Primer on Nerve Injuries in the Emergency Setting

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The ability to evaluate possible nerve injuries is an essential skill for any physician who sees patients in the emergency room. This module will concentrate on the evaluation of the hand and upper extremity for nerve injuries.

Nerve injuries are potentially devastating injuries which severely affect the function of the hand. An acute injury may arise from a variety of causes including a laceration, an avulsion, crushing or traction.

Seddon classified nerve injuries into three:

1. Neuropraxia: There is a physiologic disruption of nerve function but anatomical structures are intact. Prognosis for full recovery is good.
2. Axonotmesis: Individual axons within the nerve are severed but the basal lamina of the Schwann cells remains intact and the nerve grossly maintains its continuity. Recovery is variable depending on the degree of axon injury and whether the epineurium is intact.
3. Neurotmesis: The nerve is cut and therefore there is an interruption of the continuity of all the elements of a nerve. Without repair or reconstruction, this type of injury has no chance of recovery.

In an acute setting of an injury to the limb, it is often difficult to differentiate the three types. What is important is to detect the presence of these injuries and thus direct immediate and subsequent treatment to alleviate the effects.

A history should include the timing of the injury, the mechanism and symptoms such as pain or absence thereof. Paralysis is sometimes not immediately brought up because of the patient's overwhelming concern for the bleeding and/or pain and this needs to be actively investigated by the examiner.

Examination

When a patient with a wound comes into the emergency room, after primary survey and control of bleeding, assessing for peripheral nerve injury should be part of the secondary survey. A knowledge of the anatomy of the injured area is helpful in trying to ascertain which nerve, if at all, is involved. For instance, a self-inflicted laceration on the non-dominant wrist should prompt an investigation (aside from a psychiatric consult) for injuries to the median and ulnar nerves by an examination distal to the wound, in this case the hand. Once a patient is stabilized, a thorough nerve examination should be performed as can be done, dictated by the condition of the patient. The function of a nerve can be divided into three: sensory, motor and autonomic. A good examination includes all three.

Sensory Loss

In the emergent setting, finer tools for assessment of neuropathy are unnecessary. Frequently, a wound demands an immediate and simple answer to the question "Is the nerve injured?" The answer, even if the injury is partial, is a yes or no. Thus what is needed in an examination of sensory function is testing for light touch and pain perception. An area of pure sensory innervation is chosen. If median nerve injury is suspected, the pulp of the index finger is tested by pinprick or is touched lightly with a blunt or soft object. For the ulnar nerve, the pulp of the small finger is tested and for the radial nerve, the skin of the dorsal web space. The patient is then asked if he/she can detect the stimulus. He/she should also be asked to detect the absence of the stimulus to prevent error. Comparison should be made with areas known to be normal. This can be repeated numerous times to ascertain that the findings are accurate. This cannot be done in an uncooperative patient and therefore in this instances, other methods of assessment are employed.

More sophisticated and detailed sensory examinations are available such as the Semmes-Weinstein monofilament test, 2-point discrimination (2PD), moving 2PD, etc. These tests are more suitable for assessing a chronic nerve compression, neuropathy of varying etiologies or monitoring nerve recovery and have little to no role in the acute setting.

Paralysis

An injured motor nerve will result in paralysis of its distally innervated muscles. To ascertain loss of motor function of a nerve, it is most convenient to test the distal-most muscles, namely the intrinsic muscles in the hand. The hand has 19 intrinsic muscles and remembering all of them with their innervations may be a challenge in the emergent setting, much less testing each of them. So, a quick diagnosis necessitates the testing of one muscle for each nerve.

Of the five intrinsic muscles innervated by the median nerve, the abductor pollicis brevis (APB) is the most conveniently tested. With the hand flat on a surface and the palm up, the patient is asked to use his/her thumb to point straight up or toward the ceiling. Alternately, the patient can be asked to snap his fingers, also a test for APB function. A person with a transected median nerve at or proximal to the wrist should be unable to perform this.

The ulnar nerve innervates a majority of the intrinsic muscles of the hand (14 of the 19). A number of tests have been described to test motor function.

1. Froment's test is used to examine the adductor pollicis muscle. The patient is asked to hold on to a piece of paper by using the thumb to pinch the paper against the radial side of metacarpophalangeal joint of the index finger, keeping the interphalangeal joint extended. The test is positive (there is ulnar nerve injury) if:

a. The patient is unable to hold on to the piece of paper;
b. The patient flexes the IP joint (flexor pollicis longus, median nerve) and uses the pulp of the thumb to hold on to the paper.

2. Egawa's test is performed by asking the patient to put his hand flat on the table with the palm down and to move his middle finger radially and ulnarly.
3. Crossing of the middle finger over the index finger.

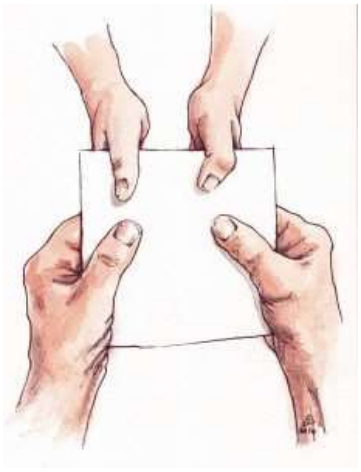


Illustration of Froment's sign. The left hand of the patient shows compensation by flexion of the interphalangeal joint of the thumb while the right hand is able to hold on to the paper.

Figure from: https://www.donaldsammut.com/gallery/testtechnique/froments-sign-1/

There are no intrinsic muscles that are innervated by the radial nerve so testing of the motor function involves testing muscles whose bellies are in the forearm. A high radial nerve injury (injury at or above the level of the elbow) is tested by asking the patient to extend the wrist (extensor carpi radialis longus and brevis) and a low radial nerve, also known as a posterior interosseous nerve injury, is tested by asking the patient to give a thumbs up sign (extensor pollicis longus).

The inability to move a part of the hand or wrist is not necessarily a sign of nerve injury. There are instances that pain or nervousness prevent a patient from performing the motions requested. This may be circumvented by asking the patient to resist movement instead. The examiner can position the part of the limb in the position which the muscle being tested normally produces and then instruct the patient to keep it in that position and not allow the examiner to move it.

Classic deformities associated with different nerve injuries have been described. The ulnar claw, papal benediction sign, median claw, etc. are all postures seen in nerve injuries but these are usually not evident in the acute setting.

Autonomic Loss

Sweat loss is a characteristic in the distribution of the injured peripheral nerve. The skin in the affected region is dry and smooth when compared to adjacent, unaffected parts. Another technique is to use a smooth plastic object such as the barrel of a pen and moving it across the skin. Gliding is much smoother in the denervated area compared to the resistance felt on unaffected areas.

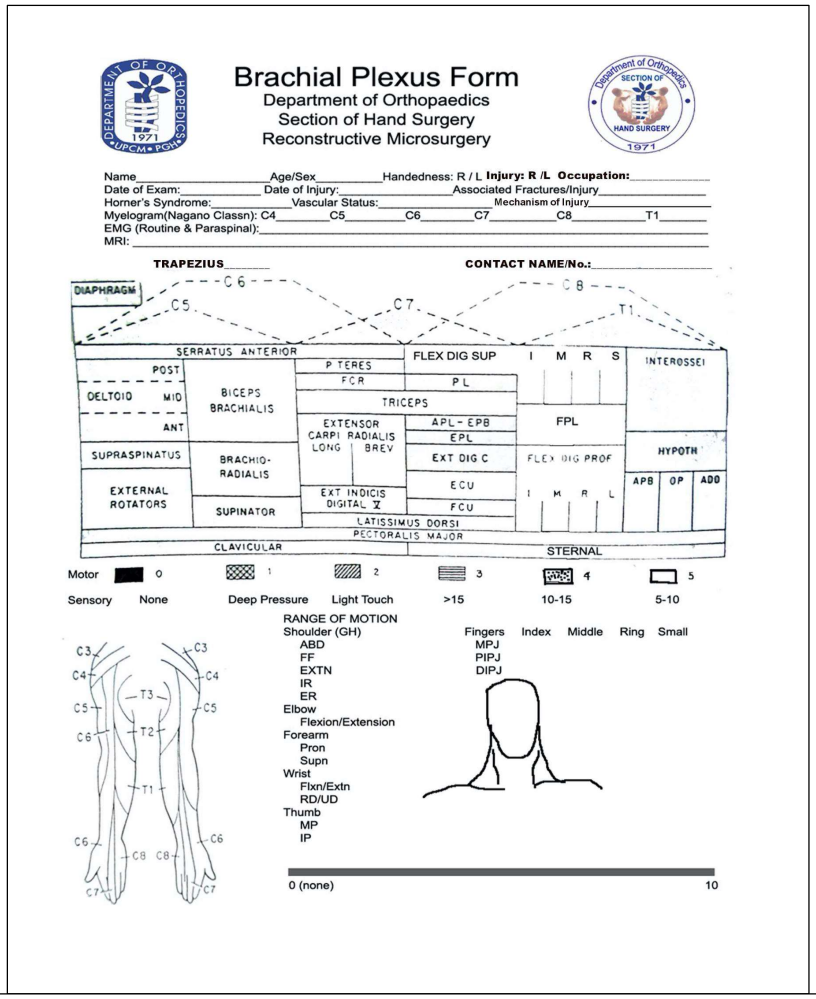
A wrinkle test can also be performed. Immersing the hand in water for around five minutes should produce wrinkling of the digital pulps of the fingers with sensory innervation. An absence of wrinkling with the pulp remaining smooth indicates denervation.

Tests for autonomic loss are much more subjective and more difficult to perform and takes experience to perform well. These tests are therefore reserved for the uncooperative patient, such as those unable to respond, unable to follow instructions or young children.

Closed injuries

Traction, avulsion or crushing injuries frequently occur in a setting where there is no wound in the skin. Frequently, these patients are involved high energy trauma and have multiple injuries such that the life-threatening and bleeding ones take precedence. Often these are not picked up until the patient is able to communicate them to his health care provider. These injuries may involve peripheral nerves or more proximal structures.

An example of this is a brachial plexus injury in a patient with head injuries or multiple fractures. Paralysis of the involved extremity may be overlooked and attributed to decreased sensorium or bony injuries. Fortunately, it is rare for these injuries to require immediate management and detection and a full assessment that is done after a few weeks has little to no impact on management or prognosis. In such patients a thorough neurologic examination of the extremity is warranted when the patient is stable and cooperative. The examination in these cases is dermatome-based rather than based on peripheral nerve distribution.



The evaluation form for brachial plexus injuries used in the Department of Orthopedics of the Philippine General Hospital emphasizing dermatomal distribution of sensory and motor innervation.

Treatment

Treatment in the emergency room is directed towards the wound rather than the nerve injury. Bleeding control and wound care are the initial actions taken. Once the patient is stable then a plan can be formulated to address the nerve. Acute repair can be done if the setting is ideal. Short delays of weeks or even a few months will still consistently produce good results. However, it is important to keep in mind that the results of treatment of nerve injuries frequently depend on timely treatment. Delays of months may affect overall recovery and the longer the delay beyond this, the poorer the chances of recovery. This is especially true for motor nerves where after a certain delay, usually pegged at 12 months of denervation, the injury becomes permanent because of the irreversible atrophy of the motor end plates Other factors that affect outcome are the level of injury (proximal

or distal), the mechanism of injury (clean cut better than avulsion, crushing or segmental), the use of a graft (primary repair better than grafting), and the type of nerve (pure sensory or motor better than mixed).

Management of nerve injuries depend on the type of injury sustained. Transected nerves that are apposable can be repaired while those with gaps can be grafted. Nerve injuries sustained in gunshot wounds are not usually repaired. In these injuries, a nerve that is physically continuous may have neuropraxia or axonotmesis and monitoring for recovery and subsequent reconstruction if necessary are the mainstays of treatment. Even with transection, nerve repair for gunshot wounds do not consistently result in recovery because of the extent of the axonal damage beyond the level of the transection. Brachial plexus injuries are managed with varying strategies based on timing and extent and may include nerve grafts, nerve transfers or muscle and nerve reconstruction.

References:

1. Smith, Paul. Lister's The Hand: Diagnosis and Indications, 4th ed.
2. Wolfe, et al. Green's Operative Hand Surgery, 7th ed.