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Assessment of nerve conduction parameters in Median nerve among patients with Symptomatic Carpal Tunnel Syndrome – A Cross-sectional study

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ABSTRACT:
Background: Carpal Tunnel Syndrome (CTS) is the most common entrapment syndrome of the upper limb with a peak incidence during the fifth to sixth decade and a definite prevalence in women (3:1). It is caused by compression of the median nerve (MN) at the wrist. Diagnostic tests in patients complaining of Carpal tunnel syndrome (CTS) are based on physical examination, electrodiagnostic tests (EDTs), and diagnostic imaging. Timely diagnosis helps prevent permanent nerve damage and its sequelae in terms of functional impairment.
Objective: i. To analyze the nerve conduction parameters of Median nerve in patients with symptoms of Carpal Tunnel Syndrome. ii. To emphasize the use of Nerve conduction studies as a diagnostic approach and hence aid in the early diagnosis and prompt treatment.
Materials and Methods: Motor and Sensory nerve conduction studies were conducted in 38 symptomatic carpal tunnel syndrome patients in both Upper limb nerves (Median and Ulnar nerves) using bipolar surface electrodes with RMS EMG EP MARK-II machine. Parameters were statistically analysed and results interpreted.
Results: Results of the present study indicated an increase in the difference in latencies between median and ulnar nerve, a definite decrease in amplitude and nerve conduction velocities of both the sensory and motor components of median nerve.
Conclusion: NCS being a simple, harmless, non-invasive and objective technique along with easy interpretation of results can be used routinely to evaluate the status of nerves and grade the severity in patients with Carpal Tunnel Syndrome and prevent more disabling state at the earliest.
Key Words: Carpal Tunnel Syndrome, Nerve Conduction Study (NCS), Median nerve

I. INTRODUCTION

It is estimated that one in five patients presenting with upper limb pain, numbness, tingling, and weakness have the diagnosis of CTS. The incidence of CTS has increased almost two-fold over the last two decades.[1] [41] Carpal Tunnel Syndrome (CTS) accounts for 90% of all compression or entrapment neuropathies[2] i)with a peak incidence in fifth to sixth decade and aCTS was initially defined as a clinical disorder diagnosed by pattern recognition of patients presenting with similar symptoms and careful clinical examination.

With definite prevalence in women (3:1), caused by compression of the median nerve (MN) at the wrist.[3,4]CTS is more common in women, is most prevalent after 50 years of age, and usually involves the dominant hand first.[1] 41 Even the symptomatic patients who visited our neurophysiology lab came with predominant involvement of the right hand. Since it occurs in the dominant hand causes more debilitating effects requiring early diagnosis and judicious treatment either surgical or conservative. The diagnosis is made easy by nerve conduction studies and the severity grading helps in deciding the surgical or conservative line of treatment.

CTS was initially defined as a clinical disorder diagnosed by pattern recognition of patients presenting with similar symptoms and careful clinical examination. Rudimentary EDX for CTS began in the mid-1950s. [5]13

The EDX methodology for evaluating CTS has served as an example for the study of all focal neuropathies.[6]3,4. Electrodiagnostic studies rather than other clinical methodologies, were determined to be the most sensitive and specific.

Use of electrodiagnostic testing has proved to be indispensable in confirming the diagnosis of carpal tunnel syndrome[7] [ii)]So the present study was done to evaluate the median nerves in the symptomatic patients and observe the relevance of electrodiagnostic studies in these patients.

Objectives:

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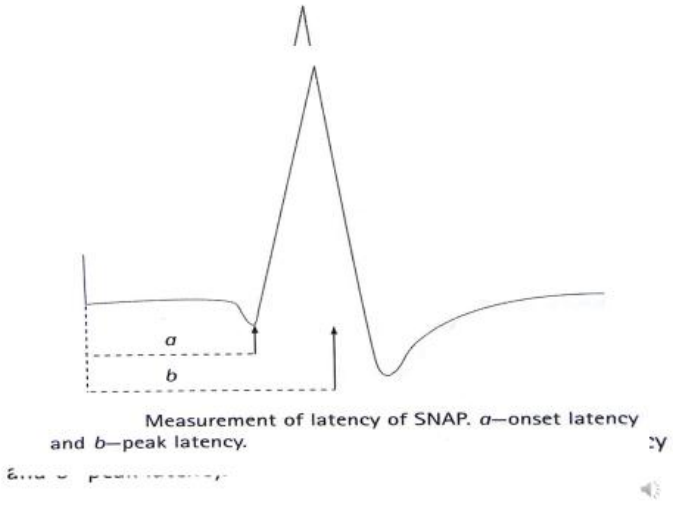
i.To analyze the nerve conduction parameters of Median nerve in patients with symptoms of Carpal Tunnel Syndrome
ii.To emphasize the use of Nerve conduction studies as a diagnostic approach and hence aid in the early diagnosis, prompt treatment and its sequelae in terms of functional impairment

II. METHODS&MATERIALS

A cross sectional study of Motor and Sensory nerve conduction studies of Rt. & Lt. median nerves was conducted in 38 symptomatic patients(Rt. Carpal tunnel syndrome) using bipolar surface electrodes with RMS EMG Salus-4C machine

Limb temperature was maintained such that there is no sweating, and the surface was cleaned with spirit. Resistance was checked and was kept below 3kΩ, electrodes were applied using electrode gel and

Motor and sensory nerve conduction studies were conducted in both Median nerves usingbipolar surface electrodes in 38symptomatic patients(Rt. Carpal tunnel syndrome) referred to our neurophysiology lab for NCS, after taking informed consent. NCS was performed with RMS EMG EP MARK II machine and temperature of the lab was maintained at 21-23ºC. Latency, Amplitude, conduction velocity and F-wave studies were done by placing the active electrode over the motor point and reference electrode on the tendon with stimulation proximally and distally. Both active and reference electrodes are placed on the nerve in sensory nerve studies with Ground electrode between stimulating and recording electrode. Values taken as reference from normal values of motor and sensory nerve conduction from study by Misra and Kalita.
The figure shows how to determine the latency of a sensory conduction study.



Measurement of latency of SNAP. *a*—onset latency and *b*—peak latency.

Motor nerve conduction studies[8]

Median motor nerve conduction- Recording electrode is placed close to the motor point of abductor pollicis brevis and reference electrode 3 cm distal at first metacarpophalangeal joint. A supramaximal stimulation isgiven at wrist (3 cm proximal to the distal crease) and at elbow (near the volar crease of the brachial pulse). The figure shows how to determine the latency, amplitude of a motor conduction study.

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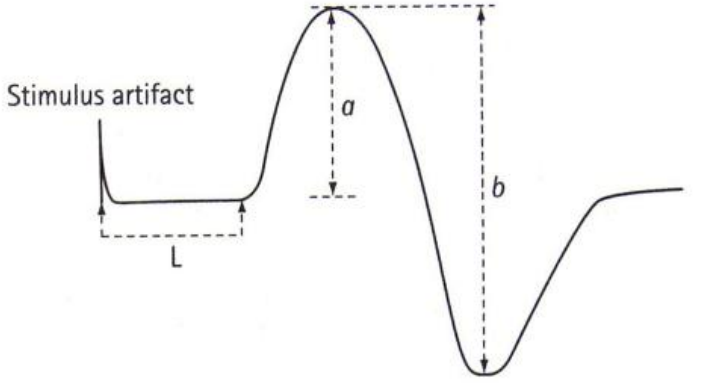

Measurement of CMAP latency and amplitude. L—onset latency, *a*—base-to-peak amplitude, and *b*—peak-to-peak amplitude.

III. STATISTICAL ANALYSIS AND RESULTS

Statistical analysis was done using paired t-test. 28 out of 30 cases were considered for analysis as 2 cases being Severe debilitating neuropathy, no response was obtained on both motor and sensory nerve stimulation even with supramaximal strength of stimulation.

Age : 50 ± 12.9

Paired Samples Correlations

		Correlation	Sig.
	MSR_Latency & MSL_Latency	.45	.06
	MSR_Velocity & MSL_Velocity	.13	.60
	MSR_Amplitude & MSL_Amplitude	.63	.00
	MMR_Latency & MML_Latency	-.20	.43
	MMR_Velocity & MML_Velocity	.36	.14
	MMR_Amplitude & MML_Amplitude	.10	.69

Paired Samples Statistics

	Mean	Std. Deviation
MSR_Latency	5.43	1.08
MSL_Latency	4.05	.62
MSR_Velocity	35.07	8.22
MSL_Velocity	41.89	8.72
MSR_Amplitude	22.06	24.57
MSL_Amplitude	31.71	21.19
MMR_Latency	6.95	1.36

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MML_Latency	5.42	1.94
MMR_Velocity	49.29	6.00
MML_Velocity	49.89	11.96
MMR_Amplitude	5.98	3.84
MML_Amplitude	5.90	2.13

Paired Samples Test

	Mean	95% Confidence Interval of the Difference			
		Lower	Upper		
	Paired Differences	t	Sig. (2-tailed)	6.02	.00
MSR_Velocity - MSL_Velocity	-6.82	-12.37	-1.26	-2.59	.02
MSR_Amplitude - MSL_Amplitude	-9.65	-19.51	.20	-2.07	.05
MMR_Latency - MML_Latency	1.53	.25	2.81	2.52	.02
MMR_Velocity - MML_Velocity	-.59	-6.21	5.02	-.22	.83
MMR_Amplitude - MML_Amplitude	.08	-2.01	2.17	.08	.93

Results indicated an increase in the difference in latencies between Rt.median(affected side) and Lt. Median (normal) nerve, a definite decrease in amplitude and nerve conduction velocities of both the sensory and motor components of median nerve with significant changes seen in sensory nerve.

Motor nerve conduction studies Mean of Distal motor latencies of Rt.Median nerves were increased significantly in comparison with mean latencies of the left Median nerves ($p<0.02$). Mean of Amplitude of CMAP (compound muscle action potential) was reduced in Rt.Median nerves but the decrease was not statistically significant.There was a reduction in Mean Motor nerve conduction velocities though it was not a statistically significant decrease. F-wave response was not obtained mostly from 5right median nerves indicating severe neuropathy. F minimum latencies, were increased showing Demyelinating type of Neuropathy

Sensory nerve conduction studies – There was a significant increase in latency, decrease in amplitude and conduction velocity.Statisticallysignificant difference in mean values of right and left median nerves was observed signifying the presence of neuropathy in the affected Right median nerves. 2 cases being Severe neuropathy, sensory response was not recordable.

IV. DISCUSSION

The carpal tunnel is a dumb-bell-shaped passage, with an estimated width of 25 mm at its entrance and exit and 20 mm at its narrowest.[9,10] 23,24 The carpal tunnel is bounded dorsally and laterally by the carpal bone and on the volar surface by the thick transverse carpal ligament ; through this pass nine flexor tendons and the median nerve Because of this crowded arrangement, any tenosynovial proliferation, wrist joint abnormality, tumor, or muscular anomaly can lead to carpal tunnel syndrome[11](iii) Carpal pressure measured in carpal tunnel syndrome subjects had a mean of 32mm Hg, compared with 2.5mm Hg in the healthy control group[12] (iv)

Large myelinated nerve fibres in the carpal tunnel are most susceptible to mechanical and ischemic damage

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In Carpal tunnel syndrome , microscopy has shown that disruption of myelin and the nodes of Ranvier results in conduction dysfunction and, when severe enough, axonal death[13] (v)The preferential loss of the large fast-conducting myelinated nerve fibres could also result in slower nerve conduction and delayed distal motor latency[7](ii)

Comparing the conduction velocity and distal motor latency of median nerve to that of the ulnar nerve, which travels outside the carpal tunnel, helps to confirm carpal tunnel syndrome and differentiate it from length-dependent peripheral polyneuropathy[12](iv)

V. CONCLUSION

From our study, we conclude that increased distal motor latencies, reduced amplitude of CMAP and motor conduction velocities in Right Median nerves indicates involvement of these nerves in the symptomatic patients compared to the Left Median nerves. Although there was no statistical significant difference in motor nerve conduction velocity and amplitude of CMAP of the motor component of the affected median nerves indicating motor neuropathy in those nerves. F minimum latencies increased showing a demyelinating type of Neuropathy cases with absent F-wave response in 5 right median nerves. There is a considerable statistically significant increase in latency, decrease in amplitude of SNAP (sensory nerve action potential) and conduction velocity in the sensory nerves. The features found to be of varying –both sensory and motor involvement, axonal and demyelinating type of neuropathy.

Jablecki et al., states nerve conduction studies with needle electromyography were used as the reference standard for the diagnosis of carpal tunnel syndrome (CTS)[14] 31

Masahiro Sonoo et al states that NCS provide a reliable measure to document MNW (motor neuropathy at wrist) and therefore contribute to the diagnosis of CTS.[15] 32 so the electrodiagnostic studies that is the nerve conduction studies help in making diagnosis of carpal tunnel syndrome

Electrodiagnostic (EDX) studies are often necessary for confirmation of CTS diagnosis and exclusion of other possible causes of symptomatology, such as, cervical radiculopathy or peripheral polyneuropathy. In addition, nerve conduction studies could be used to predict the risk of development of CTS symptoms in asymptomatic patients[16] [5] Hence we can conclude that nerve conduction studies help us to rule out other causes of median neuropathy and make differential diagnosis of carpal tunnel syndrome.

Eklund first described prolongation of median palm-to-wrist sensory nerve latency.[17]The inching method, described by Kimura, consists of antidromic serial 1-cm stimulation of the median nerve across the carpal tunnel recording, from the index or middle fingers.[18,19][13,14] latencies Comparison of the median and ulnar nerves from the ring finger with antidromic[20,21][15,16] or orthodromic[22,23][17,18] stimulation isanother sensitive method of diagnosis. These different tests along with the sensory and motor conduction studies described in our study help a neurosurgeon to plan a surgery for the patients with severe neuropathy and also help a neurophysician in deciding the line of treatment either conservative or surgical.

NCS being a simple, harmless, non-invasive and objective technique along with easy interpretation of results can be used routinely to evaluate the status of nerves in patients with carpal tunnel syndrome to prevent more disabling state at the earliest. Neuropathic symptoms may take years to appear, but even before, neuropathy can be diagnosed by NCS, and further damage to the nerves can be curtailed.The. Neuropathy due to compression is curable, and hence if detected, the proper treatment can be instituted in early stages, which again, can give rise to good outcome. As the peripheral nerve has the ability to regenerate, line of treatment can be planned. Symptoms usually develop at any degree of neuropathic impairment or may not occur at all which indicates the need for doing nerve conduction studies. Nerve conduction studies may be effectively used to select the most beneficial therapy.

Although CTS is a condition that is relatively easy to recognize, investigations aim for early detection, effective treatment including outcomes are warranted with the ultimate goals to alleviate suffering and disability.

NCS being a simple, harmless, non-invasive and objective technique along with easy interpretation of results and repeatability, can be used routinely to evaluate the status of nerves and grade the severity in patients with Carpal Tunnel Syndrome and prevent more disabling state at the earliest using appropriate surgical or physiotherapy intervention.

Limitation of our study is small sample size due to which the features could not be delineated at large and reference standard values of nerve conduction parameters are considered from the study done by Misra and Kalita

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