

Clinical science

# THE MOST COMMON DISORDERS OF THE HAND ASSOCIATED WITH CARPAL TUNNEL SYNDROME IN ADULTS

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## Abstract

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Клинички истражувања

## НАЈЧЕСТИ НАРУШУВАЊА НА РАКАТА КАЈ ВОЗРАСНИ ПАЦИЕНТИ ПОВРЗАНИ СО СИНДРОМ НА КАРПАЛЕН ТУНЕЛ

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## Изводок

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**Печатарски права:** ©2021 Душанка Грујоска-Вета, Даниела Георгиева, Ненад Атанасов, Илир Шабани, Лилјана Ангелеска, Антонио Георгиев, Јасна Богданска. Оваа статија е со отворен пристап дистрибуирана под условите на нелокализирана лиценца, која овозможува неограничена употреба, дистрибуција и репродукција на било кој медиум, доколку се цитираат оригиналниот(ите) автор(и) и изворот.

**Конкурентски интереси:** Авторот изјавува дека нема конкурентски интереси.

Синдром на карпалниот тунел (СКТ) е состојба на периферна невропатија предизвикана од хронична компресија на п. medianus во предел на карпалниот тунел, и има мултифакторска етиологија. Често пати овој синдром кај возрасни лица е поврзан и со состојби на закочени прсти и де Куервенова болест. Целта на овој труд беше да ги прикаже поврзаните состојби на стенозирачки теносиновити на раката кај оперативни лекуваните возрасни пациенти со СКТ и нивните демографски карактеристики. Материјал и методи: Оваа проспективна клиничка студија на 116 возрасни оперирани пациенти со дијагноза СКТ (потврдена со клинички и електрофизиолошки испитувања) беше изведена на Клиниката за ортопедски болести - Скопје. Релевантни демографски податоци, наоди од историја на болеста и клиничките испитувања беа регистрирани и статистички обработени според утврдени критериуми за вклучување на испитаниците со СКТ. Резултати: Испитаниците беа на возраст од 29 до 75 години, со просечна возраст од 55,41 ± 10,7 години и доминантност на пациентите од женски пол (75%). 63,8% од пациентите со СКТ имаа една или повеќе придружни болести. Кај 15,51% пациенти беа истовремено дијагностицирани состојби на закочени прсти и де Куервенова болест на истата рака и тие беа оперативни третирани во еден акт со отворената декомпресија на п. medianus. Заклучок: Истовременото постоење на СКТ и стенозирачки теносиновити (закочени прсти и де Куервенова болест) со различно време на појавување упатуваат на заеднички етиолошки фактори. Најглавни заеднички ризик-фактори за појава на овие состојби е женскиот пол кај пациентите и возраст од 40-60 години.

## Introduction

Carpal tunnel syndrome (CTS) is one of the most common non-traumatic disorders of the hand in adult patients and the most common reason for visiting orthopaedic surgeons. This syndrome is often associated with trigger fingers and de Quervain's disease in adults. These disorders might exist separately, but also might be concomitantly present on the same hand or appear after surgical procedures of one of them.

Carpal tunnel syndrome (CTS) is a peripheral neuropathy caused by chronic compression of the median nerve in the area of the carpal tunnel and its etiology is multifactorial. The clinical picture depends on the duration and intensity of pressure on median nerve, which is a mixed type of nerve with sensitive and motor nerve fibers. At the beginning, the discomfort is in the form of sensory disturbances (numbness, paresthesia and/or pain in the fingers - from the thumb to the radial side of the ring finger, tingling and burning pain even radiating to the elbow or shoulder, nocturnal pains). Later, in more severe cases, when motor component of the median nerve is involved, clumsiness during everyday activities and hypotrophy of tenor muscles, are observed.<sup>1</sup> Nocturnal pains are typical due to the additional pressure on median nerve because of the prolonged flexion position of the wrist during sleeping. Shaking of the hand during nights is a typical act in patients with CTS in order to relieve pain.

The exact incidence and prevalence vary depending on the diagnostic criterion. The highest incidence is in patients aged 50-60 years and more often in females.<sup>2</sup> The exact prevalence of people with complaints is from

13.0% to 15.8% in the general population, and according to the clinical picture and confirmed by ENMG examinations varies from 2.7% to 5.8%.<sup>3</sup> Surgical carpal tunnel release is a treatment of choice in cases where conservative therapy for CTS failed.

Trigger finger is a disorder characterized by an impaired smooth sliding of the flexor tendons of the fingers due to the mechanical entrapment usually at the level of the first annular pulley, caused by multifactorial etiology. Chronic discrepancy between the flexor tendons with tenosynovitis and the first annular pulley is the cause of morphological and functional disorders. According to the Green classification, complaints might be pain and discomfort, painful tenderness on palpation at the level of the metacarpophalangeal joint on palmar side, locking of fingers in flexion/extension or inability of passive extension of fingers due to flexion contracture of proximal interphalangeal joint.<sup>4</sup> Prevalence of 2.6% is frequent in the general population aged 40-60 years.<sup>5</sup>

Morbus de Quervain (mother's wrist, mommy thumb) is a disorder characterized by an impaired smooth sliding of the tendons of m. abductor pollicis longus (m.APL) and m. extensor pollicis brevis (m.EPB) due to the mechanical entrapment at the level of the first dorsal compartment. Tenosynovitis of those tendons, caused by multifactorial etiology, is a reason for pain and burning sensation in the radial area of the wrist during thumb movements. Complaints are more often in females, especially after delivering a baby.<sup>6</sup> Most of the patients have positive provocative Finkelstein's test (pain in the area of radial styloid during passive ulnarward deviation of the wrist). Wolf reported rate of

de Quervain's disease in 2.8 cases per 1000 persons/year in females and 0.6 cases per 1000 persons/year in males, in a study conducted from 1998-2006 on United States military personnel.<sup>7</sup>

Surgical release of A1 pulley and first dorsal compartment release are done in cases where conservative therapy is ineffective.

Occupations that include repetitive movements, packing, counting money, clothing industry, use of vibrating machines are main risk factors for development of these disorders.<sup>8</sup>

Although the etiology is multifactorial, coexistence of several diseases (diabetes, rheumatoid arthritis, and hypothyroidism, overweight) in the same person is noticeable.<sup>9</sup>

The aim of this paper was to present the most commonly associated disorders of the hand in surgically treated adult patients with CTS and by evaluating the demographic data of these patients to identify possible risk factors for the coexistence of these three disorders.

## Material and methods

One hundred and sixteen surgically treated patients with CTS were included in our prospective clinical study that was conducted at the University Clinic for Traumatology, Orthopedic Diseases, Anesthesiology, Reanimation and Intensive Care Medicine and Emergency Department, Clinical Center Mother Theresa, Skopje, RNM during a three-year period. Patients were with clinical diagnosis of CTS and confirmed by electroneuromyographic examination (ENMG). Data from surgically treated hands were analyzed, and in cases with bilateral involvement, only data from the first treated hands were included.

Inclusion criteria:

- persons aged 25-75 years
- anamnestic data on tingling and/or pain in the thumb, second, third and radial part of the fourth finger, nocturnal paresthesia, clumsiness with the fingers of the affected hand
- positive provocative tests
- confirmed diagnosis of CTS by ENMG

Exclusion criteria:

- persons under 25 years of age and older than 75 years
- pregnant women
- people with reduced cognitive abilities
- detainees and prisoners
- previous hand surgery
- soft-tissue injuries or fractures of the bones of the forearm and wrist
- polyneuropathy, hereditary neuropathy

The following data of interest for the study were recorded:

- personal and family medical history, occupation, education, comorbidities and demographic characteristics (age, sex, dominant hand, height, weight, body mass index (BMI), nationality, place of residence),
- complaints and their duration until surgery,
- findings of clinical examination of symptomatic hand (thenar hypotrophy, positive provocative tests of Phalen and Finkelstein, signs of trigger fingers).

The clinical study was approved by the Ethics Committee for Human Research at the Faculty of Medicine in Skopje, Ss. Cyril and Methodius University in Skopje, R N Macedonia (Approval No. 03-2895/7). All the partic-

ipants were informed and gave their written consent for the examination and surgical procedures.

### Statistical analysis

A descriptive-analytical statistical method was used for the statistical processing of the results obtained in the clinical study. Statistical analysis was made with the software SPSS, version 22.0. Descriptive data are presented as mean $\pm$  standard deviation (SD), or as median. Percentages are given for categorical variables. The threshold for statistical significance was set at  $p < 0.05$ .

### Results

One hundred and sixteen patients surgically treated at the University Clinic for Orthopedic Diseases in Skopje were enrolled in this study according to the inclusion criteria. They were examined with ENMG prior to the surgical procedure. 74.14% (86) of patients were from Skopje. In the distribution according to the level of education, most of the patients had completed secondary education - 62.9% (73). 86.2% (100) of CTS patients were of Macedonian ethnicity, followed by patients of Albanian - 6% (7), and Serbian ethnicity - 4.3% (5). Two patients were of Turkish and one patient was of Roma ethnicity.

Eighty-seven patients were female and twenty-nine male, with a mean age of  $55.41 \pm 10.7$  years (age range 29-75). Female patients with CTS were younger than male patients, but the mean age was not statistically significant ( $p = 0.16$ ). The mean age of female patients was  $54.6 \pm 10.4$  and of male patients  $57.83 \pm 10.9$  years.

The body mass index (BMI) had an average value of  $27.7 \pm 5.6$  kg/m<sup>2</sup> and ranged from 27.7 to 46.5 kg/m<sup>2</sup>. 33.6% of patients had normal weight and 30.2% patients were obese. The body mass index did not differ significantly between patients according to their gender ( $p = 0.71$ ).

36.2% of patients smoke more than 20 cigarettes per day.

Table 1 shows the percentage of comorbidities in operated patients. 63.8% of patients with CTS had one or more comorbidities, mainly joint diseases (polyarthritis), tenosynovitis and diabetes mellitus - 24.1%, 19% and 18.1%, respectively. (Table 1)

**Table 1.** Comorbidities in patients with CTS

Other diseases	n (%)
absent	42 (36.21)
present	74 (63.79)
1. Hypothyroidism	3 (2.59)
2. Diabetes mellitus	21 (18.1)
3. Metabolic diseases	4 (3.45)
4. Rheumatic diseases	6 (5.17)
5. Tenosynovitis	22 (18.96)
6. Chronic renal failure	8 (6.9)
7. Osteoporosis	5 (4.31)
8. Joint diseases (Polyarthritis)	28 (24.14)
9. Malignant diseases	3 (2.59)
10. Cardiovascular diseases	11 (9.48)
11. Discopathy (cervical or lumbal)	13 (11.21)
12. Psychic diseases	3 (2.59)

CTS - carpal tunnel syndrome

The type and duration of the complaints and the clinical findings in the patients were examined. Table 2 presents the most common symptoms and duration of symptoms by gender. The results obtained showed that



all patients complained on tingling and numbness in the thumb, second, third and radial side of the fourth finger. 17.2% of CTS patients had pain during daytime. Nocturnal pains and sleep disturbance were predominant symptoms in 47.4% of patients. Sleep disturbance and clumsiness of the hands were positive in 35.35% patients, who also had hypotrophy of thenar and muscle weakness. The symptomatology was significantly dependent on the gender of the patients, ( $p=0.034$ ), meaning that 55.2% male patients complained more on tingling, nocturnal pains, sleep disturbances and clumsiness compared to 28.7% female patients. Duration of characteristic symptoms of more than 2 years was noted in 50.9% (59) of CTS patients. Male patients had longer duration of symptoms but without statistically significant difference ( $p=0.13$ ) (Table 2).

62.1% of patients had a positive provocative test of Phalen on clinical examination and 37.93% of patients had hypotrophy of thenar preoperatively. 95.69% of patients were right-handed. Open carpal tunnel release (OCTR) under local anesthesia was performed in all patients. Of them, 56.9% were on the right hand and 43.1% on the left hand.

Table 3 presents the percentage of concomitant disorders in 116 surgically treated patients for CTS. Duration of symptoms due to these disorders was from 2-6 months. 18% of these patients underwent additional surgical procedures. 15.51% of these patients were diagnosed with trigger fingers and de Quervain's disease upon admittance for OCTR. All trigger fingers and thumbs were in the third stage of Green's classification (locking in flexion and assisted exten-

**Table 2.** Distribution of patients with CTS according to symptomatology and gender

Variables	n	gender		p-level
		Female n (%)	Male n (%)	
<b>Main complaints</b>				
Tingling	116	87 (75%)	29 (25%)	
Tingling, pains,	20	17 (19.54)	3 (10.34)	$\chi^2 = 6.73$
Tingling, pains, sleep disturbance	55	45 (51.72)	10 (34.48)	$p = 0.034$ sig
Tingling, pains, sleep disturbance clumsiness with hands	41	25 (28.74)	16 (55.17)	
<b>Duration of symptoms</b>				
6 - 12 months	15	10 (11.49)	5 (17.24)	$\chi^2 = 4.08$
12 - 24 months	42	36 (41.38)	6 (20.69)	$p = 0.13$ ns
> 24 months	59	41 (47.13)	18 (62.07)	

p (Pearson Chi-square), CTS-carpal tunnel syndrome

sion). They were surgically treated following OCTR as "one-stage procedure" under local anesthesia. 2.58% of female patients were diagnosed

with tumor-like lesions and they were surgically treated 3 months after OCTR (Table 3).

**Table 3.** Percentage of patients with CTS and additional concomitant disorder on the same hand

Concomitant disorder	n (%)	gender	
		Female	Male
none	95 (81.89)		
Trigger thumb	11 (9.48)	8	3
Trigger fingers (third and fourth)	6 (5.17)	3	2
De Quervain's disease	1 (0.86)	1	
TLL	3 (2.58)	3	

TLL-tumor-like lesions (1 Ganglioma, 2 benign giant-cell tumors of tendon sheet), CTS -carpal tunnel syndrome

## Discussion

CTS, trigger fingers and de Quervain's disease are so called "disorders of entrapped nerves and tendons". They are a result of special anatomy of the hand adjusted for fulfillment of precisely coordinated movements. Special anatomy of tunnels with bone floors and soft-tissue roofs allows the passage and facilitates movements of nerves and tendons. Mutual existence of CTS and stenotic tenosynovitis (trigger finger and de Quervain's disease) with different times of occurrence refer to common etiological factors that act on a similar anatomical structure and lead to inadequacy of the space in the bone-fibrous tunnel and its contents (nerve and tendon), resulting in morphological and functional changes of both of them. The clinical picture depends on the duration of chronic pressure on the median nerve or tendons. In the beginning symptoms are similar, while in later stages, when more changes develop due to prolonged pressure, the differentiation of these disorders becomes clearer.

Our results presented in Table 1 show that about 63% of patients with CTS had one or more comorbidities. 33% of respondents suffered from cardiovascular, metabolic and hormonal

diseases, which are possible causes for the microvascular changes expressed mostly in nerves located in narrow bone-fibrous tunnels such as the median nerve.<sup>10, 11</sup>

Other comorbidities (rheumatic diseases, tenosynovitis, arthritic changes and chronic renal failure) may also be responsible for the increased chronic pressure of the median nerve at the level of the carpal tunnel. It is assumed that this leads to many alterations, especially intraneural circulation that cause morphological changes of the nerve in the form of swelling and change shape, with progressive demyelination, eventual axonal degeneration and fibrosis.<sup>12</sup>

Histopathological studies of stenotic tenosynovitis have shown that non-inflammatory hypertrophy and fibrosis of tendon sheath are biggest at the level of the first annular pulley and there is deposition of an abundant extracellular matrix with chondroid in the deep parts of the pulley. These changes lead to difficult movement, i.e. sliding of the flexor tendons in the inner lining.<sup>13</sup>

A similar process develops in de Quervain's disease. Thickening of the tendon sheath due to mucopolysaccharide deposition and myxoid degeneration corresponding to chronic

degenerative changes, rather than an inflammatory reaction, was demonstrated in a study conducted in England by examining histopathological specimens taken from 23 operatively treated patients with de Quervain's disease.<sup>14</sup>

Some of the comorbidities listed in this paper were: diabetes, cardiovascular and metabolic diseases, hypothyroidism, chronic renal failure, rheumatic diseases.<sup>15,16,17,18,19</sup>

The results obtained in our study have shown that majority of participants (75%) were of female gender. Female patients in our study were younger than male patients, but the mean age was not found to be statistically significant ( $p=0.16$ ). This finding was consistent with other studies.<sup>20, 21</sup>

According to the results in Table 2, the duration of symptoms in female patients until surgery was shorter and the functional discomfort was smaller compared to male patients

The symptoms (pain, insomnia, clumsiness and hypotrophy of thenar) as signs of more advanced damage of the median nerve were statistically more common ( $p=0.034$ ) in males than in females, 55.2% vs 28.7%. The reason for delayed surgery was mostly due to the refusal of the operation, fear of it, reduced funds due to sick leave and the fear of losing a job (as obtained from our talks with the participants).

Overall, more women suffer CTS from than men and it has been reported in a large number of epidemiological studies.<sup>22, 23</sup> In a retrospective study done in New Zealand including 2,313 patients who underwent CTR, 61% were female and 39% were male.<sup>22</sup> In another study conducted by Farioli et.al. in Italy between 1997 and 2000, an almost 4-fold increase in the

risk of surgically treated CTS was observed in women compared to men among non-manual workers.<sup>23</sup> In a study of Nosewicz et al. 60.3% of 967 participants with CTS were females.<sup>24</sup>

The mean age of female participants in our study was  $54.6\pm 10.4$ , implicating that they were in the reproductive and menopausal period and the hormonal changes during these periods might be responsible for the onset of tissue edema and an increased pressure on the median nerve and tendons.<sup>25</sup> Our clinical study confirmed a concomitant presence of CTS, trigger fingers and de Quervain's disease in 15.51% of patients at admittance for CTR. The majority of them were also females, which could be explained by increased work in postpartum period, repetitive movements in taking care of small children and during housework.<sup>26</sup> The research by Rottgers also showed concomitant presence of CTS and trigger fingers, even in higher percentage of 61%.<sup>27</sup> In other prospective study of 211 patients with trigger finger, 43% were diagnosed with CTS, too.<sup>28</sup>

Many authors report an increased incidence of trigger fingers on the same hand following CTR. Lin et al. in a retrospective study conducted on 10,420 patients with CTS and 2,605 patients with CTR reported a 6.71% incidence of trigger fingers, while after open decompression of the median nerve, the overall risk of trigger fingers was 3.63 times higher in the operated patients in the first 6 months after the intervention.<sup>29</sup> In another study comprising patients with CTS, where 66.7% were female, prevalence of trigger fingers after CTR was 26.3%.<sup>30</sup> According to Acar et al., the incidence of occurrence of trigger fingers after open decompression of the median nerve was 13.9%, and if the distal fascia of

the forearm was also released, the incidence was up to 31.3% in patients with more severe EMG findings.<sup>31</sup>

The trigger thumb was the most common finger (9.48%), followed by ring and middle finger (5.17%) in our study. These findings are consistent with data from a study conducted on 497 patients with CTR, of which in 229 patients with postoperatively developed trigger fingers, the thumb was registered in 42.22% after 3.5 months of intervention, and the fourth and third trigger finger were registered in 46.66% after 7.5 months.<sup>32</sup> The thumb and the ring finger were the most common trigger fingers in another study.<sup>33</sup> Some authors explain the more common occurrence of trigger fingers after surgical decompression of the median nerve by the displacement of the tendons of the superficial flexors of the fingers towards the volar, which leads to a mechanical irritation of the tendon sheath and its hypertrophy, usually at the level of the A1 pulley.<sup>34, 35</sup> However, the existence of trigger fingers without CTS or CTR suggests other, still unknown etiological factors.

Disadvantages of our clinical study were the small number of patients, their inhomogeneity in terms of occupation and comorbidities, and the lack of a control group.

The importance of this paper is that this is the first research in our country, according to the available data, which deals with the association of CTS with simultaneous coexistence of de Quervain's disease and trigger fingers according to precisely defined inclusion and exclusion criteria. The results determined the prevalence of the females at the age of 40-60 years. The research findings can be the basis for further investigation of other

risk factors, and thus the detection of possible preventive measures and appropriate treatment.

## Conclusion

Our study showed a simultaneous coexistence of CTS and stenotic tenosynovitis -trigger fingers and de Quervain's disease with different time of onset. Our results also indicated that common risk factors were the female gender in patients and the age of 40-60 years. It might be assumed that common etiological factors, which act on a similar anatomical structure and lead to inadequacy of the space in the bone-fibrous tunnel and its contents (nerve and tendon), result in morphological and functional changes. In order to conduct a more significant statistical analysis and reach valid statistical conclusions, it would be necessary to perform research in the future on large groups of patients with CTS according to certain inclusion criteria in terms of comorbidities, physiological conditions and occupation.

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