Carpal Tunnel Syndrome: Objective Measures and Splint Use

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ABSTRACT. Kruger VL, Kraft GH, Deitz JC, Ameis A, Polissar L: Carpal tunnel syndrome: objective measures and splint use. Arch Phys Med Rehabil 1991;72:517–20.

• One hundred five adults with carpal tunnel syndrome (CTS) were studied to assess the efficacy of a neutral-angle wrist splint, and to identify criteria for splint referral. Ten observations before and after treatment were analyzed with descriptive and inferential statistics. After splint use, 67% of the subjects reported symptom relief. *T*-test comparison of sensory latency of values before and after treatment indicated improvement for the total group. Chi-square and *t*-tests failed to reveal significant differences between relief and no-relief groups for gender, affected hand, presence of concomitant conditions, duration of symptoms before treatment, age, length of time between pretreatment and posttreatment nerve conduction testing, initial nerve latency of motor and sensory fibers, or the difference between pretreatment and posttreatment sensory latencies. A significant difference was found for motor latency; the relief group improved and the no-relief group deteriorated. Data suggest that splinting is most effective if applied within three months of symptom onset. Those with damage to the wrist structures or median nerve were least responsive to splinting.

KEY WORDS: Carpal tunnel syndrome; Median nerve; Nerve conduction; Splints

It is well established that surgery which includes release of the flexor retinaculum affords the most permanent relief of symptoms of the carpal tunnel syndrome (CTS).[1-5] Other conventional treatments include steroid injections into the carpal tunnel, diuretics, and splints. In cases where no denervation is present and symptoms are mild and of short duration, or in the presence of coexistent medical conditions which would preclude surgery, conservative treatment is preferred.

Splinting, as a conservative treatment for CTS, has been recommended by several authors.[6-10] The rationale for this comes from the findings of pressure-related effects on symptomatology. It has been demonstrated that patients with CTS have elevated resting intracanal pressure.[11-13] It has also been demonstrated that wrist flexion and extension result in pressure increases of from three to six times that found in the neutral wrist position.[12,14,15] Extension resulted in somewhat greater increases than flexion, especially in the distal portion of the tunnel.[13] Immobilizing the wrist in neutral maximizes available carpal tunnel space, minimizing compression and providing symptomatic relief. Splinting thus remains a popular initial treatment and may, with favorable results, be the only treatment necessary.

The few studies conducted to address splint efficacy[1,3,4,16-18] reported variable results using volar-based plaster of paris night splints. These splints were cumbersome and unduly restrictive, extending distally to the metacarpophalangeal joints or fingertips. In addition, plaster of paris has limited daytime usefulness as it cannot be cleaned and does not withstand humidity. With the advent of low-temperature thermoplastics, the difficulties inherent in previous splint designs have largely been surmounted. Occupational therapists can now design and fabricate durable temporary splints which can be worn during most activities.[19,20] Using lightweight functional design splints which could be worn full time and which minimally restricted function, Bengzon and Eichman[21] and Dolhanty[22] reported significantly higher success rates than did the earlier investigators.

No objective criteria for splint referral have been established. However, Bengzon and Eichman[21] and Dolhanty[22] intuitively support the use of splints in cases of mild symptoms of recent onset. Considerable time and expense could be spared if criteria could be identified to differentiate patients who benefit from splint use from those who do not.

This study was conducted to examine any differences in nerve latencies before and after treatment to determine whether or not changes occurred after splint use. Interrelationships between objective measures and observations were also examined. To identify objective criteria for splint prescription (referral), ten variables were assessed for possible differences between those patients who reported relief and those who did not.

MATERIALS AND METHODS

We reviewed the medical records of 105 adult patients with CTS who had been treated with a neutral-angle wrist splint. All 105 patients were evaluated by one physiatrist, and one technician performed the standardized nerve conduction testing. Subjects were excluded from the study if they were receiving diuretics or anti-inflammatory medications concurrently.

Eligible subjects received their splints and instructions within one week of referral date. All follow-up electromyograms (EMGs) were done within 17 months of referral. At that time, patient response to a yes/no question as to whether or not subjective relief was experienced was also recorded.

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Submitted for publication October 2, 1989. Accepted in revised form June 19, 1990.

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Data were collected on age (at time of splint application), gender, affected hand, length of time symptoms had been present before treatment, and the presence of any concomitant conditions. These were categorized as unknown etiology, arthritis, Colles fracture/trauma, known job stress, or pregnancy. The results and the number of days between initial and follow-up EMGs were recorded. In addition, the difference between nerve latencies before and after treatment was calculated. Data on symptom duration before treatment were originally categorized into one of five time intervals (less than 1 month, 1 to 3 months, 4 to 6 months, 7 to 11 months, and 1 year or more). To facilitate analysis, these values were recorded to the mean of each time interval. Eighteen months was used as the mean of the greater-than-one-year category. This method was chosen because the onset of symptoms is usually gradual and more precise information was unavailable.

The electromyograph used was a portable Cadwell 5200A.[a] The testing protocol was standardized.[23,24] A sensory peak latency above 3.7msec at a gain setting of 20μV per division, a motor latency above 4.2msec at a gain setting of 10mV per division, or a latency in excess of 1msec greater than the ipsilateral ulnar or contralateral median nerve was defined as constituting a positive diagnosis.

Splints used were fabricated of Jobst perforated JU 1000[b] low-temperature, thermoplastic material (see figs 1 and 2). This material was selected because it is lightweight, fully washable, and withstands temperatures of up to 45C. An ulnar gutter design was used which allowed full digital mobility, pronation, and supination, while restricting wrist flexion, extension, and deviation. Splints were affixed with Velcro straps. Patients were instructed to wear splints at night and during the day as much as possible.

Fig 1—Jobst JU 1000 splint used in study, dorsal view.

RESULTS

Table 1 provides demographic information on the sample and the association of these factors with relief. Of the 105 subjects, 67% reported obtaining relief with the use of their splints. Thirty-nine percent of the sample sought treatment early after onset of symptoms; 25% from four to 12 months; and 36% waited for at least a year before receiving medical attention (table 1). Subjects ranged from 20 to 86 years of age. All follow-up nerve conduction testing was done within 17 months of treatment.

The characteristics of the relief and no-relief groups were very similar, making discrimination between them difficult. Results of chi-square and unpaired *t*-tests for the demographic variables were not statistically significant at $p \leq .05$ (two-tailed test).

Descriptive statistics for pretreatment and posttreatment nerve latencies for all 105 subjects are shown in table 2. There were no significant differences for the motor fibers; however, the difference was statistically significant ($p \leq .02$) for the sensory nerve.

Results of the unpaired *t*-tests of nerve latency values between relief and no-relief groups are shown in table 3. The only statistically significant variable found between the two groups was the computed difference in motor fiber latency values before and after treatment. Positive values for the difference in latencies between pretreatment and posttreatment changes indicate improvement; negative values signal deterioration. For both fibers, mean differences for the group reporting relief were positive. These values were larger than those found for the no-relief group and were statistically significant for the motor fibers ($p \leq .04$). No statistically significant difference between the groups was demonstrated for pretreatment values (at $p \leq .05$, two-tailed test).

DISCUSSION

Most of the subjects were middle-aged women, a patient population similar in gender and age distribution to others reported in the literature.[6-8]

The finding of improvement of the sensory fibers for the whole group is not surprising, as it has been demonstrated that these fibers are more sensitive to compression and decompression than the motor fibers.[14,25] Data suggest that improvement in motor latency is probably associated with patient perception of relief. The data collected for this study do not seem to form the basis for predicting motor latency response, or discriminating between those who reported relief and those who did not. Further study is indicated to identify the factors responsible for individual response to treatment.

Although not statistically significant, several patterns emerged

Fig 2—Jobst JU 1000 splint, volar view.

which may have clinical significance. Because 67% of the subjects reported obtaining symptomatic relief with use of their splints, one would expect a similar percentage of relief vs no-relief in those factors determined not to have a bearing on treatment outcome. This was the case for most of the variables. However (as shown in table 1), of those receiving treatment within one to three months of onset, 28 of 35 subjects (80%) reported relief, compared with 54% in the seven- to 12-month category. Of those with an etiology of known job stress, seven of nine (78%) reported relief after treatment. This result should be viewed with caution due to the relatively small number of subjects in this category. It is possible that a placebo effect may be partially responsible for improvement. Least responsive to treatment were those with structural changes in the wrist (ie, Colles fractures or direct trauma), with 10 of 19 (53%) claiming relief.

Data were unavailable on the schedule of splint use that each subject followed. Although patients were instructed to wear the splints all night and during the day as much as possible, the nature of some subjects' work prevented an optimum regimen. Those who improved may have been able to wear their splints for longer periods of time and/or during activities known to exacerbate symptoms. It is also possible that spontaneous remission may have occurred.

Table 1: Percent of Patients Experiencing Relief by Selected Descriptive Characteristics

Variable	*n*	Percent relief
All subjects	105	67
Gender		
Male	21	67
Female	84	67
Affected hand		
Bilateral	38	61
Dominant	59	71
Nondominant	8	63
Concomitant conditions		
Unknown	55	69
Rheumatoid arthritis/ Degenerative joint disease	16	69
Colles/trauma	19	53
Job stress	9	78
Pregnancy	6	67
Number of months symptoms present pretreatment		
< 1	5	60
1–3	35	80
4–6	14	64
7–12	13	54
> 12	37	59

We treated 424 individuals with the splint described. The 105 subjects of this study included only those who returned for follow-up nerve conduction testing. The characteristics of the group who elected not to return for follow-up are not known. Results may have been different had all potential subjects been eligible for inclusion in the study.

CONCLUSION

Clinical intuition has supported splint use for mild symptoms of less than one year, normal sensibility, normal thenar strength and mass, and one-second to two-second prolongations of either motor or sensory latencies.[2,3] In view of the 67% rate of subjective relief, the improvement of the distal motor fiber latencies for those in the relief group, and the improvement of the distal sensory fiber latencies for the whole group, splinting seems worthy of a trial. This study suggests that optimal results will be obtained if the splint is applied

Table 2: Comparison of Fiber Latency Values Before and After Treatment for All Subjects

Nerve latencies in msec (*n*)	Mean	SD	*t*	*df*	*p**
Median motor (103)			.81	101	.42
Pretreatment	4.65	.90			
Posttreatment	4.58	1.01			
Median sensory (98)			2.44	96	.02
Pretreatment	4.14	.74			
Posttreatment	3.99	.72			

*Two-sided paired *t*-test.

Table 3: Comparison of Nerve Latency Values Between Relief and No-Relief Groups

Nerve latencies in msec (*n*)	Mean	SD	*t*	*df*	*p**
Pretreatment					
Median motor			−.30	101	.77
Relief (69)	4.63	.89			
No relief (34)	4.69	.92			
Median sensory			−.38	98	.71
Relief (66)	4.15	.71			
No relief (34)	4.22	.90			
Differences in latencies before and after treatment					
Median motor			2.05	100	.04
Relief (68)	.18	.82			
No relief (34)	−.17	.78			
Median sensory			.63	95	.53
Relief (64)	.18	.60			
No relief (33)	.10	.63			

*Two-sided unpaired *t*-test.

within the first three months of onset, and that those with no structural damage may have a more favorable response.

Acknowledgments: The authors wish to express appreciation to Lois A. Nicholls, OT(C) for her assistance in the fabrication of splints and collaboration on the selection and collection of the data. Thanks also to Darlene Wailes for performing the nerve conduction testing.

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