Iranian Red Crescent Medical Journal

ORIGINAL ARTICLE

Changes in ulnar nerve conduction velocity across different angles of elbow flexion

S Sattari[1]*, MR Emad[2]

[1]Department of Physical Medicine and Rehabilitation, Isfahan University of Medical Sciences, Isfahan, Iran, [2]Department of Physical Medicine and Rehabilitation, Shiraz University of Medical Sciences, Shiraz, Iran

Abstract

Background: Evaluation of the ulnar nerve at the elbow is one of the most challenging areas in electrodiagnosis. The goal of this study is to determine the changes in motor and sensory nerve conduction velocity (NCV) of the ulnar nerve at the elbow area in different angles of the elbow flexion and also to define the optimum angle at which there is an ideal correlation between the elbow across and below NCVs of the ulnar nerve.

Methods: Motor and sensory NCVs of the ulnar nerve were studied in 50 able-bodied subjects (100 limbs below and across the elbow segments to determine the effect of 5 different angles of the elbow (0º, 45º, 90º, 110º and 135º of the elbow flexion) on NCV changes of the ulnar nerve. At each angle, the elbow NCVs were compared with below and across segments.

Results: At 0º of the elbow flexion, the across elbow NCVs were slower than the below elbow segments and at 45º there was no statistical difference between below and across elbow NCVs. At each subsequent angles of the elbow flexion, there was an increment in motor and sensory NCVs for the across compared to below elbow segment ($P<0.05$). This increment rose as the degree of flexion increased. So the most erroneous increment was found at 135º of the elbow flexion.

Conclusion: Since elbow flexion at 45º was found to be the position of the least variation in motor and sensory NCVs between the across and below elbow segments, this position of the elbow flexion seems to be the ideal angle during the nerve conduction study of the ulnar nerve at the elbow area. In this position, the upper limit of normal difference between the across and below elbow motor NCVs (mean+2SD) was calculated 8 m/sec.

Keywords: Ulnar nerve; Conduction velocity; Angle; Elbow flexion

Introduction

Ulnar nerve compromise about the elbow region is second only to carpal tunnel syndrome with respect to the frequency of occurrence regarding focal neuropathies in the upper limb.[1,2] Evaluation of the ulnar nerve at the elbow is one of the most challenging areas in electrodiagnosis.[3,4] The most uncertainty begins as the patient is prepared for the test and is in the proper position of the elbow during nerve conduction studies (NCS).[2,5-11] According to the convoluted nature of the ulnar nerve at the elbow, evaluation of the nerve length in this area by surface measurement does not properly reflect the true anatomic length of the nerve.[12,13] On the other hand, the anatomic length of the ulnar nerve at the elbow will change with variation in degrees of the elbow flexion. In previous studies there were a lot of controversies about the ideal position of the elbow during NCS,[2,4,7,14-17] and even some studies have denied the effect of the elbow position on nerve conduction velocity (NCV) of the ulnar nerve at the elbow area.[5,11] This study is designed to determine the ideal position of the elbow in able-bodied subjects at which skin distance measurement more accurately reflects the true length of the nerve and also the ideal position of the elbow flexion where there is the least disproportion between the across elbow (AE) and below elbow (BE) motor and sensory NCVs of the ulnar

---

***Correspondence:** Soheil Sattari, MD, Assistant Professor of Department of Physical Medicine and Rehabilitation, Isfahan University of Medical Sciences, Isfahan, Iran. e-mail: sattari@med.mui.ac.ir
Received: July 11, 2007 Accepted: October 28, 2007

nerve. For this reason motor and sensory NCVs of the ulnar nerve at the elbow area were measured in 5 different positions of the elbow (0º,45º,90º,110º,135º of elbow flexion) and compared with forearm NCVs.

Materials and Methods

50 able-bodied persons (100 limbs) between 20-40 years (mean 31years) served as the subjects (32 men and 18 women). Exclusion criteria included a history of radicular pain, paresthesia or numbness, repetitive manual work, cigarette smoking >5 years,[18] tinnel sign and unstable ulnar nerve at retrocondylar groove. No volunteer was found to have any systemic disease known to affect NCV. Surface recording electrodes mounted on a plastic bar were applied on more prominent parts of the abductor digiti minimi muscle (for motor responses) and the fifth digit (for sensory responses). The interelectrode distance was constant and 4 centimeters from center to center. The ground electrode was located on the dorsum of the hand. Three landmarks were made on the skin for sites of stimulation as follows: A. 8cm (motor) and 14cm (sensory) from active recording electrode, B. 4cm distal and C. 6cm proximal to the line connecting the medial epicondyle to the olecranon process; approximating the pathway of the ulnar nerve at the elbow area. All subjects were tested in supine position with the shoulder abducted to 90 degrees and forearm supinated and wrist in neutral position. Then the elbow was adjusted in each 5 prescribed positions and motor and sensory NCVs were measured for AE segment. To prevent any changes in the elbow angle during each phase of the test, a modified hinged elbow splint that could be locked in each prescribed angles was applied. In each angle of the flexion, the distance between two proximal stimulation landmarks (B &C) was re-measured and corrected if necessary. Thus the AE segment was always 10cm.The onset motor and peak sensory latencies were applied to calculate NCVs. A standard clinical Toennies electrodiagnostic device model "Neuroscreen" was applied to obtain data and all the responses were obtained with supra-maximal stimulation of 0.1 m/sec pulse duration. Skin distance was measured using a measuring tape and skin temperature was checked in all sequences.

Results

Table 1: The Mean and SD for ulnar motor NCVs at the elbow area in different angles of the elbow flexion.

Angle (degree)	Mean (m/sec)	SD
0	54.0	6.0
45	57.9	6.7
90	59.8	6.5
110	60.8	6.1
135	63.4	6.0

Table 2: The Mean and SD for ulnar sensory NCVs at the elbow area in different angles of the elbow flexion.

Angle (degree)	Mean (m/sec)	SD
0	56.7	7.5
45	59.8	7.8
90	62.7	7.9
110	64.6	7.8
135	67.0	7.9

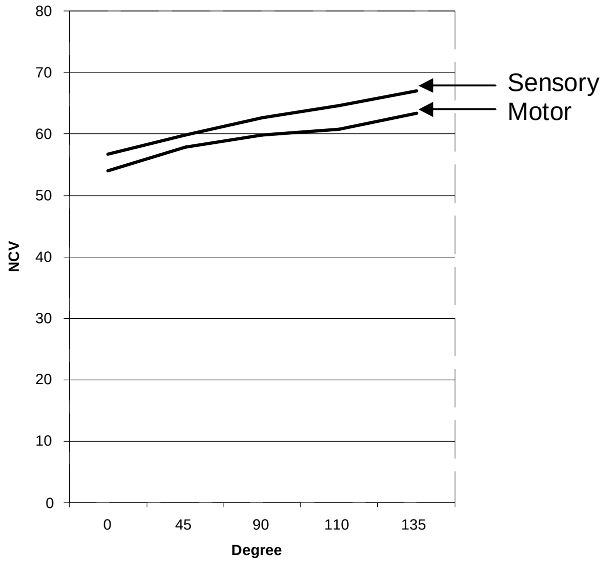

Fig 1: Mean motor &sensory NCVs of ulnar nerve at different angles of elbow flexion

The mean and standard deviation of motor and sensory NCVs in different angles are shown in Fig 1, Tables 1 and 2. The mean conduction velocities of the ulnar nerve for BE area were also calculated 58.5±6.3 m/sec for motor and 60.3±6.5 m/sec for sensory NCVs. As shown in the tables, at 0 degree of the elbow flexion (elbow Extended) the mean motor and sensory NCVs of AE segment were slower than those of BE segment. At 45º of the elbow flexion, there was no statistical difference between the NCV of AE and BE segments in both motor and sensory NCVs ($P>0.05$). At each subsequent angles of the elbow flexion, there was an increment in AE motor and sensory

NCVs compared to BE segments ($P<0.05$). This increment rose as the degree of flexion increased.

Based on diagram 1, it can be seen that motor and sensory NCVs of AE segment increased significantly with the elbow flexion and the lowest and highest NCVs were seen in 0 and 135 degrees of the elbow flexion, respectively. The changes in the sensory NCVs with the elbow flexion were similar to motor NCVs in direction but greater in amounts of variations as compared to changes in motor NCVs. The position of the elbow flexion at which there was the least variation between AE and BE segments for both sensory and motor NCVs was at 45º (Tables). At this angle, the mean motor and sensory NCVs were calculated 57.9±6.7 m/sec and 59.8±7.8 m/sec, respectively for AE segment.

Discussion

The ulnar nerve compromise about the elbow area has numerous etiologies.[8,12,13,19] Its most reliable electrodiagnostic finding is slowing of the ulnar motor NCV to less than 50 m/sec at the across elbow area while recording from abductor digiti minimi muscle.[1,12] Another diagnostic criteria is a decrease in AE NCV more than 10 m/sec compared to the forearm NCV.[20,21] The most challenging problem in this area is the proper position of the elbow during a study.[22] Harding and Halar showed that the across elbow length of the ulnar nerve changes with increase in the elbow flexion in cadavers.[7] In our study, a slowing of AE NCV compared to BE segment was observed in full extension that is similar to other findings.[7] This finding seems to be due to disproportionate measurement of the true length of the ulnar nerve at the elbow area. According to our findings, the slowing of AE NCV compared to BE segment was reversed at 45º of the elbow flexion, which is similar to Harding and Halar's findings for motor NCV. It is suggested that at 45º of the elbow flexion there is a reasonable correlation between the true length of the nerve and surface measurement at the elbow area. Based on this findings, it seems that although the AE NCV increases with elbow flexion, the increment beyond 45º seems to be erroneous and most probably due to discrepancy between skin measurement and the true length of the nerve. According to these findings, while there was no significant difference between AE and BE segments at 45º, this angle could be ideal for NCS of the ulnar nerve at the elbow area and at this angle the mean motor and sensory latencies were calculated 57.9±6.7 m/sec and 59.8±7.8 m/sec, respectively. Based on our findings, at this angle the mean ±2SD could be an acceptable normal difference between AE and BE NCVs that was calculated 0.5±3.7 m/sec for motor NCV. Using these data, the authors concluded that an AE slowing of more than 8 m/sec compared to BE segment at 45º of the elbow flexion could be suspicious for the ulnar nerve compromise at the elbow area.

Considering sensory NCVs, differences at the elbow area show a wide range of variations in each angle of the elbow flexion and, therefore, it seems not to be ideal to be compared with forearm sensory NCVs. We did not find any reason for this wide range of sensory NCV changes, but it could be due to difficulty in the accurate determination of peak latencies of small dispersed sensory responses detected from the elbow area stimulation.

References

1. Dawson DM, Hallet M, Millender LH. Entrapment Neuropathies. Sec edition. Boston, Little Brown, 1990.
2. Dumitru D, Amato A, Zwarts M. Electrodiagnostic medicine,sec. edition. Hanley and Belfus Inc. pp, 1070-86, 2002.
3. Felsenthal G, Freed MJ, Kalafut R. Across elbow ulnar nerve sensory conduction technique. *Arch Phys Med Rehabil* 1989;**70(9):**668-72.
4. Kimura J. Electrodiagnosis in diseases of nerve and muscle. 3rd edition, Oxford, pp, 724-7, 2001.
5. Britz GW, Haynor DR, Kuntz C, et al. Ulnar nerve entrapment at the elbow: Correlation of MRI, clinical electrodiagnostic and intra operative findings. *J Neurosurgery* 1996;**38:** 458-65.
6. Checkles NS, Russakov AD, Piero DL. Ulnar nerve conduction velocity-effect of elbow position on measurement. *Arch Phys Med Rehabil* 1971;**52:**362-5.
7. Harding C, Halar E. Motor and sensory ulnar nerve conduction velocities:effect of elbow position. *Arch Phys Med Rehabil* 1983; **64:**227-32.
8. Jenkins DB. Hollinshead`s functional anatomy of the limbs and back. 7th edition, WB Saunders Co. pp 115-25, 1998.
9. Kim BJ, Lee SH, Hur SY. Distance measure error induced by displacement of the ulnar nerve when the elbow is flexed. *Arch Phys Med Rehabil* 2005;**86(4):**809-12.
10. Miller RG. Cubital tunnel syndrome: diagnosis and precise localization. *Ann Neurol* 1979;**6:**56-9.
11. Roger M, Nelson MS. Effect of elbow position on motor conduction velocity of the ulnar nerve. *J. Physiotherapy* 1980;**6(3):**780-3.
12. Engber WD, Gmeiner JG. Palmar cutaneous branch of the ulnar nerve.

J Hand Surgery 1980;**5:**26-9.

13 Marine R, Mc Millian D. Ulnar neuropathy associated with subdermal contraceptive implant. *S Med J* 1998;**91:**875-8.

14 Merleveda K, Theys P, Van Hees J. Diagnosis of ulnar neuropathy:a new approach. *Muscle Nerve* 2000; **23(4):**478-81.

15 Paik NJ, Han TR, Lee IS. Effect of elbow position on motor conduction study of the ulnar nerve. *Muscle Nerve* 2001;**25:**583-6.

16 Raynor EM, Shefner JM, Preston DC, et al. Sensory and mixed nerve conduction studies in the evaluation of ulnar neuropathy at the elbow. *Muscle Nerve* 1994;**17:**785-92.

17 Yokota T, Hamada M, Nagashima H. Diagnostic sensitivity of motor nerve conduction studies in ulnar neuropathy at the elbow. *Acta Med Okayama* 1995;**49(5):**261-5.

18 Richardson JK, Jamieson SC. Cigarette smoking and ulnar mononeuropathy at the elbow. *Am J Phys Med Rehabil* 2004;**83:**730-4.

19 Richardson JK, Green DF, Jamieson SC, et al. Gender,body mass and age as risk factors for ulnar mono neuropathy at the elbow. *Muscle Nerve* 2001;**24:**551-4.

20 Mark EL, Myran I, Kristen C, et al. Changes in nerve conduction velocity across the elbow due to experimental error. *Muscle Nerve* 2002; **26:**838-40.

21 Suehun H, Teresa S, James W, et al. Risk factors for ulnar neuropathy at the elbow:A prospective study. *Arch Phys Med Rehabil* 2006; **87(11):**15-6.

22 Kincaid JC, Philips LH, Daube JR. The evaluation of suspected ulnar neuropathy at the elbow, Normal conduction velocity values. *Arch Neurol* 1986;**43(1):**44-7.