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Electrodiagnostic Study of the Patients with Suspected Carpal Tunnel Syndrome

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ABSTRACT

Background: Various electrodiagnostic tests are employed for diagnosis of carpal tunnel syndrome reporting wide range of sensitivity and specificity for each test in clinical practice. Therefore, the aim of our study is to assess the sensitivity of electrodiagnostic tests used in our set up for the diagnosis of carpal tunnel syndrome.

Methods: This cross-sectional study consisted of 21 patients suspected with carpal tunnel syndrome who were referred to neurophysiology lab for electrodiagnostic evaluation and 21 age-group gender matched healthy controls. Digit 4, lumbrical versus ulnar interossei latencies and conventional nerve conduction variables were recorded. A p value of less than 0.05 was considered significant.

Results: The sensitivity of median versus ulnar digit 4 sensory latency difference was the highest (72.72 %) whereas the conduction velocity of median nerve was the lowest (45.45%). The lumbrical versus ulnar interossei latency difference was significant between groups; however the sensitivity was only 51.52%. The conduction velocity of median nerve was relatively slower in the suspected cases than controls (49.67±13.75 vs. 60.90 ±6.70; p=0.007). The distal sensory latency of median nerve was significant between groups (3.47 ±0.58 vs. 2.16±0.25; p=0.03). The distal and proximal latencies of motor median nerve were significant between suspected cases and controls (4.70±1.82 vs. 2.75±0.38; p=<0.001).

Conclusions: The sensitivity of median versus ulnar digit 4 sensory latency difference was the highest in our set up therefore, addition of this test with conventional method can be helpful in achieving a higher diagnosis rate.

Keywords: Carpal tunnel syndrome; nerve conduction study; sensitivity

INTRODUCTION

Carpal tunnel syndrome (CTS) is the most commonly reported nerve compression syndrome.[1]The golden standard for diagnosis of CTS relies on the combination of clinical and electrophysiological findings.[2]Early diagnosis of CTS is important to exclude other causes[3] and to prevent further nerve damage.

Patients are referred earlier in the course of disease and up to 40% of patients with typical CTS symptoms fail to show electrodiagnostic abnormalities by conventional method.[5] Several nerve conduction studies (NCS) have been developed to improve electrodiagnostic yield. However, there is no consensus among researchers on selecting the most practical NCS parameters to ascertain CTS definite incidence.[4] The electrodiagnostic parameters sensitivity for CTS diagnosis in the previous published studies was reported in wide ranges.[6]

Till date, we report the suspected cases of CTS by using conventional NCS and additional comparative tests. Therefore, the purpose of our study is to determine sensitivities of NCS in our set up.

METHODS

This cross-sectional study was conducted in Department of Basic and Clinical Physiology at B.P. Koirala Institute of Health Sciences, Nepal from 20th October 2019 to 20th November 2020. The ethical approval was obtained from the Institutional Review Committee (IRC). The procedure was fully explained and informed written consent was taken from all the subjects enrolled for the study.

The study group included 33 hands of 21 patients with suspected CTS who were referred to neurophysiology laboratory, BPKIHS for electrodiagnostic evaluation. The age of the patients were ranged from 21 to 57 years. The sample size was calculated from the published data using

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two mean formulas.[6]The referred patients were further screened based on the clinical history and physical examination including detailed neurological assessment. Any history of upper limb traumatic injuries, peripheral neuropathy, diabetes mellitus, thyroid disorders, pregnancy and postpartum women were excluded from the study. The control group consisted of age-group gender matched 42 hands of 21 healthy subjects. Both groups were selected from B.P. Koirala Institute of Health Sciences.

Anthropometric, cardiorespiratory and nerve conduction variables were studied. Nerve conduction study (NCS) was performed in Neurophysiology laboratory. The room temperature was maintained at 26±2 degree Celsius during recording. All data were analyzed statistically for comparison between the groups.

NCS of the median nerve was recorded using Digital Nihon Kohden (NM420S_ H636, Japan) by belly- tendon montage. For each site of stimulation, proximal latency, distal latency, amplitude, nerve conduction velocity (NCV) of compound muscle action potentials (CMAPs) was recorded. Orthodromic method of stimulation was employed for testing the median nerve using ring electrodes. For each site of stimulation, onset latency, amplitude and NCV of sensory nerve action potentials (SNAPs) were recorded.

Antidromic method of stimulation was employed for testing each nerve (median and ulnar) at the wrist one at a time with ring electrode placed over digit 4. CMAPs from both the median innervated 2nd lumbrical (2L) and ulnar innervated interosseous (INT) were recorded by placing the active electrode slightly lateral to the midpoint of the third metacarpal with the reference electrode over the proximal interphalangeal joint of the second digit.

The data was first entered into Microsoft Excel worksheet and then statistical analysis was done using SPSS 20.0 version. The data of anthropometric, cardiorespiratory and NCS variables were normally distributed. Independent sample t test was used to compare NCS between the groups. The sensitivity of each test was calculated as: number of hands with an abnormal study result / number of CTS hands ✕ 100%. The p value <0.05 was considered statistically significant.

RESULTS

The mean duration of symptoms of the CTS was 5.77±7.46 months. Out of 21 patients, there were 18 females and 3 males with a ratio of 6:1. Ten patients had symptoms in both hands.

Anthropometric variables were comparable between the patients with suspected CTS and controls in terms of their age, weight, height, body mass index (BMI) and upper limb length (ULL). Similarly, cardiorespiratory variables such as systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse rate (PR) and respiratory rate (RR) were comparable between the groups (Table 1).

Table 1. Comparison of anthropometric and cardiorespiratory variables between suspected CTS and controls.

Variables	Suspected CTS (n=21); Mean ± SD	Control group (n=21); Mean ± SD	p value
Age (years)	41.38 ±10.41	37.71±8.21	0.13
Weight (Kg)	62.0±6.81	61.95±5.81	0.25
Height (m)	154.10±7.04	155.14±4.56	0.17
BMI (Kg/m^2)	26.56 ± 3.02	25.68±1.72	0.06
ULL (cm)	66.71±5.31	66.33±4.32	0.29
SBP(mmHg)	120±3.09	120.27±0.94	0.69
DBP(mmHg)	80.0 ±0.62	79.55±3.75	0.58
PR (bpm)	73.45±1.97	72.82±1.82	0.27
RR(breaths/ min)	17.27±0.98	16.64±1.29	0.07

p<0.05=significant

Sensory conduction variables of the median nerves are presented in Table 2. The onset latency of the median nerve (DSL) was significant between the patient with suspected CTS and control; however, it was within normal limits. Although the amplitude of the median nerve was not found significant; but it was relatively reduced compared to controls. Sensory nerve conduction velocity of the median nerve (SMNCV) was slower in the suspected CTS than controls. About 45.50% of hands showed no response on sensory stimulation of the median nerve.

Table 2. Comparison of sensory median nerve conduction variables between suspected CTS and controls.

Variables	Suspected CTS (n=21); Mean ± SD	Control group (n=21); Mean ± SD	p value
DSL (ms)	3.47 ±0.58	2.16±0.25	0.03
SMNA (mv)	17.57±3.75	27.00 ± 6.93	0.26
SMNCV (m/s)	32.60±5.91	51.59±6.09	0.52

DSL: distal sensory latency, SMNA: sensory median nerve amplitude, SMNCV: sensory median nerve conduction velocity, ms: millisecond, mv: millivolt, m/s: meter per second; p<0.05= significant

Motor conduction variables of the median nerve are presented in Table 3.The distal latency of the median nerve was prolonged (≥ 4) in the patients suspected CTS as compared to controls. The conduction velocity was slower than controls. Similarly, the proximal latency of median nerve was prolonged in comparison to controls. About 3.03% of the hands showed no response on stimulation.

Table 3. Comparison of motor median nerve conduction variables between suspected CTS and controls.

Variables	Suspected CTS (n=21); Mean ± SD	Control group (n=21); Mean ± SD	p value
DML (ms)	4.70±1.82	2.75±0.38	<0.001
PML(ms)	9.28±2.42	6.57 ±0.68	<0.001
MDA (mv)	8.05±2.47	10.52 ±2.43	0.92
MPA(mv)	7.13 ±2.26	9.05 ±2.14	0.98
MNCV(m/s)	49.67±13.75	60.90 ±6.70	0.007

DML: distal median latency, PML: proximal median latency, MDA: median distal amplitude, MPA: median proximal amplitude, MNCV: median nerve conduction velocity; p<0.05=significant

Digit 4 median versus ulnar latency differences (D4M-D4U) was more than 0.5 in the patients with suspected CTS in comparison to controls. Similarly, median 2nd lumbrical versus ulnar interossei latency differences (2L-INT) were found significant between the suspected CTS and controls (Table 4). About 48.50% of hands showed no response on digit 4 stimulation.

Table 4. Comparison of D4M-D4U and 2L-INT between the suspected CTS and control group.

Variables	Suspected CTS (n=21)); Mean ± SD	Control group (n=21)); Mean ± SD	p value
D4M-D4U	0.67±0.78	0.37±0.31	0.001
2L-INT	0.82±1.47	0.21±0.18	< 0.001

D4M-D4U: median versus ulnar digit 4 sensory latencies differences, 2L-INT: median 2nd lumbrical versus ulnar interossei distal motor latencies differences; p<0.05= significant

D4M-D4U was the most sensitive whereas MNCV was the least sensitive among the electrodiagnostic tests performed in our setting. Both were found significant when compared with controls and were above the normal limit (Table 5).

Table 5. Sensitivities of the median nerve conduction variables of suspected CTS.

Variables	Abnormality criteria	Sensitivity
DML (ms)	≥4	54.55%
DSL (ms)	≥ 3.5	57.58%
MNCV (m/s)	≤ 50	45.45%
SMNCV (m/s)	≤ 45	63.64%
D4M-D4U	> 0.5	72.72%
2L-INT	> 0.5	51.52%

DISCUSSION

Carpal tunnel syndrome (CTS) is one of the most common disorders for which nerve conduction studies (NCSs) are performed. A variety of sensitive NCS are available for the evaluation of a patient with suspected CTS.[9,10] Unfortunately, there is no agreement regarding what qualifies the number and type of nerve conduction tests needed to establish the neurophysiological diagnosis in CTS.[11] Previous studies have reported the sensitivities of the conventional NCS to be 56% to 85%.[4, 7]

In this study, the sensitivities of DSL and DML of the median nerve were 57.58 % and 54.55 % respectively. The most sensitive parameters of sensory NCSs were D4M-D4U (72.72 %) followed by SMNCV (63.64 %) whereas DML (54.55 %) followed by 2L-INT (51.52%) for motor NCSs. However, sensory parameters were more sensitive than motor NCSs which are in accordance with previous studies.[12] Usually isolated abnormalities of median motor nerve conduction with normal median sensory NCSs are not due to CTS.[9] However, studies have found DSL in symptomatic hands performed by conventional techniques within normal limits in 8%-25% of cases.[13]These discrepancies between the clinical and electrophysiological findings may partly be due to selection, but more likely to the fact in general the study of sensory nerve conduction is performed by examining only one digit.[14]

The sensitivity of D4M-D4U (72.72%) was the highest in our study. Both DSL and D4M-D4U were affected in 19 hands. Normal DSL with D4M-D4U more than 0.5 was present in 10 hands, whereas prolonged DSL (≥3.5) with normal D4M-D4U in 2 hands. Previous publications have reported a wide range of results for the sensitivity of D4M-D4U: Aygul et al (77%), [12] Uncini et al (77 %), [15] Sheu et al (70.2%) [16]and Demicri et al (85%) [17]. This might be allied to the funicular topography of the median nerve in the distal part of carpal tunnel where the compression

is usually more severe.[15] Median cutaneous fibers from the third and, specially, fourth digits appears to be more susceptible to compression as these fibers are located superficially in the anteroulnar section, just beneath the transverse ligament.[18]Several studies revealed that comparison of sensory nerve responses is more effective than the use of absolute median nerve latency in documenting the median nerve abnormalities consistent with CTS.[10]

In 45.45 % of hands, MNCV was slightly slowed in the forearm, usually in association with prolongation of the DML. The sensitivities reported by Aygul et al and Vahdatpour et al were 20.6% and 14% respectively, even lower than our study.[6, 12] The cause of the slowing of median motor conduction in the forearm of CTS patients is not clear. Wilson et al documented that the measured slowing is due to the block of conduction of the faster conducting fibers at the wrist.[19] However, Chang et al denied the role of selective conduction block of the large fibers and suggested that the slowing is due to retrograde axonal atrophy of motor fibers in the forearm segment of the median nerve.[20]

The sensitivity of 2L-INT was found 51.52% in our study. Several studies have reported the diagnostic value of a 2L-INT test in CTS.[21, 22] However, our results showed the sensitivity of DML higher than 2L-INT. Reported sensitivities of the 2L-INT were as follows: Loscher et al (86.1%), [23] Boonyapist et al (92.8%), [24] Brannegan et al (77%), [25] Lee et al (75%).[26] However, these studies were recorded in severe cases. Argyriou et al found 2L-INT highly sensitive (95.2%) even in mild cases.[2]The anatomical investigations of Sunderland et al revealed that the 2L fibers were located more centrally on the nerve on its way across the carpal tunnel than ABP and sensory fibers.[27] This observation suggests that motor fibers to ABP must be affected early and in greater degree and 2L fibers must be relatively preserved in severe CTS.[15, 18] The disparity in the sensitivities among different studies is probably a consequence of selection biases in the choice of population, differences in methodology and the use of different cut off points to define an abnormal value and different statistical methodologies.

CONCLUSIONS

In our study, sensory and motor latencies of the median nerve were found significant in the suspected cases. Besides, the motor NCV was found slower than controls. Furthermore, D4M-D4U was the most sensitive in our set up. Therefore, an addition of this test with conventional NCSs can be of great value in providing the better electrodiagnosis of CTS.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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