PERIPHERAL NERVE COMPRESSION AS A CAUSE OF WRIST AND HAND PAIN IN THE ATHLETE

– Written by Jean Paul Brutus and Bianief Tchiloemba, Canada

INTRODUCTION

Peripheral nerve damage in athletes can result from subacute or chronic injury secondary to repetitive microtrauma, ultimately leading to entrapment. Predisposing factors include improper training technique, age, overtraining, repetitive stress, and use of protective equipment.

Neurapraxia is the most benign type of nerve injury and results from an ischemic event or crush injury that causes temporary damage to the myelin sheath without affecting the axons. Motor and sensory fibers may be affected, resulting in weakness, and tingling or loss of sensation. The axons are intact, and the prognosis is good, with full recovery expected within 8 weeks. Nerve conduction studies may show a conduction block. This means that conduction is normal distal to the injury but not across it. Electromyography (EMG) may show reduced recruitment.

Axonotmesis is a more severe form of nerve injury and often results from a crush injury. In this injury, both the axons and the myelin sheath are damaged. Because the axons are damaged, there is no conduction at, or distal to, the injury site (Wallerian degeneration). EMG will show signs of denervation with no recruitment, positive sharp waves, and fibrillations. Recovery may take months.

There are several mechanisms by which peripheral nerves can be injured in sports, including compression, stretching, traction, crushing, or even laceration. Peripheral nerves travel through tunnels that act like pulleys as they cross joints such as the elbow or wrist and must glide with joint movement. When an injury occurs, adhesions can form between the epineurium and the surrounding sheath or tunnel, causing ischemic damage within the nerve and additional traction insult.

The prognosis for recovery depends on several factors, including the degree of demyelination, axonal loss, and distance to the target muscle. Irreversible atrophy usually occurs after 12 months. In this article, we will review the nerve compressions of the three nerves affecting the hand and wrist – the ulnar, median and radial nerves – and how this syndromes may occur in athletes.

ULNAR NERVE

Proximal entrapment of the ulnar nerve – Cubital Tunnel Syndrome

Background:

Cubital tunnel syndrome (CuTS) is the most common site of peripheral entrapment in baseball players[1] and throwing athletes. Due to repetitive valgus stress on the elbow, the ulnar collateral ligament becomes stretched, resulting in medial elbow laxity and subsequent increased mobility of the ulnar nerve in the groove (cubital tunnel). Stretching and compressing the ulnar nerve, even sometimes resulting in subluxation of the nerve.

Symptoms:

Early signs of ulnar nerve entrapment may include cold intolerance, numbness

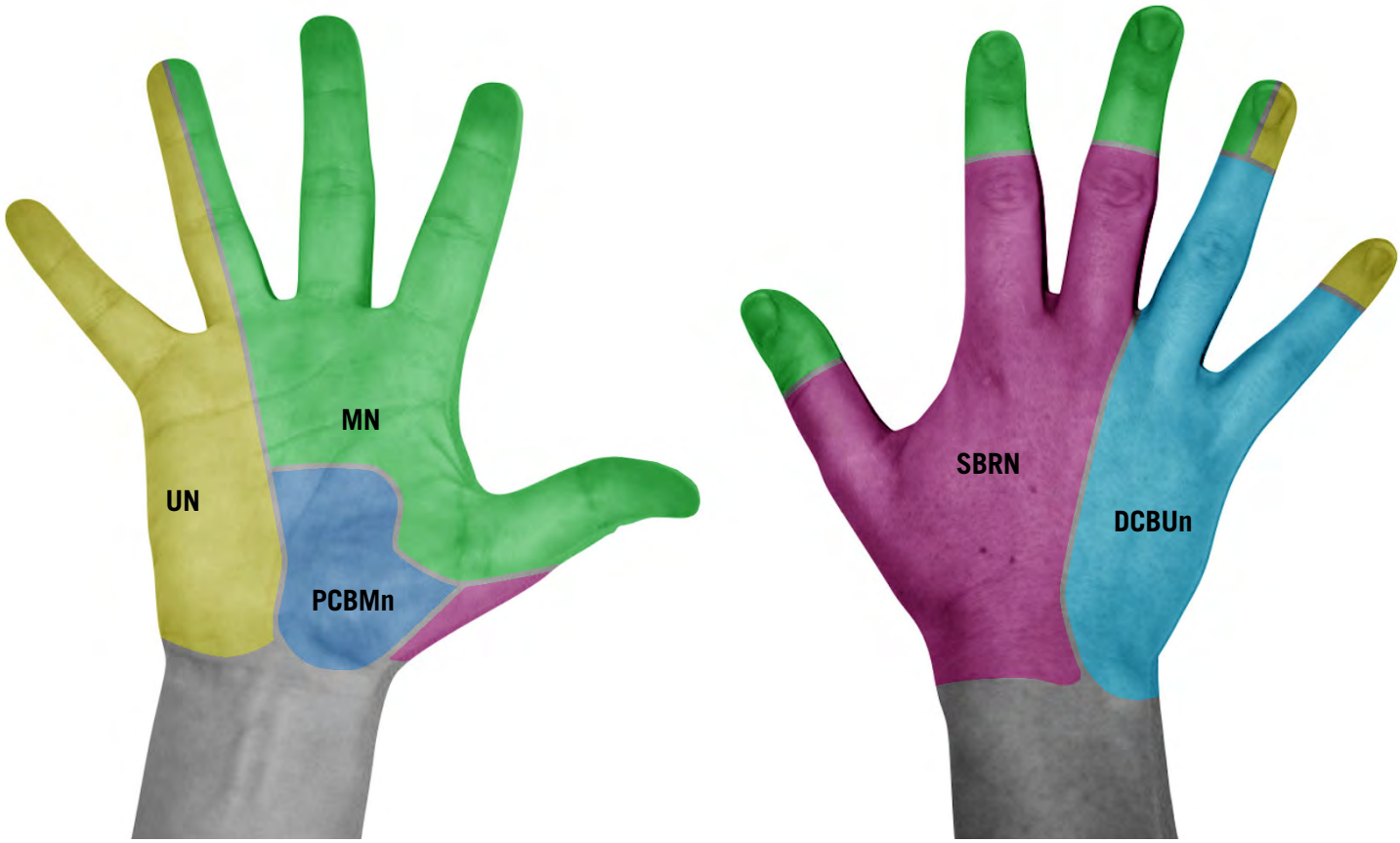

Figure 1: Sensory distribution of the volar and dorsal aspects of the hand.

DCBUn=dorsal cutaneous branch of the ulnar nerve; MN=median nerve; PCBMn=palmar cutaneous branch of the median nerve; SBRN=sensory branch of the radial nerve; UN=ulnar nerve.

or tingling in the hand or fingertips of the fourth and fifth digits, shooting pain from elbow to the forearm and hand, and clumsiness. Other symptoms include weakness and pain in the medial aspect of the elbow.

Symptoms are exacerbated when the elbow is flexed, as the ulnar nerve is both stretched and compressed in this position. A snapping or popping sensation may be present with ulnar nerve subluxation as the elbow moves from extension to flexion.

Clinical findings:

The most important test is of motor and sensory function, where weakness will be seen in the deep flexor to the little finger (FDP V). Tinel's test over the cubital tunnel will elicit paresthesias in the UN territory of the hand, both dorsally and volarly (see Figure 1). 2-point discrimination (2PD) may reveal loss of sensation in the little finger and ulnar aspect of the ring finger.

Diagnostics:

Electrodiagnostic studies may remain normal until the advanced stages of the disease. Therefore, a negative test cannot rule out ulnar nerve entrapment in the elbow[1].

Ultrasound can be used as an adjunct to the physical examination to assess for nerve subluxation and swelling of the nerve (increased cross-section area).

Treatment:

Conservative therapy consists of rest, night splinting for up to six weeks, range of motion nerve gliding exercises, and correction of exercise technique[1]. If symptoms do not improve, surgical decompression may be considered.

Surgical techniques include in situ decompression (mini-open or endoscopic), decompression with submuscular transposition, or anterior subcutaneous transposition.

It is important to diagnose nerve instability as simple decompression of the nerve will worsen the instability [2]. In cases of confirmed nerve instability, subcutaneous transposition has been preferred in recent years with lower rates of persistent postoperative neuritis symptoms and lower morbidity. Furthermore, disruption of the flexor pronator mass is undesirable in the throwing athlete, and submuscular transposition of the nerve should therefore be avoided.

Distal entrapment of the ulnar nerve – Ulnar Tunnel Syndrome

Background:

Nerve entrapment in Guyon's canal is seen in activities that involve prolonged pressure on the wrist. This condition is called ulnar tunnel syndrome (UTS). As the ulnar nerve enters this canal on the medial side of the wrist, it divides into a superficial branch and a deep motor branch.

UTS is particularly common in cyclists due to constant pressure on the handlebars, and is commonly known as handlebar palsy[3]. It is also seen in golfers, ice hockey and baseball players as well as wheelchair athletes. Due to their sports, the bat/stick/wheel can cause a fracture if the hook of the hamate, leading to compression on the ulnar nerve.

Symptoms:
An entrapment can occur at different locations in the canal and symptoms can vary accordingly, with sensory, motor, or both sensory and motor symptoms. Froment's, Tinel's and Wartenberg's signs are often positive. In severe cases, deformity of the hand with atrophy of the intrinsic muscles is possible.

Clinical findings:
It is important to evaluate the strength of the FDP5 and the Flexor Carpi Ulnaris (FCU) to differentiate between proximal elbow (CuTS) and distal wrist compression (UTS), as the FDP5 power will be weak in the former but normal in the latter (Table 1). Loss of sensation in the territory of the dorsal branch of the ulnar nerve also helps to differentiate between the two, with normal dorsal sensation in UTS but not CuTS.

In addition, the clinician should be reminded that both conditions can co-exist in a double-crush syndrome, when the ulnar nerve is entrapped at the elbow and the wrist simultaneously.

Table 1

Weakness	*Affected Nerve*	*Entrapment site*
APB	*Median*	*Carpal tunnel (wrist)*
FPL+FDP2+FCR	*Median*	*Lacertus Fibrosus (elbow)*
FPL+ FDP2 with normal FCR	*Median*	*Ant. Interosseous Syndrome (forearm)*
ADM, IOD1	*Ulnar*	*Guyon (wrist)*
FDP4, ADM	*Ulnar*	*Cubital tunnel (elbow)*
ECRB+EIP+EPL	*Radial*	*Proximal (arm)*
ECU	*Radial*	*Forearm, arcade of Frohse*
EDC	*Radial*	*Distal edge of Supinator (forearm)*

Table 1: Diagnosing nerve entrapment level using Manual Muscle Testing

APB=abductor pollicis brevis; FPL=flexor pollicis longus; FDP2=flexor digitorum profundus index; FDP4=flexor digitorum profundus index; FCR=flexor carpi radialis; ADM=abductor digiti minimi; IOD1=first dorsal interosseous; ECRB=extensor carpi radialis brevis; ECU=extensor carpi ulnaris; EIP=extensor indicis proprii; EPL=extensor pollicis longus; EDC=extensor digitorum communis

Diagnostics:
A CT scan, ultrasound, or MRI may be useful to rule out the presence of a mass such as a ganglion cyst, tumor in the canal, or thrombosis of the ulnar artery. Electrodiagnostic studies are used to assess the severity of compression.

Treatment:
Conservative treatment involves night splinting of the wrist for six to 12 weeks. The decision for conservative or surgical management depends on the duration and severity of symptoms and the etiology identified.

Hook of the hamate fractures resulting from acute or chronic athletic trauma are often treated with excision of the hook, with low morbidity and early return to play. In chronic cases, surgical decompression of the nerve and its branches is usually curative[4].

MEDIAN NERVE

Proximal entrapment of the median nerve
Background:
The median nerve innervates forearm flexors and some of the hand intrinsic muscles in the thenar eminence. Possible sites of entrapment include the ligament of Struthers (rare), the lacertus fibrosus (very common), between the two heads of the pronator teres muscle or under the arch of the flexor digitorum superficialis muscles.

It is particularly common in activities that involve repetitive pronation combined with flexion of the elbow, such as in tennis players, bodybuilders, weightlifters, rowers, climbers or archers[5].

Symptoms/clinical findings:
The most common site for entrapment of the median nerve at the elbow is under the lacertus fibrosus (expansion of the biceps aponeurosis)[6]. The condition is known as lacertus syndrome (LS) and is characterized by weakness of the Flexor Pollicis Longus (FPL), Flexor Carpi Radialis (FCR) and Flexor Digitorum Profundus to the index finger (FDP2) with occasional paresthesias in the radial fingers (Table 1).

Pain is often present on the medial aspect of the elbow with proximal radiation to the shoulder or scapula. Patients may report sensory disturbances that mimic carpal tunnel syndrome. However, symptoms do not have a nocturnal component[7].

Diagnostics:
It is important to note that nerve conduction studies are usually normal and do not detect this condition[6].

Ultrasound may at times show a swelling at the elbow but is most often normal.

The diagnosis is primarily clinical, with a combination of patient history and clinical findings leading to the establishment of the diagnosis.

Treatment:
Early onset of LS may be treated by ultrasound-guided corticosteroid injection, and nerve gliding exercises.

Surgical treatment is common as it is associated with high level of success and low morbidity. The surgery involves a release of the lacertus fibrosus through a 10-20 mm transverse incision in the elbow crease and is curative, with immediate restoration of strength and pain relief[6].

Distal entrapment of the median nerve – Carpal Tunnel Syndrome (CTS)
Background:
Distal entrapment of the median nerve occurs in the wrist. CTS is the most common upper extremity nerve entrapment and causes numbness, tingling and a burning sensation in the thumb, index, middle and ring fingers, usually at night or early in the morning[5].

It is common in bodybuilders, cyclists, motorcyclists, hockey players, race car drivers, rock climbers, rowers, gymnasts, swimmers and wheelchair athletes.

The mechanics involved include forceful, repetitive wrist flexion or extension and unique prolonged wrist postures required in certain activities.

Symptoms/clinical findings:
Numbness is the most common symptom, especially at night, and with worsening on flexion of the wrist or overhead work. Tinel's and Phalen's tests will be positive.

There is no weakness in the FPL, FDP2 or FCR, unless a lacertus syndrome is present. Both conditions are frequently associated, in double crush syndromes.

Diagnostics:
Nerve conduction studies are frequently used and will show slowing of the sensory nerve velocity over the carpal tunnel.

Ultrasound is increasing in use and popularity as it can readily show swelling and increased cross-sectional area in the median nerve, where >10mm2 in cross-sectional area is pathological.

Treatment:
Treatment includes correction of training techniques, avoidance of the activity and nerve gliding exercises. Night splinting to prevent wrist flexion helps with carpal tunnel syndrome but not with lacertus syndrome.

Corticosteroid injection into the carpal tunnel can be curative in early cases but a recurrence is possible.

Surgery is the definitive treatment for carpal tunnel syndrome and has been shown to provide lasting relief[9].

RADIAL NERVE

Forearm entrapment of the radial nerve – Radial Tunnel Syndrome (RTS)

In the forearm, the radial nerve divides into the posterior interosseous and superficial sensory nerves. The posterior interosseous (PIN) branch of the radial nerve is susceptible to repetitive overuse at the proximal fibrous origin of the supinator muscle (arcade of Frohse) or at the fibrous bands of the radiocapitellar joint and the tendinous origin of the extensor carpi radialis brevis, especially with repetitive pronation and supination.

The condition is described in swimmers, bodybuilders, tennis players, and gymnasts[7] due to repetitive load on the forearm extensors and the supinator. It is often misdiagnosed or found in conjunction with, tennis elbow (lateral epicondylitis).

Symptoms/clinical findings:
The most common symptom is pain in the proximal lateral aspect of the forearm and elbow.

On clinical examination, there is tenderness over the radial tunnel, about 3 fingerbreadths distal to the lateral epicondyle.

Muscle testing will show weakness of the Extensor Carpi Ulnaris (ECU) with preserved strength of the triceps muscle (Table 1).

There is no sensory loss associated with RTS.

Diagnostics:
Nerve conduction and EMG studies are usually normal.

Ultrasound can be a valuable tool to rule out ganglion cysts from the radiocapitellar joint as a cause of nerve compression. The PIN may at times be seen enlarged

at the proximal edge of the supinator on ultrasound.

Treatment:
Wrist splinting and nerve gliding exercises are the mainstay of conservative management. Ultrasound-guided cortisone injection may be considered in the event of failure.

Surgical decompression may be required[9,10] and is performed through a 5 cm incision over the radial tunnel. Pain relief and return of strength are immediate with low morbidity.

Distal entrapment of the radial nerve – Wartenberg Syndrome
Background:
Wartenberg's syndrome is a painful condition resulting from irritation or entrapment of the distal radial nerve. It may be associated with de Quervain's tenosynovitis. The superficial branch of the radial nerve (SBRN) is often compressed at the site where it passes through the fascia between the brachioradialis and extensor carpi radialis longus to become subcutaneous.

The SRN exits dorsal to the brachioradialis (BR) 8-9 cm proximal to the radial styloid. Restriction of nerve gliding of the SRN causes neuritic symptoms. Compression is often seen in sports that require repetitive, forceful pro-supination of the forearm. Direct trauma can cause scarring and perineural fibrosis with entrapment of the nerve, such as in ice hockey or football players.

Symptoms/clinical findings:
Symptoms include neuropathic pain radiating into the thumb and paresthesias over the dorsum of the thumb and dorsoradial hand. (Figure 1)

Tinel's sign is positive over the site of compression, about 8-9 cm proximal of the radial styloid. Symptoms worsen with ulnar deviation of the wrist, which can falsely suggest de Quervain's tenosynovitis.

Muscle testing is normal, as this compression involves a purely sensory nerve.

Diagnostics:
Nerve conduction studies may at times show slowing of the sensory response in the SBRN but is often a painful test for the patient.

Ultrasound can show swelling of the nerve at the site of entrapment.

Diagnostic blocks may support the clinical diagnosis.

Treatment:
Most cases respond well to non-operative treatment with ice, rest, non-steroidal anti-inflammatory drugs, corticosteroid injections, and splinting in supination.

Neurolysis is recommended only for refractory cases and involves decompression of the SBRN from the radial styloid through the fascia joining the brachioradialis and extensor carpi radialis longus.

Distal Posterior Interosseous Nerve Impingement Syndrome
Although rarely seen, distal compression of the terminal branch of the PIN is also possible in athletes who are involved in repetitive and forceful wrist hyperextension, such as gymnasts or bodybuilders. Repetitive trauma on the back of the wrist can also cause this painful condition. Palpation over the fourth extensor compartment will be painful and symptoms will be exacerbated by forced wrist extension. A lidocaine test (diagnostic block) will help with the diagnosis by providing temporary relief. Most cases are managed conservatively with immobilization and anti-inflammatories but in some cases, a surgical PIN neurectomy may be necessary.

NERVE DECOMPRESSION IN THE UPPER EXTREMITY, SIMPLIFIED. MOVING FROM GENERAL AND REGIONAL ANESTHESIA TO LOCAL ANESTHESIA ON WIDE-AWAKE PATIENTS.
Walant
The Wide-Awake Local Anesthesia No Tourniquet (Walant) technique has changed peripheral nerve surgery since it was described and popularized by Lalonde[11].

Walant involves the use of tumescence with a local anesthetic solution of lidocaine with epinephrine to induce vasoconstriction and prolong the anesthetic effect[12]. Walant allows patients to remain awake throughout the procedure, allowing for real-time communication and active participation. This approach effectively avoids the risks associated with general anesthesia or regional nerve blocks.

All the above techniques, from neurolysis to nerve transfer, are now routinely

The WALANT technique has changed peripheral nerve surgery as it allows intraoperative strength testing after nerve release.

performed in awake patients under Walant anesthesia. Multiple sites can be decompressed simultaneously when indicated.

CONCLUSION

Because peripheral nerve injuries are uncommon in sports, they are often misdiagnosed and poorly managed. An accurate diagnosis relies on a careful history and thorough examination of the upper extremity. The clinician treating such lesions should be aware that multiple entrapment sites on the same or different nerves are common; a careful motor and sensory examination will reveal one or more entrapment sites. Nerve conduction studies are used when appropriate to confirm the clinical diagnosis or to quantify the extent of nerve damage, but normal studies do not rule out compression. Most upper extremity nerve entrapments can be successfully treated conservatively. When conservative treatment fails, Walant makes surgery less invasive than ever before, to the benefit of the athlete, the surgeon, and society.

Jean Paul Brutus MD

Bianief Tchiloemba MD

Exception MD

Montreal, Qc, Canada

Contact: jpbrutus@drbrutus.com

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