Review Article

Entrapment Neuropathies of the Upper and Lower Extremities: Utility of Electrodiagnostic Studies

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ABSTRACT

Entrapment neuropathies of the upper and lower extremities are commonly seen in Orthopedics consultations. In these evaluations, it is important to understand the usefulness of electrodiagnostic (EMG/NCS) studies for supporting these diagnoses. This is a review of the most common nerve entrapments of the upper and lower extremities and the critical EMG/NCS data. This summary identifies locations, signs and symptoms, nerve conduction study data, and electromyography data in effort to distinguish these focal neuropathies and expand understanding of EMG/NCS data and application.

INTRODUCTION

Signs and symptoms of upper and lower extremity neuropathies are a common reason for an Orthopedics referral. These may vary widely, including but not limited to numbness, tingling, sensory loss on examination, weakness, and/or pain. These symptoms may occur intermittently, consistently, chronically, or even persistently.

Electrodiagnostic studies (EMG/NCS) can be of help to identify specific nerve entrapments and precise locations. They are an extension of the physical examination and can help to support findings of neurologic and musculoskeletal examinations. EMG/NCS identify disorders affecting the peripheral nervous system and include localization to the anterior horn cell and below (nerve roots, plexus, peripheral nerves, primary motor and sensory neurons, neuromuscular junctions, and muscles). Evaluation of the sensory nerves, motor nerves, and analyzing motor unit morphology can aid in the development of a differential diagnosis and often helps confirm a single lesion. The severity can also be indicated by this testing. In this review, we will discuss the most common entrapment neuropathies of the upper and lower extremities and highlight the utility of EMG/NCS for each of the common entrapments.

UPPER EXTREMITY NERVE ENTRAPMENTS

Entrapment of the Median Nerve

Median neuropathy at the wrist (carpal tunnel syndrome): It is estimated that 90% of the upper extremity entrapment neuropathies are due to Carpal Tunnel Syndrome (CTS) [1]. The median nerve becomes entrapped in the anterior forearm at the wrist between the flexor retinaculum and carpal bones. Incidence of this nerve compression may be as high as five percent in the general population [2,3]. Symptoms of carpal tunnel syndrome can include but are not limited to: parasthesias, pain, numbness, tingling, and/or weakness. It usually involves the first three digits and the lateral half of the 4th digit. Classically, some may cite nighttime awakenings fueled by

parasthesias [4], along with then are wasting. It is important to remember that symptoms usually appear slowly and progress over months to years.

Sensory Nerve Action Potentials (SNAPs) most commonly reveal prolonged peak latencies. The conduction velocity may typically be reduced and the amplitude may be affected in moderate to severe cases. In more severe cases, one may record 'no response' from the median SNAP. If median SNAP and ulnar SNAP studies are normal, one must consider comparative studies of the ulnar and median nerves (ie. Lumbrical-interossei testing or transcarpal/palmar mixed sensory studies) (Table 1).

Table 1: Upper extremity nerve entrapments and summary of electrodiagnostics.

	Upper Extremity Nerve Entrapments				
	Median Nerve at Wrist	Median Nerve at the Elbow	Ulnar Nerve at the Wrist	Ulnar Nerve at the Elbow	Radial Nerve at the Spiral Groove
Clinical Symptoms	+Parasthesias, pain, numbness and/or weakness in first three digits and lateral 4th digit +Nighttime awakenings ±Thenar wasting	+Forearm pain and sensory loss to lateral palm and thenar eminence +Sensory changes in same distribution as CTS but includes thenar eminence	+Weakness of ulnar innervated interossei +Sensory loss or parasthesias or pain in medial half of 4th digit and 5th digit-palmar side +Dorsal sensation intact	+Sensory loss and parasthesias to digit 5 and the medial half of the 4th +Weakness of ulnar interossei ±Decreased fine motor skills ±Pain at elbow	+Weakness and pain over the proximal and lateral forearm ±Wrist drop +Normal strength at triceps
SNAPs	Median nerve +prolonged peak latency ± reduced CV ± decreased amplitude	Median nerve +reduced CV ± decreased amplitude	Ulnar nerve -prolonged peak latency ± reduced CV ± decreased amplitude DUC -normal	Ulnar nerve & DUC -prolonged peak latency ± reduced CV ± decreased amplitude	Radial nerve +prolonged peak latency ± reduced CV ± decreased amplitude
CMAPs	Median nerve at APB +Prolonged distal latency ± reduced CV ± decreased amplitude -No significant slowing across the elbow	Median nerve at APB +Normal at the wrist +Decreased CV or amplitude at the forearm	Ulnar Nerve at FDI and at Hypothenar Muscles +Prolonged distal latency ± reduced CV ± conduction block or CV<37m/s from wrist to palm at FDI ± decreased amplitude -No significant slowing across the elbow	Ulnar Nerve +CV across elbow <50m/s OR +Drop in CV ≥ 10m/s across elbow OR +Decreased CMAP amplitude from below elbow to above elbow of >20%	Radial nerve at EIP recorded in the proximal forearm, lateral epicondyle, spiral groove, and proximal to the spiral groove ±decreased amplitude ±decreased CV ±conduction block
Extra Studies	Lumbrical/Interossei Study +Stimulate at 10cm distance for median and ulnar nerves ≥0.5 microvolts OR Mixed palmar studies +Stimulate at 8cm distance for median and ulnar nerves		Lumbrical/Interossei Study +Stimulate at 10cm distance for median and ulnar nerves ≥0.5 microvolts		

	≥0.4 microvolts				
EMG Abnormalities (Neurogenic changes ± active denervation)	APB	APB Flexor carpi radialis ±Pronator teres depending on compression site	Ulnar innervated hand muscles affected +FDI +ADM -FDP 4&5 -Flexor carpi ulnaris	Ulnar hand muscles +FDI +ADM Forearm flexors +Flexor carpi ulnaris +FDP 4&5	Distal radial muscles +Brachioradialis +Extensor carpi radialis +EDC +EIP -Triceps

CTS: Carpal Tunnel Syndrome; CV: Conduction Velocity; DUC: Dorsal Ulnar Cutaneous Nerve; FDI: First Dorsal Interosseous; APB: Abductor Pollicis Brevis; ADM: Abductor Digiti Minimi; FDP: Flexor Digitorum Profundus; EIP: Extensor Indicis Proprius; EDC: Extensor Digitorum Communis

Compound Motor Action Potentials (CMAPs) on nerve conduction studies are recorded from the abductor pollicis brevis muscle. Again, delay of the distal motor latency is usually affected first with conduction velocity following closely behind. Needle Electromyography (EMG) adds additional information with regard to active denervation or chronic muscle changes including axonal loss and reorganization in the abductor pollicis brevis. Active denervation may reveal increased insertional activity with presence of positive sharp waves and/or fibrillation and fasciculation potentials. Chronic neurogenic changes may reveal increased duration and amplitude and decreased recruitment. Needle EMG may also help in severe cases of CTS. For example, if the median sensory response is absent and the median motor response is absent, the needle EMG is very important. If there are no voluntary motor units identified, then surgery may not help the patient. However, if there is even one motor unit present, then axonal continuity is still preserved and surgical decompression of the nerve would be of benefit.

Median neuropathy at the elbow (pronator teres syndrome): Located in the proximal forearm, attaching from the medial humeral supracondylar ridge to the ulnar head, the median nerve can become entrapped where it passes through the bulk of the pronator teres muscle, at the proximal arch of the flexor digitorum superficialis [5], or under the bicipital aponeurosis. This is a more uncommon upper extremity nerve entrapment.

Most commonly, it results in forearm pain and sensory loss to the lateral palm and thenar eminence. Given it is part of the median nerve; some of the symptoms can be similar to median neuropathy at the wrist with parasthesias and numbness to the first three digits and half of the fourth digit. However, a distinguishing feature is sensory loss/parasthesias in the distribution of the palmar cutaneous branch of the median nerve, i.e. The thenar eminence, as this branch site is proximal to the carpal tunnel. Patients do not commonly report nocturnal parasthesias often described in carpal tunnel syndrome.

Use of electrodiagnostic studies in the diagnosis of pronator teres syndrome is controversial. Some data states that EMG/NCS are mostly normal with rates of abnormal electrodiagnostic studies at only 7-31% for those who undergo surgical intervention [6]. Another study reported 13/13 cases had abnormal EMG/NCS [7]. One study reviewed EMG/NCS findings in 83 limbs of 72 patients to further delineate what might be helpful sources of electrodiagnostic testing for this diagnosis [8]. Sixty-five percent of patients had abnormal median sensory studies of conduction velocity or amplitude, while only 30% of cases revealed decreased median nerve conduction velocities or amplitude on CMAPs at the forearm with the wrist preserved. Needle EMG is very important in distinguishing this from median neuropathy at the wrist. Involvement of a proximal median innervated muscle, such as the flexor carpi radialis would help to identify the lesion proximally. It is important to know that in certain cases, the pronator teres may be spared where the flexor carpi radialis is involved.

Entrapment of the Ulnar Nerve

Ulnar neuropathy at the wrist (Guyon's canal).Even less common is the ulnar nerve entrapment at Guyon's canal located in the proximal hand. This canal, also known as the ulnar canal or tunnel, is created by the superficial palmar carpal ligament superficially and the flexor retinaculum and hypothenar muscles below with carpal bones forming the medial and

lateral borders, the pisiform and the hamate, respectively. Within Guyon's canal, the ulnar nerve will bifurcate into a superficial and deep branch.

Entrapment of the ulnar nerve at this site can result in weakness of the interossei but spares the flexors of the wrist. One may have sensory loss, parasthesias or pain in the medial half of the fourth digit and the fifth digit on the palmar side, and it may result in atrophy or fasciculations of the intrinsic hand muscles. The Dorsal Ulnar Cutaneous sensory branch (DUC) will remain unaffected, with sensation to the dorsal surface of the fourth digit and fifth digits remaining intact [9].

EMG/NCS can be used to help localize ulnar neuropathy at the wrist. One should evaluate for segmental or focal slowing across the wrist with denervation of ulnar innervated hand muscles. The dorsal ulnar cutaneous sensory study is very useful for localization. If amplitude is less than eight microvolts or if amplitude is decreased by greater than fifty percent when comparing sides, then the DUC is abnormal; the DUC SNAP is typically normal in ulnar neuropathy at the wrist. The compound motor action potentials of the ulnar motor nerve should be tested over the First Dorsal Interosseous (FDI) as well as the hypothenar muscles. Sometimes, the motor study to the FDI is abnormal but the study to the Abductor Digiti Minimi (ADM) is normal. The lumbrical interosseous motor comparison study is often helpful, comparing the median and ulnar distal latencies.

Overall, findings should be as follows to indicate an ulnar neuropathy at the wrist: reduced or absent sensory nerve action potential, a normal dorsal ulnar cutaneous sensory study, reduced compound motor action potential amplitude at abductor digiti minimi and/or the first dorsal interosseous and prolongation of the distal latency with no significant slowing at or across the elbow, and a prolonged latency of ulnar compared to median when testing the lumbrical-interossei motor study. EMG may be tested in ulnar innervated muscles including abductor digiti minimi, first dorsal interosseous, flexor digitorum profundus (digits 4 and 5) and flexor carpi ulnaris, with abnormalities expected in the first dorsal interosseous and abductor digiti minimi.

Ulnar neuropathy at the elbow (cubital tunnel syndrome).The more common of the ulnar neuropathies and the second most common neuropathy of the upper extremity [10,11], second to median neuropathy at the wrist, is ulnar nerve entrapment at the elbow, known as cubital tunnel syndrome. Sites of compression at the elbow are multiple, but the most common is the cubital tunnel, which is located posterior to the medial epicondyle and is covered by the Osborne ligament [12]. Symptoms are usually more progressed by the time patients present as compared to carpal tunnel syndrome [13].

Symptoms can include sensory loss and parasthesias to digit five and the medial half of the fourth digit, worse with elbow flexion. One may also have weakness of the ulnar-innervated interossei resulting in decreased grip strength and increased clumsiness with fine motor skills affected. Pain at the elbow may also occur with weakness at finger and wrist flexion. One can have medial elbow aching pain and loss of dexterity for lifting and gripping [10,11].

Classically, electrodiagnostic studies would demonstrate an abnormal ulnar SNAP, abnormal DUC SNAP (if tested), decreased conduction velocity across the elbow by greater than 10 m/sec in flexed elbow position, and/or the presence of conduction block across the elbow segment (a reduction of >20% of the motor amplitude). If needed, segmental inching across the elbow segment may help to identify the location of the focal slowing more precisely. Needle EMG may reveal active or chronic denervation in the ulnar innervated hand muscles as well as the forearm. In particular, needle EMG changes in the Flexor Carpi Ulnaris (FCU) and superficial head of the Flexor Digitorum Profundus (FDP) digits four and five localize the lesion to the elbow [14]. It is important to note that the FCU may be spared, whereas the FDP is typically involved in ulnar nerve entrapment at the elbow.

Entrapment of the Radial Nerve

Radial neuropathy at the spiral groove (Saturday night palsy).The radial nerve runs longitudinally along the humerus and wraps around the shaft from the medial side. Prolonged pressure at this site, including but not limited to draping one's arm over the bed or chair, having someone with their head lying on one's extended arm, fracture to the humerus, or excessive muscle contraction, can result in symptoms of weak wrist extensors, finger extensors, brachioradialis, thumb abduction, and the abductor pollicis longus. Symptoms include weakness and pain over the proximal and lateral forearm. One may have difficulty extending the wrist (wrist drop), fingers, and thumb. Triceps strength should remain normal.

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EMG/NCS is used to help diagnose radial nerve entrapment. However, radial motor or sensory conduction block or reduced sensory nerve action potentials are reportedly of uncertain yield. EMG is required to confirm the diagnosis [12]. Though SNAPs can be helpful for the radial nerve, one will need to evaluate CMAPs if concerned for this site of entrapment. The SNAP and CMAP should be abnormal if the radial nerve is entrapped at the spiral groove, while posterior interosseous nerve entrapment spares the radial SNAP [15]. The radial SNAP recorded at the anatomic snuff box may be normal or reveal prolonged distal latency and/or reduced conduction velocity. In traumatic radial neuropathies, there is more commonly axonal loss resulting in decreased amplitudes. Radial SNAP amplitudes can also be compared between sides looking for a difference of greater than 50% [16]. For radial CMAP, the recording electrode is placed on the muscle belly of the extensor indicis proprius and the stimulation sites may include: four to eight centimeters proximal to the middle of the forearm, at the lateral epicondyle, around the spiral groove, and above the spiral groove in an effort to find and localize conduction block. CMAP results may include decreased amplitude or reduced conduction velocity at or above the spiral groove. EMG should reveal sparing of the triceps but abnormalities in the distal radial musculature if entrapment occurs at the spiral groove, including the extensor indicis proprius, the extensor digitorum communis, the extensor carpi radialis, and the brachioradialis. The triceps and anconeus should be spared.

Lower Extremity Nerve Entrapments

Entrapment of the femoral nerve: The femoral nerve originates from L2-L4 nerve roots, beginning its course in the pelvis with close association to the iliopsoas muscle. Primarily, the femoral nerve innervates the iliopsoas and the quadriceps muscles. It travels beneath the inguinal ligament to enter the thigh, dividing then to anterior and posterior divisions. Compression of the femoral nerve within the pelvis or distal to the inguinal ligament can be determined by involvement of the iliopsoas muscle on electromyography. Common causes of entrapment may include: pelvic mass, fracture, retroperitoneal hematoma, and trauma [17] (Table 2). Signs and symptoms of entrapment include weakness of hip flexion and/or knee extension, depending on site of entrapment. Sensory changes can include loss in the anterior thigh and medial leg. Weakness in these muscle groups may affect walking. Thigh adduction should be preserved as the obturator nerve supplies the key muscles of this group. One may also have reduced patellar reflex and saphenous nerve involvement resulting in numbness and/or pain of the medial leg.

Electrodiagnostic studies should include nerve conduction studies of the tibial, peroneal, and sural nerves and may require saphenous or femoral nerves as well. Saphenous NCSs, if performed, should be performed bilaterally for comparison purposes. One can stimulate the saphenous nerve with G1 on the anterior medial malleolus and stimulate 10cm proximal to G1 between the tibia and gastrocnemius. Results should be compared to the asymptomatic limb as these can be technically challenging to obtain. Amplitude should usually be greater than 3.5 mV, with a reduction of greater than 40% being abnormal [17]. Femoral motor studies typically do not help as the study can be technically difficult and thus most electromyographers rely upon the needle examination to help localize the lesion. Electromyography should include testing of quadriceps, iliopsoas, an adductor (obturator nerve), paraspinals and distal leg muscles to help rule out radiculopathy, polyneuropathy, or plexopathy. Abnormalities should be seen in the quadriceps and may or may not be at the iliopsoas depending on the site of entrapment.

Entrapment of the common peroneal nerve and its branches (deep and superficial): The common peroneal nerve is the most common site of nerve entrapment in the lower extremity. It is most often affected as it travels around the fibular head just below the lateral knee. It is often a compression injury but compression can also occur as it passes between the peroneus longus muscle and the fibula prior to its division into the superficial and deep peroneal nerves. More proximally, the nerve can be injured as it divides from the sciatic nerve, particularly in the case of femur fractures. The common peroneal nerve innervates the short head of the biceps femoris as it divides from the sciatic nerve. The deep peroneal nerve goes on to innervate tibialis anterior, extensor digitorum longus, extensor hallucis longus, and extensor digitorum brevis. The deep peroneal nerve also supplies sensation to the web space of digits one and two. The superficial peroneal nerve is a branch of the common peroneal nerve which passes through the peroneus longus and brevis muscles; it then divides into

Table 2: Lower extremity nerve entrapments and summary of electrodiagnostics.

	Upper Extremity Nerve Entrapments				
	Femoral Nerve (within pelvis or at inguinal ligament)	Sciatic Nerve	Common Peroneal Nerve	Deep Peroneal Nerve	Superficial Peroneal Nerve
Clinical Symptoms	+Weakness of hip flexion (if in pelvis) +Weakness of knee extension +Difficulty walking -Thigh adduction should be preserved	+Foot drop +Radiating pain down the posterior thigh ±Decreased ankle jerk ±Weak knee flexion ±Weak dorsi- & plantarflexion ±Weak ankle inversion ±Sensory loss foot/lateral shin	+Sensory loss and/or pain involving the lateral calf and dorsal surface of the foot +Weakness of ankle dorsiflexion +Weakness of ankle eversion	+Sensory loss of the webspace between digits one and two of the foot +Weakness of ankle dorsiflexion ±Some level of foot eversion weakness is possible	+Sensory loss and/or pain involving the lateral calf and dorsal surface of the foot +Weakness of ankle eversion -Weakness of ankle dorsiflexion
SNAPs	Saphenous nerve, distal or proximal stimulation sites +prolonged peak latency ± reduced CV ± decreased amplitude	Sural Nerve +Decreased amplitude ±prolonged peak latency ± reduced CV Superficial Peroneal Nerve +Decreased amplitude ±prolonged peak latency ± reduced CV	Sural nerve -normal Superficial peroneal nerve ±reduced amplitude ±absent	Sural nerve -normal Superficial peroneal nerve ±reduced amplitude ±absent	Sural nerve -normal Superficial peroneal nerve ±reduced amplitude ±absent
CMAPs	Femoral nerve at rectus femoris +Prolonged distal latency +Decreased amplitude (Must compare to asymptomatic side; only one stimulation site, therefore, no CV)	Peroneal nerve at the EDB +Prolonged distal latency +Decreased amplitude +Reduced CV Tibial nerve at the AH ±abnormalities in latency, CV, and amplitude	Peroneal nerve at the EDB +Decreased amplitude ±Reduced CV ±Prolonged latency ±Drop in CV at more proximal stimulation sites Tibial nerve at AH -Normal	Peroneal nerve at the EDB +Decreased amplitude ±Reduced CV ±Prolonged latency ±Drop in CV at more proximal stimulation sites Tibial nerve at AH -Normal	Peroneal nerve at the EDB -Normal Tibial nerve at AH -Normal
EMG Abnormalities (Neurogenic changes ± active denervation)	Quadriceps ±Iliopsoas -Thigh adductors	EDB Tibialis anterior Tibialis posterior	Tibialis anterior EDL EDB	Tibialis anterior EDL EDB	Peroneus longus Peroneus brevis -TA

	-Paraspinals	Gastrocnemius ±Short/Long head of biceps -Vastus medialis -Paraspinals -Gluteus med -Gluteus max -TFL	EHL EHB Peroneus longus Peroneus brevis *Will spare the short head of biceps if entrapment is at the fibular neck	EHL EHB -Peroneus longus -Peroneus brevis	-EDL -EDB -EHL -EHB

CV: Conduction Velocity; EDB: Extensor Digitorum Brevis; AH: Adductor Hallucis; TFL: Tensor Fascia Lata; Gluteus med: Gluteus Medius; Gluteus max: Gluteus Maximus; EDL: Extensor Digitorum Longus; EHL: Extensor Hallucis Longus; EHB: Extensor Hallucis Brevis

sensory branches providing sensation to the distal anterolateral lower leg and dorsum of the foot. The superficial peroneal nerve can be entrapped near its branch site at the fibular head or at the ankle [18]. Common peroneal nerve entrapments result in lower lateral limb and foot pain or sensory loss as well as foot drop with weakness of ankle dorsiflexion and foot eversion as well as toe extension. The deep peroneal nerve may result in loss of sensation just in the webspace between the first and second digits of the foot with weakness of ankle dorsiflexion and toe extension but less commonly ankle eversion. The superficial peroneal nerve, however, results in sensory changes to the lateral calf and dorsal foot with weakness mostly in ankle eversion due to the motor supply to the peroneal longus and peroneus brevis [19].

SNAPs should be obtained of the sural and superficial peroneal nerve. They may or may not be abnormal depending on the site of compression but most often the sural SNAP should be normal with the superficial peroneal SNAP reduced in amplitude or absent altogether. Electrodiagnostically, both the common and deep peroneal nerve entrapments may results in reduced amplitudes of the peroneal CMAPs recording from the Extensor Digitorum Brevis (EDB) at the ankle, fibular neck, and popliteal fossa. In particular, it is important to recognize that focal atrophy of the EDB may result in poor CMAP response even if the nerve is healthy. Peroneal CMAPs are often also recorded from the tibialis anterior to differentiate focal EDB atrophy resulting in poor responses or nerve injury resulting in the same. Conduction velocity may also be slowed across the fibular head at the site of compression. Peroneal CMAPs recorded from the tibialis anterior at the fibular neck and popliteal fossa may show decreased amplitude or drop in amplitude across the fibular head or reduced conduction velocity [20]. The tibial nerve CMAPs should also be tested and will be normal in any peroneal neuropathy. Needle EMG is the most telling portion of electrodiagnostic testing for differentiating common, deep, and superficial peroneal neuropathies. Entrapment of the common peroneal nerve may result in neurogenic needle findings of the tibialis anterior, extensor digitorum longus, extensor hallucis longus, EDB, extensor hallucis brevis, peroneus longus, and peroneus brevis. The deep peroneal branch, however, will involve all the above but spare the peroneus longus and brevis; both of these will be affected in isolation in a superficial peroneal neuropathy.

Entrapment of the Sciatic Nerve

Sciatic nerve entrapment is the second most common mononeuropathy seen in the lower extremity. The longest and widest nerve in the body, the sciatic nerve divides to form the peroneal nerve and the tibial nerve distally, about six centimeters above the popliteal fossa. It exits the pelvis near the sciatic notch through the greater sciatic foramen. Often, it travels beneath the piriformis muscle and then travels between the greater trochanter of the femur and ischial tuberosity of the pelvis. Etiologies of sciatic nerve entrapment include but are not limited to: hip trauma, hip surgery, sacroiliitis, tumor compression, gynecologic causes, etc. Sites of entrapment include the hip given its proximity to the iliofemoral joint, gluteal site near the sciatic notch, and thigh including those caused by positioning/pressure to the area of the course of the nerve. Patients often present with foot drop and may experience radiating pain down their posterior thigh. It often

mimics a common peroneal neuropathy at the fibular head. One may also see decreased ankle jerk, weakness in knee flexion, ankle plantarflexion, ankle inversion, ankle dorsiflexion, toe extension/flexion, and sensory loss in the foot and lateral shin [21].

EMG/NCS can help to identify the compression site and severity. SNAPs may show reduced superficial peroneal and sural amplitudes. Peroneal CMAP amplitudes will be reduced but tibial CMAPs can be normal. In fact, one study showed that peroneal CMAPs were abnormal in 80% of adults while tibial CMAPs were only abnormal in 52% of adults (n=100) [22]. Electromyography may include extensor digitorum brevis, tibialis anterior, tibialis posterior, and gastrocnemius, short/long head of biceps femoris. One must also focus on differential when needling and will need to try to eliminate or identify other lesions that could lead to similar findings. One may want to test vastus medialis (femoral nerve), paraspinal muscles (lumbosacral radiculopathies), gluteus medius and maximus to exclude L5 or S1 radiculopathy, respectively. It is important to remember that if the lesion is chronic, the hamstrings may have improved innervation overtime while more distally located muscles may still be more affected.

Summary of Sciatic Nerve Entrapment Mimics

One must consider a wide differential when evaluating foot drop in the clinic. Sciatic neuropathy, common peroneal neuropathy, lumbosacral plexopathy, L5 radiculopathy can all be associated with foot drop. Though examination findings regarding distribution of weakness may help to narrow the differential, understanding EMG/NCS findings can be an ideal way to tease out the diagnosis clearly. Sciatic neuropathy will have reduced or absent ankle jerk with reduced peroneal CMAP amplitude and may or may not show reduced tibial CMAPs. Sural SNAPs may or may not be affected but superficial peroneal SNAP will be reduced. A common peroneal neuropathy will have a normal ankle jerk with reduced peroneal CMAPs and superficial peroneal SNAP but normal tibial CMAP and sural SNAP. A lumbosacral plexopathy will show patchy changes throughout various muscles on EMG and can result in reduced CMAPs and SNAPs of the lower leg. An L5 radiculopathy should reveal reduced peroneal CMAP but normal tibial CMAP, sural SNAP, and superficial peroneal SNAP.

CONCLUSION

These are the most common entrapment neuropathies of the upper and lower extremities with a focus on utility of EMG/NCS in diagnosis. This summarizes the most often seen electrodiagnostic findings for the multiple nerve compressions that can be found within the arm and leg and those that are most often referred for surgical intervention.

REFERENCES

1. Mondelli M, Gianni F, Giacchi M. (2002). Carpal tunnel syndrome incidence in a general population. Neurology. 58: 289-294.
2. Atroshi I, Gummesson C, Johnsson R, Ornstein E, Ranstam J, et al. (1999). Prevalence of carpal tunnel syndrome in a general population. JAMA. 281:153-158.
3. Centers for Disease Control and Prevention. (2011). Morbidity and Mortality Weekly Report. 60: 1679.
4. Ibrahim I, Khan WS, Goddard N, Smitham P. (2012). Carpal tunnel syndrome: a review of the recent literature. Open Orthop J. 6: 69-76.
5. Rodner CM, Tinsley BA, O'Malley MP. (2013). Pronator syndrome and anterior interosseous nerve syndrome. J Am Acad Orthop Surg. 21: 268-275.
6. Olehnik WK, Manske PR, Szerzinski J. (1994). Median nerve compression in the proximal forearm. J Hand Surg Am. 19: 121-126.
7. Lee AK, Khorsandi M, Nurbhai N, Dang J, Fitzmaurice M, et al. (2012). Endoscopically assisted decompression for pronator syndrome. J Hand Surg Am. 37:1173-1179.
8. Bridgeman C, Naidu S, Kothari MJ. (2007). Clinical and electrophysiological presentation of pronator syndrome. Electromyogr Clin Neurophysiol. 47: 89-92.
9. Kothari, MJ. (1999). Ulnar neuropathy at the wrist. Neurlogic Clinics.17: 463-476.
10. Soltani Am, Best MJ, Francis CS, Allan BJ, Panthaki ZJ. (2013). Trends in the surgical treatment of cubital tunnel syndrome: an analysis of the national survey of ambulatory surgery database. J Hand Surg Am. 38: 1551-1556.
11. Lauretti L, D'Alessandris QG, De Simone C, Sop FYL, Remore LM, et al. (2017). Ulnar nerve entrapment at the elbow. A surgical series and a systematic review of the literature. 46: 99-108.

12. Staples JR, Calfee R. (2017). Cubital tunnel syndrome: current concepts. Am Acad of Orthop Surg. 25: 215-224.
13. Naran S, Imbriglia JE, Bilonick RA, Taieb A, Wollstein R. (2010). A demographic analysis of cubital tunnel syndrome Ann Plast Surg. 64: 177-179.
14. Quan D, Vedanarayanan VV, Leis, AA, Oswald T. (2013). Upper Extremity Focal Neuropathies. Workshop conducted at the American Association of Neuromuscular and Electrodiagnostic Medicine, San Antonio, TX.
15. Freedman M, Helber G, Pothast J, Shahwan TG, Simon J, et al. (2012). Electrodiagnostic evaluation of compressive nerve injuries of the upper extremities. Orthop Clin N Am. 43: 409-416.
16. Wang LH, Weiss MD. (2013). Anatomical, clinical and electrodiagnostic features of radial neuropathies. Phys Med Rehabil Clin N Am. 24: 33-47.
17. Leis AA, Subramony SH, Vedanarayanan V, Ross MA. (2012). Lower extremity focal neuropathies. Workshop conducted at the American Association of Neuromuscular and Electrodiagnostic Medicine, Orlando, FL.
18. Saeed MA, Oh SJ, Singh S, Falco FJE. (2001). Entrapment neuropathies in the lower extremity. Workshop conducted at the American Association of Neuromuscular and Electrodiagnostic Medicine.
19. Baima J, Krivickas L. (2008). Evaluation and treatment of peroneal neuropathy. Curr Rev Musculoskelet Med. 1: 147-153.
20. Marciniak C. (2013). Fibular (peroneal) neuropathy: electrodiagnostic features and clinical correlates. Phys Med Rehabil Clin N Am. 24: 121-137.
21. Distad BJ, Weiss MD. (2013). Clinical and electrodiagnostic features of sciatic neuropathies. Phys Med Rehab Clin N Am. 24: 107-120.
22. Yuen EC, So YT, Olney RK. (1995). The electrophysiologic features of sciatic neuropathy in 100 patients. Muscle Nerve. 18: 414-20.