

Functional Outcome following Conservative Management of Mild to Moderate Carpal Tunnel Syndrome

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ABSTRACT

Background: Carpal tunnel syndrome (CTS) is a common neuropathy caused by median nerve compression at the wrist, resulting in pain, numbness, and tingling. Conservative treatment is generally recommended for mild to moderate CTS and includes wrist splinting, corticosteroid injection, and physical therapy. Although these approaches can improve symptoms and hand function, evidence on their functional outcomes in Bangladeshi patients remains limited. Therefore, this study aimed to evaluate symptom improvement and functional outcomes following conservative treatment in patients with mild to moderate CTS. **Methods & Materials:** A prospective study was conducted among 60 patients with mild to moderate CTS. Clinical symptoms, Boston Carpal Tunnel Questionnaire (BCTQ) scores, grip and pinch strength, and pain intensity were assessed at baseline and after 6 weeks of conservative treatment. Clinically meaningful functional improvement was defined as a ≥ 0.5 -point reduction in the BCTQ Functional Status Score. **Results:** Among 60 patients, the mean age was 44.3 ± 8.7 years and 63.3% were female. Nocturnal paresthesia (88.3%) was the most common symptom, followed by numbness (83.3%). After 6 weeks of conservative treatment, BCTQ symptom severity and functional status scores significantly improved (2.86 to 1.92 and 2.63 to 1.78, respectively; both $p < 0.001$). Grip strength, pinch strength, and VAS pain scores also improved significantly (all $p \leq 0.002$). Clinically meaningful functional improvement was achieved by 38 (63.3%) patients. Improvement was significantly higher in mild CTS than moderate CTS (74.3% vs. 48.0%; $p = 0.039$). **Conclusion:** Conservative treatment improved symptoms and function in mild

to moderate CTS, particularly in mild cases, supporting its use as first-line management.

Keywords: Carpal Tunnel Syndrome, Functional Outcome, Conservative Management, BCTQ Symptom Severity Score

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INTRODUCTION

Carpal tunnel syndrome (CTS) is a common condition caused by compression of the median nerve at the wrist, resulting in pain, numbness, and tingling in the hand and arm [1]. The prevalence and incidence of CTS vary depending on the diagnostic criteria used. Overall, approximately one in ten people may develop CTS during their lifetime. Clinical criteria generally produce higher prevalence estimates than electrophysiological criteria [2].

CTS is characterized by pain, sensory loss, and tingling involving the thumb, index, middle, and radial half of the ring finger. It develops due to increased pressure on the median nerve within the carpal tunnel and is primarily diagnosed through clinical assessment of characteristic symptoms and signs [3-5]. Several factors increase the risk of CTS, including older age, female sex, diabetes, hypothyroidism, obesity, systemic diseases, smoking, previous wrist injury, and occupational activities involving repetitive or prolonged wrist and hand movements [6-8]. Progressive compression of the median nerve may cause thenar muscle weakness, reduced grip strength, impaired hand function, and decreased quality of life. In severe cases, symptoms may extend to the forearm and upper arm [2,9]. Due to its high prevalence, functional limitations, and socioeconomic impact, CTS is also

recognized as an important occupational health problem [4].

Management of CTS depends on disease severity. Clinical practice guidelines generally recommend conservative treatment for mild to moderate CTS, whereas surgical treatment is recommended for severe CTS or persistent symptoms despite conservative management [10]. Conservative treatment includes wrist splinting, corticosteroid injections, physical therapy, therapeutic ultrasound, and other supportive measures [11-14]. Nighttime wrist splinting is a simple and effective initial treatment, while local corticosteroid injections may provide temporary symptom relief and delay the need for surgery. Oral corticosteroids may provide short-term relief, whereas NSAIDs, diuretics, and vitamin B6 are not generally recommended. Physical therapy may also improve symptoms, although supporting evidence remains limited [11-14].

Global evidence has shown that conservative treatment of CTS can provide meaningful improvement in symptoms and hand function, although the effectiveness varies among different treatment modalities. Long-term follow-up has also demonstrated sustained benefits in many patients, although some may experience persistent or recurrent symptoms. Overall, conservative treatment appears to be effective,

particularly in mild to moderate CTS, although long-term outcomes may vary between patients [9,15]. Bangladeshi studies have also reported favorable outcomes with conservative management of CTS. A hospital-based study demonstrated improvement in clinical symptoms and functional status following treatment, while a prospective study among pregnant women found that conservative treatment effectively reduced symptoms, supporting its beneficial role in this population [16,17].

Despite these findings, evidence regarding the functional outcomes of conservative treatment specifically among patients with mild to moderate CTS remains limited in Bangladesh. Therefore, this study aims to assess symptom improvement and functional outcomes following conservative management in patients with mild to moderate CTS.

METHODS & MATERIALS

Study Design and Study Period

A prospective observational study was conducted to evaluate the functional outcome following conservative management of patients with mild to moderate carpal tunnel syndrome (CTS). The study was conducted over a period of one year, from July 2025 to June 2026, with each participant followed for 6 weeks after initiation of conservative treatment.

Study Population and Setting

The study population consisted of adult patients diagnosed with mild to moderate CTS who attended the department of Neurology, Rajshahi Medical College, Rajshahi, Bangladesh, during the study period. A total of 60 eligible patients were included in the final analysis.

Eligibility Criteria

Patients aged ≥ 18 years with a clinical diagnosis of mild or moderate CTS, symptoms such as hand numbness, tingling, nocturnal paresthesia, pain or functional difficulty, and suitability for conservative management were included in the study. Patients who provided informed consent and were willing to complete the 6-week follow-up were also eligible. Patients with severe CTS requiring surgical intervention, previous carpal tunnel release surgery, significant peripheral neuropathy, cervical radiculopathy, major hand or wrist trauma, inflammatory arthropathy affecting the wrist, or other conditions likely to substantially impair hand function were excluded from the study.

Diagnosis and Classification of Carpal Tunnel Syndrome

The diagnosis of CTS was established based on clinical assessment, including characteristic symptoms and provocative tests such as Phalen's test and Tinel's sign. Where available, nerve conduction studies were used to support the diagnosis and determine disease severity. Patients were classified as having mild or moderate CTS according to the clinical and/or electrodiagnostic criteria used at the study center. Patients with severe CTS, marked thenar muscle wasting, or severe motor deficit were excluded because they were considered more appropriate for surgical or specialist intervention.

Conservative Management

All enrolled patients received conservative treatment appropriate for mild to moderate CTS. Management primarily consisted of night wrist splinting in a neutral position, activity modification, patient education regarding avoidance of repetitive wrist movements and prolonged wrist flexion, and appropriate therapeutic exercises. Patients were advised to use the wrist splint during nighttime throughout the 6-week treatment period. Symptomatic treatment was provided when clinically indicated according to routine clinical practice. Treatment adherence and any adverse effects were assessed during follow-up.

Baseline Assessment

At enrollment, demographic and clinical information was collected using a structured data collection form. The collected variables included age, sex, duration of symptoms, affected hand, dominant hand involvement, presenting symptoms, and clinical examination findings. Baseline assessment included documentation of nocturnal paresthesia, hand numbness, tingling sensation, pain or discomfort, reduced grip strength, Phalen's test, and Tinel's sign. Baseline CTS severity was also recorded as mild or moderate.

Assessment of Functional Outcome

Functional outcome was assessed using the Boston Carpal Tunnel Questionnaire (BCTQ), which consists of a Symptom Severity Scale (SSS) and a Functional Status Scale (FSS). The BCTQ Functional Status Scale (BCTQ-FSS) was considered the primary measure of functional outcome. The FSS assesses the degree of difficulty experienced while performing activities requiring hand function, with each item scored from 1 to 5; higher scores indicate greater functional impairment. The mean FSS score was calculated for each participant at baseline and after 6 weeks of conservative management. Pain severity was assessed using a 10-cm Visual Analogue Scale (VAS), while grip and pinch strength were measured using an appropriate hand dynamometer.

Definition of Clinically Meaningful Functional Improvement

The primary functional outcome was determined from the change in BCTQ-FSS score between baseline and 6 weeks. A reduction of ≥ 0.5 points in the BCTQ-FSS score from baseline was predefined as clinically meaningful functional improvement, whereas a reduction of < 0.5 points was considered no clinically meaningful improvement.

The outcome groups were defined as follows:

- **Clinically meaningful improvement:** reduction in BCTQ-FSS ≥ 0.5 points from baseline.
- **No clinically meaningful improvement:** reduction in BCTQ-FSS < 0.5 points from baseline.

Follow-up

All participants were reassessed after 6 weeks of conservative treatment. At follow-up, BCTQ-FSS, BCTQ symptom severity

score, VAS pain score, grip strength, and pinch strength were reassessed. Treatment adherence, persistence or improvement of symptoms, and any adverse effects were also documented.

Statistical Analysis

Data were entered, cleaned, and analyzed using IBM SPSS Statistics 27. Continuous variables were expressed as mean $\pm$ standard deviation (SD), while categorical variables were presented as frequencies and percentages. Changes in continuous outcome measures between baseline and 6 weeks were assessed using the paired-samples t-test when the assumptions of parametric testing were satisfied. The BCTQ-FSS, BCTQ symptom severity score, grip strength, pinch strength, and VAS pain score were compared between baseline and follow-up. The association between baseline CTS severity (mild versus moderate) and clinically meaningful functional improvement was assessed using the Pearson's chi-square test. A p-value of < 0.05 was considered statistically significant.

Ethical Considerations

The study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was obtained from the appropriate institutional ethical review committee before commencement of the study. Written informed consent was obtained from all participants before enrollment. Participant information was kept confidential and was used solely for research purposes.

RESULTS

Table 1 shows total of 60 patients with mild to moderate carpal tunnel syndrome (CTS) were included in the study and completed the 6-week follow-up. The mean age of the participants was 44.3 ± 8.7 years, with an age range of 27–62 years. Female patients predominated, accounting for 38 (63.3%) participants, while 22 (36.7%) were male. The largest proportion of patients belonged to the 51–60 years age group (30.0%), followed by 41–50 years (28.3%) and 31–40 years (26.7%). The mean duration of symptoms was 8.2 ± 4.6 months. Right-hand involvement was predominant in 32 (53.3%) patients, while 14 (23.3%) had left-hand involvement and another 14 (23.3%) had bilateral involvement. Dominant hand involvement was observed in 39 (65.0%) patients.

Table IBaseline demographic and clinical characteristics of the study participants ($n=60$).

Variables	Frequency (%) / Mean $\pm$ SD
Age (years)	44.3 $\pm$ 8.7
Age range (years)	27–62
Age group (years)	
20–30	5 (8.3)
31–40	16 (26.7)
41–50	17 (28.3)
51–60	18 (30.0)
>60	4 (6.7)
Sex	
Male	22 (36.7)
Female	38 (63.3)
Duration of symptoms (months)	8.2 $\pm$ 4.6
Right hand predominantly affected	32 (53.3)
Left hand predominantly affected	14 (23.3)
Bilateral involvement	14 (23.3)
Dominant hand involvement	39 (65.0)

Table II presents the most common presenting symptom was nocturnal paresthesia, reported by 53 (88.3%) patients, followed by hand numbness in 50 (83.3%), tingling sensation in 46 (76.7%),

pain or discomfort in 43 (71.7%), and reduced grip strength in 31 (51.7%). On clinical examination, Phalen's test was positive in 48 (80.0%) patients and Tinel's sign was positive in 44 (73.3%). Regarding

baseline disease severity, 35 (58.3%) patients had mild CTS and 25 (41.7%) had moderate CTS.

Table IIBaseline clinical characteristics and symptoms of the participants ($n=60$).

Clinical characteristics	Frequency (%)
Nocturnal paresthesia	53 (88.3)
Hand numbness	50 (83.3)
Pain/discomfort	43 (71.7)
Reduced grip strength	31 (51.7)
Tingling sensation	46 (76.7)
Phalen's test positive	48 (80.0)
Tinel's sign positive	44 (73.3)
Mild CTS	35 (58.3)
Moderate CTS	25 (41.7)

Table III shows following 6 weeks of conservative management, significant improvements were observed in all major clinical and functional outcome measures. The mean Boston Carpal Tunnel Questionnaire (BCTQ) Symptom Severity Score decreased from 2.86 ± 0.43 at baseline to 1.92 ± 0.51 at 6 weeks,

representing a mean reduction of 0.94 points ($p<0.001$). Similarly, the mean BCTQ Functional Status Score decreased from 2.63 ± 0.48 to 1.78 ± 0.46 , with a mean reduction of 0.85 points ($p<0.001$). Objective measures of hand function also improved significantly. Mean grip strength increased from 21.8 ± 5.4 kg at baseline to

25.6 ± 5.7 kg after 6 weeks, corresponding to a mean increase of 3.8 kg ($p<0.001$). Mean pinch strength increased from 5.1 ± 1.4 kg to 5.9 ± 1.5 kg ($p=0.002$). In addition, the mean VAS pain score decreased from 5.2 ± 1.5 at baseline to 2.7 ± 1.4 after treatment, with a mean reduction of 2.5 points ($p<0.001$).

Table IIIComparison of functional outcome measures before and after conservative management ($n=60$).

Outcome measure	Baseline Mean $\pm$ SD	6 weeks Mean $\pm$ SD	Mean difference	p-value
BCTQ Symptom Severity Score	2.86 ± 0.43	1.92 ± 0.51	0.94	<0.001
BCTQ Functional Status Score	2.63 ± 0.48	1.78 ± 0.46	0.85	<0.001
Grip strength (kg)	21.8 ± 5.4	25.6 ± 5.7	3.8	<0.001
Pinch strength (kg)	5.1 ± 1.4	5.9 ± 1.5	0.8	0.002
VAS pain score	5.2 ± 1.5	2.7 ± 1.4	2.5	<0.001

Table IV shows among the 60 participants, 38 (63.3%) demonstrated a clinically meaningful improvement in functional

status after 6 weeks of conservative management, whereas 22 (36.7%) did not

achieve the predefined threshold for clinically meaningful improvement.

Table IV
Functional outcome after 6 weeks of conservative management based on change in BCTQ Functional Status Score (n=60).

Functional outcome	Definition	Frequency (%)
Clinically meaningful improvement	Reduction in BCTQ-FSS ≥ 0.5 points from baseline	38 (63.3)
No clinically meaningful improvement	Reduction in BCTQ-FSS < 0.5 points	22 (36.7)
Total		60 (100.0)

Note: BCTQ-FSS = Boston Carpal Tunnel Questionnaire Functional Status Scale. A reduction of ≥ 0.5 points from baseline was considered a clinically meaningful functional improvement.

Table V presents patients with mild CTS had a significantly higher proportion of clinically meaningful functional improvement than those with moderate CTS. Improvement was observed in 26 (74.3%) patients with mild CTS compared with 12 (48.0%) patients with moderate CTS (p=0.039).

Table V
Association between baseline CTS severity and clinically meaningful functional improvement after 6 weeks (n=60).

Baseline CTS severity	Clinically meaningful improvement n (%)	No clinically meaningful improvement n (%)	Total	p-value
Mild	26 (74.3)	9 (25.7)	35 (100.0)	
Moderate	12 (48.0)	13 (52.0)	25 (100.0)	
Total	38 (63.3)	22 (36.7)	60 (100.0)	0.039

Pearson's chi-square test.

Thus, the likelihood of achieving clinically meaningful functional improvement following conservative management was significantly greater among patients with mild CTS than among those with moderate CTS.

DISCUSSION

In the present study, 60 patients with mild to moderate CTS had a mean age of 44.3 ± 8.7 years, with females predominating. Most patients were aged 41–60 years, and the mean symptom duration was 8.2 ± 4.6 months. Right-hand and dominant-hand involvement were most common, while bilateral involvement was observed in 23.3% of patients. These findings were broadly comparable with a previous Bangladeshi study, which reported a mean age of 49.68 ± 1.36 years and a marked female predominance (male = 1:3). Right-hand involvement was reported in 19/50, left-hand involvement in 11/50, and bilateral involvement in 20/50 patients. Thus, the demographic and clinical profile of the present cohort was generally consistent with previous findings in Bangladesh [18]. Nocturnal paresthesia was the most common presenting symptom in the present study, followed by hand numbness, tingling, pain/discomfort, and reduced grip strength. Phalen's test was positive in 80.0% and Tinel's sign in 73.3% of patients. Mild CTS was present in 58.3%, while 41.7% had moderate CTS. Similarly, a study of elderly patients with CTS reported sensory loss in 91.7% and abductor pollicis brevis weakness in 61.6% of affected hands, with thenar atrophy in 26.0% [19]. The predominance of sensory symptoms in both studies supports the typical clinical presentation of CTS. Following 6 weeks of conservative management, significant improvements

were observed in all assessed clinical and functional outcomes. BCTQ Symptom Severity and Functional Status Scores decreased by 0.94 and 0.85 points, respectively, while grip strength increased by 3.8 kg, pinch strength by 0.8 kg, and VAS pain score decreased by 2.5 points. These findings are consistent with a recent randomized controlled trial demonstrating significant improvements in pain, symptoms, functional status, quality of life, and hand–forearm muscle strength following conservative treatment of CTS [20]. The improvement across both subjective and objective measures suggests that conservative management can provide meaningful short-term benefits in mild to moderate CTS. Clinically meaningful functional improvement, defined as a ≥ 0.5 -point reduction in BCTQ Functional Status Score, was achieved by 38 patients, whereas 22 did not reach this threshold. This indicates that conservative management provided meaningful functional benefit for the majority of patients. Evidence from an updated systematic review also supports the effectiveness of conservative treatment for improving symptoms and function, although surgical treatment may provide greater and more sustained benefits in patients with persistent or severe CTS [20]. Importantly, clinically meaningful improvement was significantly greater among patients with mild CTS than moderate CTS. This finding suggests that treatment response may be better when conservative management is initiated at an earlier stage of disease. Previous randomized and long-term studies have demonstrated beneficial outcomes with conservative treatment and support its use particularly in less severe CTS [12,15,21]. Therefore, early identification and conservative intervention may improve the

likelihood of meaningful functional recovery and potentially delay the need for surgical treatment.

Overall, six weeks of conservative management produced significant improvements in symptoms, pain, grip and pinch strength, and functional status, with a greater likelihood of clinically meaningful improvement among patients with mild CTS.

CONCLUSION

Conservative management significantly improved symptoms, pain, grip and pinch strength, and functional status in patients with mild to moderate carpal tunnel syndrome over 6 weeks. Clinically meaningful functional improvement was achieved in nearly two-thirds of patients, with significantly better outcomes among those with mild CTS than moderate CTS. These findings support conservative management as an effective and practical first-line treatment for mild to moderate CTS, particularly in patients with less severe disease.

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