6). This portion can also be pulled tightly, as it will not cause bunching of the suture material since it is protected by the underlying square knot (Fig 7). The following are teaching techniques used to help the surgeon be reminded of the sequence:

1. Two forward—gently tighten suture next to tissue (Fig 3).
2. One forward—gently tighten suture material, making granny knot (Fig 4).
3. One reverse—secure knot with tight pulling, which forms a square knot (Fig 5).
4. One reverse—secure knot with...
FIGURE 3. Suture knot begins with two forward loops.

FIGURE 4. Step 2 is one forward loop.

FIGURE 5. Step 3 is one reverse loop.

FIGURE 6. Step 4 is a single forward loop.

FIGURE 7. A completed granny-square-granny knot.

Nontension primary closure should be achieved after dental implant placement. Particular attention should be given to the underlying implant cover screw height, especially in single implant placement between two teeth. When necessary, the buccal periosteum can be relieved using a curved blade in an apical-horizontal direction (Fig 9). Tissue forceps are used to pull the buccal tissue over the implant cover screw or bone grafting material. If the implant healing screw or grafting material is still evident visually at the buccal-lingual tissue interface (Fig 10A), then vertical incisions through the proximal tissue, including the papillae, are used. These vertical incisions should first be made in attached gingivae only (Fig 10B). If the wound margins still do not approximate, the vertical incision is then carried into the alveolar mucosa (Fig 10C). Further horizontal incisions, made in the underside of the flap, may again be required. The aforementioned incision protocol is usually indicated when 4-6 mm of bone width is required. Typical clinical procedures that create this amount of width include bicortical bone expansion and on-lay grafting using bone-grafting materials. When procedures like chin grafts create more than 6 mm of bone width, a double clo-
sure technique, explained later in this paper, is used.

When crestal incisions alone provide nontension closure, tissue forceps are first used to hold the lingual flap away from the bone, which allows the suture needle to penetrate 2 mm of lingual tissue. The needle is pulled completely through the lingual tissue and re-entered into the buccal tissue papillae in a lingual to buccal direction (Fig 11A). An interrupted suture knot is tied next to the proximal tooth (Fig 11B). The same type of interrupted suture knot is tied next to the adjacent tooth. Single interrupted sutures are placed every 3–4 mm on the crest of the ridge to close the incision (Fig 11C). It is imperative that the tissues closely approximate the proximal teeth without tension.

Vertically incised attached gingival tissue is sutured immediately after placing the proximal-crestal sutures. Passing the needle through tissue on both sides of the vertical incision line can simultaneously result in torn tissue and compromise esthetics. The vertical suturing technique described significantly reduces this unwanted result. First, the suture needle incorporates 2 mm of tissue and is passed through the loose portion of the flap. A 2-mm tissue “bite” is recommended, as unattached tissue is friable and thin needle penetration can easily tear the tissue. Next, the needle is pulled through the incision line and then reinserted into the bound tissue of the adjacent tooth (Fig 12). One interrupted suture is placed to secure the tissue, adjacent to the vertical incision line, next to the tooth. As discussed earlier, securing a square knot between two granny knots will prevent unwanted torn tissue adjacent to the vertical incisions.

**Mandibular buccal tissue management with crestal incision approach**

Buser et al describe lateral ridge augmentation using autografts and barrier membranes. The same surgical techniques also apply to allografts or implant placement. Figure 13 shows the patient presenting with mandibular edentulism distal to the second bicuspid tooth and displays a tissue flap design. Using a straight scalpel, a full thickness incision is started posteriorly in unattached gingivae buccal to the buccal raphae proceeding anteriorly onto the crest of the ridge. Care is taken to bisect available crestal attached tissue. The incision then continues until the scalpel handle contacts the distal of the bicuspid tooth. A curved blade is then used to continue the crestal incision where it bisects the distal papillae. The curved scalpel is also used to incise the crevicular sulcus midway around the buccal and lingual aspects of the bicuspid tooth.

Beginning in the crestal incision line, a no. 9 periosteal elevator is used next to carefully elevate a full thickness flap. To ensure full thickness flap elevation, the periosteal elevator should be forc-
ably pressed against the bone. The tissue should be reflected in an anterior to posterior direction. During tissue elevation, the surgeon's thumb (Fig 14) is used to resist the pressure of the elevator. Opposing thumb resistance is used to protect the elevated tissue from tearing, avoid elevator bone slippage, and reduce unwanted periosteal tissue tags, thereby resulting in an unwanted split thickness flap. Sufficient buccal and lingual tissue is reflected to evaluate buccal-lingual bone dimension, thereby determining treatment needs.

**Tissue closure of mandibular posterior edentulous area**

As mentioned earlier, wound margins should always approximate without tension. The operator can easily determine wound closure tension by pulling the reflected buccal flap margin, with a tissue forceps, over the crest of the ridge. If the tissue lies passively over the implant cover screws and/or bone grafting materials, the operator can begin suturing. If flap tension is present, a no. 12 Bard Parker curved scalpel is used to place 1-mm-deep horizontal relieving incisions in the periosteum/tissue interface (Fig 2).

Using a tissue forceps, the periosteum is exposed by gently pulling the buccal flap away from the underlying bone. The relieving incisions are then made beginning inferiorly at the periosteal/bone interface. As the incisions proceed coronally, the operator will notice tissue “growth” or lengthening. Periodically, the flap is reapproximated and examined until passive wound margin closure is established. Only then should suturing commence.

Suturing begins along the distal surface of the most anterior tooth (bicuspid in drawing). Starting at the lingual side, the needle should penetrate 2 mm of the lingual papillae without engaging the buccal papillae. Attempting to penetrate the buccal and lingual tissue at one time can result in the needle contacting the occlusal aspect of the alveolar ridge, resulting in inadequate tissue penetration of the opposing papillae. After pulling the needle through the lingual papillae, the forceps are used to hold the buccal tissue. The needle is then advanced through the lingual side of the buccal papillae. A 2-mm bite of buccal tissue should be achieved and an interrupted suture is tied as described in Fig 15A. Using a mouth mirror, the operator should then carefully inspect this suture to ensure that close tissue adaptation around the distal of the bicuspid tooth is achieved and that the knot is securely closed without tissue tension (Fig 15B). A horizontal mattress continuous suture is now used to close the tissue in an anterior to posterior direction (do not close the tissue from posterior to anterior). Proceeding the closure from anterior toward posterior allows for proper tissue approximation. To prevent premature opening, a few interrupted sutures should be placed along the continuous suture line (Fig 15C).

**More Complex Tissue Management Procedures**

*Mandibular tissue management with a remote buccal incision: the tunneling technique*

Resorption in the edentulous posterior mandible primarily occurs in a buccal to lingual direction with a resultant thin, vertical, bony lingual cortex. Patients who wear removable partial dentures usually exhibit greater degrees of bone loss than those who do not wear removable appliances. Increasing bone width for future implant placement can be accomplished by on-laying grafting particulate bone material through a remote incision entry. The author has found the remote incision with tunneling approach to be more predictable than the crestal approach, mentioned above, for these types of grafts.

Figure 16 illustrates a mandibular posterior edentulous area distal to the first bicuspid. As illustrated in the drawing, a full thickness 10-mm-long vertical incision is made in alveolar mucosa anterior to the canine fossae between the bicuspid and cuspid roots.
Beginning in the incision line, a Nordent no. 14 thin periosteal elevator is then used to lift the alveolar mucosa away from the buccal aspect of the bony ridge. The dissection/reflection continues distally, in alveolar mucosa only, and terminates buccal to the pterygoid mandibular raphae. Alveolar tissue can be quite friable. The operator should press his/her thumb over the site where the tissue is being elevated to minimize unwanted tissue tearing (Fig 17A). The opposing thumb pressure protocol should be used for the remainder of the elevation. The next step is to reflect the attached gingival connective tissue fibers located on the buccal crest of the edentulous ridge. Once loosened, the occlusal portion of the attached gingivae is carefully freed (Fig 17B). Perforating the lingual tissue with the periosteal elevator could necessitate aborting the graft but is not recommended for the most predictable results.

The most technically challenging portion of the tunneling procedure is now undertaken. Figure 17C shows a dull waxing instrument bent by the author specifically for this procedure. There is a commercially designed instrument sold by Miter Corp (Heller tunnelling instrument). The tunnel-reflecting instrument should be dull to the feel and used as a blunt instrument. This bent reflecting instrument allows access to the lingually attached crestal fibers (which can extend up to 3 mm), maintains bone contact for full thickness reflection, and follows the lingual bony contour for subsequent reduction of tissue tearing. The lingual tunnel dissection is started just anterior to the raphae and continues anteriorly toward the distal of the bicuspid tooth using the opposing thumb pressure protocol described earlier. It is very important to proceed from posterior to anterior, allowing for better control of the bent instrument to reduce lingual tissue penetration. Once the cresto-lingual fibers are freed, the bent instrument is manipulated to elevate the lingual mucosa to the mylohyoid muscle attachment (Fig 17D). The resultant freely movable pocket of tissue can now allow for placement of grafting materials and lambone tissue barriers. Through the vertical access incision, a straight handpiece with a no. 4 round bur is now used to either scratch the buccal bone or, if thickness allows, create perforations into the medullary bone (Fig 17E).

**Tissue barrier and grafting material placement within the tunnel**

A 25 × 20-mm sheet of demineralized freeze dried bone (DFDB) lambone is slightly hydrated in sterile saline, then molded into a “U” shape. Using cotton pliers forceps, the “U”-shaped lambone is carried through the vertical incision to the most proximal aspect of the receptor site (ie, tunnel). The lambone is then manipulated to create a tent which extends from the mylohyoid region to the buccal bone. The lambone barrier will now become the superior wall of the receptor site, acting as a roof.

Using a no. 9 periosteal elevator to hold up the lambone, the author suggests a bone mixture of 90% irradiated bone with 10% tricalcium phosphate. The mixture is loaded into a syringe and placed into the most posterior aspect of the receptor site (pocket), where the graft mixture is extruded. The dull, bent instrument is then used to push the graft material over the crest of the ridge and into the mylohyoid area (Fig 17F). The author has found that lingual tissue reattachment during the healing phase creates tension at the receptor site, thereby increasing graft morbidity and failure. Therefore, it is important that the operator place adequate graft material onto the lingual side of the crest to increase case success rates. Syringe material is placed repeatedly into the pocket, pushing the material lingually and then buccally until the receptor site is filled with grafting material (Fig 17G).

The use of thumb and forefinger pressure can mold the graft material under the tissue to equalize the width of the graft. Vicryl suture (3-0) is now used to close the vertical incision by starting at the superior portion of the incision. Interrupted sutures are placed every 3 mm inferiorly until the incision is closed. Finger pressure using wet gauze is applied to the area for 2–3 minutes to help hemostasis as well as to remold material in the tunnel pocket.

**Tissue management and flap design for sinus grafting procedures**

The flap design for the sinus augmentation procedure will assume edentulism distal to the maxillary cuspid. Entrance into the maxillary sinus via the lateral wall approach has been thoroughly described by Tatem et al. and others.

The initial incision begins with directing a straight scalpel into the distal-crestal aspect of the fibrous maxillary tuberosity and continues anteriorly along the alveolar crest for 3–5 mm. The incision then traverses the palatal incline of the maxillae in an anterior-superior direction to avoid the greater palatine foramina and its contents. The scalpel continues this path until it is within 4 mm of the palatine process of the maxillae. At this point, the incision alters into an anterior only...
direction and continues to the cuspid apex. Once reached, the blade is turned toward the disto-lingual aspect of the cuspid (Fig 18A), where it enters the sulcus. The intrasulcular incision continues facially around the cuspid to include the mesial cuspid papillae where it terminates. Beginning in the mesial cuspid papillae, a vertical releasing incision is directed toward the root of the central incisor, thereby creating the desired trapezoidal flap (Fig 18B).

Palatal tissue, composed of fat cells and fibrous tissues, can measure up to 15 mm in thickness and can be difficult to evaluate. Therefore, the previously described opposite thumb technique (Fig 18C) is recommended when elevating the following flap. Releasing the buccal tissue of the fibrous tuberosity begins the full thickness reflection. The palatal incline tissue is elevated by first pushing a periosteal elevator apically against bone, then applying pressure in a buccal direction. This flap is elevated to the crest of the ridge and extends from the tuberosity to the cuspid. Starting at the disto-buccal line angle of the cuspid, the reflection continues onto the buccal ridge in a distal
direction for 5 mm. At this point, the perioseal elevator is angled parallel to the crest of the ridge as the dissection continues distally to meet the already reflected buccal portion of the tuberosity. Particular care should be taken when elevating the thin buccal tuberosity tissues. The entire flap is now elevated to expose the anterior, inferior, and posterior portions of the maxilla's zygomatic process. The buccinator and canines muscles insert into the zygomatic process, thereby offering resistance to elevation.

A curved Uchi Retractor (Miter Corp) allows maximum access to the surgical field (Fig 18D). Lateral window preparation, Schnidierian membrane elevation, bone augmentation, and window barrier procedures are completed prior to flap repositioning. Flap reapproximation begins with the tissue being held in the mid-flap area and being positioned next to the attached mucosa of the palate. When on-lay bone grafting accompanies a sinus augmentation procedure, the receptor site bone width increases, thereby requiring horizontal relieving incisions for nontension closure. The incisions are begun in the superior aspect of the exposed flap near the zygomatic process (Fig 19). A curved scalpel is used to penetrate the periosteum in a posterior to anterior direction, carefully avoiding the infraorbital foramen and associated structures. Horizontal relieving incisions should be performed prior to the on-lay bone grafting procedure. A simple technique to assess flap tension is to hold the reapproximated flap with gentle finger pressure and to visually determine wound margin openings.

Suturing should begin only after passive wound margin closure is achieved. An interrupted suture is first placed in the tissue found at the disto-lingual line angle of the cuspid (Fig 20A). A second interrupted suture is placed further distally and holds the repositioned flap in the correct posterior position. The anterior buccal flap is then stabilized. First, the suture needle is passed from the buccal through the buccal flap at the mesial cuspid papilla, then directed inferiorly through the lateral-cuspid contact without engaging the lingual tissue. The needle is pulled through the papilla, leaving a 1-inch suture tail. The needle is then routed to the disto-buccal aspect of the cuspid and, from the buccal, passed through the buccal flap only. The needle is then pulled inferiorly through the lateral-cuspid interproximal contact and tied (Fig 20B). This suturing technique circumvents the lingual tissue, thereby maximizing tooth-tissue contact and soft tissue esthetics. A mouth mirror is used to ensure that both tissue and suture are closely adapted to the tooth. Closure of the vertical releasing incision begins at the coronal aspect of the wound margin and continues superiorly until the wound is closed (Fig 20C). Interrupted sutures should be placed at 3-mm intervals. Palatal interrupted sutures are then placed at 10-mm intervals to further stabilize the palatal flap. Bending the needle to shorten its circumference allows the operator to easily negotiate the attached palatal mucosa for the desired 3-mm tissue bite. A continuous interlocking suture is then extended in an anterior direction from the tuberosity to the distal of the cuspid (Fig 20D).
**Double tissue closure technique for premaxillary bone graft receptor sites**

Advanced resorption of the premaxillae often requires autogenous grafting prior to dental implant placement. The chin and lateral ramus are two commonly used sites for harvesting donor bone. Proper flap design is required for obtaining successful access and closure for the donor and receptor sites. A double tissue closure reduces the probability of postoperative receptor site wound opening, thereby increasing the survival rate of the graft. Due to its intricacies, receptor site exposure should be accomplished first.

**Tissue management for the ramus donor site**

The surgery begins with a full-thickness incision that bisects the pterygomandibular raphae. A straight scalpel is angled toward the buccal to avoid the lingual nerve. The incision continues anteriorly onto the ridge crest for approximately 15 mm (Fig 21A). The blade is then reversed so the cutting edge is facing superiorly and placed into the distal of the incision, where it continues in a buccolateral direction for approximately 15 mm. A periosteal elevator is used to reflect the raphae tissue toward the lingual. The buccal full thickness flap is then reflected to sufficiently expose the external oblique ridge and ramus areas (Fig 21B). The ramus bone is then harvested and placed into sterile saline. Replacing the donor site with allograft and/or alloplast prior to closing is optional. Closing the wound in the raphae usually occurs without incident because the tissue is quite mobile. First, an interrupted suture is secured in the attached gingivae at the most anterior aspect of the incision. Prior to continuing, the tissue should be evaluated with a mouth mirror for close tissue approximation. Wound closure then proceeds using a continuing locking suture in an anterior to posterior direction. Several interrupted sutures are then placed along the incision line for additional support.

**Tissue management for the chin donor site**

Using a straight scalpel, a horizontal incision is made 2–3 mm below the inferior border of the buccal attached gingivae. The incision extends from cuspid eminence to cuspid eminence (Fig 22A). A no. 9 periosteal elevator is used in an inferior direction to elevate a full thickness flap to the inferior border of the mandible. The dissection then proceeds laterally to expose the mental nervebundles (Fig 22B). To avoid the inferior alveolar nerve’s anterior loop, bur penetration begins 5–7 mm lateral to its entry into the bone.
mm anterior to the mental foramen. Receptor site ridge deficiency determines the amount and shape of donor bone required. The donor bone is then harvested and the remaining void is filled with a grafting material.

The tissue flap is placed over the grafted bone and pressure is applied to the site with wet gauze until homeostasis ensues (usually 2–3 minutes). Vicryl suture (3–0) is then used to close the donor site tissues. For proper alignment, interrupted sutures are first placed at the ends of the incision line. A continuous locking suture is used to close the remaining wound. Interrupted sutures are then placed every 5 mm along the incision line for additional support (Fig 22C). A moist gauze is used again to apply pressure to the site with wet gauze until homeostasis.

**Double closure tissue management for the premaxillary receptor site**

Careful preoperative planning is needed to achieve successful double tissue closure results. Proper flap design includes a trapezoidal shape (Fig 23A). The dissection begins with two full thickness vertical incisions that include the proximal papillae. A split thickness horizontal incision is made approximately 2 mm inferior to the mucobuccal fold connecting it to the two vertical incisions. Grasping the buccal tissue with a tissue forceps, the unattached mucosa is carefully undermined in a coronal direction (Fig 23B). The split thickness dissection is continued until it reaches attached gingivae. At this level, a horizontal incision is made through the periosteum, uniting it with the two vertical incisions (Fig 23C). A full thickness reflection is then made to expose both crestal and palatal bony surfaces (Fig 23D). The remaining buccal periosteum is now carefully reflected to expose the nasal spine and nares floor (Fig 23E). The donor bone is screwed into position after reshaping it with burs or diamonds bathed in a saline spray. Any autogenous bone voids are filled with bone grafting materials. The entire graft is then covered with a lamina barrier.

The buccal periosteum is grasped with tissue forceps and undermined apically with a curved scalpel. This provides the periosteum with the additional elasticity and mobility required for primary wound closure. The periosteum is then pulled as far coronally as possible over the grafted bone and sutured to the lingual attached tissue. Figure 23F shows how the periosteum is sutured to the lingual full thickness flap in order not to shorten the lingual flap. Step-by-step format has the suture needle passing through the periosteum flap from the buccal to the lingual and entering the lingual flap apically from the buccal to the lingual. The needle then re-enters the lingual tissue from lingual to buccal direction and then re-enters the periosteal flap from lingual to buccal. The suture is then gently pulled tight and tied to bring the periosteal flap coronally over the grafted material as far as possible. (Note suture pathways drawn in red color) Vicryl suture (3–0) is used every 5 mm to hold the periosteum over the buccal aspect of the grafted bone.

The remaining flap is now brought to the buccal over the top of the sutured periosteal flap and sutured into position buccally (Fig 23G). The flap is first tacked coronally with interrupted sutures next to the proximal teeth. A continuous suture is then used to secure the vertical and apical portions of the flap (Fig 23H). Interrupted sutures are used every 5–7 mm for extra support. A moist gauze is placed over the newly double sutured flap and pressure is applied for 2–3 minutes for homeostasis.

**Tissue management for second-stage surgery maintaining papillae**

Takei et al. describe preservation of papillae around natural teeth, which can also be applied to dental implants. Second-stage uncover surgery is done with the hope of either maintaining or developing a papillae. If one tooth space is to be uncovered, a flap leaving the adjacent papillae is recommended. A crestal incision is made toward the lingual one third of the crestal tissue with a scalpel, leaving the adjacent papillae untouched (Fig 24). If attached gingival tissue must be created buccally with the second-stage surgery, the lingual-crestal incision continues into the proximal tissue crevice around the labial and lingual of the adjacent teeth (Fig 25A). After reflection of either flap design is completed, a healing abutment or implant abutment is threaded into the implant and the connection is checked with a radiograph. The labial tissue may bunch up (Fig 25B) and project coronally when first repositioned but will flatten out when the proximal sutures are placed. Final pap-
Detached gingival graft

A detached gingival graft is recommended when the anticipated peri-implant tissue abutment will emerge into a zone of unattached gingivae. This graft should be completed before uncovering the submerged healing screw. The rationale for soft-tissue grafting and vestibuloplasty with dental implants is well covered in Hoelscher and Simons' literature review article.

Figure 26 shows the labial bed of unattached tissue is prepared by using a straight scalpel starting at the horizontal line angle of the mucogingival junction. The amount of attached tissue needed determines the size of the graft. A split thickness flap is created and the supraperiosteal tissues are pushed apically. A 1-1.5-mm-thick wedge of attached tissue is taken from the palate and placed on a glass slab. A blade is used to remove excess fatty and connective tissues. The patient is then instructed to wear a previously fabricated palatal acrylic healing stent for 7-14 days. By covering the donor site, the stent promotes homeostasis and reduces postoperative pain. The modified donor graft tissue is then positioned on the receptor bed and tacked with vicryl 3-0 sutures at the coronal aspect, which assures correct tissue placement. Vertical line sutures are placed to further support the graft. Pressure is then placed on the graft with a moistened gauze for homeostasis. Periodontal dressing or butylcyanoacrylate liquid can be placed over the graft edges.

Corrective tissue management techniques for premature opening

Excess postoperative swelling can lead to premature suture loss and compro-

Figure 23. (A) The split thickness dissection is continued until it reaches the attached gingivae and (B) then a horizontal incision is made through the periosteum. (C) A trapezoidal-shaped flap. (D) A full thickness reflection exposes both crestal and palatal bony surfaces. (E) The buccal periosteum is reflected to expose the nasal spine and nares floors. (F) The buccal periosteum is pulled over the grafted bone and sutured to the lingual attached tissue. (G) The remaining lingual flap is brought to the buccal over top of the sutured periosteal flap and sutured into position buccally. (H) A continuous suture secures the vertical and apical portions of the flap.

Figure 24. A crestal incision is made toward the lingual one third of the crestal tissue with a scalpel, leaving the adjacent papillae untouched.
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If attached gingiva must be created buccally
lingual
2nd stage surgery

25. (A) The lingual-crestal incision continues into the proximal tissue crevice around the labial and lingual of the adjacent teeth. (B) The labial tissue may bunch up but will flatten out when the proximal sutures are placed.

Figure 25. (A) The lingual-crestal incision continues into the proximal tissue crevice around the labial and lingual of the adjacent teeth. (B) The labial tissue may bunch up but will flatten out when the proximal sutures are placed.

Create receptor site for free gingival graft unattached gingiva attached gingiva

26. The unattached tissue is prepared using a straight scalpel starting at the horizontal line angle of the mucogingival junction.

Figure 26. The unattached tissue is prepared using a straight scalpel starting at the horizontal line angle of the mucogingival junction.

Open suture line epithelium grown into wound
freshen area to be sutured

27. (A) An opened suture line where the epithelium has grown into the wound. (B) The exposed tissue should be freshened. (C) A split thickness internal incision should be made with a curved scalpel to relieve the tissue. (D) The resected muscle is sutured until more healing occurs.

Figure 27. (A) An opened suture line where the epithelium has grown into the wound. (B) The exposed tissue should be freshened. (C) A split thickness internal incision should be made with a curved scalpel to relieve the tissue. (D) The resected muscle is sutured until more healing occurs.

Resuturing techniques

When flaps are approximated correctly, microvascular anastomosis occurs, leading to re-epithelialization and complete wound margin closure. When a repositioned flap prematurely opens, initial tissue repair has often already occurred (Fig 27A). When this happens, the wound margins should be incised or healing by primary intention will not occur (Figure 27B, C).

If tension persists, disallowing for a nontension buccal-lingual flap apposition, vertical relieving incisions are used. When tension persists in newly sutured tissue, an external buccal vestibular horizontal releasing incision is made. The scalpel should penetrate the labial mucosa to a depth of 3–5 mm (Fig 27D). The operator can determine releasing incision effectiveness by simply pulling the lip in various directions while observing suture line movement. Additional scalpel penetration into the underlying muscle is required if significant suture line movement remains (Fig 27D). Resorbable gut suture is then placed into the apical portion of the vestibule to hold the resected muscle until further healing occurs (Fig 27D).

DISCUSSION

The soft tissue management techniques described in this article promote predictable tissue coverage over dental implants and bone grafts. The rationale for successful tissue flap coverage includes nontension wound margin approximation, establishing adequate blood supply to nourish the surgical field, and maintaining wound closure using a proven knot-tying technique. Flap design should include a trapezoidal shape with the wider portion at the base. The trapezoidal shape maximizes tissue flap blood supply and flexibility for nontension primary wound closure over bone grafted sites. Effective intervention can be achieved with routine postoperative treatment and communication with the patient.

REFERENCES

6. Tarnow DP, Eskow RN, Zamzok J.


