Effect Of Long Standing Carpal Tunnel Syndrome On Median Nerve Conduction

M.M.U. Kabiraj, M.D.[1]*, V.P. Gupta, Ph.D.[2], A.A. Jamil, M.D.[2] and A.H.Shah, Ph.D., D.Sc.[2]

[1]Department of Neuroscience, Riyadh Armed Forces Hospital, P.O. Box N-641, Riyadh-11159, Saudi Arabia

[2]Riyadh Medical Complex, Central Laboratories, P.O. Box 9120, Riyadh-11413, Saudi Arabia.

ABSTRACT

To evaluate the possible induction of retrograde changes in the median nerve of the forearm, a total of 41 upper extremities of 31 Saudi patients who fulfilled the criteria for the diagnosis of long standing Carpal Tunnel Syndrome [CTS] were studied. The mean motor conduction velocity [MNCV] (43.90+3.35m/sec), motor terminal latency [MTL] (6.03+1.36 msec), sensory terminal latency [STL] (3.99+0.49 msec), amplitude of the compound muscle action potential [CMAP] (2.85+ 1.04 mv) and motor terminal latency index [MTLI] of the median nerve were significantly abnormal ($P<0.001$) in the study group while compared to those for the control.

The results of the present study also verified that the prolonged MTL, STL, and markedly reduced CMAP ($P<0.001$) are useful parameters for the diagnosis of CTS. The significantly reduced median MNCV ($P<0.001$) in comparison to those for the control group and to those for the ulnar nerve of the symptomatic hand indicate retrograde changes of the median nerve in the forearm in our study group. The incidence of abnormally low MTLI in mild to moderately affected CTS patients emphasized its role in detecting retrograde changes of the entrapped median nerve in an early stage.

(Key Words: Carpal Tunnel Syndrome; CTS; Nerve Conduction Velocity; Terminal Latency; Terminal Latency Index; retrograde changes; Abductor Policis Brevis; health studies)

INTRODUCTION

In patients suffering from carpal tunnel syndrome (CTS) a decrease in motor and sensory conduction velocities of the median nerve across the wrist has been reported (Buchthal et al., 1974; Chassin et al. 1987). However, there are diverse findings regarding the reduction of the nerve conduction velocities in the forearm of patients with CTS (Pease et al., 1990; Stoehr et al., 1978; Thomas et al. 1963). Hansson (1994) demonstrated that the reduction of sensorimotor conduction velocities in the forearm reflect retrograde changes of the median nerve better than the data on the mixed nerve conduction velocity. In an animal model experiment, a significant decrease in the conduction velocity of the proximal segment of a severed nerve was observed (Cragg and Thomas, 1961). It was suggested that any reduction in the amplitude of the mixed nerve action potential [MNAP] proximal to the tunnel might be considered as a sign of retrograde degeneration in that area (Stoeher et al. 1978).

Shahani et al. (1979) reported that at an early stage of the disease, motor terminal latency index (MTLI) might be considered as another sensitive tool to measure the unequal conduction of the proximal and distal segments of the median nerve across the carpal tunnel.

We recently reported our findings on some of the clinical-physiological aspects of CTS (Kabiraj et al. 1998) and presented our data on the neuropathological changes induced by CTS (Kabiraj et al. 2000). In continuation of our work (Kabiraj et al. 2000), the present study was designed to investigate the association of changes in median nerve conduction [MNC] with the damage caused to the nerve fibers in the wrist due to CTS in Saudi patients. The present study also includes investigations on the importance of retrograde changes in CTS for proper understanding of the clinical findings and to classify the electrophysiological test parameters to follow the natural course of the untreated cases.

MATERIALS AND METHODS

Patients: Nerve conduction studies and TLI calculations were performed in Saudi patients of either sex, aged between 28 to 85 years (10 male and 21 female) included in the present study. All the patients had strong clinical evidence supportive of the diagnosis of CTS such as: painful paraesthesia in the relevant upper limb, worse in the palmar aspect of the hands, and occurring more severely at night in addition to wasting and weakness of thenar muscles, and positive Tinel's and Phalen's signs. The following criteria were adopted in selecting the patients:

i). The distal motor latency for the median nerve to be more than 4.02 msec (mean + 2SD control) with obvious weakness of the abduction of the thumb and signs of atrophy.

ii). Decreased MCV of 47.57 m/sec (mean - 2SD control) with normal ulnar nerve conduction.

iii). Decreased CMAP from the abductor pollicis brevis [APB] (mean - less than 1 SD of the control CMAP amplitude).

iv). Prolonged and/or absence of median sensory action potentials [SAP].

Control: The control group included 38 healthy volunteers (19 male and 19 females) aged between 20 to 79 years. All these subjects were free from symptoms and signs suggestive of any neurological diseases. They were informed about the study and gave their consent. Similar measurements of nerve conduction velocities [NCV] were performed for the control group as well.

Motor and sensory conduction studies of the median nerve were performed using conventional techniques and recordings were made on a MEDELEC Mystro II instrument. In each case the skin temperatures ranged between 32 to 34 °C. The compound muscle action potential [CMAP] was recorded with a surface electrode placed on APB. The reference electrode was placed 3 cm distal to the recording electrode. For each patient, both

the motor conduction velocities [MCV] of the median and ulnar nerves from elbow to the wrist were recorded. The motor terminal latency [MTL] was measured from the stimulus artifact to the beginning of the CMAP of APB muscle. The distance between the stimulating electrode at the wrist and the recording electrode at APB was 75.77 mm ± 8.17mm (SD) for both the control subjects as well as for the patients. In each case the sensory nerve conduction velocities [SNCV] for both nerves were studied by stimulating their digital branches. Routine needle was done for weak/atrophied thenar muscles.

The MTLI for the median nerve was calculated using the formula of Shahani et al. (1979) as follows:

MTLI = Terminal distance (mm) / MCV (m/sec) x MTL (msec)

The ranges of different parameters explaining the severity of CTS as mild, moderate and severe was done according to the following arbitrary scale presented in Table 1.

Table 1: The Ranges of Different Parameters used for the Classification of Severity of CTS.

Severity	MTLI	Parameters	
		Terminal Latency (msec)	MNCV (m/sec)
Mild	0.3 - 0.33	4.07 - 4.89	45.0 - 47.6
Moderate	0.26 - 0.29	4.90 - 5.50	40.0 - 44.9
Severe	≤ 0.25	≥ 5.6	≤ 39.9

Statistical Analysis: The electrophysiological data were grouped separately for the control subjects and the patients. Comparisons were made by using the matched paired Student's t- test and analysis of variance as appropriate. The significance value was set at $p \leq 0.05$.

RESULTS

The results of the present study are presented in Tables 2 and 3. The mean MTL of the median nerve in the patients as well as the mean MCV in their forearm was significantly lower ($P < 0.001$) as compared to the control. Similarly the mean MTLI of patients was significantly lower ($P < 0.001$) as compared to the control. The data on severity of CTS showed that 38.7% of the patients had moderate and 38.7% had severe reduction of MTLI while 51.5% of patients had severely-prolonged MTL. Mild reduction in MNCV in the forearm of 51.5% patients was observed. However, MTLI of two patients (1 male and 1 female) were with in the normal limits.

The MCV of the ulnar nerves for the symptomatic hands was 59.0 ± 6.31 m/sec. Routine electromyographic records showed active signs of denervation in the atrophied thenar

muscles. The correlation coefficient studies between MNCV and MTL revealed no significant differences, however the ***r*** -value for MTLI correlated well with MTL and was significant.

Table 2. Summary of Neurophysiological Findings.

Parameters (mean ± S.D.)		Median Nerve		Ulnar Nerve Patients (n = 31)
		Control (n = 38)	Patients (n = 31)	
CV (msec)	Motor	56.57 ± 4.50	43.90 ± 3.35*!	59.01 ± 6.31
TL (msec)	Motor	3.25 ± 0.41	6.03 ± 1.36*!	2.61 ± 0.45
	Sensory	2.61 ± 0.40	3.99 ± 0.49*!	2.20 ± 0.66
CMAP (Mv)		5.04 ± 2.17	2.85 ± 1.04*!	5.44 ± 3.03
MTLI		0.43 ± 0.05	0.26 ± 0.06*	----

* P < 0.001 (as compared to the control)
! P < 0.001 (as compared to ulnar nerve)
CV = Conduction velocity
TL = Terminal Latency
CMAP = Compound muscle action potential
Msec = Millisecond
Mv = Millivolt

Table 3. The Frequency of Different Degrees of Abnormalities in Median Nerve Conduction Studies of CTS Patients.

Parameters	Degree of Abnormalities - Number of Patients (%)			
	Normal	Mild	Moderate	Severe
MTLI	2 (6)	5 (16)	12 (38.7)	12 (38.7)
MTL	0	8 (26)	8 (26)	15 (48)
MNCV	0	16 (51.5)	11 (35.5)	4 (13)

MTLI = Motor terminal latency index
MTL = Motor terminal latency
MNCV = Motor nerve conduction velocity

DISCUSSION

These findings are in agreement with the earlier reports where slowing of the forearm MNCV was observed not to be proportional to the increase in distal motor latencies (Buchthal et al. 1974).

The observed significantly low (P < 0.001) mean MNCV of the median nerve of the patients as compared to the control and than that of the ulnar nerve of the same symptomatic hands indicated retrograde involvement of the mean nerves. Similarly, the prolonged MTL of the patients indicated a significant distal involvement. These findings were substantiated by the recorded decrease in the amplitude of CMAP from APB and prolonged SAP latencies. The routine electromyographic observations including fibrillation potentials, positive sharp waves

and polyphasic longer duration motor unit potentials showed good correlation with the atrophy of the thenar emineces.

Our observations added support to the reports of earlier workers (Uchida and Sugioka, 1993; Hansson, 1994). The observed normal MNCV of the ulnar nerve of the symptomatic hands in the present study supported entrapment of the median nerve axons in the carpal tunnel and ruled out the presence of generalized neuropathy.

In our present study no correlation could be found between the reduction of forearm MNCV for the median nerve and prolongation of MTL. It was noticed that a high proportion of our subjects (87%) were suffering from mild to moderate reduction of median MNCV, while 74% suffered from moderate to severely prolonged MTL. However, based on MTLI, 77% of the patients belonged to the moderate to severely affected group. There was a good correlation between the reduction of MTLI and prolongation of MTL ($r = 0.67$) reflecting disproportionate conduction across the carpal tunnel with predominant distal slowing.

CONCLUSIONS

Based on these findings it is concluded that in severe cases of CTS retrograde degeneration of median nerve is a common phenomenon. Similar observations were made earlier by Uchida and Sugioka (1993). Due to lack of correlation between the magnitude of reduction of MNCV and prolongation of MTL, the significantly low MTLI observed in the present study clearly demonstrated reduction in the distal conduction as compared to that of the proximal conduction. MTLI appeared as a useful variable for showing the unequal conduction defect between the proximal and distal segments of the median nerve across the carpal tunnel (Shahani et al. 1979). It is worth mentioning that in the present study two patients were found to have normal MTLI. Normal MTLI with prolonged MTL indicated a decrease in the conduction of the median nerve across the wrist. The higher frequency of moderate to severe MTLI changes and mild to moderate abnormality of MNCV of the median nerve in the forearm clearly reflected the disproportionate conduction across the carpal tunnel. It is, therefore, concluded that MTLI may be considered as a sensitive parameter in detecting the retrograde changes of the nerve at its early stage. Such information would facilitate an appropriate management to reduce the process of degeneration and help improve changes in denervated muscles for reinnervation.

The observed relatively greater incidence of lower values for MTLI reflected higher incidence of retrograde changes in female patients. It showed females to be more prone to such changes. The frequency of pregnancy and hormonal influences may not be ruled out to be involved in enhancing the observed effects. Our findings warrant further studies on the sex dependence of these changes.

REFERENCES

Buchthal, F., A. Rosenfalck and W. Trojaborg. 1974. “Electrophysiological findings in entrapment of the median nerve at wrist and elbow”. J. Neuro. Neurosurg. Psychiatr. 37: 340-360.

Chassin, S.L. and J.W. Little. 1987. “Compound nerve action potentials from the median and ulnar nerves”. Arch. Phys. Med. Rehab. 68: 31-35.

Gragg, B.G. and P.K. Thomas. 1961. “Changes in conduction velocity and fibre size proximal to peripheral nerve lesions”. J. Physiol. 157: 315-327.

Kabiraj, M.M.U., S. Al-Rajeh, A.R. Tahan, M. Abdusljabbar, M. Al-Bunyan, A.K. Daif and A. Awada. 1998. "Carpal tunnel syndrome: a clinico-electrophysiological study”. Med. Sci. Res. 26: 631-633.

Kabiraj, M.M.U., V.P. Gupta, A.A. Jamil and A.H. Shah. 2000. “Comparison of terminal latency index in patients with entrapment and generalized neuropathy”. Greenwich J. Sci. Tech. 1(1): 4-10.

Pease, W.S., H.H. Lee and E.W. Johnson. 1990. “Forearm median nerve conduction velocity in carpal tunnel syndrome”. Electromyogr. Clin. Neurophysiol. 30: 299-302.

Stoehr, M., F. Petruch, K. Scheglmann and K. Schilling. 1978. “Retrograde changes of nerve fibers with the Carpal tunnel syndrome”. J. Neurol. 218: 287-292.

Thomas, P.K. and P.M. Fullerton. 1963. “Nerve fiber size in the carpal tunnel syndrome”. J. Neurosurg. Psychiatr. 26: 520-527.

Hansson, S. 1994. “Does forearm mixed nerve conduction velocity reflect retrograde changes in carpal tunnel syndrome?”. Muscle & Nerve 17: 725-729.

Shahani, B.T., R.R. Young, F. Potts and P. Maccabe. 1979. “Terminal latency index and late response studies in motor neuron disease (MND) peripheral neuropathies and entrapment syndromes. Acta Neurol. Scand. (Suppl. 73) 60: 118.

Uchida, Y. and Y. Sugioka. 1993. “Lectrodiagnosis of retrograde changes in carpal tunnel syndrome”. Electromyogr. Clin. Neurophysiol. 33: 55-58.

About the Authors:

Mohammad Kabiraj, M.D. is a Consultant/Neurophysiologist at the Armed Forces Hospital in Riyadh. Dr. Kabiraj earned his MBBS (1969) and his Masters degree (1974) with honors, from Dhaka University, Bangladesh in the field of Physiology. Dr. Kabiraj has conducted physiology studies as a research scholar in Sweden and as an Assistant Professor of Physiology at the King Saud University in Riyadh. His primary research interests lie in the areas of electrodiagnostic medicine and intra-operative monitoring for epilepsy surgery.

Vijay Prakesh Gupta, D.F.M., Ph.D. presently works for the Ministry of Health in Riyadh, Kingdom of Saudi Arabia as Legal Specialist and Clinical Toxicologist. Dr. Gupta also serves as an Adjunct Professor at Greenwich University. He earned his M.B.B.S. from Agra University in India, his D.F.M. in Forensic Medicine from Bangalore University, India and his Ph.D. in Forensic Medicine and Toxicology from Greenwich University. Dr. Gupta is a

member of ten international medical, forensic and toxicological societies; has written more than 17 published papers on forensic science and toxicology and received awards for his work in both India and the Kingdom of Saudi Arabia.

Anis Ahmad Jamil, M.D., D.C.H. currently serves as a Senior Consultant/Pediatric Neurologist and Head of the Department of Pediatric Neurology and Clinical Neurophysiology at The Children's Hospital, Department of Pediatric Neurology, Riyadh Medical Complex. Dr. Jamil formerly served as the Director of the Arab and Saudi Board Residency Program (Pediatric) and as the Co-Chairman of the Department of Postgraduate Medical Education and Academic Affairs. Dr. Jamil brings over 25 years of clinical experience in pediatrics and neurology to his research and has authored or co-authored over 30 professional papers. Dr. Jamil completed his M.B.B.S. in 1973, his D.C.H. in 1976, and earned his Doctorate in Pediatrics (M.D.) in 1981. Additionally, he is currently completing a Ph.D. in Neurology at Greenwich University. His main research interests lie in the areas of epilepsy, epileptic syndromes, and movement and neurometabolic disorders.

Arif Hussain Shah, Ph.D. D.Sc., currently serves as the Head of the Central Instrumental, Drug Stability & Research Departments at the Central Laboratory for Drug & Food Analysis, Ministry of Health in Riyadh, Saudi Arabia, where he is also the Drug Analysis Specialist/Consultant. Professor Shah also currently holds teaching positions the Open International University and Greenwich University. He has also held teaching and research posts at King Saud University and Gomal University. Prof. Shah has authored or co-authored over 125 research articles in various international journals on topics of structural determination of new compounds, toxicity evaluation, and assay methods for drug products. He received his B.Sc. and M.Sc. from the University of Peshawar in Peshawar, Pakistan and his M.S. and Ph.D. from the Institute of Organic Chemistry & Biochemistry, in Bonn, Germany.

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