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Original Article

Normative Data for Upper Limb Nerve Conduction Study in North India

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Abstract

Introduction: *Nerve conduction study assesses peripheral motor and sensory functions by recording the evoked response to electrical stimulation of peripheral nerves. Nerve conduction studies have become a simple and reliable test of peripheral nerve function. With adequate standardization, nerve conduction studies not only identify the lesion but also localize the site of maximal involvement of the nerve. It is important to acquire adequate normative data for an electrophysiological laboratory for working reference as variation due to demographic profile, anthropometric data and laboratory conditions are recorded in literature.*

Aim and Objective: *To obtain normative electrophysiological data of Nerve Conduction for Median and Ulnar Nerves of Upper Limb in normal healthy adult individuals of North India.*

Material and Method: *The study was conducted in the Department of Physiology, Maharishi Markandeshwar Institute of Medical sciences and Research, Mullana (Ambala). The study comprised of 200 healthy subjects between the age group of 16-55 years consisting of equal number of males and females. The equipment used was Allengers Scorpio EMG EP NCS system provided by Allengers Medical System Limited, Chandigarh. Compound Muscle Action potential (CMAP) and Sensory Nerve Action Potential (SNAP) of Median and Ulnar nerve were recorded using standardized technique.*

Result and Conclusion: *The normal values of various parameters of Nerve conduction study obtained in our study are: Median motor nerve- Latency 3.12±0.39 ms, Amplitude 13.78±2.45 mv, Velocity 56.79±3.68 m/s; Ulnar motor nerve- Latency 2.59±0.39 ms, Amplitude 10.16±1.76 mv, Velocity 56.92±3.67 m/s; Median sensory nerve- Latency 2.53±0.19 ms, 35.15±7.66 µv, Velocity 55.51±4.12 m/s; Ulnar sensory nerve- Latency 2.44±0.22 ms, Amplitude 31.37±6.72 µv, 56.49±3.86 m/s. The results of the present study were compared with the data which has been published in the literature. we found out some differences which could be attributed to a variety of causes which may include Age of the subjects; number of the subjects examined; the laboratory conditions and the equipment used.*

From our study, we concluded that it is necessary that each neurophysiological lab needs to have normative data from its own population to be used as reference values for giving reports on abnormal results.

Keywords: *Compound muscle action potential, Sensory nerve action potential, Latency, amplitude, Nerve conduction velocity.*

Introduction

The electro-diagnostic assessment of peripheral nerves includes two major components: 1. Nerve Conduction Study (NCS) and 2. Needle electromyography (EMG). Nerve conduction study assesses peripheral motor and sensory functions by recording the evoked response to electrical stimulation of peripheral nerves[1,2,3].

Nerve conduction studies have become a simple and reliable test of peripheral nerve function. With adequate standardization, nerve conduction studies not only identify the lesion but also localize the site of maximal involvement of the nerve[4]. These enable the clinicians to differentiate the two major groups of peripheral diseases: Demyelination and Axonal degeneration [5].

Nerve conduction studies have been used clinically for many years to identify the location of peripheral nerve disease in single nerves and along the length of nerves. These studies are also used to differentiate nerve disorders from diseases of muscle or neuromuscular junction(6). Routine nerve conduction study 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 and SNAP include latency, amplitude and conduction velocity.

Every clinical neurophysiology lab need to set up its own normative data for its population. This is required in clinical practice to identify the abnormal subjects. There are anatomical and physiological aspects to nerve conduction velocity. The conduction velocity of the nerve depends on the fiber diameter, degree of myelination and the internodal distance. There are several other factors which may influence nerve conduction study such as temperature, age, height, body mass index (BMI) etc.[7-9]. They have to be taken into consideration while doing nerve conduction study.

As the parameters of Nerve Conduction vary according to different geographical region, so each neurophysiological lab needs to have standard data for its population to identify abnormal subjects. We have done this study to furnish normative data for adult population of this region of North India to be used for evaluation of peripheral nerve diseases and identify the abnormal cases.

Material and Method

The study was conducted in the Department of Physiology, Maharishi Markandeshwar Institute of Medical sciences and Research, Mullana (Ambala).

The study comprised of 200 healthy subjects between the age group of 16-55 years consisting of both males and females.Subjects were made comfortable with the laboratory set up and conditions and familiarized with procedure. They were advised to relax completely during recording. Informed written consent was taken from volunteers. Anthropometric data i.e. age, height and weight was noted and BMI was calculated by using Quetelet's index i.e. Weight (in kg)/ (Height (in m)) ^{2}. The subjects were screened for any history of drug intake or medical illness i.e. Neuropathy, Limb Injury, Neuromuscular transmission disorders and myopathy likely to affect the nerve conduction study parameters based on clinical history and physical examination including detailed Neurological assessment.

Exclusion Criteria

- Age less than 16 years or greater than 55 years.
- Diabetes
- Hypertension
- Alcohol intake
- Smoking
- Obese (BMI $\geq$ 25kg/m^2 As per revised body type classification for Indian population recommended by Health ministry and Diabetes Foundation of India in 2008)[10]

- Limb injury
- Neuropathy
- Neuromuscular transmission disorders
- Myopathy

Recording procedure

The Equipment used was Allengers Scorpio EMG EP NCS system provided by Allengers Medical Systems Limited, Chandigarh. Nerve conduction study was done at the room temperature of 26ºc. At this temperature, the skin temperature of 31-34ºc is achieved and in this range normal Nerve Conduction Velocity may be obtained (11,12). Filters were set at 2 Hz to 5 kHz and sweep speed was 5 ms per division for motor study and for sensory study, filters were at 20 Hz to 3 kHz and sweep speed was 2 ms per division. Duration of stimulus for both motor and sensory study was at 100 µs. A current of supramaximal stimulus was delivered in order to get adequate responses.

Compound Muscle Action potential and Sensory Nerve Action Potential of: (i) Median nerve (ii) Ulnar nerve was recorded. Two sites of stimulation were used for motor nerve conduction study. The site of stimulation for motor median and ulnar nerves were wrist and elbow and recording site were motor point of abductor pollicis brevis and abductor digiti minimi respectively. Disc electrodes were used for motor nerve study. The distance between the two points of stimulation was measured.

For Sensory nerve conduction study, antidromic study using ring electrodes was done. Electrodes were placed on index and little finger for median and ulnar nerve respectively and point of stimulation was wrist. The various sites of stimulation and recording are summarized in [table 1] [13].

For each stimulation site, the following parameters were recorded for both motor and sensory nerves.

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)

The conduction velocity in m/s for motor nerve between the two sites of stimulation is calculated by

$$\text{Conduction velocity} = \frac{\text{Distance in mm}}{(\text{Latency}_{\text{proximal}} - \text{Latency}_{\text{distal}}) \text{ in ms}}$$

Sensory nerve conduction velocity unlike motor conduction velocity may be measured by stimulating at a single stimulating site, because the residual latency, which comprises of neuromuscular transmission time and muscle propagation time is not applicable in sensory nerve conduction. Thus, the sensory conduction velocity is calculated by dividing the distance between stimulating and recording sites by the latency.

$$\text{Conduction velocity} = \frac{\text{Distance in mm}}{\text{Latency in ms}}$$

Observations and Results

The study comprised of 200 healthy subjects between the age group of 16-55yrs consisting of both males and females.

The mean age, weight, height and BMI of all the subjects is summarized in [Table 2].

The normative data of various parameters of Nerve Conduction Study i.e. Latency, Amplitude and Nerve conduction velocity of right side of both the Motor and Sensory Median and Ulnar nerves is shown in [Table 3].

Table 1 various sites of stimulation and recording for upper limb nerve conduction study.

NERVE		STIMULATION SITE	RECORDING SITE
MEDIAN	MOTOR	1.PROXIMAL: - ANTICUBITAL FOSSA (Medial to the biceps tendon) 2.DISTAL: - WRIST (Between the flexor carpi radialis and the Palmaris longus tendon)	THENAR MUSCLE (Abductor Pollicis Brevis)
	SENSORY	WRIST (Medial to the flexor carpi radialis tendon)	INDEX FINGER
ULNAR	MOTOR	1.PROXIMAL:- ELBOW (Distal to the medial epicondyle) 2.DISTAL:- WRIST (Posterior to the flexor carpi ulnaris tendon)	HYPOTHENAR MUSCLE (Abductor Digiti Minimi)
	SENSORY	WRIST (Posterior to the flexor carpi ulnaris tendon)	LITTLE FINGER

Table 2: Mean age, weight, height and BMI in all subjects.

	AGE GROUP (yrs)	N	AGE(yrs) MEAN±SD	WEIGHT(kg) MEAN±SD	HEIGHT(cm) MEAN±SD	BMI(kg/m^2) MEAN±SD
ALL SUBJECTS	16-55	200	34.33±11.5	61.96±8.67	167.11±8.4	22.09±1.92

Table 3: Normative data of various parameters of Nerve Conduction Study of both Motor and sensory Median and Ulnar nerves.

PARAMETERS	MEDIAN MOTOR (MEAN±SD)	ULNAR MOTOR (MEAN±SD)	MEDIAN SENSORY (MEAN±SD)	ULNAR SENSORY (MEAN±SD)
LATENCY	3.12±0.39 ms	2.59±0.39 ms	2.53±0.19 ms	2.44±0.22 ms
AMPLITUDE	13.78±2.45 mv	10.16±1.76 mv	35.15±7.66 µv	31.37±6.72 µv
VELOCITY	56.79±3.68 m/s	56.92±3.67 m/s	55.51±4.12 m/s	56.49±3.86 m/s

Table 4 Median motor nerve parameters of present study and those reported by other workers.

Studies	Latency (ms) (Mean±SD)	Amplitude (mv) (Mean±SD)	Conduction Velocity (m/s) (Mean±SD)
Our study	3.12±0.39	13.78±2.45	56.79±3.68
Pawar et al	3.25±0.5	14.00±4.08	56.33±4.57
Robinson et al	3.6±0.4	9.5±2.9	54.4±3.8
Kimura J	3.49±0.34	7.0±3.0	57.7±4.9
Shahabuddin et al	3.18±0.61	11.79±0.59	53.59±0.6

Table 5: Ulnar motor nerve parameters of present study and those reported by other workers.

Studies	Latency (ms) (Mean±SD)	Amplitude (mv) (Mean±SD)	Conduction Velocity (m/s) (Mean±SD)
Present study	2.59±0.39	10.16±1.76	56.92±3.67
Pawar et al	2.31±0.38	13.05±2.76	58.13±4.70
Robinson et al	2.9±0.4	8.4±2.1	56.3±6.2
Kimura J	2.59±0.39	5.7±2.0	58.7±5.1
Shahabuddin et al	2.45±0.34	11.26±1.07	55.72±3.24

Table 6: Median sensory nerve parameters of present study and those reported by others

Studies	Latency (ms) (Mean±SD)	Amplitude (mv) (Mean±SD)	Conduction Velocity (m/s) (Mean±SD)
Present study	2.53±0.19	35.15±7.66	55.51±4.12
Pawar et al	--	37.32±13.69	58.35±7.1
Robinson et al	--	38.7±13.6	54.6±3.7
Kimura J	2.84±0.34	38.5±15.6	56.2±5.8
Shahabuddin et al	3.03±0.54	35.23±5.84	56.56±3.42

Table 7: Ulnar sensory nerve parameters of present study and those reported by others

Studies	Latency (ms) (Mean±SD)	Amplitude (mv) (Mean±SD)	Conduction Velocity (m/S) (Mean±SD)
Present study	2.44±0.22	31.37±6.72	56.49±3.86
Pawar et al	--	28.46±13.89	58.22±6.76
Robinson et al	--	34.4±14.65	57.7±5.6
Kimura J	2.54±0.29	35.0±14.7	54.8±5.3
Shahabuddin et al	2.9±0.34	26.71±0.59	56.49±0.59

Discussion

Our study evaluates the nerve conduction parameters of most commonly tested nerves in the right upper limb of healthy population in North India to assess normal values for reference in our neurophysiology laboratory.

Our study comprised of 200 healthy subjects in the age group of 16-55 years. Comparison of the values of our study parameters was made with those of other workers. The comparison of median and ulnar motor nerve parameters is shown in [Tables 4 and 5].

The findings of our study are in agreement with other workers in term of motor parameters of median and ulnar nerves. The findings of Robinson et al and Kimura J in respect of amplitude are somewhat lesser than those of our study and other workers [14-17].

The comparison of median and ulnar sensory nerve parameters is shown in [Tables 6 and 7].

Our study results are in agreement with the results of other workers in respect of median and ulnar sensory nerves.

The difference between the results of the present study and the data which has been published in the literature could be attributed to a variety of causes which may include: -

Age of the subjects; number of the subjects examined; the laboratory conditions and the equipment used; the population composition, body built and climatic dwelling conditions and ethnicity and demographic factors[18]. Some studies were done on Caucasian subjects and others were done on Asians.

Conclusion

From our study, we conclude that it is necessary that each neurophysiological lab needs to have normative data from its own population to be used as reference values for giving reports on abnormal results.

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