

# Selected questions from aetiopathogenesis of carpal tunnel syndrome

( Wybrane zagadnienia z etiopatogenezy zespołu kanału nadgarstka )

Jarosław Strychar<sup>1,A,D</sup>, Zbigniew Kopański<sup>2,D,F</sup>,  
Adelaida Maria Castro Sanchez<sup>3,E</sup>, Aleksandra Lizik<sup>1,B</sup>

**Abstract** – Introduction. The carpal tunnel syndrome (CTS) means compression mononeuropathy of upper extremity, which is currently diagnosed with 1-3% of the total population of people in middle and old age. The increase of the problem awareness has prompted the authors to make their own research.

The aim of the study. The aim of this thesis was to present the selected questions from the anatomy of the carpal tunnel and the causes of carpal tunnel syndrome development.

Selection of material. The search was performed in Scopus base, using the concepts of carpal tunnel syndrome and its causes in years 1995-2018. Literature found in Google Scholar database was analysed for the number of citations. Literature selected in this way served as the material for the thesis.

Conclusions. The carpal tunnel syndrome is an aetiologically complex syndrome, frequently with idiopathic background.

**Key words** - carpal tunnel syndrome, the reasons for the development of the syndrome.

**Streszczenie** – Wstęp. Zespół kanału nadgarstka (carpal tunnel syndrome - CTS) oznacza mononeuropatię uciskową kończyny górnej, która w chwili obecnej dotyczy 1-3% ogólnej populacji osób w średnim i starszym wieku. Wzrastająca aktualność tej problematyki skłoniła autorów do podjęcia badań własnych.

Cel pracy. Celem pracy było przedstawienie wybranych zagadnień z zakresu anatomii kanału nadgarstka oraz przyczyn powstawania zespołu kanału nadgarstka.

Dobór materiału. Poszukiwania przeprowadzono w bazie Scopus używając pojęć zespół kanału nadgarstka, przyczyny powstawania za okres 1995-2018r. Znalezione piśmiennictwo w bazie Google Scholar przeanalizowano pod kątem największej liczby cytowań. Tak wyselekcjonowane piśmiennictwo posłużyło za materiał do opracowania niniejszej pracy.

Wnioski. Zespół kanału nadgarstka jest złożonym etiologicznie zespołem chorobowym, często o idiopatycznym tle.

**Słowa kluczowe** – zespół kanału nadgarstka, przyczyny powstawania zespołu.

## Author Affiliations:

1. Collegium Masoviense – College of Health Sciences, Poland
2. Faculty of Health Sciences, Collegium Medicum, Jagiellonian University, Poland
3. University of Almería, Spain

## Authors' contributions to the article:

- A. The idea and the planning of the study
- B. Gathering and listing data
- C. The data analysis and interpretation
- D. Writing the article
- E. Critical review of the article
- F. Final approval of the article

## Correspondence to:

Prof. Zbigniew Kopański MD PhD, Faculty of Health Sciences, Collegium Medicum, Jagiellonian University, Piotra Michałowskiego 12 Str., PL- 31-126 Kraków, Poland, e-mail: zkopanski@o2.pl

**Accepted for publication:** May 06, 2019.

## I. INTRODUCTION

The carpal tunnel syndrome (CTS) means compression mononeuropathy of upper extremity, which is currently diagnosed with 1-3% of the total population of people in middle and old age. The disease reduces the patient's quality of life, progressively limiting the patient's movements, including the ones related to important activities. [1]

The aim of the study was to present the selected questions from the anatomy of the carpal tunnel and the causes of carpal tunnel syndrome development.

## II. SELECTION OF MATERIAL

The search was performed in Scopus base, using the concepts of carpal tunnel syndrome and its causes in years 1995-2018. Literature found in Google Scholar database was analysed for the number of citations. Literature selected in this way served as the material for the thesis.

## III. ANATOMY OF CARPAL TUNNEL

The carpal tunnel (canalis Carpi) is restricted from the dorsal side of the hand and its sides with the bones of the wrist, and from its palm – with flexor retinaculum located between the pisiform bone and the hook of the hamate bone as well as the nodules of scaphoid bone and the trapezium bone. The median nerve and tendons of the following muscles: flexor digitorum superficialis m., flexor digitorum profundus m., flexor pollicis longus m., flexor carpi radialis m. pass through the canal (Figure 1). [2-4]

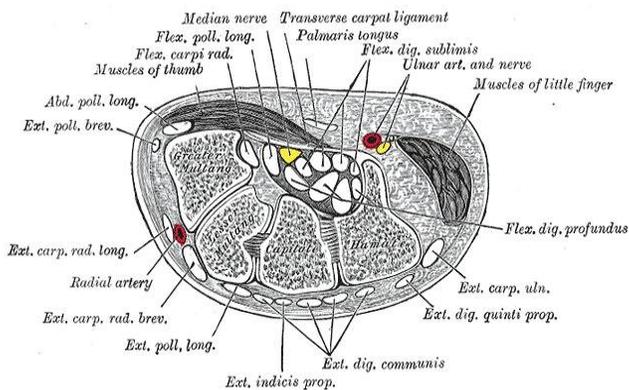


Figure 1. Anatomy of carpal tunnel [5]

## IV. THE CAUSES OF CARPAL TUNNEL SYNDROME

This syndrome is classified in ICD-10 under the symbol 56.0 G, where it is named as upper extremity mononeuropathy. [6] CTS is one of the most common mononeuropathies affecting 1-3% of the general population of persons

in middle and old age. CTS occurs as a result of chronically elevated pressure in the carpal tunnel, which exceeds the critical level of 30 mm Hg, causing a decrease in blood supply to the median nerve and thus disrupting this supply.

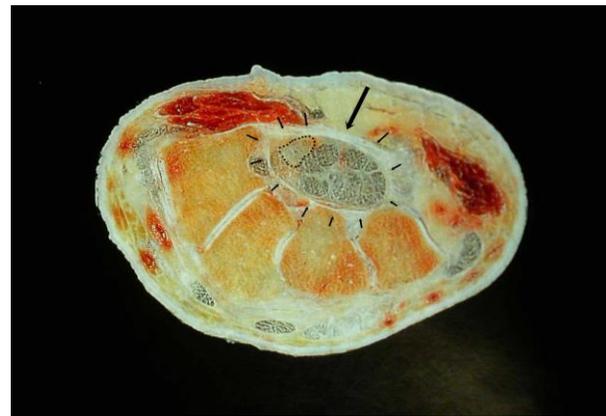


Figure 2. Anatomical preparation. In cross section one can observe the median nerve surrounded by a dotted line inside the carpal tunnel marked with small arrows. Externally to the nerve, there are flexor tendons placed in the longitudinal direction. Large arrow indicates the transverse ligament of the wrist. [5]

In the initial period, the disorders are functional, but in time they may change into morphological ones. They occur in the form of demyelination and lead to axon degeneration<sup>1</sup>. [1,7-9]

The symptoms of CTS were first described in 1854 by James Paget, who noticed that the median nerve can be pressured in the carpal tunnel, which causes a neuropathy of the upper extremity. In 1890, a group of patients with pain and the median nerve paraesthesias were examined. On the basis of this study, in 1908 the impact of the median nerve injury, caused by professional activities, on the occurrence of conduction disturbances in the nerve movement component, was first described. In the course of further studies, a direct relationship between muscle atrophy of the thenar of the thumb and the pressure on the median nerve in the carpal tunnel, was proved. In 1938, the name of “carpal tunnel syndrome”, also defined as the wrist me-

1. The axon degeneration, also defined as Wallerian degeneration, means a neuropathological change arising as a result of breaking the integrity of nerve fibres. This change can be caused by the intersection of the nerve, crushing the nerve, its excessive stretching or the nerve ischaemia. It was named in honour of the phenomenon discoverer, a British neurophysiologist, Augustus Waller, living in years 1816-1870. [7]

dian nerve compression, was introduced for the description of the above mentioned pathologies. [9-14]

The median nerve compression syndrome is caused by pressing the median nerve within the carpal tunnel. This condition can be caused by inflammation occurring in the tendon sheaths or changes in the tunnel form resulting, for example, from a bone fracture. It is assumed that the pressure inside the carpal tunnel measured in neutral position in healthy people should be about 14 mm Hg. Experimental studies have shown that lowering the conductance speed by stimulating the fibres of the median nerve occurs after 4-5 weeks of pressure on the median nerve with the pressure level of 50, 60 or 70 mm Hg or 80 mm Hg, after just one week.

With the pressure of 30 mm Hg on the median nerve, the first clinical symptoms appear and the changes in the neurophysiological parameters of nerve compression occur. The pressure of 60 mm Hg induces paraesthesias, inhibits conduction of sensory stimulation and as a result in 10 to 30 minutes the conduction inside the motor fibres of median nerve becomes disturbed. [15,16]

Moreover, it has been revealed that the movement of upper extremity in the radial- carpal joint has an impact on the carpal tunnel diameter, whereas the palmary and dorsal flexion of the hand changes the anatomic conditions inside the tunnel inducing the increase of pressure inside the carpal tunnel even by 100 mm Hg. The dorsal flexion of the hand can cause the increase of pressure inside the tunnel even 10 times its normal level, while the palmary flexion- 8 times. It has been proved that in CTS patients with palmary flexion the pressure inside the tunnel amounts to 94 mm Hg, while in patients with dorsal flexion- 110 mHg. For comparison, the pressure inside the tunnel in healthy patients equals, respectively, 31 mm Hg (palmary flexion) and 30 mm Hg (dorsal flexion). [13,15,16]

A continuous pressure on the median nerve can cause its narrowing or even breaking. In such situation, the first stage of nerve damage occurs implying the initial part of the second stage, i.e. an advanced CTS.

It is estimated that women suffer from the carpal tunnel syndrome around 3-5 times more frequently than men. The syndrome is most common with patients aged 40-60, and is most frequently diagnosed in patients over 55. [9,17-19] Regardless the discrepancies in the epidemiological incidence of carpal tunnel syndrome, it is said that these differences may result from hormonal changes occurring in women, especially after menopause with hormonal therapy and during pregnancy.[9,13,14,17]

## V.FACTORS CAUSING PRESSURE IN THE CARPAL TUNNEL

Excessive pressure in the carpal tunnel leads to demyelination and/or degeneration of the axonal median nerve. The following factors favour the phenomenon [7,8,10,20,21]:

- palmary wrist pressure caused by hypertrophy of the transverse ligament of the wrist,
- excessive pressure from the dorsal side (bone tunnel of the wrist) caused by a fracture of the radius bone in a typical place or fracture/ dislocation of the wrist bone,
- excessive pressure from the centre of the carpal tunnel caused by excessive growth of anatomical structures (e.g. hypertrophy of tendon sheaths in the course of rheumatoid arthritis) or the development of pathological structures (e.g. ganglions, tumours, etc.) occurring inside the tunnel.

In the etiopathogenesis of CTS formation, the involvement of local and systemic factors is taken into consideration. Local factors include disease processes that occur within the carpal tunnel [7,8,10,15,16,20,21]:

- post-traumatic changes related to carpal bone tunnel, in particular the fracture of the distal radial bone and the lunate bone dislocation, as well as liming hematomas,
- degenerative and overload changes of bones and soft tissues in this area,
- inflammatory changes occurring in the tendons and tendon sheaths,
- atavistic anatomic structures associated with developmental defects, e.g. additional tendons, bellies of a muscle,
- post-burn and post-traumatic scars,
- nodular changes in the course of systemic or local diseases,
- hematomas after anticoagulant therapy.

The systemic factors that can foster CTS are: [8,13-15,22]:

- hormonal disorders occurring in acromegaly, during pregnancy, menopause, and hypothyroidism,
- metabolic disorders, e.g. obesity, diabetes, amyloidosis,
- vascular disorders, e.g. in Raynaud's disease, in hypertension or following thrombotic changes,
- allergic reactions, avitaminosis (B6, B12).

The main factors that can both cause and exacerbate CTS-related discomfort are primarily associated with long-term

activities involving alternate bending and straightening of the wrist. It should also be emphasized that the occurrence of CTS is associated with long hours of placing the wrist in a bent or straight position. In these situations, shaking the hand or warming it up brings temporary relief. Over time, however, the muscle strength of the upper limb (hand) is significantly weakened, which causes problems, for example, in unscrewing or screwing the lid of the jar.

In the initial period, the symptoms of carpal tunnel syndrome occur primarily at night and after waking up the tingling of the hand occurs. These symptoms intensify when the limb is raised and when performing those activities that require frequent bending of the dorsal part of the wrist (dishwashing or driving a motor vehicle). Lowering the hand reduces discomfort and brings immediate relief to the patient.

In a large number of CTS cases the background of existing ailments is idiopathic, which prevents causal treatment and allows only symptomatic (conservative or surgical treatment). [15,16,20,21]

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