

Influence of gender on nerve conduction parameters of median and ulnar nerves in healthy individuals

Samol S¹, Hui M², Parmar D³, Dixit R⁴

¹Dr. Shaesta Samol, Resident, Department of Physiology, Government Medical College, Surat, ² Dr.Mohsin Hui, Surat General Hospital, Surat, Gujarat, ³Dr. Dharitri Parmar, Professor & Head, Department of Physiology, ⁴Dr. R. Dixit Dean, Government Medical College, Surat, Gujarat, India

Address for Correspondence: Dr. Shaesta I Samol, Department of Physiology, Government Medical College, Surat. E-mail: dr.shaesta.samol@gmail.com

Abstract

Background & objectives: Nerve conduction studies are used to diagnose disorders of the peripheral nervous system. They are influenced by number of variables i.e. age, gender, height, temperature, fiber diameter, degree of myelination, inter nodal distance etc. This study was conducted to analyze the effect of gender on nerve conduction parameters of upper limb nerves. **Materials & Methods:** The study comprised of 50 males and 50 females between the age group of 18-25 years. Distal latency, amplitude and conduction velocity of Median and Ulnar nerve were recorded using standardized technique. **Results:** The mean distal latency of sensory Median and Ulnar nerve were found to be significantly greater in males ($p < 0.05$), whereas mean sensory amplitude was found to be significantly higher in female subjects, but the conduction velocity did not show any statistically significant difference ($p > 0.05$). Mean distal latency and amplitude of motor median and ulnar nerve was found higher in males than females whereas conduction velocity was found to be higher in females but the difference was statistically insignificant. **Conclusion:** Gender has definite and significant influence on various Nerve Conduction Parameters. Without adjustment for this factor, the sensitivity and specificity of NCS will decrease when using the same reference data in patients with different gender.

Key words: Compound Muscle Action Potential; Median Nerve; Nerve Conduction Velocity; Sensory Nerve Action Potential; Ulnar Nerve

Introduction

In the past few decades, major changes have taken place in the field of peripheral nerves especially in the relation to its ultra structure, neurophysiology and axonal transport system. The widespread interest in disorders of peripheral nervous system, which has increased in recent years, primarily has its origin in the introduction of new investigating techniques. The electro-diagnostic assessment of peripheral nerves includes two major components: nerve conduction (NCS) and needle electromyography (EMG) studies [1]. Nerve conduction study is a part of electro diagnostic procedures that help in establishing the type and extent of the abnormality of the nerves. It assesses motor and

sensory functions by recording the evoked response to electrical stimulation of peripheral nerves.

Nerve conduction studies are most often used to diagnose disorders of the peripheral nervous system. They help in differentiating between the two major peripheral nerve diseases: demyelination and axonal degeneration [2]. Routine NCS includes assessment of compound muscle action potential (CMAP) and sensory nerve action potentials (SNAP) of accessible peripheral nerves in upper and lower limbs including median, ulnar, radial, common peroneal, tibial and sural nerves. Commonly measured parameters of CMAP include latency, amplitude, duration, conduction velocity and late response, e.g. F-waves. Similarly for SNAP, latency, amplitude, duration and conduction velocity are

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routinely measured [1]. Among the NCS parameters, conduction velocity and latency quantify the speed of nerve impulse propagation and are altered in diseases causing demyelination. Amplitude reflects the number of functioning nerve fibers and is reduced in diseases causing axonal degeneration [3].

The conduction velocity of the nerve depends on the fiber diameter, degree of myelination and the inter nodal distance. Other factors such as age, temperature, height, gender, and limb are the physiological variables affecting nerve conduction study [4]. The use of conduction velocity measurement as a diagnostic procedure in neurology requires a knowledge of the range of values encountered in healthy individuals. The present study was conducted to analyze the effect of gender on nerve conduction parameters of upper limb nerves. The motor as well as sensory nerve conduction parameters of Median and Ulnar nerve have been studied in both the sex.

Materials & Method

This study was conducted at Government Medical College, Surat with prior approval from institutional ethical committee. The study was performed in 50 male and 50 female healthy subjects of age group between 18 to 25 years. Written and informed consent was taken. Procedure was explained. Relevant clinical history was taken and clinical examination was done. Age, sex, height (in cm), and weight (in kg) were recorded. BMI was calculated [5].

Subjects were selected on the basis of inclusion & exclusion criteria. Those with the history of diabetes, hypertension, alcohol intake, smoking, obese (BMI $\geq 24.99\text{kg/m}^2$) or any other disease likely to affect nerve conduction parameters like Limb injury, Neuropathy, Neuromuscular transmission disorder and Myopathy were excluded.

A NEUROSTIM EMG/NCV/EP machine NS: 4-4 CHANNEL manufactured by Medicaid systems provided by Department of Physiology, GMC Surat was used. Median and Ulnar Nerves were tested for motor and sensory conduction. The electroneurographic setting was as follows:

For motor study filters were set at 2 Hz to 5 kHz and sweep speed 2-5 ms per division and for sensory study filters were set at 20 Hz to 3 kHz and sweep speed 1- 2

ms per division. Duration of stimulus for both motor and sensory study was 100 μs . Supramaximal strength of stimulus was used. For motor and Sensory nerve conduction following parameters were recorded:-

1. Latency in milli-seconds (ms)
2. Amplitude in milli-volt (mV) and micro-volt (μV) for Motor and Sensory nerves respectively.
3. Conduction velocity in meters per second (m/s).

To ensure adequate skin contact, skin was cleaned with the spirit and electrode gel was used between the electrodes and the skin.

The ground electrode was placed on the dorsum of the hand, between the stimulating and the recording electrodes. For the motor evaluation, the active electrodes were placed over the motor point of the abductor pollicis brevis for the median nerve, and over the abductor digiti minimi for the ulnar nerve. The reference electrode was placed 3 cm distal over the 1st metacarpo-phalangeal joint for the median nerve and over the 5th metacarpo-phalangeal joint for the ulnar nerve. The sites of stimulation for both were the wrist and elbow. With surface electrodes, distal stimulations were performed at the wrist (3 cm proximal to the distal wrist crease) between the flexor Carpi radialis and the Palmaris longus tendon for the median nerve, while they were performed posterior to the flexor Carpi ulnaris for the ulnar nerve. Similarly stimulation of the median nerve at the elbow was performed medial to the biceps tendon, on the volar crease of the brachial arterial pulse, whereas for the ulnar nerve, stimulation was 3-4cm distal to the medial epicondyle, with the wrist and the elbow in 135° of flexion [4]. For the sensory studies, the median and the ulnar nerves were examined antidromically. The ring electrode was placed over the 2nd and 5th digits to record the responses along the median and the ulnar nerves, respectively. The reference electrode was placed about 3 cm distal to the ring electrode. The median nerve stimulation was performed 14 cm proximal to the active electrode and medial to the flexor Carpi radialis tendon. For the ulnar sensory nerve, the stimulation was performed 10cm proximal to the active electrode and posterior to the flexor Carpi ulnaris tendon [4].

Statistical Analysis-Values are expressed as mean \pm SD. Microsoft Office Excel 2007 and Graph pad software were used for data analysis. Comparison between two groups is done by T test. The probability level for significance was set at $p < 0.05$.

Results

Median and Ulnar Nerves were tested for motor and sensory conduction in 50 male and 50 female healthy subjects of age group between 18 to 25 years in Department of Physiology.

The various anthropometric measurements of males and females are summarized in Table 1. Descriptive statistics of various parameters of motor and sensory Median and Ulnar nerves for both sexes are shown in Table 2 and 3.

The data was separately analyzed for males and females. On analyzing nerve conduction parameters of motor median and ulnar nerves in 50 male and 50 female subjects, mean distal latency and CMAP amplitude of motor median and ulnar nerve was found higher in males than females but the difference was statistically insignificant whereas conduction velocity was found to be higher in females for both the nerves but the difference was statistically insignificant ($p>0.05$).

On analyzing nerve conduction parameters of sensory median and ulnar nerves in 50 male and 50 female subjects, mean sensory latency was found significantly longer in male subjects for both median and ulnar nerves ($p<0.05$) whereas mean sensory amplitude was found to be significantly higher in female subjects for both the nerves ($p<0.05$), but the conduction velocity did not show any statistically significant difference ($p>0.05$).

Table-1: Various anthropometric measurements in males and females

| Variable MEAN±SD | Males(N=50) | Females(N=50) | p-value* |
|-------------------------|-------------|---------------|----------|
| Age(years) | 18.36±0.48 | 18.42±1.07 | $p>0.05$ |
| Height(cm) | 172.46±6 | 158.18±5.26 | $p<0.05$ |
| Weight(kg) | 62±7.46 | 50.9±6.73 | $p<0.05$ |
| BMI(kg/m ²) | 20.78±1.69 | 20.42±4.23 | $p>0.05$ |

* $p>0.05$ considered as not significant $p<0.05$ is taken as significant

Table-2: Gender wise distribution of Motor Nerve Conduction Study Parameters

| Nerve | Parameters | Males(N=50) MEAN±SD | Females(N=50) MEAN±SD | p-value* |
|---------------------------|--------------------------|------------------------|--------------------------|----------|
| Motor right Median | LATENCY(ms)** | 3.48±1.02 | 3.27±0.87 | $p>0.05$ |
| | AMPLITUDE(mv)*** | 11.79±4 | 11.67±3.17 | $p>0.05$ |
| | CONDUCTION VELOCITY(m/s) | 62.31±5.12 | 63.72±4.12 | $p>0.05$ |
| Motor left Median | LATENCY(ms)** | 3.56±1.1 | 3.37±0.94 | $p>0.05$ |
| | AMPLITUDE(mv)*** | 12.79±3.19 | 12.22±3.16 | $p>0.05$ |
| | CONDUCTION VELOCITY(m/s) | 62.01±4.18 | 63.60±4.11 | $p>0.05$ |
| Motor right Ulnar | LATENCY(ms)** | 3.53±1.03 | 3.34±0.81 | $p>0.05$ |
| | AMPLITUDE(mv)*** | 12.3±3.84 | 12.21±3.24 | $p>0.05$ |
| | CONDUCTION VELOCITY(m/s) | 62.97±3.5 | 63.85±4.15 | $p>0.05$ |
| Motor left Ulnar | LATENCY(ms)** | 3.52±0.96 | 3.38±0.98 | $p>0.05$ |
| | AMPLITUDE(mv)*** | 12.59±3.31 | 12.02±3.12 | $p>0.05$ |
| | CONDUCTION VELOCITY(m/s) | 62.26±3.22 | 63±4.34 | $p>0.05$ |

* $p>0.05$ considered as not significant $p<0.05$ taken as significant when various parameters of both the sexes were compared.

**Distal motor latency measured from onset of action potential.

***Amplitude measured from peak to peak.

Table-3: Gender wise distribution of sensory nerve conduction study parameters

| Nerve | Parameters | Males(N=50) MEAN±SD | Females(N=50) MEAN±SD | p-value* |
|-----------------------------|--------------------------|------------------------|--------------------------|----------|
| Sensory right Median | LATENCY(ms)** | 2.45±0.27 | 2.31±0.28 | p<0.01 |
| | AMPLITUDE(μv)*** | 62.18±31.56 | 74.58±31.09 | p<0.05 |
| | CONDUCTION VELOCITY(m/s) | 54.77±5.35 | 54.81±5.5 | p>0.05 |
| Sensory left Median | LATENCY(ms)** | 2.47±0.34 | 2.25±0.26 | p<0.01 |
| | AMPLITUDE(μv)*** | 57.36±26.67 | 80.75±37.97 | p<0.01 |
| | CONDUCTION VELOCITY(m/s) | 55.14±6.12 | 55.74±4.83 | p>0.05 |
| Sensory right Ulnar | LATENCY(ms)** | 2.41±0.27 | 2.3±0.25 | p<0.05 |
| | AMPLITUDE(μv)*** | 59.57±30.02 | 81.25±34.27 | p<0.001 |
| | CONDUCTION VELOCITY(m/s) | 55.19±5.21 | 54.4±4.97 | p>0.05 |
| Sensory left Ulnar | LATENCY(ms)** | 2.38±0.33 | 2.23±0.29 | p<0.05 |
| | AMPLITUDE(μv)*** | 58.08±27.02 | 84.58±45.70 | p<0.01 |
| | CONDUCTION VELOCITY(m/s) | 55.99±5.93 | 56.67±5.95 | p>0.05 |

*p>0.05 considered as not significant, p<0.05 considered as significant, p<0.01 and p<0.001 considered as very significant when various parameters of both the sexes were compared.

**latency measured from onset of action potential.

***Amplitude measured from peak to peak.

Discussion

This study aimed to investigate the effect of gender on various parameters of nerve conduction study of median and ulnar nerves in normal healthy individuals. Latencies of both the nerves i.e. median and ulnar for motor and sensory were observed to be longer in males than the females but motor distal latency difference was statistically insignificant. Results are similar to previous researches done by LaFratta & Smith, (1964) [6], Stetson DS et al, (1992) [7], Shehab DK, (1998)[8], Kimura (2005)[9]. Probably, the reason behind this finding may be the greater height and limb length of the male volunteers [10].

Huang et al, (2009) [11] found that female subjects had higher median and ulnar sensory amplitude. Robinson et al (1993) [10] in their study found that three of the four sensory amplitudes were larger in women; two of four motor amplitudes were larger in men and women had significantly faster conduction velocities than men for all nerves except median motor. Our study has some

similarity and some dissimilarity with this study, in our study sensory nerve amplitudes of both the nerves were significantly higher in the females than males and motor nerve amplitudes did not show any statistically significant difference, whereas the conduction velocity for motor and sensory median and ulnar nerve was observed to be greater in females but the difference was not statistically significant.

Hennessey et al [12] and Fujimaki et al [13] in their study found that women had greater sensory nerve action potential (SNAP) amplitude than men in the upper limb nerves which is in accordance with our study. Whereas Stetson D S et al [7] (1992) in their study in the upper limb nerves (median, ulnar) confirmed that gender did not have any statistically significant effect on SNAP amplitude.

Garg R et al [14] in their study of upper limb in malwa region had found that sensory nerve action potential

(SNAP) amplitude of Median and Ulnar nerves was significantly greater in females than males. Bolton CF et al [15] had found that the amplitude of human, antidromic, sensory nerve action potentials recorded from median and ulnar digital nerves is greater in females than males.

The negative linear correlation between sensory nerve action potential amplitude and circumference holds true for persons of the same sex. The possible cause of gender differences in median and ulnar sensory amplitude study may be related to smaller finger circumference in females [7, 12, 15,16]. The less subcutaneous tissue in fingers closer to the recording of sensory response in females can explain the higher sensory nerve action potential amplitude than males [1]. Thicker subcutaneous tissue provides greater distance between digital nerve and surface ring electrode in males and this may diminish SNAP amplitude [7,12,15,16].

Conclusion

In conclusion, our study demonstrates that gender has definite and significant influence on various nerve conduction study parameters. These effects are not identical in different motor and sensory nerves of upper limb. Males have longer motor and sensory nerve latencies while conduction velocity as well as Sensory nerve action potential (SNAP) amplitude is greater in Females. The results of the present study have many similarities and some dissimilarity with the reported NCS variables, the probable reasons could be the true differences among populations, and small sample size.

Using the same reference data in patients with different gender may result in erroneous reporting; thus both the sexes should have their own reference data for clinical purpose to differentiate between normal and abnormal cases.

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