Chapter 33

NERVE AND VASCULAR INJURIES OF THE HAND

KEY FIGURES:
Digital nerve location on finger
Epineurial repair

Nerves and blood vessels of the hand and fingers usually are quite delicate, and some are quite small. Optimal repair of injuries often requires the microsurgical expertise of a reconstructive surgeon. However, an understanding of basic principles is useful when you find yourself without specialist support.

Nerve Injuries

Nerve Physiology

When a nerve is cut, the distal part of the nerve slowly dies and cannot regrow. The proximal part of the nerve will regenerate. However, without proper treatment, there is no guarantee that the nerve will grow correctly or that function (sensory or motor) will be restored.

The nerve laceration should be repaired by sewing the cut ends together. Repair increases the likelihood that the living proximal part will grow in the proper direction, along the path left by the disintegrating distal part.

Nerves grow at a rate of 1 mm/day once the reparative process begins (usually within a few weeks of injury).

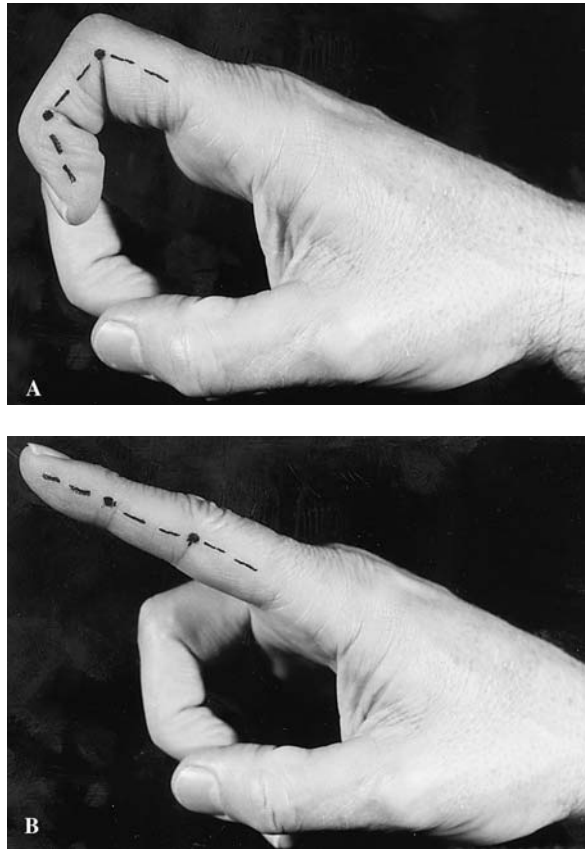
Remind the patient that even if the nerve is repaired, normal sensation and movement will not be apparent immediately after the procedure. It will take many months to know the final outcome.

General Nerve Anatomy

Nerves are made up of axonal fibers running in parallel. These fibers are surrounded by loose connective tissue, called **epineurium**. In larger nerves that have many different axons (some sensory, some motor in function), the connective tissue between the individual axons is called **perineurium**. Sutures should be placed in the loose connective tissue around the axons, *not* in the axonal substance itself.

Digital Nerves

Digital nerves are approximately 2–3 mm in diameter. They run with the digital arteries along the sides of each finger. If you look at your



Determining the position of the digital nerve. *A*, Flex the finger and mark the most dorsal aspect of both PIP and DIP flexion creases with a dot. Connect the dots in a straight line. *B*, The course of the digital nerve is illustrated by the dashed line.

finger from the side and completely flex the distal (DIP) and proximal interphalangeal (PIP) joints, the neurovascular bundle runs along a line that connects the flexion creases of these joints.

Digital nerves are purely sensory. If a digital nerve is cut, the patient feels numbness on the corresponding side of the finger. Motor function in the finger should be normal, because it is controlled by the tendons, whose muscles are innervated more proximally in the forearm. Impairment of motor function (other than pain with movement) suggests that tendon injury also is present.

Injury to a digital nerve at any point proximal to the DIP flexion crease should be repaired. In the fingertip (distal to the DIP flexion crease), the nerve divides into its terminal branches, which are too small to repair. With distal nerve injuries, sensation may return without formal nerve repair.

Larger Nerves

Nerves in the forearm and wrist (e.g., median and ulnar nerves at the wrist) are much larger than digital nerves; their diameters range from 5–10 mm. Most have both motor and sensory functions. When you look at the cut ends of the nerve, especially under magnification, you can see that the inner nerve fibers are of various diameters and that some fibers seem to be grouped together within the nerve.

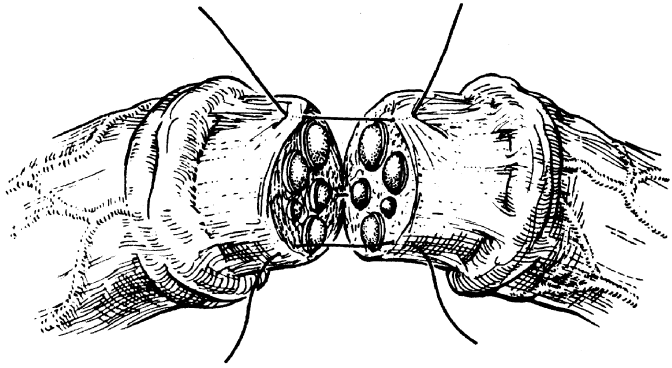
For optimal outcome, the proximal sensory fibers should be sutured to the distal sensory fibers and the proximal motor fibers to the distal motor fibers. Specialists sometimes repair larger nerves with electophysiologic guidance. This technique uses electric stimulators to identify which fibers are sensory and which are motor. Thus, the surgeon can determine exactly which fibers should go together. However, this specialized equipment usually is found only in high-technology hand centers.

Your best strategy is to try to align the nerve, using whatever landmarks you can discern. For example, try to line up the tiny blood vessels in the connective tissue around the nerve and fibers of similar size.

Nerve Repair

For optimal results, use at least twofold magnification (glasses or microscope). The more magnification, the better. Twofold magnification glasses make the image appear twice as large as with the naked eye.

Use the most delicate instruments you have—jewelers forceps, fine needle holders, fine scissors—and the smallest needle you can find (8-0 or 9-0 nylon is best).



Epineurial repair. Sutures are placed in the connective tissue surrounding the nerve fibers. (From McCarthy JV (ed): Plastic Surgery. Philadelphia, W.B. Saunders, 1990, with permission.)

Place your sutures in the epineurium, not in the nerve fibers. This approach aligns the nerve fibers and allows proper growth.

There should be no tension on the repair. You may need to free the nerve from the surrounding soft tissues to remove tension. You also can change the position of the patient's fingers or wrist to allow the ends to meet more easily. **Caution:** if you bend the finger or wrist during surgery to bring the nerve ends together, it must stay in this position for 10–14 days. If you accidentally straighten the hand in the operating room, you will disrupt the repair.

If you have no magnification and minimal instruments: For a digital nerve, place a single simple suture to bring the ends together. For a larger nerve, 3–4 sutures should be placed.

If you have magnification and very small sutures (8-0 or 9-0): For a digital nerve, place 2–4 simple sutures to bring the ends together. For larger nerves, place as many as you need to get a smooth repair (i.e., nerve fibers should not protrude from the epineurium).

If there is too much tension on the nerve repair despite different positioning techniques, a nerve graft is required. This technically challenging procedure requires referral to a specialist for optimal outcome. Even so, there is no guarantee that a nerve graft will work. To facilitate future exploration and nerve grafting, mark the ends of the nerve by placing a 4-0 or 5-0 nylon or prolene simple suture in the epineurium. Be sure to use a nonabsorbable material, which helps to locate the nerve ends at the next operation. The surgeon performing the subsequent procedure will be grateful.

Postoperative Care

The repair should be immobilized by splinting the hand or finger for a minimum of 10–14 days.

If the finger or hand required special positioning to get the nerve ends to meet during the operation, the patient should begin to open the finger or hand *slowly* (over the subsequent 1–2 weeks) to avoid disruption of the repair.

If a motor nerve is injured, the patient should move the joints of the hand regularly to prevent stiffness. It takes months for the nerve to start working again. Even if the nerve repair is successful, the patient may not regain function if the joints have become stiff from disuse.

If a sensory nerve is injured, remind the patient to be careful around very hot, very cold, or sharp objects to prevent accidental injury to the insensate area.

Vascular Injuries

First, address the risk of exsanguination (bleeding to death), which is a real danger with arterial injuries.

If serious bleeding persists: Apply point pressure over the wound. This does not mean placing gauze in the wound and wrapping the area with an Ace bandage. It means placing a wad of gauze over the injured area and using two fingers to apply firm point pressure to the injured site. You may need to hold the pressure for several minutes before the bleeding stops. If the bleeding is arterial, exploration is needed.

If you cannot control an exsanguinating hemorrhage, place a tourniquet or blood pressure cuff proximal to the injury (closer to the heart). If you use a blood pressure cuff, it must be inflated to at least 50 mmHg above systolic arterial pressure (usually to at least 200–250 mmHg). *Tourniquets hurt* and place the tissues at risk for ischemic injury. The tourniquet should not be left in place for more than 15–20 minutes. If a tourniquet is needed, urgent operative exploration is required.

Patients with a history of pulsatile bleeding (blood squirting out from a hand or forearm wound) must be explored surgically, even in the absence of active bleeding at the time of exam. Failure to tie off or repair the vessel is associated with a high incidence of pseudoaneurysm (outpouching of the vessel). A pseudoaneurysm can be dangerous because of its propensity for rupture in the future.

Digital Artery

Bleeding from a digital artery usually can be controlled by repairing the skin laceration and applying pressure over the injured area. In the rare instance when this approach fails, the vessel can be tied off with a very small suture (5-0 or 6-0 silk or chromic).

Caution: The digital nerve is adjacent to the artery. Do not accidentally place the suture around the nerve as well as the artery. *If you accidentally tie off a digital nerve, the patient will have considerable postoperative pain.*

Radial Artery

Although we palpate the radial artery to check heart rate, it is not the dominant source of circulation to the hand. Many patients with a radial artery injury still have adequate circulation in the injured hand, as evidenced by good capillary refill and normal hand temperature (compared with the other hand). The artery does not necessarily need to be repaired or reconstructed. The vessel can be tied off with minimal morbidity. Remember to tie off both ends of the vessel.

Because a significant amount of pressure pushes blood through an artery, a preferable and more secure way to tie off a larger artery is to use a "stick tie." Both techniques are discussed in the chapter 2, "Basic Surgical Skills."

However, if circulation to the hand is insufficient, as evidenced by poor capillary refill and cold skin, the vessel should be repaired. Repair of the blood vessel involves joining together the two severed parts of the artery so that blood can flow as it did before the injury. Blood vessels in the distal forearm are quite small, and repair requires microsurgical equipment and expertise. Transfer to a specialist is vital to save the hand.

Ulnar Artery

The ulnar artery is the dominant artery to the hand in most people. Thus, if it is injured, it should be repaired or reconstructed. Repair requires microsurgical expertise, because the ulnar artery is even smaller than the radial artery.

The vessel should be tied off only if no one with microsurgical skills is available or if the patient is actively bleeding. In addition, some patients have sufficient circulation to the hand even if the ulnar artery is injured. In these few patients, the vessel can be safely tied off. In general, however, it is not recommended to tie off the ulnar artery permanently if specialists are available for referral.

Bibliography

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