

Nonsurgical Treatment for Symptomatic Carpal Tunnel Syndrome: A Randomized Clinical Trial Comparing Local Corticosteroid Injection Versus Night Orthosis

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Purpose For carpal tunnel syndrome (CTS), local corticosteroid injection (corticosteroid), and/or wrist immobilization with night orthosis (orthosis) are commonly prescribed and are supported by strong evidence. The aim of this study was to compare orthosis versus corticosteroid for patients with CTS.

Methods A CTS diagnosis was made clinically and supported by electrodiagnostic study. Patients were randomly allocated to either orthosis or corticosteroid. Clinical assessments were performed before the intervention, within the first week of the intervention, and 1, 3, and 6 months after the intervention. Primary outcomes were improvement in nocturnal paresthesia and Boston-Levine questionnaire (BLQ) score. Secondary outcomes were pain assessed by visual analog scale and complications.

Results Of 100 patients enrolled in the study, 95 completed the planned follow-up (45 in the orthosis arm and 50 in the corticosteroid arm). Corticosteroid injections were superior to orthosis in remission of nocturnal paresthesia (remission rates at 1 month, 84.6% versus 43.83%; 3 months, 71.1% versus 40.4%; and 6 months, 80.3% versus 28.8%). The BLQ scores (functional and symptom subscales) were also more favorable for corticosteroid at 1, 3, and 6 months (minimal clinically important differences for Function > 0.5 and Symptom > 0.16). Pain scores were lower and favored the corticosteroid group. There were no complications in either group.

Conclusions Both options are effective in the short term. Corticosteroid is superior to orthosis for improving CTS-related nocturnal paresthesia, BLQ scores, and pain. (*J Hand Surg Am.* 2021;46(4):295–300. Copyright © 2021 by the American Society for Surgery of the Hand. All rights reserved.)

Type of study/level of evidence Therapeutic I.

Key words Carpal tunnel syndrome, conservative treatment, randomized controlled trial.

 Additional Material
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CARPAL TUNNEL SYNDROME (CTS) is the most common neuropathic compressive syndrome of the upper limbs. It is caused by compression of the median nerve in the wrist.^{1,2} Symptoms of pain, hypoesthesia, paresthesia, and weakness are common; symptoms worsen at night and may be related to overuse of the hands.^{2,3}

There is no gold standard for establishing a diagnosis of CTS. Diagnosis is performed through the evaluation of symptoms and physical examination. Nerve conduction studies may be of value to confirm the diagnosis and stage severity and to rule out other compression sites, such as cervical radiculopathy.⁴

Treatment options can be divided into surgical and nonsurgical procedures.¹ Options for nonsurgical treatment include activity modification and use of oral corticosteroids, orthoses, and steroid injections into the carpal tunnel.^{1,5} Currently, nighttime orthosis wear and corticosteroid injections in the carpal tunnel are supported by strong evidence and are recommended by the American Academy of Orthopedic Surgeons Evidence-Based Clinical Practice Guideline on carpal tunnel management.⁶

During sleep, the wrist takes a natural position of flexion, thus causing increased pressure in the carpal tunnel. As an effective and inexpensive treatment option, nocturnal orthoses are useful for minimizing symptoms by addressing that position.⁷ The studies comparing night orthoses and local corticosteroid injection are scarce and have had some methodological flaws, such as short periods of follow-up and an absence of patient-reported measures.^{1,5}

This study tested the hypothesis that corticosteroid injection is superior to orthosis wear in the short term and may be considered the first-line treatment for CTS. The aim of this study was to compare orthosis and corticosteroid after a minimum follow-up period of 6 months.

METHODS

This study was approved by the Human Research Ethics Committee of the Hospital Pró-Cardíaco under the number 61121816400005533. This protocol was registered under the title Non-surgical Treatment of Carpal Tunnel Syndrome: Night Splint Versus Local Corticosteroid Infiltration under the number NCT03196817, with the identification HAMJQ01, available at <https://clinicaltrials.gov/>. All patients provided written informed consent and agreed to share their data for research purposes.

Type and location of the study

This study was a randomized clinical trial evaluating 2 options for nonsurgical treatment for CTS, corticosteroid injection, and nighttime orthosis wear. This study followed the CONSORT (Consolidated Standards of Reporting Trials) statement standards (<http://www.consort-statement.org>) and was developed at the hand surgery and microsurgery section of Hospital Alvorada, Américas, São Paulo/SP.

Participants

Inclusion criteria: This study included adult patients 40 years of age or older, with 4 or more of the following 6 clinical signs and symptoms suggested by Graham et al⁴ (CTS-6): paresthesia in the territory of the median nerve; nocturnal paresthesia of the hand; atrophy of the thenar musculature; positive Tinel sign; positive Phalen test; loss of 2-point discrimination (>6 mm).

Patients were included in the study if they had symptoms for at least 1 month and also had a positive nerve conduction study indicating motor and sensory involvement, classified as moderate or severe.⁸

Patients were excluded for the following reasons: previous treatment with a corticosteroid or orthosis in the last 6 months; previous surgical treatment for CTS; wrist conditions associated with trauma; non-trauma-associated conditions (cervical pain, shoulder girdle pain [chosen to rule out thoracic outlet syndrome], long-term uncontrolled diabetes); hypersensitivity/allergy to corticosteroids; presence of persistent paresthesia in the median nerve territory (radial fingers); refusal to participate.

No restrictions were made regarding the presence of unilateral or bilateral disease. No attempt was made to exclude or stratify patients by onset or duration of symptoms. Patients were informed that treatment would be focused on the most symptomatic side, as a subjective shared clinician-patient decision.

Randomization and allocation concealment: The allocation of patients was performed using opaque envelopes with consecutive numbers. We considered the patient as the unit of randomization, and in bilateral disease, we considered the most symptomatic limb for the research purposes. No treatment was offered for the less symptomatic limb for the duration of the study. Envelopes were only opened after verification of inclusion criteria and signing of the informed consent form. The randomization procedure was performed by a person not directly involved in the study. Outcome assessments were performed by blinded researchers.

Intervention

Corticosteroid injection technique: Patients were seated with the wrist in a neutral position. The needle was introduced at the ulnar border of flexor carpi radialis tendon at an angle of 30° directed toward the carpal tunnel.⁹ We utilized 6.43 mg (1 mL) of betamethasone dipropionate, 2.63 mg of betamethasone disodium phosphate, and 0.5 mL of 2% lidocaine (xylocaine), totaling 1.5 mL. After injection, a simple dressing was applied.

Night orthosis: A forearm-palmar orthosis with the wrist immobilized in a neutral position was used at night while sleeping and removed in the morning. The duration of orthosis use differed because sleeping times were different between individuals. The orthosis was used throughout the study period.

Outcomes

Patients were assessed for all outcomes immediately before the intervention; within 1 week of the intervention; and 1, 3, and 6 months postintervention.

All patients were evaluated for a minimum follow-up period of 6 months after the intervention by 3 of the hand surgeons (J.Q., V.Y.M., J.C.B.) involved in the study. Loss to follow-up was considered at random and data were managed following the intention-to-treat principle.

Remission of nocturnal paresthesia: Evaluation was performed by patient report of paresthesia during the nighttime period after the intervention. We considered paresthesia as in remission when patients indicated that they did not experience sleep interruption owing to paresthesia during the research timeframe.

Boston-Levine questionnaire (BLQ): This questionnaire was developed for patients to self-evaluate their symptom severity and degree of manual ability.¹⁰ The symptoms severity scale (SSS) evaluates symptom severity, frequency, time, and type. The functional status scale (FSS) assesses how the symptoms affect activities of daily living. Higher scores indicate greater symptom severity. We instructed the patients to answer the questionnaire with respect to the most symptomatic side.

Pain assessment by visual analog scale: The pain assessment was performed by measuring the distance between the start of a 10-cm line and the mark made by the patient at the time of the assessment. The anchors were no pain and worst pain ever.

Complications: All complications that occurred owing to corticosteroid injection or orthosis that required

additional interventions not provided for in this protocol were considered complications. Specific situations were considered: paresthesia/Tinel sign worsening at the injection site—suggesting the possibility of postinjection nerve dysfunction; and skin and subcutaneous tissue atrophy. We did not anticipate complications in the orthosis group.

Failure: Failure of the intervention was considered when there was worsening of, or no improvement in, CTS-related signs and symptoms, therefore requiring another therapeutic intervention.

Statistical analysis

Normality of the distribution for the primary outcome (BLQ) was assessed by using the Kolmogorov-Smirnov test. To compare the results between the injection-treated group and the nocturnal immobilization group, Mann-Whitney U test was used for numerical variables and the Fisher F test was used for categorical variables. The level of significance was set at P less than .05.

Sample size calculation

Considering a 30% difference in the improvement of nocturnal paresthesia after 6 months of follow-up as clinically relevant, with a 95% confidence interval and statistical power of 80%, we estimated a sample size of 84 patients. Considering a loss rate of 15% after 6 months of follow-up, 100 patients were included in this study.

RESULTS

One hundred patients were included in this study; 52 patients were allocated to the corticosteroid group, and 48 patients were allocated to the orthosis group. There was an overall loss to follow-up of 5 patients (5%). In the orthosis group, 1 patient did not return in the third month of follow-up, and another 2 were lost in the sixth month (6.25%). In the corticosteroid group, 2 patients (3.8%) did not return in the sixth month assessment. Demographic data and BLQ baseline scores are shown in Table 1.

Primary outcomes

Remission of nocturnal paresthesia: Corticosteroid demonstrated effectiveness in the remission of nocturnal paresthesia after 7 days of treatment (Baseline versus 7 days: corticosteroid, 17 of 52 versus 28 of 52; $P < .05$). The same was not observed for the orthosis group (Pre versus 7 days: 20 of 48 versus 23 of 48; $P = .60$). In comparing the results between the corticosteroid and the orthosis groups, we found a

TABLE 1. Baseline Data

Characteristics	Corticosteroid (n = 52)	Orthosis (n = 48)
Female, n (%)	42 (80.8)	41 (93.2)
Right hand affected, n (%)	36 (70.6)	30 (66.7)
Presence of nocturnal paresthesia, n (%)	17 (35)	22 (42)
Nerve conduction study severe, n (%)	5 (9.6)	9 (18.7)
Age (y)	54.2	54.4
SSS (SD)s	3.32 (0.74)	3.06 (0.93)
FSS (SD)	2.77 (1.0)	2.74 (1.12)
Pain, VAS (SD)	6.27 (2.49)	6.24 (2.49)

VAS, visual analog scale.

statistically significant difference in all evaluations after 1 month, favoring the corticosteroid group (1 month: corticosteroid 44 of 52, orthosis 21 of 48; 3 month: corticosteroid 37 of 52, orthosis 19 of 47; 6 months: corticosteroid 40 of 50, orthosis 13 of 45; $P < .05$ for all comparisons; Fig. 1).

Boston-Levine questionnaire: Baseline data demonstrated similar scores for SSS and FSS. The SSS for both groups had clinically relevant improvement at the 7-day assessment and was sustained until the 6-month assessment (minimal clinically important difference [MCID] for SSS, >0.16).¹¹ In the 1-, 3-, and 6-month follow-ups, the corticosteroid group SSS scores had greater improvement than those of the orthosis group. Improvement from baseline was clinically relevant for both and was maintained until the 6-month follow-up. The same occurred for the FSS scores, however, at the later time frame, clinically relevant differences favoring the corticosteroid groups at the 3- and 6-month assessments were observed (MCID for FSS, >0.50)¹¹ (Table 2 and Fig. 2).

Secondary outcomes

Baseline data showed similar scores for pain in both groups. Improvement after both interventions was observed from baseline until the final assessment. The corticosteroid group had lower pain scores in the 1-, 3-, and 6-month assessments (MCID for visual analog scale, >1.2)¹¹ (Table E1, available on the Journal's Web site at www.jhandsurg.org).

Complications were not seen at any time in either group. Four patients asked for surgical treatment, all between the third and the sixth months of treatment (corticosteroid, orthosis: 5.7% versus 2.1%; $P = .61$).

DISCUSSION

In this study, 2 nonsurgical treatment methods were compared: corticosteroid injection and nighttime orthosis wear. Both methods showed improvement in the symptoms of patients with CTS. Overall, in comparison with orthosis wear, better results were demonstrated in the corticosteroid injection group.

These 2 options of nonsurgical treatment are both effective in the short term (up to 6 months) for CTS.⁶ Our data suggest that improvement can be noted as early as 1 week after treatment and may be greatest in the period 1 to 3 months after treatment starts. Our data indicate that, for both options, a trend toward returning to baseline status begins around the sixth month following treatment. This information is relevant because patients should be made aware of the possibility that symptoms will recur. If symptoms recur, surgery may be indicated for most patients.

The American Academy of Orthopedic Surgeons Clinical Practice Guideline on Carpal Tunnel Syndrome Diagnosis and Treatment also states as “strong recommendations” the use of immobilization and steroid injections.⁶ The recommendations are supported for both alternatives up to 3 months. For longer follow-up, evidence is lacking. A Cochrane Collaboration systematic review of local corticosteroid injection demonstrates better effectiveness compared with placebo (up to 1 month) or oral corticosteroids (up to 3 months).¹² The review also indicates that increasing the number of corticosteroid injections is not effective. Both documents are in line with our findings.

A comparison of corticosteroid injection and orthosis wear has been performed in a few studies, most with important methodological flaws, such as quasi-randomization, small samples, a focus on nerve conduction studies-related outcomes, and a lack of

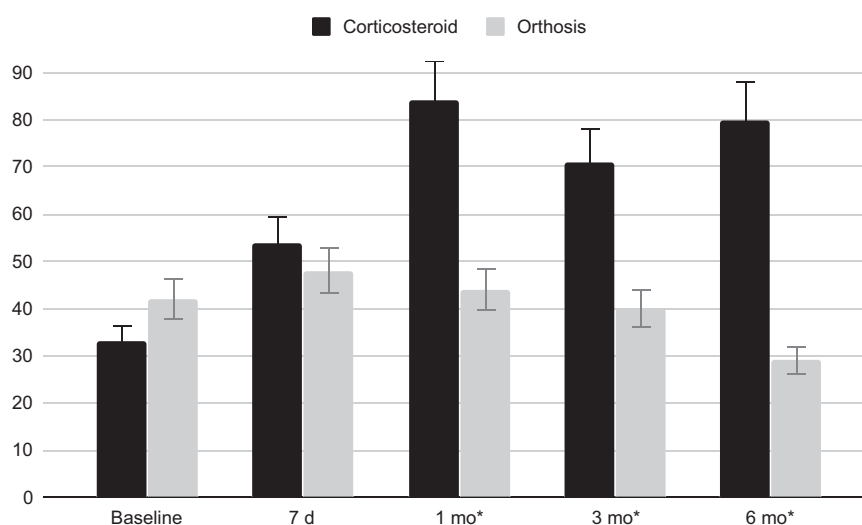


FIGURE 1: Rates of remission of nocturnal paresthesia. * $P < .05$.

TABLE 2. Results of the BLQ Subscales

BLQ	Group	n	Mean	SD	P Value
SSS, 7 d	Orthosis	48	2.36	0.95	.37
	Corticosteroid	52	2.20	0.80	
FSS, 7 d	Orthosis	48	2.25	1.04	.49
	Corticosteroid	52	2.12	0.85	
SSS, 1 mo	Orthosis	48	2.20	0.98	<.05
	Corticosteroid	52	1.68	0.53	
FSS, 1 mo	Orthosis	48	2.17	1.08	.11
	Corticosteroid	52	1.88	0.74	
SSS, 3 mo	Orthosis	47	2.55	0.95	<.05
	Corticosteroid	52	1.78	0.95	
FSS, 3 mo	Orthosis	47	2.41	1.07	<.05
	Corticosteroid	52	1.90	0.98	
SSS, 6 mo	Orthosis	45	2.73	0.98	<.05
	Corticosteroid	50	1.83	0.89	
FSS, 6 mo	Orthosis	45	2.64	1.12	<.05
	Corticosteroid	50	1.91	1.04	

VAS, visual analog scale.

Bold values indicate significant ($P < .05$).

patient-reported outcomes, such as the BLQ.^{13–18} Our study tried to address these issues by having a sample adequately powered for the primary outcomes and focusing on validated patient-reported outcome measures.

We hypothesize that the superior performance of corticosteroid injection is due to a long-lasting anti-inflammatory effect, whereas nocturnal immobilization acts only on a contributing factor of this condition, which is flexion of the wrist during sleep.

Although the role of inflammation in CTS is not clear, clinical evidence may support this rationale.¹⁸ In the remission of paresthesia, our results were better than those found by Girlanda et al,¹⁹ in which 50% of patients had recurrence of symptoms 6 months after injection.

The BLQ and pain assessment had similar findings to remission of paresthesia. The absence of injection complications indicates that the procedure may not need ultrasound guidance; however, larger studies are

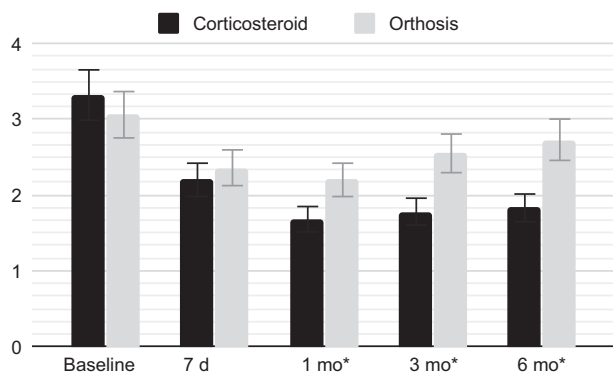


FIGURE 2: BLQ scores, SSS. * $P < .05$.

needed. In agreement with our findings, 1 study that compared ultrasound-guided and nonguided injections demonstrated no difference in the frequency of side effects.²⁰ Our decision not to include ultrasound guidance is related to the fact that this technology may not be easily available in real-world practice.

A large multicenter randomized trial²¹ has shown results that are similar to ours. They also have demonstrated that corticosteroid is more cost-effective than night orthoses. There are some differences between the trials: the previous study had a shorter follow-up period (6 weeks) and carpal tunnel severity was based only on clinical assessment.

Our study has the limitations of being a single-center study, and the follow-up time was relatively short. We believe that longer follow-up would not have changed the direction of our results; there is general consensus that CTS outcomes are known to be static by 6 months.^{2,5,12,22} However, with a longer follow-up time, we might detect the eventual recurrence of the symptoms in the group treated with corticosteroid. We did not assess the rates of surgical treatment following the study interventions because surgery was not the focus of the study and whether either treatment has an effect on the eventual requirement for is unknown.

In conclusion, both options are effective in the short term. Corticosteroid is superior to orthosis in the remission of nocturnal paresthesia, BLQ score, and pain assessment at 1, 3, and 6 months.

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TABLE E1. Time-Point *P* Values for Steroid and Splint Groups

Characteristics	Corticosteroid (n = 52)	Splint (n = 48)
VAS, baseline-7 days	<0.05	<0.05
VAS, 7days- 1 month	<0.05	<0.05
VAS, 1 month-3 month	0.08	0.12
VAS, 3 month-6 month	0.54	<0.05

SD, standard deviation; SSS, boston questionnaire, symptom severity scale; VAS, visual analogue scale