ORIGINAL ARTICLE

VALIDITY OF F-WAVE MINIMAL LATENCY OF MEDIAN AND ULNAR NERVES FOR DIAGNOSIS AND SEVERITY ASSESSMENT OF CARPAL TUNNEL SYNDROME IN TYPE II DIABETES MELLITUS

Ashraf Husain, Syed Shahid Habib, Syed Aftab Omar, Abdul Majeed Al-Drees
Department of Physiology, King Khalid University Hospital, King Saud University, Kingdom of Saudi Arabia

Background: Type II diabetes mellitus is a common problem and is sometimes associated with Carpal Tunnel Syndrome (CTS) due to compression of median nerve at wrist. Electrophysiological tests are frequently used for its diagnosis. In this work, F-wave minimal latency (FWML) difference between median and ulnar nerve and F-ratio is used to facilitate the diagnosis and severity of CTS in type II diabetes mellitus (T2DM). **Methods:** Thirty control cases were selected who were physically fit for normal electrophysiological values. Thirty-two patients with a long history of type II diabetes mellitus were studied for electro-diagnostic tests. All patients had clinical evidence of CTS. Among all diabetics about 20 cases had poor glycaemic control (HbA1c>7.5). F-wave minimal latency (FWML) were measured in median and ulnar nerves and F-ratio of median nerve were also noted. The mean values in different groups were compared using *t*-test and $p \leq 0.05$ was considered significant. **Results:** In control group, the ulnar FWML was either equal or slightly longer that the median FWML value. In CTS group with type II diabetes mellitus the FWML value of median nerve were significantly longer than FWML of the ulnar nerve. Moreover, in uncontrolled diabetic patients the FWML values was very much longer than controlled group. Similarly the F-ratio of median nerve was significantly low. **Conclusion:** In addition to the specific criteria for CTS diagnosis, the parameters like FWML difference in median and ulnar nerve with reduced F-ratio of median nerve can be useful in establishing the diagnosis and severity of CTS in type II diabetes mellitus.

Keywords: F-wave minimal latency, median nerve, ulnar nerve, carpal tunnel syndrome, type II diabetes mellitus, electromyography

INTRODUCTION

Type II diabetes mellitus (T2DM) is a common global problem. Patients with long standing history of diabetes mellitus are often associated with carpal tunnel syndrome (CTS).[1] It is an entrapment neuropathy of median nerve at wrist and is due to compression of median nerve between the transverse carpal ligament and other structures present inside the tunnel.[2] Neuropathy is estimated to be present in 7.5% of patients at the time of diabetes diagnosis. One half of patient have distal symmetrical neuropathy and one fourth hand compression neuropathy mainly carpal tunnel syndrome. In a cohort study of 4400 Belgian patients, Pirart *et al* found 7.5% patients already had neuropathy diagnosed with diabetes.[3] CTS often is bilateral and more common in women (3:1). CTS is diagnosed on the basis of symptoms, sign and electrophysiological study of the median nerve.[4] Electrophysiological parameters for diagnosis of CTS are, motor and sensory conduction velocity, distal motor latency, compound muscle action potential amplitude (CMAP) and sensory nerve action potential amplitude (SNAP). Although F-wave minimal latency (FWML) is included in the diagnostic parameters but it has not been given the importance that it deserves. In our work we wish to highlight FWML as an effective parameter for CTS diagnosis in T2DM patients.[5]

PATIENTS AND METHODS

This cross sectional case control study was conducted in the Department of Clinical Physiology, King Abdulaziz and King Khalid University Hospital, Riyadh, Saudi Arabia between Feb 2006 and Feb 2007 which is a part of an ongoing research in our clinical physiology unit. Thirty control cases were selected who were physically fit. The control cases were examined and had no neurological disease. Sixty normal upper limbs were studied which acted as control and compared with 64 symptomatic upper limbs in patients with type II diabetes mellitus.

Verbal informed consent was obtained in each case. Prior to test, skin temperature was monitored from the dorsum of the hand and temperature on test was kept about 30°C. In both the hands the electrophysiological tests were conducted in subjects with T2DM with strong clinical findings of CTS in hand e.g., pain, paraesthesia, nocturnal pain, wasting with weakness of thenar group of muscles with positive Tinel's and Phalen's signs. The parameters included were: a) nerve conduction studies: Motor and sensory conduction of median and ulnar nerves were performed according to the standard electro-physiologic method described in American Academy of Orthopaedic Surgeons clinical practice guideline on the Diagnosis of Carpal Tunnel Syndrome endorsed by American Academy of Neurological and electro-diagnostic medicine (AANEM).[6] The CMAP

was recorded with a surface electrode placed on abductor pollicis brevis muscle (APB). The reference electrode was placed 3 cm distal to the recording electrode. The stimulating electrode was at 8cm from anode proximally and the recording electrode at the APB muscle.[7,8] The amplitude of both sensory and motor potentials was noted. The distal motor latency of median and ulnar nerves was recorded. The sensory stimulation of median and ulnar nerve was done antidromically at a distance of 14 Cm from the recording electrode at the finger. The recording electrode was placed at the index finger for the median nerve and fifth digit for the ulnar nerves; b) F-wave studies[9]: ten supramaximal stimulations were given to the median and the ulnar nerves at the wrist. The recording was made through surface electrode placed over the abductor pollicis brevis and abductor digiti minimi. The ground electrode was placed on the dorsum of the hand and F-wave responses were recorded. The shortest F-wave latency was noted. This is known as the F-wave minimal latency (FWML) of the APB for median and ADM for the ulnar nerve. The FWML difference between the median and ulnar nerve was noted. The electrophysiological data were grouped separately for controls and patients. The control data were evaluated with respect to the median and ulnar FWML in the same side. The ulnar FWML was subtracted from the median FWML to calculate F-wave minimal latency difference for each limb separately.[10,11]

The data was analysed using SPSS-10. Descriptive characteristics of the study patients were calculated as Mean±SD for continuous variables and as percentages for categorised variables. Student's *t*-test was used for comparison between different groups and $p<0.05$ was considered as statistically significant.

RESULTS

The average age of control subjects was 45±7.68 years. Results of control group are presented in Table-1 and 2. Sixty-four symptomatic upper limbs were all confirmed cases of diabetes mellitus type II having diabetes duration of more than 15 years. They were either on insulin or oral hypoglycaemic drugs. Twenty patients were not well controlled and their glycosylated haemoglobin was >7.5. Their total cholesterol (TC), triglycerides (TGs) and low-density lipoprotein (LDL) values were significantly high, suggestive of lack of adequate glycaemic and lipid control. Among all symptomatic upper limbs 32 were right and 22 were left. In five patients symptoms of CTS were present bilaterally. Electro-diagnostic tests were done in all symptomatic limbs. Comparison of Median Nerve Motor and Sensory Conduction parameters between Control and DM with CTS is expressed in Table-1. Significant differences were observed in Motor Conduction Velocity (MCV), Distal Motor latency (DML), Compound motor action potential (CMAP), Sensory Conduction Velocity (SCV), Distal sensory latency (DSL), and Sensory nerve action potential (SNAP). The F-ratio of median nerve in diabetic patients was found to be significantly reduced ($p=0.0001$) (Table-1). Comparison of Ulnar Nerve Motor and Sensory Conduction parameters in Control and DM with CTS are shown in Table-2.

Significant differences were observed in all parameters except Sensory nerve action potential (SNAP). We compared F Wave Minimal Latency and its difference between Median and Ulnar nerve in Control Group and the difference was non significant ($p=0.5432$), while it was highly significant in CTS Group with DM ($p<0.0001$) (Table-3). This indicates that FWML is longer in median than the ulnar nerve in diabetic patients having CTS. This is an important finding in patients having CTS. TC, LDL, TG and FWML were significantly higher in diabetics with poor glycaemic control than good control except for HDL levels (Table-4).

Table-1: Comparison of Median Nerve Motor and Sensory Conduction parameters in Controls and Diabetics with CTS

	Median Nerve		*p*-value
	Control (n = 60)	DM with CTS (n = 64)	
Motor			
MCV m/Sec	60.27±5.81	53.49±9.17	0.0001
DML mS	3.17±0.49	5.26±1.12	0.0001
CMAP mV	10.16±3.89	7.02±3.35	0.0001
Sensory			
SCV m/Sec	53.77±6.62	30.63±16.52	0.0001
DSL mS	2.73±0.55	3.66±1.96	0.0010
SNAP µV	31.44±19.72	16.71±15.97	0.0001
F ratio	7.58±1.46	4.89±1.01	0.0001

All values are expressed as Mean±SD
Motor Conduction Velocity (MCV), Distal Motor latency (DML), Compound motor action potential (CMAP), Sensory Conduction Velocity (SCV), Distal sensory latency (DSL), Sensory nerve action potential (SNAP)

Table-2: Comparison of Ulnar Nerve Motor and Sensory Conduction parameters in Controls and Diabetics with CTS

	Ulnar Nerve		*p*-value
	Control (n=60)	DM with CTS (n= 64)	
Motor			
MCV m/Sec	65.76±5.49	58.09±8.82	0.0001
DML mS	2.57±0.31	3.09±1.01	0.0004
CMAP mV	8.29±2.11	7.47±2.93	0.0113
Sensory			
SCV m/Sec	55.66±6.20	46.84±11.97	0.0001
DSL mS	2.58±0.53	3.21±1.41	0.0043
SNAP µV	28.85±15.22	28.42±27.63	0.6647
F ratio			

All values are expressed as Mean±SD
Motor Conduction Velocity (MCV), Distal Motor latency (DML), Compound motor action potential (CMAP), Sensory Conduction Velocity (SCV), Distal sensory latency (DSL), Sensory nerve action potential (SNAP)

Table-3: F Wave Minimal Latency and its difference between Median and Ulnar nerve in Control Group (N=60) (p=0.5432) and DM with CTS Group (N=64 limbs) (p<0.0001)

Control	Median	Ulnar
FWML mS	25.30±2.22	25.50±1.78
FWML Difference (mS) Between Median and Ulnar nerve of the same side	0.11	
CTS	Median	Ulnar
FWML mS	29.79±3.45	26.94±2.83
FWML Difference (mS) Between Median and Ulnar nerve of the same side	2.85	

Table-4: Glycaemic control, lipid profile and FWML in good and poor glycaemic control group

	HbA1c <7.5 (n=34)	HbA1c ≥ 7.5 (n=20)	*p*-value
HbA1c	6.58±0.56	10.08±1.05	0.0001
TC	4.25±0.65	5.72±0.79	0.0412
TG	1.49±0.83	2.70±0.51	0.0314
LDL	2.20±0.67	3.82±0.55	0.0327
HDL	1.25±0.20	1.40±0.29	NS
FWML	28.5±2.63	29.9±2.80	0.0512

Total cholesterol (TC), Triglycerides (TG), Low density Lipoprotein (LDL) and High density lipoprotein (HDL), F Wave Minimal Latency (FWML)

DISCUSSION

Carpal tunnel syndrome is a common complication of type II diabetes mellitus. This is caused by median nerve entrapment leading to demyelination of the nerve inside the tunnel.[12] Sometimes even with a good history and physical examination it becomes difficult to diagnose CTS. The electrophysiological study is a gold standard diagnostic test.[13,14] We found all the electro-diagnostic parameters, like delayed motor and sensory conduction velocity of median nerve across the carpal ligament of wrist, delayed distal motor latency of median nerve and decreased amplitude of CMAP from APB muscle required for the diagnosis of CTS. The above results are comparable with the results of other workers.[15,16]

In this study we have attempted to draw the attention that measurement of FWML of median and ulnar nerve is an extremely useful parameter in the diagnosis of carpal tunnel syndrome in patients with diabetes mellitus. Daniel in 1997[11] reported that the median nerve F-wave minimal latency (FWML) tends to be shorter than of the ulnar nerves in healthy population. Similar to our results, Pinheiro *et al* reported that F-wave latencies is a parameters that has best reproducibility, followed by conduction velocities and amplitudes.[17]

The reason being that the F-wave latencies showed less variability than the other parameters of conduction studies, and, among them, the F-wave mean latency of the tibial nerve has been the one with the higher reproducibility. The explanation given was that the length of the median nerve from the roots to the abductor pollicis brevis (APB) is shorted than the length of the ulnar nerve from its root to abductor digiti minimi (ADM), hence the latency is shorter in the median nerve. In our CTS group of diabetic patients, the FWML of the median nerve was longer than ulnar nerve. This ulnar, median latency difference was highly significant. It has been further observed that patient with uncontrolled diabetics having carpal tunnel syndrome. The FWML difference was significantly high. This can be explained on the basis of demyelination or axonal damage occurring in the distal course of the nerve in severe uncontrolled diabetic patients.[18] Antidromic stimulation activates the different anterior horn cells at different times leading to latency difference of F-wave with each stimulation, hence, the F-wave minimal latency measurement is done as to achieve a consistent results. The other parameter like F-ratio of median nerve was also decreased consistently in diabetics having CTS.

CONCLUSIONS

In addition to the specified criteria for CTS diagnosis, the parameters like FWML difference in median and ulnar with reduced F-ratio of median nerve can be useful in establishing the diagnosis and severity of CTS in type II diabetes mellitus.

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Address for Correspondence:

Dr. Syed Shahid Habib, Department of Clinical Physiology (29), College of Medicine and King Khalid University Hospital, Riyadh 11461, Kingdom of Saudi Arabia.
Email: shahidhabib44@hotmail.com