

Motor terminal latency index in carpal tunnel syndrome

M.M. Kabiraj,¹ S. Al-Rajeh,¹ A.R. Al-Tahan,¹ M. Abduljabbar¹ and M. Al-Bunyan¹

مَنْسَب الكُمون الطرْفِي الحركِي فِي متلازِمَة النفق الرِسْغِي

محمد مسلم الدين كابيراج وسعد محمد الراجح وعبد الرحمن يوسف الطحان ومحمد صالح عبد الجبار ومنيرة عبد الله البنيان

خلاصة: في هذه الدراسة حدّدنا مَنْسَب الكُمون الطرْفِي الحركِي للعصب الناصف (المتوسط) عبر النفق الرِسْغِي، في واحد وأربعين ذراعاً لواحد وثلاثين مصاباً بمتلازمة النفق الرِسْغِي. وتبيّن أن حدوث تغيّرات في متوسط سرعة التوصيل الحركِي، والكُمون الطرْفِي الحركِي، والفعل الحسّي الكامن، ومدى الفعل العضلي المركب مسجّلاً من العضلة القصيرة المقرّبة لإبهام اليد، كانت كلها ظواهر دالة على تأثر الجزأين القاصي والداني من العصب عبر النفق الرِسْغِي. ولم يكن هناك ارتباط بين متوسط سرعة التوصيل الحركِي بالسّاعد وبين الكُمون الطرْفِي الحركِي ($r = 0.40$)، وإن كان مَنْسَب الكُمون الطرْفِي الحركِي وجد مرتبطاً بالكُمون الطرْفِي الحركِي ($r = 0.67$) وليس بمتوسط سرعة التوصيل الحركِي، الأمر الذي يدل على أن التوصيل عبر النفق الرِسْغِي كان غير متناسب.

ABSTRACT We determined the motor terminal latency index (MTLI) of the median nerve across the carpal tunnel in 41 upper extremities of 31 patients with carpal tunnel syndrome. Changes in motor nerve conduction velocity (MNCV), motor terminal latency (MTL), sensory action potential and the amplitude of the compound muscle action potential recorded from the abductor pollicis brevis muscle were all suggestive of proximal and distal segment involvement of the nerve across the carpal tunnel. There was no correlation between forearm MNCV and MTL ($r = 0.40$), although MTLI was correlated with MTL ($r = 0.67$) but not with MNCV, indicating a disproportionate conduction across the carpal tunnel.

L'indice de latence distale motrice dans le syndrome du canal carpien

RESUME Nous avons déterminé l'indice de latence distale motrice du nerf médian dans le canal carpien, et ce dans 41 membres supérieurs chez 31 patients atteints du syndrome du canal carpien. Des changements dans la vitesse de conduction motrice (VCM) moyenne, la latence distale motrice, le potentiel d'action sensitive et l'amplitude du potentiel d'action musculaire globale enregistrés au niveau du court abducteur du pouce étaient tous évocateurs d'une atteinte des segments proximal et distal du nerf passant dans le canal carpien. Il n'y avait aucune corrélation entre la vitesse de conduction motrice moyenne et la latence distale motrice de l'avant-bras ($r = 0,40$) même s'il existait une corrélation de l'indice de latence distale motrice avec la latence distale motrice ($r = 0,67$) mais pas avec la vitesse de conduction motrice, indiquant une conduction disproportionnée dans le canal carpien.

¹ Department of Neurology and Clinical Neurophysiology, King Khalid University Hospital, King Saud University, Riyadh, Saudi Arabia.

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Introduction

A decrease in motor and sensory conduction velocities of the median nerve across the wrist is seen in carpal tunnel syndrome (CTS) [1,2]. Findings vary regarding the reduction in nerve conduction velocities in the forearm of patients with CTS [3-5]. A recent study has suggested that the reduction of sensorimotor conduction velocities in the forearm reflected retrograde changes to the median nerve better than mixed nerve conduction velocity [6]. Animal studies have shown the conduction velocity of the proximal segment of a severed nerve to be significantly decreased [7]. Another sign of retrograde degeneration proximal to the tunnel is the reduction in amplitude of the mixed nerve action potential [4]. It has also been shown that with patients with severe CTS with gross atrophy of the abductor pollicis brevis (APB) muscle, motor nerve conduction velocity (MNCV) and compound muscle action potential (CMAP) amplitude could not be measured. However the evoked mixed nerve action potential (EMNAP) recorded from the forearm was a useful measure of retrograde changes in CTS [8]. The motor terminal latency index (MTLI) is another sensitive way to measure the unequal conduction of the proximal and distal segments of the median nerve across the carpal tunnel at an early stage [9].

The objectives of this study were:

- to evaluate whether the reduction of median nerve conduction is caused by damage to the nerve fibres in the wrist in CTS;
- to recognize the importance of retrograde changes in CTS for understanding the clinical findings;

- to classify the electrophysiological test parameters to follow natural courses of untreated cases.

To our knowledge, no study has been carried out of MTLI changes in Saudi patients with this condition. We therefore designed a study on MTLI changes in these patients.

Patients and methods

Nerve conduction studies and MTLI calculations were performed on 31 patients (10 males, 21 females) aged 28–85 years. All patients had strong clinical evidence to support a diagnosis of CTS. This included painful paraesthesia in the relevant upper limb (worse in the palmar aspect of the hands and occurring more severely at night), wasting and weakness of the thenar muscles, and positive Tinel's and Phalen's signs.

Selection criteria were applied to include patients with:

- distal motor latency for the median nerve > 4.02 m/sec (mean ± 2 SD of the control) with obvious weakness of the abduction of the thumb and signs of atrophy;
- decreased motor conduction velocity of 47.57 m/sec (mean $- 2$ SD control) with normal ulnar nerve conduction;
- decreased CMAP from the APB muscle (mean $- < 1$ SD of the control CMAP amplitude);
- prolonged and/or absent median sensory action potential (SAP).

Similar measurements of nerve conduction velocities were performed in a control group of 38 healthy volunteers (19 males, 19 females), aged 20–79 years, who were free from symptoms and signs of neurolog-

ical disease. Informed consent was obtained from all the participants.

Motor and sensory conduction studies of the median nerve were performed using conventional techniques. Recordings were made on a "Medelec Mystro II" machine. Skin temperatures ranged between 32 °C and 34 °C. The CMAP was recorded with a surface electrode placed on the APB muscle. The reference electrode was placed 3 cm distal to the recording electrode. The motor conduction velocities of both the median and ulnar nerves, from elbow to wrist, were recorded for each patient. The MTL was measured from the stimulus artifact to the beginning of the CMAP of the APB muscle. The distance between the stimulating electrode at the wrist and the recording electrode at the APB muscle was 75.77 ± 8.17 mm, for both controls and patients. The sensory nerve conduction velocities for both nerves were studied by stimulating their digital branches. Routine needle was applied for weak/atrophied thenar muscles.

The MTLI for the median nerve was calculated using the formula [9]:

$$\text{MTLI} = \frac{\text{Terminal distance (mm)}}{\text{MCV (m/sec)} \times \text{MTL (m/sec)}}$$

The classification categories for severity of carpal tunnel syndrome are given in Table 1. Electrophysiological data were grouped separately for controls and patients. Comparison was made using the Student *t*-test and analysis of variance as appropriate. The significance value was set at $P \leq 0.05$.

Results

The mean MTLI of patients was 0.26 ± 0.06 , which was significantly lower than

Table 1 Classification categories for severity of carpal tunnel syndrome

Severity	Parameters		
	MTLI	Terminal latency (m/sec)	MNCV (m/sec)
Mild	0.30–0.33	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

MTLI = motor terminal latency index

MNCV = Motor nerve conduction velocity

the calculated mean of 0.43 ± 0.05 in controls ($P < 0.0005$). Table 2 summarizes the significant changes in the median nerve in patients compared with controls. The MTL of the median nerve in the patients was 6.03 ± 1.36 m/sec, while the mean motor conduction velocity in the forearm was 43.9 ± 3.35 m/sec, which was significantly less than the mean value of 56.57 m/sec obtained in controls ($P < 0.0005$) (Table 2).

According to our criteria for classifying patients as mildly, moderately and severely affected groups, 12 out of the 31 patients (38.8%) had moderate reduction of MTLI and 12 (38.8%) had severe reduction. Of the 31, 16 patients (51.5%) had severely prolonged MTL and an equal number had mild reduction in MNCV in the forearm (Table 3). The MTLI of two patients (1 male, 1 female) were within normal limits. Motor conduction velocity of the ulnar nerves for the symptomatic hands was 59.01 ± 6.31 m/sec. Routine electromyographic records showed active signs of denervation in the atrophied thenar muscles. Correlation between MNCV and MTL was not significant ($r = 0.40$), while MTLI was significantly correlated with MTL ($r = 0.67$).

Table 2 Summary of neurophysiological findings (mean \pm s)

Parameter	Median nerve		Ulnar nerve Patients
	Controls	Patients	
Conduction velocity (m/sec) motor	56.57 \pm 4.50	43.9 \pm 3.35	59.01 \pm 6.31
Terminal latency (m/sec) motor	3.25 \pm 0.41	6.03 \pm 1.36	2.61 \pm 0.45
	2.61 \pm 0.40	3.99 \pm 0.49	2.20 \pm 0.66
CMAP (Mv)	5.04 \pm 2.17	2.85 \pm 1.04	5.44 \pm 3.03
MTLI	0.43 \pm 0.05	0.26 \pm 0.06	

All control versus patient median nerve comparisons by t-test are highly significant ($P < 0.0005$).

All patient median versus ulnar nerve comparisons by t-test are highly significant ($P < 0.0005$).

CMAP = compound action muscle potential

MTLI = motor terminal latency index

Table 3 Frequency of different degrees of abnormalities in median nerve conduction studies (carpal tunnel syndrome patients)

Parameter	Mild		Moderate		Severe	
	No.	%	No.	%	No.	%
Motor terminal latency index ^a	5	16.0	12	38.8	12	38.8
Motor terminal latency	8	26.0	7	22.5	16	51.5
Motor nerve conduction velocity	16	51.5	11	35.5	4	13.0

^aMotor terminal latency index was normal in two patients (6%).

Discussion

The significantly low MTLI in our study reflects the greater reduction of distal conduction in relation to that of the proximal. This finding agrees with Buchthal et al. [1], who found that slowing of forearm MNCV was not proportional to the increase in distal motor latency.

The mean MNCV of the median nerve was significantly lower in patients compared to controls, as well as lower than that of the ulnar nerve of the same symptomatic hands ($P < 0.0005$). This finding indicates retrograde involvement of the median

nerves. Similarly, the significantly prolonged MTL of the patients indicates a significant distal involvement, which is further supported by low amplitude CMAP from the APB muscle and prolonged SAP latencies. The fibrillation potentials, positive sharp waves and the polyphasic longer duration motor unit potentials were recorded. Our routine electromyographic observations appeared to correlate well with the atrophy of the thenar eminences and agreed with the reports of others [6,8]. The normal MNCV of the ulnar nerve of the symptomatic hands would support entrapment of the median nerve axons only in the carpal tun-

nel, rather than the neuropathy being generalized. However, a conduction study of other nerves, especially the sural nerve (not done), could be a more reliable marker for generalized neuropathy.

We found no correlation between the reduction of forearm MNCV for the median nerve and prolonged MTL. The results showed a high proportion of our subjects (87%) had mild to moderate reduction of median MNCV, although 74% belonged to the category with moderate to severely prolonged MTL. However, with regard to MTLI, 24 out of 31 subjects (77%) were in the moderate to severely affected group. There was therefore a good correlation between MTLI reduction and MTL prolongation ($r = 0.67$) reflecting disproportionate conduction across the carpal tunnel with predominant distal slowing.

We therefore conclude that in CTS, especially in severe cases, retrograde degeneration of the median nerve is a common phenomenon [8]. Because of the lack of correlation between the magnitude of MNCV reduction and that of MTL prolongation, MTLI would appear to be a useful variable for showing the unequal conduction defect between the proximal and distal segments of the median nerve across the

carpal tunnel [9]. Only two patients had normal MTLI. Normal MTLI with prolonged MTL may indicate a proportional decrease in the conduction of the median nerve across the wrist. The higher frequency of moderate to severe MTLI changes, but mild to moderate abnormality of MNCV of the median nerve in the forearm, also reflects disproportionate conduction across the carpal tunnel. MTLI thus appears sensitive in detecting retrograde changes of the nerve at an early stage, so appropriate management may halt the progress of degeneration and provide an early chance to the denervated muscles for reinnervation. The greater incidence of lower MTLI in females in our series may reflect a higher occurrence of retrograde changes as compared to males. However, this, and the part played by frequent pregnancy and hormonal influences, require further study.

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Note from the Editor

We wish to announce that the next volume of the EMHJ (Vol. 5, No. 3) will focus on noncommunicable diseases.