



Guyon canal syndrome and handlebar palsy – summary of available knowledge

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Abstract

Introduction and Objective. Guyon canal syndrome (GCS) is rare neuropathy of the ulnar nerve, caused by its compression at the level of the wrist. In GCS, nerve compression may be caused by endogenous and exogenous reasons. It leads to motor or sensory dysfunction regarding IV and V finger and hypothenar area. When symptoms occur among cyclists, the condition is described as handlebar palsy – malfunction due to long-distance bike rides, as a result of repeatable vibrations and bearing bodyweight on wrists and hands.

Review methods. The Summary is based on academic literature and scientific publications available in Portal Komunikacji Naukowej, PubMed and NCBI – National Library of Medicine databases. After evaluation of abstracts, articles were selected and analyzed, considering the references cited. Publications that were analyzed, was two academic literature positions in Polish and both Polish and international publications from the fields of neurology, orthopaedics and radiology, containing a prospective study, retrospective study, systematic review, case study and several articles.

Brief description of the state of knowledge. Diagnostic methods of GCS were based on the evaluation of clinical symptoms and radiological or electrophysiological methods, such as USG, MRI or EMG. Treatment is based mainly on conservative management – rest, NSAIDs and steroid injections. Cyclists should take into consideration change of gear or bike position. The ultimate methods are surgical treatments, based on relieving compression of the ulnar nerve.

Summary. Guyon canal syndrome is a significantly rare condition, often connected with sport activities, leading to malfunction of the hand mainly in its hypothenar area, which can be treated conservatively and surgically.

Key words

ulnar nerve, neurology, orthopaedics, guyon canal syndrome

INTRODUCTION

Anatomy of the Guyon canal and ulnar nerve. The Guyon canal, also named ulnar canal or ulnar tunnel, is a small space located in the wrist, through which the ulnar nerve reaches the hand [1, 2]. It was first described by Guyon in 1861. The tunnel is a spot where the ulnar nerve is exposed to injury connected with cycling, mostly generated by compression or repetitive vibrations. Another point where the nerve can be affected by compression is the ulnar joint [3]. Limitations of the Guyon canal are [1]:

- volar carpal ligament **from the top**;
- transverse carpal ligament **from the bottom**;
- the hook of hamate bone **from the radial side**;
- pisiform, pisohamate ligament and the abductor digiti minimi muscle **from the ulnar side**.

The ulnar nerve is one of the structures located in the Guyon canal. It is created from nerve roots C7-8 – T1, which form lower trunk of the brachial plexus. Subsequently, the plexus divides into three cords – posterior, lateral and medial. The ulnar nerve originates from the medial cord [4]. On the upper arm, ulnar nerve is located medially to the brachial artery, and proximally to the medial nerve, which originates from lateral and posterior cords of the brachial plexus [1, 4].

The nerve then courses towards the wrist, being located on the ulnar side of the forearm, and finally reaching the hand, entering it through the Guyon canal [1]. In the ulnar tunnel, the nerve is dividing into two branches – deep branch and superficial branch [4]. The deep branch has a strictly motor function. It provides innervation of muscles, such as the abductor digiti minimi, interossei muscles, the profound head of the flexor pollicis brevis, and adductor pollicis. The superficial branch provides sensory innervation the half of the fourth and fifth fingers, and the hypothenar area of the hand [1, 4]. Apart from the ulnar nerve, the ulnar artery is also located in the Guyon canal [5].

MATERIALS AND METHOD

The review is based on academic literature and scientific publications which are available in the Portal Komunikacji Naukowej, PubMed and NCBI – National Library of Medicine databases. After evaluation of article's abstracts, articles were selected and analyzed, considering the references cited. Publications that were analyzed, was two academic literature positions in Polish and both Polish and international publications from the field of neurology, orthopaedics and radiology, containing a prospective study, retrospective study, systematic review, case study, and several articles.

Guyon canal syndrome and handlebar palsy. Guyon canal syndrome (GCS) is the second most recognized pressure palsy (or pressure syndrome) of the wrist, after carpal tunnel

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syndrome [2]. Compared to carpal tunnel syndrome, GCS is a relatively rare mononeuropathy of the upper limb – it is a peripheral neuropathy of the ulnar nerve. The syndrome is caused by the distal part of the ulnar nerve lesion on the wrist level [2, 3]. The pressure palsies group is characterized by nerve function loss – loss of sensation, loss of motor function or autonomic function – which is caused by compression of the nerve by its surroundings. Another reason can be nerve swelling, leading to pressure caused by physiological anatomic restrictions [6]. Symptoms are listed in Table 1 [1, 2, 6, 7].

Table 1. Symptoms of Guyon canal syndrome

- tingling sensation in fingers, mostly IV and V
- numbness of fingers, mostly IV and V
- loss of function of the hand
- atrophy of local muscles
- anesthesia of the skin in the hypothenar area

Neurological symptoms are mostly limited to the dorsal side of the hand. Malfunctions can be motor, sensory or mixed. Patients have also reporting loss of grip strength.

Among the potential intrinsic etiology of Guyon canal syndrome, one can found causes listed in Table 2 [1, 2, 3, 6, 7, 8].

Table 2. Potential intrinsic etiology of GCS

- ganglion cyst
- tumours – such as lipoma, fibroma, lipo-fibroma
- hook of the hamate fracture and dislocation
- muscle deformation in the Guyon canal – e.g. of the adductor pollicis
- ulnar artery aneurysm
- abnormal fat tissue in the Guyon canal
- thrombosis of the ulnar artery
- exposure for repetitive trauma – handlebar palsy, hypothenar hammer syndrome (caused by vibrations)

This list points out the most reported causative factors of the syndrome. Among the less common causes one can demonstrate diseases leading to wrist structures degeneration or metabolic diseases – rheumatoid polyarthritis, sclerodermia, amyloidosis, sarcoidosis [2].

In 2009, a rare case of ulnar nerve function lesion at the Guyon canal was reported, caused by arteriovenous malformation regarding the ulnar artery and vein [9]. The patient was a 60-year-old female who had been suffering from a tingling sensation in IV and V finger for two years. The patient was diagnosed with diabetes mellitus five years earlier, but diabetic neuropathy was excluded as a potential cause of patient's symptoms. The treatment was surgical resection of the malformation, which improved the patient's condition – symptoms were completely reduced [9]. The authors suggest that a vascular malformation should be considered as another potential reason for Guyon canal syndrome [9].

Another condition that may lead to GCS, is an anatomical variant, such as incorrect course of the ulnar nerve – superficially to the flexor retinaculum, or an additional muscle in the canal – additional palmaris longus muscle or additional abductor digiti minimi muscle [3]. Accessory palmaris longus muscle can occur in 25% of the population and in most cases it is completely asymptomatic, although, it can predispose to the neuropathy on a wrist level [3].

It is worth mentioning that most of the GCS cases are connected with nerve compression, but the compression

is significantly more rare than on the ulnar joint level [3]. Idiopathic GCS cases are casuistry [3].

In the literature, there are four types of Guyon canal syndrome described [2, 5, 10] (Tab. 2).

Table 3. Types of Guyon canal syndrome

- type I – compression of the ulnar nerve in the proximal part of the ulnar canal
- type II – compression of the profound branch of the ulnar nerve
- type III – compression of the ulnar nerve in the distal part of the ulnar canal
- type IV – compression of superficial branch of ulnar nerve, distal from ulnar canal

An interesting case can be extrinsic cause such as repetitive trauma, which can occur after long-lasting bike rides, which is described as handlebar palsy or cyclist's palsy – described as GCS type II [5, 10]. Type II compression of the nerve is explained in literature as pressure in the pisiform-hamate area, connected mostly with muscle function loss, but without significant sensory loss [5]. Injury to the ulnar nerve may occur because of chronic pressure or vibrations, commonly experienced during bicycle rides [3, 10, 14]. The anatomical basis for this condition can be the fact that the ulnar nerve lies on a hard, inflexible hook of hamate during constant bearing bodyweight on a wrist while cycling – which predispose to pressure palsy. However, this cause is not commonly reported, but when it is – the pressure is usually applied for months or years [3, 11]. Symptoms, such as tingling, numbness or loss of grip strength can occur among cyclists for days, up to months [10]. A retrospective study by Lee et al. between January 2001 – December 2020 reviewed patients who underwent surgical management of GCS [12]. The authors listed 20 professions of the patients who suffered from this condition, and the most common occupations were office worker (19,6%), housewife (10,7%) and manual worker (8,9%). This observation may lead to the conclusion that repetitive manual activities – such as working on a computer, writing, or manufacturing, may also lead to compression of the ulnar nerve at the level of wrist. Ulnar nerve lesions at the level of wrist among athletes is mostly associated with cycling, but can also be reported among weightlifters, tennis players, squash players, golfers, gymnasts, climbers or rowers [2, 13].

Handlebar palsy was first reported in 1975 by Eckman et al. after a long bicycle tour of 3,000 miles in 30 days, when a 22-year-old male suffered pure motor function loss in both hands due to ulnar nerve lesion, which had been exposed to repetitive pressure and vibrations [14].

In the literature, the prevalence of ulnar and medial nerve damages vary from 10%–70% among long-distance bike riders, regarding motor or sensory function loss [11]. In 2003, Patterson et al. conducted a prospective study examining cases of ulnar nerve injury among long-distance cyclists. The group consisted of 25 randomly chosen cyclists aged 20–60, who had taken part in a 600 km bike trip over four consecutive days [16]. Their ulnar and medial nerves function and sensations were evaluated via a questionnaire on the first day of the bike tour, and the answers were compared after evaluating their sensations once again on day four: 70% of participants reported the existence of some neurological manifestation in their hands; 36% of the cyclists described motor loss; 10% – sensory loss, and 25% reported both motor and sensory loss. The study did not prove any significant difference between experienced and inexperienced cyclists [16].

Diagnostics. Diagnosing Guyon canal syndrome and handlebar palsy is mostly based on evaluating clinical symptoms of the patient. The most common symptoms reported are numbness or tingling sensations, usually involving the dorsal side of the hand and IV and V fingers, and loss of motor function [1, 6, 7, 8]. When diagnosing GCS, the following tests can be performed [2]:

- **Tinel's sign** – percussing the course of ulnar nerve and asking the patient if any painful sensations are occurring.
- **Froment's sign** – patient holds a piece of paper between thumb and metacarpus, and the physician tries to remove the paper.
- **Wartenberg's sign** – abducting V finger.

Radiological diagnostics should consist of an MRI scan of the hand or the cervical spine, to exclude pathological structures in the Guyon canal or any pathology or injury of the cervical roots – especially the roots C7–8 to T1 [8, 14]. This concerns primarily patients with unusual neurological symptoms, or those who cannot attribute the lack of motor or sensory function strictly to cycling activities.

Another useful diagnostic method is electromyography (EMG) of the hand [14]. Results from examining types I-III of Guyon canal syndrome [5]:

- **type I** – denervation of all muscles of the hand supplied by ulnar nerve;
- **type II** – denervation of all muscles of the hand supplied by ulnar nerve, excluding abductor digiti minimi muscle;
- **type III** – correct nerve function of all muscles of the hand supplied by the ulnar nerve.

When diagnosing Guyon canal syndrome and handlebar palsy, a safe and efficient method is ultrasonography (USG) which allows the physician to reveal abnormalities in the tunnel [3, 6]. USG is especially helpful while revealing pathological structures in the ulnar canal, such as lipomas, ganglion tumours, or ulnar artery aneurysms [3]. It is important to pay attention to the hook of hamate while performing USG examination – its fracture is ordinarily more visible in the USG than in RTG or MRI scans [3]. It is vital to examine the course and patency of the ulnar artery and the ulnar canal itself, evaluating its anatomical borders. There are no specific laboratory tests helpful when diagnosing the described condition [6].

Patients, who definitely relate their clinical manifestations to bicycle rides, mostly do not need any further diagnostics [14].

Treatment. Guyon canal syndrome and handlebar palsy are usually self-limiting conditions.

Methods of GCS management include using anti-inflammatory medications or painkillers, such as NSAIDs, immobilization of the wrist and hand, or steroid injections, preferably under USG control [6]. In most cases, conservative methods are not sufficient to relieve the patient's symptoms [2].

The ultimate treatment method is surgery, the main aim of which is to relieve the compressed nerve [6, 7]. Surgery is implemented mostly when conservative methods are not effective, or the reason is organic [2]. Among potential post-surgery complications, one can list [2]:

- nerve injury during surgery;
- infection;

- scar or keloid formation;
- vascular problems, such as thrombophlebitis.

Post-operative complications are relatively rare, but it is necessary to take them into consideration at all times [2].

Apart from the management techniques listed above, handlebar palsy is almost fully curable when a rider takes a few months break from cycling [11]. Prevention methods include [11]:

- wearing padded cycling gloves;
- frequent changes of hand position;
- using handlebars that allow resting the upper limbs on forearms instead of wrists.

The treatment should include adjusting the sitting position on the bike, as well as modifying the hand grip (bikefitting). These simple modifications may lead to fast and nearly complete recovery. These adjustments also protect the cyclist from the further damage caused by repetitive pressure and vibrations occurring when cycling [14].

In 2011, Slane et al. conducted a study to evaluate the influence of padded cycling gloves on the reduction of handlebar palsy symptoms [10]. The participants were 36 experienced cyclists, both male and female, who had been road cycling for at least three hours per week for more than one year before the study. The cyclists did not report any cardiovascular, pulmonary or neurological issues, and had not undergone any upper limb surgery in the past. During the study, researchers used stationary bikes configured the same way as the private road bikes of the participants (saddle height, handlebar height, geometry). After 5–10 minutes of warm-up, the cyclists performed a tempo workout for one to two hours, maintaining a constant cadence. During the ride, pressure on the handlebars was measured, and the participants performed a series of tests, including changing cycling gloves (no gloves, non-padded gloves, foam-padded gloves of three to five millimeters, gel-padded gloves of three to five millimeters, and hand position on the handlebar (tops, hooks and hood grips). The researchers' measurements showed that the drop hand position generated the most pressure.

Another conclusion was that not wearing gloves and wearing non-padded gloves did not significantly affect the pressure level on the hypothenar area. On the other hand, the pressure was significantly reduced when using padded cycling gloves. Foam-padded gloves provided only a slight reduction of the maximum force on the handlebars compared with the gel-padded gloves. In both glove types, gel or foam-padded, when the pad thickness was increased from three to five millimeters, the pressure on the hands was decreased. Slane et al. measured that padded gloves reduce maximum pressure on the handlebars from 10 – 29%, but changing hand position while cycling appears to be vital for preventing handlebar palsy symptoms during long-distance bike rides [10].

CONCLUSIONS

- Guyon canal syndrome is a significantly rare condition leading to malfunction of the hand, mostly involving its dorsal side and the hypothenar area. The syndrome is common among cyclists.

- Diagnostic methods of GCS are based on evaluating clinical symptoms and estimating radiological scans – USG or MRI, or electrophysiology methods such as EMG.
- Treatment methods are mostly based on conservative management – rest, NSAIDs and steroid injections, or gear and position changes when cycling. The ultimate methods are surgical treatments, based on relieving compression on the ulnar nerve.

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