DEPARTMENT OF SURGERY

WOUND HEALING

MANUAL

Plastic Surgery is a specialized branch of surgery concerned with deformities and defects of the skin and the underlying musculoskeletal framework.

"Plastikos" means "form" in Greek and plastic surgery refers to form. This includes reconstructive and aesthetic surgery. Reconstructive surgery is an attempt to restore the individual to normal; while aesthetic surgery is an attempt to surpass the normal.

The first plastic surgery was done in 600-700 years B.C. in India for nasal reconstruction, as amputation of the nose was common punishment for criminals and conquered prisoners.

Plastic surgery includes the following:
Hand Surgery
Burn Surgery
Aesthetic Surgery
Craniofacial Surgery
Head and Neck Surgery
Maxillofacial Trauma Surgery
Microsurgery

SUTURE TECHNIQUE OR WOUND CLOSURE

The most useful and commonly used suture technique is the simple through-and-through suture. It may be used either as an interrupted or as a continuous suture. The needle should enter the epidermis at a right angle to the skin's surface and the natural curve of the needle should be followed. Forceps should be used as infrequently as possible to avoid further wound trauma. The needle should be held by the needle holder halfway along its length. If the needle is held too far from its tip, it tends to bend when inserted through tough tissue. The needle should travel downward through the epidermis, dermis, and a bit of subcutaneous tissue at a right angle to the would surface. Slight eversion of wound margins (which is preferred) can be accomplished if the suture takes a slightly bigger bite of the deeper part of the wound. This time the needle should travel in a reverse manner upward through the subcutaneous tissue, dermis, and epidermis. The suture is usually tied using an instrument rather than fingers. The wound edges should be approximated but not strangulated. Postoperative edema will force the wound edges together tightly. If the edges are already opposed tightly, the edema may compress the capillaries and thereby reduce the blood supply to the wound edges with resultant nacrosis or delayed wound healing. On the other hand, the tie should be tight enough to obliterate any dead space between the wound edges. A compromise between excessive looseness and excessive tightness must be reached. In general, small sutures placed close together create a more cosmetic closure than large sutures placed far apart. If there is a large amount of subcutaneous tissue, it may be necessary to place a deep simple suture to obliterate dead space prior to skin edge reapproximation.

It is sometimes difficult to evert the wound edges and in these situations a vertical mattress suture may help. A vertical mattress suture consists of a simple loop suture which passes again through both sides of the cut edge of the epithelial surface prior to knot tying.

The subcuticular (intradermal) suture is difficult to insert, but when it is executed properly it looks neat and leaves no suture marks. It may be performed with either absorbable (e.g. chronic gut, Dexon, or Vicryl) or nonabsorbable (e.g. monofilment nylon) suture material. The needle is passed horizontally through the dermis on each side of the would alternately, picking up small parts of the dermis each time. If nonabsorbable material is used, it is commonly brought out beyond both ends of the incision and either knotted or cut long so that the suture is accessible. It may be removed by pulling on one end. Absorbable suture material may be buried in the wound and left indefinitely.

The continuous suture is not as accurate as the interrupted suture, and it cannot be adjusted as easily. Another disadvantage is that it cuts off more of the blood supply to the healing wound edge. However, in certain circumstances (e.g. bleeding scalp wound in a severely injured patient) it is quite effective and can save time. The blanket suture does not bunch up the wound as does the continuous simple suture but it too can cause wound ischemia.

When the laceration bends sharply (creating a flap) or where it has a T-junction, a corner suture will facilitate wound closure. Simple through-and-through sutures strangulate the blood supply to the tip of the flap as they approach it. The three-point (U or corner suture) is recommended because it interferes with the blood supply as little as possible, thereby giving the flap a good chance to survive. It is inserted as a horizontal mattress suture through the epidermis and dermis away from the tip of the flap or opposite the T-junction. The suture is brought out through only the dermis of the flap tip. It is then exited through the dermis and epidermia on the non-flap side and tied. The corner suture may also be used to suture an entire flap into position. Thus the flap is held by interrupted mattress sutures on the non-flap side and subcuticular sutures on the flap side.

REFERENCES

1. Essentials of Plastic Surgery, W.M. Cocke, R.H. McShane, J.S. Silverton, Little, Brown and Company, Boston, 1979. pp. 16-22.

2. Surgical Skills in Patient Care, C.W. VanWay III, and C.A. Buerk, St. Louis, Mosby, 1978. pp. 20-26, pp. 60-64.

SUTURES

ABSORBABLE SUTURES

Plain Gut

Chronic gut

Dexon (polyglycolic acid, Davis & Geck)

Vicryl (polyglactin 910, Ethicon)

NONABSORBABLE SUTURES

Silk

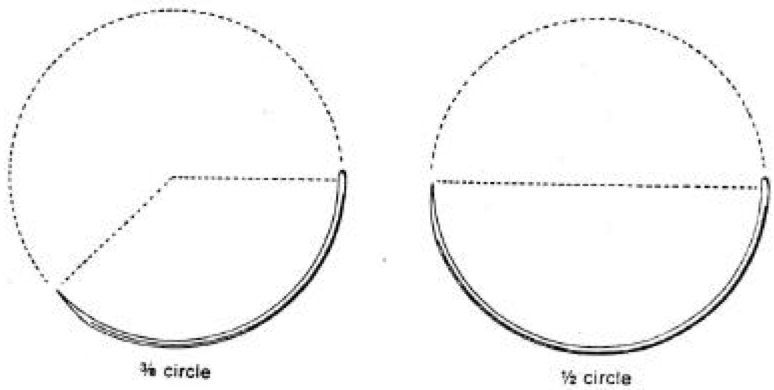
Twisted or braided

Cotton

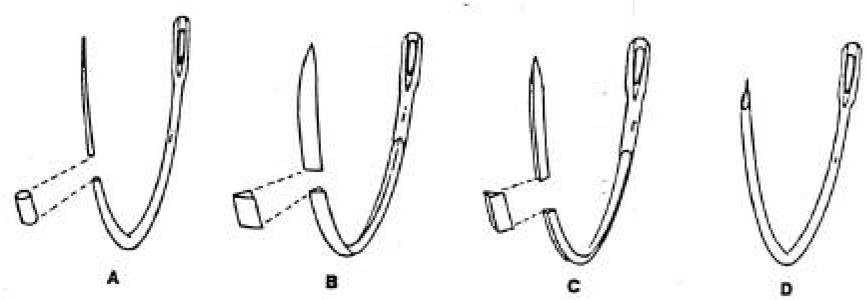
- **Twisted**

Dacron Polyester

- **Braided**
  - **Dacron (Deknatel, Davis & Geck)**
  - **Mersilene (Ethicon)**
- **Braided, impregnated with Teflon**
  - **Ethiflex (Ethicon)**
  - **Tevdek (Deknatel, heavily impregnated)**
  - **Polydek (Deknatel, lightly impregnated)**
- **Braided, treated with Silicone**
  - **Ti-cron (Davis & Geck)**
- **Braided, coated with Polybutilate**
  - **Ethibond (Ethicon)**
- **Nylon**
  - **Monofilament**
  - **Braided (Neurolon, Ethicon; Surgilene, Davis & Geck)**
- **Polypropylene**
  - **Monofilament (Prolene, Ethicon; Surgilene, Davis & Geck)**
- **Stainless Steel**
  - **Monofilament**
  - **Braided**



Shapes of Needles

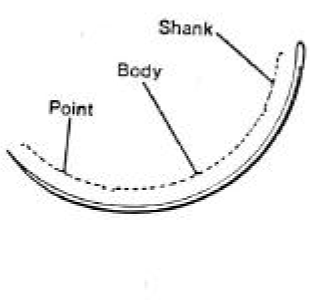


A. Taper Needle

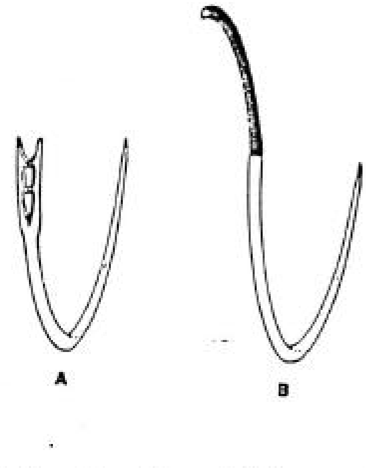
B. Conventional Cutting Needle

C. Reverse Cutting Needle

D. Ground Point Wire Needle



Parts of a Needle



A. French Eye Needle

B. Swaged Needle

Surgical Knots: Instrument Tie

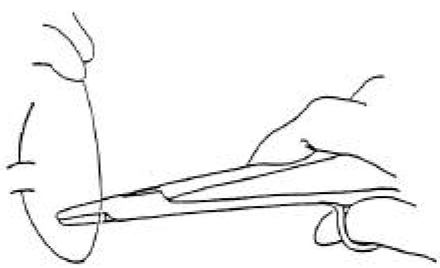


Fig. 3.23 Hold the needle holder parallel with the incision or vessel being tied. Drape the nonworking end over the instrument. Leave the working end short.

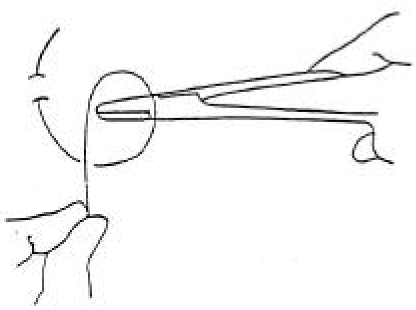


Fig. 3.24 Form a loop around the instrument. Make a double loop if a friction knot is desired.

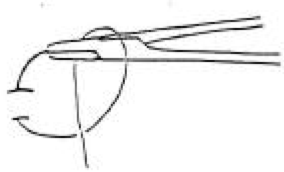


Fig. 3.25 Grasp the end of the working strand.

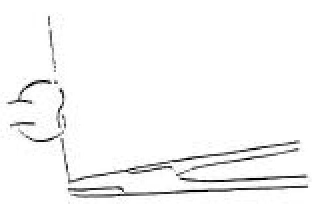


Fig. 3.26 Reverse the nonworking strand and bring the working end toward you.

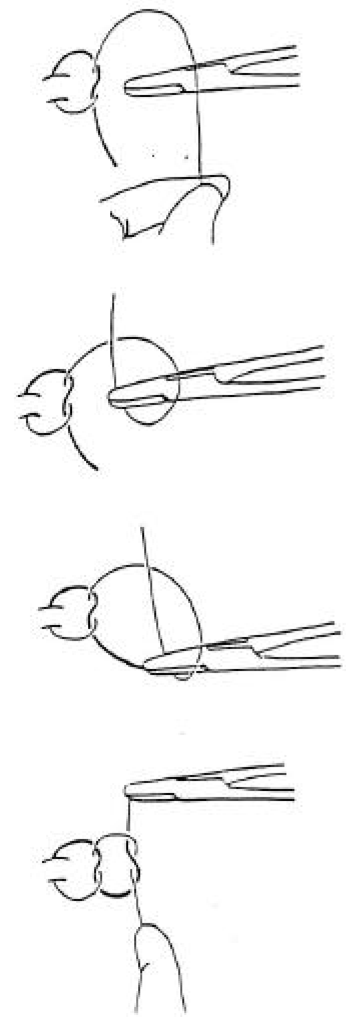


Fig. 3.27 Repeat the first four maneuvers shown in the left column in the opposite direction.

This tie is useful when working with very fine suture material and when multiple knots are needed, e.g., as in tacking down a skin graft.

The needle holder need not be held rigidly perpendicular to the axis of the loop but will move naturally to assist formation of the loop as you get a feel for this tie.

Two-Hand Tie (Working Strand toward Operator)

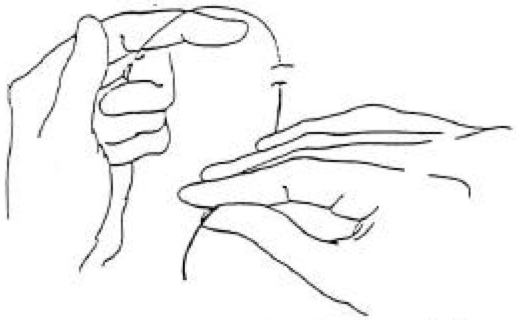


Fig. 3.1 Hold the left index finger beneath the non-working strand.

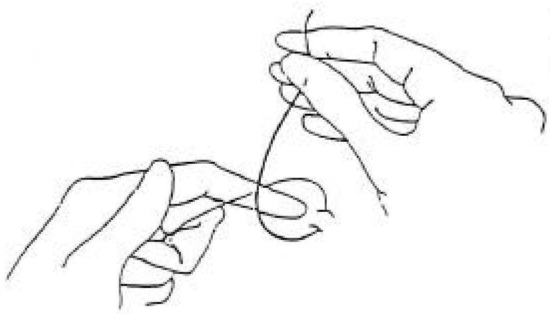


Fig. 3.2 Form a loop over the index finger, using the working strand in the right hand.

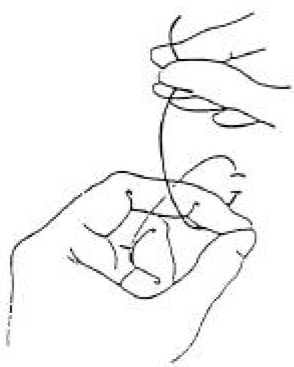


Fig. 3.3 Pinch left thumb and index finger together away from the intersecting strands of the loop.

To make a surgeon's or friction knot, repeat steps 3, 4 and 5 to pass the working strand through the first loop two times.

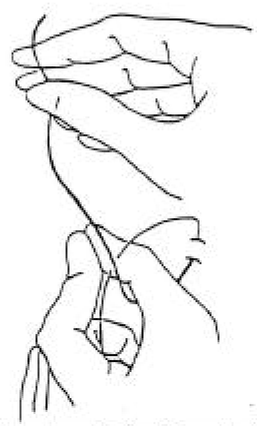


Fig. 3.4 Swing thumb and index finger to the opposite side of the loop to grasp the working strand. Shift the right shoulder in toward the table to make this move comfortably.

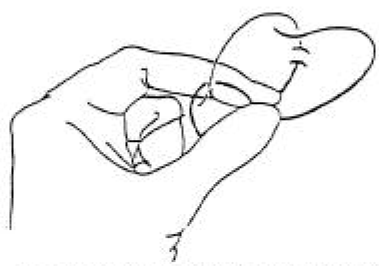


Fig. 3.5 Pass the working strand cleanly through the loop and re-grasp it with the right hand.

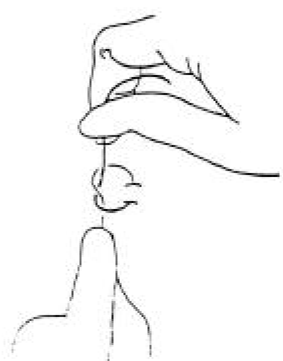


Fig. 3.6 The left index finger is now in proper position to put down next to the knot as the working strand is pulled to the side opposite the operator. The strands and knot are kept in a straight line each time a throw is tightened.

Two-Hand Tie (Working Strand opposite Operator)

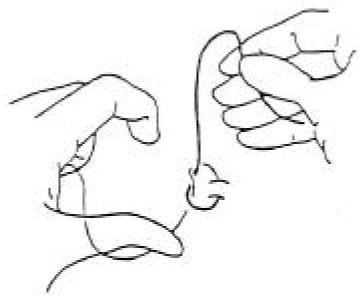


Fig. 3.7 Move the left thumb inside the nonworking strand.

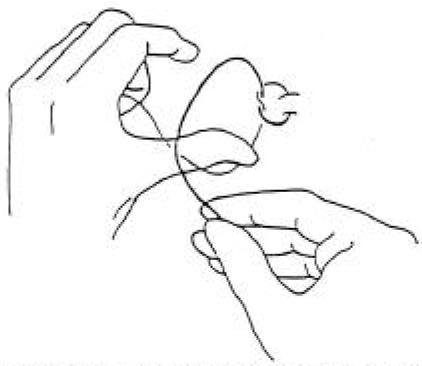


Fig. 3.8 Form a loop over the thumb, using the working strand in the right hand.

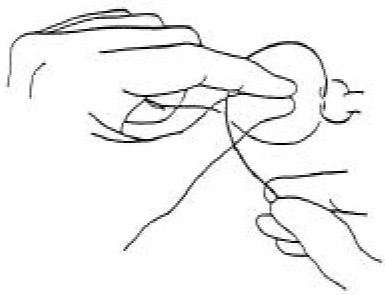


Fig. 3.9 Pinch left thumb and index finger together keeping clear of the loop.

In the two-hand tie the left hand takes an active part in setting up the loop and manipulating the working strand. It is important to do the pinching maneuvers away from the loop to avoid entanglement.

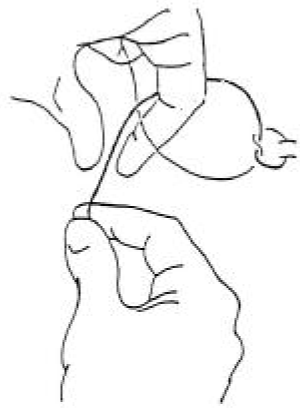


Fig. 3.10 Swing thumb and index finger to the opposite side of the loop to grasp the working strand. Rotate the left shoulder in toward the patient at this point.

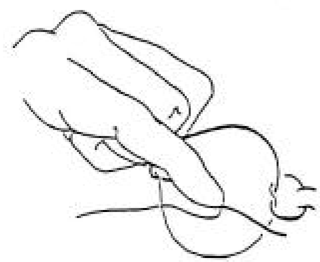


Fig. 3.11 Pass the working strand through the loop and re-grasp it with the right hand.

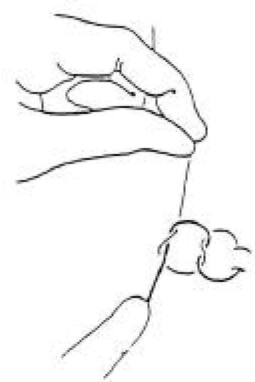


Fig. 3.12 The right index finger is now in proper position to put down next to the knot as the working strand is pulled toward the operator.

One-Hand Tie (Working Strand toward Operator)

Fig. 3.13 Drape a comfortable length of working strand over the fingers of the right hand, grasping the strand with the thumb and middle fingers.

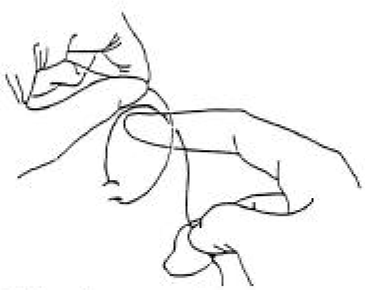


Fig. 3.14 Move the nonworking strand over the right index finger to set up a loop.

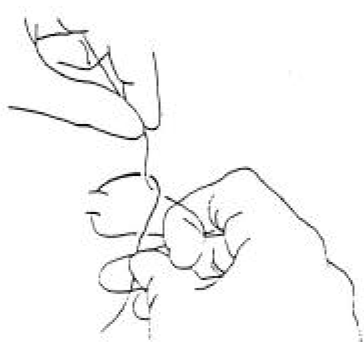


Fig. 3.15 Flex the right index finger, catching the non-working strand.

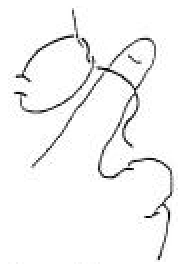


Fig. 3.16 Sweep the working strand through the loop with the index finger.

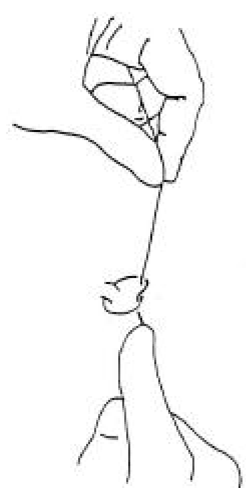


Fig. 3.17 Grasp the working strand with the right hand and tighten with the right index finger.

Note that the working strand has finished opposite to where it started. Keeping a smooth open loop until the throw is tight helps keep this key relationship clear. It also prevents reversing the throw into a half hitch, which happens more frequently with the one-hand tie. If the left (or nondependent) index finger were placed below the knot, the throw would be reversed into a half hitch.

One-Hand Tie (Working Strand opposite Operator)

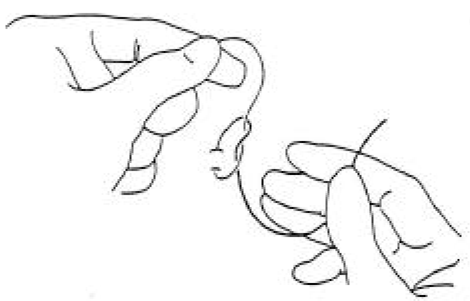


Fig. 3.18 Drape the working strand over the fingers of the right hand from the ulnar side with the thumb and index finger grasping the strand.

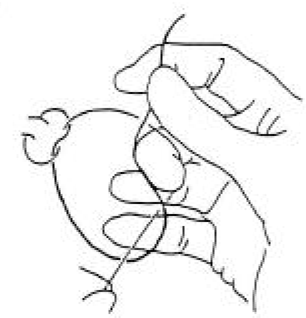


Fig. 3.20 Flex the middle finger to pull the nonworking strand behind the working strand.

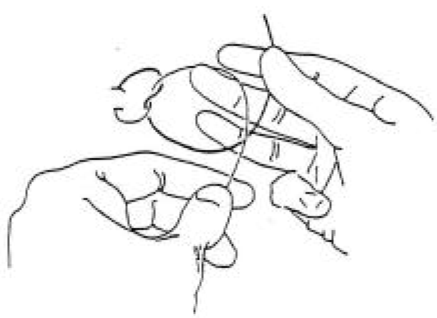


Fig. 3.19 Move the nonworking strand over the right middle finger to set up a loop.

Fig. 3.21 Sweep the working strand through the loo using the right middle finger.

In the one-hand tie the right hand sets up the loop and manipulates the working strand. Compare this to the two-hand tie.

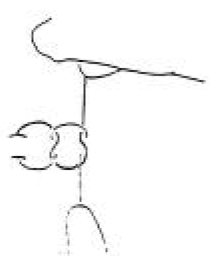


Fig. 3.22 Tighten the throw with the left index finger

Basic Surgical Maneuvers: Suture Patterns

Several basic suture patterns are presented in the next three pages, with elaboration on skin suture technique. Stitches used for abdominal closure and retention sutures are discussed in the chapter on laparotomy.

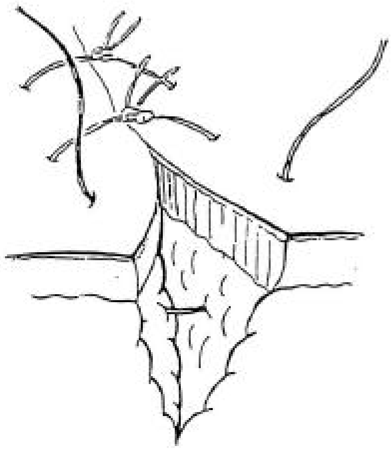


Fig. 5.60 The *simple suture* should have a square profile to avoid inverting skin edges. This is accomplished as shown in Figures 5.64–5.68. A good general rule for placement is that the width of each stitch equals the distance between sutures. The width varies with the thickness of the skin, the location, and the purpose of the suture.

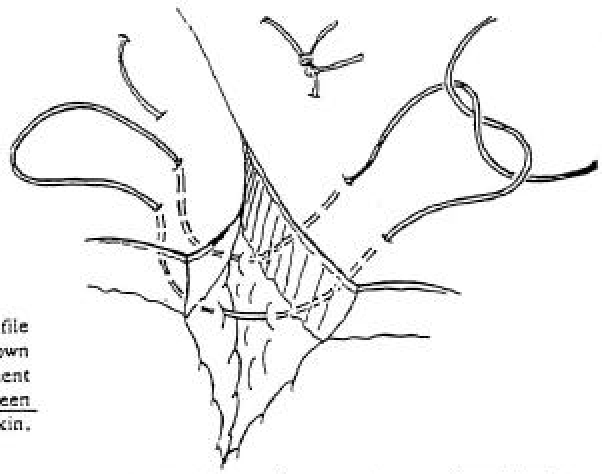


Fig. 5.62 The *horizontal mattress* is an everting stitch that is more commonly used in fascia than in skin.

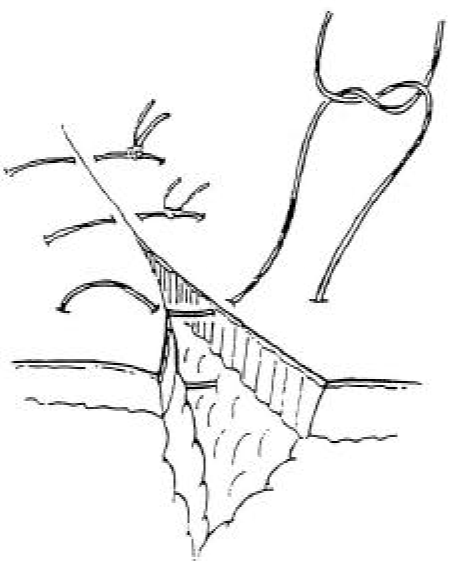


Fig. 5.61 The *vertical mattress* is used when precise edge approximation is important and cannot be achieved with a simple suture. This is the most common skin closure pattern. It consists of two tiny epidermal-thickness bites of the edges added to the simple suture. Gentle, loose approximation allows for the edema that inevitably follows wounding.

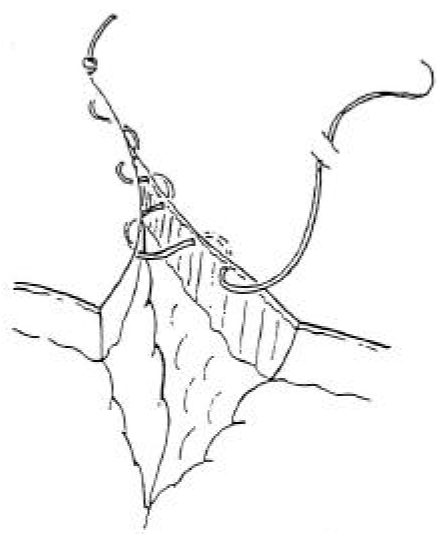


Fig. 5.63 The *subcuticular closure* may be interrupted or continuous. It may be done with absorbable or nonabsorbable material. In the former case the end knot is usually buried. The technique is discussed in more detail in the section on minor surgery.

Basic Surgical Maneuvers: Suture Patterns

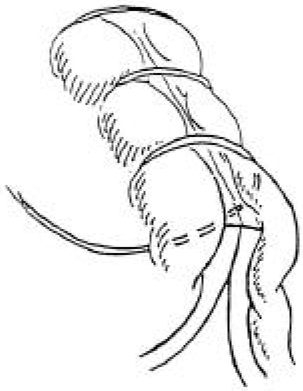


Fig. 5.69 The simple over and over *continuous suture* is the one most often used on bowel. The continuous suture is quicker than the interrupted suture and may distribute tension more evenly. Care must be exercised not to pull too tightly, however, or a rigid purse string results, which can compromise the lumen at an anastomosis. Another disadvantage of continuous suture is that a single break compromises the entire suture line. The needle should be released and the suture periodically untwisted when doing a long continuous row. The surgeon sets the tension for each stitch of a continuous suture and the assistant holds the strand at that tension while the next stitch is placed.

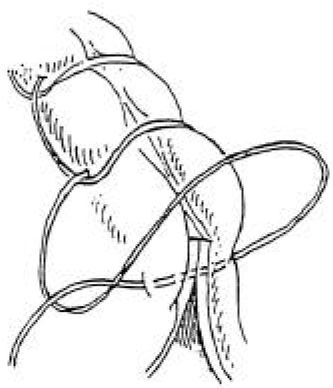


Fig. 5.70 A *continuous locking suture* is created by passing the needle through the loop of the previous stitch. The purpose is to prevent slippage and to aid hemostasis in a cut edge. The assistant flips the loop over so that the surgeon automatically withdraws the needle through it.

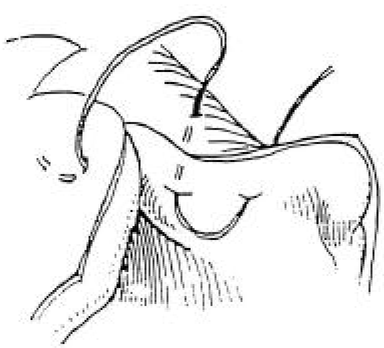
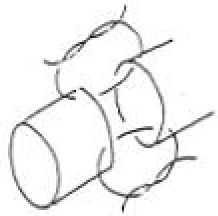
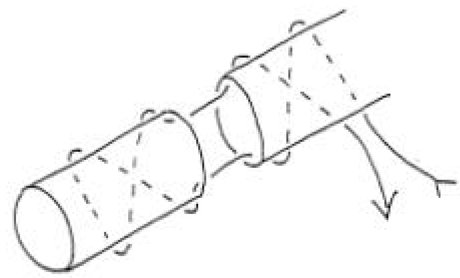


Fig. 5.71 The *Connell* stitch is a continuous inverting suture commonly used for the first layer (anterior wall portion) of a bowel anastomosis. The technique is discussed with small bowel resection.

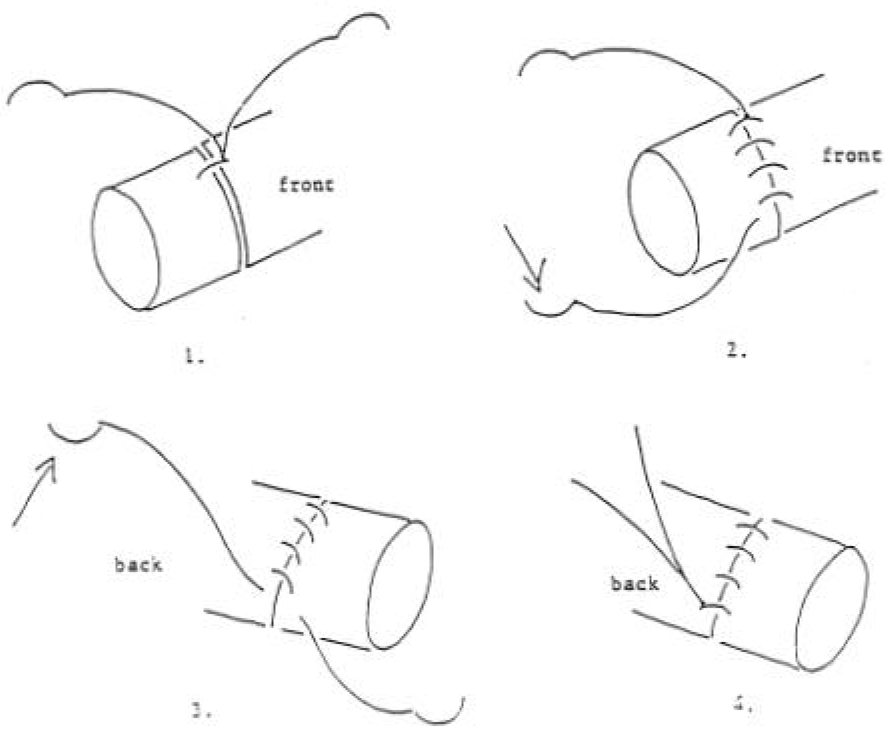
Figure-eight Suture



Nerve Anastomosis



Tendon Anastomosis



Vascular Anastomosis

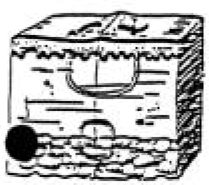
Types of Suture

Nylon	Nonabsorbable	Cotton	Nonabsorbable
Silk	Nonabsorbable	Stainless Steel	Nonabsorbable
Chromic	Absorbed in 2-4 weeks	Dexon (Polyglycolic Acid)	Absorbed in 2-3 weeks
Plain Gut	Absorbed in 7-10 days	Prolene ((Polyprolene)	Nonabsorbable

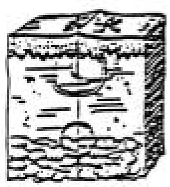
The following guidelines for time for suture removal" must be modified to fit the individual situation-see Pearl #18.

Face Wound	Remove sutures in 3-5 days.
Scalp Wound	Remove sutures in 5-7 days.
Non mobile parts of extremities	Remove sutures in 7 days.
Thick skin (e.g. shoulders, soles, palms)	Remove sutures in 10-14 days.
Mobile body parts (over joints, on back)	Remove sutures in 14-21 days.

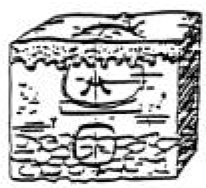
Some types of stitches



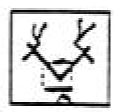
Vertical Mattress



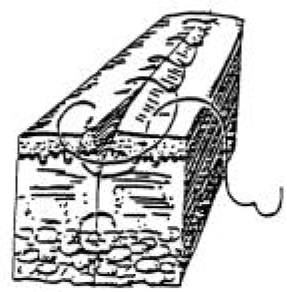
Horizontal Mattress



Simple



Corner Stitch



Running Lock Stitch

References: "Office Suturing" AFP Monograph #7, May 1980.
"Principles of Surgery" 2nd edition by Schwartz, et al., Chapter 8.
"Textbook of Surgery" 11th edition by Sabiston, et al., Chapter 14.

Running Stitches

Running stitches, whichever method is used, are a convenient, rapid means of suturing well-approximated tissue with equal wound edges on which little tension is placed. Running stitches are valuable on eyelids, neck, scrotum, or wherever loose skin is found. They should not be placed deeply, or where dead space has not previously been closed. It is important to place one end of the stitches perpendicular to the suture line. Running stitches can be used to apply equal tension rapidly to wound edges and to obtain final eversion of wound edges. The running horizontal mattress stitch is especially good for these purposes.

The running subcuticular stitch is the most difficult of the running stitches to master. However, when used properly, it provides superior cosmetic results because it leaves no suture exit and entrance marks along the edge of the suture line. The running subcuticular stitch should be used only on excisions where the sound is well approximated, the edges are everted, any dead space has been eliminated, and wound tension is minimal. This stitch can be left in place for long periods of time and should be placed using a monofilament suture such as Prolene (see Appendix D). There are several ways to anchor the loose ends of the stitch. One method is to pull the end of the suture to the desired tension, place the loose suture ends in Mastisol (or tincture of benzoine), and affix them with a Steri-strip. My favorite method is to tie the ends back on themselves.

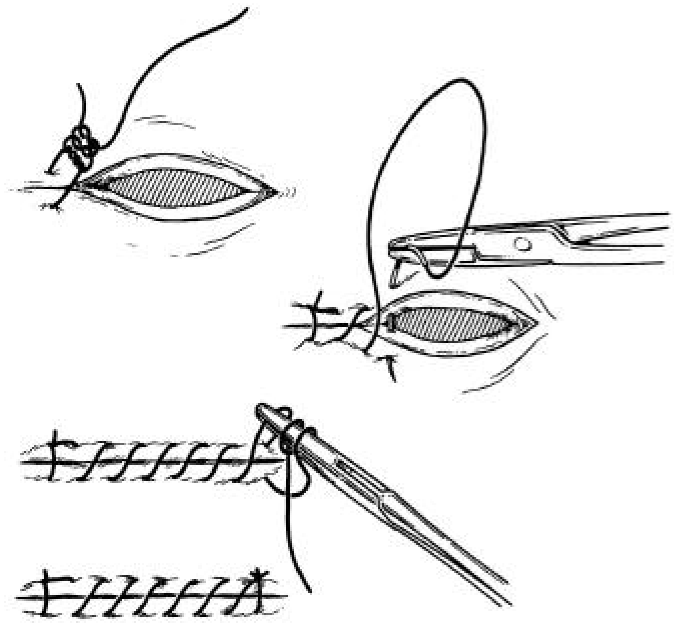
For ease of suture removal, a long wound should have an exit point from the subcuticular stitch every 2 to 3 cm, as diagrammed in Figure 27. This sis sometimes called leaving an extracutaneous loop of suture.

After placing a running subcuticular stitch, there are often a few small gaps left along the suture line. These may be sutured using very shallow, interrupted stitches, called epicuticular stitches, or by placing a second, more superficial, running subcuticular stitch. The following exercises explain these stitches in detail.

EXERCISE 14: BASIC RUNNING STITCH

1. **Make a long (5 cm or 2 inc.), narrow excision in the pig's foot.**
2. **Begin at whichever end you prefer and make an interrupted stitch. Tie with instrument (Figure 24).**
3. **Cut the short end only.**
4. **Make evenly placed interrupted passes with the needle for the length of the wound, keeping each pass perpendicular to the suture line.**
5. **With the last stitch, leave a loose "loop" to use in the tie.**
6. **Begin the tie as in Exercise 4, only grasp the loop (both strands) instead of a free end when laying down the knot.**
7. **Finish the knot.**

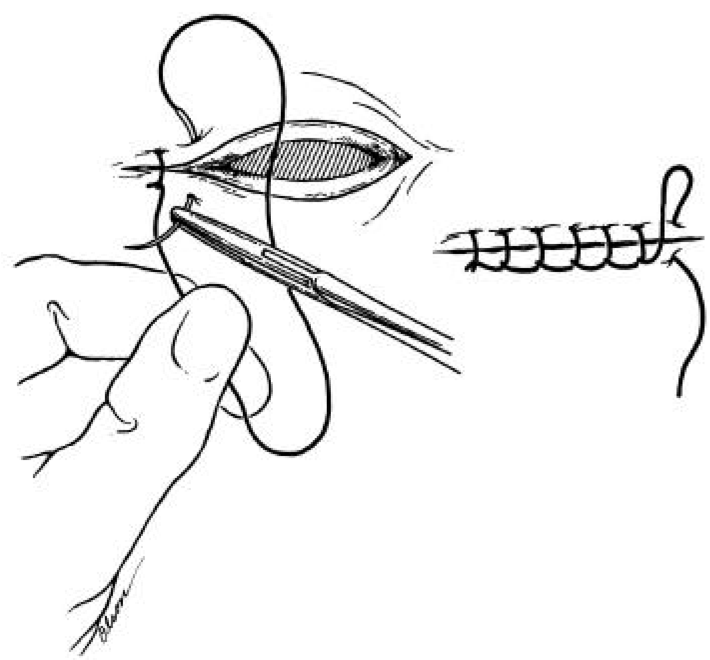
Figure 24
Basic running stitches



EXERCISE 15: RUNNING LOCKED STITCH

1. Make a new excision, or removed the sutures from an old one. Begin the stitch as in steps 2 and 3 in Exercise 14.
2. Put tension on the long end of the stitch with your odd hand, and pass the needle as if making the next stitch (Figure 25).
3. As the needle tip exits the skin, make a loop with your odd hand, pass the needle-holder tip through this loop, grasp the needlepoint, and pull through the loop creating a “locked” stitch.
4. Repeat steps 2 and 3 for the length of the wound.
5. Place your last stitch without the lock, as in Exercise 14, so as to leave a looped end with which to tie.
6. Tie as in Exercise 14.

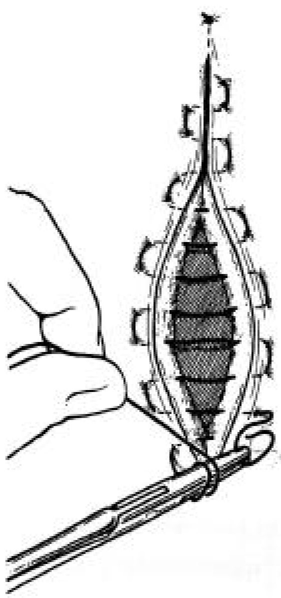
Figure 25
Running locked stitch



EXERCISE 16: RUNNING HORIZONTAL MATTRESS STITCH

1. **Begin as in Step 1 in Exercise 15.**
2. **Beginning at one end of the excision, place an interrupted stitch. Cut both strands, but leave one longer than the other.**
3. **Now, begin at the opposite end of the wound, and place and tie an interrupted stitch. Again, leave one strand of the suture long.**
4. **Place an interrupted stitch, exiting on the opposite side of the wound (Figure 26).**
5. **Reverse the needle in the needle holder and, beginning on the same side from which you exited, place an interrupted stitch.**
6. **Again, reverse the needle in the needle holder and place an interrupted stitch in the opposite direction to which the last stitch was placed.**
7. **Continue this procedure for the length of the wound, until the opposite end is reached.**
8. **Using the suture end, which you left long in step 2, finish this stitch by tying it to the loose end of the suture. This is an excellent way to finish a running stitch, if you think far enough in advance to leave the loose end long when placing the interrupted stitch. It prevents the bulky knot that results when a running stitch is tied back onto a loop as in Exercises 13 and 14.**

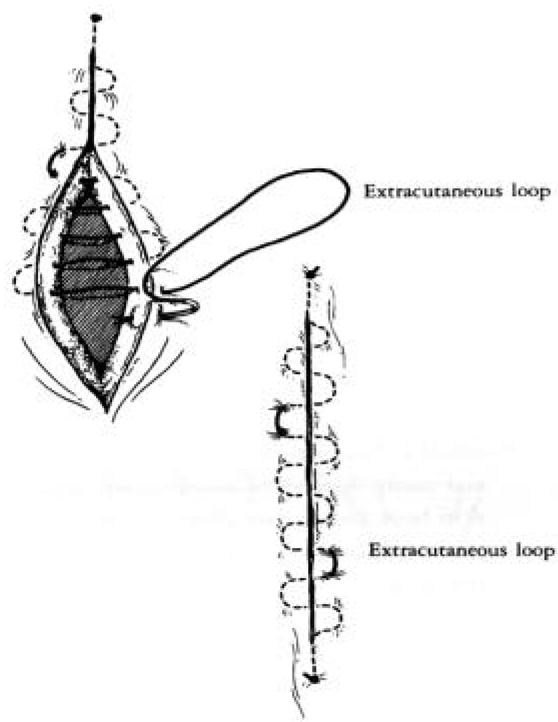
Figure 26
Running horizontal mattress stitch



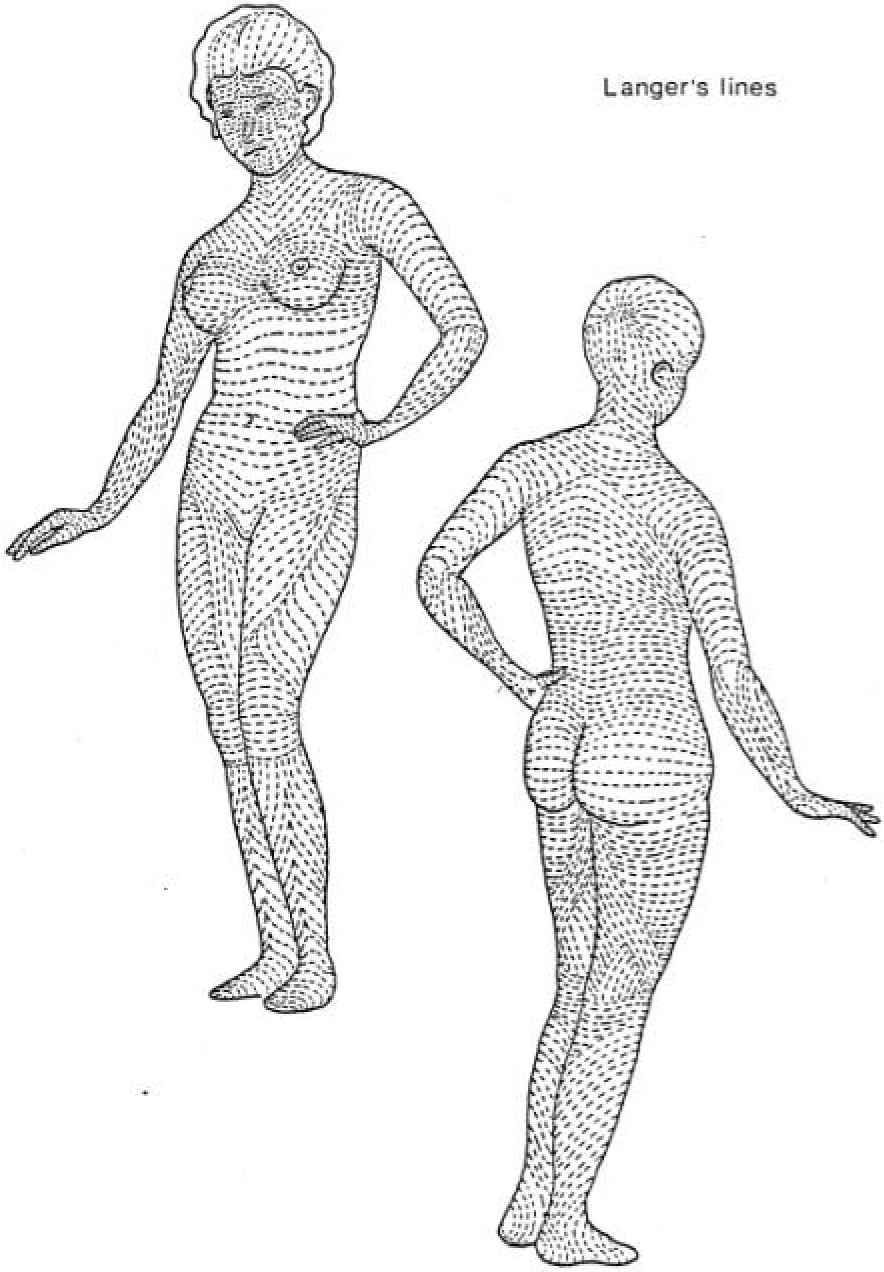
EXERCISE 17: RUNNING SUBCUTICULAR STITCH

1. **Remove suture and use the incision from Exercise 14 or 15.**
2. **Begin at one end of the wound, approximately 1 cm opposite the apex of the ellipse.**
3. **Make a bite, as if placing an interrupted stitch exactly at the apex of the excision.**
4. **Select one edge of the wound, and make a subcuticular bite parallel to the skin surface.**
5. **Make a similar bite, backspacing slightly, in the opposite edge of the wound.**
6. **Continue this procedure, exiting the skin (as shown in Figure 27) after you have gone 2 cm, until you reach the other apex of the excision. Remember to backspace slightly, as this is critical to fine, equal eversion of the wound edges.**
7. **Make your last bite, with the needle pointing upward, at the apex.
Exit the skin approximately 1 cm opposite the apex.**
8. **Pull gently to approximate the wound.**
9. **Anchor the ends by tying the suture back on itself.**
10. **If there is a small gap in the closure line, approximate it using a fine epicuticular interrupted stitch.**

Figure 27
Running subcuticular stitch



Langer's lines



The general course of bundles of connective tissue within the dermis. Wounds that cross these lines tend to be widened by the inherent tension.

Skin Grafting

Successful skin grafting is most likely when a good wound bed is available, the proper kind of graft is selected, and the techniques of graft cutting and fixation are performed correctly.

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● Skin grafting is a method of transferring tissue from one part of the body to another to cover open wounds. Free skin grafting was introduced in the mid-1800s by Reverdin and others.[1] In the early part of this century and into the 1930s, plastic surgeons realized that skin grafting was most effective and provided useful wound cover when it included substantial amounts of dermis as well as epidermis. Modern skin grafts are composed of the epidermal layer and varying portions of the underlying dermis (Figure 1).

Many surgeons believe that the most important part of skin grafting is the surgical cutting of the graft. In fact, selection of the type of graft and preparation of the recipient wound bed are equally important in providing the best possible result.

Graft Selection

The surgeon contemplating skin grafting first has to decide whether full-thickness or split-thickness skin is to be used. A number of variables are important in making this decision. The characteristics and ultimate fate of these two types of skin grafts are shown in Table 1. When healed, full-thickness skin grafts appear and function like normal skin.[2] Therefore, ideally, full-thickness grafts should be used whenever possible to avoid problems of graft deformity and wound contraction. However, full-thickness grafts can be harvested only in small areas and can be placed only on ideal wound beds. Therefore, larger wounds or those with bacterial contamination, such as granulating wounds, usually are grafted with split-thickness skin.[3] Extensive studies have shown that the absolute thickness of the graft, i.e., its thickness in millimeters, is not the determinant of how the graft ultimately will function. Rather, the critical factor is what percentage of the total dermis thickness is grafted. Thus, a full-thickness graft from a thin area such as the upper eyelid will behave like any other full-thickness graft, even though it may be thinner than a split-thickness graft taken from a thick-skinned area such as the buttocks.

Preparation of the Recipient Wound Bed

To survive, a skin graft must find a vascular supply in the wound upon which it is placed. This wound bed must not be infected, and the union of graft and wound must be undisturbed long enough to allow blood vessels to grow between them. Skin grafts, thus, cannot be placed on avascular tissues, such as cartilage, tendon, or bone (except in the rare instance of the vascular bone of the inner maxilla). For a graft to survive, an avascular surface must be converted to a vascular one. If this is not possible, then flap coverage will be needed.

To be skin grafted successfully, a fresh open wound must be debrided of necrotic tissue and foreign material. If the wound is excessively bloody, it may be best to defer grafting rather than to place a graft

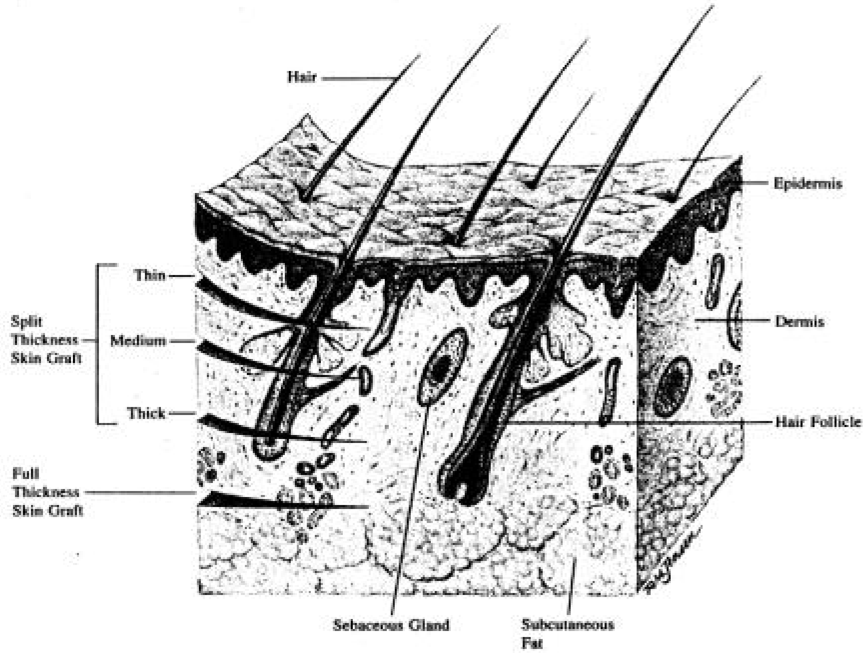

Figure 1—The anatomy of the skin, with differing levels of harvest, is shown.
Illustration by Robin M. Jensen

over a hematoma, which will cause loss of that graft. Meticulous hemostasis can be obtained using conservative electrocautery and pressure. The use of particulate hemostatic agents is discouraged because they leave a barrier between the graft and the wound bed.

Chronic wounds, such as those filled with granulation tissue, are suitable for grafting if certain criteria are met (Table 2).[4] If a vascular, noninfected wound bed cannot be provided, a skin graft is likely to be unsuccessful. Far more grafts are lost because of poor wound conditions than technical failures related to graft cutting or fixation. Chronic wounds are best prepared for grafting by surgical debridement, followed by the use of topical half-strength Dakin's solution (0.25% sodium hypochlorite).

Cutting the Graft

Split-Thickness Skin Grafts—Split-thickness skin grafts are cut within the dermis. Such grafts commonly are cut at 0.015 of an inch. Either handheld knives or mechanical dermatomes are used. Drum dermatomes allow the skin to be glued to a drum, which, as it is rotated, allows cutting with a sliding knife. In the United States, most skin grafts are cut using mechanically powered dermatomes, such as the Brown air dermatome or the Padgett® or Brown electric dermatome.

A point of utmost importance in cutting a split-thickness graft is judging the thickness of the skin from which it is going to be cut. The thigh of an adult man may be exceedingly thick, whereas that same area in a fragile, elderly woman or young child may be very thin. Adjustment in the thickness of skin-graft cutting must be made to avoid cutting full-thickness skin with the dermatome.

If a power dermatome is selected, the skin is lubricated with mineral oil. Certain skin preparations, such as Betadine®, are very sticky and must be washed off thoroughly before the graft can be cut. After lubrication of the skin and the dermatome, the dermatome is placed flat on the skin, the power turned on, and the dermatome advanced (Figure 2). Another word of warning: The calibrating devices on dermatomes occasionally are inaccurate and the surgeon should check the graft-cutting aperture personally to be sure it is correct. Conveniently, a Bard-Parker blade has a thickness of approximately 0.015 of an inch and can be used as a shim to test the cutting opening of the dermatome.[3]

Full-Thickness Graft Cutting—Full-thickness grafts, in contrast to split-thickness grafts, are cut freehand with a scalpel. The graft border is outlined, usually with an appropriate pattern made from the recipient site. The graft is then cut and removed at the junction of the dermis and the subcutaneous fat (Figure 3). A full-thickness graft should have no fat on the undersurface. A convenient way to achieve this is to turn the graft upside down and drape it over the gloved finger. Liberal application of saline solution will keep the graft from curling on itself. Small, curved scissors can be used to trim the fat carefully from the undersurface of the graft (Figure 4). This is both more effective and more elegant than trying to scrape fat off the undersurface with a knife blade.

Skin Graft Characteristics

Variable	Full Thickness	Split Thickness
Shrinkage	Minimal or none	Considerable
Growth in children	Good	Reduced
Pigmentation	Normal or pink	Often abnormal
Accessory function	Good	Variable
Resistance to trauma	Good	Variable
Survival on wound	Requires ideal circulation	Wound can be less desirable
Donor site	Requires closure	Spontaneous healing
Reuse of donor site	None	Possible

Table 1

Criteria for Grafting Granulating Wounds

Minimal exudate
Beefy red color
Flat, smooth, shiny, painless surface
Edge reepithelialization
$<10^5$ bacteria per gram of biopsy

Table 2

Care of the Donor Site

Full-thickness skin graft donor sites are closed primarily. Split-thickness grafts, in contrast, are dressed so as to allow spontaneous healing by epithelialization. I most commonly use a Xeroform® gauze on the wound surface covered by Telfa® and then by absorbent gauze. On the first postoperative day, this dressing is removed, except for the bottom layer of Xeroform gauze. The wound is then allowed to air dry, which reduces the likelihood of infection. Semiocclusive or occlusive dressings have been used by some surgeons and are claimed to reduce the pain of a split-thickness graft donor site. Although this is true, the occlusive nature of such dressings may make infection of the donor site more likely. Should a split-thickness graft donor site become infected, it is at risk for conversion to full-thickness loss and must be treated with local cleansing and antibiotics.

Graft Fixation

An important part of the process of skin grafting is rigid fixation of the graft to the underlying bed. Small vessels begin to grow across from the bed to the graft within two days,[2] but the union is not relatively solid for at least a week. The most effective way to fix a graft to the bed is to use the so-called *stent* dressing. This

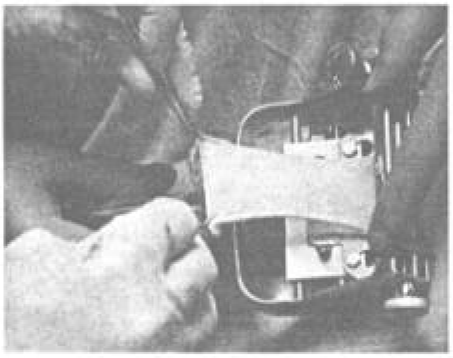

Figure 2—This split-thickness skin graft is cut with a Brown air-powered dermatome. The cut graft is displayed by an assistant. (All photos reprinted with permission from Rudolph R, Fisher JG, Ninnemann JL: Skin Grafting, pp 41, 87, 88, 98. Boston, Little, Brown and Company, 1979.)

Figure 3—This full-thickness skin graft is cut from the postauricular sulcus, just under the dermis.

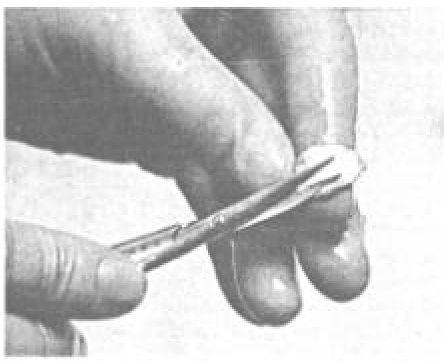

Figure 4—Small, curved scissors are used to trim the fat carefully from the undersurface of this full-thickness skin graft.

Figure 5—This stent dressing is composed of silk sutures tied over a bolus of Xeroform gauze and saline-soaked cotton.

name is derived from a British dental compound that initially was placed as a bolus inside skin grafts (raw side out) that were placed in the labial sulcus when it was being recreated surgically. However, the term "stent" has now been expanded to include essentially any method of graft fixation.

By far the most commonly used stent is one made of spongy material that is held in place by the fixation sutures used to hold the graft in place. When I sew a split-thickness or full-thickness graft and intend to use a stent, I use 4-0 or 5-0 silk sutures that are left long. When the graft has been sutured in place, Xeroform gauze is placed over the graft and then saline-soaked cotton is placed over the gauze. The sutures can be tied firmly, creating a bolus dressing that presses the graft firmly into position (Figure 5). As this material dries, it becomes almost cast-like, assuring continued fixation of the graft and avoiding hematoma underneath (if the graft bed was properly dry at the time of surgery). Foam rubber also can be used instead of the cotton. If the graft bed has multiple deep hollows, quilting sutures of chromic catgut can be placed into the depths to help hold the graft. In addition, appropriate shaping of the stent will allow the graft to be held down into these recesses.

On occasion, grafting on a convex surface can be done without the use of a stent if an overlying snug dressing is applied, such as gauze covered by an Ace® bandage or cast. This method presupposes that the patient will not move the extremity excessively. On rare occasions, grafts may be left completely open if they are being placed on convex surfaces in cooperative patients, primarily those who are hospitalized. If the open graft method is used, small seromas and/or hematomas can be evacuated by incising the graft over the fluid collection, which is then expressed directly. This method is superior to rolling fluid from the center to the edge, which destroys small, sprouting blood vessels.

On rare occasions, "mesh" grafting can be used. This involves using an instrument that cuts multiple fine slits within the graft. Such grafts may adhere slightly better than flat sheets of skin but have the disadvantage of healing with a waffle-iron appearance. In addition, if such grafts are expanded and then placed on a surface such as the elbow or back of the hand, substantial wound contraction can occur in the open spaces of the graft mesh. Meshed grafts are most useful when donor skin is in short supply, as in a massive burn.

Graft Healing

As shown in Table 1, full-thickness skin grafts ultimately heal with the most natural skin appearance. In particular, they reduce the likelihood of wound contraction and look like normal skin, except for the surrounding scar. Hair may grow in a full-thickness graft, which may be desirable if hair transplants are being done but undesirable if a graft is being placed on an area such as the face. Therefore, graft selection should take into account the absence or presence of hair either at that time or in the future if a child is being grafted. Split-thickness skin grafts may undergo substantial contraction. If split-skin grafting is unavoidable, physical therapy with gentle stretching and the use of splints can reduce the likelihood of such contraction becoming severe.

If graft selection, wound bed preparation, cutting of the graft, and graft fixation are done properly, most skin grafts will take. Some surgeons have a fatalistic view that a certain percentage of all grafts must fail, and this prophecy often is self-fulfilling. Most grafts are lost not because of technical errors, but because of poor preparation of the wound bed or inadequate immobilization. Common causes of graft failure are listed in Table 3. All of these causes can be prevented with appropriate care. ● ●

Causes of Skin Graft Failure
Inadequate wound bed blood supply
Hematoma under graft
Movement preventing vessel linkup from wound
Infection, especially *Streptococcus*
Technical errors, such as upside-down graft, placement over epithelializing wound, too-thick graft

Table 3

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