Original Article

Normative Ulnar Nerve Conduction Study: Comparison of Two Measurement Methods

Abstract

Background: Given the high prevalence rate of ulnar neuropathy and importance of its proper management, to have a baseline information about the normative value of motor nerve conduction of first dorsal interosseous (FDI) muscle and abductor digiti minimi muscle (ADM) and their differences as well as their relation with different demographic characteristics of our population, we aimed to determine and compare the mean value of motor conduction velocity of FDI and ADM at forearm and across the elbow among the normal population. **Materials and Methods:** In this cross-sectional study, healthy participants were enrolled in the study. Ulnar nerve motor nerve conduction velocity (MNCV) was recorded from the ADM and the FDI at forearm and across the elbow. Mean MNCV of the ulnar nerve recorded from ADM and FDI was compared. In addition, MNCV of the ulnar nerve measured at the forearm and across the elbow was compared also. **Results:** During this study, 165 healthy volunteers selected and participated in the study. Mean of ulnar nerve MNCV for ADM was significantly lower than FDI, both at forearm and across the elbow ($P < 0.001$). Mean of ulnar nerve MNCV was significantly lower at forearm comparing than elbow level for both ADM and FDI ($P < 0.001$). **Conclusion:** The findings of the current study provide us a baseline data regarding the normative mean value of ulnar nerve MNCV in different locations, which could be used for providing an appropriate diagnostic protocol for ulnar nerve neuropathy. However, further studies among patients suspected with ulnar nerve neuropathy are needed.

Keywords: *Conduction velocity, elbow, electromyography, forearm, ulnar neuropathy*

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Introduction

Ulnar neuropathy is one of the most common entrapment neuropathies. It mainly presents with weakness of ulnar innervated muscles and paresthesias of the fourth and fifth digits.[1] The first dorsal interosseous (FDI) muscle and the abductor digiti minimi muscle (ADM) are the two muscles which frequently impaired. The neuropathy has a heterogeneous clinical presentation based on the different involvement of fascicles within the ulnar nerve.[2,3]

Diagnosis of the neuropathy is based on clinical and electrodiagnostic findings. Electrodiagnosis is typically performed to localize the nerve damage at the elbow and to determine the severity of nerve involvement. Evidences demonstrated that using motor nerve conduction study (NCS) is more practical for localizing nerve damage.[4]

There is a great controversy regarding the utility of motor conduction studies for ADM and FDI recordings. Some reported higher sensitivity for the conduction block of the fibers for FDI than ADM due to the more frequent block of FDI fibers than ADM and earlier atrophy of FDI than ADM.[5-7] Others found that the utility of motor conduction studies recording from FDI and ADM is similar.[8] Moreover, there are also controversies regarding the sensitivity of the value of ulnar nerve conduction velocity recorded across the elbow in comparison with its value at the forearm.[9]

However, baseline reference data with reliable details about the mentioned values and their utility are needed for the proper detection of ulnar nerve lesions. Some previous studies have evaluated the sensitivity of mentioned electrophysiological value, and different results have reported in this field.[10,11] However, it seems that using regional normative values would be more accurate in this regard.

Given the high prevalence rate of ulnar neuropathy and importance of its proper

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management, to have a baseline information about the normative value of motor nerve conduction of FDI and ADM and their differences as well as their relation with different demographic characteristics of our population, we aimed to determine and compare the mean value of motor conduction velocity of FDI and ADM at forearm and across the elbow among the normal population.

Materials and Methods

In this cross-sectional study, healthy participants aged ≥18 years, referred to Physical Medicine and Rehabilitation Clinics of Alzahra and Noor hospitals, affiliated to Isfahan University of Medical Sciences were enrolled in the study.

The protocol of the study was approved by the Regional Ethics Committee of Isfahan University of Medical Sciences (research project number: 293282).

The participants were selected by the simple random sampling method. They examined clinically, and those with a normal neurologic examination of upper arms were included in the study. Pregnant women and those with a history of diabetes, thyroid and other metabolic disorders, cervical radiculopathy, history of nerve injury in upper extremities, and hereditary or acquired neuropathies were excluded from the study.

Written informed consent was obtained from each participant.

Baseline and demographic characteristics of all participants were recorded using a questionnaire. Selected participants underwent NCSs. Those with suspected electrophysiological signs of a polyneuropathy or those with Martin-Gruber anastomosis were also excluded from the study.

Ulnar nerve motor nerve conduction velocity (MNCV) was recorded from the ADM and the FDI at forearm and across the elbow. Mean MNCV of the ulnar nerve recorded from ADM and FDI was compared. In addition, mean MNCV of the ulnar nerve measured at forearm and across the elbow was compared also.

Electrophysiologic study

NCSs in participants were performed in supine position. The position of the shoulder was in external rotation and 90° abduction, and the position of elbow was in 135° flexion. The wrist was in the neutral position.

Before and during neurophysiologic evaluation, skin temperature was measured by a thermometer for maintaining the temperature >32°C.

All NCSs were performed using Cadwell system model Sierra Wave 2 Channel machine (manufactured by Cadwell Inc, Kennewick, WA, USA). The compound muscle action potentials (CMAPs) recorded from ADM and FDI using the same surface electrode type. For ADM muscle records, the E1 and E2 electrodes were placed on the muscle's bulk between the pisiform osseous prominence and the fifth metacarpophalangeal joint (MCPJ) and on the distal portion of the fifth MCPJ, respectively. For FDI records, the E1 and E2 electrodes were placed on the muscle's bulk between the first and second metacarpal bones and distal to the first MCPJ, respectively.

The ground electrode was located between the sites of stimulation and recording.

The sites of stimulation for FDI and ADM were as follows:

1. Wrist: 8 cm proximal to E1 electrode of the two muscles
2. Below the elbow: 4 cm distal to the medial epicondyle
3. Above the elbow: 6 cm proximal to the medial epicondyle.

Nerve stimulation was applied in all cases, while the pulse duration was set on 100 ms, and the intensity of stimulation and CMAP amplitude increased slowly to achieve a supramaximal level which intensity is 25% higher than maximum CMAP amplitude. Other parameters of the device including sensitivity, sweep speed, and low and high frequency filters were fixed in all cases.

Statistical analysis

Data were processed by SPSS statistical software program version 20 (SPSS Inc., Chicago, IL, USA). To compare the result of NCSs based on sex and age of patients, respectively, independent *t*-test and one-way ANOVA were used. Results were reported as mean (standard deviation) or *n* (%). A two-tailed $P < 0.05$ was considered statistically significant, and a 95% confidence interval was used.

Results

During this study, 165 healthy volunteers selected and participated in the study. Demographic characteristics and results of NCSs of the study population are presented in Table 1.

Results of NCSs of the study population recorded from ADM and from FDI at forearm and across the elbow are presented in Table 2. According to this table, mean of studied electrophysiological variables were significantly lower in male than female population except for ulnar nerve MNCV recorded from FDI at forearm. Mean of the variables was not different significantly in different age groups.

Furthermore, mean of ulnar nerve MNCV for ADM was significantly lower than FDI, both at forearm and across the elbow ($P < 0.001$). Mean MNCV was significantly lower at forearm comparing than elbow level for both ADM and FDI ($P < 0.001$) [Figure 1].

Mean differences of ulnar nerve MNCV for ADM and ulnar nerve MNCV for FDI at forearm and across the elbow are presented in Table 3. Mean differences between ADM and FDI at forearm and elbow were −1.38 and −2.13, respectively. Mean differences recorded at forearm and elbow for ADM and FDI were −6.73 and −7.49, respectively.

Discussion

In this study, we determined the normative mean value of ulnar nerve MNCV using FDI and ADM at forearm and across the elbow. Our results indicated that the mean of ulnar nerve MNCV for ADM was significantly lower than FDI both at the forearm and across the elbow. The value was significantly lower at forearm comparing than elbow level for both ADM and FDI. There are reports regarding the differences between mean values reported from FDI and ADM as well as forearm than the elbow.[12,13]

There are not many studies in this field, and available reports were mostly among patients with ulnar neuropathy, not general healthy ones. The most challenging issues in the diagnosis of the neuropathy are the lower sensitivity of electrodiagnosis (78%) and false-negative reports for early or mild ulnar nerve involvement.[14] Hence, it is suggested that providing baseline normative value for the population could help us to prepare a more accurate diagnostic protocol. Hence, considering that there was only one similar study among the Iranian population, this study was designed as a complementary study.

Recently, Ehler *et al*. in the Czech Republic have reported the mean normative value of ulnar nerve MNCSs for FDI and ADM above and below elbow among 227 healthy volunteers according to the recommendation of the American Association of Neuromuscular and Electrodiagnostic Medicine. The results of their study showed that ulnar nerve MNCV recorded from FDI and ADM at forearm were 60.4 (5.2) and 59.7 (4.7) m/s, respectively. Reported ulnar nerve MNCV from FDI and ADM across the elbow was 57.1 (5.9) and 56.5 (5.7), respectively. Mean differences of MNCV at forearm and across the elbow recorded from ADM and FDI were 3.3 (6.6) and 3.2 (6.4), respectively.[15]

In a similar study, Azma *et al*. have compared the normal value of ulnar nerve MNCV using FDI and ADM at forearm and across the elbow among fifty healthy participants. Their results indicated that mean ulnar nerve MNCV recorded from ADM and FDI across the elbow was 62.65 (7.62) and 60.49 (7.42) m/s, respectively. MNCV recorded from ADM and FDI at forearm was 63.8 (0.36) and 62.9 (0.38), respectively. Mean differences of ulnar nerve MNCV at forearm and across the elbow recorded from FDI and ADM were 2.39 and 1.19, respectively.[16]

The results of our study indicated that the mean value range of studied variables was similar to previous studies, but mean value of ulnar nerve MNCV recorded from FDI

Table 1: Demographic characteristics of studied population

Characteristics	Total (*n*=165)
Age (year)	45.59 (10.75)
≤40	49 (29.7)
41-50	67 (40.6)
>50 year	49 (29.7)
Sex	
Male	48 (29.1)
Female	117 (70.9)

Data are shown mean (SD) or *n* (%). SD: Standard deviation

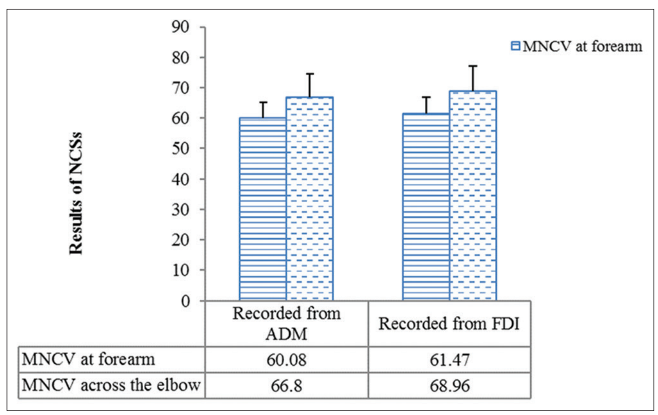

Figure 1: Bar chart of mean of results' nerve conduction studies recorded from abductor digiti minimi muscle and from first dorsal interosseous at forearm and across the elbow

Table 2: Results of nerve conduction studies of studied population recorded from abductor digiti minimi muscle and from first dorsal interosseous at forearm and across the elbow based on sex and age

Factors	Recorded from ADM		Recorded from FDI	
	MNCV at forearm	MNCV across the elbow	MNCV at forearm	MNCV across the elbow
Age (year)				
≤40	59.73 (3.86)	67.53 (6.74)	61.00 (3.71)	69.31 (7.13)
41-50	59.90 (5.78)	67.33 (8.61)	61.16 (5.55)	70.27 (8.76)
>50 year	60.69 (5.35)	65.41 (7.55)	62.35 (6.42)	66.82 (7.89)
P	0.60	0.31	0.39	0.07
Sex				
Male	57.79 (3.08)	62.42 (4.17)	60.52 (3.98)	64.77 (4.41)
Female	61.03 (5.51)	68.62 (8.21)	61.85 (5.82)	70.68 (8.68)
P	<0.001	<0.001	0.14	<0.001

ADM: Abductor digiti minimi muscle, MNCV: Motor nerve conductive velocity, FDI: First dorsal interosseous

Table 3: Mean differences of ulnar motor nerve conduction velocity for abductor digiti minimi muscle and motor nerve conduction velocity for first dorsal interosseous at forearm and across the elbow

MNCV	Factors	Mean differences (SD)	*P*
UNCV of ADM - FDI at forearm	Age (year)		
	≤40	−1.26 (2.60)	0.88
	41-50	−1.26 (5.80)	
	>50	−1.65 (4.04)	
	Sex		
	Male	−2.72 (2.97)	0.01
	Female	−0.82 (4.91)	
UNCV of ADM - FDI across elbow	Age (year)		
	≤40	−1.77 (3.72)	0.13
	41-50	−2.94 (4.98)	
	>50	−1.40 (3.96)	
	Sex		
	Male	−2.35 (3.42)	0.68
	Female	−2.05 (4.71)	
UNCV of ADM at forearm - ADM at elbow	Age (year)		
	≤40	−7.79 (5.75)	0.004
	41-50	−7.43 (5.20)	
	>50	−4.71 (3.71)	
	Sex		
	Male	−4.62 (3.54)	0.001
	Female	−7.59 (5.44)	
UNCV of FDI at forearm - FDI at elbow	Age (year)		
	≤40	−8.30 (7.51)	0.002
	41-50	−9.10 (7.86)	
	>50	−4.46 (4.69)	
	Sex		
	Male	−4.25 (3.77)	<0.001
	Female	−8.82 (7.83)	

ADM: Abductor digiti minimi muscle, MNCV: Motor nerve conduction velocity, FDI: First dorsal interosseous, UNCV: Ulnar nerve conduction velocity

was higher than ADM, and values recorded at forearm were lower than elbow. Our results were not similar to the findings of Azma *et al*. or Ehler *et al*.

Caliandro *et al*. have reported that in normal participants, FDI-CV is faster than ADM-CV. Considering that the conduction velocity of each axons is associated with the external nerve fiber diameter, they suggested that higher diameter of fastest fibers to FDI than ADM could explain the findings. Moreover, susceptibility to damage is higher in fibers to FDI than ADM.[17]

Some studies did not report any significant differences for ulnar nerve MNCV recorded from ADM and FDI across the elbow.[18-20]

The observed differences between our results and others could be explained by factors such as the method of selection of healthy participants, differences in electrophysiological techniques, number of examined hands, and positions of the hand during the electrophysiological evaluation.

It is suggested that many factors such as age, sex, occupation, anatomic location of the nerve, and conduction velocity of other nerves in that regions could influence the MNCV. In this study, mean of ulnar nerve MNCV was not different in different age groups, and they were lower in male population than women. It is recommended for obtaining more accurate results; larger sample size is needed.

The limitation of our study was the small sample size of the studied population. It seems that evaluating larger sample size provides us more accurate results. Due to the small sample size, we did not compare the mean value of studied variables in dominant and nondominant hand.

Conclusion

The findings of the current study provide us a baseline data regarding the normative mean value of ulnar nerve MNCV in different locations, which could be used for providing an appropriate diagnostic protocol for ulnar nerve neuropathy. However, further studies among patients suspected with ulnar nerve neuropathy are needed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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