Basic Wound Repair: Surgical Techniques, Flaps, and Grafts

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An understanding of wound healing and basic surgical technique is important for optimum surgical results. Wound healing may be divided into two categories: (1) primary intention occurs when the skin edges are apposed, and (2) secondary intention occurs in an untreated wound with or without tissue loss. In primary wound healing, there are an inflammatory phase, a fibroblastic phase, and a maturation phase. In the inflammatory phase, immediately after wounding, there is a release of cellular enzymes including amines, lymphokines, and other chemotactic factors. Initial vasoconstriction leads to a vasodilatation, increased capillary permeability, and recruitment of macrophages and lymphocytes. This establishes the environment for the process of wound healing and lasts from 4 to 7 days. In the well-sutured wound, a fibrin-platelet clot bridges the cut surface followed by migration and proliferation of epithelial cells toward the base of the wound until an epithelial bridge is formed in 12–24 h. Epithelial hyperplasia with capillary vascular formation and epithelial reorganization occurs during days 10–15.

The fibroblastic phase is characterized by production of collagen by fibroblasts around day 3 after injury. Collagen is synthesized over the next 10 days with an increase in tensile strength over 4 weeks. The maturation phase is characterized by an alignment and restructuring of collagen fibers. During this phase, collagen synthesis is balanced by collagenolysis. This may continue for months.

Suture Techniques

Maximizing an optimum incision with minimal scarring requires good suture techniques and principles:

1. First, it is important to place a skin incision along the lines of facial expression or skin tension lines (Fig. 3.1). Incisions made parallel to these lines tend to heal with less scarring than those that are oriented tangentially.
2. Second, it is generally preferable to make the incision perpendicular to the skin surface. Beveled wounds retard healing and are more difficult to approximate. Beveled incisions, however, are often used in the eyebrow to minimize trauma to the eyebrow lash follicles.
3. Third, it is important to relieve tension along the wound edge with properly placed deep sutures to facilitate compact scar formation. If this is ignored, the epithelial bridge will extend downward in an extended wound, and a depressed wide scar will occur.
4. Fourth, delicate tissue handling with minimal crush injury to wound edges will reduce the inflammatory phase.
5. Fifth, it is important to have slight eversion of the wound edges. This compensates for contraction during wound healing and avoids or minimizes depressed scar formation (Fig. 3.2). Interrupted sutures offer great safety in that if

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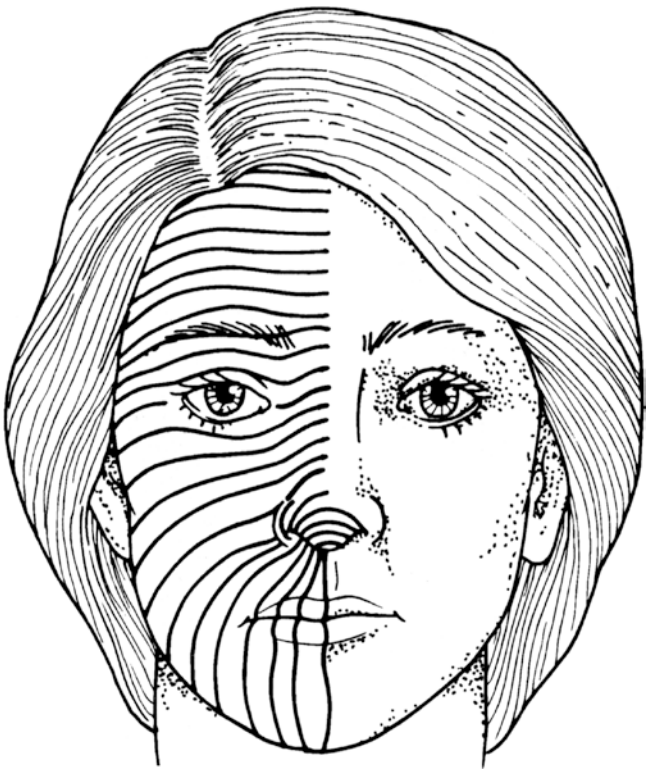

Fig. 3.1 Sites of skin tension lines where incisions may be made

one suture breaks or unties, the remaining sutures may prevent dehiscence. Because a running suture distributes the tension relatively evenly along the entire extent of the suture, interrupted suturing techniques may better maintain tension for a curved incision or complex laceration.

6. Sixth, wound eversion can be exaggerated by a vertical mattress that provides good deep support and wound edge eversion (Fig. 3.3). A horizontal mattress suture distributes the coaptive tension of the suture along a greater length of the wound. This may be of value when closing a wound with friable wound edges (Fig. 3.4).

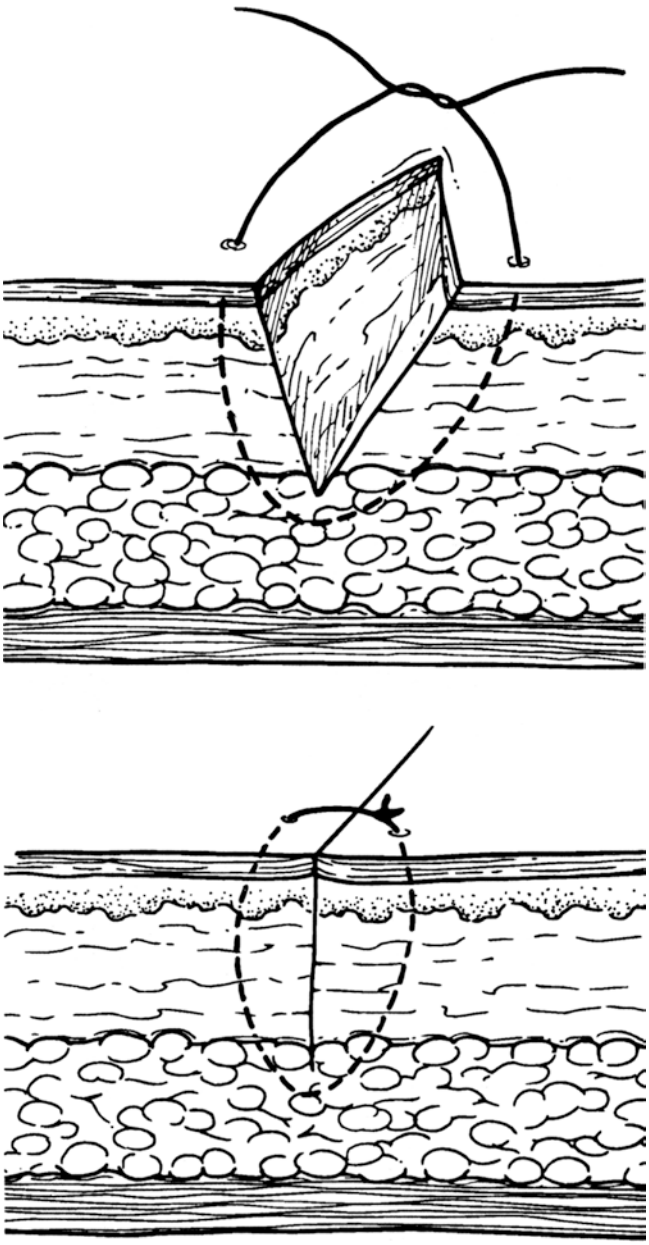

Fig. 3.2 Slight eversion of wound edges

Suture Material

Suture material may be absorbable or nonabsorbable and may best fit certain situations depending on the age of the patient, type of incision, location, amount of wound tension needed, and suture handling characteristics.

Fast-absorbing gut suture comes from the intestinal mucosa of a sheep. The sutures lose 50% of the tensile strength in 3–5 days. It should only be used in wound closure that has little or no tension. Plain gut sutures lose half of the tensile strength in 7–10 days, whereas chromic catgut sutures, which have been treated with chromic oxide solution, lose 50% of tensile strength in 10–14 days. Synthetic sutures such as polyglycolic acid (Dexon) and polyglactin (Vicryl) are braided sutures and are less reactive than gut and lose 50% of their tensile strength over 2–4 weeks. Nonabsorbable sutures include silk, Dacron, nylon, and Prolene. Silk is a naturally occurring braided suture that is very surgeon friendly, and it maintains its tensile strength over 2 years. Mersilene (Dacron) is a synthetic braided suture that holds its tensile strength for 2 years. Nylon is a monofilamentous synthetic suture that maintains 70% of its tensile strength over 2 years. It does not lay down as well as silk, but it is easier to remove because it is monofilamentous. Prolene is a synthetic monofilamentous suture with 100%

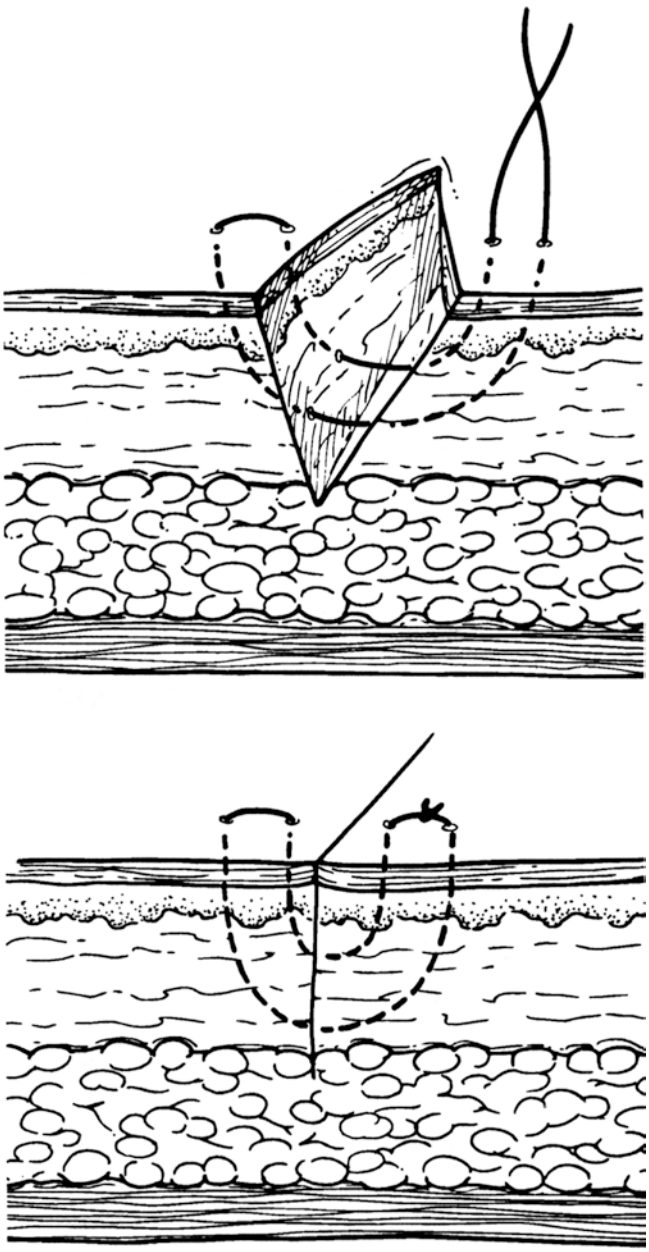

Fig. 3.3 Vertical mattress suture

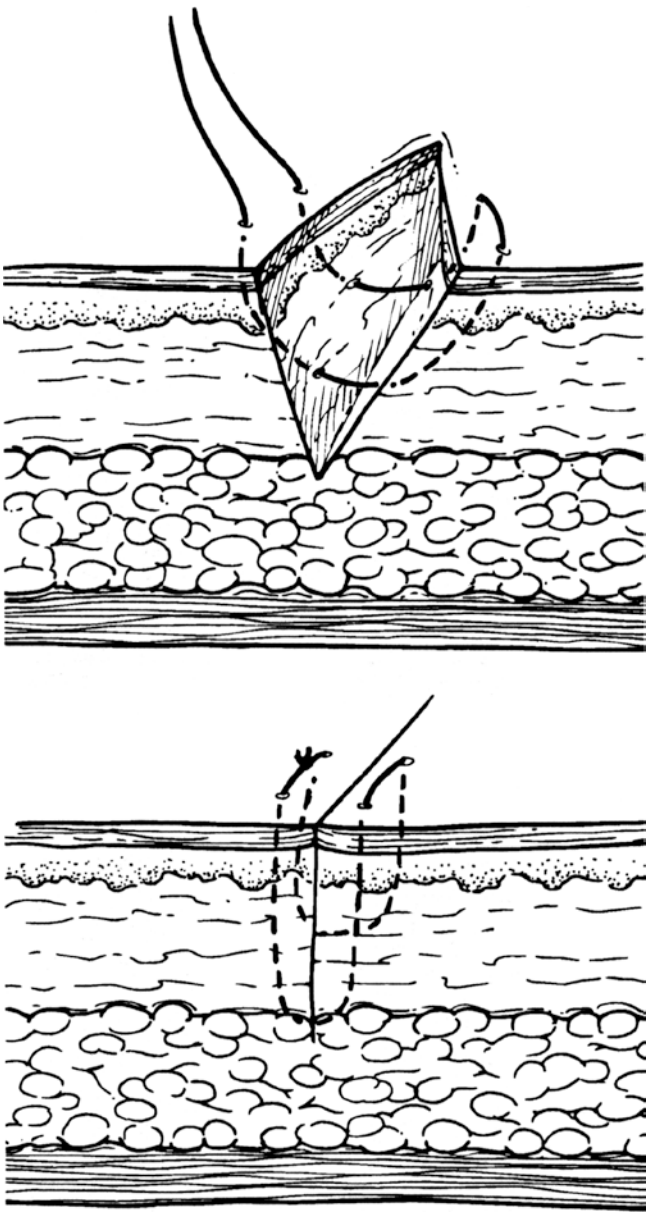

Fig. 3.4 Horizontal mattress suture

tensile strength over 2 years. Finally, the most inert suture material is stainless steel wire with little tissue reactivity.

Periocular Flaps and Grafts

Tumor excision may result in a defect that is larger or more complicated than estimated in the preoperative evaluation. The oculoplastic surgeon must be able to adapt to different, unexpected intraoperative situations that can arise with these procedures. Small skin defects may be closed by direct apposition and closure of the wound edges. Free skin grafts and vascularized skin flaps are commonly used in larger defects. Flaps may be used to minimize the tension during closure of an adjacent or nonadjacent skin defect or to release tension of contracted scars. A myocutaneous flap is designed pre- and intraoperatively according to the size, shape, and location of the defect or scar. Occasionally, a simple skin flap does not provide adequate closure due to the size or location of the defect. A free skin graft may be harvested from a more distant site, minimizing the extent of tissue mobilization and deformity. The donor choice will depend on the size and depth of the defect as well as the integrity of the blood supply in the recipient bed. Recruitment of available tissue with retention of its vascular supply through an unaltered base makes a flap superior to a free graft in cir-

cumstances where the skin needs to be mobilized over an area of compromised arterial supply, such as free grafts or exposed bone. The right blood supply is also helpful, decreasing the risk of infection and ischemic necrosis of the mobilized tissue. In other words, the survival of the tissue is dependent on the degree of perfusion, which in turn is proportional to the size and length of the flap. Hemostasis is important but should be achieved with judicious cautery to prevent vascular compromise. Meticulous and proper handling to avoid crushing of the furthermost edge of the flap is vital because this is the area most susceptible to ischemia. Blanching due to poor vascular supply is an indication, especially in large flaps, for a delayed procedure until revascularization occurs.

A flap reduces the morbidity by using available neighboring tissue. Contracture of a flap is significantly less than in a free skin graft. However, overcorrection is still recommended to provide for the expected amount of contracture of the donor tissue. It also allows a better match in color and texture of the skin. The major disadvantage over a graft is the higher incidence of subcutaneous hypertrophy that could mask the recurrence of a malignant tumor.

There are several general rules that need to be followed when creating a flap. First, it is vital that the surgeon fully understands and feels comfortable with the facial anatomy. This is especially important when reconstructing danger zones such as the area overlying the zygoma between the tragus of the external ear and the tail of the brow where the facial nerve becomes more superficial. Incisions should be made parallel to the relaxed skin tension lines to minimize the tension during the healing period of the wound. Flaps in the lower lid should displace the tissue in a horizontal vector to prevent retraction of the eyelid caused by cicatricial displacement. The amount of undermining and mobilization required to close a defect depends on the laxity of the surrounding tissues. Younger patients with tighter, unyielding skin and large defects are usually more challenging to reconstruct. A flap should have minimal tension, but its length should not surpass three times the span of the base unless exceptional perfusion is observed at the most distal edge. Judicious cautery and careful handling of the tip of the flap are essential for its survival. Torsion, as well as tension, at the base of the flap should be minimal to ensure adequate arterial support. Different types of periocular flaps will be discussed in this chapter. Sliding, advancement, rotation, and transposition flaps are used to close a variety of anterior lamella defects. Others, such as the Z-plasty and V-Y-plasty, are commonly used to reduce the tension in contracted scars.

Sliding Flap

The sliding flap is the simplest form of tissue recruitment for wound closure. This technique is effective in closing small elliptical defects. The tissue surrounding the defect is undermined with sharp dissection. The edges of the wound are then gently drawn together with toothed forceps to determine the amount of residual tension. Care should be taken to avoid damage to the skin with the forceps. If the wound edges are still under tension, further dissection should take place to take on more tissue (Fig. 3.5).

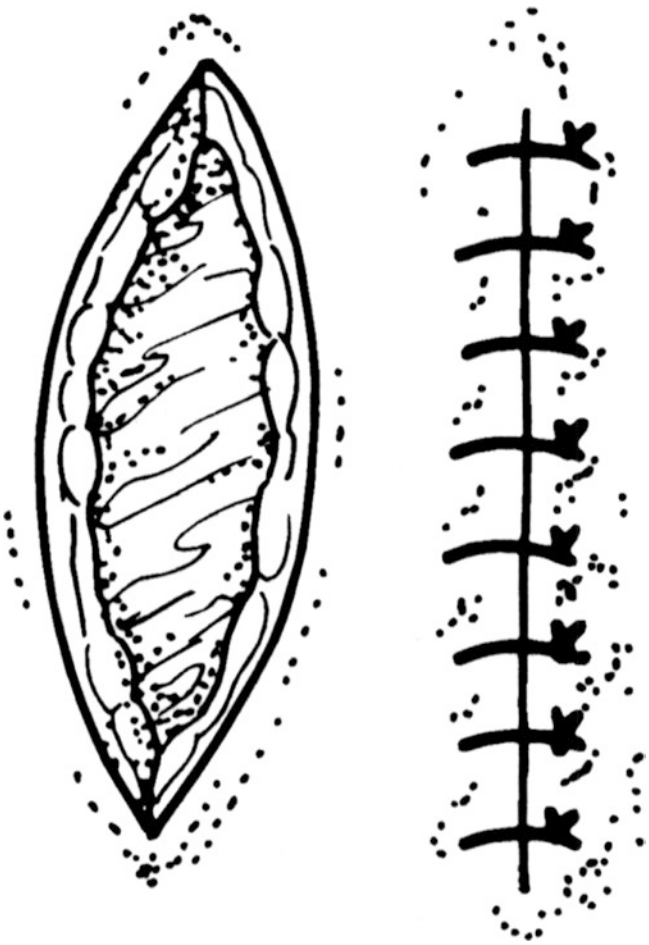

Fig. 3.5 Sliding flap. Redrawn from FA Nesi et al. (eds). *Smith's Ophthalmic Plastic and Reconstructive Surgery*, 2nd ed. St. Louis, MO: Mosby; 1998;90. Virginia Hoyt Cantarella, Medical Illustrator

Advancement Flap

A more advanced technique should be planned when a simple sliding flap does not provide sufficient mobilization. An advancement flap is generally used to close rectangular or square defects. The skin next to the defect is undermined, and relaxing incisions parallel to the edges of the wound are created to advance the tissue. As previously mentioned, the length of the flap should not exceed three times the size of its base unless there is evidence of perfect arterial flow. Burrow's triangles need often to be released at the base of

the flap to reduce tension and to prevent irregular cicatrization. Advancement flaps are commonly used as part of other eyelid reconstructive procedures such as Hughes and Cutler-Beard procedures (Fig. 3.6 and Videos 3.1 and 3.2).

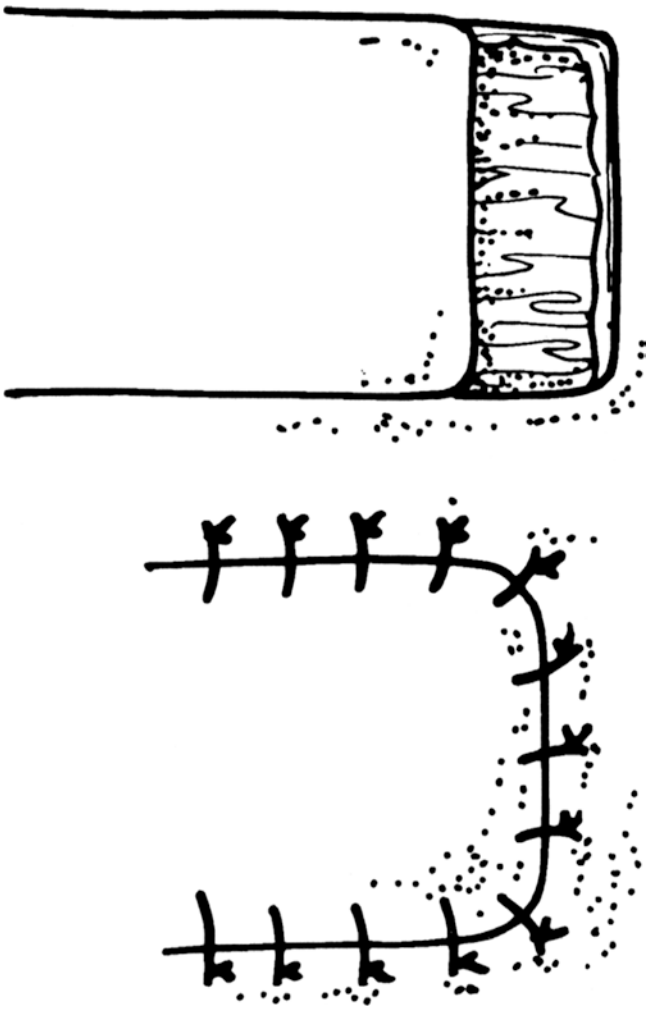

Fig. 3.6 Advancement flap. Redrawn from FA Nesi et al. (eds). *Smith's Ophthalmic Plastic and Reconstructive Surgery*, 2nd ed. St. Louis, MO: Mosby; 1998;90. Virginia Hoyt Cantarella, Medical Illustrator

Rotation Flap

The rhomboid rotational flap is used moving tissue around a stationary base to close an adjacent defect. A flap is created as in an advancement flap and is rotated on its own axis to fill in the defect. The corners of the flap are used as landmarks to begin the closure. The puckered tissue created by the rotation of the skin can be excised as triangles before closure of the wound. Examples of advanced reconstructive techniques that incorporate the use of rotation flaps are the Tenzel semicircular flap and Mustarde flap (Fig. 3.7 and Video 3.3).

Rhomboid Flap

The rhomboid rotational flap is a very useful variation of the standard rotation flap. This technique is used to close diamond-shaped defects especially in the cheek, temple, and lateral canthal areas. The flap should be created on the side of maximum skin availability and laxity by extending an incision at a 120° angle with one of the edges of the rhomboid defect. The dimensions of the sides of the flap should be equal to the sides of the defect. A second incision is made at the end of the first incision. This should be placed parallel to the defect and 60° from the first incision. Meticulous undermining of the flap provides sufficient mobilization to fill in the defect with minimal tension. The donor area should be closed first because it is the site where most of the tension is located following rotation of the flap. Subcutaneous sutures may be used to further reduce the tension exerted on the wound closure (Fig. 3.8 and Video 3.4).

Transposition Flap

A transposition flap may be used to close a large anterior lamella defect when adjacent tissue is not available. This technique requires the transposition of the nonadjacent flap over normal tissue. Once the flap is created and the surrounding area

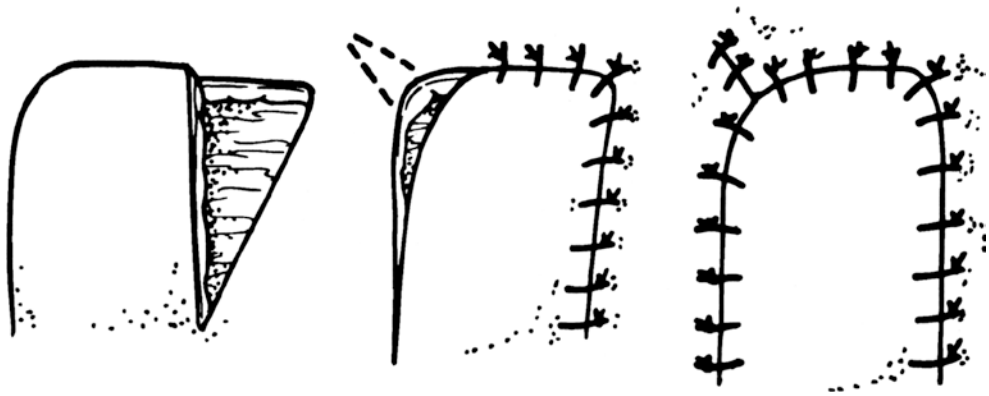

Fig. 3.7 Rotation flap. Redrawn from FA Nesi et al. (eds). *Smith's Ophthalmic Plastic and Reconstructive Surgery*, 2nd ed. St. Louis, MO: Mosby; 1998;90. Virginia Hoyt Cantarella, Medical Illustrator

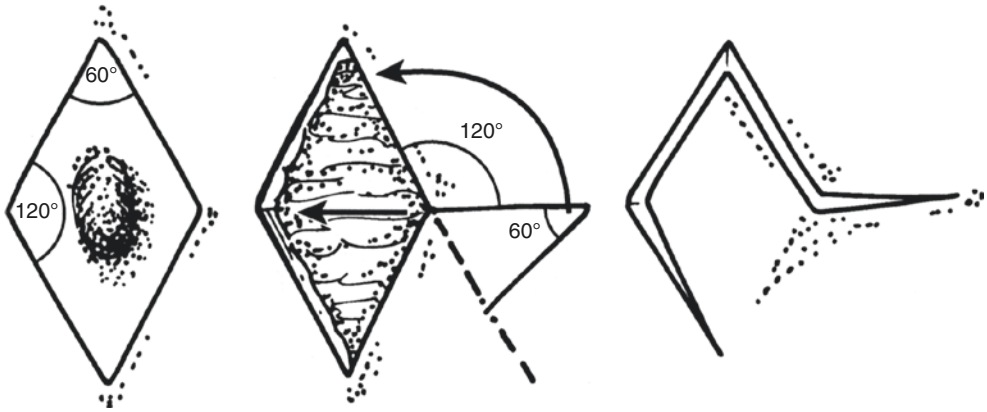

Fig. 3.8 Rhomboid flap. Redrawn from FA Nesi et al. (eds). *Smith's Ophthalmic Plastic and Reconstructive Surgery*, 2nd ed. St. Louis, MO: Mosby; 1998;90. Virginia Hoyt Cantarella, Medical Illustrator

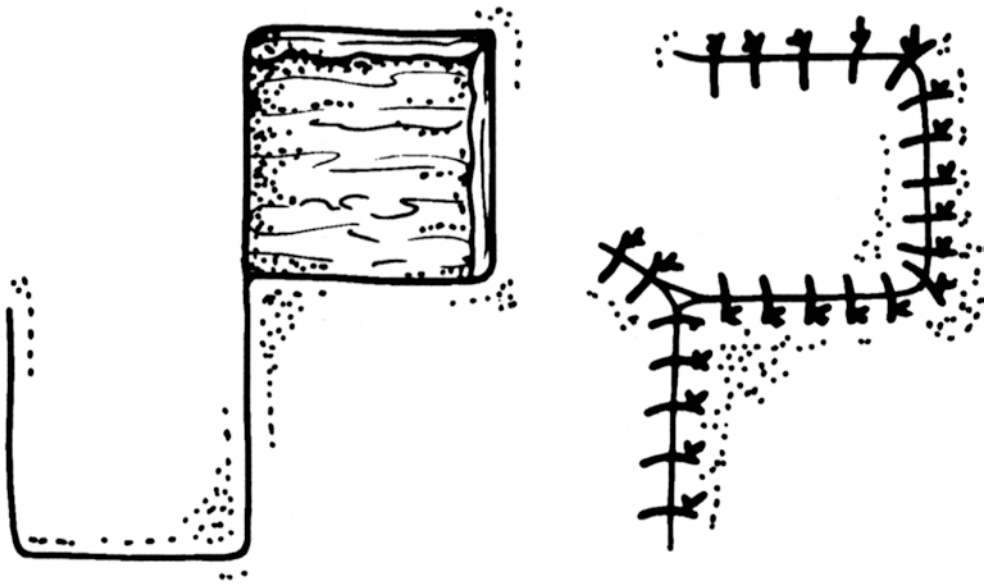

Fig. 3.9 Transposition flap. Redrawn from FA Nesi et al. (eds). *Smith's Ophthalmic Plastic and Reconstructive Surgery*, 2nd ed. St. Louis, MO: Mosby; 1998;90. Virginia Hoyt Cantarella, Medical Illustrator

undermined, it is pivoted into position. Care should be taken to avoid tension at the base of the transposed flap to preclude strangulation of the blood supply. Transposition flaps from the glabellar, temporal, or nasolabial fold areas generally possess excellent vascular supply. Transposition flaps are often used to reconstruct medial canthal defects in which the glabellar flap becomes the donor tissue. The patient should be aware that further debulking might be necessary due to the high incidence of hypertrophy of the flap (Fig. 3.9 and Video 3.5).

Z-Plasty

The Z-plasty is a variation of the transposition flap used to relieve tension in contracted scars. The central arm of the Z-plasty should correspond to the line of maximum tension of the scar. The two side incisions of the Z should be placed at 60° from the central arm. This creates two mirror-image triangles with equal dimensions and angles, allowing a straightforward closure. A longer Z incision with angles larger than 60° amplifies the lengthening of the cicatrix but is more challenging to close. Extensive undermining of the two triangular flaps and the available surrounding skin allows proper closure with minimal tension on the incision. Both flaps are transposed and sutured into their new recipient location. The central arm of the Z will rotate 90° from its original position, decreasing the tension of the scar. Closure should take place first at the apex of the flaps with subcutaneous sutures to further decrease the incisional tension (Fig. 3.10). The O-Z-plasty combines the elliptic excision of a scar or mass with a Z-plasty-like closure. The mass should be included within the central incision. Curved offset incisions are created to close the defect with two advancement flaps (Fig. 3.11 and Video 3.6).

V-Y-Plasty

This technique is especially useful in the treatment of lateral and medial canthal deformities. The V-Y-plasty is another approach to the contracted scar. The axis of the contraction

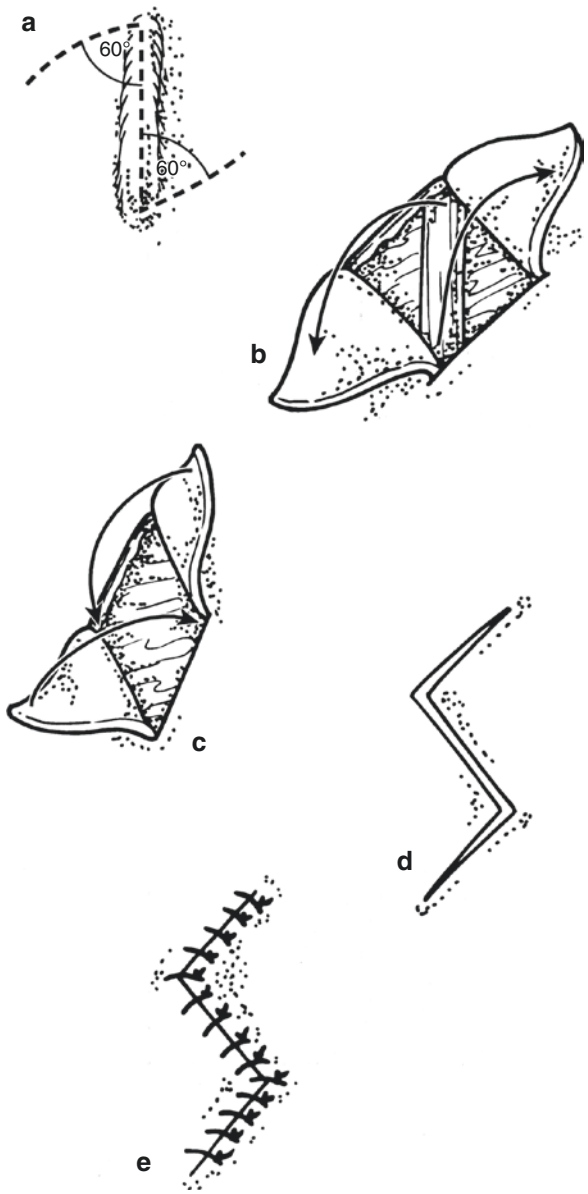

Fig. 3.10 Z-plasty. Redrawn from FA Nesi et al. (eds). *Smith's Ophthalmic Plastic and Reconstructive Surgery*, 2nd ed. St. Louis, MO: Mosby; 1998;90. Virginia Hoyt Cantarella, Medical Illustrator

should be bisected by the V-shaped incision. The skin is undermined to release the flap and the available surrounding tissue. As the tissue is mobilized, the released V-shaped flap becomes a Y, releasing the tension on the axis of the scar (Fig. 3.12). When the technique is reversed, a Y-V-plasty results, advancing the tissue toward the long axis of the Y.

Bilobed Flap

A variation of the transposition flap is the bilobed flap, which is especially useful for closure of the nose and cheek defects. Care is needed when designing bilobed flaps. The first lobe is the same width as the defect and directly adjacent to the defect. The second lobe is the same width as the first lobe but twice the height. The second lobe fills the defect created by the first lobe. The defect from the second lobe is closed by undermining and mobilizing the adjacent skin (Fig. 3.13 and Video 3.7). By rotating the second lobe, the skin tension is distributed over a greater area and is significantly less. The small triangle between the first lobe and the defect may create a standing defect and can be excised similar to a Burrow's triangle. The angle between the first and second lobe is approximately 45°. The total angle of rotation should not exceed 90–100° in order to avoid excess tension. Bilobed flaps allow for excellent tissue matching, but due to the geometry of the flap, incisions may fall against relaxed skin tension lines.

Split-Thickness Skin Grafts

Split-thickness skin grafts are rarely used in oculoplastic surgery (Video 3.8). They are usually harvested with a dermatome and consist of epidermis and a portion of dermis. In general, a split-thickness skin graft is inadequate for eyelid reconstruction due to its poor thickness, texture, and color match as well as for its marked tendency to contract. The main advantage is its ability to survive in areas with poor vascular supply, such as the periosteum and bone following orbital exenteration.

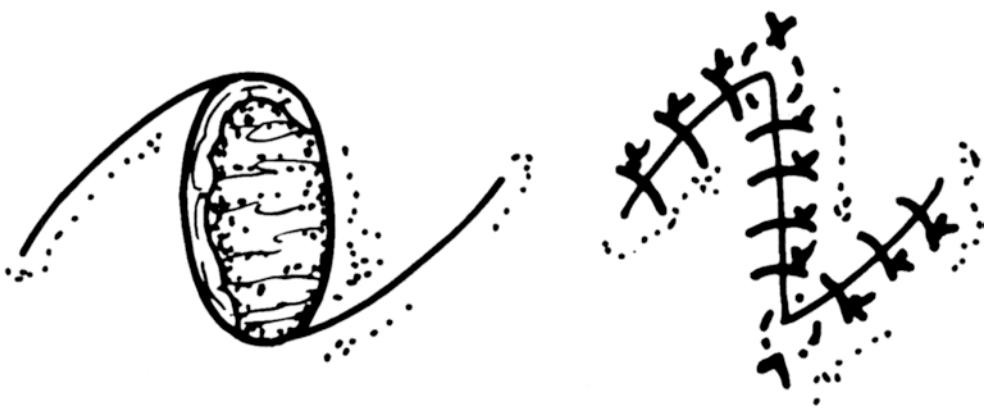

Fig. 3.11 O-Z-plasty. Redrawn from FA Nesi et al. (eds). *Smith's Ophthalmic Plastic and Reconstructive Surgery*, 2nd ed. St. Louis, MO: Mosby; 1998;90. Virginia Hoyt Cantarella, Medical Illustrator

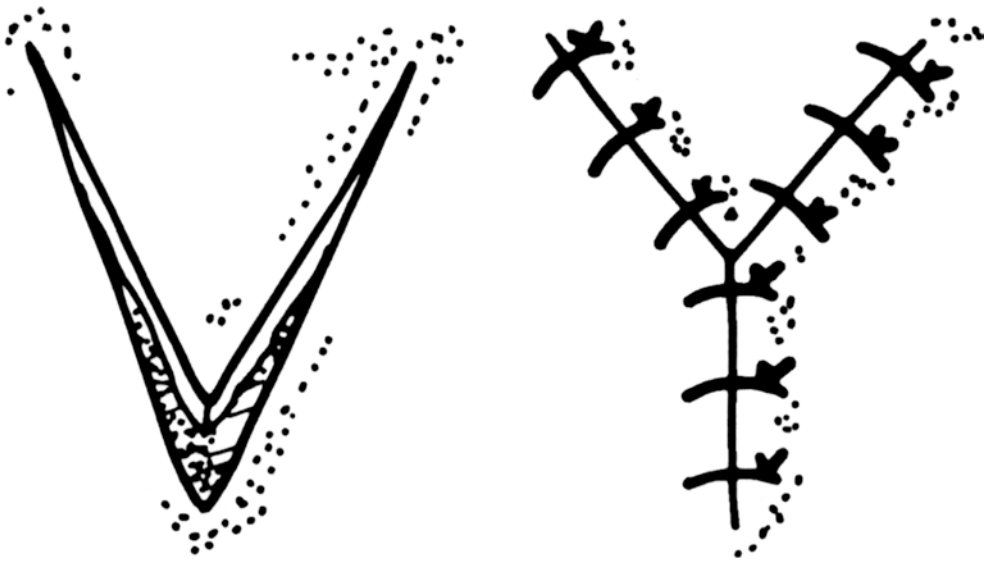

Fig. 3.12 V-Y-plasty. Redrawn from FA Nesi et al. (eds). *Smith's Ophthalmic Plastic and Reconstructive Surgery*, 2nd ed. St. Louis, MO: Mosby; 1998;90. Virginia Hoyt Cantarella, Medical Illustrator

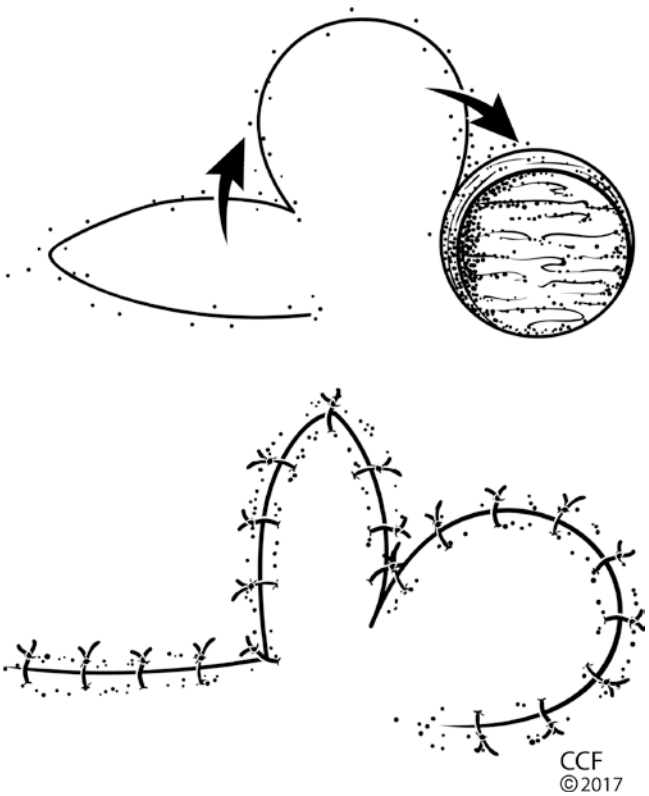

Fig. 3.13 Bilobed flap. Printed with permission, Cleveland Clinic Center for Medical Art & Photography ©2017. All Rights Reserved

Full-Thickness Skin Grafts

In the case of a full-thickness skin graft, the epidermis and dermis are well-preserved for transfer. These can be used to repair small defects measuring up to 5 cm. When possible, the tissue should be obtained from the contralateral eyelid for an optimal color, thickness, and texture match between the graft and the host site. Other donor choices, in order of preference, are the preauricular, retroauricular, and supraclavicular areas. The recipient bed should possess an intact vascular supply for the graft to survive. Hemostasis should be performed in a meticulous manner to ensure proper apposition of the donor and recipient sites.

A template made of nonadhesive dressing should be fashioned to match the size and shape of the defect. This is transferred to the area where the graft is to be harvested. The outline of the graft should be approximately 20% larger than the actual template to allow for the expected contracture. The skin graft is then excised, and the subcutaneous tissue is removed to allow revascularization of the full-thickness skin graft (Video 3.9). After closure of the wound, small draining incisions can be made and a cotton bolster secured, placing gentle pressure over the graft.

Full-thickness skin graft survival depends on the vascularity of the recipient bed, careful removal of the subcutaneous tissue in the graft, and direct apposition of the tissues in the absence of an interface created by hemorrhage.

Summary

Understanding basic wound healing and basic surgical techniques is critical to optimizing surgical outcomes. This chapter gives a brief overview on wound healing, suture techniques, and materials. Advantages and disadvantages of periocular flaps and grafts are also reviewed.

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