

Original Research Article

Assessment of the diagnostic accuracy of nerve conduction study and the correlation between severity of symptoms and nerve conduction studies in carpal tunnel syndrome

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ABSTRACT

Background: This study was done to assess the diagnostic accuracy of nerve conduction study in carpal tunnel syndrome and comparability of nerve conduction measures before and after carpal tunnel release.

Methods: 31 patients (30 females and 1 male) with carpal tunnel syndrome were subjected to nerve conduction study and Boston symptom severity scores before surgery and at 3 months post-operative period and nerve conduction values compared. The effect of duration of symptoms on nerve conduction values was studied.

Results: Nerve conduction studies were found to be reliable in diagnosing carpal tunnel syndrome. 61.30% patients showed a right-handed involvement, or right side getting affected first in a bilateral case. 60-80% patients had Boston symptom severity scores which were comparable to the nerve conduction grades ascertaining the relationship between them. Only 58.8% patients with extreme and severe NCS grades preoperatively showed improvement post-surgical release. In patients with symptoms for more than 12 months, only 33.33% had improved nerve conduction grades post-surgical release at 3 months, validating the need for early surgical release.

Conclusions: Nerve conduction study was found to be a reliable diagnostic modality for diagnosis of carpal tunnel syndrome and nerve conduction study values correlated with the Boston symptom severity score. The post-operative nerve conduction values revealed definite neurological improvement in patients who underwent early surgical management. Hence, we recommend early release for carpal tunnel syndrome patients for speedy recovery from the condition.

Keywords: Nerve conduction study, Carpal tunnel syndrome, Boston symptom severity score, Median nerve

INTRODUCTION

Carpal tunnel syndrome is a common, chronic and disabling condition afflicting many people.^{1,2} It occurs more often in women, in a ratio of 5:1.^{3,4} The common age at onset is 40 to 50, although a person of any age may be affected.

The diagnosis of carpal tunnel syndrome is often based on clinical findings alone. Electrodiagnostic studies of

carpal tunnel syndrome were first established in 1956 by demonstrating focal slowing of median nerve conduction at wrist. Both sensory and motor conduction of median nerve are abnormal but rarely only one may be affected. Electrodiagnostic studies are usually necessary for confirmation and exclusion of other conditions that may mimic carpal tunnel syndrome

This study is done to assess the diagnostic accuracy of nerve conduction study in carpal tunnel syndrome and

comparability of nerve conduction measures before and after carpal tunnel release.^{5,6}

METHODS

This is a prospective study conducted in Pushpagiri Institute of Medical Sciences, Thiruvalla between January 2014 to July 2015 on all cases of carpal tunnel syndrome reported in the out-patient department. Each wrist was considered separately in clinical diagnosis. All cases were examined clinically, and patient's symptoms and functional status were evaluated by Boston carpal tunnel questionnaire.⁷ Following which they were subjected to nerve conduction studies and decompression of median nerve.

In the questionnaire each response is given a score from one to five points. No response is given zero points. Each score of the patient is calculated as the mean of the responses of the individual questions.

Patients with bilateral symptoms were evaluated by two questionnaires one for each hand separately.

Patients were divided into five groups according to their mean score.

Extreme:	4.1 – 5.0 points
Severe:	3.1 – 4.0 points
Moderate:	2.1 – 3.0 points
Mild:	1.1 – 2.0 points
Minimal:	1.0 point

Definition of cases

The major criteria for diagnosis of carpal tunnel syndrome are⁸

- Paresthesia in the hand in median nerve, median nerve and ulnar nerve, or glove distribution (all cases must meet this criterion)
- Paresthesia aggravated by activities such as working with the hands raised, holding a book, holding the telephone receiver
- Paresthesia and pain in the hand that awaken the patient from sleep and
- Paresthesia relieved by shaking the hand or holding it in a dependent position.

The minor criteria for diagnosis of carpal tunnel syndrome are

- Subjective weakness of the hand
- Clumsiness of the hand or dropping objects.
- Presence of positive result to any of provocative tests of Phalen's, Reverse Phalen, Gilliatt, Durkan's and Tinel's sign.

Patients were categorized clinically as Definite carpal tunnel syndrome if they had major criterion number 1 and at least two other major criteria with or without minor criteria or as "Possible carpal tunnel syndrome" if they had major criterion number 1 and at least one other major or minor criterion. Patients not meeting either of these definitions were excluded from the study.

Under this criterion 31 patients were selected (30 females and 1 male), symptom severity score charted and were subjected to nerve conduction studies.

Nerve conduction study

It was done for all cases as per American Association of electrodiagnostic Medicine recommendations.⁹ All tests are done in the same room and in similar temperature conditions.

Measurements used in the study: sensory nerve conduction velocity in two-digit/wrist segments and median distal motor latency from the wrist to the thenar eminence, median sensory latency and motor conduction velocity.

It was conducted using the NIHON KOHDEN neuropack system.

The severity of electrophysiological impairment is graded by classification reported by Padua.¹⁰

Negative: normal findings on all tests.

Minimal: abnormal comparative tests only.

Mild: abnormal digit/wrist sensory nerve conduction velocity and normal distal motor latency.

Moderate: abnormal digit/wrist sensory nerve conduction velocity and abnormal distal motor latency.

Severe: absence of sensory response and abnormal distal motor latency.

Extreme: absence of motor and sensory responses.

All clinically defined and symptomatic patients supported by positive nerve conduction studies were subjected to open carpal tunnel release (Standard volar approach to the wrist) after appropriate pre-operative work up. Bilateral carpal tunnel syndrome with each wrist taken as individual case, release was done at an interval of four to six weeks.

Post operatively wrist was immobilized in a plaster slab till suture removal which was done on the tenth day following procedure.

The patients were reviewed at regular intervals and at three months interval postoperatively and were told to indicate overall change in their hand symptoms and a review nerve conduction study was done.

Statistical analysis

Data were analysed using computer software, Statistical Package for Social Sciences (SPSS) version 10. Data are expressed in its frequency and percentage as well as mean and standard deviation. To elucidate the associations and comparisons between different parameters, Chi square (χ^2) test was used as nonparametric test. Sensitivity and specificity of NCS diagnostic methods were also elucidated with respect to symptom severity scale (SSS). Student's t test was used to compare mean values between two groups. For all statistical evaluations, a two-tailed probability of value, <0.05 was considered significant.

RESULTS

Common age group getting affected was between 50–59 years (Table 1). Among the 31 patients in our study group 30 were females and 1 male, showing females being affected more common than males in general population. 19 patients (61.30%) showed a right-handed involvement, or right side getting affected first in a bilateral case demonstrating an increased prevalence in dominant hand compared to 12 patients with left non-dominant hand involvement (38.7%).

Table 1: Distribution of age in study population.

Age (years)	Frequency	Percentage (%)
20-29	2	6.5
30-39	6	19.4
40-49	8	25.8
50-59	11	35.5
≥60 yrs	4	12.9

Table 2: Duration of symptoms.

Duration (months)	Frequency	Percentage (%)
<6	14	45.2
6–12	14	45.2
>12	3	9.7

Table 3: Clinical distribution according to Boston symptom severity score.

SSS	Frequency	Percentage (%)
Mild	10	32.3
Moderate	13	41.9
Severe	7	22.6
Extreme	1	3.2

Nerve conduction studies were found to be reliable in diagnosing carpal tunnel syndrome with a sensitivity of

100%, specificity of 47.06%, positive predictive value of 60.87% and an accuracy of 70.97 in our study (Table 5). In our study 60–80% patients had Boston symptom severity scores which were comparable to the nerve conduction grades ascertaining the relationship between them (Table 6).

Table 4: Nerve conduction study grade before and after surgical release.

NCS grade-before release	N	%	NCS grade-after release	NCS grade-after release	
				N	%
Mild	6	19.4	Normal	7	22.6
Moderate	8	25.8	Mini	2	6.5
Severe	15	48.4	Mild	10	32.3
Extreme	2	6.5	Moderate	5	16.1
			Severe	6	19.4
			Extreme	1	3.2

N=Frequency.

Table 5: Sensitivity and specificity.

Parameter	Percentage (%)
Sensitivity	100.00
Specificity	47.06
Positive predictive value	60.87
Negative predictive value	100.00
Accuracy	70.97
Likelihood ratio +	1.89
Likelihood ratio -	0

Table 6: Association of Boston symptom severity score with nerve conduction study grade.

SSS	NCS grade			
	Mild	Moderate	Severe	Extreme
	N (%)	N (%)	N (%)	N (%)
Mild	6 (60)	3 (30)	1 (10)	
Moderate		5 (38.5)	7 (53.8)	1 (7.7)
Severe			6 (85.7)	1 (14.3)
Extreme				1 (100)

Chi square = 22.638; p<0.01

Table 7: Diagnostic accuracy of nerve conduction study with respect to Boston symptom severity score.

SSS	NCS grade	
	Low	High
Low	14 (60.90)	9 (39.10)
High		8 (100.00)

Chi Square =8.881; p<0.01.

70.9% patients had improved nerve conduction study grades at 3 months post-surgical release. 85.7% patients with mild and moderate NCS grades pre-operatively showed improvement with surgical release post -

operatively at 3 months. Only 58.8% patients with extreme and severe NCS grades preoperatively showed improvement post-surgical release (Table 9). Post-operative evaluation of nerve conduction studies revealed

significant improvement in conduction and latency measurements showing the benefit obtained by carpal tunnel release (Table 8).

Table 8: Comparison of mean latency (ms) and velocity (m/sec) before and after release.

	Group	Mean	±SD	t value	P value
Latency (ms)					
MSL	Before release	3.22	0.90	4.161	<0.01
	After release	2.59	0.90		
DML	Before release	6.12	2.83	4.784	<0.001
	After release	4.48	2.17		
Velocity(m/sec)					
MNCV	Before release	54.39	6.30	-2.582	<0.05
	After release	56.45	4.17		
SNCV	Before release	41.83	7.08	-6.161	<0.001
	After release	49.98	4.64		

Table 9: Percentage change in nerve conduction study grade after release.

NCS grade-before release	NCS grade-after release					
	Normal	Minimal	Mild	Moderate	Severe	Extreme
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Mild	4 (66.70)	1 (16.70)	1 (16.70)			
Moderate	2 (25.00)	1 (12.50)	4 (50.00)	1 (12.50)		
Severe	1 (6.70)		5 (33.30)	3 (20.00)	6 (40.00)	
Extreme				1 (50.00)		1(50.00)

Chi square: 35.218; p<0.01.

Table 10: Relationship between duration of symptoms and effect of surgical release.

Duration (months)	NCS grade before release	NCS grade after release						Chi square	P value
		Normal	Mini	Mild	Moderate	Severe	Extreme		
		N (%)	N (%)	N (%)	N (%)	N (%)	N (%)		
<6	Mild	3 (75)	1 (25)					6.813	<0.05
	Moderate	2 (40)	1 (20)	2 (40)					
	Severe	1 (20)		3 (60)		1 (20)			
6-12	Mild	1 (50)		1 (50)				23.888	<0.01
	Moderate			2 (66.7)	1 (33.3)				
	Severe			2 (25)	3 (37.5)	3 (37.5)			
	Extreme						1 (100)		
>12	Severe					2 (100)		3.001	>0.05
	Extreme				1 (100)				

Among the patients with symptoms for more than 12 months, only 33.33% of patients had neurological improvement in NCS grades post-surgical release at 3 months (Table 10). In contrast, 92.8% of patients with duration of symptoms less than 6 months and 57.1% of patients with duration of symptoms between 6-12 months had neurological improvement in NCS grades post-surgical release, validating the need for early surgical release (Table 10).

DISCUSSION

The diagnosis of carpal tunnel syndrome is based mainly on the patient’s history and clinical findings.¹ Majority of our study group were women as per prior studies but the common age group in our study was 50-59 years compared to 40-50 years in most other studies.¹ Our study concentrated on symptom severity score of Boston carpal tunnel questionnaire since improvement in symptoms is what really is of concern to the patient,

though objective findings are important.⁵ Surgical release of carpal tunnel syndrome gave significant symptomatic relief in our study group according to Boston carpal tunnel questionnaire.

Confirmation of carpal tunnel syndrome has been traditionally based on nerve conduction studies. On review of literature, it has been seen that there are enough controversies around the issue of recommending a gold standard investigation for carpal tunnel syndrome.^{6,8} Hence, we tried to sort this out through this study by finding out reliability of nerve conduction study for carpal tunnel syndrome.

The clinically defined patients when subjected to nerve conduction studies showed a hundred percent sensitivity and an accuracy of seventy percent in showing nerve conduction studies were reliable in diagnosing carpal tunnel syndrome. Though there were some difference in their severity grade, 60-80% remained within their grade when symptom severity score was compared to nerve conduction studies ascertaining an association between them. Studies showed a significant shift in nerve conduction measures after surgery compared to the pre-operative measurement. There was considerable decrease in median nerve sensory and motor latency with increase in conduction velocities after the release. This is in agreement with previous studies. Approximately 70-90% of patients have good to excellent long-term outcomes following carpal tunnel release.¹¹

An important observation in this comparison is that those hands diagnosed to have higher degrees of severity in affection in nerve conduction studies didn't show much of changes post operatively denoting an irreversible damage which has occurred due to compressive neuropathy. 40% of those with severe grade in pre-operative nerve conduction remained same after the release.

While outcomes are generally good an important factor contributed to the poorer results even after surgical release was duration for which median nerve was compressed. In patients who underwent surgical release after a symptomatic period of 1 year, the neurological improvement post-surgical release was not satisfactory. Long term chronic carpal tunnel syndrome mainly in elderly can thus result in permanent nerve damage with irreversible numbness, muscle wasting and weakness with not much significant change in nerve conduction measures. Hence, we recommend early release for carpal tunnel syndrome patients for better recovery.

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Ethical approval: The study was approved by the institutional ethics committee

REFERENCES

1. Phalen GS. The carpal tunnel syndrome: Clinical evaluation of 598 hands. *Clin Orthop.* 1972;8:29-40.
2. Phalen GS. The carpal tunnel syndrome: seventeen years' experience in diagnosis and treatment of six hundred fifty-four hands. *J Bone Joint Surg Am.* 1966;48:211-28.
3. Brain WR, Wright AD, Wilkinson M. Spontaneous compression of median nerve in carpal tunnel. *Lancet.* 1947;1:277.
4. Fowler JR, Munsch M, Huang Y, Hagberg WC, Imbriglia JE. Preoperative electrodiagnostic testing predicts time to resolution of symptoms after carpal tunnel release. *J Hand Surg Eur Vol.* 2016;41(2):137-42.
5. You H, Simmon Z, Frievalds A, Kothari M. Relationships between clinical symptom severity scales and nerve conduction measures in carpal tunnel syndrome. *Muscle Nerve.* 1999;22:497-501.
6. Fullerton PM. The effect of ischemia on nerve conduction in the carpal tunnel syndrome. *J Neurol Neurosurg Psychiatry.* 1963;26:385-97.
7. Levine DW, Simmons PB, Koris MJ. A self-administered questionnaire for assessment of severity of symptoms and functional status in carpal tunnel syndrome. *J Bone Joint Surg Am.* 1993;75:1585-92.
8. Witt JC, Hentz J, Stevens JC. Carpal tunnel syndrome with normal nerve conduction studies. *Muscle Nerve* 2004;29(4):515-522.
9. AAN, AAEM, AAPMR. Practice parameter for carpal tunnel syndrome (summary statement). *Neurology.* 1993;43:2406-9.
10. Padua L, Lo Monaco M, Gregori B, Valente EM, Padua R, Tonali P. Neurophysiological classification and sensitivity in 500 carpal tunnel syndrome hands. *Acta Neurol Scand.* 1997;96:211-17.
11. Turner A, Kimble F, Gulyas K, Ball J. Can the outcome of open carpal tunnel release be predicted? a review of the literature. *ANZ J Surg.* 2010;80:50-4.

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