



Chapter 39

EXPLORATION OF AN INJURED HAND OR FOREARM

KEY FIGURES:

Tourniquet	Dorsal incisions
Midlateral finger incisions	Proximal and distal extension of wound
Brunner zigzag incisions	
Volar surface incisions	

When exploring an injured forearm or hand, you must be aware of the surrounding tendons, nerves, and blood vessels. You do not want to injure one of these structures accidentally. This chapter explains basic principles about how to operate safely on an injured hand or forearm. It is not intended to qualify you as a hand specialist; it is intended for rural health care providers who have no access to hand or reconstructive specialists. The chapter also provides important background information for all health care providers.

Anesthesia

To operate on an upper extremity properly, you must provide adequate anesthesia. Either general anesthesia or some type of nerve block must be given so that the patient feels no pain and is able to stay completely still during the operation. (See chapter 3, “Local Anesthesia.”)

Tourniquet Use

The hand has an excellent blood supply. Thus, any incision into the tissues will ooze blood continuously throughout the procedure, making it difficult to see exactly what you are doing. To prevent inadvertent injury to the important nearby structures (tendons, nerves, and blood vessels), it is best to operate in a bloodless field. This means that the circulation to the hand must be temporarily interrupted while you operate.

To interrupt the vascular supply to the hand, a tourniquet is placed proximal to the site where you are working to compress the blood vessels supplying the extremity.

Equipment and Supplies

Before placing the tourniquet, be sure to pad the area where the tourniquet will be placed with two layers of web roll (soft cotton wrap).

A pneumatic tourniquet is the best equipment to use because you can accurately set the inflation pressure as well as a time limit. An alarm will sound when the time limit has been reached.

A regular blood pressure cuff also can be used as a tourniquet. It is best used for short procedures because the pressure in the cuff often gradually decreases, and the bloodless field is lost. It is helpful to have someone available to monitor the cuff pressure and pump up the cuff before the pressure decreases too much.

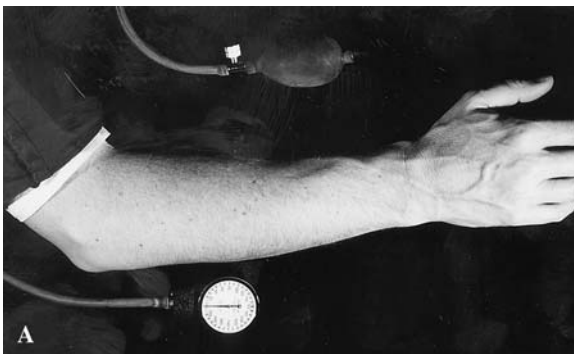
An alternative is to wrap an Esmarch (wide rubber wrap) tightly around the upper arm 4–5 times and tape it in place. This technique is effective, but should be used only as a last resort.

Placement of the Tourniquet

For procedures that will take longer than 30 minutes to complete, it is best to place the tourniquet on the upper arm. Because such procedures usually are done with a Bier block, an axillary block, or general anesthesia, pain control should not be an issue.

For short procedures (less than 20 minutes) that involve the hand or wrist, a forearm tourniquet can be used with a digital or wrist block as appropriate. For this short period, most patients can tolerate the discomfort associated with the inflated tourniquet on the forearm.

When you are working on a simple, isolated finger injury, a digital tourniquet can be used. (See chapter 29, "Fingertip and Nail Bed Injuries.")



A blood pressure cuff can serve as a tourniquet to allow the procedure to be done in a bloodless field. Note the padding beneath the tourniquet. A, Upper arm. (Figure continued on next page.)



A blood pressure cuff can serve as a tourniquet to allow the procedure to be done in a bloodless field. Note the padding beneath the tourniquet. *B*, Forearm.

Exsanguination of the Extremity

Before the tourniquet is inflated, the extremity should be exsanguinated (i.e., all blood should be removed from the extremity). For this purpose, a large rubber wrap (Esmarch) can be wrapped around the extremity before the tourniquet is inflated. Start at the fingertips, and proceed proximally. The Esmarch should be stretched as you wrap it around the extremity to squeeze blood out of the tissues. You should allow a few centimeters of overlap with each turn of the wrap. Once you have reached the tourniquet, inflate the tourniquet and remove the wrap.

An alternative method is to have several assistants use their hands to apply pressure to the patient's elevated extremity. In this way, they manually squeeze the blood from the tissues. Inflate the tourniquet while their hands are still in place. This method requires several assistants.

You should *not* exsanguinate the hand if infection is present. Exsanguinating an infected extremity may spread the infection proximally and have serious consequences.

Inflation Pressure

Amount

The tourniquet should be inflated to a pressure approximately 100 mmHg higher than the patient's systolic blood pressure—usually 250–300 mmHg. This pressure level applies to the pneumatic tourniquet and blood pressure cuff. The pressure of a rubber wrap cannot be measured.

Duration

A pneumatic tourniquet can stay in place for 2 hours before it is necessary to let down the tourniquet (release the pressure).

If you are using an Esmarch wrap as a tourniquet, I recommend removal after 1–1½ hours.

If necessary, the tourniquet can be reinflated after the extremity is given a few minutes of uninterrupted blood flow.

Tourniquet Release

When the tourniquet is released, circulation returns to the extremity. For the first 5–10 minutes, the blood flow is greater than usual and the hand becomes very red. This increase in blood flow is due to the effects of ischemia on the tissues. The vessels dilate for the first few minutes after blood flow returns. The initial effect is increased bleeding from the incision, which can be a little scary if you are not expecting it.

To prevent blood loss, place saline-moistened gauze in the wound before deflating the tourniquet and apply gentle pressure while the tourniquet comes off. Continue the pressure for several minutes.

Of course, the bleeding may be due to an injured vessel. If it is particularly brisk and does not decrease after several minutes of direct pressure, the wound should be checked thoroughly to rule out vascular injury. If you have any concern that you may have accidentally injured a blood vessel during the procedure, the tourniquet should be deflated before the incision is closed.

Make sure that all pulses are intact after the tourniquet is released. The tourniquet can cause a blood vessel to clot, although clotting is unusual and occurs only in severely diseased blood vessels.

If you are reasonably sure that you have not accidentally injured a blood vessel during the procedure, you may close the wound *before* releasing the tourniquet. Be sure to use a secure dressing and to apply gentle pressure to the area before deflating the tourniquet.

Incisions

Depending on the reason for exploration, you may not have much choice about where to place the incision. If the patient has a laceration or an abscess, its location dictates the placement of the incision. Even in these situations, however, you may need to extend the incision for adequate exploration and treatment. Thus you should know the basics about proper placement of incisions on the hand.

Proper placement of incisions is important for several reasons. One reason is to prevent injury to underlying structures. Another is that improperly placed incisions can result in poor wound healing, tight scarring, and, ultimately, limitation in hand function. You do not want to worsen the problem because of a lack of understanding about the proper way to position an incision.

It is always best to draw out your planned incisions before cutting the skin. This technique allows you to think carefully about the design and to make changes *before* you create the incision.

Fingers

Volar Surface

An incision that crosses the joint flexion crease incorrectly often heals with a tight scar. A tight scar on the volar surface of the finger can result in permanent flexion of the finger and limitation of finger movement.

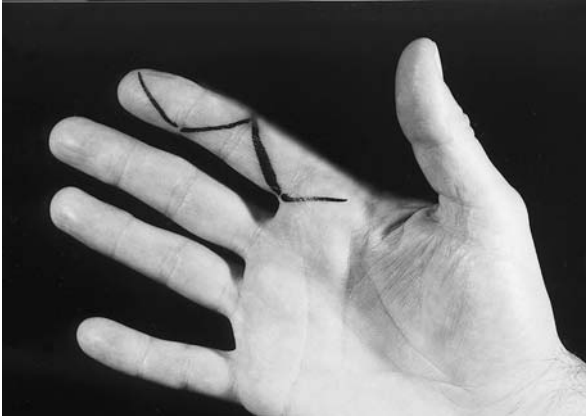
There are two correct ways to make incisions for access to the volar tissues of the fingers. Both avoid crossing the joint flexion creases incorrectly. The choice depends on the area in which you need access to underlying tissues.

Midlateral incisions can be placed on either side of the finger, volar to the digital vessels. They can extend from the metacarpophalangeal flexion crease to the distal phalanx.

The midlateral incision is one approach to the volar side of the finger. Note the position of the digital nerve (*dashed line*) in relation to the planned incision (*solid line*).



Brunner zigzag incisions go on a diagonal from the lateral edge of the joint crease to the opposite lateral edge of the next crease. They give the best exposure to the central aspect of the digits.



Brunner zigzag incisions provide another approach to the volar side of the finger and allow access to the center of each finger. To prevent tight scarring, the volar skin creases should not be crossed at a 90° angle (as would occur with a straight longitudinal incision through the central volar aspect of the digit.)

Dorsal Surface

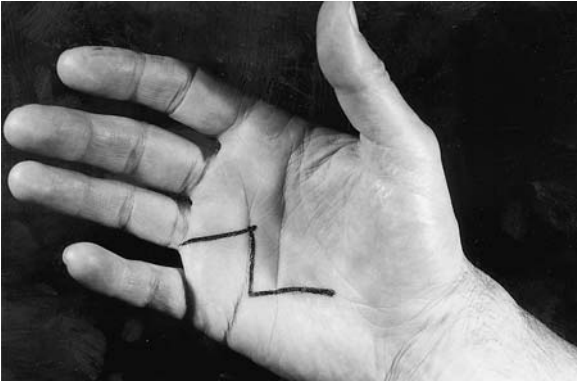
On the dorsal surface of the finger, there is less concern about crossing the skin creases. Simple longitudinal incisions usually provide the best exposure and heal well.

Hand

Volar Surface

Straight incisions on the volar surface of the hand often result in tight scars that may prevent full opening of the hand and thus lead to decreased function. For this reason, diagonal incisions that zigzag across the palm are recommended.

Brunner zigzag incisions. Using a nearby flexion crease as a starting point and guide, make incisions that follow a diagonal and zigzag across the palm. On the average, each incision should only be 2–2½ cm in length. The incisions should be placed at a > 30° angle to one another.



Incision for the volar surface of the hand. The palmar skin creases should be incorporated into the incisions. The incisions then should be extended in a zigzag fashion.

Dorsal Surface

As on the fingers, a tight scar on the dorsal surface of the hand may interfere with hand function. Longitudinal incisions usually provide the best exposure.

Alternatively, to prevent the need for multiple longitudinal incisions if you need access to a large area of the dorsal surface, a transverse incision is acceptable.



Incisions on the dorsal surface of the hand and fingers. Multiple choices are available depending on where exposure is needed. Placement is not as critical as on the volar surface.

Forearm

Volar and Dorsal Surfaces

Longitudinal incisions can be used on the volar and dorsal surfaces. If a wound from an injury is already present, simply extend it in a curvilinear manner parallel to the long axis of the forearm.

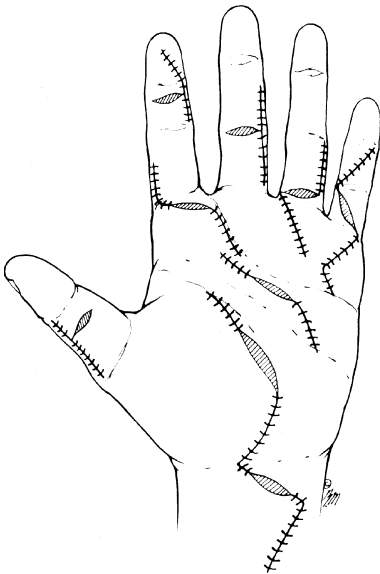
At the Elbow

Do not cross the flexion crease of the elbow (the antecubital fossa) in a straight line. Such incisions can lead to tightness about the elbow when the wound heals. It is best to use a zigzag technique.

Alternatively, make a transverse incision at the antecubital crease and then extend the ends of the incision in a curvilinear fashion down the forearm or up the upper arm as needed.

When a Laceration is Present

Often the patient with a hand injury in need of surgical exploration already has an open wound. It is best to incorporate the wound into your incision by extending the edges of the wound, using the above mentioned principles for proper incision placement.



When exploring a hand with a traumatic laceration, use the wound incision whenever possible. If more exposure is needed, try to extend the traumatic wounds in a zigzag fashion. The original wound should be extended only as far as necessary, using proper incisions. (Illustration by Elizabeth Roselius © 1998. From Green DP, et al (eds): *Operative Hand Surgery*, 4th ed. New York, Churchill Livingstone, 1999, with permission.)

Bibliography