INTRODUCTION

Traumatic wounds or skin lacerations are among the most common injuries, occurring in people of all ages, that require evaluation and treatment in the Emergency Department. The result of many if not all wound closures is scar formation. Although most wounds heal with a surprisingly pleasing cosmetic transformation from their initial presentations, it is not uncommon for some wounds to present complications during the healing period as well as to produce an undesirable scar. A systematic approach to wound management serves to help in deciding how to close complicated wounds, reduce the risk for infection, and minimize less favorable outcomes.

Wound management in the Emergency Department includes an assessment of the mechanism and conditions that were present at the time of injury. Initially, one must address the concerns of the patient, family members, or friends with a concise explanation of how the wound will be treated and what can be anticipated for aftercare. Many lawsuits and concerns of poor care evolve from poor cosmetic outcomes. **It is recommended that verbal wound care instructions be offered once wound closure is completed, in addition to giving the patient written discharge instructions.**[1]

Regardless of the severity of the wound or possible inherent complications associated with the injury, many patients are primarily concerned with the potential for scarring or disfigurement. Most patients expect cosmetic and functional perfection as an ultimate result after their wounds are treated and the healing process is completed. These expectations are often not clearly expressed during the evaluation and treatment in the Emergency Department. **The Emergency Physician must openly explain and discuss the fact that virtually no wound heals without a scar following wound closure.**[1,2] A clear understanding of this is not to be used as an explanation for a poor outcome but to counter any misconception that a wound will heal to look exactly like the previously intact skin. Treatment is rendered to offer the best possible functional and esthetic outcome while reducing the risk of potential soft tissue infection.

An overall plan of wound site preparation and closure will be needed to provide the greatest likelihood of a pleasing cosmetic result.[1] The mechanism of injury, severity of the wound, location of the wound, and the presence or risk of necrotic tissue can all influence the risk of infection. Additionally, the decision of how to approach wound closure will be affected by the patient's skin type, age, gender, occupation, and hobbies.

Wound healing ultimately takes place over at least 6 to 9 months. Any wound presenting with concerns for a poor outcome or an obvious likelihood of wound revision in the future should be evaluated and treated by a Plastic Surgeon when possible.[1,2] All other wounds requiring complex closures should be properly assessed and treated by the Emergency Physician.

ANATOMY AND PATHOPHYSIOLOGY

In order to have a better understanding of scar tissue formation and the antecedent techniques of wound closure, the Emergency Physician should have knowledge of specific physiologic conditions and anatomic areas that may increase the chances of unfavorable scarring following wound repair.[2,3] The age of the patient and appearance of the patient's intact skin should be taken into consideration. The younger patient tends to heal more rapidly, while the older patient tends to have a more favorable cosmetic outcome with wound closure. Older patients have less overall elastic and subcutaneous tissue and more wrinkling, thus decreasing the tension on the healing wound and making scarring less noticeable.[2,3] Wrinkling, or lines of minimal tension, makes wound repair more technically challenging.

Suturing of asymmetrical, deep, or large wounds requires particular attention to the preexisting lines of minimal

tension or lines of facial expression. Without properly addressing such preexistent anomalies, the cosmesis of wound repair can be grossly affected.[2,3] Scars from wounds closed perpendicular to preexisting functionally anatomic lines undergo repetitive physical stress and may result in hypertrophic scar tissue. With markedly less skin elasticity and subcutaneous fat, older patients will often experience more favorable cosmetic results from less complex wound closures. However, younger patients will benefit from more advanced wound closure techniques to properly close large or complicated wounds. Rotational and advancement flaps are frequently performed to make scarring less obvious when suturing across lines of tension.[3]

The type of skin, regardless of age, will affect scar formation.[3,4] Oily or hyperpigmented skin more frequently has poor scar tissue formation, resulting in scars that are hypertrophic, deep, and asymmetrical. Consideration of wound outcome should be given to areas of the skin that are rich in sebaceous glands or simply hyperpigmented (from environmental exposure or ethnicity). Patients with underlying connective disease disorders or conditions with a high likelihood of concomitant vitamin deficiencies should also be scrutinized, as wound closure and healing may be compromised in such cases, resulting in highly variable and less predictable outcomes.

The mechanism of injury, including environmental exposure to underlying tissue, should not be overlooked, so that adequate debridement and preparation may be done prior to a complex wound closure. This allows the physician to better visualize the anatomic layers of the skin. It can be difficult to determine a clear delineation between the anatomic layers of the skin when the wound was a result of a crush injury, shredding mechanism, or any circumstance resulting in uneven or macerated wound edges. Delineate the pigmented epidermis from the thicker underlying dermis, especially when multilayer wound closures are required, as suturing may then become unnecessarily complicated and affect the overall integrity of the wound closure.

It should be noted that the literature supports a significant underutilization of multilayer closures, though these are often necessary. Single-layer closures and excessively large suture materials are the greatest causes of residual scar tissue.[1] It is recommended to prepare the wound edges by creating a bevel or undercutting of the wound margin to allow subtle epidermal eversion, thus augmenting the natural process of scar formation.[1,2] This allows the natural flattening and depression of the forming scar to occur without excessive depression from the wound margins.[2] This will also help to reduce the thickness of the scar tissue and decrease the refraction of light from the scar, making it less noticeable.

Depending on the presentation of the tissue defect, more than one wound closure technique may be used to adequately close a wound. Utilizing more than one technique will help remove underlying tension and allow better approximation of the epidermis. With the help of specific camouflage techniques used in closing the epidermis, irregularly shaped wounds can heal with less obtrusive scarring. Familiarity with a few of these techniques and their application will allow the Emergency Physician to comfortably close the more challenging wounds encountered, with expectantly more favorable cosmetic prognoses.

INDICATIONS

Advanced wound closure techniques are indicated for closing wounds with irregularly shaped defects. They can be used to close circular, square, elliptical, or asymmetrical skin defects. Advanced wound closure techniques are beneficial when there is a need to reduce skin tension and contracture, which are likely to result in hypertrophic scar formation.[3,4] Rotational and advancement flap techniques are useful in areas where tissue loss must be avoided and the undermining of wound edges must be minimized. This is often encountered with facial wounds in proximity to the eyelids, eyebrows, canthi, nasolabial folds, or lip borders. These techniques allow the initial shape of the wound to be altered such that there is reduced tension on the wound edges, which may then be closed simply.

CONTRAINDICATIONS

Specific wound closure techniques should take into account the potential for scar formation to occur in an undesirable location. This can happen when a wound must be elongated to create parallel lines and to decrease the tension on the wound edges. Elongation of a wound may bring it into proximity of other anatomic positions or landmarks, thus further complicating the healing process. If not planned well, excessively large defects may

result, making it more likely that the scar will require later revision. More obvious conditions may exist that compromise complex wound closures. Particular attention must be given to crush injuries with devitalized or contaminated tissues. Severely contaminated wounds, including those with prolonged exposure, generally are at greater risk of infection with multilayer closures. Careful wound assessment may result in a decision to use simple approximation of the wound edges with close follow-up for ongoing wound care. Contraindications to complex wound closures will at times be reliant on temporal factors, such as the need to close a wound prior to the patient receiving surgical intervention for more life threatening injuries. There must be a commonsense approach in deciding how to close more challenging wounds in the Emergency Department.

PATIENT PREPARATION

Explain the risks, benefits, and complications of the wound closure to the patient and/or their representative. Discuss the presence of a visible scar after the repair, which may require subsequent revision. Explain the aftercare and follow-up. Obtained a signed informed consent for the procedure.

Place the patient in a position of comfort that is equally comfortable for the physician. This should allow for appropriate stretcher or seat height, lighting, and maneuverability so that physical obstacles are not a complicating variable during the wound repair. Clean the wound and surrounding skin of any dirt and debris. Flush the wound with normal saline. Apply povidone iodine solution to the surrounding skin, not the wound, and allow it to dry. Anesthetize the area using local or regional anesthesia (refer to Chapters 105, 106, 107, 108, and 109).

Examine the wound for obvious foreign bodies or contaminants. Remove these with pressure irrigation using sterile saline. Apply sterile drapes to demarcate a sterile field. Apply the drapes so that the wound may be approached easily from different angles and without the risk of contaminating the site or any of the materials being used. There can be a great degree of variability in sterile techniques; therefore it is important to note that the best way to avoid wound infections is to employ and maintain consistency with sterile procedures throughout the wound repair.

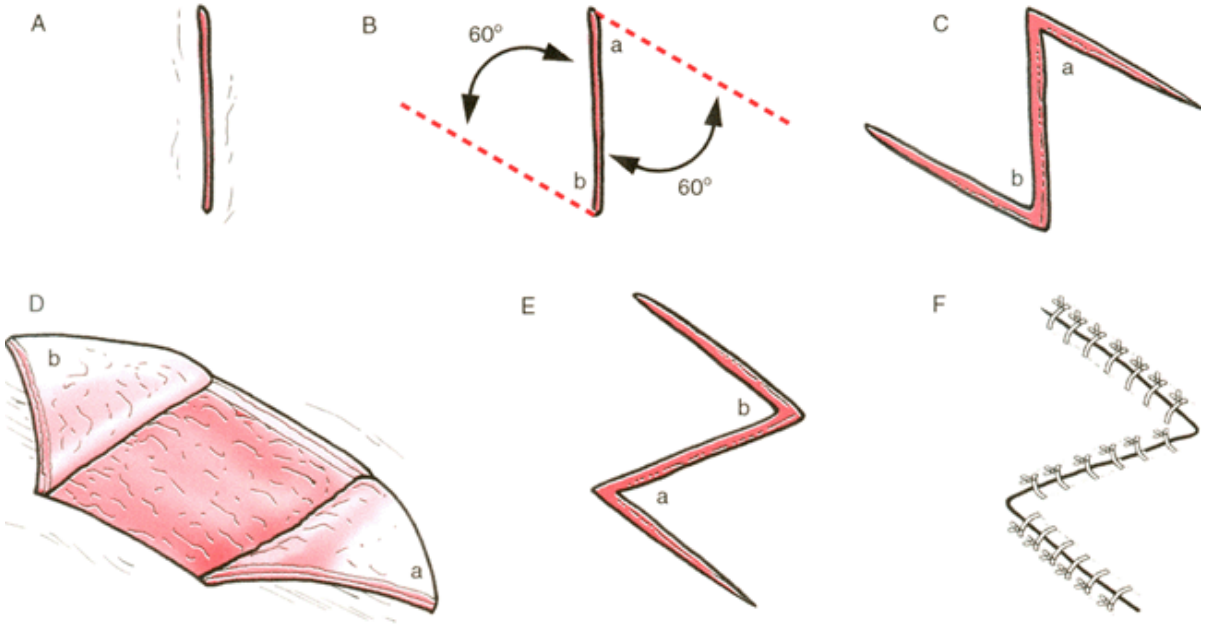
TECHNIQUES

Z-Plasty

It can be challenging to change the axis of orientation of a wound. **The reason for changing the orientation of a wound is to create a more functionally and cosmetically pleasing scar**. The Z-plasty has been described as a basic technique for scar revision, though its application also proves useful to lengthen and reorient wounds.[5] Wound lengthening reduces the formation of contractures, which often occur when the wound crosses areas of flexion. The Z-plasty should not be used for wounds from burn injuries where normal skin is not present. It also breaks up a linear scar into an accordion-like scar that has some degree of elasticity.

The Z-plasty is generally described to redirect a wound occurring across a flexion crease, over a joint, or on the face. It requires two incisions that create two triangular flaps with approximately 60 degrees of separation between the flaps, though the angle may vary between 30 and 90 degrees (Figure 79-1).[5] The greater the angle, the greater the gain in wound length. Sharper angles increase the risk of necrosis in the tip of the flap. Broader angles result in difficulty in rotating the flaps. Angles of 60 degrees increase the wound length by 75 percent. Angles of 45 degrees increase the wound length by 50 percent. Angles of 30 degrees increase the wound length by 25 percent. **The length of both arms of the incision must be the same length as the wound.** The undermining and separation of the two triangular flaps lengthens the wound and allows it to be reoriented perpendicularly to the original location. Additionally, small Z-plasties may be used in sequence to offset the appearance of straight wounds crossing lines of flexion or where contractures are likely to occur, so that the wound site then becomes parallel to the lines of flexion, further reducing occurrence of contracture formation.[3,4]

Figure 79-1



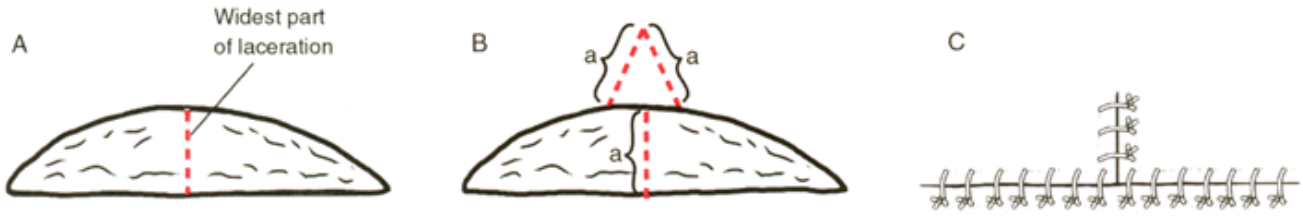
The Z-plasty. *A.* The original laceration. *B.* Draw the arms of the Z at a 60 degree angle from the ends of the lacerations. The arms must be the same length as the laceration. *C.* The skin has been incised to form the Z. *D.* Undermine and elevate the flaps. *E.* Transpose the flaps to reorient the wound. *F.* Approximate the wound edges with simple interrupted sutures.

Clean, prep, and anesthetize the wound and surrounding skin. If the wound edges are irregular, sharply debride them using a # 15 scalpel blade to form straight edges (Figure 79-1*A*). Measure and draw 60 degree angles from the ends of the laceration (Figure 79-1*B*). Draw the arms of the Z on the patient's skin with a skin-marking pen. **The arms must be the same length as the original laceration**. Incise the arms of the Z using a #15 scalpel blade (Figure 79-1*C*). Undermine the flaps of the Z and the surrounding skin. Elevate the flaps of the Z (Figure 79-1*D*). Transpose the flaps so that the wound is reoriented (Figure 79-1*E*). Place simple interrupted sutures to approximate the wound edges (Figure 79-1*F*).

Approximating the Edges of a Laceration with Grossly Unequal Lengths

Creating an equilateral triangle from the midpoint of the longest wound edge allows wound edges of unequal length to be closed easily (Figure 79-2).[3–5] Determine the widest point between the two wound edges. Determine which of the two wound edges is longer. Mark the middle of the longest wound edge (Figure 79-2*A*). Draw an equilateral triangle centered at this mark (Figure 79-2*B*). **The sides and base of the triangle must all be of equal length and the same length as the widest part of the original wound**. Incise the arms of the equilateral triangle with a #15 scalpel blade and remove the tissue (Figure 79-2*B*). Undermine the wound edges. Close the wound and the perpendicular incision from the triangle with simple interrupted or running sutures (Figure 79-2*C*). Closure of the two wounds results in a clean linear wound with a short perpendicular linear wound offsetting the previously unequal edges (Figure 79-2*C*).

Figure 79-2

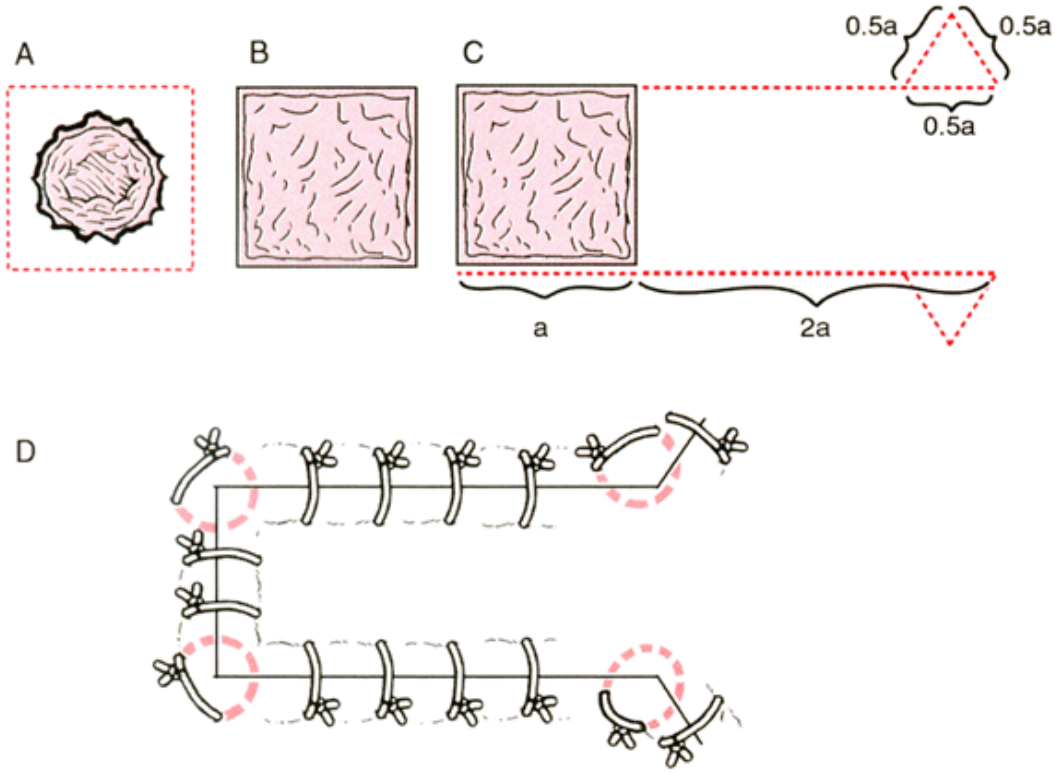


Approximating edges of grossly unequal lengths in repairing a laceration. *A.* The laceration. *B.* Draw an equilateral triangle along the longest side and centered about the widest part of the laceration. The sides of the triangle must be equal to the length of the widest part of the original laceration. *C.* Approximate the wound edges with simple interrupted sutures.

Closing a Square-Shaped Defect

Wounds are rarely square-shaped after an injury (Figure 79-3*A*). Debride the wound to make a square-shaped defect (Figure 79-3*B*). Square-shaped defects can be difficult to close and require a single pedicle advancement flap.[3] Elongating two sides of the square allows small and moderate-sized defects to be closed primarily (Figure 79-3*C*). Draw lines to extend two parallel edges of the square by twice their length (Figure 79-3*C*). Draw Burow's triangles on the ends of the extended lines (Figure 79-3*C*). These triangles will be removed, allowing the flap to be transposed into the wound and creating a more symmetrical flap.[3–5] Draw the Burow's triangles as equilateral triangles whose sides are half the length of the square defect (Figure 79-3*C*).

Figure 79-3



Closure of a square-shaped defect. *A.* The original tissue defect. Draw lines around the defect to form a square. *B.* The skin has been incised and the original defect removed to create a square-shaped defect. *C.* Draw lines to extend two sides of the square into a rectangle. Draw Burow's triangles at the ends of the rectangular lines. *D.* Advance the flap and approximate

the wound edges.

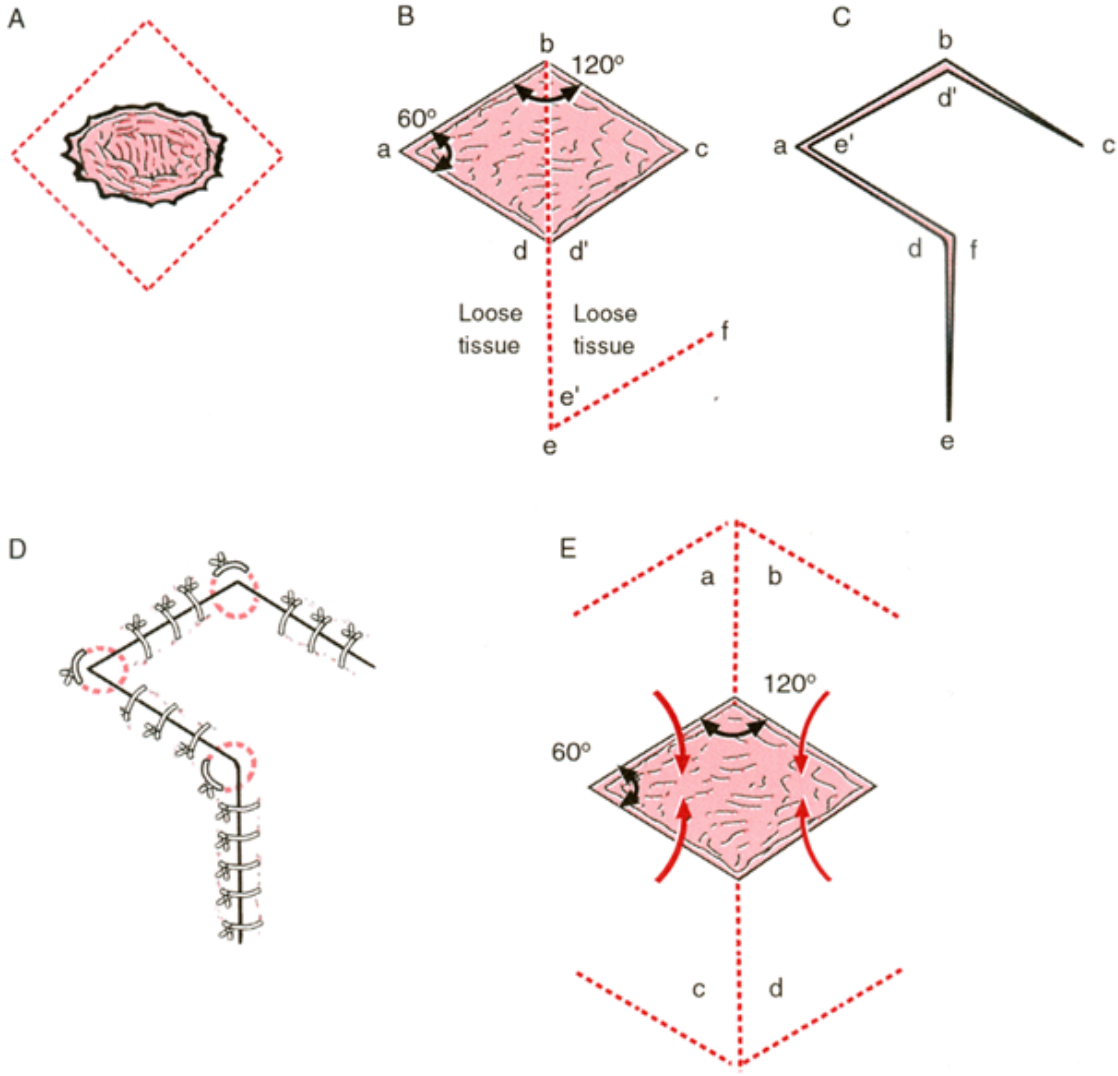
Incise along the extended lines and Burow's triangles with a #15 scalpel blade. Remove the tissue of the Burow's triangles. Undermine the rectangular flap and the area surrounding the base of the flap. **Do not undermine the area lateral to the extended lines**. Advance the tissue flap to close the defect (Figure 79-3*D*). Place a simple interrupted suture in the center of the short edge of the flap to hold it in position. Place half-buried horizontal mattress sutures to secure the corners of the flap. Approximate the wound edges with simple interrupted sutures along the long arms. Approximate the corner of the Burow's triangles with half-buried horizontal mattress stitches and the rest of the triangle with simple interrupted sutures.[3–5]

Closure of a Diamond-Shaped Defect

Diamond- or rhomboid-shaped defects require the rotation of a flap referred to as a Limberg flap. **The Limberg flap is a transposition flap suitable only for closing a diamond- or rhomboid-shaped defect. It requires the formation of two adjacent angles of the rhomboid that must be 60 and 120 degrees for an optimal flap**.

Wounds are rarely diamond-shaped after an injury (Figure 79-4*A*). Debride the wound to make a diamond-shaped defect (Figure 79-4*A*). Draw a line to extend the distance of the short diagonal of the defect to double its total length (Figure 79-4*B*). Draw a line from the extended line and parallel (back cut) to the adjacent wound edge that is equal to the length of the extended line (Figure 79-4*B*). Incise along the extended lines with a #15 scalpel blade. Undermine the flap and adjacent skin. Rotate the flap into the diamond-shaped defect (Figure 79-4*C*). Approximate the wound edges with simple interrupted sutures along the linear edges and half-buried horizontal mattress sutures at the intersection or angles of the wound edges (Figure 79-4*D*).[3–5] Depending on the location of loose tissue and adjacent structures, one of four Limberg flaps can be created to close the defect (Figure 79-4*E*).

Figure 79-4

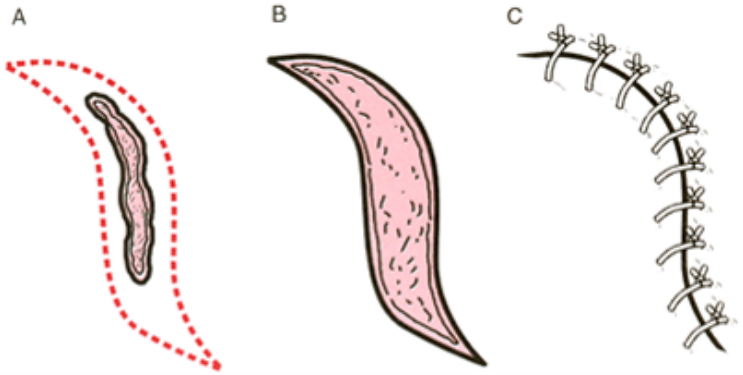


Closure of a diamond- or rhomboid-shaped defect. *A.* The original tissue defect. Draw lines around the defect to form a diamond or rhomboid. *B.* The skin has been incised to create a diamond-shaped defect. Draw lines to form the flap. Extend the short diagonal (BD) by one times its length to form line DE. Draw line EF parallel to line CD and the same length as line CD. *C.* Transpose the flap to close the defect. *D.* Approximate the wound edges. *E.* The four available Limberg flaps that can be created to fill the defect.

Closure of an Elliptical Defect

Wounds are often irregular and elliptical (Figure 79-5*A*). Creating an ellipse from a wound allows more even closure of asymmetrical wounds. This is also referred to as an S-plasty. This technique may be used when there is concern of significant scarring and contracture formation from an associated thermal burn injury and Z-plasties are not recommended.[4] The less acute and more rounded edges of the ellipse tend to result in less tissue necrosis.[3,4]

Figure 79-5



Source: Reichman EF, Simon RR: *Emergency Medicine Procedures*: http://www.accessemergencymedicine.com.

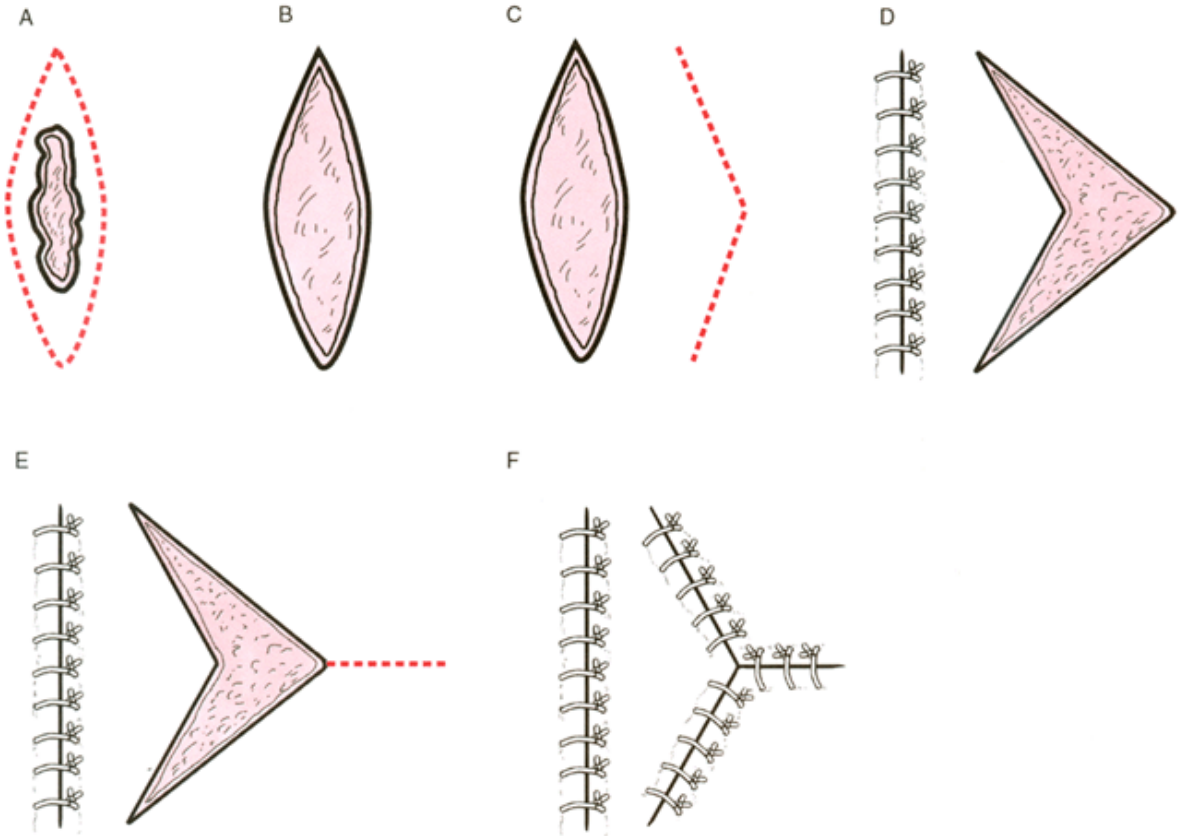
Closure of an elliptical defect. *A.* The original tissue defect. Draw lines around the defect to form an S-shaped defect. *B.* The skin has been incised and the original defect removed to create an S-shaped defect. *C.* Approximation of the wound edges with simple interrupted sutures.

Draw lines to debride the wound and form an S-shaped defect (Figure 79-5*A*). Incise the extended lines with a #15 scalpel blade to form the S-shaped defect and excise the wound (Figure 79-5*B*). Undermine the wound edges. Place buried sutures to close the wound and prevent tension on the wound edges. Approximate the wound edges by placing simple interrupted sutures alternating at each end of the S-shaped defect and ending in the middle (Figure 79-5*C*). Suturing from the ends and moving inward reduces the tension on the wound edges.[3,4]

Closure of a V-Y Advancement Flap

The V-Y flap is not a rotational flap but rather a V-shaped flap created away from the wound site, which then allows the skin to be advanced into the defect (Figure 79-6).[3–6] These advancement flaps may be used to avoid defects from lacerations of the fingertips, lips, or face.

Figure 79-6



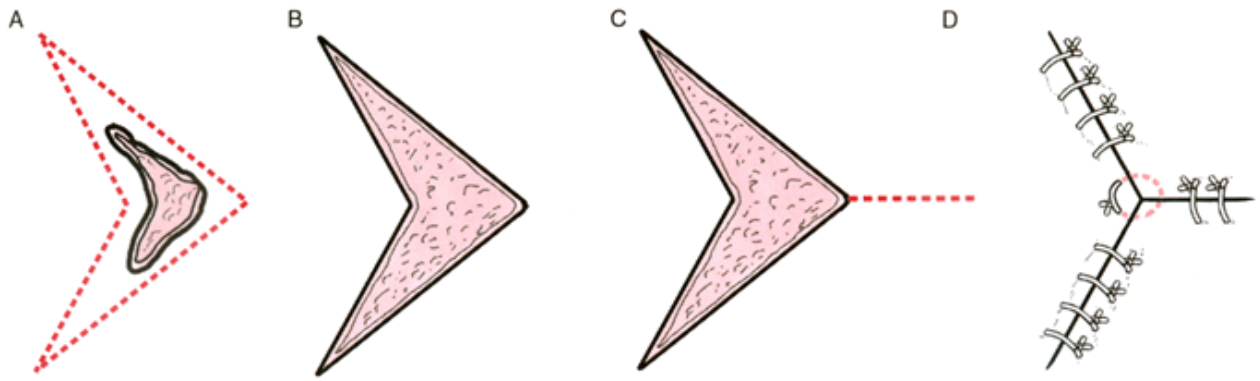
Source: Reichman EF, Simon RR: *Emergency Medicine Procedures*: http://www.accessemergencymedicine.com.

Closure of a V-Y advancement flap. *A.* The original tissue defect. Draw lines around the defect to form an oval. *B.* The skin has been incised and the original defect removed to form an oval-shaped defect. *C.* Draw a V-shaped line adjacent to the oval defect. It should be positioned the maximum width of the oval defect from the wound edge. *D.* Incise the V and undermine the skin edges. Approximate the oval-shaped defect with buried sutures and simple interrupted sutures. *E.* Draw and incise a line perpendicular to the apex of the V and equal to the maximum width of the V-shaped defect. This forms the V into a Y. *F.* Approximation of the Y-shaped defect.

Wounds may be oval and elliptical (Figure 79-6*A*). Creating an oval from a wound allows more even closure of asymmetrical wounds. Draw lines to debride the wound and form an oval-shaped defect (Figure 79-6*A*). Incise along the lines with a #15 scalpel blade to form the oval-shaped defect and excise the wound (Figure 79-6*B*). Draw a V-shaped line adjacent to the oval-shaped defect (Figure 79-6*C*). **The line should be the length of the oval-shaped defect and approximately the width of the original wound away from the defect along its entire length.** Although the two sites do not directly communicate with each other, the V-shaped incision allows the original wound to be closed primarily and without tension. Undermine the wound and the V-shaped incision. Approximate the oval-shaped defect with buried sutures, if necessary, and simple interrupted sutures (Figure 79-6*D*). This will result in an opening of the V-shaped defect (Figure 79-6*D*). Draw and incise a line perpendicular to the apex of the V-shaped defect with a #15 scalpel blade (Figure 79-6*E*). The line should be as long as the width of the V-shaped defect. Approximate the arms of the defect with simple interrupted sutures to form a Y (Figure 79-6*F*).

An alternative V-Y advancement flap can be used to close the injury without making a second wound (Figure 79-7). Draw lines to debride the wound and form a V-shaped defect (Figure 79-7*A*). Incise along the lines with a #15 scalpel blade to form the V-shaped defect and excise the wound (Figure 79-7*B*). Draw and incise a line perpendicular to the apex of the V-shaped defect with a #15 scalpel blade (Figure 79-7*C*). The line should be as long as the width of the V-shaped defect. Undermine the V-shaped defect and the perpendicular line. Place a half-buried horizontal mattress suture to close the center of the Y (Figure 79-7*D*). Approximate the edges of the defect with simple interrupted stitches (Figure 79-7*D*).

Figure 79-7

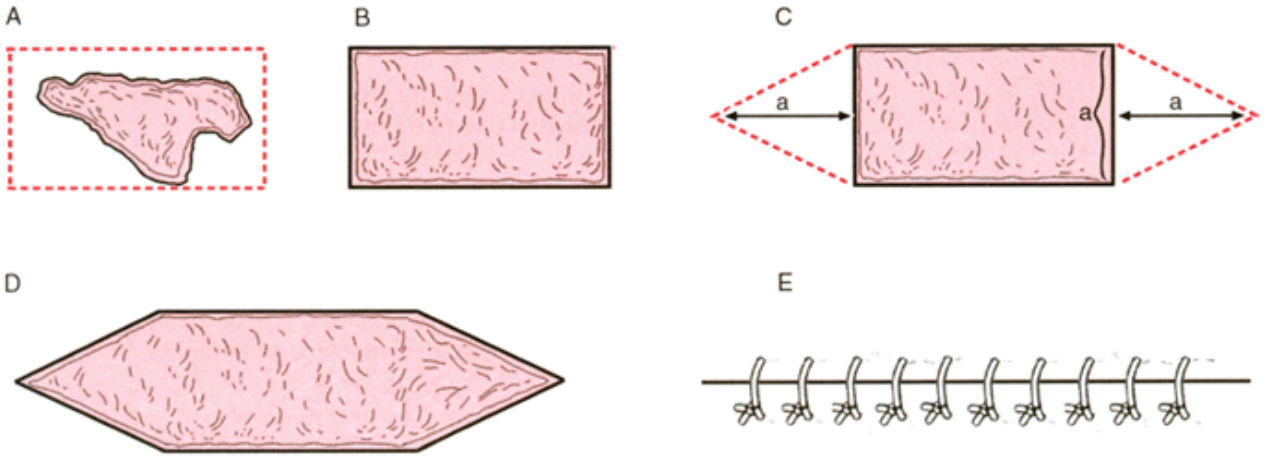


An alternative V-Y advancement flap closure. *A.* The original tissue defect. Draw lines around the defect to form a V. *B.* The skin has been incised and the original defect removed to form a V-shaped defect. *C.* Draw and incise a line perpendicular to the apex of the V and equal to the maximum width of the V-shaped incision. *D.* Approximate the center of the Y with a half-buried horizontal mattress suture. Approximate the arms of the Y with simple interrupted sutures.

Closure of a Rectangular Defect

Wounds may be in the form of an ellipse or oblong (Figure 79-8*A*). These can be converted into a rectangular defect to allow primary closure.[3] Draw lines to debride the wound and form a rectangular defect (Figure 79-8*A*). Incise along the lines with a #15 scalpel blade to form the rectangular defect and excise the wound (Figure 79-8*B*). Draw lines to convert the short ends of the rectangle into triangles (Figure 79-8*C*). **The width of the rectangle should serve as the measurement to create an equal distance between the base and the apex of the triangle.** Excising triangles from the ends of the rectangular defect reconfigures the ends of the wound. Incise along the lines with a #15 scalpel blade and remove the triangles (Figure 79-8*D*). Undermine the skin surrounding the defect. Approximate the wound edges with simple interrupted sutures to form a straight line (Figure 79-8*E*).

Figure 79-8



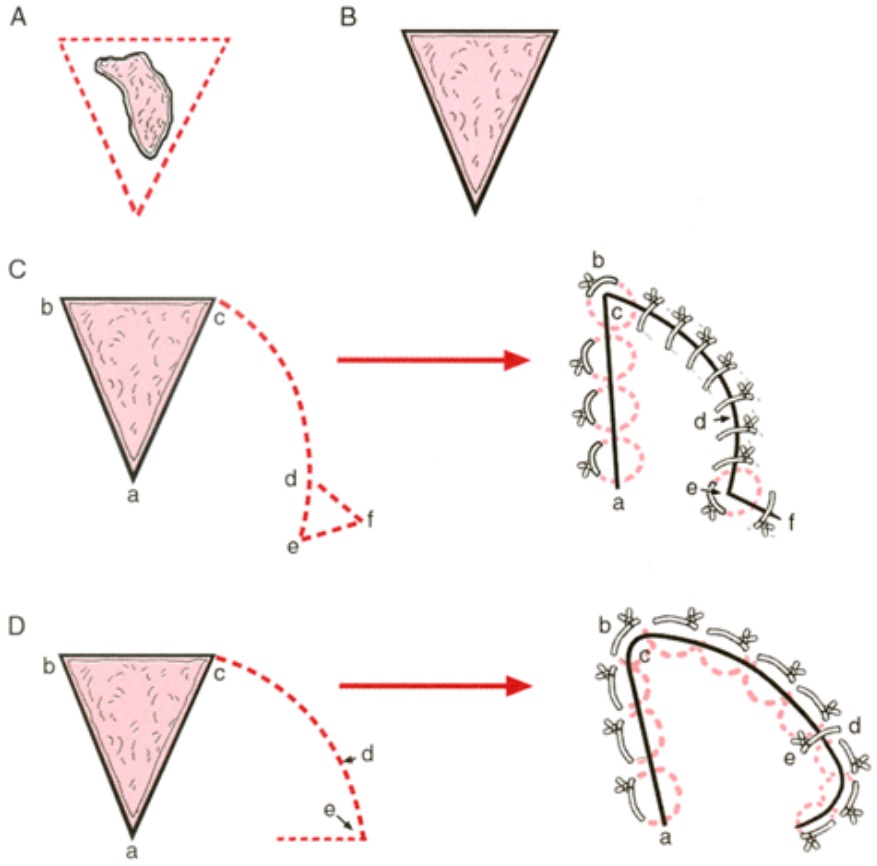
Closure of a rectangular defect. *A.* The original defect. Draw lines around the defect to form a rectangle. *B.* The skin has been incised and the original defect removed to form a rectangle. *C.* Draw triangles along the short sides of the rectangle. The length from the apex to the base of the triangle must be equal to the width of the rectangle. *D.* The resulting defect

after incising and removing the triangles. *E.* Approximation of the wound edges to form a linear scar.

Closure of a Triangular Defect (Rotation Flap)

Closing of a triangular defect can be accomplished with the use of a rotational flap (Figure 79-9). These flaps can be turned on a pivot point. **The flap must be planned carefully so that the direction of rotation coincides with the geometry of the defect.**[3–5] **Always plan and draw the arch of the flap carefully to visualize the pivot point and direction of rotation prior to making the incision. The creation of a rotation flap is a significant procedure. It can result in a vascular disaster and leave a deformity greater than the original defect it was supposed to correct. Do not create a rotation flap unless you have experience with this technique and know that the flap has an adequate vascular supply.**

Figure 79-9



Source: Reichman EF, Simon RR: *Emergency Medicine Procedures*: http://www.accessemergencymedicine.com.

Closure of a triangular defect. *A.* The original defect. Draw lines around the defect to form a triangle. *B.* The skin has been incised and the original defect removed to form a triangle. *C.* Draw a line to extend the base of the triangle in a wide arc that is three to four times the length of the base of the triangle. Make sure that the arc is drawn beyond the line from point a to point d. Draw a Burow's triangle at the end of the arc. The base of the Burow's triangle should be half the length of the base of the triangular defect. Approximate the triangular defect and any corners with half-buried horizontal mattress sutures. *D.* An alternative technique. Draw a wide arc from the base of the triangle similar to that in *C* but which ends opposite the apex of the triangle (point a). Draw a line to make a back-cut that is three-fourths the length of the base of the triangular defect. Approximate the entire wound edge with half-buried horizontal mattress sutures.

Wounds are often irregular and elliptical (Figure 79-9*A*). Draw lines to debride the wound and form an isosceles triangular defect. Incise along the lines with a #15 scalpel blade to form the triangular defect and excise the wound (Figure 79-9*B*). **Draw the rotation flap very carefully.** The edge of the flap is an arch from the base of the triangle and three to four times longer than the actual base of the triangle (Figures 79-9*C* and *D*).[3] Draw a second triangle as a Burow's triangle in the area next to the pivot point of the flap (Figure 79-9*C*).[3–5]**The**

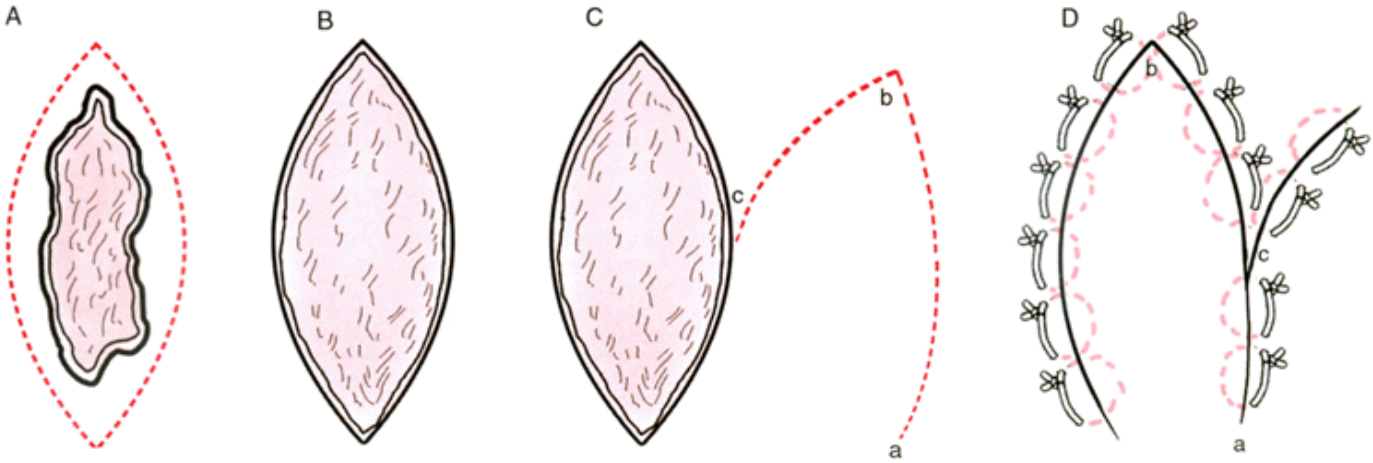
base of the Burow's triangle should be half the length of the base of the triangular defect, with one corner of the base formed by the end of the arch. Incise along the lines with a #15 scalpel blade. Remove the Burow's triangle. Undermine the rotation flap and the surrounding skin. Rotate the flap to close the defect and approximate the wound edges with interrupted sutures (Figure 79-9*C*). Place half-buried horizontal mattress sutures to approximate the triangular defect and any corners. Place simple interrupted sutures to approximate the remaining wound edges.

A triangular defect may be closed with a modification to the above technique when there is minimal room to form and excise the Burow's triangle or if lines of skin tension limit the location of the pivot point.[3] **This modified technique should be considered only when necessary, which may occur from poor planning of the initial flap or in areas where fascia can be separated from the subcutaneous layer (scalp wounds and areas involving the trunk).**[3–5] Form the triangle to debride the wound and draw the arch as described previously. **Do not draw the area beyond the point perpendicular to the apex of the triangle (Figure 79-9*D*).** Rather than drawing a Burow's triangle for excision, draw a line to make a back-cut from the pivot point (the end of the arc) and along the base of the flap (Figure 79-9*D*).[3,5] **This line should be three-fourths the length of the base of the triangular defect.** Incise along the lines with a #15 scalpel blade. Undermine the defect and the rotation flap. Rotate the flap to close the defect and approximate the entire wound edge with half-buried horizontal mattress sutures (Figure 79-9*D*). Suture the back-cut prior to closing the triangular defect or the arch.[3] **This alternative technique carries the risk of having a poor blood supply to the flap due to its small base.**

Closure of an Oval Defect

Oval defects can be closed by creating a rotational or interpolation flap from the intact adjacent tissue (Figure 79-10).[3] Wounds are often irregular and elliptical (Figure 79-10*A*). Choose a side of the oval defect to form the flap. The adjacent skin used to make the flap must be vascularly intact to avoid the risk of tissue necrosis once the flap is sutured into position. Draw lines to debride the wound and form an oval defect (Figure 79-10*A*). Incise along the lines with a #15 scalpel blade to form the oval defect and excise the wound (Figure 79-10*B*). **Draw the rotation flap very carefully. Draw a mirror image of the defect abutting the original wound (Figure 79-10*C*)**. Incise only along the lines noted with a #15 scalpel blade. Undermine the rotation flap and surrounding skin. Rotate the flap to close the defect (Figure 79-10*D*). Approximate the edges of the flap with half-buried horizontal mattress sutures (Figure 79-10*D*). Approximate the wound from where the flap originated with simple interrupted sutures, if it is not excessively large or under tension, or with half-buried horizontal mattress sutures.

Figure 79-10



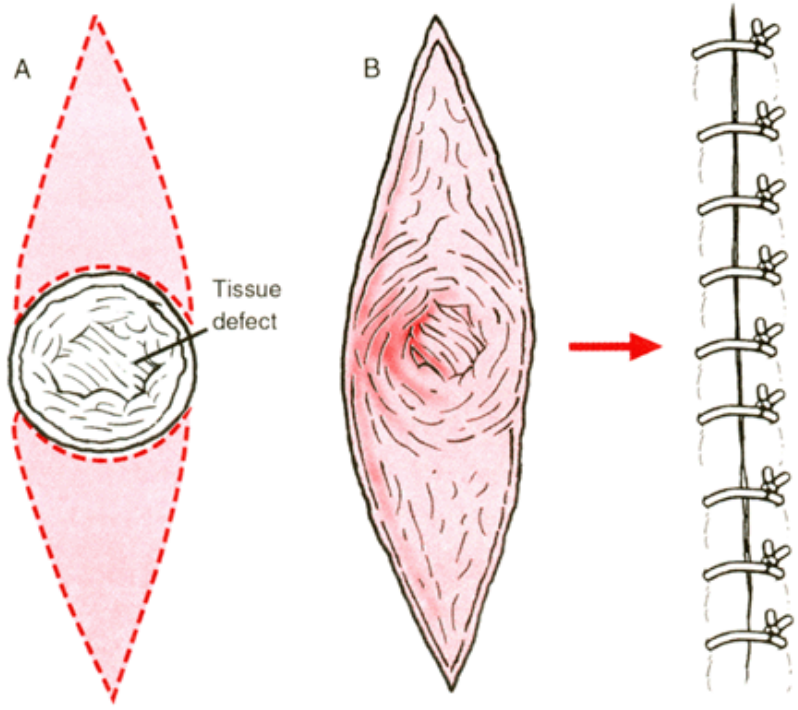
Source: Reichman EF, Simon RR: *Emergency Medicine Procedures*: http://www.accessemergencymedicine.com.

Closure of an oval-shaped defect. *A.* The original defect. Draw lines around the defect to form a rectangle. *B.* The skin has been incised and the original defect removed to form an oval. *C.* Draw a mirror image of the defect so that it is abutting the defect. *D.* The flap has been rotated and the wound margins approximated with half-buried horizontal mattress sutures.

Closure of a Circular Defect

Some defects can be closed primarily. Examples include circular defects or triangular defects that are converted to ellipses (Figure 79-11). Excise the tissue defect to form a circle. Excise a surrounding ellipse of tissue centered about the circle (Figure 79-11*A*). **The ellipse must be 2½ to 3 times as long as its greatest width.** Undermine the edges of the ellipse. Close the resulting defect with deep sutures if required and cutaneous sutures (Figure 79-11*B*).

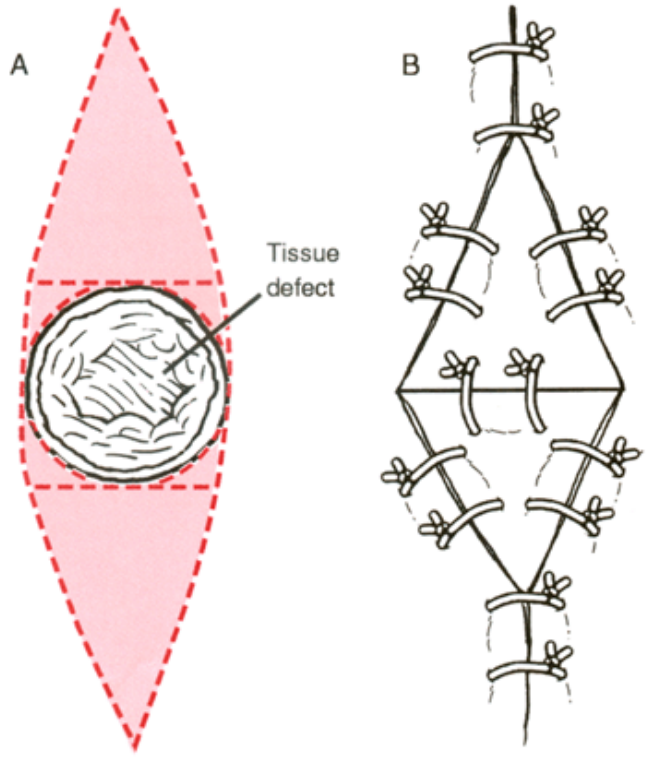
Figure 79-11



Closure of a circular tissue defect. *A.* Excise the defect and a surrounding ellipse. *B.* Approximation of the wound edges with deep and cutaneous sutures.

Larger defects require the use of a double V-Y closure (Figure 79-12). Create two sliding pedicle flaps with a #15 scalpel blade. **Incise the skin and dermis but not the underlying subcutaneous tissue**, to form an ellipse centered about the tissue defect (Figure 79-12*A*). Remove the tissue defect and debride the tissues at the base of the flaps to form two straight edges (Figure 79-12*A*). Gently undermine the edges of the ellipse. **Do not undermine the triangular tissue flaps, so that their vascular supply is preserved.** Slide (advance) the flaps on their subcutaneous pedicles until the bases are touching. Approximate the base of one flap to the other using simple interrupted sutures (Figure 79-12*B*). Approximate the arms and bases of the Y's using simple interrupted sutures.

Figure 79-12



The double V-Y closure to repair a tissue defect. *A.* Create an ellipse centered about the tissue defect. Remove the tissue defect and form straight edges at the bases of the triangular flaps. *B.* Approximate the bases of the triangular flaps, followed by the arms and bases of the "Y's," using simple interrupted sutures.

ASSESSMENT

Inspect the wound edges carefully for adequate approximation. Observe the wound for a period of time to make sure that it remains viable and is not compromised due to a poor blood supply or tight sutures. **A nonviable repair requires immediate removal of the sutures and consultation with a Plastic Surgeon.**

AFTERCARE

Pull the suture knots lying directly over the wound margin to one side so that all the knots lie on the same side. Wipe off any residual povidone iodine solution with sterile saline. Apply a topical antibiotic ointment to the wound, followed by sterile gauze or a nonadherent dressing. Arrange follow-up in 24 hours with the patient's Primary Care Provider, a Plastic Surgeon, or the Emergency Department.

Instruct the patient and/or their representative regarding wound care and dressing changes. Provide clear instructions of what to look for regarding possible signs of early infection, both localized around the wound site as well as systemic symptoms. Any patient who experiences excessive swelling, erythema, a purulent or foul smelling discharge, significant pain from the wound site, or fever should return to the Emergency Department immediately.

COMPLICATIONS

A brief discussion of the complications of wound closure is presented below. Refer to Chapter 77 for a more complete discussion. The complications of any wound can be greatly affected by the preparation of the wound prior to wound closure. The maintenance of sterile technique throughout wound closure and adequate irrigation of the wound will limit the risk of infection. It is unrealistic to expect any wound site to be bacteria-free.

Wounds may show poor scar formation or delayed healing due to several factors. Poor aftercare without

adequate dressing changes or neglect (including premature exposure to environmental irritants such as dirty water, direct and excessive sun exposure, or chemicals) will likely result in a less favorable and unpredictable healing process. The wound site should be protected from excessive contact or use during the initial healing period. Mechanical trauma or overuse can increase the chance of edema or hematoma formation, leading to wound dehiscence or atypical scar formation.

Proper follow-up should be arranged and stressed within the initial 24 to 48 hours following the treatment and thereafter as may be warranted. Awareness that wound healing takes place in sequential physiologic steps is needed to properly direct patients, so that the risk of complications or the need for antibiotics will be minimal.

SUMMARY

Patients present to the Emergency Department with a wide variety of wound types. The use of local flap techniques allows the Emergency Physician to close difficult and complex wounds. If primary closure is not possible, these techniques decrease the tension on a wound and allow for appropriate cosmesis. They require close follow-up and appropriate patient selection if complications are to be prevented.

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