

Cyclists Palsy, Clinical Presentation and Electrodiagnostic Evaluation during the Covid Pandemic

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Abstract

Overuse injuries account for over 60% of all sports related injury. Nerve injuries are associated with 7% of all sports injury. Overuse of musculoskeletal structures can result in micro-trauma and damage to peripheral nerves, resulting in clinical syndromes.

Distal Ulnar and Median neuropathies can occur singularly or in combination in the cycling population, due to hand position and microtrauma associated with the activity. The patient presenting with a combination of sensory alteration and loss of hand and finger function. The condition is often referred to as a Cyclist's Palsy.

Cycling a bicycle places these two neurological structures (the median and ulnar nerve) in a vulnerable position due to the impaction on the handlebars. Forced flexion of the wrist or direct trauma on the wrist from bicycle riding can directly affect the median nerve resulting in a distal median neuropathy (carpal tunnel syndrome). Similarly, trauma at the level of the hypothenar eminence can place significant trauma on the median nerve prior to and as it enters Guyon's canal.

Keywords: Cyclist Palsy; CTS; Guyon's Canal; Covid Pandemic; Handlebar Palsy; Electrodiagnostic Medicine

Introduction

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Cycling a bicycle places these two neurological structures (the median and ulnar nerve) in a vulnerable position due to the impaction on the handlebars. Forced flexion of the wrist or direct trauma on the wrist from bicycle riding can directly affect the median nerve resulting in a distal median neuropathy (carpal tunnel syndrome). Similarly, trauma at the level of the hypothenar eminence can place significant trauma on the median nerve prior to and as it enters Guyon's canal.

The two neuropathies, median and ulnar, are usually self-limiting resulting in a variety of clinical presentation affecting both sensory and motor function of the hands and upper limbs. The neuropathies themselves are non-fatal, however they can result in acute loss of hand function which has been reported as a contributory factor in fatal road deaths in the cycling population. Therefore, awareness with careful evaluation and treatment of this condition is essential.

Sports and activity related peripheral nerve injury

Peripheral nerve injuries frequently can be associated with sports and recreational related trauma. The instance of peripheral nerve injuries has increased as observed by Li., *et al.* in 2020 [1]. In their study, a review of emergency room attendances in the United States was undertaken and a relationship with sport exercise and recreational activities between 2009 and 2018 was studied. Of over 552,000 patients presenting with peripheral nerve injuries to the emergency room, 21.9% were associated with exercise, sport or recreation. This incidence significantly increased between 2009 and 2018 with an overall incidence rate of 36.9 per million person years. Males were more commonly affected than females and the 4th and 5th decades were the most common periods of life when these peripheral nerve injuries occurred. In this 10-year study, American football for the under 20-year-olds was the most common activity and general exercise participation for the over 20-year-olds was the most common cause in this demographic.

Peripheral nerve injuries are usually assessed in an electrodiagnostic laboratory, thus allowing a more detailed examination of the peripheral nervous system using this methodology increases the yield of diagnosing this relatively common occurrence of sports related peripheral nerve injury [2].

Cycling participation has increased significantly during the Covid pandemic

Cycling rates increased dramatically during the early stages of the Covid pandemic in early 2021. This was in part due to a fulfil a singular exercise need and an avoidance of public transport. In one survey Fuller reported that 63% of respondents in an Australian population study indicated that they increased cycling during COVID-19 restrictions. Recreational cycling has increased significantly. The Guardian newspaper reported on the 22nd of September 2021 that in the UK the number of cycling trips made by women rose by 50%.

The increase in cycling participation has come an increase in cycling accidents, injury and road death.

This alarming increase in cycling-related deaths was noted in 2020, some months into the Covid pandemic. According to data from the national highway traffic administration in the UK (NHTA) 2018 was the deadliest year for bicyclists since 1990 with 857 bicycle-related deaths [4]. In 2019 there was a slight improvement, but the numbers of fatalities remained at the high level of 846. This increase in bicycle-related deaths in 2020 is probably related to the surge in bicycle use and bicycle sales, which translates into more cyclists on the road. In 2020 the NPD group, a market research company, indicated that there was a 75% uplift in bicycle sales in the UK, generating an unprecedented 1 billion sales per month.

Hence, even though there was less traffic due to the pandemic, there were more cyclists and as a result more deaths on the road during this period of Covid-related lockdown.

Distal median neuropathy (Carpal tunnel syndrome)

Carpal tunnel syndrome is the most common focal neuropathy. It is caused by compression of the median nerve at the level of the flexor retinaculum as it travels through the carpal tunnel into the hand. It is associated with a number of medical conditions, such as thyroid disease, rheumatoid arthritis and diabetes. It can also be associated with trauma, such as wrist fractures and micro trauma caused by repetitive activity. It has a wide variation in clinical presentation with symptoms of pain, numbness and weakness dominating.

Injury of the median nerve can occur in the cycling population caused by direct trauma to the nerve when the volar aspect of the wrists is placed on top of the handlebars (Figure 1) or if the wrist is held in a forced flexed position folding the fingers around the hoods of dropped handlebars (Figure 2). Cyclist are advised to change hand position regularly to avoid this pattern of compression. Correct seat height and position are also important in preventing the cyclist assuming a forward position which places greater weight and pressure on the hands.



Figure 1: Median nerve traumatised by the volar aspect of the wrist resting on the top of the handlebars.



Figure 2: Median Nerve compression by the fingers folding around the hoods of the dropped bike handlebars, placing the wrist in a forced flexed position.

This pattern of nerve injuries is also reported in association with other activities other activities involving prolonged pressure on the volar wrist such as jackhammer use, vibrating tools, wheelchair use or prolonged typing [5,6].

Distal ulnar neuropathy (Guyon's canal syndrome)

Injury of the ulnar nerve at the wrist is common in cyclists because the ulnar nerve gets compressed against the handlebar during cycling. The ulnar nerve passes through the wrist in Guyon's canal, which is at the base of the wrist on the medial side (pinky side) of the

hand. It is also called ulnar tunnel or ulnar canal. It is anatomical canal located made of bone and soft tissue on the medial side of the hand (pinkie). It extends between the proximal boarder of the pisiform bone and distally at the hook of the hamate.

The ulnar nerve is entrapped on the medial border of the hand as it travels through Guyon’s canal. Guyon’s canal is a bony and ligamentous canal, the ulnar nerve travelling between the pisiform bone and the hamate bone.

The nerve divides into a superficial sensory branch and a deeper motor branch in this area. Thus, Guyon’s canal can be separated into three zones based on which portion of the ulnar nerve are involved.

The three zones are identified schematically. A sensory branch is frequently given off in zone A prior to entering the canal with the remaining nerve containing predominantly motor fibres which supply the intrinsic muscles of the hand. This sensory branch passes on the radial side of the hook of the hamate in many instances in the company of the ulnar artery and veins. This is possible as the roof of Guyon’s canal does not directly connect with the hamate bone, the roof extending radially to the hook of the hamate and attaching the flexor retinaculum:

- Zone 1: Motor and sensory symptoms
- Zone 2: Motor only symptoms
- Zone 3: Sensory only symptoms.

Electrodiagnostic (EDX) testing differentiates the type of motor and sensory involvement, clarifying the diagnosis and location of injury.

The compression occurring at or distal to Guyon’s Canal in Zone 1 will result in sensory symptoms of paraesthesia’s in the fourth and fifth digits. Digit weakness and intrinsic hand muscle weakness can also occur in Zone 1 compressions. EDX testing will confirm the abnormalities. Zone 2 injuries will also have the motor symptoms and EDX abnormalities. Zone 3 injuries only have the sensory symptoms and EDX findings.

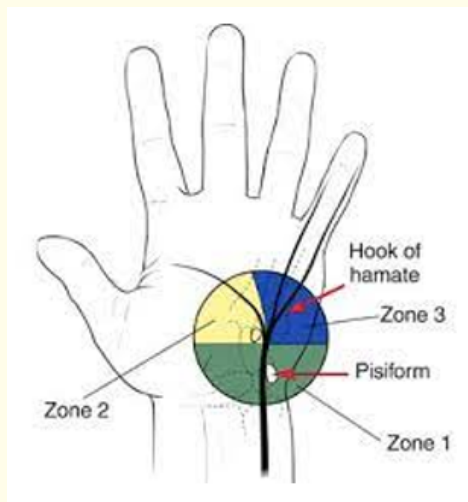


Figure 3: The 3 zones of ulnar neuropathy at Guyon’s canal.

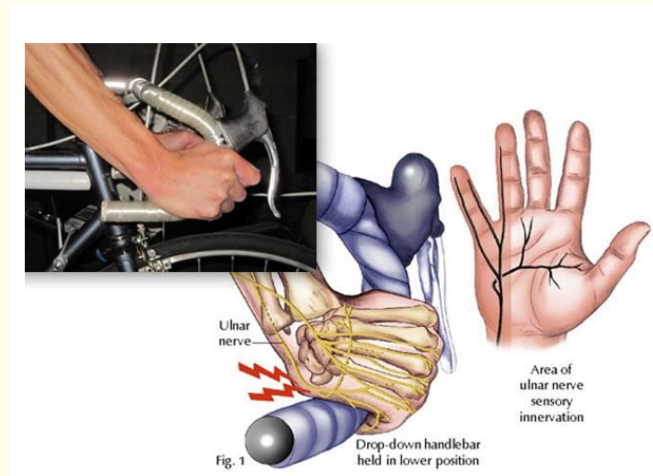


Figure 4: Ulnar nerve compression by bike handlebars at the level of Guyon's canal.

How common is cyclist palsy (combined distal and ulnar neuropathy in a cyclist)

Cyclist palsy is the combination of a median and ulnar neuropathy at the wrist in a cyclist.

Cyclist's palsy is now a commonly recognised phenomenon, is in part due to the increase in the cycling boom, where bicycle riding has become a common leisure pursuit in the general population as well as being a competitive sporting pursuit. It is not unusual for a recreational cyclist to cover 100 km on a weekly basis. This has become more commonplace during the current Covid pandemic [3,4,7,8].

In Patterson's study of 2003, 23 of 25 cyclists experienced either motor or sensory symptoms or both in the median and ulnar nerve distribution in association with bicycle riding. This assessment of elite cyclists was an effort to identify the actual incidence of this condition or the condition of cyclist palsy.

Many cyclists will report lack of sensation from the median neuropathy with pins and needles frequently encountered in the thumb, index, long and ring finger. If the ulnar nerve is also affected at Guyon's canal, the remaining half of the 4th and 5th finger may also be affected. The motor consequences of weakness to the thenar eminence in cases of median neuropathy may result in clumsiness and difficulty in controlling the bike. However, when this is associated with motor changes in the ulnar nerve then the intrinsic muscles of the hand can be affected and controlling a bicycle may become significantly problematical due to both motor and sensory deficiencies in the cyclist.

Cyclist palsy, a cause fatal cycling injury

Compression of both median and ulnar nerves result in sensory alteration throughout the hand and digits, resulting in a loss of bike steering ability, due to the sensory deficit. Further compression affects the deeper elements of the nerve where motor supply resides, this results in a loss of motor function in the thenar muscles in the case of the median nerve and more critically loss of the hypothenar muscles and intrinsic muscles of the hand in the case of the ulnar nerve. This results in weakness and a loss of control over the handlebars and accidents. This can occur at high speeds with the resultant injuries, occasionally catastrophic.

In 2014 a coroner reported at an inquest into the death of a 24-year-old female who was training for a 100-mile ride when she hit a wall while travelling down a hill in Devon. There was no mechanical failure found on the bicycle on which the deceased was travelling prior

to her careering into a house, resulting in the fatality. It was suggested at the inquest that there may have been an association with cyclist palsy, which did not allow the 24-year-old woman to adequately squeeze her brakes and direct her bicycle away from the danger [9].

The number of preventable deaths from bicycle transportation incidents increased 6% in 2019 and have increased 37% in the last 10 years, from 793 in 2010 to 1,089 in 2019. At the same time, the number of preventable nonfatal injuries has declined 40%, from 515,861 in 2010 to 308,864 in 2019. However, the number of preventable nonfatal injuries did increase 7% in 2019 from 2018 [3,4,7].

Bicycle-related deaths peak in the summer months, starting in June, and they remain high through September. In 2019, the most deaths occurred in August and the fewest in January [3,4].

Clinical assessment of a patient suspected of cyclist palsy

A high index of suspicion of cyclist palsy should be present if a recreational or elite cyclist presents with vague symptoms of sensory alteration in the hand or fingers associated with arm pain and motor weakness in the thenar or hypothenar eminence. The weakness is usually throughout the C5, C6, C7 and C8 myotomal distribution. Care should be taken in the history to out-rule cervical or brachial plexus pathology. Other rarer causes such as polyneuropathies associated with medical conditions such as diabetes mellitus, thyroid disease and other systemic conditions should also be assessed. A careful drug history to include performance enhancing drugs and street drugs should also be undertaken. The use of anabolic agents being associated with the development of peripheral neuropathies. Specific identification of hand positions on the handlebars and the distance travelled should also be considered. In the case of the acute bilateral cyclist palsy [9] the individual held his wrist in a forced flexed position for the first leg of the 24-hour cycle and placed the palmar aspect of his wrist on top of the handlebars for the second half of the cycle, the former resulting in the median neuropathy and the latter resulting in the Guyon’s canal syndrome [10,11].

Physical and electrodiagnostic examination of cyclist palsy

The physical examination should involve a careful assessment of the cervical spine and brachial plexus as well as a detailed examination of the hand.

The Tinel’s testing should be performed for both median nerve and Guyon’s canal, although these are not pathognomonic of the conditions. Phalen’s test and compression test of the median nerve can also be of assistance.

Motor function testing is essential to identify the function of the abductor pollicis brevis muscle (median innervated) and the intrinsic muscles of the hand (ulnar innervated) In this instance, Froment’s test should be performed and compared with the opposite side.

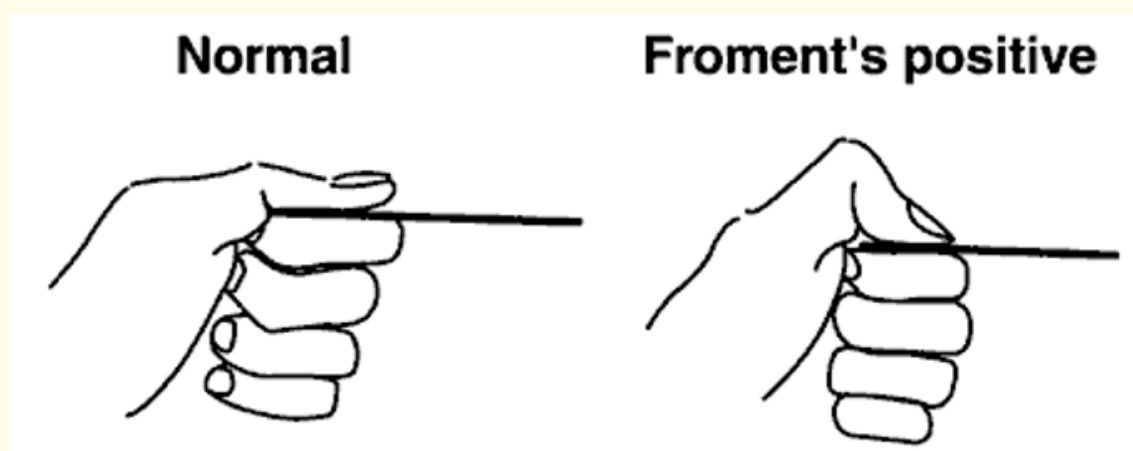


Figure 5: Froment’s tests.

Inspection of the wrist joint should also rule out the presence of ganglion cyst, both at the wrist joint and at both of the canals.

These tests are an assistance rather than a diagnosis of the pathology.

A standard battery of assessments of median and ulnar nerves should be performed. These should include proximal and distal ulnar and median nerve motor conduction studies. Distal sensory nerve conduction studies assessing the median, ulnar and radial nerves. Needle EMG of the C6, C7 and C8 innervated limb muscles.

Motor Nerve Conduction Studies			
Motor Nerve	Recording muscle	Stimulation	
Median	APB	Wrist	Elbow
Median F wave	APB	Wrist	
Ulnar	ADM	Wrist	Elbow and above
Ulnar	1 st DI	Wrist	
Ulnar F wave	ADM		
Ulnar F wave	1 st DI		

Sensory Nerve Conduction Studies		
Sensory Nerve	Recording site	Stimulation
Median	Digit 2	Wrist
Median	Wrist	Palm
Ulnar	Digit 5	Wrist
Radial	1 st web space	Wrist

Needle EMG		
Muscle	Nerve root	Peripheral nerve supply
APB	C8	Median
ADM	C8	Ulnar
1 st DI	C8	Ulnar
EIP	C678	Radial
Pronator Teres	C5678	Median
FCU	C8	Ulnar

Table 1: Electrodiagnostic test protocol for assessment of cyclist palsy.

Positive electrodiagnostic findings in cases of cyclist palsy

In cases of cyclist palsy, there is usually evidence of both Guyon’s canal syndrome and carpal tunnel syndrome. In the case of the carpal tunnel syndrome, the median transpalmar mixed nerve study, median sensory study and median motor study will show either a single or a combination of tests with prolongation of distal latency [13]. In more severe cases, amplitude of response will also be reduced. This data is compared to standard laboratory data. Many laboratories have their own standard range of normal and other laboratories use published data from recognised authorities, such as AANEM and CSCN [11].

In the case of Guyon's canal syndrome, the distal ulnar motor study through Guyon's canal stimulating at the wrist and recording at the 1st dorsal interosseous muscle usually shows a prolongation of distal latency in comparison to normal data. Amplitude of response can also be altered. The sensory nerve conduction study may or may not be affected and this depends on which zone of Guyon's canal is affected by the trauma. In this instance, the distal ulnar innervated muscles will show evidence of denervation on needle EMG testing. Similarly, the APB muscle will also show evidence of denervation in cases of carpal tunnel syndrome.

EMG of the proximal ulnar and median innervated muscles is undertaken and in cases of cyclist palsy these will be normal.

A radiculopathy screen is also performed at this time to assess the C5, 6, 7 and 8 muscles, which are not innervated by the median or ulnar nerve, to ensure there is no secondary pathology such as a cervical radiculopathy.

Radiology

If there is evidence of cyclist palsy, radiology is frequently undertaken to assess the status of the two canals. The presence of ganglion cysts or varicose veins is also checked. Ultrasound is considered to be the best tool in this radiological evaluation.

Treatment

In many instances, treatment involves modification of the activity and cessation of cycling for a period of time frequently has a positive effect [10,11,14].

Injection of the two canals with a combination of steroids and local anaesthetic is frequently undertaken using ultrasound and EMG guidance for accuracy [11].

Should the condition fail to respond to conservative therapy, then surgery releasing the flexor retinaculum above the carpal tunnel is performed. This is required in over 15% of cases and can be performed microscopically [3,11,12].

Surgery to release the ulnar nerve in Guyon's canal is only occasionally considered. Exceptions would include cases where there are space occupying lesions in Guyon's canal such as ganglion cysts or aberrant blood vessels. Radical treatment option of surgery to relieve pressure on the ulnar nerve by reducing the tension in the volar carpal ligament which forms the roof of Guyon's canal, is rarely undertaken.

Prevention

Prevention of this condition follows the normal protocol for overuse-type injuries, namely in the first instance addressing intrinsic and extrinsic factors associated with the activity [9-15].

The intrinsic factors would include the wrist morphology and any underlying conditions, which may make the individual susceptible to entrapment neuropathies. A square wrist Extrinsic element would include bicycle fit. This has become a more exact science in the past decade with bicycle fitters now placing both the body and upper limbs in the correct position to prevent injury.

The use of cycling gloves has also been a significant factor in preventing this type of injury. Newer products on the market [16] use gel padding placed over the vulnerable areas and in this way, individuals can return safely to their activity using these prophylactic aids.



Figure 6: Cycling gloves with specific padding over the carpal tunnel and Guyon’s canal.

In some instances, alteration of handlebar type as well as position is contemplated and often the use of straight handlebars resolves many of these issues.

Conclusion

Cyclist palsy, the entrapment of the median and ulnar nerve at the level of the wrist, is becoming a more commonly encountered occurrence in clinical practice. Of itself it is not a fatal condition, however it has been associated with fatalities due to a failure of function in the median and ulnar nerves resulting in inability of the cyclist to control the bicycle. A high index of suspicion should be the cornerstone of the examining physician. Clinical examination can be helpful in steering the clinician to a diagnosis; however, electrodiagnostic evaluation is the cornerstone in the diagnostic armoury.

Treatment may include alteration in equipment, bike fitting and the use of prophylactic cycling gloves.

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