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Enhancing Awareness and Management of Carpal Tunnel Syndrome Among Medical Professionals and Athletes

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Abstract

Introduction and objective: The objective of this research is to enhance the awareness of carpal tunnel among medical professionals and individuals engaged in sports. The acquired knowledge will enable medical professionals to more effectively identify, treat, and prevent issues related to carpal tunnel. Additionally, individuals engaged in sports will be able to prevent the occurrence of carpal tunnel syndrome in themselves or their pupils, thereby allowing them to engage in long-term and safe physical activity.

Review methods: Review and summary of research studies available in open-source format on Google Scholar, PubMed.

Abbreviated description of the state of knowledge: Carpal tunnel syndrome is a disease belonging to the group of compression neuropathies. The symptoms of carpal tunnel syndrome typically manifest as an uncomfortable sensation in the thumb, index finger, and

half of the ring finger. Such symptoms may include numbness and tingling. In some cases, weakness of the hand muscles may occur, and in rarer instances, atrophy of the hand muscles. The condition of carpal tunnel syndrome is primarily the result of repetitive movements of the fingers and wrist. Such activities include typing, using a mouse, riding a bicycle, or playing a musical instrument.

Summary: Carpal tunnel syndrome is a prevalent condition among the general population. This condition may affect individuals who engage in regular physical activity, resulting in diminished efficiency and a notable reduction in the quality of life. The objective of this study is to examine the risk factors, symptoms, and diagnostic methods associated with carpal tunnel syndrome. In the context of sports, we will examine the mechanisms of disease development in athletes and focus on prevention. This encompasses the rehabilitation of individuals at risk of developing the disease and patient education, which will facilitate the minimisation of the appearance or recurrence of disease symptoms.

Keywords: median nerve; activity and health; carpal tunnel syndrome; physical activity; cycling;

Introduction

Carpal tunnel syndrome (CTS) is a common medical condition caused by median nerve compression. CTS accounts for about 90% of all entrapment neuropathies[1]. This most common peripheral nerve entrapment occurs when the median nerve is compressed as it travels through the carpal tunnel (CT) in the wrist. Pain, numbness, tingling and weakness are common symptoms of CTS in the thumb, index, middle finger and the radial side of the ring finger. Annual incidence differs depending on the study and the country, it is estimated to affect 3.8 individuals out of a 1000 in the general population. Women are more often affected than men and the individuals with CTS are usually between 40 to 60 years of age[2]. CTS can be treated surgically or non-surgically depending on the patients and the severity of the symptoms.

Pathophysiology

In order to understand CTS pathophysiology, review of basic anatomy is needed. As the median nerve makes its way to the wrist, it passes through the anatomical landmark - carpal

tunnel. It is enclosed by eight carpal bones and a transverse carpal ligament (TCL). Other structures that pass through the carpal tunnel, apart from the median nerve, are nine flexor tendons; synovial fluid lessens the friction between the elements of CT. As there is a lot of structures passing through a fairly tight space, any state increasing the volume of the structures can cause median nerve compression[1].

Yet, the exact pathogenesis of CTS is unknown. Pathophysiology involves a mix of increased pressure, mechanical trauma, and ischemic damage[3].

Repetitive wrist motions is a significant risk factor for CTS[3]. Thus, extended wrist movements involving wrist flexion increase fluid pressure. The fluid pressure in the CT increases significantly when the position of the wrist is changed[4]. Extension caused 10-times increase in pressure compared to initial level, and wrist flexion caused 8-times increase in pressure[5].

At the location of median nerve compression, the blood-nerve barrier is changed, which leads to endoneurial edema development and demyelination[3,4]. Increased pressure, mechanical trauma and ischemic damage are the processes occurring concurrently in the CTS.

Complications

Complications of CTS are severe and arise directly proportional to the risk factors, especially those which are irreversible (eg. motor neuron diseases). Surgical treatment is associated with a greater risk of complications as well in comparison to non-surgical treatment[6]. Speaking of non-surgical treatment, the most frequent complication of surgical treatment which is a neuroma in the palmar cutaneous branch of the median nerve can be avoided[7]. The complications can be divided into the groups of muscles and nerves. When it comes to the nerves, untreated CTS may lead to the median nerve damage, which will manifest with increased pain and palm disability. Other complication is a loss of sensation in fingers. During treatment, the rate of complications of non-surgical treatments like corticosteroids injections are rare[8]. The least risk of any complications is physical therapy, if done correctly[9].

Any other complications are connected to muscles and refer to muscle weakness and atrophy of a thumb due to the pain and numbness. If non-surgical options of the treatment present incomplete resolution of the problem or complications are too severe, the next step would be a choice of the surgical treatment.

Symptoms

The most characteristic and common symptoms of carpal tunnel syndrome are numbness, tingling and discomfort in the area innervated by the median nerve. Symptoms can be triggered by activities that require flexing or prolonged lifting of the hand, such as driving or holding a telephone. In many cases, the discomfort is worse at night when the hand is elevated. They often result in awakening from sleep and relief is provided by shaking the hand[10,11]. Sensory fibres are more sensitive to pressure than motor fibres. Paralysis and pain usually predominate in the early stages of carpal tunnel syndrome. In more severe cases, the symptoms also affect the motor fibres, leading to weakness of the muscles innervated by the median nerve. This can make it difficult to hold objects, perform precise movements such as pressing buttons or working on a computer. The disappearance of pain is an advanced symptom that may indicate a permanent loss of sensation[10].

According to a study conducted between April 2009 and June 2011 at the Physiology Department of the Medical College of King Saud University in Riyadh, Saudi Arabia, the distribution of symptoms may depend on the age of the patient. In the studies cited, patients were divided into two groups. One group was under 50 years of age and the other group was over 50 years of age. The distribution of symptoms in the three lateral fingers of the hand was significantly higher in the over-50 group than in the under-50 group. However, the distribution of CTS symptoms at the level of the wrist was significantly higher in patients under 50 years of age compared to patients over 50 years of age. There was no significant difference in the distribution of CTS symptoms at the level of the fingertips, the whole hand and the forearm between patients[12].

Diagnosis

In the diagnostic process, it is very important to gather a detailed medical history, which includes obtaining information about the onset of symptoms, their duration, location, severity, progression, factors that exacerbate or alleviate symptoms, treatment undertaken, lifestyle, and activities performed. Obtaining this information helps in diagnosing carpal tunnel

syndrome and planning appropriate treatment, or it may lead to the diagnosis of another medical condition[13].

Another important part of the diagnostic process is the physical examination. It includes sensory examination, assessment of potential thenar muscle atrophy (a rarely occurring symptom but may have high predictive value in carpal tunnel syndrome)[14], and provocative tests. The most commonly used diagnostic and provocative tests are the Phalen's test and Tinel's test. A positive result of the Phalen's test is when holding the wrist in a flexed position elicits symptoms of tingling, numbness, or pain in the area innervated by the median nerve. The sensitivity of this test ranges from 67% to 83%, while the specificity ranges from 40% to 98%. The presence of tingling, numbness, or pain in the area supplied by the median nerve upon tapping over the nerve trunk in the carpal tunnel indicates a positive Tinel's sign. Its sensitivity ranges from 48% to 73%, and specificity from 30% to 94%[15].

Nerve conduction studies may also be helpful in diagnosing carpal tunnel syndrome. They allow for the detection of abnormalities in median nerve conduction by comparing it with conduction in another nerve that does not pass through the carpal tunnel, such as the ulnar nerve. This type of study is useful in diagnosing patients with atypical symptoms or in assessing the severity of CTS[16]. Another electrodiagnostic test is electromyography, which helps to rule out other conditions or assess the severity of carpal tunnel syndrome.

Ultrasonographic examination also finds its application in diagnosis. The indicator used during this examination is the assessment of the cross-sectional area of the median nerve. Finding a value equal to or greater than 10mm² is a very accurate parameter in diagnosing carpal tunnel syndrome. The diagnostic sensitivity has been evaluated at 97% using this parameter[17,18].

Carpal tunnel syndrome in athletes

It has been demonstrated that when cyclists hold their wrists on top of the handlebars or when they fold their fingers around the hoods of the handlebars, they can cause injury to the median nerve. It is recommended that cyclists regularly alter their hand position in order to avoid the aforementioned pattern of compression[19]. A study conducted in 2019 revealed that 36% of gamers engaged in online sports reported experiencing discomfort in their wrists. The symptoms may be attributed to compression of the median nerve resulting from improper work practices[20]. The use of a special ergonomic pad when working with a mouse, the

wearing of orthoses or the performance of stretching exercises will result in a reduction of pain[21,22]. Individuals at an elevated risk of developing carpal tunnel syndrome may benefit from performing self-directed exercises to prevent the disease and enhance their overall mobility. One such exercise involves alternating between flexion and extension of the arms with dorsal flexion of the wrists, or imitating the motion of a tennis ball being thrown downward.

Treatment

Laser therapy has been demonstrated to increase cellular oxygen consumption, elevate the level of serotonin and endorphin in tissues, enhance blood circulation and stimulate ATP production by mitochondria. These effects have been observed to result in anti-swelling, anti-inflammatory and regenerative effects on tissues exposed to low-energy laser therapy[23]. Low-level laser therapy has been identified as an effective treatment option for patients presenting with mild and moderate carpal tunnel syndrome[24]. One of the therapeutic modalities employed in the treatment of carpal tunnel syndrome is sonotherapy, which utilizes ultrasonic waves to affect the structures of the wrist. It has been established that ultrasound waves possess anti-inflammatory properties, which facilitate the regeneration of nerves and enhance nerve conductivity[25]. Therapeutic ultrasound was highly effective, with an impressive 74% of patients experiencing satisfactory improvement or complete remission of symptoms. This was a significantly higher percentage than those who received the placebo treatment (20%)[26]. It is posited that the technique of shockwave therapy can be classified as a noninvasive physical therapy method. The application of shock wave therapy has been demonstrated to result in a positive impact on a number of key indicators, including pain, functionality, and electrophysiology measurements, in individuals diagnosed with mild-to-moderate carpal tunnel syndrome. The benefits persist at least one month after the initial application[27]. The primary objective of kinesiotherapy, massage and soft tissue mobilization treatments is to enhance flexibility of muscles, tendons, ligaments and the median nerve. The rationale behind kinesiotherapy is based on the premise that specific sequences of movements of the wrist, elbow, and shoulder joints can facilitate the neuromobilization of the median nerve[29]. Irrespective of the severity of the syndrome, immobilisation in an orthosis has a therapeutic effect in all patients. In patients with severe CTS, an orthosis may be employed in the interim period prior to surgical intervention[32].

The severity of the disease is the primary factor in determining the management of CTS. In cases of mild and moderate severity, it is recommended that conservative treatment be employed. In cases of advanced CTS or where evidence of nerve damage has been identified through electrodiagnostic tests, surgical treatment should be considered. Some examples of non-surgical conservative treatments include the use of orthoses, steroids, and therapeutic ultrasound. A switch to another form of treatment may be necessary if there is no improvement within six weeks. As a general rule, conservative treatments are effective in improving symptoms within a period of 2–6 weeks[28].

The administration of prednisone at a dosage of 20 mg over the course of 10 days has been observed to result in a reduction in symptom severity and an improvement in performance. This beneficial effect has been documented up to the 8th week post-treatment[10].

Injections of glucocorticosteroids, administered locally, are a common treatment for carpal tunnel syndrome. A study comparing the utility of ultrasound-guided injection with landmark-guided injection in persons with CTS found that ultrasound-guided injection was more efficacious than landmark-guided injection in alleviating symptom intensity in patients with CTS. There were no meaningful differences in functional status or electrodiagnostic changes between the two methods[30]. The occurrence of adverse events, such as tendon rupture, intraneural injection and gangrene is observed at a frequency of less than 0.1%[31].

A highly effective method for providing long-term relief from pain is surgical treatment[34]. The surgical procedure involves reducing the pressure in the carpal tunnel. During OCTR(open carpal tunnel release), the surgeon makes an incision at the base of the hand and then cuts the transverse carpal ligament, which eliminates the mechanical pressure on the median nerve. The procedure is considered when symptoms are still present after a long period of non-surgical treatment and when EMG shows severe damage to the median nerve. Another indication for surgical intervention is the permanent loss of movement or sensation. The return to normal function is typically achieved within two weeks[36]. The use of orthoses postoperatively may contribute to the formation of adhesions[33]. The endoscopic method of decompression of the carpal tunnel is also a viable option. ECTR(endoscopic carpal tunnel release) is associated with a faster recovery than OCTR[35].

Conclusions

It has been postulated that patients with carpal tunnel syndrome may be less active due to the discomfort associated with this disease. This may result in a reduction in physical activity. Athletes who suffer from carpal tunnel syndrome may experience poorer performance in sports than those who do not have the disease, and may also be more prone to missing training sessions. It is of great importance for healthcare professionals and those involved in the sporting world to be aware of the underlying mechanisms that contribute to the development of this disease. Appropriate work ergonomics, physical exercise and the early recognition of initial symptoms may result in a more effective coping strategy and a faster return to normal physical activity. The most crucial aspect is the education of the patient, ensuring the accuracy of the exercises performed and directing them to the appropriate medical specialists. In the majority of instances, a rapid introduction of physiotherapy is sufficient in alleviating the presenting symptoms, thereby avoiding the necessity for surgical intervention. It is advisable to consult a physiotherapist without delay, in order to implement preventative measures and avoid the recurrence of the symptoms.

Disclosure

Author's contribution

Conceptualization: Rafał Makuch and Adam Kucharski; Methodology: Alicja Wawrzyniak; Software: Alicja Chrościcka; Check: Andrzej Czajka and Kamil Gała; Formal analysis: Konrad Pilarski and Martyna Dewicka; Investigation: Paweł Lenard and Sara Michalska; Resources: Kamil Gała; Data curation: Alicja Chrościcka; Writing - rough preparation: Adam Kucharski and Rafał Makuch; Writing - review and editing: Alicja Wawrzyniak and Konrad Pilarski; Visualization: Martyna Dewicka; Supervision: Sara Michalska; Project administration: Rafał Makuch and Paweł Lenard; Receiving funding - no specific funding.

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Conflict of interest

The authors deny any conflict of interest.

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