Splinting is effective for night-only symptomatic carpal tunnel syndrome patients

Gulistan Halac[1]*, Saliha Demir[2], Hulya Yucel[3], Elvin Niftaliyev[1], Gulsen Kocaman[1], Humeyra Duruyen[1], Tansel Kendirli[4], Talip Asil[1]

[1] Department of Neurology, Medical Faculty, Bezmialem Vakif University: 34093 Fatih, Istanbul,Turkey
[2] Department of Physical Medicine and Rehabilitation, Medical Faculty, Bezmialem Vakif University, Turkey
[3] Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Bezmialem Vakif University, Turkey
[4] Department of Neurology, GATA Haydarpasa Teaching Hospital, Turkey

Abstract. [Purpose] Carpal tunnel syndrome is the most common entrapment neuropathy of the median nerve. Splinting is one of the most used conservative treatment methods for carpal tunnel syndrome. The aim of this study was to show the effectiveness of splinting in carpal tunnel syndrome patients who were divided into two groups according to their level of symptoms. [Subjects and Methods] A total of 40 carpal tunnel syndrome patients were divided into 2 groups based on having symptoms only at night or during the day were included in this study. These two groups were compared at the end of a 3-months splinting therapy in terms of improvement of severity of symptoms, functional capacity, pain level, and electrophysiological findings. [Results] Pain levels of both groups were similar at baseline. After splinting, pain levels of night-only symptomatic patients were lower than those of sustained symptomatic ones. No differences were found in symptom severity, functional capacity, and the electrophysiological findings in either group after the splinting. [Conclusion] The results of this study show that splinting alone may be sufficient to decrease the pain for night-only symptomatic patients. Combined therapy methods may be needed for sustained symptomatic patients.
Key words: Carpal tunnel syndrome, Symptom, Splinting

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INTRODUCTION

Carpal tunnel syndrome (CTS) is one of the most common entrapment neuropathies and is caused by compression of the median nerve traveling through the carpal tunnel. The incidence of CTS is 0.1% in the population and it has negative effects on patients' quality of life[1]. Nerve damage due to compression of the median nerve leads to entrapment neuropathy. Histological studies have found varying degrees of segmental demyelinization and Wallerian degeneration in nerves that have been chronically compressed[2]. Obstruction of venous return from the funiculi as a result of increased pressure in the carpal tunnel leads to intrafunicular anoxia which is the initial lesion of median nerve. This causes progressive intrafunicular edema and an increase in intrafunicular pressure which impairs the blood flow and results in compression[2]. Alfonso et al. divided CTS patients into three stages according to their symptoms and signs[3]. In stage 1, patients are symptomatic during the nights. In this stage, morning stiffness in the hands generally continues, but patients do not complain of numbness, pain, and tingling during the day[3]. In stage 2, patients are also symptomatic during the day[3]. According to histopathological examination, capillary circulation slows down during this period, protein accumulates in endoneurial spaces, and edema increases[2]. In stage 3, hypoatrophy or atrophy in the thenar region is observed[2–4]. Fibroblasts proliferate in the protein exudate and irreversible changes are found as intrafunicular fibrosis[5].

Some studies have reported that CTS can be treated successfully without surgery[6, 7] while other authors say that conservative treatments are ineffective[8, 9]. There are numerous conservative treatment methods available for CTS management including splinting, activity modification, non-steroidal anti-inflammatory drugs, pyridoxine, exercise practices, local injections, and treatments with physical therapy agents. Splinting is the most popular conservative treatment for CTS[9, 10]. In patients with low/moderate degree CTS, splinting only is a sufficient method. The effectiveness of neutral wrist splinting has been validated in the previous studies[11–13]. There have been few studies of prognostic indicators of conservative treatment success in CTS patients[14].

*Corresponding author. Gulistan Halac (E-mail: halacdr@yahoo.com)

The early detection of patients who benefit from splinting is important in clinical practice to avoid delay in deciding the appropriate treatment. For this purpose, determining whether splinting would be more useful for night-only symptomatic patients than day and night (sustained) symptomatic patients would help clinicians in terms of prognostication.

As far as we know, there is no study in the literature that has evaluated the utility of splinting considering the levels of patients' symptoms. In this study, we aimed to study the effectiveness of splinting for CTS patients according to their levels of symptoms and to compare the value of splinting in the early stages of CTS in patients who had symptoms only at night, and during the day and night.

SUBJECTS AND METHODS

The subjects were patients who were diagnosed as having CTS according to subjective symptoms and examination electrophysiological at a neurology outpatient clinic. All individuals gave their informed consent to participation in this study, and the local ethics committee of Bezmialem Vakif University approved this study.

All participants were eligible to participate in the study if their age was 18 years or over, and they were able to understand the content of the questionnaires. Musculoskeletal and neurological examinations of all the patients were performed by the same specialist. After these evaluations, patients with low or moderate degree CTS were included in the study.

Patients with thenar atrophy, impaired two-point discrimination (>5 mm), history of splint use, structural diseases that may lead to CTS (diabetes mellitus, gout, thyroid disease, chronic kidney disease, and rheumatologic disorders), pregnancy, history of traumatic or inflammatory events affecting the hand region such as wrist fractures, tenosynovitis, and surgery, other disorders of the upper extremities or cervical region such as epicondylitis, disc herniation, patients with electrophysiologically severe CTS, clinical or electrophysiological evidence of accompanying conditions that mimic CTS or interfere with its evaluation such as proximal median neuropathy, cervical radiculopathy, polyneuropathy, brachial plexopathy, or thoracic outlet syndrome were excluded.

The Tinnel and Phalen tests were performed on patients suspected of having CTS. In the Tinnel test, percussion was applied over the median nerve at the level of the carpal tunnel. The test was considered positive if there was numbness in the median nerve-innervated digits. In the Phalen test, the median nerve was compressed at the proximal edge of the carpal tunnel by wrist flexion. Tingling and /or pain in the median nerve innervation area within 30–60s were considered positive.

Nerve conduction studies (sensory and motor impulses of the median and ulnar nerves in the affected extremity) and needle EMG (electroneuromyography) were performed using EMG device (Natus, Dantec, Keypoint Focus Workstation). Limb temperature was kept above 32°C. We studied the median sensory nerve action potential, latency, amplitude, and sensory conduction velocity of the 2nd and 4th digits of all patients. In addition, the median nerve motor distal latency and median motor nerve conduction in the wrist-elbow segment were performed. Sensory and motor

examinations of the ulnar nerve were performed to verify whether the ulnar nerve was participating in the condition. An needle EMG examination was also performed for the median nerve innervated muscles abductor pollicis brevis, flexor carpi radialis, and flexor pollicis longus, ulnar nerve innervated muscles abductor digiti minimi and the first dorsal interosseos, and radial nerve innervated muscles extensor digitorum communis. Patients who had a median sensory response latency of >3 ms and an impulse rate of <50 ms of the 2nd digit or a median-ulnar sensory response peak latency of >0.4 ms of the 4th digit, and normal distal motor conduction time between the wrist and thenar muscles were included in the study.

Based on anamnesis, neurological examinations, and electrophysiological studies, 66 patients were included in this study. However, a total of 26 patients were excluded from the study. Among them 22 could not adapt to the use of splints and 4 wanted exit from the research. The study was continued with a total of 40 patients (20 had night-only complaints, and 20 had both day and night complaints). Only one hand of each patient was evaluated.

We used the 11-item symptom severity scale (SSS), and the 8-item functional status scale (FSS) to evaluate subjects at the beginning and the end of the intervention 90 days[15]. The symptom severity scale determines the severity and duration of symptoms during the day, and how these factors affect the patient, on a 5-point scale, with 1 point indicating non-symptomatic or performing the activity easily, and 5 points indicating severely symptomatic or not capable of performing the activities[15]. The functional status scale evaluates the degree of difficulty while performing the most often performed activities in the patients' daily life. It runs from 1 to 5, with 1 indicating no difficulty, and 5 indicating unable to do an activity[15]. We evaluated pain intensity using a visual analog scale (VAS)[16]. We asked patients to mark the intensity of their pain at rest and during activity on a 10-centimeter line; then we recorded the values as the length in centimeters from the origin to that point. All examinations were re-tested after splinting.

We gave a neutral static wrist splint to the symptomatic hands of the patients of both groups and asked them to wear it for 90 nights. The angle of the wrist was adjusted to 0–5 degrees of extension, metacarpophalengeal joints as well as the fingers and the elbow were free to move. Cotton-polyester material was used in the construction of the splint. Both groups used the same kind of splint. We made a calendar for each patient to assess their compliance and asked them to note the days that they used the splint. According to the calendar program, we analyzed the patients who adopted splint usage for over 90% of the intervention period and re-evaluated them after 90 days.

Data were analyzed using SPSS for Windows. Descriptive data are presented as the mean±standard deviation (SD). Demographic characteristics were compared using the χ^2 and Fisher's exact tests. The Mann-Whitney U test was used for the comparison of pre-treatment and post-treatment values between groups when variables did not show a normal distribution. Wilcoxon's signed rank test was used to analyze the differences between pre-treatment and post-treatment values within groups. The comparison of the improvement (differ-

Table 1. Group pre-treatment and post-treatment values of symptomatic and functional parameters

	Night-only symptomatic		Sustained symptomatic	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
VAS	4.80±2.52	2.10±2.67	5.15±1.98	3.75±2.07*
SSS	29.3±7.1	25.4±7.5	28.1±9.9	27.4±9.2
FDS	15.9±5.9	16.0±6.9	17.5±6.1	16.8±4.9
Scv	47.1±5.6	48.0±5.9	46.6±4.7	48.2±6.2
Sdl	2.7±0.5	2.6±0.7	2.9±0.31	2.8±0.41

VAS: visuel analog scale, SSS: symptom severity scale, FSS: functional status scale, Scv: sensory nerve conduction time, Sdl: sensory response distal latency
Data are expressed as means ± SD. *$p<0.05$

ences of pre-post scores) between groups was also evaluated using Mann-Whitney U test. P values less than 0.05 were considered statistically significant.

RESULTS

Among the 66 patients who were diagnosed with CTS clinically and electrophysiologically, 40 patients with regular splinting compliance were enrolled in this study. Of these 40 patients, 20 (2 men and 18 women) were night-only symptomatic and 20 (4 men and 16 women) were sustained symptomatic. The mean age was 53.3 ± 8.8 years (42–70) in the sustained symptomatic group and 48.1 ± 7.0 years (32–60) in the night-only symptomatic group.

VAS scores after splinting in both groups improved compared to baseline. Pain levels were similar between the groups before splinting, but after treatment, it was lower in the night-only symptomatic group than in the sustained symptomatic group (p = 0.016) (Table 1).

The SSS results of the sustained symptomatic group did not improve (p = 0.677) after splinting. There was a significant improvement in the night-only symptomatic patients at the end of the treatment (p = 0.008), but the difference after splinting was not significant between two groups (p> 0.05). Differences in the FSS results were not significant in either group after splinting (p = 0.701, 0.958, respectively) (Table 1).

The results of sensory nerve conduction speed were not significantly different in either grou after splinting (p = 0.246 for the sustained symptomatic group, p = 0.350 for the night-only symptomatic group). There were no differences in the median nerve distal latency of the sustained and night symptomatic groups after splinting (p-values of 0.157 and 0.564, respectively) (Table 1).

DISCUSSION

The conservative therapy methods used in CTS treatment include splinting, activity modification, non-steroidal drugs, pyridoxine, exercise, local injections and physical therapy. Splinting in combination with exercise was reported to be effective in CTS treatment[17–19]. Baysal et al. compared the therapeutic effect of three different combinations of conservative treatments for CTS. The combinations included exercises in combination with splinting, ultrasound treat-

ment in combination with splinting, and the combination of ultrasound, splinting, and exercises. They suggested that a combination of splinting, exercise and ultrasound therapy is an effective method of CTS treatment[17]. Splinting is an acceptable method for patients in the early phases of CTS, because it is simple, inexpensive, and it can be applied at home. It's important to know which patients will benefit from the usage of splinting alone. Predicting a lack of response to splint therapy alone in early stage patients would allow us to alter the treatment method and use splinting in combination with other conservative therapies, possibly leading to more effective treatments. In one study, longer duration of symptoms and greater severity of symptoms were found to be related with poorer surgical outcomes[20]. We did not find any initial differences between our two groups other than pain levels and severity of symptoms. After splinting for 90 days, VAS scores showed a significant improvement in both groups. Improvement of VAS scores in the night-only symptomatic group was significantly better than that of the sustained symptomatic group, and SSS scores of the night-only symptomatic group showed significant improvements after splinting, but the improvements were not statistically significant in the sustained symptomatic group. There were no significant improvements in the functional status or electrophysiological parameters of either group.

The aim of splinting is to immobilize the wrist in a neutral position in order to avoid flexion or extension of the wrist[21]. Neutral wrist splinting reduces the pressure on the median nerve and increases blood flow, especially at night when the wrist is held in a flexion position. Hence, splinting leads to a reduction in the complaints caused by compression of the median nerve sensory fibers and relaxes the patient. In a review assessing the effectiveness of conservative therapy for carpal tunnel syndrome, it was reported that splinting is an effective method especially if used full-time[11]. In our study, our patients used splints every night. We advised night splinting for patients who had symptoms occurring only at night, and continuous splinting for patients with sustained symptoms. Manenti[22] and Premoselli[23] reported improvements in SSS and FSS results at the end of the first and 3rd months of splinting, compared to a control group. We observed no differences in FSS values between the groups.

The electrophysiological findings of patients in both groups fit a diagnosis of mild CTS. There were no significant differences in sensory conduction velocities at baseline and

3 months after splinting. We did not have a control group, since our aim was not to show the efficacy of splinting for the treatment of CTS.

The pathophysiology of CTS and the relationship between symptoms of CTS are not yet fully understood. In our study, we found that improvements in pain were greater in the patients who had symptoms only at night than in the patients with sustained symptoms. Several studies have shown the effect of splinting therapy is greater in the first 3 months[6, 22]. On the other hand, Piremoselli et al. determined the symptomatic, functional, and neuropsychological improvements elicited by night splinting after a period of at least 6 months[23]. In our study, we evaluated the data at the end of 3 months.

In conclusion, we observed significant improvements in the pain levels after a 3 months of splinting therapy in both of the groups which was more evident in the night-only symptomatic group of patients than in the sustained symptomatic group. There were significant improvements in the symptoms of patients who were symptomatic only at night; however, the difference after splinting was not significant between the two groups. In this study, we found 3 months of splinting alone had no effect on the functional status and electrophysiological parameters in the treatment CTS. Based on the results of this study, we think that night splinting alone as an initial therapy may be sufficient for patients with symptoms occurring only at night, but combined treatment methods should be suggested for patients with sustained symptoms.

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