

The Symptomatic Upper Extremity: An Algorithmic Approach to Diagnosis, Part 2

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Dorsal scapular nerve entrapment:

Entrapment of the dorsal scapular nerve is easily overlooked as a cause of upper-arm pain. Regarded as somewhat obscure, the dorsal scapular nerve receives notoriety as the first branch of the brachial plexus - C5 ventral rami. Although it has no specific cutaneous distribution, afferents are carried from the spindles of the muscles it innervates, the rhomboids and levator scapuli. As such, there is minimal or no sensory loss. But mild lower scapular winging, accentuated by overhead placement of the arm, may be present. Because the nerve is usually trapped as it exits from the lower two-thirds of the scalenus medius, neck rotation or extension may reproduce or exacerbate symptoms. Conservative treatment can effectively control symptoms when entrapment occurs from a hypertonic scalenus medius, abnormal insertion of the scalenus medius into the first rib, or mechanical friction or rub on the nerve. An abnormal EMG of the rhomboids, when other C5 root innervated muscles are normal, can help confirm the diagnosis.

Trigger Points:

Trigger points, popularized by Travel and Simons, are widely recognized as a source of local and referred pain. When there hyperirritable areas occur within taut bands of skeletal muscle or its fascia, patients may experience symptoms at a distant location. Palpating muscles of the neck, girdles, and limbs may locate a sensitive band or nodule that, when pressed, reproduces the patient's symptoms. This is a common phenomenon, which can be treated conservatively. Improvement after an initial trial of care eliminates the need for expensive EMG/NCV testing. Consult "Myofascial Pain and Dysfunction: The Trigger Point Manual" by Travel and Simons for more information.

Radiculopathy:

Radiculopathy describes an event that occurs when a nerve root is compromised. The root of a spinal nerve is that portion found passing through the intervertebral foramen (IVF). Root lesions may follow degenerative or neoplastic processes that narrow the IVF, cause mechanical friction or rub on the nerve, or create traction on the nerve from fixed adhesions. If the lesion involves sensory fibers or compresses cell bodies within the dorsal root ganglion, patients may experience pain in the form of paresthesia, hyperesthesia, or hyperalgesia in a dermatomal pattern. Motor involvement is less common but elicits a greater degree of concern (see nerve root charts.) An upper-extremity radiculopathy should prompt a careful evaluation of the long tracts (i.e., vibration, temperature, sharp vs. dull, Babinski, Hoffman, balance, and proprioception), which, if abnormal, suggests concomitant myelopathy. In older patients, spondylotic changes may compress both the nerve root and spinal cord, producing cervical spondylotic myelopathy. In younger patients, with both nerve root and spinal cord signs, a central disk lesion or neoplastic process may be found.

Although the region of the intervertebral foramen is a common site of entrapment, other sites exist. For example, the medial branch of the dorsal rami may be entrapped as it passes by the joint capsule, of the apophyseal joint. Additionally, cutaneous nerve branches may be trapped as

they pass through muscle and fascia en route—for example, the dorsal rami of C2 (the greater occipital nerve) can be entrapped as it pierces suboccipital muscles.

Differentiating radiculopathy from peripheral nerve entrapment is usually straightforward. Sensory disturbances are found within a dermatomal, rather than peripheral, nerve distribution. Patients with radiculopathy usually experience neck pain that may be accompanied by pain in the medial scapular and precordial areas. Valsalva exacerbates a root lesion because the root traverses the subarachnoid space. Cervical compression tests reproduce the radicular pattern of pain. Weakness is found in muscles innervated by the particular root, which may encompass muscles innervated by several different peripheral nerves. Electromyographic evaluation will be normal initially, but abnormal potentials may be seen in paraspinal muscles at two weeks. Limb muscles do not demonstrate EMG abnormalities until several weeks later and are confined to muscles of that particular root. Peripheral nerve conduction velocities are normal, but F-wave, H-reflex, and somatosensory evoked potentials may be helpful in identifying the specific root and degree of involvement.

Axillary nerve entrapment:

Axillary nerve entrapment occurs infrequently, but may complicate humeral fracture or reduction following dislocation. Weakness of the deltoid and teres minor will affect the patient's strength in abduction beyond 30 degrees (initially performed by the supraspinatus) and external rotation. Atrophy of the deltoid produces a flattening of the shoulder. Sensory changes are confined to a small area on the lateral aspect of the shoulder. The usual site of entrapment is within the quadrangular space, which is a narrow arcade bordered by the teres major superiorly, teres minor inferiorly, surgical neck of the humerus laterally, and long head of the triceps medially.

Suprascapular nerve entrapment:

The usual site of entrapment of the suprascapular nerve is in the suprascapular notch, sometimes called the spinoglenoid notch. Although an uncommon neuropathy, scapular trauma, weight on the shoulder, acromioclavicular joint separation, or humeral fracture may predispose the nerve to compression, traction, or friction. Cutaneous skin changes do not occur, but articular fibers may mediate nociceptive information from the shoulder or acromioclavicular joint regions. As a result, patients may complain of a deep pain from the posterolateral aspect of the shoulder. The supraspinatus and infraspinatus will be weak, and eventually atrophy becomes apparent. External rotation of the shoulder and the initiation of abduction will be impaired.

Figure 3 generates a list of conditions that predominantly involve the lateral antebrachium (the outside of the forearm).

Median nerve - anterior interosseous nerve entrapment:

The anterior interosseous nerve originates in the proximal forearm from the main trunk of the median nerve. It provides motor input to the pronator quadratus, radial half of the flexor digitorum profundus, and flexor pollicis longus. Although commonly regarded as a pure motor nerve, it does transmit articular afferents and efferents from the spindles of the muscles it innervates. The most frequent clinical manifestation is weakness in flexion involving the distal interphalangeal (DIP) joints of the thumb and index finger. This weakness is made apparent during forced pinch-weakness of flexion at the DIP joints of the thumb and index inhibits the patient's ability to approximate the tip of the index finger to the tip of the thumb under pressure without their flattening. Patients may complain of wrist and proximal forearm pain owing to articular fibers that mediate the nociceptive input. Nerve compression may result from fibrous bands, anomalous vessels, or muscles. Aggressive forearm exercise may precipitate it, or it may occur in association with acute brachial neuritis.¹⁵

Carpal tunnel syndrome:

The carpal tunnel is a fibro-osseous canal between the anterior annular ligament and the carpal bones, it transmits the median nerve and tendons of the flexor digitorum superficialis and profundus and flexor pollicis longus. Swelling of the tendon sheaths following repetitive flexion and extension of the wrist increases pressure within the canal. Instead of compensating by expansion, the pressure is absorbed internally by the contained structures (i.e., the median nerve and tendons). As tissue fluid pressure rises, the vasoneurovascular bundle becomes occluded, leading to nerve ischemia or even frank compression of the nerve. Nocturnal radial digital paresthesia relieved by movement of the hand is seen early in the disorder (i.e., flick sign). Conservative management consisting of activity modification and wrist splints can be very gratifying when employed early. When the condition is allowed to continue, digital paresthesia may occur in temporal relation to activity or position and may be associated with pain in the wrist and forearm and, infrequently, the shoulder. Significant motor fiber involvement is uncommon, but results in weakness of the abductor pollicis brevis, opponens pollicis, superficial head of the flexor pollicis brevis, and the first two lumbricals. Of these, the first two muscles listed are the easiest to test manually. The abductor pollicis brevis can be tested when the thumb is abducted perpendicular to the plane of the palm, and the opponens pollicis is tested by having the patient approximate the thumb and fifth digit. Many other risk factors for the development of carpal tunnel syndrome have been identified in the literature, and interested readers should consult a neurological text.

Median nerve entrapment in the forearm:

Carpal tunnel syndrome is recognized as the most common peripheral entrapment neuropathy in the general population. Among athletes, however, forearm entrapment of the median nerve is more common.¹⁵ Repetitive forearm flexion and extension or pronation and supination movements pose a risk for compression of the nerve beneath the lacertus fibrosis. The nerve may also be entrapped as it courses between the two heads of the pronator teres (pronator syndrome) or under the fibrous arch of the flexor digitorum superficialis. Repetitive, rapid, or forced supination to pronation implicates the prior, and finger-gripping the latter. The anomalous presence of a supracondylar spur is a somewhat more proximal site of median nerve entrapment. Although rarely present (about one percent of the population), the spur is usually found bilaterally. The ligament of Struther's is an anomalous fibrous band that extends from the supracondylar spur to the medial epicondyle. It is another potential site where the median nerve may be entrapped proximally. Patients with bilateral median nerve symptoms who do not participate in vigorous activity should have x-rays of the humerus to rule out this surgically correctable lesion if the electrophysiological data suggest proximal compromise.

The branch of the median nerve that provides motor input to the pronator teres originates proximal to the nerve's entry into this muscle. Consequently, in pronator syndrome, the pronator teres is not affected and forearm pronation should be preserved. It contrasts with carpal tunnel syndrome in that other median innervated forearm muscles may be weak. The first of these is the flexor carpi radialis. In addition, carpal tunnel syndrome alters sensation in the radial three and a half digits with sparing of the palm. The base of the palm and the thenar and hypothenar regions are preserved in carpal tunnel syndrome because the palmar cutaneous branch of the median nerve originates in the distal forearm proximal to the wrist and carpal tunnel. As a result, pronator syndrome and other proximal forearm lesions of the median nerve produce symptoms that involve the digits and the base of the palm. ~:~

High median nerve entrapment:

High median nerve entrapment neuropathies, those that occur in the upper arm and axilla, result in weakness and sensory loss of all median innervated muscles and cutaneous distributions. Weakness of forearm pronation locates the lesion proximal to the elbow. The pronator teres is the

first muscle innervated by the median nerve and receives its innervation from a branch arising before the main part of the nerve courses between its two heads. In my experience, a patient was seen with bilateral high median nerve lesions after working on his car. He had been holding a very heavy part with both arms resting over the frame of the engine compartment, which served as a fulcrum and site of focal nerve compression.

Musculocutaneous nerve entrapment:

The musculocutaneous nerve arises from the lateral cord of the brachial plexus and provides motor input to the biceps, brachialis, and coracobrachialis. Nerve entrapment anterior to the humerus will affect the strength of forearm flexion from a supinated position. Pure forearm supination may also be affected, but some power remains because the supinator is innervated by the radial nerve. The biceps reflex may also be decreased or absent. As the musculocutaneous nerve approaches the elbow, it traverses the fascia to a more superficial position and bifurcates into an anterior and posterior lateral antebrachial cutaneous nerve. This carries sensation from the skin over the radial half of the forearm from the elbow to the wrist. Unlike a C6 radiculopathy, symptoms do not involve the digits. Isolated lesions of the lateral antebrachial cutaneous nerve (where strength is preserved) are usually the result of compression beneath the lateral free margin of the bicipital aponeurosis (Lacertus fibrosis). Full elbow extension with wrist pronation may aggravate, and tapping the nerve at the elbow may elicit a Tinel's sign. Baseball pitchers, racquet players, and backhand stroke swimmers are at risk because they perform rapid, repetitive forearm supination to pronation maneuvers with the elbow extended.¹⁵ Electrodiagnosis is again useful in establishing the diagnosis.

Figure 4 generates a list of conditions that predominantly involve the medial antebrachium (the inside of the forearm).

Ulnar nerve entrapment at the wrist:

As the ulnar nerve traverses the forearm en route to the wrist, a dorsal ulnar cutaneous branch arises. This cutaneous branch is responsible for sensation from the dorsal ulnar one and a half digits. Because of the dorsal ulnar cutaneous nerve's proximal origin (about 10 cm proximal to the wrist in the forearm), compressive neuropathies of the ulnar nerve at the wrist involve only the volar aspect of the ulnar digits. Complaints that involve both the dorsal and volar surfaces of the ulnar digits suggest compression proximal to the wrist. At the wrist, the ulnar nerve bifurcates into a sensory branch subserving skin over the volar surfaces of the ulnar one and a half digits and hypothenar region. The other branch, a motor branch, innervates ulnar intrinsics. It supplies muscles of the hypothenar eminence and then enters the Tunnel of Guyon, a fibro-osseous canal bordered by the aponeurosis of the flexor carpi ulnaris anteriorly, the flexor retinaculum posteriorly, and the pisiform and hook of the hamate. When the ulnar nerve exits this canal, it takes a slightly recurrent course through the arch of the palm to supply the dorsal and volar interossei, third and fourth lumbricals, deep head of the flexor pollicis brevis, and adductor pollicis.

Ulnar neuropathies occurring at the wrist are seldom idiopathic. Ganglion cysts, carpal subluxation/dislocation, or ulnar artery aneurysms are a few pathological etiologies. Using the base of the palm as a hammer (e.g., carpet layers) or sustained volar pressure (e.g., bicycle riding) are known "use-related" ulnar neuropathies.

Weakness of the third palmar interosseous muscle causes the fifth digit to maintain a position of slight abduction. This is known as Wartenburg's sign.

Cubital tunnel syndrome:

Ulnar neuropathies at the elbow are relatively common. The nerve's superficial position renders it

vulnerable to extrinsic compression (e.g., striking the "funny bone" on the edge of an object). Several other factors contribute to the frequency of ulnar nerve lesions at the elbow. Mechanically, elbow flexion stretches the ulnar nerve, producing a tensile or tractional load. Further, friction fibrosis may occur in the presence of posterior condylar groove osteophytes. Friction fibrosis may also result from hypermobility of the ulnar nerve. That is, with elbow flexion, the ulnar nerve moves medially out of the posterior condylar groove, rubbing repetitively over the medial epicondyle. Finally, elbow flexion tightens structures overlying the nerve (i.e., triangular arcuate ligament and flexor carpi ulnaris) and relaxes the medial ulnar collateral ligament.^{15,17} These events further narrow available space and compress the nerve.

Ulnar neuropathies at the elbow typically preserve the flexor carpi ulnaris and ulnar half of the flexor digitorum profundus. Fibers to these muscles either arise proximal to the usual site of compression or are topographically situated in a protected position within the nerve fascicle. Clawing of the hand may be apparent. The fourth and fifth digits are hyperextended at the metacarpophalangeal joints and flexed at the interphalangeal joint. Unopposed activity of the radially innervated extensor digitorum communis and an intact flexor digitorum profundus respectively account for these physical manifestations. Because the lesion is proximal to the origin of the dorsal ulnar cutaneous nerve, sensation from the dorsal and volar aspects of the ulnar one and a half digits is affected.^{15,17}

Figure 5 generates a list of conditions that predominantly involve the medial brachium and antebrachium (the inside of the arm and forearm).

Klumpke's paralysis:

The C8 and T1 nerve roots are susceptible to avulsion during hyperabduction loads on the upper extremity. Sensory disturbances extend along the medial aspect of the arm from the axilla to the digits. Clawing of the hand and ulnar intrinsic muscle wasting are pronounced. The concomitant presence of sympathetic signs (e.g., Homer's syndrome) indicate involvement of the stellate ganglion, and should elicit concern of an invasive lesion.

Figure 6 generates a list of conditions that predominantly involve the dorsum of the hand and forearm (the back of the hand and forearm).

High radial nerve lesion:

The radial nerve continues from the posterior trunk of the brachial plexus and receives contributions from the C5-T1 nerve roots. Its first branch arises in the axilla and provides cutaneous input from a small patch of skin on the posterior shoulder and motor to the long head of the triceps.¹⁵ As the radial nerve descends, it moves from a medial to lateral position by wrapping itself posteriorly around the humerus in the spiral groove. High radial nerve lesions produce weakness of elbow, wrist, and finger extension, forearm supination, and abduction of the thumb in the plane of the palm (abductor pollicis longus). Elbow extension will be significantly weaker when the lesion is at the axilla (e.g., crutch, park bench palsy) than when it is at the spiral groove (e.g., humeral fracture with callous formation) or deltoid insertion. Sensation from the dorsum of the forearm and hand proximal to the proximal interphalangeal joint will be impaired.

Radial nerve lesions at the elbow:

The radial nerve approaches the elbow after piercing the lateral intermuscular septum and passing between the brachioradialis and brachialis. It then bifurcates into motor and sensory branches. The sensory branch runs beneath the brachioradialis in the forearm to provide cutaneous input to the dorsum of the radial three and a half digits proximal to the proximal interphalangeal joints and hand. This is called the superficial radial nerve. While forearm

entrapment is possible, the usual site of compression is at the wrist. Tight bands or direct trauma to the nerve at the wrist may produce a neuropathy of the superficial radial nerve. Non-traumatic factors like poor fascial glide between the tendons of the extensor pollicus longus and brachioradialis may result in friction rub and subsequent neuropathy. ¹⁵

The motor branch of the radial nerve innervates forearm extensors and is called the posterior interosseous nerve. Proximal to the elbow, the main trunk of the radial nerve lies anterior to the lateral epicondyle. Consequently, in order to innervate extensors it has to traverse the interval from its initial volar position to a dorsal one. The supinator channel, or arcade of Frohse, is a short conduit for the posterior interosseous nerve. As the nerve enters this channel, the sharp proximal edge of the superficial head of the supinator may entrap the nerve. Another potential site of radial nerve entrapment is the disputed radial tunnel. This is a fibro-osseous canal located between the biceps, supinator, radial head, and extensor mass. Radial tunnel syndrome is sometimes said to masquerade as chronic tennis elbow.

SUMMARY:

Numerous conditions, notably nerve entrapment syndromes, account for symptoms in the upper extremities. Some are quite common and familiar, while others are remote. In this article, an algorithmic approach has been utilized to describe a broad variety of neurological and non-neurological conditions and to provide readers with an overview of each. The algorithm is intended to be used by the non-specialist who is interested in expanding his list of differential diagnoses for a patient's complaint, it is a reference tool, not a cookbook for diagnosis. Likewise, a planar diagram cannot provide a definitive diagnosis. Common sense and experience will do that.

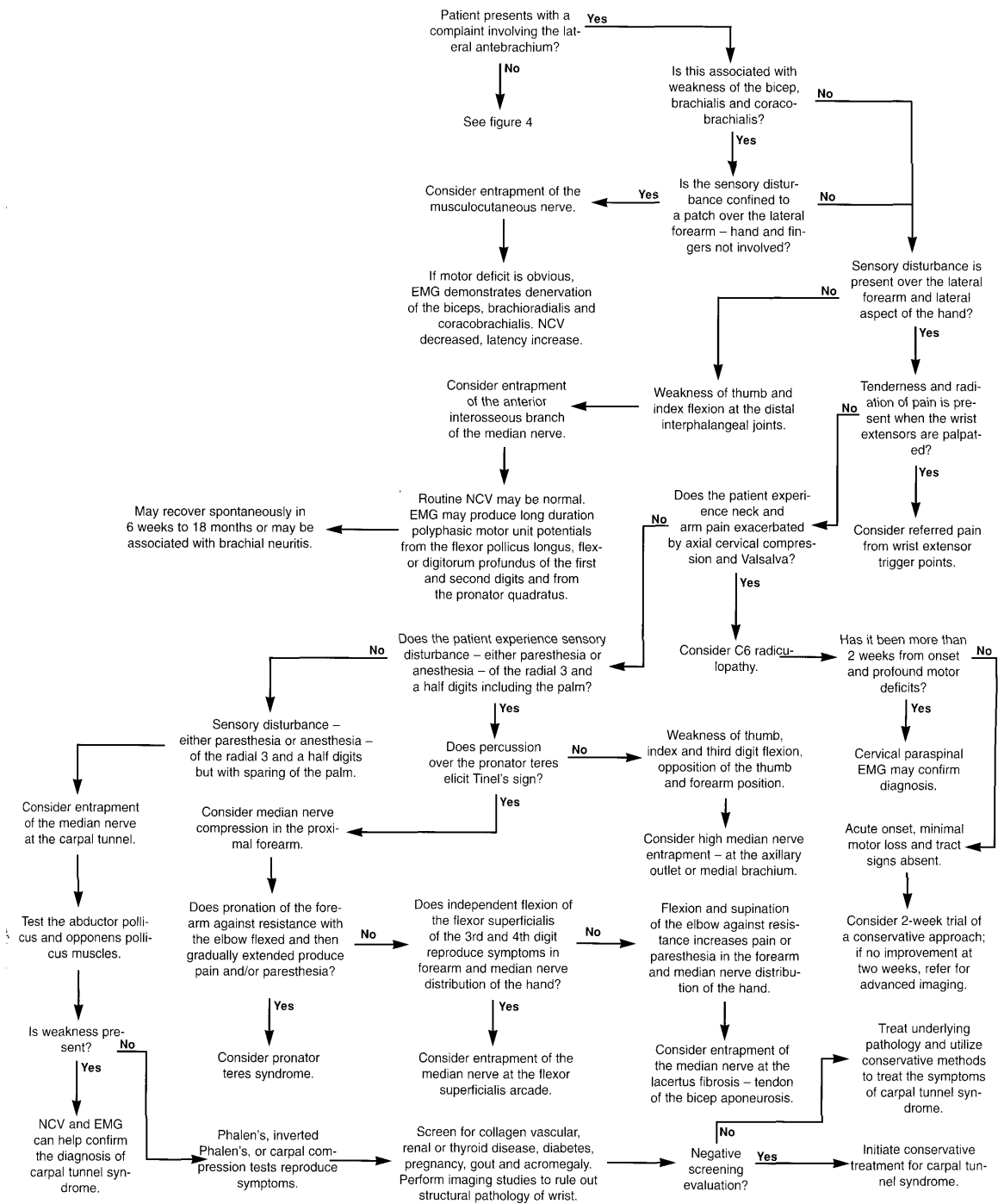
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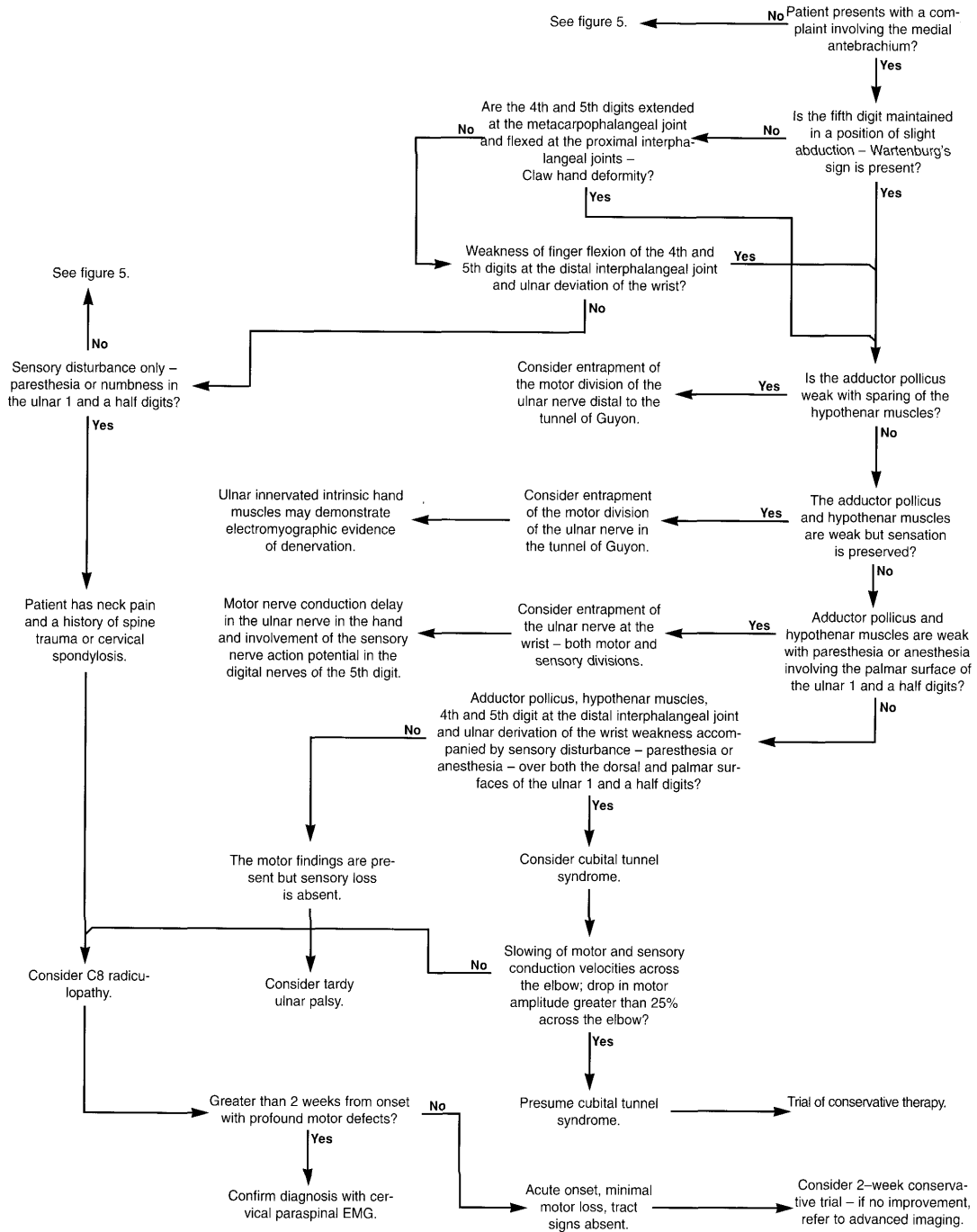
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Figures Will Follow...

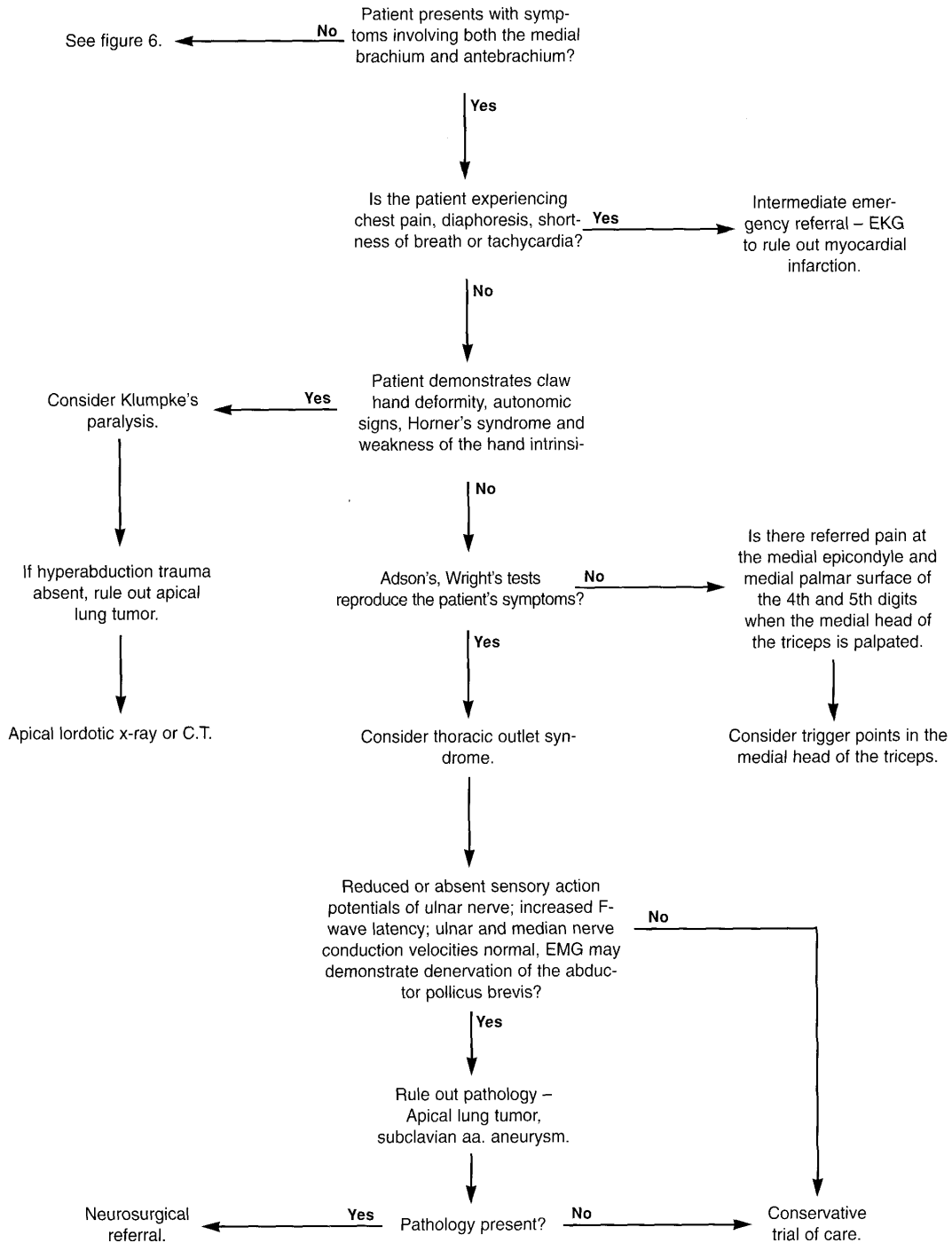
Lateral antebrachium complaint – figure 3



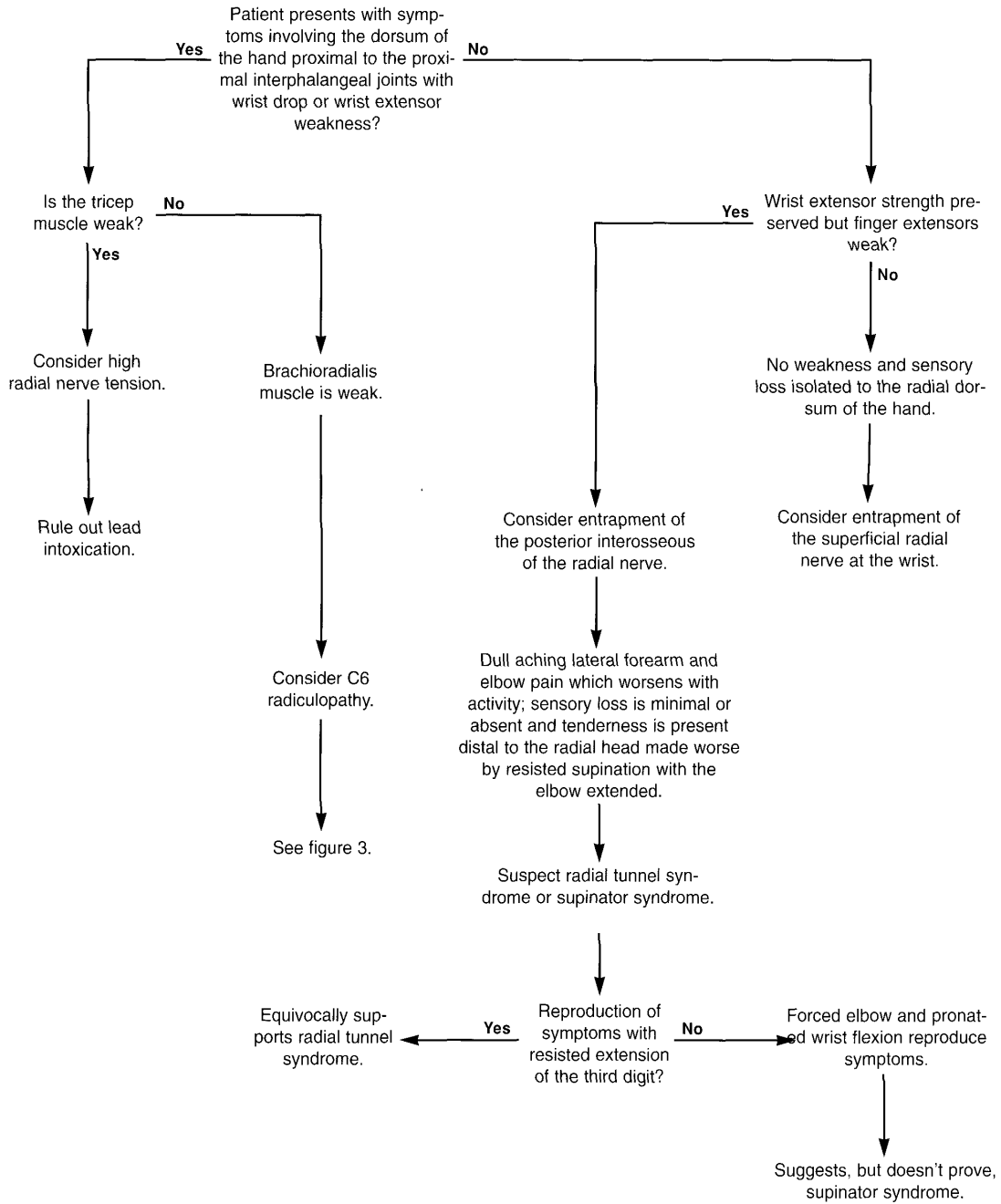
Medial antebrachium complaint – figure 4



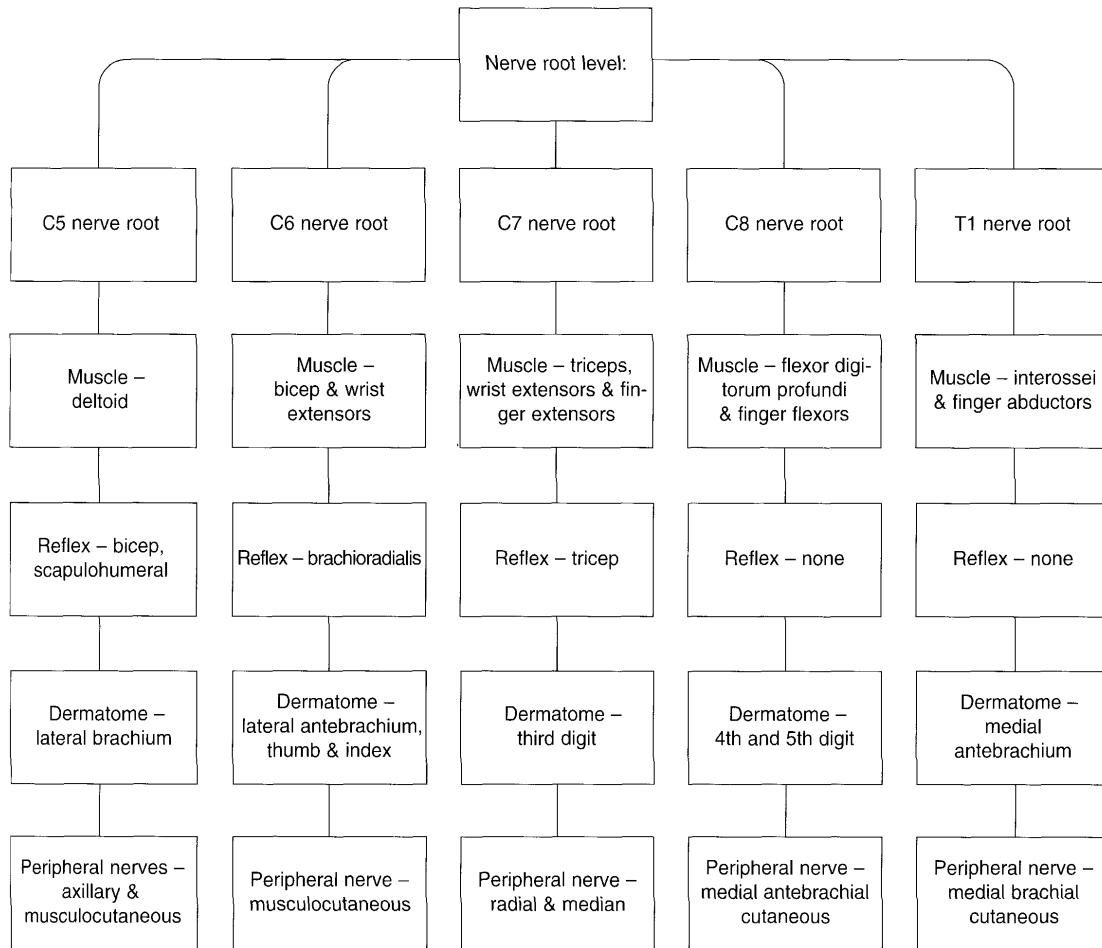
Medial brachium and antebrachium complaint – figure 5



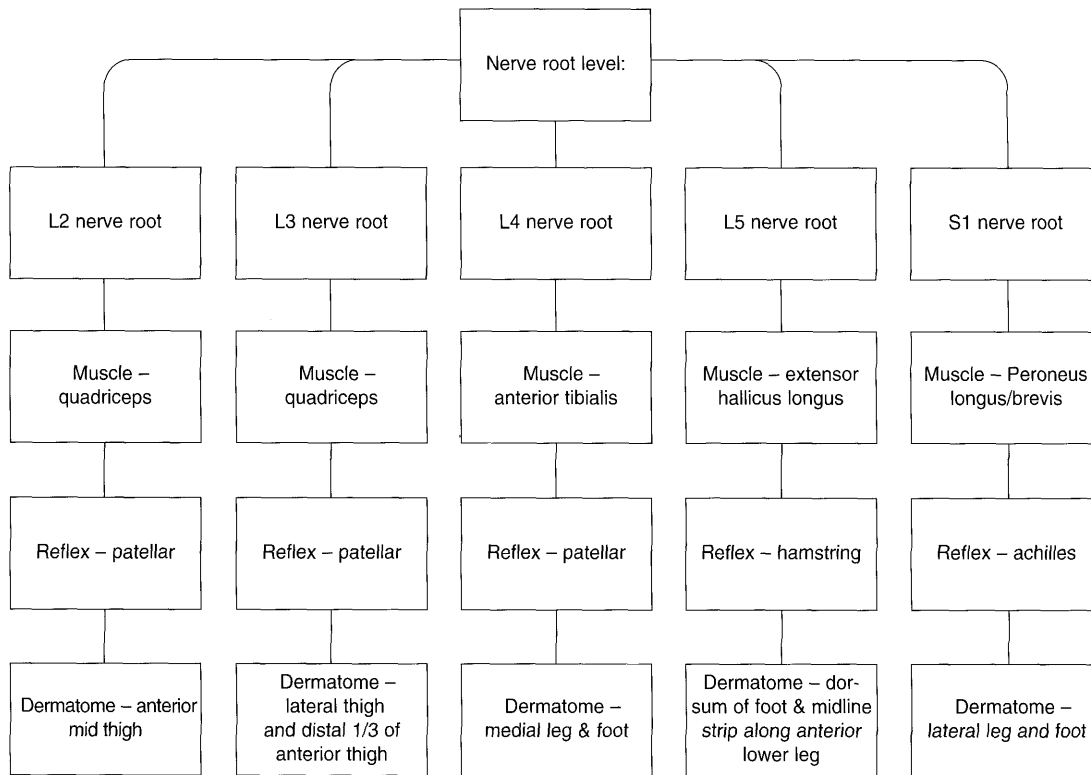
Dorsum of hand proximal to proximal interphalangeal joint complaint - figure 6



Upper Extremity Nerve Root Chart



Lower Extremity Nerve Root Chart



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