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Original Article

Evaluation of Coexistence of Cervical Radiculopathy in Patients with Carpal Tunnel Syndrome Based on Electromyography Findings in Patients Referred to Physical Medicine and Rehabilitation Clinic of Imam Khomeini Hospital, Tehran, Iran

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Seyede Zahra Emami Razavi[1], Shahram Rahimi[2], Maryam Hosseini[2], Mohaddeseh Azadvari[2], Behnam Ghorbani[3]

[1] Associate Professor, Department of Physical Medicine and Rehabilitation, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran
[2] Assistant Professor, Department of Physical Medicine and Rehabilitation, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran
[3] Medical Student, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran

Keywords
Carpal tunnel syndrome; Cervical radiculopathy; Double crush syndrome

Abstract

Background: Carpal tunnel syndrome (CTS) is the most common neuropathy caused by nerve compression. The "double crush syndrome" (DCS) theory suggests the coexistence of CTS and cervical radiculopathy (CR). Studies on DCS have focused mainly on nerve damage in the proximal part and, subsequently, vulnerability of the distal part of the nerve to injuries, in particular, entrapment. There are few studies on the presence of distal injury following the vulnerability of the proximal portion. Therefore, the current study deals with the evaluation of the simultaneous presence of CR in patients with CTS.

Methods: This retrospective study was performed on 309 upper limb electromyography (EMG) records of patients with CTS. These patients referred to the physical medicine and rehabilitation clinic of Imam Khomeini Hospital, Tehran, Iran, during 2016 to 2019 with complaints of neck pain or tingling hands to have an EMG. The demographic data and EMG findings were analyzed using SPSS software.

Results: Of 309 patients with CTS, 17 (5.5%) patients had CR. The prevalence of CTS and DCS increased with age and it was higher in women compared to men. However, this increase was not significant for DCS. The present study showed that C5-C6 nerve roots were more involved in CTS and DCS in comparison to other nerve roots.

Conclusion: The findings of this study suggested that concurrent incidence of CR was very low in patients with CTS. This may indicate that nerve damage in the distal part does not predispose the proximal area to injury.

Email: farapuboffice@gmail.com

Corresponding Author: Mohaddeseh Azadvari; Department of Physical Medicine and Rehabilitation, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran
Email: drazadvari@yahoo.com

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Introduction

Symptoms such as neck and upper limb pain and numbness of hands are common complaints among patients referring to physical medicine and rehabilitation clinics for electromyography (EMG) tests.[1]

Carpal tunnel syndrome (CTS) is the most common neuropathy caused by nerve compression in the upper limb and accounts for about 90.0% of neuropathies caused by nerve entrapment.[2] This disease has a prevalence rate of about 3.6% in the normal population, with a higher prevalence in women. Although most of the time, this syndrome is idiopathic, there are also some risk factors introduced for this disease which include occupational risk factors and concomitant diseases including hypothyroidism, pregnancy, rheumatism, menopause, obesity, kidney failure, etc.[3]

This syndrome is initially diagnosed on the basis of history and clinical examination and is confirmed by electrodiagnosis (EDX). The sensitivity and specificity of the EDX test for the diagnosis of CTS are about 85.0% and 95.0%, respectively.[4]

Cervical radiculopathy (CR) is caused by the involvement of the cervical nerve roots. This disorder is caused by inflammation or compression of the nerves at their exit, the most common cause of which is intervertebral disc protrusion and vertebral degeneration.

Clinically, CR and CTS can mimic similar clinical symptoms and may also occur concurrently.[5] Given the theory of "double crush syndrome" (DCS), there is a greater chance of simultaneous CTS and CR. According to this theory, pressing a nerve in one area increases its sensitivity to pressure in other areas.[6]

However, most studies suggest that pressure at the proximal end of the nerve reduces the tolerance of pressure on the distal part.[7] The cause of this vulnerability can be due to disruption of the axoplasmic flow.[8] The DCS theory justifies the presence of pain in the forearm, elbow, arm, and shoulder areas in patients with CTS as well as the failure of surgical treatment in these patients.[9]

The nerve DCS theory was first developed in 1973 in a study conducted by Hurst et al. on 115 patients. This theory claims that the pressure due to successive entrapments on a peripheral nerve has a synergistic effect on its signaling.[10] In fact, nerve compression at the proximal end reduces the tolerance of pressure on the distal part.[7]

The specific anatomic position of the carpal tunnel exposes many patients to CTS. Nevertheless, DCS may be another reason for the high prevalence of CTS.[10]

Some studies confirm the DCS theory and some reject it. There is also controversy as to whether the site of nerve compression is of importance regarding the occurrence of DCS. Based on the conflicting studies, this study was carried out to investigate the coexistence of CR in patients with CTS and to determine whether the nerve end damage predisposes the nerve to damage in the proximal segment.

Methods

This cross-sectional study was performed retrospectively on EMG records of patients with CTS between 2016 and 2019. In addition to the findings of EMG, the demographic information of the patients such as sex and age was also assessed.

All EMG tests were performed using a Medelec EDX device (Medelec Premiere plus, USA). The patients' hand temperature during the study was above 32 °C.

The data collected were analyzed in SPSS software (version 25, IBM Corporation, Armonk, NY, USA).

Results

Of 309 subjects included in the study, 23.0% and 77.0% were men and women, respectively. The prevalence of CTS in individuals aged 30-40 years was 46.9%, which had the highest rate of prevalence. Sixteen (5.2%) patients were older than 50 years (Table 1).

Table 1. Age, sex, and intensity of carpal tunnel syndrome (CTS) frequency distribution in patients with CTS

Variable		n (%)
Age (year)	Less than 30	63 (20.4)
	31-40	145 (46.9)
	41-50	85 (27.5)
	More than 50	16 (5.2)
Sex	Male	71 (22.9)
	Female	238 (77.0)
Intensity	Mild	97 (31.4)
	Moderate	141 (45.6)
	Severe	71 (23.0)

Table 2 examines the prevalence of DCS by age, sex, and severity of CTS in patients with CTS.

Given this table, out of 309 patients with CTS, 17 (5.5%) patients had CR. The prevalence of DCS was greater in women over the age of 50; in addition, the moderate and severe intensities accounted for the higher rates.

Table 3 demonstrates the prevalence of DCS based on the level of the cervical nerve root involvement. According to these findings, the prevalence of DCS in the C5 and C6 cervical nerve roots was higher than the rest of the nerves, with 7 out of 17 patients having 41.2% cervical nerve root involvement.

Table 3. Prevalence of double crush syndrome (DCS) based on cervical nerve root involvement in patients with carpal tunnel syndrome (CTS)

Variable	n (%)
C7	5 (29.4)
T1	2 (11.8)
C5-C6	7 (41.2)
C5-C6-C7	3 (17.6)
Total	17 (100)

Table 4 illustrates the prevalence of risk factors in all patients with DCS alongside their respective odds ratio (OR) and 95% confidence interval (CI) compared to pure CTS. The results of this table showed that the prevalence of DCS increased by 5.4% for one year of increase in the patients' age. This increase was statistically significant ($P < 0.001$). Moreover, the incidence rate of DCS in women was about 11.0% higher than in men, but this increase was not statistically significant ($P = 0.839$) due to the low prevalence of DCS in this study.

Table 4. Prevalence of risk factors for double crush syndrome (DCS) with odds ratio (OR) and confidence interval (CI) of 95%

Variable	OR	95% CI	P
Age (year)	1.05	(1.04-1.07)	< 0.001
Sex (male)	1.11	(0.39-3.11)	0.839

OR: Odds ratio; CI: Confidence interval

Discussion

The results of the present study suggested that the highest prevalence of CTS was in individuals aged 30-40 years (46.9%) (Tables 1-4).

Table 2. Prevalence of double crush syndrome (DCS) by age, sex, and severity of carpal tunnel syndrome (CTS) in patients with CTS

Variable		CR and CTS		P
		No [n (%)]	Yes [n (%)]	
Age (year)	Less than 30	60 (20.60)	3 (17.64)	0.020
	31-40	140 (47.90)	5 (29.41)	
	41-50	81 (27.70)	4 (23.53)	
	More than 50	11 (3.80)	5 (29.41)	
Sex	Male	66 (22.60)	5 (29.40)	0.517
	Female	226 (77.40)	12 (70.60)	
Intensity	Mild	92 (31.50)	5 (29.40)	0.040
	Moderate	135 (46.20)	6 (35.30)	
	Severe	65 (22.30)	6 (35.30)	

CR: Cervical radiculopathy; CTS: Carpal tunnel syndrome

Additionally, based on the above tables, the findings show that out of 309 patients with CTS, only 17 (5.0%) had CR, indicating that the prevalence of DCS was low and only CTS was reported in most patients examined in this study. The current study also revealed that the prevalence of DCS was higher in higher ages, with a rate of 29.41% over the age of 50 years. Overall, the results of this study show that the prevalence of DCS increases by 5.4% for one year of increase in the patients' age. This increase was statistically significant ($P < 0.001$).

The results of the present study regarding the rate of coexistence of CR with CTS are similar to those of the study by Morgan and Wilbourn, showing that about 3.4% of cases of CR are associated with CTS.[8]

In this regard, a study by Moghtaderi and Izadi indicated that in 149 patients with CTS and 36 patients with DCS, the mean age for both syndromes was approximately 39 years,[11] which is in line with the present study in terms of age.

Of 309 patients with CTS, 238 (77.0%) and 71 (23.0%) were women and men, respectively. Overall, the current study findings suggested that the prevalence of DCS in women was approximately 11.0% higher than in men. However, this increase was not statistically significant ($P = 0.839$), which may be due to the low prevalence of DCS in this study.

Lo et al. achieved these findings in a retrospective study on 866 patients with CTS and CR symptoms. After eliminating 101 patients with suspected symptoms, 151 (20.0%) patients had only CTS, 362 (47.0%) patients had only CR, and 198 (26.0%) patients had DCS. In this study, the coexistence of CTS and CR was high,[1] which is contrary to the results of the present study.

In this context, some previous studies have shown that the prevalence of CTS and DCS is non-sex-related;[11,12] whereas, the current study showed that the prevalence of these two syndromes was higher in women, which is inconsistent with the results of these studies.

The results of the present study revealed that the prevalence of DCS in patients with moderate to high CTS was higher than in patients with mild CTS, with a prevalence of 35.5% in patients with moderate to severe CTS, indicating that the prevalence of DCS is directly related to the severity of CTS.

The current findings showed that the prevalence of DCS in C5 and C6 cervical nerve roots was higher than other nerves, with 7 out of 17 patients having 41.2% nerve root involvement in this region (Table 3).

In a study on 53 patients with CTS, Baba et al. showed that C5-C6 and C6-C7 cervical nerve roots were more involved.[7]

Furthermore, Richardson et al. in a study on patients with CR, concluded that the sensory part of the median nerve in these patients was of the C6-C7 origin and the motor origin of the median nerve was from the C8 branch.[13]

The results of this study also revealed that the prevalence of CDS in C5 and C6 nerve roots was higher (41.2%) than in other nerve roots.

Conclusion

The prevalence of DCS is low (5.5%) based on the findings of this study, which may indicate that nerve damage in the distal part does not predispose the nerve to damage in the proximal area.

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Conflict of Interest

Authors have no conflict of interest.

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