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Original Article

The effects of carpal tunnel syndrome on sleep quality

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Abstract

Aim: Carpal tunnel syndrome (CTS) is the most common mononeuropathy of the upper extremities. The aim of this study was to investigate the relationship between different compression levels and sleep quality in patients with clinically and electrophysiologically diagnosed CTS.

Material and Methods: Patients with CTS diagnosed by electroneuromyographic evaluation and healthy controls were included in the study. Demographic characteristics and disease symptoms were recorded carefully. The Boston Carpal Tunnel Questionnaire [symptom severity scale (SSS) and functional status scale (FSS)] was used to assess the severity of symptoms. Pittsburgh Sleep Quality Index (PSQI) was used to evaluate sleep quality and disorders.

Results: A total of 94 CTS patients (80 female, 14 male) and 33 healthy controls were included. The median ages were similar among the groups (patient vs. control, mild-CTS vs. moderate-CTS, unilateral CTS vs. bilateral CTS; p = 0.11, p = 0.54, p = 0.22, respectively). The mean PSQI of patient group was higher than control group (7.81 ± 3.97 vs. 3.66 ± 2.08, p=0.000). While PSQI values were significantly different (p= 0.03) between unilateral-CTS and bilateral-CTS patients, no significant difference was observed in Boston-SSS, Boston-FSS, and total Boston values (p= 0.51, p= 0.29, p= 0.34 respectively). There was no significant difference between patients with mild-CTS and those with moderate-CTS in terms of PSQI, Boston-FSS, Boston-SSS, and total Boston values (p= 0.61, p= 0.54, p= 0.62, and p= 0.53 respectively). There was a positive correlation between PSQI and Boston-SSS, Boston-FSS, and total Boston values (p <0.001).

Conclusion: Sleep quality was significantly affected in CTS patients, with a significant decrease in sleep time. While an increase in electrophysiological severity in patients with CTS did not affect the sleep quality, an increase in symptom severity decreased the sleep quality, with the greatest effect observed in patients with bilateral CTS.

Keywords: Carpal tunnel syndrome; sleep disorder; electromyography; sleep quality; symptom severity

INTRODUCTION

Although many diseases have been shown to cause carpal tunnel syndrome (CTS), most cases are idiopathic (1). The exact pathophysiology of CTS is thought that the median nerve is damaged by mechanical compression and chronic ischemia in the carpal tunnel. The combination of ischemic changes and prolonged mechanical pressure causes changes in the myelin sheath (2). In addition, there are changes in intra-neural microcirculation and vascular permeability, with an impaired axonal transport, leading to edema and impaired signal transmission (3).

CTS is the most common mononeuropathy in the general population. Diagnosis is made on the basis of typical clinical symptoms, examination findings, and electrophysiological tests. In the studies, it is reported that CTS can be diagnosed with the help of clinical evaluation and electrophysiological findings, with accuracy greater than 90%. Nerve conduction studies are accepted as the 'gold standard' for the diagnosis of CTS (4,5).

Typical finding is increased numbness and tingling in the median nerve area of the hand, especially at night (6,7). In fact, the diagnosis of CTS remains ambiguous if typical symptoms do not worsen at night. Prolonged wrist flexion during sleep increases pressure within the carpal tunnel and causes ischemia and paresthesia in the median nerve (8). Although nighttime symptoms were more pronounced

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for most patients, studies have remained limited to the effect of CTS on functional limitations; therefore, fewer studies investigating the relationship between CTS and sleep quality were available (9).

Recent researches have shown that reduced sleep quality has negative effects on human body. Decreased sleep quality is thought to cause increased activity of the sympathetic nervous system and longer exposure to physical and psychological stress factors. Accordingly, evidence has been shown that there is a significant relationship between poor sleep quality and the development of comorbid conditions such as obesity, hypertension, diabetes mellitus, chronic pain, and even death (9,10).

The aim of this study was to investigate the effect of CTS on sleep quality and disorders. Specifically, we intended to determine whether the severity of CTS was associated with sleep disorders and sleep components.

MATERIAL and METHODS

Study design and data collection

This study was a prospective observational clinical study and included the patients with CTS and healthy controls who were admitted to the electroneuromyography (ENMG) laboratory of Physical Medicine and Rehabilitation Clinic between 2015 and 2016.

Demographic characteristics of the patients including complaints at the time of admission, and examination findings were recorded carefully.

Study criteria

Patients with adequate literacy who were diagnosed with mild- or moderate-CTS by electrophysiological studies were the included in the study. Exclusion criteria were defined as follows; severe CTS in electrophysiological study, inflammatory rheumatic disease, sleep pathologies (e.g., sleep apnea, restless leg syndrome), autoimmune disease, endocrine or metabolic disorders, systemic diseases such as severe kidney or liver disease, previous operation for CTS or peripheral nerve lesion in the forearm, central nervous system pathologies, cervical disc disease, polyneuropathy, pregnancy and lactation, and hand or wrist pathologies including advanced-degenerative osteoarthritis, anatomical variation, ganglion cyst, tenosynovitis and tendinitis.

Ethical approval

Prior to the study, the ethics committee approval was obtained from the hospital ethics committee, with the decision number 83894237/900-773.99. The study was conducted in accordance with the Helsinki declaration. The patients were informed before the study and their written consent was obtained.

Electrophysiological assessment

Electrophysiological examination was performed with 'Medtronic Keypoint' device and diagnosed of CTS was made according to the criteria of American Association of the Electrodiagnostic Medicine (AAEM) (11). Bilateral ENMG was performed in patients. All participants underwent electrophysiological examination by two fixed investigators. For the diagnosis of CTS in nerve conduction studies; median nerve motor distal latency (MDL), median nerve motor conduction velocity, median nerve sensory conduction velocity, median motor nerve compound muscle action potential (cMAP) amplitude at wrist level, median nerve sensory conduction rate in second digit-wrist segment, and median nerve sensory action potential (SNAP) amplitude in second digit-wrist segment were measured.

Patients who have a normal median nerve MDL but slowed-median nerve sensory conduction velocity were considered as mild CTS. Patients with slowed-median nerve sensory conduction velocity and prolonged-median nerve MDL were considered as moderate CTS (11).

Based on the electrophysiological examination performed for both hands of the patients; the affected hand of the patient with unilateral CTS, the hand with more severe symptoms of the patient with bilateral CTS, and the dominant hand of the patient with bilateral CTS (if the severity of symptoms were equal in both hands) were included in the study. In addition, the patients were divided into 2 groups as unilateral CTS or bilateral CTS.

Diagnostic tests for the assessment

Phalen's test; the paresthesia in the sensory area of the median nerve, when the dorsal sides of the hands are mutually pressed together and maintained for one minute, with both elbows and wrists flexed 90° (12,13).

Tinel's test; the paresthesia in the sensory area of the median nerve as a result of lightly percussing over the median nerve in the wrist (14).

The Visual Analogue Scale (VAS); a scale which involves a subjective scoring by patient, with scores ranged from 0 (no pain) to 10 (unbearable pain) points.

Boston Carpal Tunnel Questionnaire; BCTQ, a patient-oriented outcome measure of symptoms, is first developed by Levine et al. in 1993 and consists of two parts, namely, symptom severity scale (SSS) and functional status scale (FSS). SSS consists of 11 parts and FSS consists of 8 parts. Each part has five separate answers, with each answer scored from 1 to 5. Average score is calculated by dividing the total score by the number of questions. The mean score is calculated separately for SSS and FSS. The Turkish validity and reliability of the BCTQ is available (15,16).

Pittsburgh Sleep Quality Index; PSQI evaluates sleep quality and disorders in the last 1 month, consisting of 24 questions and 7 components. These components are respectively overall sleep quality, sleep latency, duration of sleep, sleep efficiency, sleep disturbance, need medication to sleep, and day dysfunction due to sleepiness, with each component scored between 0-3; total PSQI score is obtained by summing the scores of all components. A total score of 5 or higher is considered to be poor sleep quality. The Turkish validity and reliability of the PSQI was conducted by Agargun et al., and also it was used to investigate sleep disorders in many diseases (17-20).

Statistical methods

SPSS version 22.0 for Windows (IBM, Armonk, NY) was used for all statistical analysis. Kolmogorov-Smirnov test was performed to determine whether the group was normally distributed or not. Student t test was used for comparison of normally distributed data, whereas Mann Whitney U test was used for comparison of non-normally distributed data. Chi-square test was used to compare categorical data. Spearman and Pearson correlation tests were used to determine the correlation between the parameters. P <0.05 was considered statistically significant.

RESULTS

A total of 94 CTS patients (80 women, 14 men) and 33 healthy subjects were included in the study. The median age was 52.04 ± 11.16 for the patient group and 48.42 ± 11.21 for the control group. The distribution of demographic characteristics and clinical symptoms by groups is shown in Table 1. The median ages were similar between the subgroups (patient vs. control, mild-CTS vs. moderate-CTS, unilateral CTS vs. bilateral CTS; p = 0.11, p = 0.54, p = 0.22, respectively). The median time of onset of complaints was 13 (range, 1-360) months. About 77.7% of CTS patients had poor sleep quality (PUKI ≥ 5). The mean PSQI was 7.81 ± 3.97 for patient group and 3.66 ± 2.08 for control group and this was statistically significant (p=0.000), indicating that patients with CTS had significantly worse sleep quality than the control group. Compared with healthy controls, patients with CTS had worse scores for duration of sleep, sleep disturbances, sleep latency, sleep efficiency, sleep quality, and day dysfunction due to sleepiness (p = 0.000, p = 0.007, p = 0.000, p = 0.002, p = 0.011 and p = 0.026, respectively) (Table 2). Female patients with CTS had significantly worse sleep quality than male patients (p = 0.000). While PSQI values were significantly different (p= 0.03) between unilateral-CTS and bilateral-CTS patients, no significant difference was observed in Boston-SSS, Boston-FSS, and total Boston values (p= 0.51, p= 0.29, p= 0.34

Table 1. Distribution of demographic characteristics and clinical symptoms by groups

Variables	Mild-CTS (n=37)	Moderate-CTS (n=57)	Unilateral-CTS (n=40)	Bilateral-CTS (n= 54)
Gender, n (%)				
Female	34 (91.8)	46 (80.7)	34 (85)	46 (85.2)
Male	3 (8.2)	11 (19.3)	6 (15)	8 (14.8)
Age (years), mean ± SD	51.16 ± 12.85	52.61 ± 9.99	50.4 ± 13.03	53.2 ± 9.48
Dominant hand, n (%)				
Right	32 (86.4)	54 (94.7)	34 (90)	50 (92.5)
Left	5 (13.6)	3 (5.3)	6 (10)	4 (7.5)
Duration of symptoms (months), median (min – max)	12 (1 - 180)	24 (1 - 360)	19.5 (1 - 180)	12.5 (1 - 360)
Symptoms, n (%)				
Pain	11 (29.7)	27 (47.3)	15 (37.5)	23 (57.5)
Hypoesthesia	35 (94.5)	57 (100)	39 (97.5)	53 (98.1)
Paresthesia	16 (43.2)	27 (47.3)	20 (50)	23 (42.5)
Weakness	12 (32.4)	19 (33.3)	16 (40)	15 (27.7)
Physical Examination, n (%)				
Tinel's sign	29 (78.3)	47 (82.4)	29 (72.5)	47 (87)
Phalen's sign	30 (81)	44 (77.1)	28 (70)	46 (85.1)

SD, standard deviation

Table 2. Comparison of PSQI parameters between patients with CTS and healthy controls

Variables	CTS patients	Control	P
PSQI, mean ± SD	7.81 ± 3.97	3.66 ± 2.08	0.000
Duration of sleep, median (min – max)	1 (0 - 3)	0 (0 - 2)	0.000
Sleep disturbance, median (min – max)	1(0 - 2)	1(0 - 2)	0.007
Sleep latency, median (min – max)	2 (0 - 3)	0 (0 - 2)	0.000
Need medication to sleep, median (min – max)	0 (0 - 3)	0 (0 - 1)	0.449
Daytime dysfunctions due to sleepiness, median (min – max)	1(0 - 2)	0 (0 - 1)	0.026
Sleep efficiency, median (min – max)	1 (0 - 3)	0 (0 - 1)	0.002
Sleep quality, median (min – max)	2 (0 - 3)	1 (0 - 3)	0.011

SD, standard deviation

respectively). There was no significant difference between patients with mild-CTS and those with moderate-CTS in terms of PSQI, Boston-FSS, Boston-SSS, and total Boston values (p=0.61, p=0.54, p=0.62, and p=0.53 respectively). Among PSQI components, sleep disturbances and day dysfunction due to sleepiness were significantly greater in patients with bilateral CTS (p=0.001, p=0.008, respectively) (Table 3).There was a positive correlation between PSQI and Boston-SSS, Boston-FSS, and total Boston values (p <0.001) (Table 4). When the effects of symptoms and examination findings on these tests were examined, Boston-SSS was significantly higher in patients with numbness (p=0.065). PSQI, Boston-SSS, Boston-FSS, and total Boston values were significantly different in patients with pain symptoms (p=0.006, p=0.00, p=0.00, p=0.00, respectively). Boston-FSS values were statistically worse in patients with loss of hand power (p=0.03). There was no significant relationship between Tinel's or Phalen's positivity and above-mentioned tests (p>0.05)

Table 3. Comparison of PSQI and Boston scale among the groups

Variables	Mild (n=37)	Moderate (n=57)	P	Unilateral (n=40)	Bilateral (n=54)	P
PSQI	8.08±3.56	7.64±4.24	0.61	6.82±4.10	8.55±3.75	**0,03***
Duration of sleep	1 (0-3)	1 (0-3)	0.78	1 (0-3)	1 (0-3)	0.83
Sleep disturbance	1 (0-2)	1 (1-2)	0.17	1 (0-2)	2 (1-2)	**0.001***
Sleep latency	2 (0-3)	2 (0-3)	0.90	2 (0-3)	2 (0-3)	0.17
Need medication to sleep	0 (0-3)	0 (0-3)	0.16	0 (0-1)	0 (0-3)	0.17
Daytime dysfunction due to sleepiness	1 (0-2)	1 (0-2)	0.38	0 (0-2)	1 (0-2)	**0.008***
Sleep efficiency	1 (0-3)	0 (0-3)	0.96	0.5 (0-3)	1 (0-3)	0.77
sleep quality	2 (0-3)	2 (0-3)	0.84	1.5 (0-3)	2 (0-3)	0.37
Boston-SSS	31.35±7.94	30.38±7.37	0.54	30.17±8.56	31.20±6.80	0.51
Boston-FSS	22.44±6.95	21.64±7.53	0.62	21.02±8.08	22.62±6.61	0.29
Boston total	53.78±12.86	52.03±13.57	0.53	51.20±15.16	53.85±11.66	0.34

PSQI, Pittsburgh Sleep Quality Index; Boston-SSS, Boston symptom severity scale; Boston-FSS, Boston function severity scale

Table 4. Correlation between PSQI and Boston parameters

Variables	Boston-SSS	Boston-FSS	Boston total
PSQI	**p=0.00*** r=0.47	**p=0.00*** r=0.61	**p=0.00*** r=0.60
Duration of sleep	**p=0.00*** r=0.38	**p=0.00*** r=0.59	**p=0.00*** r=0.52
Sleep disturbance	**p=0.002*** r=0.31	**p=0.00*** r=0.37	**p=0.00*** r=0.37
Sleep latency	**p=0.01*** r=0.26	**p=0.00*** r=0.50	**p=0.00*** r=0.44
Need medication to sleep	p=0.17 r=0.14	p=0.18 r=0.13	p=0.12 r=0.16
Daytime dysfunction due to sleepiness	p=0.44 r=0.08	**p=0.02*** r=0.22	p=0.15 r=0.14
Sleep efficiency	**p=0.00*** r=0.36	**p=0.00*** r=0.57	**p=0.00*** r=0.52
Sleep quality	**p=0.00*** r=0.57	**p=0.00*** r=0.37	**p=0.00*** r=0.54

PSQI, Pittsburgh Sleep Quality Index; Boston-SSS, Boston symptom severity scale; Boston-FSS, Boston function severity scale

DISCUSSION

Sleep quality is expected to be adversely affected in patients with CTS and the lack of nighttime complaints may cause suspicion in its diagnosis. Although many studies have shown that sleep quality is negatively affected in CTS (21,22), it is also important which components of sleep are mainly influenced. In addition, the relationship between the severity of CTS and sleep disorder has remained an issue of debate. In our study, we observed that sleep quality was significantly impaired in patients with CTS compared to healthy controls. Excluding the need for medication to sleep, each component of sleep was severely impaired in the CTS group, such as falling asleep, maintaining sleep and quality of sleep. Although sleep quality did not change according to electrophysiological severity of CTS, it was affected in accordance with symptom severity and functional status measured by Boston scale. Moreover, Boston scale did not reveal any significant finding in patients with electrophysiologically more severe CTS and this is likely due to excluding the patients with severe-CTS from the study. Notably, patients with bilateral CTS had worse sleep quality, woke up more often during sleep, and experienced more day dysfunctions due to sleepiness. We observed that patients with unilateral-CTS were able to modify their sleep position by their intact hand, yet this was not possible in patients with bilateral-CTS. There are several studies that support this observation. It is reported that CTS patients try to adjust their sleep position in the way they experience less complaints during the sleep, and there may be sleep problems related to it (23-25). Similar to our findings, Patel et al. performed a study including 66 CTS patients and reported that the mean PSQI of CTS patients were compatible with poor sleep quality and significant deterioration in PSQI sub-parameters was consistent with the Boston scale, yet the lack of a healthy control group in the study was a major limitation (9). In another study, it was found that sleep quality was impaired, sleep efficiency was significantly affected in patients with CTS, and PSQI was correlated with Boston scale (26). In another study by Patel et al., it was observed that patients with CTS had difficulty in maintaining sleep (27). A few recent studies have also shown that sleep disorders are common in patient with CTS but there is no significant relationship between electrophysiological severity of CTS and sleep scales (25,28). Symptoms severe enough to affect sleep were found to be as common in mild-CTS as in moderate-CTS. Although the increased degree of involvement of the median nerve results in increased complaints such as atrophy and weakness, a decrease in paresthesia may also occur over time, which may explain the similarity of the complaints affecting nighttime sleep in mild- and moderate-CTS. In line with our findings, a study that showed a significantly higher night waking problems in patients with bilateral-CTS reported that a positive Phalen's test was associated with sleep problems, but we did not find a such a significant relationship in our study (29). Major limitations in our study were its small sample size and that the control group was smaller than the patient group.

CONCLUSION

Considering the average age of the patients included in the study, treatment of such a problem that significantly affects sleep quality and disrupts daytime functions in this productive patient group requires a great attention

and interest. Rather than electrophysiological severity, it will be more appropriate to consider symptoms and sleep complaints in the setting of treatment since patients' functionality and sleep quality are not associated with electrophysiological severity of disease.

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