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## Chapter 14

# DISTANT FLAPS

### KEY FIGURES:

Chest flap	Design of groin flap
Cross arm flap	Examples of groin flap
Cross leg flap	Examples of free flaps

A distant flap involves moving tissue (skin, fascia, muscle, bone, or some combination) from one part of the body, where it is dispensable, to another part, where it is needed. A distant flap is required when there is no healthy soft tissue adjacent to an open wound with which to provide adequate coverage.

These complex procedures are at the highest rung of the reconstructive ladder. Therefore, a distant flap is the treatment of choice when other, simpler procedures are *not* applicable.

### ***Types of Distant Flaps***

Distant flaps are divided into two categories: attached and free.

An **attached distant flap** implies that the area with the open wound initially is attached to the flap at the distant donor site. For example, the patient may have an open wound on the hand that requires soft tissue coverage. The donor site for the distant flap may be the chest (see chest flap below). Thus, the patient's hand initially is attached to the chest.

The blood supply to the flap initially comes from its pedicle (the bridge of tissue connecting the flap to its donor site). Gradually, over a few weeks, the flap develops in-growth of vessels from the recipient site (the wound). These new vessels bring blood to the flap, and the flap gradually becomes less dependent on the donor site circulation for survival. After a few weeks, the flap can be separated from its donor site and survive in the new area.

Patient inconvenience is a major drawback to attached flaps. Also, attached flaps are usually random flaps (see chapter 13, “Local Flaps”); therefore, they are not always completely reliable.

**Free flaps**, which are axial flaps, were developed to circumvent the problems inherent in attached distant flaps. Tissue supplied by a named vascular pedicle is detached completely from the donor site. The flap is then transferred to the open wound. With the aid of a microscope or other form of magnification, the flap’s blood vessels (often just a few millimeters in diameter) are painstakingly connected to blood vessels at the recipient site. As you can imagine, a free flap is a technically difficult procedure and requires special equipment not readily available in many rural areas.

In contrast, attached distant flaps do not require such highly skilled specialists, but they do require basic surgical skills. Attached flaps often are quite useful when specialty care is unavailable. For example, an attached flap can make the difference between a healed functional hand and a severely damaged dysfunctional hand in a rural patient who has sustained severe soft tissue injury. This chapter focuses primarily on attached distant flaps.

### ***Attached Distant Flaps***

The procedure for creating and placing attached distant flaps follows many of the same rules that apply to local flaps. You should review chapter 13, “Local Flaps,” for important background information.

Remember the 3:1 rule: for optimal circulation the flap length should be no more than 3 times the flap width. A delay procedure should be done if a larger flap is required.

As always, be sure that the wound is thoroughly cleansed before attaching the flap. All necrotic tissue must be removed. For a wound on the hand, it is best to debride the wound using a tourniquet. This technique allows you to remove the dead tissue carefully and avoid injury to important nearby structures. Be sure to remove the tourniquet and stop all bleeding before suturing the flap to the defect.

If the wound is covered by necrotic tissue, debride the wound a day or two before flap closure. If the wound is clean and granulating, use a scrub brush or the flat part of a scalpel blade to remove the top layer of granulation tissue before covering the wound with the flap.

## *Chest Flap*

### *Indications*

An open wound on the hand or forearm with exposed tendons/bones.

### *Anesthesia*

A chest flap can be done under general anesthesia. However, local anesthesia for the donor site and a block for the recipient site is sometimes preferable. Local anesthesia and recipient site block ensure that the patient will not accidentally pull the flap attachments apart when awakening from general anesthesia.

### *Procedure*

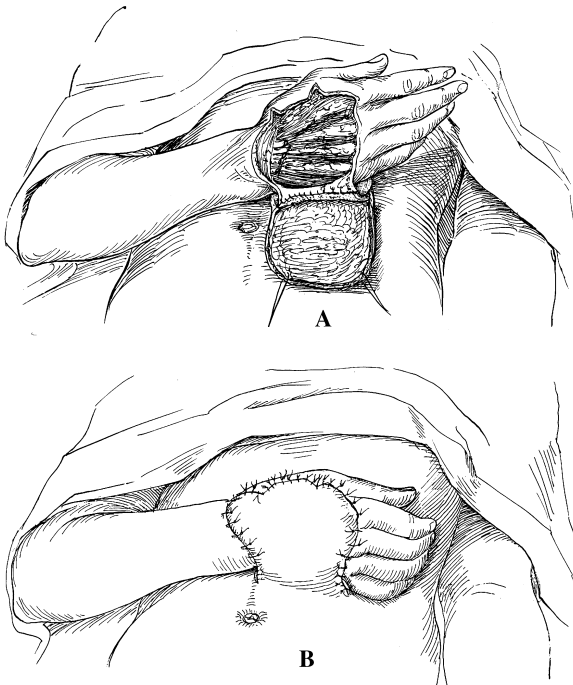
1. Ask the awake patient to position the injured hand over the chest in the most comfortable position. Stay away from breast tissue.
2. Mark this area. The flap should be drawn in such a way that the hand can be comfortably attached to the chest, but you must make sure that the pedicle does not become kinked. Usually the flap is drawn so that the pedicle is based inferiorly, but it can be designed with almost any orientation. Be sure that no scars from previous injuries are located within the flap or pedicle.
3. Design the flap so that it is slightly larger than the defect.
4. Make the incision through skin and subcutaneous tissue and into the underlying fascia (the thin layer of connective tissue over the muscle). Do not incise the muscle. The fascia contributes to the blood supply of the flap; therefore, it is important to keep it attached to the flap whenever possible.
5. Elevate the flap off the deep underlying tissues.
6. Loosely stitch the three free sides of the flap in place. Use a few dermal sutures, and then close the skin with interrupted, simple sutures. The closure does not have to be perfect. If the flap is stitched too tightly, it may compromise circulation and result in partial flap loss.
7. If possible, the donor site on the chest should be closed primarily, but usually a split-thickness skin graft is needed. Alternatively, if the wound is just a few cm in diameter, the donor site may be allowed to heal secondarily.
8. Antibiotic ointment and saline-moistened gauze dressings should be placed on the exposed undersurface of the flap. Apply antibiotic ointment around the edges of the flap.

### *Postoperative Care*

**Donor site:** Dressings should be changed daily as appropriate, depending on how you decide to treat the donor site. For example, use wet-dry dressings if the wound is allowed to close secondarily, antibiotic ointment with dry gauze if it is closed primarily.

**Flap:** Keep the recipient site and flap uncovered so that the patient and caregivers can be sure that the flap pedicle has not kinked. Any signs of venous congestion (the flap becomes purplish and swollen, with fast capillary refill) necessitates repositioning of the recipient site.

While the patient is in bed, it often helps to place a pillow under the elbow to help support the forearm and wrist. Change the dressings daily, and clean the suture lines with saline or gentle soap/water. The patient can get out of bed after surgery but must take care not to pull on the flap.



Chest flap. *A*, Open wound on the dorsum of the hand. *B*, An inferiorly based chest flap is created to cover the defect. A split-thickness skin graft is used to close the chest skin defect. (From Chase RA: Atlas of Hand Surgery. Philadelphia, W.B. Saunders, 1973, with permission.)

## *Cross Arm Flap*

### *Indications*

A cross arm flap is a good choice to cover a relatively small (maximal diameter of 2–4 cm) open wound on the hand or fingers. Usually such wounds are associated with an exposed tendon or bone.

A cross arm flap is useful when positioning makes the chest flap too uncomfortable for the patient. It is also the flap of choice if the patient prefers not to have scars on the chest or if no donor sites are available on the chest.

The inner aspect of the upper arm is the donor site.

### *Anesthesia*

A cross arm flap can be done under general anesthesia, but local anesthesia with a nerve block is preferable. Local anesthesia and nerve block ensure that the patient will not accidentally pull apart the flap attachments on awakening from general anesthesia.

### *Procedure*

1. Before surgery, ask the patient to hold the injured hand so that the wound is next to the inner aspect of the opposite upper arm.
2. The flap should be designed so that the hand can be comfortably attached to the inner arm, making sure that the attached part of the flap does not become kinked. Pick a position that allows some gentle shoulder motion to prevent shoulder stiffness.
3. Mark this area.
4. Draw the flap so that it is slightly larger than the defect. Stay away from any scars.
5. Make the incision through the skin and subcutaneous tissue; do *not* include muscle.
6. Elevate the flap off the underlying tissues.
7. Loosely stitch the three free sides of the flap in place. Use a few dermal sutures, and then close the skin with interrupted, simple sutures. The closure does not have to be perfect.
8. If possible, loosely close the donor site primarily. Alternatively, a wound no larger than a few centimeters may be allowed to close secondarily.

9. Antibiotic ointment covered with saline-moistened gauze dressings should be placed on the free undersurface of the flap. Antibiotic ointment should be placed around the edges of the flap.

### *Postoperative Care*

**Donor site:** Dressings should be changed daily as appropriate, depending on how you decide to treat the donor site.

**Flap:** Keep the recipient site and flap uncovered so that the patient and caregivers can be sure that the flap has not kinked. Any signs of venous congestion (the flap becomes purplish and swollen, with fast capillary refill) necessitates repositioning of the hand.

While the patient is in bed, it often helps to place a pillow under the elbow to help support the forearm and wrist. Change the dressings daily and clean the suture lines with saline or gentle soap and water. The patient can get out of bed after surgery but must take care not to pull on the flap.



The cross arm flap is useful for smaller defects, especially those involving the fingers.

### *Cross Leg Flap*

#### *Indications*

The most common indication for a cross leg flap is an open wound with an exposed fracture or exposed tendons of the lower third of the calf or foot. The lower calf or foot is sewn to the calf of the opposite leg for 3–4 weeks. Keeping the legs in this position can result in marked leg and hip stiffness. Therefore, a cross leg flap is best used in children or young adults; it is not recommended in patients older than 35 years.

## *Anesthesia*

Either general or spinal anesthesia is required for cross leg flaps.

## *Procedure*

1. Before administration of anesthesia, determine the best position for the patient's legs so that a flap of tissue taken from the noninjured posteromedial calf will lie easily over the defect with the least discomfort.
2. Draw the flap on the posteromedial side of the calf, overlying the gastrocnemius muscle. The flap should be slightly larger than the wound defect.
3. The flap should be designed so that it is superiorly based.
4. Incise the skin, subcutaneous tissue, and fascia overlying the gastrocnemius muscle. Elevate the flap along the plane between the fascia and underlying muscle. The fascia must stay attached to the flap.
5. Move the flap over to the open wound.
6. Loosely stitch the three free sides of the flap in place. Place a few dermal sutures, and then close the skin with interrupted sutures. The closure does not have to be perfect.
7. The donor site should be covered with a split-thickness skin graft.
8. Place antibiotic ointment and saline-moistened gauze along the free undersurface of the flap. Apply antibiotic ointment around all suture lines.
9. The patient's legs must be immobilized together to prevent accidentally separating the legs and tearing the suture line. This is best achieved with plaster. Use a lot of padding under the plaster.
10. Cut out a window in the plaster and padding over the flap so that the flap can be observed and cleansed daily.

## *Postoperative Care*

**Donor site:** Treat as you would the site of a split-thickness skin graft.

**Flap:** Keep the recipient site and flap uncovered so that the patient and caregivers can be sure that the flap has not kinked. Any signs of venous congestion (the flap becomes purplish and swollen, with fast capillary refill) necessitates repositioning of the legs.

In adults, plaster immobilization often can be removed after 4–5 days. Then a splint or gauze wrap can be created to keep the legs in the proper position.

Children must be fully immobilized in plaster until the flap is divided. You may need to change the plaster in the operating room under anesthesia.

Change the dressings daily and clean the suture lines with saline or gentle soap and water. Be careful not to pull on the flap.

### *Division of Distant Flaps*

Gradually the flap will experience an in-growth of circulation from its new site. After no less than 2 weeks, you can start to divide the pedicle, using local anesthesia such as lidocaine or bupivacaine. Do not add epinephrine to the anesthetic solution.

Cut approximately one-fourth of the way across the pedicle, and loosely stitch down the free edge to the recipient wound. A week later continue another fourth of the way across the pedicle of the flap. At 4 weeks you should be able to divide the flap completely.

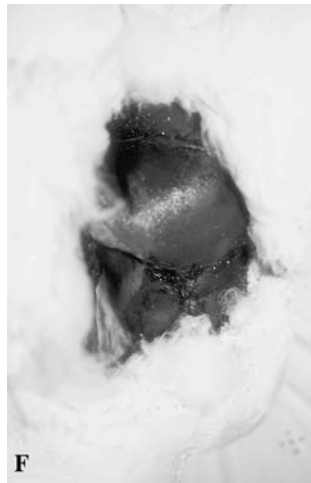
Alternatively, you may divide the flap completely in one stage 4 weeks after the initial procedure. Gradual division, however, gives the flap time to adjust to less input from the pedicle.

Suture the flap loosely to the skin edges of the recipient site. Small areas of skin separation will heal; all areas along the edge of the wound do not have to be closed completely.



Cross leg flap. *A*, Child with a congenital deformity that caused the foot to grow in an inverted position. Several previous operations failed to correct the problem. Definitive treatment required excision of the tight scar and repositioning of the foot. *B*, This procedure resulted in an open wound with exposed tendons in need of soft tissue coverage. *(Figure continued on following page.)*

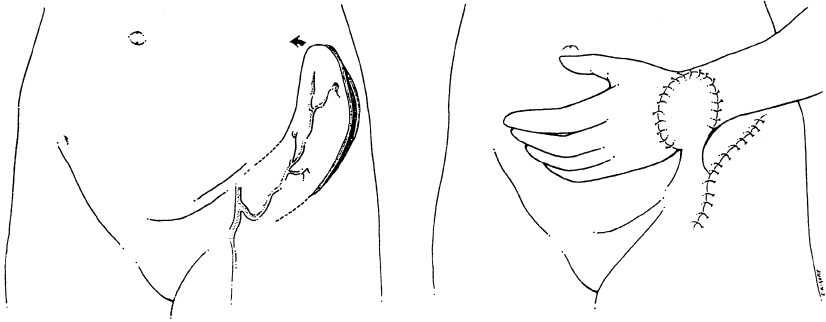




Cross leg flap (*continued*). *C*, Design of the cross leg flap. *D*, The flap after being sewn in place. *E*, The legs immobilized together in plaster. *F*, A window cut in the plaster to allow dressing changes and observation of the flap.

### *Groin Flap*

The groin flap is an axial flap, whereas the previously discussed distant flaps are random flaps. The groin flap is more reliable but also more technically difficult. Thus, only providers with advanced surgical skills should attempt this procedure. Because the groin flap may be used to save a hand with a large soft tissue defect but otherwise intact tendons and nerves, it is described in detail below.



Design of groin flap. In contrast to the previously mentioned distant flaps, the groin flap is an axial flap, and its blood supply is by way of an identifiable vessel. It is a highly reliable flap for coverage of hand wounds. (From Cohen M (ed): *Mastery of Plastic and Reconstructive Surgery*. Boston, Little, Brown, 1994, p 59, with permission.)

### *Indications*

The indication for a groin flap is an open wound on the hand or fingers in which the tendons or bones are exposed. It is also possible to take a piece of iliac bone with the flap, if needed, to reconstruct a bony defect in the hand.

### *Anesthesia*

The groin flap is usually done under general anesthesia. However, it is possible to perform the procedure using spinal anesthesia with a wrist block.

### *Design*

#### **Landmarks**

- Anterosuperior iliac spine (ASIS)
- Pubic tubercle
- Course of the inguinal ligament
- Femoral artery

The artery that nourishes the flap comes off the femoral artery within two finger widths below the point where the femoral artery meets the inguinal ligament. This artery travels in the direction of the axis of the flap toward the ASIS.

<b>Medial flap border</b>	The course of the femoral artery
<b>Upper flap border</b>	Two fingerwidths above the inguinal ligament parallel to the artery nourishing the flap
<b>Lower flap border</b>	Two fingerwidths below the take-off of the nourishing artery from the femoral artery; again, it runs parallel to the direction of the femoral artery
<b>Lateral flap border</b>	Lateral to the ASIS, as determined by the size of the wound. Once the flap is lateral to the ASIS, keep the length-to-width ratio at 1:1.

Always draw the flap first. The portion of the flap overlying and lateral to the ASIS is used to cover the open wound. Most of the medial portion of this flap is tubed and serves as the pedicle (see below).

### *Dissection*

1. Proceed from lateral to medial.
2. Start by incising the lateral half of the upper and lower markings and the lateral border of the flap.
3. Elevate the skin and subcutaneous tissue off the underlying fascia. Dissect medially until you reach the lateral aspect of the sartorius muscle; look for the muscle fibers traveling in an inferomedial direction from the ASIS to the medial knee.
4. At the lateral border of the sartorius muscle, make an up-and-down incision into the fascia.
5. Keeping the fascia attached to the skin and subcutaneous tissue of the flap, continue the dissection until enough of the flap is raised to allow inset of the flap over the wound.
6. If a branch of the blood vessel runs deep to the fascia, ligate it to prevent accidental injury.
7. Take care to avoid injury to the lateral femoral cutaneous nerve when you incise the sartorius fascia.

### *Inset of the Flap*

1. The pedicle of the flap (approximately the medial half of the flap) is sutured loosely to itself to make a tube. Simple, interrupted skin sutures are adequate. The tube allows the patient to move the shoulder without risking injury to the flap or hand attachment. It also increases postoperative comfort and makes dressing care easier.



Groin flap. *A*, Elevation of the groin flap; the medial portion is sewn together to form a tube. The donor site has been closed primarily. *B*, The patient with the hand attached to the flap.

2. Manipulate the hand / forearm into pronation or supination to determine the appropriate hand position for suturing the flap to the wound.
3. The lateral portion of the flap should be loosely sutured to the edges of the wound.
4. If the portion of the flap used to cover the wound seems too bulky, you can thin it by removing some of the subcutaneous tissue. Do not be too aggressive. The flap can be thinned at a later date once it has been divided from the donor site. Better a bulky flap than a dead one.
5. *Do not thin the flap medially, where you are making it into a tube.* You may injure the blood supply to the flap.

### *Donor Site*

The donor site should be closed primarily. You may need to flex the patient's hips to bring the wound edges together. The patient should

remain flexed for a few days after surgery. Then you may allow the patient to straighten the leg gradually over a few days.

Place a Penrose drain or a strip of sterile glove to prevent fluid from accumulating under the suture line. The drain can be removed on the day after surgery.

### *Postoperative Care*

Apply antibiotic ointment along the suture lines and saline-moistened gauze along the undersurface of the flap between the part of the flap that is tubed and the patient's hand. Change the dressing daily.

You may want to wrap the patient's arm to the chest for the first day to prevent too much arm movement. Once the patient is fully awake, this precaution is usually unnecessary.

Watch for signs of venous congestion. Check the flap regularly to ensure that the pedicle is not twisted or kinked.

### *Division of the Flap*

1. Gradually the flap will develop an in-growth of circulation from its new site.
2. After no less than 3 weeks, you may start to divide the pedicle. Cut one-fourth of the way across the pedicle, and loosely stitch down the edge to the recipient site. Local anesthetic without epinephrine should be used.
3. One week later, divide another small portion of the pedicle.
4. At 5 weeks you should be able to divide the flap completely from its pedicle. Gradual division is best; do not completely separate the flap at one time. However, if gradual division is not possible, it should be safe to divide the flap all at once at 5 weeks.
5. Suture the flap very loosely. Small areas of skin separation will heal; so do not worry that all skin edges have to be completely closed.

### *What to Do if Part of the Flap Dies*

If a portion of the flap becomes ischemic and dies, the wound often heals with local care. See chapter 13, "Local Flaps," for further details.

## ***Free Flap***

A free flap involves complete detachment of a piece of tissue (skin, fascia, muscle, bone, or some combination) with its blood supply (artery and vein). The tissue is transferred to the wound in need of

coverage. The blood vessels of the flap are then reattached to an artery and vein near the wound.

To reconnect the blood vessels requires magnification capabilities (4 × glasses at least or a microscope), tiny suture material (8-0, 9-0 nylon), and delicate instruments. The procedure takes several hours and is most efficiently done with two teams of surgeons (one working to find the vessels at the wound site, one working to dissect the flap).

In experienced hands, a free flap can achieve remarkable results. Examples include reconstruction of the tongue or jaw after ablative oncologic surgery, breast reconstruction after mastectomy, or coverage of a badly fractured ankle with soft tissue loss. Obviously, these procedures can be done only by highly experienced reconstructive surgeons with extensive microvascular training and expertise.

The following photographs show a patient with a squamous cell carcinoma of the lateral aspect of the tongue. Because of the extent of the tumor, almost one-half of the tongue and floor of the mouth needed



Free flap reconstruction. *A*, Squamous cell cancer of the lateral tongue. *B*, Design of the radial forearm flap. *C*, Blood vessels from the flap are reattached to blood vessels in the neck. *D*, Final result 1 year postoperatively.



to be resected. The reconstruction was done with a free flap taken from the volar surface of the forearm and based on the radial artery (called a radial forearm flap).

The reconstructed tongue is almost normal in size. Thus the patient was able to eat and speak normally. The flap also tolerated postoperative radiation treatment without complication. These results would be hard to attain with any other reconstructive technique.

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