Original Article

Two measurement methods of motor ulnar nerve conduction velocity at the elbow: A comparative study

K. Azma, K. Bahmanteimoury, B. Tavana, F. R. Moghaddam, N. M. Moghaddam, H. Mahmoudi*

*Department of Physical Medicine and Rehabilitation, Army University of Medical Sciences, Tehran and *Rafsanjan University of Medical Sciences, Rafsanjan, Iran*

Background: Electrodiagnostically, localization of ulnar nerve lesions, which commonly occurs at the elbow, is sometimes problematic. Measurement of motor ulnar nerve conduction velocity (NCV) at the elbow is amongst the most popular techniques to diagnose ulnar neuropathy. In this method, recording from the first dorsal interosseous muscle (FDI) is suggested to be more sensitive than the abductor digiti minimi (ADM). However, the criterion for abnormality is based on the normal values recorded from ADM. **Aims:** To determine the normal values of Ulnar motor NCV using FDI and ADM and the difference between the values obtained from FDI and ADM. Additionally, to measure the amount of reduction of NCV across the elbow for each recording site. **Materials and Methods:** This was a cross-sectional study performed on 50 healthy volunteers (100 nerves). All subjects were in the same condition regarding joint position and surface hand temperature. We recorded ulnar NCV at forearm and across the elbow with recording electrode on both FDI and ADM, simultaneously. **Results and Conclusions:** The mean NCV at the elbow recorded from ADM and FDI were 62.65 ± 7.62 m/s and 60.49 ± 7.42 m/s respectively, showing significant difference. The ulnar minimum normal NCVs recorded from ADM and FDI were 47.4 m/s and 45.6 m/s, respectively. If the normal values of ADM are used as the basis for recording from FDI, it could lead to false-positive diagnosis of cases suspicious of ulnar neuropathy. Therefore it is preferred to use the normal values of FDI itself while recording.

Key words: Abductor digiti minimi muscle, conduction velocity, first dorsal interosseous muscle, ulnar nerve damage

Introduction

After median nerve, lesions of the ulnar nerve are amongst the most common injuries of the peripheral nerves of the upper extremity.[1,2] Meanwhile, elbow is the most common region for its lesions;[3] however, they may occur in other regions such as shoulder, elbow, forearm, wrist and palm. Although this type of neuropathy is commonly observed in general population,[4] localization of its lesions in the elbow is problematic. Therefore, among suggested techniques, measurement of motor ulnar nerve conduction velocity (NCV) at the elbow is more remarkable.[1,5,6] There are, of course, some studies indicating that the measurement of the sensory NCV is more sensitive.[1,7,8] In the method of motor NCV, which is performed more commonly, some investigators believe that it would be more sensitive to record NCV from first dorsal interosseous (FDI) muscle instead of abductor digiti minimi (ADM). Nonetheless, the criterion for being abnormal in both methods is based on the normal range obtained from ADM muscle. However, one study used special NCS FDI reference values.[9]

The objective of this study is to determine the normal values of the mean ulnar motor NCV using FDI as well as ADM instead of determining the difference between the values obtained from the FDI and ADM. Additionally, to measure the amount of reduction of NCV across the elbow from recording of each muscle.

Materials and Methods

A cross-sectional study was performed on 50 healthy volunteers without any signs and symptoms of ulnar neuropathy. All the volunteers came to the clinic of Physical Medicine and Rehabilitation at '501 Military' Hospital from December 2005 to April 2006.

All the volunteers underwent comprehensive systemic examination and were reassured of being healthy. The study was explained and a consent form was obtained from all of them. The thermometer measured the temperature of their hands. The temperature was increased to reach 32°C using an infrared device whenever

Hooman Mahmoudi
Ali-Ebn Abitaleb Teaching Hospital, Rafsanjan, Iran. E-mail: hm_rehab@yahoo.com

it was less than 32°C. Then we examined the subject in supine position with his shoulder externally rotated and 90° abducted, his elbow flexed 135° and his wrist in the neutral position.

The compound muscle action potentials (CMAPs) were recorded by a 2-channel EMG machine (Medtronic, Model SW7, Version 5) simultaneously using the same disc electrode type. To record from the ADM muscle, the E_1 electrode was placed on the muscle's bulk between the pisiform osseous prominence and the 5th metacarpophalangeal joint (MCPJ). The E_2 electrode was placed on the distal portion of 2nd MCPJ. To record from FDI, the E_1 electrode was positioned on the muscle's bulk between the first and second metacarpal bones, while the E_2 electrode was placed distal to 2nd MCPJ.

The ground electrode was located between the sites of stimulation and recording. The stimulatory electrode was bipolar, superficial. Additionally, the distance between the anode and cathode was 3 cm.

The sites of stimulation included:

1. Wrist (WR): 8 cm proximal to E_1 disc's center in ADM's region
2. Below the elbow (BE): 4 cm below the medial epicondyle
3. Above the elbow (AE): 6 cm above the medial epicondyle.

Each stimulation was supramaximal, which means it was 25% more than the intensity creating maximal CMAP amplitude. In each case a pulse duration of 100 ms was used, increasing the intensity from zero to the maximal level. After recording of CAMP, the position of latency marker was set in initial reflection from baseline. The parameters of the electromyography apparatus were adjusted as follows: Sensitivity = 5 mV/div, sweep speed = 2 ms/div, low filter was 10 Hz and high filter was 10000 Hz.

The collected data were evaluated by the SPSS (Version 10) program. We used Smirnov test for determining the normal distribution of the data and paired *t*-test for evaluating the significance of the difference between the means were done. A $P<0.05$ was considered statistically significant.

Results

50 healthy volunteers entered the study. About thirty-six (72%) of them were male and 14 (28%) were female. The mean age was 36.8 ± 6.6 (range: 16-50) years old. The measurements were all done in both hands for all the volunteers.

The distribution of ulnar NCV at the elbow and the forearm, also the distribution of the difference between its NCV in these two regions recorded from ADM and FDI were all normal according to the Smirnov, skewness, and kurtosis tests.

The mean NCV of motor ulnar at the elbow recorded from ADM was 62.65 ± 7.62 m/s, whereas in the case of FDI the mean would be 60.49 ± 7.42 m/s. Confidence interval was 95% according to the paired *t*-test ($P<0.0001$, *P*- value=7.66), they show a significant difference.

The minimum normal value of the ulnar NCV across the elbow was 47.39 m/s when recorded from ADM and 45.65 m/s in case of FDI.

The mean difference between the ulnar NCV across the elbow and across the forearm was –1.19 ± 7.62 m/s when recorded from ADM. However the mean difference was -2.39 ± 7.85 m/s when recorded from FDI. Considering the paired *t*-test, they have also a significant difference ($P<0.0001$, *t*- value =3.97).

The minimal normal range difference between ulnar NCV at the elbow and the forearm from ADM and FDI were 16.4 and 18.11 m/s recorded, respectively. The data are summarized in the Tables 1 and 2.

Discussion

In a series of studies performed first by Dejerine *et al*. and afterwards by other investigators, it has been shown that the fascicles of the hand muscles especially FDI and the distal sensory fibers of digits are separated in the

Table 1: Comparison of nerve conduction velocity values between abductor digiti minimi and first dorsal interosseous recording

Nerve conduction velocity	No. recordings	Mean SD	*P-value
Abductor digiti minimi	100	62.6 to 0.76	<0.001
Elbow		60.5 to 0.74	
First dorsal interosseous			
Abductor digiti minimi	100	63.8 to 0.366	<0.001
Forearm		2.9 to 0.38	
First dorsal interosseous			
Abductor digiti minimi	100	-1.19 to 0.76	
Differences between elbow and forearm values	100	-2.39 to 0.78	<0.001
First dorsal interosseous			

*P-value <0.05 was considered significant

Table 2: Comparison of nerve conduction velocity values between left and right elbow, forearm, abductor digiti minimi, and first dorsal interosseous recording

Nerve conduction velocity	No. subjects	Mean SD	*P-value
Right abductor digiti minimi	50	63.85 to 0.51	
Elbow	50	63.83 to 0.51	0.97
Left abductor digiti minimi			
Right first dorsal interosseous	50	61.22 to 0.89	
Elbow	50	64.07 to 1.21	0.01
Left first dorsal interosseous			
Right first dorsal interosseous	50	58.91 to 0.85	
Forearm	50	62.08 to 1.17	0.01
Left first dorsal interosseous			
Right abductor digiti minimi	50	62.8 to 0.58	
Forearm	50	62.9 to 0.49	0.73
Left abductor digiti minimi			

*P value <0.05 was considered significant

proximal region and are located deeply at the elbow. Therefore, they are more possibly prone to damages.[10] Some researches have also indicated that the sensitivity of this method in evaluation of ulnar neuropathy would be increased when recording is done from FDI in comparison with ADM.[1,2,7,10] However, the results are controversial. Some authors indicated no difference between two conditions,[6,11] whereas other authors have shown that recording from ADM is more sensitive than FDI.[12]

All of the studies mentioned above have been performed on the basis of equality of the normal ulnar NCV values at the elbow, recorded from either ADM or FDI in healthy individuals.[1,2,7,10,11] Conversely, the results of this study have shown that the minimal ulnar NCV at the elbow, recorded from FDI (45.65 m/s), is less than the one recorded from ADM (47.39 m/s). Besides, it has been evidenced that the minimal normal range of the difference between motor ulnar NCV at the elbow and forearm, recorded from FDI (18.11 m/s) is more than the one recorded from ADM (16.4 m/s).

As a result both records from ADM or FDI have their own normal range of values. For this reason, using the normal values of ADM as the basis to evaluate measurements, recorded from FDI, could lead to a false positive diagnosis of subjects, suspicious of ulnar neuropathy at the elbow that would be otherwise considered as normal. The possible cause of this difference in normal value between NCS of the ADM and FDI may be due to differences in the types of nerve fibers in terms of speed of conduction. Additionally, it may be following to the mild and repeated damages to the nerve fascicles of FDI by time with daily activities, as they are more superficial. Therefore, more investigation should be performed.

Other studies are necessary both in healthy people and in patients to confirm the idea whether FDI recording should replace or simply complement ADM recording. However, in the current study, the reduction of NCV across the elbow was more prominent when recorded from FDI than recorded from ADM.

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Accepted on 22-12-2006

Source of Support: Nil, **Conflict of Interest:** None declared.