

# Upper Extremity Nerve Entrapment Syndromes

Type 4 or isolated mononeuropathies are usually caused by trauma, either blunt or penetrating. If the trauma is blunt, the injury may be secondary to compression from an internal or external source. **Entrapment neuropathies** are a subset of compression neuropathies occurring at anatomic locations where nerves traverse potentially constricting compartments or tunnels.<sup>1</sup> They may also be caused by soft tissue masses such as ganglia, and tumors (either primary or metastatic).<sup>2</sup> Isolated mononeuropathies may be acute and intermittent, or chronic and continuous. Antecedent peripheral neuropathy may be a risk factor for development of compression neuropathy (so-called double-crush syndrome), particularly in diabetics.<sup>1</sup> A fairly complete list of the upper extremity nerve entrapment syndromes are covered below. A chart summarizing is at the end. Please refer to the prints of the nerve pathways (for the radial, ulnar, and median nerves) included when reading the text. The majority of these conditions warrant referral to a neurologist or neurosurgeon, especially the areas listed without treatment suggestions.

## **Suprascapular mononeuropathy:**

- Entrapment neuropathies of the suprascapular nerve and its branches vary depending on the location of compression. Overhead activities with repetitive scapular motion, performed during sports such as volleyball and tennis, may produce stretching and compression of the suprascapular nerve and its branches under the suprascapular ligament. Repetitive adduction and internal rotation of the shoulder can stretch the nerve underneath the spinoglenoid ligament. Direct trauma, scapular fractures, or post-traumatic calcification of the suprascapular ligament may also produce compression of the nerve. Peripheral nerve injury, including suprascapular neuropathy, was noted in 28% of patients who had full-thickness tears of the rotator cuff. Iatrogenic injury to the suprascapular nerve can also occur during rotator cuff repair.<sup>2</sup>
- Involvement of both the supraspinatus and infraspinatus muscles reflects compression at the suprascapular notch, whereas isolated denervation at the infraspinatus muscle is compatible with compression at the spinoglenoid notch.<sup>2</sup>

## **Axillary mononeuropathy:**

Levels of injury:

- The quadrilateral space syndrome is defined as compression of the axillary nerve within the quadrilateral space. Fractures of the proximal humerus and scapula can produce direct nerve injury. Entrapment of the nerve can be produced by extreme abduction of the arm during athletic endeavors, or even during sleep. Mass effect secondary to tumors, hypertrophy of teres minor muscle in paraplegic patients, or by a fibrous band within the quadrilateral space are other causes of entrapment of the nerve. Symptoms related to this syndrome include shoulder pain and paresthesia. Advanced cases may result in atrophy of the deltoid and teres minor muscles.

- Up to 45% of shoulder dislocation cases may demonstrate post-traumatic axillary nerve injury. The most commonly involved nerve is the axillary nerve, because it has a relatively tethered course within the quadrilateral space. The risk for axillary nerve and brachial plexus injury is greater if the shoulder is not reduced within 12 hours. Despite the high prevalence of axillary nerve injury following shoulder dislocation, only a few reports in the radiological literature address the association of teres minor atrophy with prior dislocation.<sup>2</sup>

### Radial mononeuropathy:

Levels of injury:

- Injury at the **level of the axilla** is uncommon and usually associated with other upper extremity mononeuropathies or a brachial plexopathy. Although improper use of crutches may cause this syndrome, it usually occurs after an extended period of unconsciousness during which the arm is positioned in such a way that prolonged, deep compression is applied to the axilla. Axillary radial mononeuropathy is distinguished from the more common humeral form by the finding of triceps involvement in addition to typical wrist and finger drop. Triceps involvement occurs because the innervation to the triceps is proximal to the point where the nerve is most vulnerable as it winds around the humeral shaft.<sup>1</sup>
- **Proximal Humerus:** *Most* radial mononeuropathies are due to so-called Saturday night palsies. The euphemism is apparently derived from the association of radial mononeuropathy with improper positioning of the arm during deep, commonly inebriated sleep. Consequently, the radial nerve is trapped for a prolonged period between the humeral shaft and some firm surface (see figure), causing an external compression mononeuropathy. “Bridegroom's palsy” is another eponym for radial mononeuropathy, so named because the radial nerve may be compressed by the bride's head resting on the bridegroom's arm during sleep.<sup>1</sup>
  - Because innervation of the wrist and finger extensors occurs distal to this area of the humeral shaft, findings are characterized by wrist and finger drop and mild numbness over the skin of the first dorsal interosseus muscle. Depending on the level, degree, and duration of compression, some fascicles of the nerve may remain functional, resulting in a partial radial mononeuropathy. Thus, the superficial radial nerve may remain intact, resulting in no loss of sensation, or loss of wrist and finger extension may be incomplete. The finger drop of radial mononeuropathy places the hand at a mechanical disadvantage. Examination of ulnar function by testing interossei muscle strength may produce false-positive findings of weakness. To adjust for this, the examiner should ask the patient to place the palm on a horizontal supporting surface such as a stretcher. With the fingers extended and no longer “dropped” at the metacarpophalangeal joints, interosseous strength can now be fairly tested. Failure to perform this maneuver may cause misdiagnosis of a simple radial mononeuropathy as a brachial plexopathy in an effort to explain what appears to be radial and partial ulnar nerve involvement.<sup>1</sup>
  - About 90% of radial nerve palsies occurring during sleep, coma, or anesthesia recover fully, usually within 6 to 8 weeks. Evidence of

denervation on EMG studies predicts a slower rate of recovery. Tourniquet injuries to the radial nerve usually recover spontaneously within 2 to 4 months. If axonal degeneration is seen on electrophysiologic testing, recovery may take longer, although virtually all radial mononeuropathies caused by tourniquets eventually resolve. About 75% of radial nerve injuries associated with a closed humeral shaft fracture recover spontaneously. In contrast, surgical intervention is needed to free the nerve from entrapment associated with complex fractures.<sup>1</sup>

- **Radial tunnel syndrome** is a compressive neuropathy of the posterior interosseous nerve **at the radial tunnel** without motor deficit. Its main manifestation is pain at the radial tunnel without muscle weakness. The clinical diagnosis is often confounding, because radial tunnel syndrome can masquerade as or coexist with lateral epicondylitis. Recalcitrant lateral epicondylitis, which is refractory to conservative treatment, should raise the suspicion of radial tunnel syndrome.<sup>2</sup>
  - Dynamic compression within the radial tunnel may be secondary to repeated pronation and supination or forceful extension of the forearm. Tennis players, swimmers, housewives, welders, conductors, and violinists are frequently affected. The condition most commonly involves patients in the fourth to sixth decade of life without significant gender predilection.
  - The utility of electromyographic studies in diagnosing radial tunnel syndrome is somewhat limited because of the deep location of the posterior interosseous nerve. Surgical release of the arcade of Frohse often relieves the symptoms.
- **Posterior interosseous nerve syndrome** is defined as a motor neuropathy. Compression sites for posterior interosseous nerve syndrome are the same as those for **the radial tunnel** syndrome. Clinically, deep forearm pain and muscle weakness with loss of extension of all the digits and decrease of wrist dorsiflexion can be noted. Complete sparing of the extensor carpi radialis longus and frequent sparing of the extensor carpi radialis brevis are often observed as the branches to these muscles often originate proximal to the takeoff of the posterior interosseous nerve. The extensor carpi ulnaris longus is always affected.<sup>2</sup>
  - The initial management of posterior interosseous nerve syndrome is conservative, except in the presence of masses, fractures, or dislocation, which may require surgical intervention. When there is lack of improvement following 6 to 8 weeks of conservative treatment, surgical decompression may be warranted.<sup>2</sup>

### **Ulnar mononeuropathy:**

Levels of injury:

- Compressive neuropathy of the ulnar nerve **at the elbow** is the second most common neuropathy in the upper extremity, exceeded only by carpal tunnel syndrome. There are several potential sites of compression of the ulnar nerve at the distal arm, but at the elbow, there is the ulnar condylar groove, and the cubital canal.<sup>2</sup>

- Injury at the level of the ulnar condylar groove is likely to be secondary to trauma, fracture, or dislocation due to its superficial location. The ulnar nerve has a propensity to develop a “tardy ulnar palsy,” occurring years after a traumatic event. Many of these delayed ulnar mononeuropathies can be localized to the elbow on electrophysiologic testing.<sup>1</sup>
- Injury to the ulnar nerve can occur slightly more distally at the cubital canal as it passes posterior to the medial epicondyle. Within the cubital tunnel, the nerve is subject to friction, traction, and compressive forces. It is the most common neuropathy of the elbow area.<sup>3</sup> Transient symptoms may occur during prolonged flexion or with repeated flexion and extension at the elbow.<sup>1</sup>
  - Patients typically complain of medial elbow and forearm pain. The pain can be sharp or achy, and may radiate proximally or distally. There may be paresthesias radiating to the ulnar one and a half digits. Patients may complain of weak grip strength, hand fatigue, or clumsiness with objects. Typically the patient is involved in a throwing sport, but it can also be caused by trauma or degenerative changes.<sup>3</sup>
  - Normal loss in volume and increased pressure within the tunnel during elbow flexion can result in physiologic cubital tunnel syndrome. This is seen in “sleep palsy,” as the arm is held in flexion for prolonged periods of time.<sup>2</sup>
- Flexion at the elbow may reproduce or exacerbate symptoms. The examiner may note tenderness to palpation over the ulnar nerve posterior to the medial epicondyle. Tinel’s sign is often positive in this location. The examiner may also note decreased grip strength, decreased index pinch, hypothenar atrophy, or decreased sensation in the ulnar one and a half digits.<sup>3</sup>
- Conservative treatment consists of activity modification, ice, and NSAIDs. Splints can be worn at night with the elbow in 45° of flexion. Steroid injection is contraindicated. If conservative measures fail, the nerve can be addressed one of four ways: simple decompression, subcutaneous anterior transposition, submuscular anterior transposition, and medial epicondylectomy.<sup>3</sup>
- Compression of the ulnar nerve within **Guyon’s canal** is rare. When it does occur, it affects all of the ulnar intrinsics (i.e., the two ulnar [fourth and fifth] lumbricals) and all the interossei. However, the ulnar extrinsics (i.e., the deep flexors of the fourth and fifth digits) are not affected, nor is the ulnar flexor of the wrist. The only sensory abnormalities are those in the distribution of the superficial terminal sensory branch, sparing other areas of ulnar innervation.<sup>1</sup>
  - There are three ulnar mononeuropathies that occur distal to Guyon’s canal in the hand.<sup>1</sup>
    - The two most common ones involve the deep terminal branch, either proximal or distal to the separation of the hypothenar branches. If the lesion is proximal, it produces weakness of all the ulnar innervated muscles of the hand without sensory loss. If it is

distal, the hypothenar ulnar intrinsics are spared but the picture is otherwise similar. Usually, this occurs secondary to a laceration or repeated compression in the hand from use of certain tools, a cane, or the handle of a crutch.<sup>1</sup>

- Involvement of the superficial terminal branch arises as pure sensory loss of the palmar surface of the fifth digit and ulnar half of the fourth digit caused by direct compression of this branch just distal to Guyon's canal. The dorsal surface of these two digits should have normal sensation except for the distal tips. This configuration of findings is due to the intact innervation provided by the dorsal and palmar cutaneous branches that enter the hand without passing through Guyon's canal.<sup>1</sup>
- Although distinguishing a condylar from a cubital ulnar mononeuropathy is difficult, it is usually possible to localize the problem to the region of the elbow or the wrist. In addition to prior probability heavily favoring the elbow, the presence of sensory abnormalities in an ulnar distribution in the hand and fingers (i.e., usually including the fifth digit and “splitting” the fourth digit) strongly suggests that the lesion is at the level of the elbow rather than the wrist. The ulnar cutaneous innervation to the hand branches off from the main trunk proximal to the nerve entering Guyon's canal. Thus, a lesion at the wrist should not produce sensory abnormalities, whereas one at the elbow would be expected to do so.<sup>1</sup>

### **Median mononeuropathy:**

Levels of injury:

- **Pronator syndrome** is the most common cause of median nerve entrapment **at the elbow**. Elbow fractures and dislocations, accessory muscles such as Gantzer's muscle (the accessory head of the flexor pollicis longus muscle), soft tissue masses, and dynamic forces at the elbow have also been implicated.

Honeymooner's paralysis is related to median nerve compression secondary to prolonged pressure of a lover's head against a lover's forearm.<sup>2</sup>

- Clinical signs of median neuropathy include weak pronation of the forearm, weak flexion, and radial deviation of the wrist associated with thenar atrophy and inability to oppose or flex the thumb.<sup>2</sup>
- Numbness in the median nerve distribution with repetitive pronation/supination of the forearm, but not with flexion and extension of the elbow, is a frequent presenting symptom of pronator teres syndrome. On physical examination, forearm pain elicited by resistance to pronation or resistance to isolated flexion of the third and fourth proximal interphalangeal joints can be observed. Electromyographic studies may show only mildly reduced conduction velocities.<sup>2</sup>
- The most frequent etiology for pronator syndrome is dynamic compression of the median nerve between the superficial humeral and deep ulnar heads of the pronator teres muscle. Median nerve compression is more pronounced in pronation and elbow extension, when the distance between the two heads of the pronator teres muscle is narrowed.<sup>2</sup>

- Median mononeuropathy is usually diagnosed as **carpal tunnel syndrome** (CTS) -- the most common of all entrapment neuropathies and it occurs at the level of the wrist.
  - Although the patient may complain of bilateral symptoms, a careful history usually reveals that symptoms in one hand preceded those in the other. Awakening at night and shaking the hand is a common symptom of CTS. Symptoms are often worsened by activity. For unclear reasons, the pain may spread as high as the arm or shoulder, although the paresthesias are generally confined to the fingers. Many patients on initial questioning state that their entire hand is involved, although this is not supported by careful sensory examination. Complaints that the hands are clumsy or weak, especially when holding a glass or opening a screw-top container, are frequent. The skin of the fingers innervated by the median nerve may be drier and rougher to the touch than the corresponding ulnar skin, depending on the duration of entrapment.<sup>1</sup>
  - Because the nerve has already given off motor branches to the median extrinsic muscles to the hand, when there is motor involvement in CTS it is confined to the median intrinsics, which innervate the lumbricals (flexion of the metacarpal phalangeal joints), and subserve thumb opposition, abduction, and flexion, known as the LOAF muscles. However, the hallmark of CTS is sensory involvement, with motor abnormalities occurring later. The typical pattern of sensory innervation of the hand by the median, ulnar, and radial nerves shows marked individual variation. The most specific finding for CTS is splitting of the fourth digit (i.e., normal sensation of the ring finger on the ulnar palmar side with abnormal sensation on the median [radial] palmar side of the same finger). The most sensitive finding is abnormal sensation of the distal palmar tip of the index finger. If sensory findings are absent in the presence of motor findings consistent with median nerve involvement, it is highly unlikely that the patient has CTS, and an alternative diagnosis should be sought. If neither sensory nor motor symptoms are evident, none of the provocative tests originally reported to reproduce the sensory symptoms of CTS—of which the most common are Tinel's sign (percussion of the median nerve at the wrist) and Phalen's sign (maximal palmar flexion at the wrist)—has shown adequate sensitivity or specificity to determine which patients should be referred for electrodiagnostic studies. As suggested earlier, the best way to examine patients for sensory findings is to touch the distal palmar tips very lightly, asking the patient whether the sensation feels "abnormal."<sup>1</sup>
  - CTS appears to be associated with acromegaly, amyloid, diabetes mellitus, hypothyroidism, pregnancy, and renal failure. Of these, the two most common are diabetes mellitus and pregnancy. CTS associated with systemic illness is commonly bilateral. Although CTS in pregnancy may be self-limiting, about half the women in one series were still symptomatic at 1-year follow-up. All patients with suspected CTS should be referred for NCSs. However, because of the dissociation between clinical and

electrodiagnostic indicators of CTS early in the disease, patients with normal electrodiagnostic findings in the presence of symptoms suggestive of CTS (with or without signs) should have an MRI or sonogram.

- **For treatment options and their relative utilities, please refer to the attached review article from the Annals of Family Medicine.**

<sup>1</sup>Gallagher, E. John. Chapter 105 – Peripheral Nerve Disorders. Marx: Rosen's Emergency Medicine: Concepts and Clinical Practice, 6<sup>th</sup> ed., 2005.

<sup>2</sup>Bencardino, Jenny T. and Rosenberg, Zehava Sadka. “Entrapment Neuropathies of the Shoulder and Elbow in the Athlete.” Clinics in Sports Medicine 01-July-2006; 25(3); pp 465-87.

<sup>3</sup>Sellards, Rob and Kuebrich, Chris. “The Elbow: Diagnosis and Treatment of Common Injuries.” Primary Care: Clinics in Office Practice. 01-March-2005 32(1): pp1-16.

Isolated Mononeuropathies of the Upper Extremity			
Nerve	Origin	Innervations	Named Syndromes
Suprascapular	C <sub>5</sub> and C <sub>6</sub>	Suprascapular and infraspinatus muscles and provides sensation to the glenohumeral and acromioclavicular joints.	Suprascapular Nerve Syndrome
Axillary	C <sub>5</sub> and C <sub>6</sub>	Anterior and posterior deltoid muscle, teres minor muscle, and a sensory branch in the upper shoulder region.	Quadrilateral Space Syndrome
			Post-traumatic axillary nerve injury
Radial	C <sub>5-8</sub> and T <sub>1</sub>	Extensor musculature of the arm and forearm as well as the overlying skin.	Radial Tunnel Syndrome
			Posterior Interosseous Nerve Syndrome
Ulnar	C <sub>8</sub> and T <sub>1</sub>	Elbow joint, flexor carpi ulnaris, ulnar half of flexor digitorum profundus to 4 <sup>th</sup> and 5 <sup>th</sup> fingers, palmaris brevis, hypothenar muscles. <b>All interossei</b> , adductor pollicis, flexor pollicis brevis-deep head, flexor digiti minimi, abductor digiti minimi, and opponens digiti minimi muscles. Sensation to the medial palm, palmar and dorsal skin of the 5 <sup>th</sup> finger and medial ½ of the 4 <sup>th</sup> finger.	Cubital Tunnel Syndrome
Median	C <sub>5-8</sub> and T <sub>1</sub>	Radial side of the flexor portion of the forearm and hand (all superficial ventral muscles except the flexor carpi ulnaris, all deep ventral muscles except ulnar half of the flexor digitorum profundus)	Pronator Syndrome
			Carpal Tunnel Syndrome