48 Nerve & tendon injury

48.1 Examining peripheral nerves

In any limb injury, especially where there is a penetrating wound, test the function of the nerves and tendons before you anaesthetize the patient or refer him elsewhere. Test the most distal point supplied by each nerve. The following tests are so easy that you can do them all in a few seconds.
Always record your results as this is important not only for patients' management but also has medico-legal implications. It will then be certain if paralysis did or did not exist initially.
Record both power and sensation

QUICK TESTS FOR PERIPHERAL NERVES

MAJOR NERVE TESTING AT A GLANCE

Nerve	Motor testing	Sensory testing
Axillary	Upper arm abduction	Outer part of the shoulder, over the *deltoid* insertion
Musculo-cutaneous	Elbow flexion	Outer side of the forearm
Radial	Elbow & wrist extension	Dorsum of hand & thumb
Median	Thumb abduction & opposition	Palmar surface of the index finger
Ulnar	Little finger abduction	Palmar surface of the little finger
Femoral	Hip flexion & knee extension	Medial side of the thigh, leg & foot
Sciatic	Hip extension	Sole of the foot
Post. tibial	Ankle plantarflexion & standing on tiptoe	Sole of the foot
Common peroneal	Walking on the heels with the forefoot raised (Ankle dorsiflexion)	Posterior calf (superficial branch) Web between hallux & 2nd toe (deep branch)

Table. 48-1 TESTING MAJOR NERVES AT A GLANCE. Try to memorize these tests, so that you can make an accurate neurological summary quickly.

N.B. Testing the hand nerves, see 65-3.

(a) Axillary (circumflex) nerve
This arises from the posterior cord of the brachial plexus, and winds round the neck of the humerus to supply the *deltoid* and the skin over the lower part of this muscle. It is typically injured in shoulder dislocation.

N.B. When testing arm abduction. Put your palm over the *deltoid* (48-1): even a flicker of contraction proves some function is present.

(b) Musculocutaneous nerve
Injury occurs rarely, usually as part of a brachial plexus injury.
Elbow flexion is almost impossible if this nerve is injured.

(c) Radial nerve
This curves round the humerus, and is readily injured in fractures of the distal humerus, or improper use of crutches.

(d) Median nerve
Injury may occur in distal humeral or wrist fractures, and deep lacerations of the anterior wrist.

(e) Ulnar nerve
This is injured typically at the elbow, where the nerve passes in a tunnel behind the medial epicondyle, or in midshaft forearm fractures.

(f) Femoral nerve
Injury may occur in an inferior pubic ramus fracture.

(g) Sciatic nerve
Common injury occurs with injections in the lower medial (instead of upper outer) quadrant of the buttock, or in sacral fractures or hip dislocation.
The nerve gives rise to the posterior tibial & common peroneal nerves.

(h) Posterior tibial nerve
This is in danger with upper tibial fractures.

(i) Common peroneal nerve
Often injured by pressure on the lateral upper fibula, *e.g.* from a cast, skin traction or bedsore, or in knee dislocation.

Combine this examination routine; all motor testing except for hip extension can easily be tested on a supine patient with a quick sequence: (1) upper arm abduction, (2) elbow & wrist flexion, (3) thumb abduction & opposition, (4) finger abduction, then (5) hip flexion & knee extension, (6) ankle plantar & dorsi-flexion.

Follow this by testing sensation on the *deltoid,* outer forearm, dorsum of hand & thumb, palmar surfaces of index & little fingers; medial thigh, leg & foot, posterior calf, sole of the foot, and between the hallux & 2nd toe.

TESTS FOR SOME PERIPHERAL NERVES

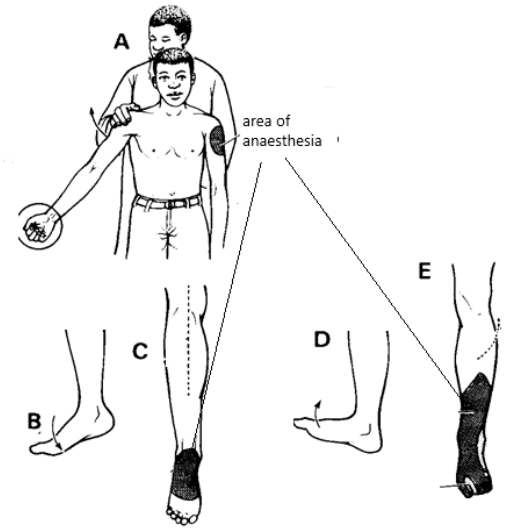

Fig. 48-1 ROUTINE TESTS FOR PERIPHERAL NERVES. A, shoulder abduction & sensation over the lateral upper arm (axillary). B, elbow flexion (musculo-cutaneous & radial). C wrist flexion (radial). D, thumb abduction & opposition (median nerve). E, little finger abduction (ulnar nerve). F, hip extension & knee flexion (femoral nerve), G, hip flexion (sciatic nerve). H, ankle plantarflexion (posterior tibial nerve). I, ankle dorsi-flexion (common peroneal nerve).
Check sensation over the *deltoid;* outer forearm, dorsum of hand & thumb; palmar surfaces of index & little fingers; medial thigh, leg & foot; sole of the foot; posterior calf and between hallux & 2nd toe.

48.2 Primary nerve repair

The digital nerves, median and ulnar nerves commonly need repairing, but almost any nerve may need repair. Whenever you clean a wound, inspect any nerves that might be injured, *but don't try to repair them*, unless they have been cut completely. Closed injuries usually only bruise nerves, so that they are able to recover in a few weeks.

One of your first problems is to distinguish a nerve from a tendon deep in a wound. Even supposedly expert surgeons have sutured a nerve to a tendon, *e.g.* the median nerve to *palmaris longus* at the wrist.

A NERVE is yellowish and flexible. You can make it lie in various positions, and if you press it, it will flatten fairly easily from side to side and from back to front. Its cut edge bulges slightly. Look at it carefully, if possible with a lens, and you will see its fibres lying in bundles, like fine spaghetti.

If it has been cut, you can easily see these bundles surrounded by connective tissue.
A nerve often has a small tortuous vessel running along its surface. This is a rare on a tendon.

A TENDON is bluish white and glistening, straighter and firmer and more difficult to deform by compression than a nerve. It has a flat smooth cut surface like wood cut across the grain, and its bundles are more difficult to see.

Try to refer nerve injuries immediately to an expert.

DISTINGUISH A NERVE FROM A TENDON

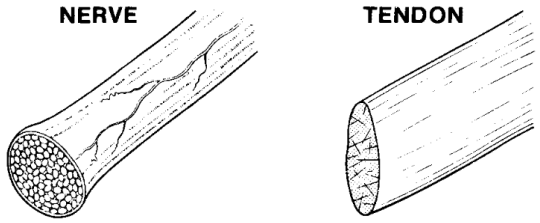

Fig. 48-2 DIFFERENTIATING BETWEEN NERVE & TENDON. A, the nerve is yellowish, softer and more flexible, its cut end bulges slightly, and has many nerve fibres in bundles, a vessel on the surface. B, the tendon is bluish white, glistening, straighter, firmer, its cut surface resembles wood. *Kindly contributed by Peter Bewes.*

The ideal is a nerve stimulator: you can make this yourself with a simple battery of 4V making an impulse of 0.1-5mA. Using a blunt needle on a motor nerve a minimum stimulus should cause muscle twitching distally; *if the stimulus is too great, the current will pass through other tissues, though!*

If nerve repair is not possible, mark the nerve ends with a non-absorbable monofilament suture. Clean the wound, and close the skin loosely. Make this quite clear to the patient and record it in his notes; also write it on a PoP if applied.

Arrange secondary repair between 3wks & 3months under controlled conditions.

PRIMARY NERVE REPAIR (GRADE 2.4)

If the wound is clean, and you have the equipment, attempt nerve repair immediately. *Don't do this if the wound is contaminated,* debride it first.

Use your finest monofilament sutures, needles, and needle holder. Ideal is a 8/0 suture on 3mm atraumatic needle.

Any suture larger than 6/0 is too big. Ophthalmic forceps and needle holders, and magnifying loupes are ideal.

REPAIRING A CUT NERVE

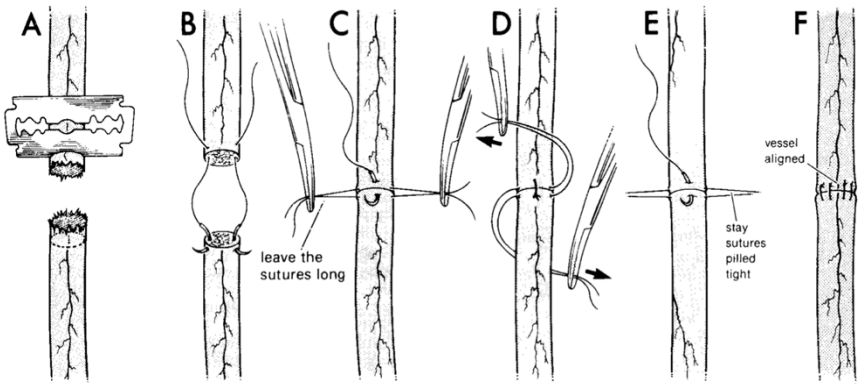

Fig. 48-3 REPAIRING A NERVE. A, freshen the ends. B, insert stay sutures. C, with the stay sutures pulled together, insert an anterior epineural suture. D, reverse the stay sutures to visualize the other side. E, insert a suture on the back side. F, complete the anastomosis by 2-6 more sutures. *Kindly contributed by Peter Bewes*

Don't use silk, catgut, human hair, or glycolic acid sutures because these are irritants.

N.B. Coarse or braided sutures may cause so much fibrosis that the nerve will never function again.

METHOD
First explore the wound (46.2). Find the cut ends of the nerve. Put the limb in a position which will help to bring the nerve ends together.

Trim back both the cut ends of the nerve by 2mm with a new sterile blade (48-3A) to obtain a flat fresh surface.

Match the cut ends in their correct anatomical position, without rotation. There are usually very fine blood vessels on one side of a nerve which will enable you to distinguish its two sides. Study the cross section of its fasciculi carefully, and get the two cut ends to match.
Try to put all sutures only into the outer sheath (epineurium) *of the nerve*, as sutures deep inside will interfere with its function seriously.

Follow the technique of 48-3.
CAUTION! Don't put >8 sutures into the epineurium; Don't let any nerve fibres stick out of the suture line.
Make sure you cover the nerve after its repair. You may need an advancement flap (46.5) to do this; a split skin graft is less satisfactory. Splint the limb in the position which best relieves tension on the nerve. If it is under tension, release the splint slowly over several weeks. *If you fail to do this, the sutures may cut out.*

While waiting for the nerve to recover its function, splint the limb to prevent contractures, and advise the patient about avoiding harm to numb areas. Start passive physiotherapy to avoid muscle & joint stiffness.

48.3 Secondary nerve repair

If a patient presents with an injured nerve late, or you decided not to repair it at the time of the injury, this will be a 'secondary' repair.

Try to refer such cases to an expert. If this is impossible, you need to prepare the surgical field carefully before you even reach the nerve!

By 3wks, a rounded neuroma forms (48-4B). You need to cut this back in small slices until you reach healthy nerve (48-4E-I). Sometimes a nerve is incompletely divided and although its ends join together, it is deformed by bulbous neuromas (48-4D). You need to cut these back until you reach a healthy nerve structure.

The best time for secondary repair is as soon as possible after the initial injury.
You may find the cut nerve ends are deep in scar tissue, and you need to look for them both proximally & distally. *Be careful to cut longitudinally* not transversely so as to avoid inadvertently dividing the nerve!

Also be careful not to divide branches, *e.g.* of the ulnar nerve to *flexor carpi ulnaris,* and the medial half of the *flexor digitorum profundus*.

You may then find that, when you have found & excised the swollen ends of the nerve, quite a gap is left. Nerves are not very elastic, so bridging this gap can be difficult.

An expert may be able to bridge the gap with a graft. You may be able to mobilize enough nerve to enable it to reach.

SECONDARY NERVE REPAIR (GRADE 2.5)

N.B. Don't consider exploring a closed wound for several months. The nerve is probably only contused, and will recover.

SECONDARY NERVE REPAIR

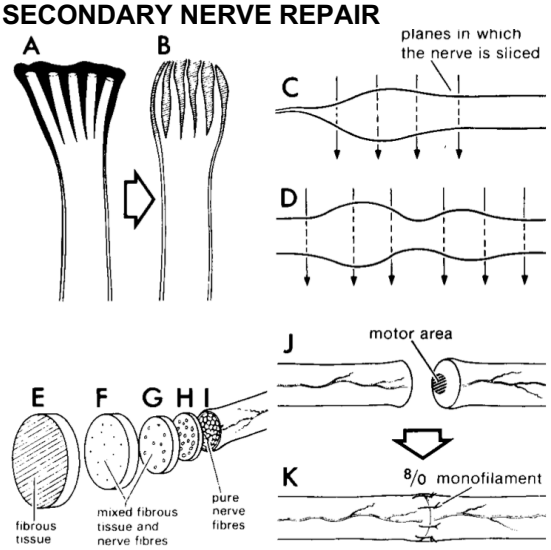

Fig. 48-4: SECONDARY NERVE REPAIR
A, a ragged recently injured nerve surrounded by blood clot. B, later, when the clot has organized and become fibrous tissue. C, taking successive sections of the thickened end of a cut nerve. D, an incompletely divided nerve with two thickened swellings. E-I, trial sections along a thickened nerve ending. J, the motor area is situated centrally in the nerve. K, try to get a tidy accurate approximation of the ends. *Kindly contributed by Peter Bewes.*

Explore the healed wound and mobilize the injured nerve, with the precautions described. Feel carefully for the parts of it that are hard and fibrosed. Use a sharp scalpel to cut thin slices across its thickest part at both ends. The 1st slice you cut from the neuroma (48-4E) may show a uniform slab of fibrous tissue. In the 2nd slice (48-4F), a few little dots of nervous tissue start to appear. In the 3rd slice (48-4G) there are more little dots. The 4th slice is mostly nerve tissue (48-4H). The final slice (48-4I) has normal fibrillary structure. You need to reach this point at both ends to perform a satisfactory repair.

Special points to note for specific nerves:
(a) Ulnar nerve
Move the nerve anteriorly from behind the medial epicondyle. This will give you the extra length you need to make a repair without due tension. Keep elbow and wrist flexed postop.

(b) Median nerve
At the wrist, you can release the nerve by incising the flexor retinaculum.

SIGNS OF SUCCESSFUL REPAIR
Tap the course of the nerve, if the patient feels tingling over its distribution, it is regenerating. (At the wrist, this is known as Tinel's sign.)

Examine and record the power of all the muscles that the injured nerve supplies. The most proximally innervated ones will recover first.

After repair, the average axonal regeneration rate is c. 1mm/day. Regenerating axons have to grow down the full course of the damaged nerve tube to the neuromuscular end-plate. After this period, nerve maturation and initial muscle recovery may take a few more months.

48.4 Tendon injury

Rupture of the belly of a muscle usually causes little disability, but rupture of its tendon or the junction of tendon with muscle is usually serious. The result depends greatly on whether or not the tendon is surrounded by a sheath. The wrist flexor tendons when cut, retract, become rounded, lie loose inside their sheath and fail to heal.

Repair is easier when a tendon has no sheath, as with the wrist extensors. Tendon injuries often involve the hand (65.15,16), or the Achilles (71.8).

SUTURING A TENDON

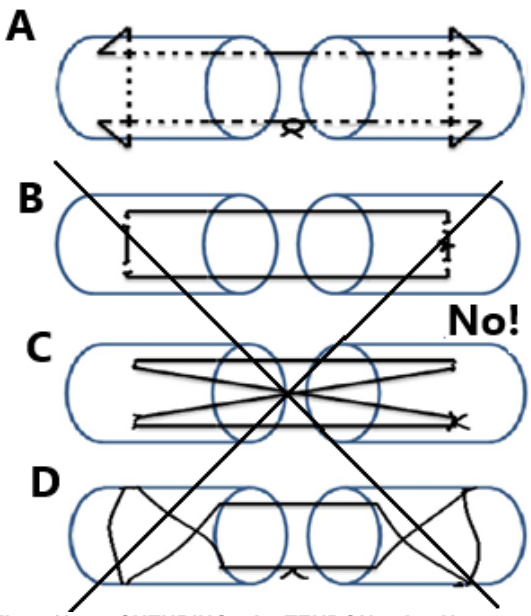

Fig. 48-5: SUTURING A TENDON. A, Use non-absorbable sutures; anchor the tendon with a transverse suture. Introduce a suture at one side of the tendon and pass it along the tendon, and out at c.2cm. Then pass it through the cut end of tendon on the opposite side, and along it 2cm along, before coming out on the same side, and then transversely through the tendon, coming back in the same way and joining the suture ends at the join. (Modified Kessler method)
N.B. Methods B,C,D are no longer recommended.

Follow general principles in all cases. The main one is the method for inserting sutures.

TENDON REPAIR (GRADE 2.3)
Do this primarily unless there is:
(1) rupture with scarred ends >1cm,
(2) segmental loss of flexor tendons,
(3) disruption of the pulley system
(4) loss of overlying soft tissues
(5) delayed presentation
You will need to open the sheaths of those tendons ruptured within a sheath. Cut off the rounded scarred ends, so you are left with plain straight cut ends.

Preferably use 3/0 monofilament nylon, fishing wire or stainless steel. *Don't use absorbable suture*. A straight needle is the easier to use.
Hold the cut ends of the tendon by stay sutures Follow 48-5.

CAUTION! Take care to identify the cut ends correctly. *Don't join a profundus to a sublimis tendon, or a nerve to a tendon!*

POSTOPERATIVE CARE
Immobilize the limb for 3-4wks in a close to functional position which will cause least tension on the cut tendon. Encourage early mobilization with dynamic splints.

Don´t force a normal range of motion, but move the tendon just as much as possible without strength. Pain is a good control to stop moving. The critical period for rupture of the repair is after 8-10days, when you remove the splint and start motion with force. So, start movements gradually, and with ascending strength over a period of another 3wks before the patient reaches a full range of motion and strength.