CORRELATION OF ULTRASONOGRAPHY AND ELECTROPHYSIOLOGICAL STUDIES IN CARPAL TUNNEL SYNDROME

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ABSTRACT

BACKGROUND

Carpal tunnel syndrome is the most frequently encountered entrapment neuropathy caused by median nerve compression at wrist.

The aim of this study was to assess the correlation of ultrasonography and electrophysiological studies in carpal tunnel syndrome.

MATERIALS AND METHODS

A cross sectional study done over a period of one year in 60 patients with clinical features of carpal tunnel syndrome with electrophysiological studies and ultrasonography.

RESULTS

An excellent agreement is obtained between severity grading by ultrasonography and severity grading by electrophysiological studies. Cross sectional area of median nerve at inlet of the median nerve increases with the severity of carpal tunnel syndrome. Ultrasonography can pick up anatomical variations of the median nerve, the carpal tunnel and the other structures within carpal tunnel.

CONCLUSION

Ultrasonography can be considered for diagnosing carpal tunnel syndrome and planning management.

KEY WORDS

Carpal Tunnel Syndrome, Ultrasonography, Electrophysiological Studies.

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BACKGROUND

Carpal tunnel syndrome is the most common entrapment neuropathy of the upper limbs. It occurs due to the compression of median nerve at the wrist. The diagnosis is mainly by clinical history and physical examination including provocative tests.[1] But in instances where, the history is vague and clinical examination is normal, the diagnosis becomes a dilemma. Electrophysiological studies are considered as the most reliable method to confirm the diagnosis and recently ultrasonography. (USG) is also coming up, but still there is no gold standard test[2]. There are several studies which show that nerve conduction studies are effective in diagnosing CTS. There are also studies showing 10 to 20% false negative and false positive rates for NCS in CTS. [3-6] Electrophysiological studies can provide an idea about the level of lesion, but it won't give any information about the anatomy of the nerve or its surroundings,[7] it is more time consuming, costly [8,9] and causes discomfort to the patient, whereas ultrasonography gives information about the anatomy of median nerve, its surroundings, the carpal tunnel and any space occupying lesions in it.[10-13]

USG has the potential advantage of being cheaper, less time consuming and offers the possibility of sonographically guided intervention and treatment. USG is operator dependent and it shows high reproducibility after adequate training of the examiners.[1]

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Aim of the Study

To compare ultrasonography and Nerve conduction studies in diagnosis of carpal tunnel syndrome (CTS).

MATERIALS AND METHODS

Study Design

Descriptive study.

Study Period

One year.

Setting

The study was conducted at the Department of Physical Medicine and Rehabilitation, Government Medical College, Kozhikode, a tertiary care centre in Kerala.

Study Group

Patients attending Department of PMR with features suggestive of carpal tunnel syndrome either idiopathic or those associated with other diseases. This study is done in such patients attending our department over a period of one year in a minimum of 60 patients.

After a thorough history and clinical examination, those who satisfy the following criteria are studied.

Inclusion Criteria

1. Patients with symptoms and signs suggestive of CTS.
2. Age group- 20-60 yrs.

Exclusion Criteria

Patients with Coexistent Conditions like-

1. Radiculopathies- for example C6 radiculopathy.
2. Cervical spondylotic myelopathy.
3. Peripheral neuropathies.
4. Chronic renal failure.
5. Rheumatoid arthritis.
6. Ganglions around wrist.
7. Fractures of wrist.
8. Surgeries around wrist.

The patients were selected as per the inclusion and exclusion criteria. After getting informed consent, patients were subjected to detailed history and clinical examination. Clinical examination includes provocative tests and detailed neurological examination to rule out the diseases mentioned in exclusion criteria. A thorough examination of sensations conducted over the median innervated fingers and comparison done with ulnar innervated area. A complete sensory system examination also was done to rule out other conditions like polyneuropathy. Manual muscle testing to find out weakness of APB was also performed. History of co morbidities and treatment history also is taken. If found necessary, the patients were advised to undergo laboratory investigations to rule out co morbidities

Electrophysiological Studies-
Nerve Conduction Test

In our department, Electrodiagnostic studies are performed using a Natus neurology electrodiagnosis machine. Both median and ulnar sensory and motor nerve conduction studies were done in each patient.

Motor Nerve Conduction-

Standard techniques as described in literature were used. A supramaximal stimulation given using the stimulator and recording done with surface electrodes and a ground electrode is placed between the stimulating and recording electrodes. For median nerve, stimulation is given above the wrist (Between Palmaris longus and flexor carpi radialis) and at the elbow (Near the volar crease of the brachial pulse) and recording is done by keeping the recording electrode close to the motor point of the abductor pollicis brevis (APB). For the ulnar nerve, stimulation is given at the wrist (Medial/lateral to flexor carpi ulnaris) and at the elbow (Ulnar groove) and recording electrode is kept close to the motor point of the abductor digiti minimi (ADM). In both cases the reference electrode is kept 3 centimeters distal to the active (recording) electrode. The measurements for motor nerve conduction study include the onset latency, conduction velocity, duration and amplitude of the compound muscle action potential (CMAP) obtained.

Sensory Nerve Conduction

In our EDx lab antidromic sensory conduction is used and ring electrodes are used. Stimulation is given for median nerve at the wrist between Palmaris longus and flexor carpi radialis (FCR). The active ring electrode is placed at the proximal interphalangeal joint of the second digit. For the ulnar nerve stimulation is given at wrist medial/lateral to flexor carpi ulnaris (FCU) and the active ring electrode is placed over the proximal interphalangeal joint of the fifth digit. Measurements include onset latency, conduction velocity, duration and amplitude of sensory nerve action potential (SNAP).

Severity of CTS according to NCS[9]

Severity grading is done according to the criteria followed in the Electrodiagnosis lab in our department which is based on the findings by Hermann and Logigian.

Mild

Increase of median distal motor and sensory latency only.

Moderate

Latency prolongation with moderate reduction of SNAP or CMAP or chronic partial denervation/reinnervation on EMG.

Severe

Unrecordable median SNAP or severe reduction of CMAP with active denervation or severe chronic denervation/ reinnervation.

For diagnosis of CTS the values taken are-

- Onset latency of SNAP >3.5 ms
- Conduction velocity- <50 m/s
- Distal latency of CMAP- >4.4 ms
- Median distal latency-ulnar distal latency >1.1 ms
- Amplitude of CMAP <5.48 mV (≤2mV in severe)

Ultrasonography

USG is done using the Esaote MyLab 40 ultrasound system under the guidance of a physiatrist with experience in ultrasonography, in all the selected patients within a period of 7 days of the NCS. Patients were seated in a chair keeping their hands on an examination couch, elbow extended, wrist in neutral position and fingers semi-extended. Using the high frequency linear transducer (10-18 MHz) both transverse and longitudinal scanning of the median nerve is done. The transducer is kept in such a way that no additional weight is applied, other than the weight of the transducer. The location and the characteristic stippled, or the honeycomb appearance helps to identify the median nerve. It is also less anisotropic than the surrounding tendons. The CSA is measured at the tunnel inlet at the level of pisiform. USG evaluation of the median nerve at the wrist includes both transverse and longitudinal views. Transverse view is used for assessing the cross-sectional area (CSA) of the median nerve which can be done at different levels. But studies have shown that the CSA measured at the level of pisiform is the most reliable. The CSA is measured by the direct tracing through the inner margin of the epineurium. Cut off value of CSA at the inlet is taken as 10 mm^2.

Severity Grading as Per CSA Measured by USG[12]

- 10-13 mm^2 – mild.
- 13-15 mm^2 – moderate.
- >15 mm^2 – severe.

Statistical Analysis

All the data were coded and entered in Microsoft excel sheet, rechecked and analysed using statistical package for social sciences (SPSS 18.0) software. Quantitative variables are presented as mean and standard deviation. Qualitative variables are presented as frequency and percentages.

Comparison of means was done by using one-way ANOVA (Analysis of variance) test. The Post Hoc comparison using Bonferroni test was done, if ANOVA test was found statistically significant. Correlation was measured in terms of Karl Pearson correlation test. The measure of agreement between severity of NCS with severity of cross-sectional area assessed through USG by Kappa statistics through cross tabulation.

Ethical Aspect

- The study protocol was submitted to the scientific research committee as well as the institutional ethics committee of the Government Medical College, Kozhikode, and clearance was obtained for conducting the study
- Informed consent was obtained from all the study participants.
- All the information that was collected was kept confidential.
- No procedure was carried out which directly or indirectly produced risk to the subjects.

A cross sectional study was conducted to find out the correlation between soft tissue ultrasonography and electrophysiological studies in carpal tunnel syndrome (CTS). A total of 69 patients were chosen for the study, 2 patients denied consent, 4 patients did not turn up for the study on time and 3 patients were excluded following USG as they were having bifid median nerve. Out of these 60 patients, 47 were having features of bilateral CTS, 11 were having unilateral CTS and 2 patients already had surgery for the same on the opposite hand. So, in 47 cases both hands were taken for study and in 13 cases (11 unilateral cases and the 2 cases with history of surgery on opposite side) the involved side only was taken. The results obtained from the study are presented here.

Socio Demographic Profile

The study population included 60 patients who belonged to the age group of 26 to 58 years. The mean age of the study population was found to be 42.47 ± 8.48. The minimum age in the study group was 26 and the maximum was 58 years. There were 55 females (91.7%) and 5 males (8.3%).

Considering the occupational distribution of the study group, there were 43 housewives who made the majority of population. There included 8 manual labourers, 3 typists, 2 clerks, 2 salesmen, 1 receptionist and 1 nurse.

Measure of Agreement between Nerve Conduction Study (NCS) Severity Grading & Ultrasonography (USG) Severity Grading

Severity Grades NCS		Severity Grades USG				Total
		0	1	2	3	
Right		n (%)	n (%)	n (%)	n (%)	
0	n (%)	2 (100%)	0 (0%)	0 (0%)	0 (0%)	2 (100%)
1	n (%)	0 (0%)	15 (100%)	0 (0%)	0 (0%)	15 (100%)
2	n (%)	0 (0%)	1 (6.3%)	15 (93.8%)	0 (0%)	16 (100%)
3	n (%)	0 (0%)	0 (0%)	0 (0%)	26 (100%)	26 (100%)
Total	n (%)	2 (3.4%)	16 (27.1%)	15 (25.4%)	2 (44.1%)	59 (100%)
Total	n (%)	2 (3.4%)	16 (27.1%)	15 (25.4%)	2 (44.1%)	59 (100%)

	Value	p value
Measure of Agreement Kappa	.975	.000

Measure of agreement between nerve conduction study (NCS) & ultrasonography (USG) gradings on right

A kappa value of 0.975 was obtained, which means an excellent agreement between NCS and USG. A p value of less than 0.001 proves that it is significant.

Severity Grades NCS		Severity Grades USG				Total
		0	1	2	3	
Left		n (%)	n (%)	n (%)	n (%)	
0	n (%)	3 (75%)	1 (25%)	0 (0%)	0 (0%)	4 (100%)
1	n (%)	0 (0%)	10 (100%)	0 (0%)	0 (0%)	10 (100%)
2	n (%)	0 (0%)	0 (0%)	14 (100%)	0 (0%)	14 (100%)
3	n (%)	0 (0%)	0 (0%)	0 (0%)	20 (100%)	20 (100%)
Total	n (%)	3 (6.3%)	11 (22.9%)	14 (29.2%)	20 (41.7%)	48 (100%)

	Value	p value
Measure of Agreement Kappa	0.970	0.000

Measure of agreement between nerve conduction study (NCS) & ultrasonography (USG) severity gradings on left side

A kappa value of 0.970 on left was obtained, which means an excellent agreement between NCS and USG. A p value of 0.001 proves that it is significant.

Cross Sectional Area Vs Nerve Conduction Study (NCS) Severity

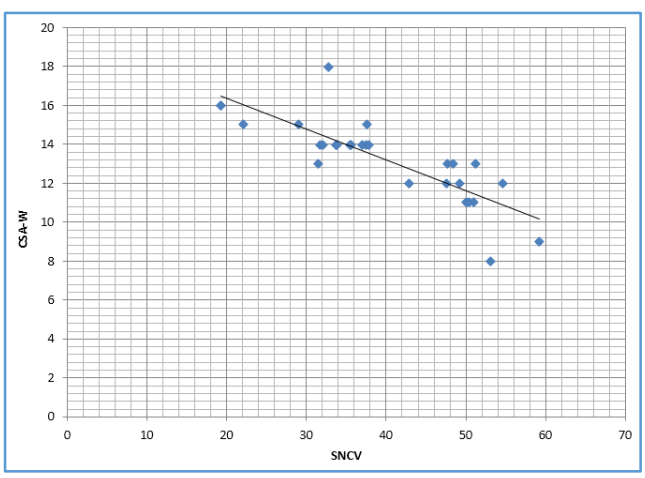
	NCS Severity	RIGHT			LEFT		
		Mean	SD	p value	Mean	SD	p value
Cross Sectional Area at wrist (CSA)	0	8.50	0.71	0.000	9.00	0.82	0.000
	1	11.87	0.92		11.60	0.70	
	2	14.13	0.50		14.07	0.27	
	3	21.62	5.51		21.15	4.97	

Cross Sectional Area Vs Nerve conduction study (NCS) severity.

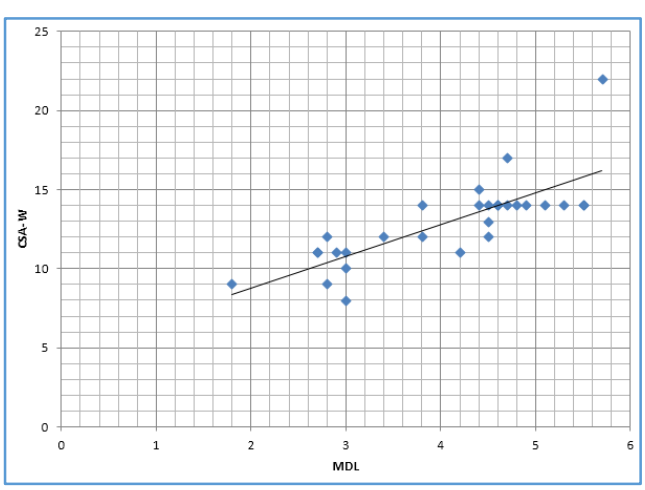
The cross-sectional area increases with NCS severity. Bonferroni correction shows that the difference between normal, mild and moderate with that of severe is significant on both sides.

Correlation of NCS parameters with CSA

Sl. No.	Parameters	Pearson Correlation/ sig	Right (37 Subjects)	Left (30 Subjects)
1	SDL	Pearson Correlation	0.588**	0.764**
		Sig. (2-tailed)	0.0001	0.0001
2	NCV	Pearson Correlation	-0.819**	-0.780**
		Sig. (2-tailed)	0.0001	0.0001
3	MDL	Pearson Correlation	0.747**	0.779**
		Sig. (2-tailed)	0.0001	0.0001
4	MDL-UDL	Pearson Correlation	0.669**	0.786**
		Sig. (2-tailed)	0.0001	0.0001
5	Amplitude	Pearson Correlation	-0.763**	-0.772**
		Sig. (2-tailed)	0.0001	0.0001



Negative correlation of sensory nerve conduction study with cross sectional area of median nerve



Positive correlation of median nerve distal latency with cross sectional area of median nerve at wrist

RESULTS

In the present study a cut-off value of CSA of the median nerve at wrist was taken as 10 mm^2 for the diagnosis of CTS which was according to the study by El Miedany et al[8] and similarly the measurement was taken at the level of pisiform. In this study we got an excellent agreement (kappa value 0.975 on right and 0.970 on left and p value 0.000 on both sides) between the severity grading by NCS and USG which is consistent with most of the other studies. There is good measure of agreement between nerve conduction study (NCS) severity grading &ultrasonography (USG) severity grading. There is also good correlation between nerve conduction parameters like sensory and motor distal latencies, amplitude and conduction velocities. There is good negative correlation between conduction velocities and median nerve cross sectional area, i.e. when conduction velocities decrease the nerve cross sectional area increases. There is good negative correlation between amplitude of Compound muscle action potential with nerve CSA, i.e. as amplitude decreases CSA increases. There is good Positive correlation of median nerve distal latency with median nerve CSA ie when distal latency increases the nerve CSA increases.

DISCUSSION

Min-Kyu Kim et al[7] in their study had shown that the CSA will increase significantly with severity of CTS. The present study similar result was obtained which is consistent with previous other studies. The present study also shows there is good correlation between NCS parameters with median nerve CSA. Ultrasonography is gaining importance as an investigation for diagnosing CTS. The severity grading by ultrasonography shows an excellent agreement with that of electrophysiological severity. The cross-sectional area of the median nerve at the inlet is used for the severity grading by USG. The advantage of Ultrasonography is that, it can provide data on the anatomy of the median nerve proximal to inlet, the carpal tunnel and the other structures in and around the carpal tunnel. In evaluation of CTS a high frequency

ultrasound examination of median nerve and cross-sectional area of median nerve at the level of pisiform is highly desirable and it can supplement nerve conduction study.

CONCLUSION

USG evaluation using cross sectional area of median nerve at wrist has similar accuracy as electrophysiological studies for the diagnosis of carpal tunnel syndrome. So, USG evaluation can be used instead of nerve conduction studies which is more time consuming and costly for the diagnosis of carpal tunnel syndrome.

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