Peripheral Nerve Entrapment and Injury in the Upper Extremity

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Peripheral nerve injury of the upper extremity commonly occurs in patients who participate in recreational (e.g., sports) and occupational activities. Nerve injury should be considered when a patient experiences pain, weakness, or paresthesias in the absence of a known bone, soft tissue, or vascular injury. The onset of symptoms may be acute or insidious. Nerve injury may mimic other common musculoskeletal disorders. For example, aching lateral elbow pain may be a symptom of lateral epicondylitis or radial tunnel syndrome; patients who have shoulder pain and weakness with overhead elevation may have a rotator cuff tear or a suprascapular nerve injury; and pain in the forearm that worsens with repetitive pronation activities may be from carpal tunnel syndrome or pronator syndrome. Specific history features are important, such as the type of activity that aggravates symptoms and the temporal relation of symptoms to activity (e.g., is there pain in the shoulder and neck every time the patient is hammering a nail, or just when hammering nails overhead?). Plain radiography and magnetic resonance imaging are usually not necessary for initial evaluation of a suspected nerve injury. When pain or weakness is refractory to conservative therapy, further evaluation (e.g., magnetic resonance imaging, electrodiagnostic testing) or surgical referral should be considered. Recovery of nerve function is more likely with a mild injury and a shorter duration of compression. Recovery is faster if the repetitive activities that exacerbate the injury can be decreased or ceased. Initial treatment for many nerve injuries is nonsurgical. (*Am Fam Physician.* 2010;81(2):147-155. Copyright © 2010 American Academy of Family Physicians.)

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Peripheral nerve injury in the upper extremity is common, and certain peripheral nerves are at an increased risk of injury because of their anatomic location. Risk factors include a superficial position, a long course through an area at high risk of trauma, and a narrow path through a bony canal. The anatomy and function of upper extremity nerve roots, as well as specific risk factors of injury, are described in *Online Table A*. The most common nerve entrapment injury is carpal tunnel syndrome, which has an estimated prevalence of 3 percent in the general population and 5 to 15 percent in the industrial setting.[1] Given the potential for long-standing impairment associated with nerve injuries, it is important for the primary care physician to be familiar with their presentation, diagnosis, and management.

Pathophysiology

The three categories of nerve injuries are neurapraxia, axonotmesis, and neurotmesis. Neurapraxia is least severe and involves focal damage of the myelin fibers around the axon, with the axon and the connective tissue sheath remaining intact. Neurapraxia typically has a limited course (i.e., days to weeks). Axonotmesis is more severe, and involves injury to the axon itself. Regeneration of the nerve is possible, but typically prolonged (i.e., months), and patients often do not have complete recovery. Neurotmesis involves complete disruption of the axon, with little likelihood of normal regrowth or clinical recovery.[2,3]

Most nerve injuries result in neurapraxia or axonotmesis. Mechanisms of nerve injury include direct pressure, repetitive microtrauma, and stretch- or compression-induced ischemia. The degree of injury is related to the severity and extent (time) of compression.[4]

General Diagnostic Approach

Nerve injury should be considered when a patient reports pain, weakness, or paresthesias that are not related to a known bone, soft tissue, or vascular injury. Symptom onset may be insidious or acute. The location of symptoms, the type of symptom (i.e., paresthesias, pain, weakness), and any relation between a symptom and specific activity

SORT: KEY RECOMMENDATIONS FOR PRACTICE

Clinical recommendation	*Evidence rating*	*References*
Patients with a brachial plexus nerve injury (i.e., stinger) should undergo periodic reexamination for two weeks after the injury. Continued or new symptoms should be evaluated using neuroimaging and electrodiagnostics because a more severe nerve injury is likely.	C	8-10
For patients with a carpal tunnel syndrome diagnosis based on typical history and physical examination findings, electrodiagnostic testing does not usually change the diagnosis.	C	24, 25
Symptom relief from splinting, corticosteroid injections, and other conservative modalities for carpal tunnel syndrome have similar outcomes. Surgical intervention has been shown to have better outcomes than splinting.	B	25, 29, 48

A = consistent, good-quality patient-oriented evidence; B = inconsistent or limited-quality patient-oriented evidence; C = consensus, disease-oriented evidence, usual practice, expert opinion, or case series. For information about the SORT evidence rating system, go to http://www.aafp.org/afpsort.xml.

should be determined. *Table 1* outlines the differential diagnosis of upper extremity nerve injury by symptom and area of the body.[5,6]

Initial physical examination of a patient with an upper extremity injury includes looking for the presence of a radial pulse, and sensation and movement in the digits. If there is no obvious neurovascular compromise, the remainder of the examination is based on the patient's history. The examination should follow the classic pattern of inspection, palpation, joint range of motion, muscle strength testing, and sensory and neurologic examination. It is helpful to understand the nerves commonly involved, their function, and the corresponding areas of the body at risk of compression or entrapment. *Figures 1 and 2* show typical distributions of nerves in the upper extremity.[7]

Table 1. Symptoms of Upper Extremity Nerve Injuries

Anatomic area	*Symptom*	*Nerve injuries to consider*
Shoulder	Pain or numbness	Axillary
		Brachial plexus
	Weakness	Axillary
		Brachial plexus
		Long thoracic
		Spinal accessory
		Suprascapular
Forearm	Pain or numbness	Pronator
		Radial tunnel
	Weakness	Posterior interosseous
Hand	Pain or numbness	Radial at wrist
		Ulnar at wrist or elbow
	Weakness	Median at wrist
		Ulnar at elbow

Information from references 5 and 6.

Common Nerve Injuries and Entrapment Syndromes of the Upper Extremity

Tables 2 through 4 outline the evaluation process and differential diagnosis of nerve injuries to the upper extremity.[5,6]

SHOULDER AND ARM

Axillary Nerve: Quadrilateral Space Syndrome. The axillary nerve is vulnerable to trauma as it passes through the quadrilateral space. Injury can occur from shoulder dislocation; upward pressure (e.g., from improper crutch use); repetitive overload activities (e.g., pitching a ball, swimming); and arthroscopy or rotator cuff repair. The typical symptom is arm fatigue with overhead activity or throwing. There may be associated paresthesias of the lateral and posterior upper arm. Examination reveals weak lateral abduction and external rotation of the arm.

Brachial Plexus Nerve: Stinger. A brachial plexus injury (i.e., stinger) is common in persons who play football, but it also occurs with other collision sports. The classic presentation is acute onset of paresthesias in the upper arm. A key characteristic is a circumferential rather than dermatomal pattern of paresthesias. Symptoms typically last seconds to minutes. Motor symptoms may be present initially or develop later.

A brachial plexus injury must be differentiated from a cervical spine injury. The initial examination should focus on the neck, with palpation of the cervical vertebrae to detect point tenderness and evaluation of neck

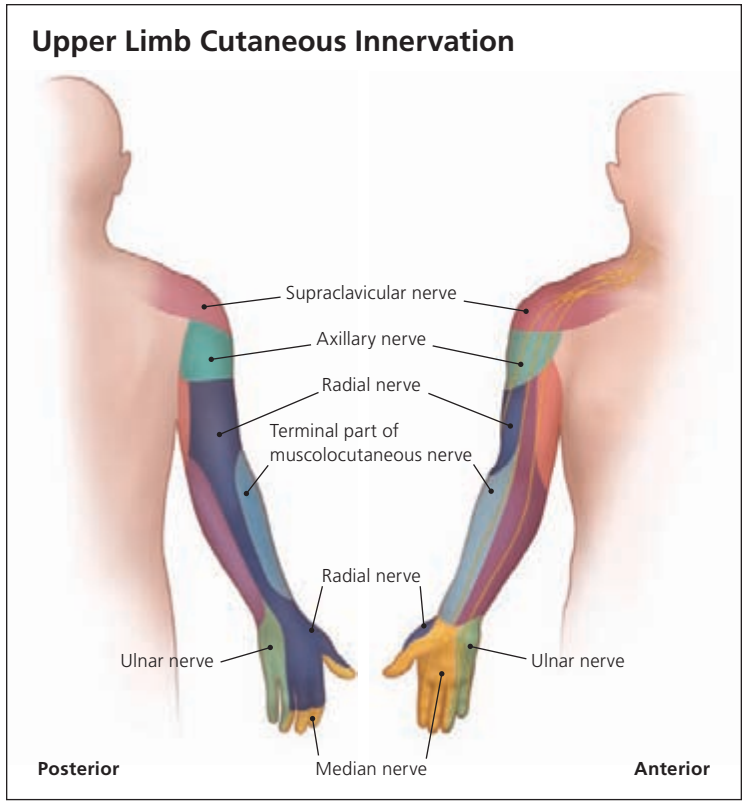

Figure 1. Posterior and anterior views of upper limb cutaneous innervation.

Information from reference 7.

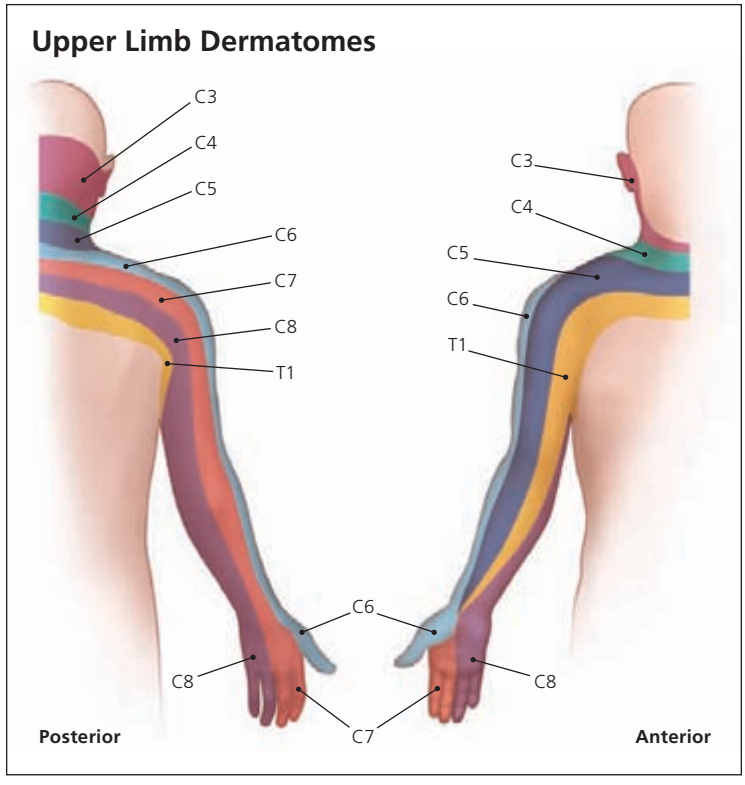

Figure 2. Posterior and anterior views of upper limb dermatomes.

Information from reference 7.

range of motion. Any indication of a cervical spine injury mandates further emergent neurologic and radiologic evaluation. Point tenderness of the cervical vertebrae or pain with neck movement is a red flag for a cervical spine injury, in which case the patient should be immobilized. Bilateral symptoms or those involving upper and lower extremities are less likely to be from a brachial plexus injury.

If motor symptoms occur, the upper extremity muscle group exhibiting weakness correlates with the part of the brachial plexus that has been injured. Because motor symptoms may occur hours to days after the injury, repeated neurologic examinations are necessary—the patient should be reevaluated after 24 hours and then at least every few days for two weeks. If new symptoms or significant worsening of existing symptoms occurs, neuroimaging, electrodiagnostics, or surgical referral should be considered.[8] Patients who have multiple occurrences of stingers should also have a more thorough workup, because they may have an underlying neck pathology that predisposes them to this injury.[9,10]

Occurrence during participation in a sporting event raises the issue of return to play. If all symptoms resolve within 15 minutes and there is no concern for cervical spine injury, the player may return to the same event with at least one repeat examination during that event.[11]

Long Thoracic Nerve. Injury to the long thoracic nerve occurs acutely from a blow to the shoulder, or with activities that involve chronic repetitive traction on the nerve (e.g., tennis, swimming, baseball). Presenting symptoms include diffuse shoulder or neck pain that worsens with overhead activities. Examination reveals scapular winging and weakness with forward elevation of the arm.

Spinal Accessory Nerve. Injury to the spinal accessory nerve can occur with trapezius trauma or shoulder dislocation. Radical neck dissection, carotid endarterectomy, and cervical node biopsy are iatrogenic sources of injury. Patients usually present with generalized shoulder pain and weakness. Examination of the shoulders reveals asymmetry. The affected side appears to sag and the patient is

Table 2. Shoulder and Arm Examination: Abnormalities That May Indicate Nerve Injury

Component of evaluation	*Evaluation area*	*Diagnoses to consider*
Inspection	Clavicle symmetry and integrity	Dislocation or fracture
	Humeral head position	Shoulder dislocation; look for radial nerve injury
	Muscle deformity or atrophy	Muscle tear or chronic nerve injury
	Shoulder symmetry	Sagging shoulder suggests spinal accessory nerve injury
	Skin ecchymoses or swelling	Localized injury
Palpation	Acromioclavicular and sternoclavicular joints	Dislocation
	Clavicle, scapular spine	Fracture
	Muscle tenderness, integrity, or deformity	Contusion or muscle tear
Range of motion*	Forward flexion 180 degrees; extension 45 degrees; lateral abduction 180 degrees; adduction 45 degrees; internal rotation 55 degrees; external rotation 40 degrees	If active range of motion is normal, no need to test passive range of motion; if active range of motion is abnormal and passive range of motion is normal, consider muscle or nerve injury; abnormal passive range of motion indicates joint pathology
Muscle strength	Adduction	Pectoralis and latissimus muscles
	Extension	Posterior deltoid muscle, axillary nerve
	External rotation	Infraspinatus muscle, suprascapular nerve; teres minor muscle, axillary nerve
	Forward flexion	Anterior deltoid muscle, axillary nerve
	Internal rotation	Subscapular muscle and nerve
	Lateral abduction	Middle deltoid muscle, axillary nerve; supraspinatus muscle, suprascapular nerve
	Shoulder protraction (reaching); possibly winged scapula	Serratus anterior muscle, long thoracic nerve
	Shoulder shrug	Trapezius muscle, spinal accessory nerve
	Weakness in many movements of the shoulder or upper arm	Brachial plexus nerve injury
Sensory/neurologic	Circumferential anesthesia or paresthesia	Brachial plexus nerve injury
	Dermatomal anesthesia or paresthesia	Individual nerve root injury

**—Measured in degrees from neutral position. Compare with contralateral side.*

Information from references 5 and 6.

unable to shrug the shoulder toward the ear. Associated weakness of forward arm elevation above the horizontal plane is common. With chronic injury, the trapezius may atrophy.

Suprascapular Nerve. Injury to the suprascapular nerve is associated with repetitive overhead loading. The suprascapular nerve serves the supraspinatus and infraspinatus muscles. The infraspinatus may be the only muscle affected, depending on the site of injury. Loss of infraspinatus function presents as weak external rotation of the arm. Supraspinatus involvement additionally presents with weak arm elevation, which is most pronounced in the range of 90 to 180 degrees. Suprascapular nerve injury can result from other shoulder pathologies, specifically a glenoid labrum tear. Cyst formation at the suprascapular notch from a labral tear is not uncommon. The cyst compresses the suprascapular nerve, affecting the supraspinatus and infraspinatus muscles.[12] Suprascapular nerve injury and rotator cuff tear both lead to supraspinatus and infraspinatus weakness. Differentiating the two injuries may require magnetic resonance imaging (MRI).

FOREARM AND ELBOW

Median Nerve at the Elbow: Pronator Syndrome. The pronator teres muscle in the forearm can compress the median nerve, which may cause symptoms that mimic carpal tunnel syndrome. Symptoms are discomfort and aching in the forearm with activities requiring repetitive pronation of the forearm, especially with the elbow extended. Paresthesias in the thumb and first two digits may be present. Forearm sensation is normal, and sensation of the digits may also be normal. In pronator syndrome, there is sensory loss over the thenar eminence, which is not a finding of carpal tunnel syndrome. Results of the Tinel sign and Phalen maneuver at the wrist should be negative in patients with pronator syndrome.[13]

Radial Nerve at the Elbow: Radial Tunnel and Posterior Interosseous Nerve Syndromes. The radial nerve divides into a superficial branch (sensory only) and a

Table 3. Elbow and Forearm Examination: Abnormalities That May Indicate Nerve Injury

Component of evaluation	*Evaluation area*	*Diagnoses to consider*
Inspection	Carrying angle in full extension (men: 5 degrees, women: 15 degrees); compare with contralateral side	Decreased angle suggests supracondylar fracture; increased angle suggests lateral epicondylar fracture; consider possible ulnar nerve injury
	Diffuse elbow joint swelling; joint held in flexion	Interarticular joint pathology
	Swelling over olecranon	Olecranon bursitis
Palpation	Biceps muscle and tendon tenderness or deformity	Ruptured distal biceps muscle or tendon
	Cubital fossa tenderness or swelling	Joint capsule strain or hyperextension injury; look for median and musculocutaneous nerve injury
	Epicondyles or distal humerus	Fracture
	Radial head	Fracture or dislocation; consider radial nerve injury
	Ulnar nerve in sulcus: tender or thickened area over nerve	Ulnar nerve injury or entrapment
	Wrist extensor tenderness	Radial tunnel syndrome or lateral epicondylitis (tennis elbow)
	Wrist flexor or pronator muscle group tenderness	Pronator syndrome or golfer's elbow
Range of motion*	Flexion 135 degrees; extension 0 to 5 degrees; supination 90 degrees; pronation 90 degrees	If active range of motion is normal, no need to test passive range of motion; if active range of motion is abnormal and passive range of motion is normal, consider muscle or nerve injury; abnormal passive range of motion indicates joint pathology
Muscle strength	Extension	Triceps muscle, radial nerve
	Flexion	Brachioradialis muscle, musculocutaneous nerve
	Pronation	Pronators, acute nerve irritation of branch median nerve
	Supination	Biceps muscle, musculocutaneous nerve
Sensory/neurologic	Biceps DTR	Musculocutaneous nerve C5
	Brachioradialis DTR	Radial nerve C6
	Triceps DTR	Radial nerve C7

DTR = deep tendon reflex.

**—Measured in degrees from neutral position. Compare with contralateral side.*

Information from references 5 and 6.

deep branch (posterior interosseous nerve) at the lateral elbow. Forearm pain that is exacerbated by repetitive forearm pronation is the presenting symptom of radial tunnel syndrome, which involves injury to the superficial branch of the radial nerve. Symptoms of radial tunnel syndrome are almost identical to those of tennis elbow (i.e., lateral epicondylitis), and distinguishing the two can be difficult because physical examination maneuvers that aggravate radial tunnel syndrome may also be positive in patients with tennis elbow (e.g., supination against resistance with the elbow and wrist extended, and resisted extension of the middle finger).[14] A differentiating factor is the point of maximal tenderness. In radial tunnel syndrome, this point is over the anterior radial neck; in tennis elbow, it is at the origin of the extensor carpi radialis brevis muscle.

The presence of any motor symptoms is more likely related to injury of the posterior interosseus nerve, which supplies the extensor muscles of the hand. Generalized hand weakness is the presenting symptom of posterior interosseus nerve syndrome. Examination reveals weakness of digit and wrist extension, although this is usually more prominent in the digits than in the wrist.

Ulnar Nerve at the Elbow: Cubital Tunnel Syndrome. The ulnar nerve at the elbow is very superficial and at risk of injury from acute contusion or chronic compression. Compression can be from an external or internal source. As the elbow flexes, the cubital tunnel volume decreases, causing internal compression. Cubital tunnel syndrome may cause paresthesias of the fourth and fifth digits. There may be elbow pain radiating to the hand, and symptoms may be worse with prolonged or repetitive elbow flexion. Paresthesias precede clinical examination findings of sensory loss. Weakness may occur, but is a late symptom. When present, motor findings are weak digit abduction, weak thumb abduction, and weak thumb-index finger pinch. Power grip is ultimately affected.

HAND AND WRIST

Median Nerve at the Wrist: Carpal Tunnel Syndrome. Carpal tunnel syndrome is the most common nerve entrapment injury.[15] Early symptoms are paresthesias of the

Table 4. Hand and Wrist Examination: Abnormalities That May Indicate Nerve Injury

Component of evaluation	*Evaluation area*	*Diagnoses to consider*
Inspection	Bilateral symmetry of knuckles in clenched fist	Asymmetry suggests metacarpal fracture
	Dorsal or volar wrist mass	Ganglion cyst
	Skin ecchymoses or swelling	Localized injury
	Symmetric bulk of thenar and hypothenar eminences	Thenar atrophy suggests chronic median nerve injury; hypothenar atrophy suggests chronic ulnar nerve injury
Palpation	Anatomical snuff-box tenderness	Scaphoid bone fracture
	Carpal tunnel (Tinel sign)	Median nerve injury
	Guyon canal (depression between hamate hook and pisiform), asymmetric or excessive tenderness	Ulnar nerve injury
Range of motion	Symmetric flexion and extension of all digits	Inability to flex or extend individual digit suggests tendon injury or fracture
Muscle strength	Active wrist extension	Radial nerve injury
	Active wrist flexion	Ulnar and/or median nerve injury
	Digit adduction or abduction	Ulnar nerve injury
	Pincer mechanism thumb and index digit	Ulnar nerve injury
Sensory/neurologic	Phalen maneuver at wrist	Median nerve injury
	Sensation lateral hand	Ulnar nerve injury
	Sensation of web space between thumb and index digit	Radial nerve injury

Information from references 5 and 6.

thumb, index digit, and long digit. Some patients also have forearm pain. The most helpful physical examination findings are hypalgesia (positive likelihood ratio of 3.1) and abnormality in a Katz hand diagram.[16] Although commonly used in patients with carpal tunnel syndrome, Tinel sign and Phalen maneuver are less accurate.[16] The sensory examination is normal initially, although late findings include sensory loss in the median nerve distribution, weak thumb abduction, and thenar atrophy. Electrodiagnostic testing can be useful and quantitates severity of entrapment, although false negatives and false positives may occur.[16,17]

Radial Nerve at the Wrist: Handcuff Neuropathy. The superficial branch of the radial nerve crosses the volar wrist on top of the flexor retinaculum of the carpal tunnel. It is vulnerable to compression by anything wound tightly around the wrist. Historically, this is an area easily injured by tight handcuffs, thus the name "handcuff neuropathy." The injury leads to numbness on the back of the hand, mostly on the radial side. Examination may reveal decreased sensation to soft touch and pinprick over the dorsoradial hand, dorsal thumb, and index digit. Motor function is typically intact.

Ulnar Nerve at the Wrist: Cyclist's Palsy. Injury of the ulnar nerve at the wrist is common in cyclists because the ulnar nerve gets compressed against the handlebar during cycling, resulting in "cyclist's palsy." This type of nerve injury occurs with other activities involving prolonged pressure on the volar wrist (e.g., jackhammer use). Symptoms are paresthesias in the fourth and fifth digits. Digit weakness is uncommon because the motor portion of the nerve at the wrist is less superficial. Unless the activity is prolonged or chronic, results of the sensory examination are normal and numbness will resolve within a few hours after stopping the activity.

Diagnostic Testing

IMAGING

Plain radiography is primarily useful for identifying other diagnoses, such as fracture or cervical spondyloarthropathy. MRI is rarely needed for initial evaluation of a typical nerve injury, although it may be helpful for specific nerves *(Table 5)*.[18]

Chronic nerve injury can lead to denervation changes in muscle. These changes may be visible on MRI as abnormal signal patterns. A normal MRI finding does not rule out nerve injury. Newer techniques, such as gadofluorine M–enhanced MRI, may ultimately be able to assess nerve regeneration.[19] Ultrasonography is a less expensive modality to define anatomic entrapment, but its use is limited by lack of standardization of technique and interpretation.[20]

ELECTRODIAGNOSTIC TESTING

Electrodiagnostic testing consists of nerve conduction studies and electromyography (EMG). Nerve conduction studies assess the integrity of sensory and motor nerves. Areas of nerve injury or demyelination appear as slowing of conduction velocity along the nerve segment in question. EMG records the electrical activity of a muscle from

a needle placed into the muscle, looking for signs of denervation.[21,22] The combination of nerve conduction studies and EMG can help distinguish peripheral from central nerve injuries. Electrodiagnostic testing is commonly used to evaluate for carpal tunnel syndrome and cubital tunnel syndrome. Nerve conduction studies have been shown to confirm carpal tunnel syndrome with a sensitivity of 85 percent and a specificity of 95 percent.[23] Nerve conduction studies also may help confirm the diagnosis in patients who have a history or physical examination findings that are atypical of carpal tunnel syndrome. For most patients who have a typical presentation, nerve conduction studies do not change the diagnosis or management.[24,25]

Treatment

The initial management of most nerve injuries is nonsurgical. The main components of treatment are relative rest and protection of the injured area. Anti-inflammatory medications are often added, although it is unknown if they aid healing. Mobility of associated joints should be maintained at full range of motion, and effort should be made to increase the strength of any supporting or accessory muscles. Specifics of conservative therapy and indications for surgical referral are shown in *Table 6*.[13,15,25-46]

Systematic reviews of carpal tunnel syndrome have found short-term benefit from local corticosteroid injection, splinting, oral corticosteroids, ultrasound, yoga, and carpal bone mobilization.[29] Symptom relief from local injection has not been shown to last longer than one month, and there is no demonstrated benefit from a second injection.[30] Clinical outcome from local corticosteroid injection is similar to that from splinting combined with anti-inflammatory medication.[29] Vitamin B_6, ergonomic keyboards, diuretics, and nonsteroidal anti-inflammatory drugs have not been shown to be beneficial.[29,30] Patient characteristics that predict a poor response to nonsurgical therapy include age older than 50 years, symptom duration longer than 10 months, history of trigger digit, constant paresthesias, and Phalen maneuver that is positive in less than 30 seconds.[47] Surgical treatment likely has better outcomes than splinting, but it is unclear if surgical treatment is better than corticosteroid injection.[48]

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Table 5. MRI Evaluation of Specific Nerves of the Upper Extremity

Nerve	*MRI usefulness*	*Comments*
Suprascapular nerve at scapula	Often useful	Useful for evaluation of suspected ganglion cyst; oblique coronal view for suprascapular notch, axial view for spinoglenoid notch; also evaluates for rotator cuff pathology
Axillary nerve in shoulder	Useful if diagnosis unclear or recovery not following expected clinical course	Useful for evaluation of suspected paralabral cyst or labral pathology; oblique sagittal view of shoulder shows nerve at inferior rim of the glenoid; MRI less useful for evaluation of quadrilateral space because it is a dynamic entity
Median nerve at wrist	Useful if diagnosis unclear or recovery not following expected clinical course	Axial images of carpal tunnel evaluates for hypertrophy of synovium, space-occupying lesions (ganglion cyst)
Radial nerve at elbow	Useful if diagnosis unclear or recovery not following expected clinical course	Axial images at elbow show mass effect from enlarged bicipitoradial bursa, hypertrophy of extensor carpi radialis brevis muscle, or vascular pathology
Ulnar nerve at elbow	Useful if diagnosis unclear or recovery not following expected clinical course	Axial images can evaluate the cubital tunnel for nerve subluxation, arcuate ligament pathology; may need views of elbow in flexion and extension if subluxation suspected
Long thoracic nerve	Occasionally useful	Imaging of nerve itself not usually useful, but can sometimes show denervation changes of supraspinatus and infraspinatus muscles

MRI = magnetic resonance imaging.

Information from reference 18.

Table 6. Treatment of Specific Upper Extremity Nerve Entrapment Injuries

Nerve injury type	*Conservative therapy*	*Therapy duration and considerations*	*Indications for surgery*
Axillary[26-28]	Shoulder range-of-motion exercises, including posterior capsule stretching; avoid heavy lifting For injuries associated with specific activity, assess shoulder biomechanics for that activity	Consider baseline nerve conduction studies at one month, repeat at three months Conservative therapy for three to six months	Rare
Carpal tunnel[15,25,29,30]	Activity modification, splints worn at night Consider one steroid injection Oral steroids, yoga, ultrasound, and carpal bone mobilization have short-term benefit	Consider nerve conduction studies if no improvement within four to six weeks	Common Consider surgery if nerve conduction studies show severe injury, thenar atrophy, motor weakness
Cubital tunnel[31-33]	Pad external elbow against external compression; decrease repetitive elbow flexion Extension splint (70 degrees) worn at night	Conservative therapy only for sensory symptoms	Occasional Consider surgery for motor weakness that is moderate or that does not respond to conservative therapy after three months Poor surgical outcome for established intrinsic muscle atrophy
Interosseous nerve syndrome[34,35]	Cock-up splint to assist weakened wrist muscles Avoid provocative activities Consider elbow immobilization	Three to six months	Consider surgery sooner if late presentation with severe weakness or atrophy, progressive weakness
Long thoracic[36,37]	Shoulder range-of-motion exercises to prevent contracture Strengthen trapezius, rhomboids, and levator scapula (remaining scapular stabilizers)	Nine to 12 months is average recovery time; consider conservative treatment for up to 24 months	Rare
Pronator[13,38,39]	Activity modification; consider single steroid injection Splinting with elbow at 90 degrees can be used, with monitoring for loss of range of motion at elbow	Three to six months	Occasional
Radial tunnel[38,40,41]	Physical therapy for extensor-supinator muscle group Consider single corticosteroid injection	Three months of physical therapy before consideration of surgery (unless intractable pain)	Consider surgical decompression for intractable pain, although no available evidence from randomized controlled trials
Radial wrist[39,42]	Eliminate external compression May consider single cortisone injection	Three months	Rare
Suprascapular[43-45]	Physical therapy to maintain full shoulder range of motion and strengthen other shoulder (compensatory) muscles Avoid heavy lifting and repetitive overhead activities	Early magnetic resonance imaging (at one month) to rule out anatomic lesion (i.e., ganglion cyst) Conservative treatment for six to 12 months if no anatomic lesion	Rare unless labral ganglion cyst present Presence of cyst indicates early consideration for surgery
Ulnar wrist[39,46]	Pad volar wrist area; activity modification Splint wrist in neutral position	Six months	Rare

Information from references 13, 15, and 25 through 46.

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