

Research Article

Increased Diagnostic Yield of Early and Mild Carpal Tunnel Syndrome by Using Median-to-Ulnar Comparative Study

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Abstract

Background: Carpal Tunnel Syndrome (CTS) is the most common focal entrapment neuropathy caused by median nerve compression in the carpal tunnel. Clinically there is pain and paresthesia in the distribution of median nerve. Electrodiagnostic (EDX) studies are gold standard means of confirming the diagnosis. Early and mild CTS cause discomfort for patients but remains undiagnosed during routine motor and sensory nerve conduction studies.

Objective: To evaluate the most sensitive electro diagnostic method i.e. comparative Median-to-Ulnar motor and sensory study, for diagnosis of early and mild CTS.

Methods: Comparative analytical cross sectional study was done in Department of Neurology, Mayo hospital Lahore, from June to November 2022. We included 50 clinically symptomatic CTS patients of both genders of age between 20 and 55 years in our study and comparison was done with healthy control. Patients were symptomatic with normal conventional EMG/NCS. Patients having moderate to severe or incidental CTS and patients with underlying polyneuropathy and radiculopathy were excluded. For comparative analysis student's t test (two tailed) was used. EDX findings were noted in the predesigned proforma along with history & demographic variables.

Results: Out of 50 patients, females were 35 and males were 15, so female: male was 7:3. Mean age of the patient group was 37.24 ± 2.27 years. Sensitivity was highest for the median-versus-ulnar palmar mixed study (80.0%), followed by median-versus-ulnar digit 4 sensory latency (32.0%) and median distal sensory latency (14.0%). Median distal motor latency had the lowest sensitivity (10.0%).

Conclusion: Conventional nerve conduction study methods i.e. median distal motor latency and median distal sensory latency tests are less sensitive in diagnosing early and mild CTS. Highly sensitive electrophysiological tests including median-versus-ulnar palmar mixed study and median-versus-ulnar digit 4 sensory study should be incorporated in the evaluation of patients with early and mild CTS to increase the diagnostic yield of CTS.

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Keywords | Carpal tunnel syndrome (CTS), Electro-diagnostics (EDX), Nerve conduction study(NCS)

Introduction

Median nerve entrapment at wrist is the most common entrapment neuropathy resulting in

array of symptoms and signs known as “carpal tunnel syndrome” (CTS).¹ Prevalence of CTS in general population is around 5%.² several studies have shown that women are more prone to CTS than men.^{3,4} Its prevalence is much higher in working population and for certain professions (where repetitive hand movements are required). Joint abnormalities, hormonal changes as in Pregnancy, metabolic changes (e.g. Diabetes) and endocrine disturbances are the major causes. Females,



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obese people, smokers and older individuals are at higher risk.³

Clinically there is pain and paraesthesia in the median innervated digits and weakness of the muscles innervated by median nerve distal to carpal tunnel.^{1,3}

It is diagnosed clinically using certain manoeuvres (Tinel's and Phalen's test) and confirmed by electrodiagnostic testing (EDX) i.e. Nerve conduction studies/ electromyography. EDX is the gold standard diagnostic tool for diagnosing CTS but unfortunately mild cases of CTS remain undetected by routine nerve conduction studies as motor nerve conduction is normal. Therefore detailed electro-diagnostic procedures i.e. median-versus-ulnar comparative studies, should be performed to diagnose mild CTS.⁴ These methods are highly specific (97%) and are more reliable than any other diagnostic procedure such as ultrasound that is only 55% sensitive.⁵

Previously, a research conducted by Werner RA et al.⁶ showed that 10- 15% of patients with CTS remain untreated due to false negative electro-diagnostic tests. In 2019, a research conducted by Jain et al. Reported that median to ulnar digit 4 sensory latency has the highest sensitivity for detecting mild CTS.

Therefore we aimed to identify the most sensitive EDX procedure for the diagnosis of early and mild CTS, as early diagnosis prevents the patients from further disease complications.

Methods

After taking the approval from ethical committee of King Edward Medical University Lahore, 50 clinically diagnosed patients of mild CTS were evaluated electro physiologically during the duration of 6 months (June 2022 to November 2022) in electrophysiology department Mayo Hospital Lahore. We also evaluated a control group of 50 healthy individuals. Study design used was comparative analytical cross sectional study. Patients were diagnosed with mild CTS using clinical diagnostic criteria given by Vogt et al⁹ as well as Bland neurophysiological grading scale for early and mild carpal tunnel syndrome was applied.²⁰ Patients were symptomatic with normal conventional EMG/NCS.

Only 20–55 year olds were included in our study (Both patient and control group). Patients with symptoms of polyneuropathy, radiculopathy were excluded. And

individuals having pacemakers, bleeding disorders were also excluded from the study. The following electrodiagnostic studies were performed on all participants:

- 1) Median distal motor study (For distal motor latency)
- 2) Median sensory study (For sensory latency)
- 3) Median-vs-ulnar palmar mixed study
- 4) Median-vs-ulnar digit 4 sensory study

These studies were performed by conventional methods given by Shaprio et al.¹ in the textbook of Electromyography and Neuromuscular disorders. All the variables (e.g. latency, amplitude, conduction velocities) were noted on a predesigned proforma along with clinical findings and demographics. Median-ulnar latency differences were calculated for later two studies.

For performing median-versus-ulnar digit 4 sensory study the stimulation was given antidromically to the median and ulnar nerve at the wrist individually, with recording over the digit 4 (G1 on metacarpophalangeal joint and G2 on distal interphalangeal joint). The same distance was used for both the median and ulnar nerve study in the range of 11–13 cm. Supramaximal responses were obtained, and the difference between the median and ulnar onset latencies were recorded. The difference of 0.5 ms was used as cutoff value and the patients with the value ≥ 0.5 ms were diagnosed with CTS.

Median-to-ulnar palmar mixed study was performed by the comparison of onset latencies of median and ulnar nerves recording in the wrist individually. Each nerve is stimulated supramaximally in the palm at the distance of 8 cm from its respective recording electrodes. Median nerve was stimulated in the web space between index and middle finger and the ulnar nerve was stimulated in the webspace between ring and little finger. Supramaximal responses were obtained, and the difference between the median and ulnar onset latencies were recorded. The difference of 0.4 ms between median and ulnar onset latencies was used as cutoff value and the patients with the value ≥ 0.4 ms were diagnosed with CTS.

Statistical analysis was performed using SPSS version 23. Mean and standard deviation was calculated for all quantitative variables e.g. age, latency etc. Frequency and percentage was calculated for qualitative variables e.g. Gender, pain, Phalen's and Tinal signs etc. Student's

t-test was used for comparative analysis. Sensitivity of each test was calculated as (no. of hands having abnormal result/ no. of CTS hands) \times 100).

Results

Out of 50 patients, 35 were females (70.0%) and only 15 were males (30.0%), so female: male was 2.3:1. Mean age of the patient group was 37.24 ± 2.27 years. Demographics of the control group were similar to the patient group. Mean symptom duration of patient group was 13.6 ± 2.84 months. Out of 35 females, 28 (80%) were housewives and engaged in household chores. Almost 24% of the patients had bilateral symptoms, 46% had right CTS and left hand was affected in 30% of cases.

Clinically, pain and sensory loss in median innervated digits was reported by 94% of patients. Tinel's test & Phalen's maneuver were positive in 34% and 62% respectively. Frequent nocturnal paresthesias were reported by 60% of patients. Detail is given in Table 1.

Table 1: Clinical characteristic of study population

	Females (n = 35)	Males (n = 15)	Total (n = 50)
Age (mean in years)	37.2	36.9	37.2 ± 2.27 years
Bilateral symptoms	07	05	12
Right hand symptoms	17	06	23
Left hand symptoms	10	05	15
Diabetes mellitus	11	07	18
Symptomatic duration (mean in years)	1.52	0.87	1.3 ± 0.99 years
Tinels's sign	11	06	17
Phalen's sign	23	08	31
Wasting	07	03	10

Electrophysiological findings of both patients and controls are shown in Table 2. In patients group, mean median distal motor latency was 3.362 ± 0.15 ms, whereas mean sensory latency was 2.7 ± 0.14 ms. Mean latency difference for median-vs-ulnar palmer mixed study was 0.60 ± 0.06 . And that of median-vs-ulnar digit 4 sensory study was 0.40 ± 0.07 .

Sensitivity was highest for the median-versus-ulnar palmar mixed study (80.0%), followed by median-versus-ulnar digit 4 sensory latency (32.0%) and median sensory latency (14.0%). Median distal motor latency had the lowest sensitivity (10.0%) as shown in figure 1.

Table 2: Shows electrophysiological findings of patients with CTS and controls.

Nerve Conduction Test	Cases (n=50)	Controls (n=50)	P (significance)
Median distal motor latency	3.66 ± 0.15	3.36 ± 0.24	<0.01
Median sensory latency	2.70 ± 0.13	2.64 ± 0.18	<0.01
Median vs Ulnar palmar mixed study latency difference	0.60 ± 0.06	0.3 ± 0.07	<0.01
Median vs Ulnar digit 4 sensory study latency difference	0.40 ± 0.07	0.1 ± 0.02	<0.01

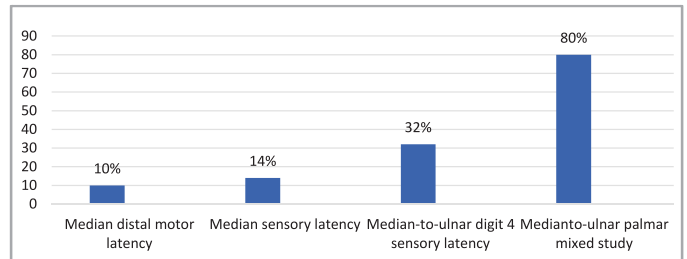


Figure 1: Sensitivities of various electrophysiological methods for the diagnosis of early and mild CTS

Discussion

In our study, we evaluated 50 patients with clinically suspected mild CTS with a mean age of 37.2 ± 2.27 . Female to male ratio of 2.3: 1 clearly shows females are more prone to CTS than males and our findings are consistent with the literature.^{7,8} This can be explained by the fact that females have narrower carpal tunnel and drastic hormonal changes (e.g. pregnancy, menopause).

It is known that CTS is mostly bilateral. In our study most of the patients had bilateral symptoms (50%) and mean symptom duration was 13.6 ± 2.84 months and our findings are consistent with a research conducted by Jain et al. (2019).⁹

Several studies^{9,12,14} have shown that sensory loss, pain & paraesthesia are most common clinical presentations of CTS, our study also reported the same findings as 94% of our patients had sensory loss. The reason for predominant sensory symptoms is, that median nerve at wrist has approximately 90% sensory fibers, says Nakhostin et al.¹⁰

A study conducted by Mustafa MM et al. which revealed combined Sensory Index Tests are more sensitive for diagnosing early CTS as compared with diagnostic ultrasonography (sensitivity 85%, specificity 100%). these

results are in agreement with our study.¹¹

The most sensitive method for diagnosing early and mild CTS using 4 different electro-diagnostic methods. Previously Moon PP et al (2017).¹³ conducted a research for evaluation of electro-diagnostic tests for CTS and showed that Comparison of (median vs ulnar digit 4 sensory latency, median vs radial sensory latencies) detected 51% of mild CTS cases with sensitivity of median vs ulnar sensory latency (85%), median palmar mixed study (80%). these result are partially similar with our study.

Another research conducted by El-Hady AO.¹⁵ in Egypt claimed that median versus ulnar palmar mixed nerve study has the highest sensitivity in diagnosing mild CTS but they didn't use other comparative methods either as used in our study.

In our study median-vs-ulnar palmer mixed study comes out to be the most sensitive method with a sensitivity of 80% followed by median-vs-ulnar digit 4 sensory latency (32%). Our findings are consistent with a research conducted by Lew et al.¹⁶ (2005), they compared 8 different EDX methods and concluded that short segment study (median vs ulnar palmer mixed study) has the highest sensitivity of 70%.

A study conducted by R Limbu in Nepal showed sensitivity of median versus ulnar digit 4 sensory latency was the highest (72.72 %)¹⁷, similar result shown by Aygul et al (77%)¹⁸, Shende VS et al(65%)¹⁹ but our study revealed less sensitivity of this test. This difference might be due to funicular topography of median nerve at wrist where compression is variable.

The median versus ulnar (Mix M-U) test was found to have a sensitivity of 85.2%, making it a reliable option for diagnosing early CTS. Additionally, the median-ulnar sensory latency difference (MUSLD) test demonstrated even higher sensitivity at 92%, especially when comparing digits 2 and 5.²¹ Median-versus-ulnar comparison increases the sensitivity of the test from 75% to 95% in early diagnosis of CTS.²² These results are consistent with our study.

There are a few limitations of our studies as we had a small study population, and hence, the results of the study may not be applicable to the whole population. We did not include other comparative methods i.e. Median-versus-radial thumb sensory study, median

second lumbrical-to-ulnar interossei, median-versus-ulnar segmental sensory study across wrist

Conclusion

Carpal tunnel syndrome is the most prevalent peripheral nerve injury affecting thousands of people worldwide both employed and unemployed. Females are at higher risk than males. Routine nerve conduction studies are not enough for the diagnosis as mild CTS remain undetected. Comparative methods especially median-vs-ulnar palmer mixed study should always be done for diagnosing early and mild Carpal Tunnel Syndrome as it has the highest sensitivity according to our research.

Ethical Approval: The Institutional Review Board, KEMU approved the study vide letter No.1054/RC/KEMU.

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Authors' Contribution:

SEF: Acquisition of data, Conception & design

SB: Conception & design, analysis & interpretation of data, drafting of article, critical revision for important intellectual content, final approval

MK: Acquisition of data, analysis & interpretation of data

AN: Analysis & interpretation of data, critical revision for important intellectual content, final approval

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