ORIGINAL RESEARCH PAPER

Volume-8 | Issue-8 | August - 2019 | PRINT ISSN No. 2277 - 8179

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

TIBIAL, DEEP PERONEAL, MEDIAN AND ULNAR NERVE CONDUCTION STUDIES: NORMATIVE DATA FOR YOUNG ADULTS IN POPULATION OF BIHAR

Physiology

Dr Yogesh Kumar Associate Professor, Department of Physiology, AIIMS, Patna

Dr Pramita Dubey* Senior Resident, Department of Physiology, AIIMS, Patna *Corresponding Author

Dr Kamlesh Jha Associate Professor, Department of Physiology, AIIMS, Patna

Dr Tribhuwan Kumar Additional Professor, Department of Physiology, AIIMS, Patna

Dr Ramji Singh Professor, Department of Physiology, AIIMS, Patna

ABSTRACT

For any lab it is imperative to have normative data for various parameters for appropriate interpretation of electrodiagnostic tests results. Normative data must be based on standardized technique with consideration of age, height, weight, and instrument used in adequate numbers of healthy subjects. This study provides comprehensive normative electrodiagnostic data for the tibial, deep peroneal, median and ulnar nerves. 61 volunteers aged 18 to 65 yrs. (mean age 37.36±13.22) were included in the study. There were 32 males (mean age 38.05±12.55) and 29 females (mean age 36.85±13.92). Distal motor latency (DML) on right side was 3.08 ± 0.61 for median and 2.61 ± 0.45 for ulnar nerve. It is 3.73 ± 0.74 for deep peroneal and 3.44 ± 0.74. Sidedness and handedness did not affect the nerve conduction parameters of this study.

KEYWORDS

nerve conduction velocity, normative data, median , ulnar, tibial , deep peroneal

INTRODUCTION

Nerve conduction studies and electromyography is the core of electro diagnostic studies for assessing patients with neuromuscular disorders. Neuro-diagnostic testing bypasses the brain by delivering an electrical charge to the patient. The equipment then is used to determine several aspects of the body's response to that signal to find whether it is functioning properly. Location and extent of the injury, acuity, prognosis, and (in few cases) specific diagnosis can be found using electro-diagnostic testing[1].

There is a need for setting normative data for these electro-diagnostic studies by every lab for its population required in clinical practice to identify abnormal subjects[3]. Many factors affect nerve conduction studies and EMG like temperature, age, height, BMI. These factors are affected by the geographical location[3, 4]. Many studies have been published with regards to the normative data for the nerves of the upper and lower limbs. However, no study has been performed in this region of Bihar, India so far. We were therefore interested to obtain a set of data in healthy adults, in order to establish the reference values for our NCV and EMG laboratory and to compare our values with other published data in the literature.

In 1960, **Johnson and Olsen'** reported nerve conduction velocity (NCV) data for the motor fibres of the median and ulnar nerves. The suspicion of disease and the influence of aging on conduction parameters over the range of ages examined limited the clinical usefulness of this study as normative data[5].The rate of conduction along proximal motor nerve fibres of radial nerve was measured by **Gassel and Diamantopoulous** (1964) and their findings in normal subjects were confirmed by **Tonnis** (1965)[6]. Reference data for a wide range of sensory and motor nerve conduction studies (NCSs) that are commonly used in routine electro-diagnostic practice was studied by **Michael and Jonnae**[7]. Data for a range of clinically applicable reference percentiles was presented but judgement regarding most appropriate for diagnostic purpose required empiric evaluation in a disease population.A study by **Falco et al**[8] in 1994 was performed to provide reliable reference data by comprehensively examining conduction characteristics in routinely tested peripheral nervesof the lower limb in a healthy elderly population.A study by **Edward et al**[6] in 2013 performed NCS of ulnar nerve in a large cohort and provided reference data.

EMG:

Galvani may be considered the originator of EMG[9] Credit for launching modern EMGgoes to **Adrian and Bronk9**.*The study by* ***Matheson et al****(1988)*[10] *provides data for normative comparisons of male and female and helps to plan and interpret future EMG studies*. The analysis by **Feistner H** (1991)[11] showed, that a muscle can be regarded pathological if more than two of a total of seven recorded motor units show pathological parameters.The importance of combining different techniques to improve diagnostic yield and specificity is stressed by **Liguori R**(2010)[12]. A study[14]by **Hassen A et al** (1991) helps establish the normative electrophysiological parameters of the commonly tested muscles in the upper and lower limbs for our EMG laboratory in Iraq. The results compared favourably with existing literature data.

Aim of the study is to provide normal physiological data for NCV and EMG for median, ulnar, deep peroneal and posterior tibial nerve in carefully screened normal healthy adult subjects.

Objectives of the study are to provide NCV normative data for population of Bihar, to compare NCV normative data of males and females and to compare NCV normative data of right and left side.

METHODOLOGY

This Study was performed in department of physiology, All India Institute of Medical Sciences, Patna after obtaining ethical clearance from ethical committee. Normal healthy adult subjects (including patient attendants, employee of AIIMS Patna) both males and females aged 18 to 65 years, visiting AIIMS Patna OPD and giving written consent were enrolled in this study. Detailed history and directed physical examination was performed. The median and ulnar nerves in the forearm and the deep peroneal and posterior tibial nerves in the leg and their corresponding muscles were chosen for study. Study was performed using Neurosoft MEP8 instrument for NCV.

Study design

It is a cross-sectional observational study.

Sample size

Exclusion and inclusion criteria

Subjects included in the study were employees of AIIMS Patna and patients' attendants visiting OPD of AIIMS Patna in age group of 18 to 65 years.

Exclusion Criteria:-

Any cause of peripheral neuropathy like Physical injury (trauma),

Metabolic and endocrine disorders, Small vessel disease, Autoimmune diseases, Kidney disorders, Cancers, Neuromas, Infections, Medication toxicity, Environmental or industrial toxins, Heavy alcohol consumption were excluded from the study. Also, Guillain-Barre syndrome, carpal tunnel syndrome, Charcot-Marie-Tooth (CMT) disease, herniated disk disease, sciatic nerve problems were excluded from the study. Any cause of neuromuscular disorder (Amyotrophic lateral sclerosis, Multiple sclerosis, Myasthenia gravis, Spinal muscular atrophy etc) or myopathy was also excluded.

Protocol for study:-

This study was performed with 8 channel Neurosoft MEP8 instrument in the Department of Physiology, with the subject lying comfortably in the supine position. The room temperature was kept within 25-28°C. The filters were set at 2-5 kHz for the motor studies and at 20-2kHz for the sensory studies. A stimulus duration of 50 ms to 1000 ms and a current of 0–100 mA were given for an effective nerve stimulation. The supramaximal stimuli was delivered in order to get adequate responses.

Cup recording electrodes were used for the motor studies and ring recording electrodes for the sensory studies. The data was collected for the following parameters:

1. For the motor nerve:

a) the onset/Distal Latency (DL),
b) the conduction velocity (MNCV) and
c) the amplitude of the Compound Muscle Action Potential (CMAPA)

2. For the sensory nerve:

a) the distal latency,
b) the Sensory Nerve Conduction Velocity (SNCV)
c) and the Sensory Nerve Action Potential (SNAPA), measured from the peak of the negative potential to the peak of the positive potential.

A standardized technique was used to obtain and to record the action potentials for the motor and sensory studies.

The motor and sensory studies was performed on the median and ulnar nerves in the forearm and the deep peroneal and tibial nerves in the leg. For the motor studies, 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 were placed 4 cm distal over the 1st metacarpophalangeal joint for the median nerve and over the 5th metacarpophalangeal joint for the ulnar nerve.

The sites of stimulation for both were wrist and elbow. With surface bar electrodes, distal stimulations was performed at the wrist (3cm proximal to the distal wrist crease) between the flexor carpi radialis and the Palmaris longus tendon for the median nerve, while posterior to the flexor carpi ulnaris for the ulnar nerve. The proximal stimulation for the median nerve was done medial to the biceps tendon, on the volar crease of the brachial arterial pulse, whereas for the ulnar nerve, the proximal stimulation was 3-4cm distal to the medial epicondyle, with the wrist and the elbow in 90° of flexion.

For the sensory studies, the median and the ulnar nerves were examined antidromically. The active ring electrode were placed over the 2nd and 5th digits to record the responses along the median and the ulnar nerves, respectively. The reference electrode were placed about 4 cm distal to the active 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.

For MNCV of deep peroneal nerve Surface recording electrodes were placed on the dorsum of the foot, over the belly of the extensor digitorum brevis. Two stimulus were given over the peroneal nerve. The first stimulation point is located one fingerbreadth over the anterior surface of the ankle, 7 cm from the recording electrode. The second electrode was placed behind the knee. A ground electrode was set on medium of leg. A mild electrical impulse was applied that was progressively increased until the maximum amplitude was obtained.

Motor conduction study of the tibial nerve was done by recording the muscle response from abductor hallucis muscle after stimulation at the popliteal fossa and at the ankle posterior to the medial malleolus.

Sensory conduction velocity of deep peroneal nerve was done by placing the active electrode in the middle of line connecting the most prominent parts of the malleoli. The reference electrode was placed two-three finger breadths proximal. The reusable ground electrode were set in the middle part of the leg. Stimulation was performed 8-10 cm below the active electrode on the dorsal part of the foot in just adjacent to projection of its dorsal artery.

Sensory conduction studies of the tibial nerve was done from the first toe with ring electrodes and antidromic stimulation at the ankle posterior to medial malleolus.

Steps to Perform Test

Subject was given rest for 5 minutes. The sensory and motor NCV for median nerve were measured followed by rest for 5 minutes. Then the sensory and motor NCV for ulnar nerve were done, with rest for 5 minutes thereafter. Similarly, the sensory and motor NCV for deep peroneal nerve was performed followed by rest for 5 minutes and then sensory and motor NCV for posterior tibial nerve.

Statistical analysis

The data obtained from the subjects was evaluated by using the Statistical Package for Social Sciences (SPSS) for the data processing. The values were expressed in form of the mean and the standard deviation.

Data for males and females were compared using student unpaired t-test. A p value of <0.05 was used as a cut-off level for the statistical significance

RESULT

61 volunteers aged 18 to 65 yrs (mean age 37.36±13.22) were included in the study. There were 32 males (mean age 38.05±12.55) and 29 females (mean age 36.85±13.92). Out of 61, 19 underwent median nerve conduction study , 11 underwent ulnar nerve conduction study, 18 underwent deep peroneal nerve conduction study and 12 underwent tibial nerve conduction study. Parameters of latency, amplitude and velocity of motor and sensory median, ulnar, deep peroneal and tibial nerves were compared using t test on right and left sided.

Descriptive statistics for motor and sensory median and ulnar nerves are shown in table 1 and 2.

Table 1

Nerve	Parameters	Right	Left	T test (p value) mean ± SD	Hennesey et al (n=44) mean ± SD	Robinson et al (n=44) mean ± SD
Motor median (n=19)	DML wrist	3.08±0.61	3± 0.74	0.61	3.2±0.4	3.6±0.4
	DML elbow	7.05±1.00	6.93 ± 1.14	0.77		
	Amp wrist	6.21±2.07	6.48 ± 2.30	0.75	12.1±3.8	9.5±2.9
	Amp elbow	5.89±1.70	6.6 ± 2.29	0.40		
	NCV	56.29±4.00	55.99 ± 4.68	0.86	59.5±4.40	54.4±3.8
Sensory median	Latency	2.34±0.38	2.13 ± 0.43	0.28	2.5±0.2	3.7±0.3
	Amp	5.68±2.09	8.75 ± 6.29	0.29	31.4±8.2	35.6±11.8
	NCV	62.11±5.99	60.14 ± 5.81	0.57	61.2±4.3	54.6±3.7

Table 2

Nerve	Parameters	Right	Left	T test (p value)	Hennesey et al (n=44) mean ± SD	Robinson et al (n=44) mean ± SD
Motor ulnar (n=11)	DML wrist	2.61 ± 0.45	2.68 ± 0.53	0.79	2.6±0.3	2.9±0.4
	DML elbow	6.7 ± 1.09	6.4 ± 1.10	0.59		
	Amp wrist	8.1 ± 1.65	7.84 ± 2.39	0.83	12.6±2.3	8.4±2.1
	Amp elbow	7.15 ± 2.16	7.75 ± 0.49	0.72		
	NCV	55.9 ± 6.75	58 ± 4.53	0.55	63±4.8	56.3±6.2
Sensory ulnar	Latency	2.3 ± 0.86	2.14 ± 0.63	0.75	2.4±0.2	3.6±0.3
	Amp	11.9 ± 3.82	8.25 ± 5.44	0.38	52.4±14.3	32.3±13.1
	NCV	62.33 ± 6.33	60.1 ± 16.55	0.81	64.0±6.9	57.7±5.6
Sensory deep peroneal	Latency	2.64±2.42	2.45±1.15			
	Amp	4.72±2.93	4.94±2.72			
	NCV	45.92±8.14	45.2±12.05	0.91		

Significance of P value is <0.05. Data presented as mean ± SD. DML: Distal motor latency; Amp: Amplitude Descriptive statistics for motor and sensory tibial and deep peroneal nerves are shown in table 3 and 4.

Table 3

Nerve	Parameters	Right	Left	T test (p value)	Abhishek K et al (n=80) mean ± SD
Motor tibial (n=12)	DML medial malleolus	3.44±0.74	3.42 ± 0.57	0.93	6.36±1.53
	DMLpoplite al fossa	11.56 ± 2.038	11.18 ± 1.65	0.65	
	Amp medial malleolus	7.04±3.29	6.66 ± 3.72	0.84	8.47±6.54
	Amp popliteal fossa	5.84 ± 2.99	5.15 ± 3.26	0.73	
	NCV	48.72± 8.46	46.09 ± 10.68	0.56	62.9±27.7

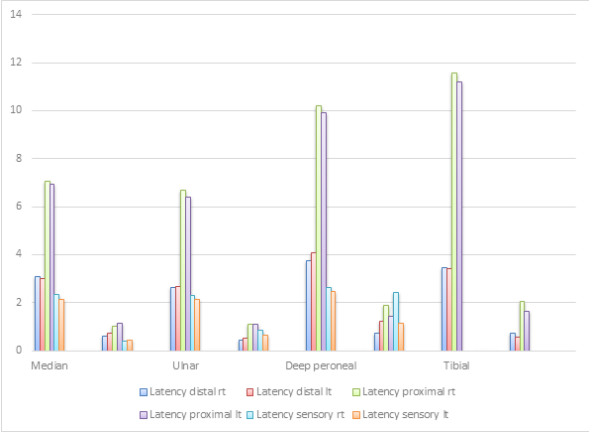
Table 4

Nerve	Parameters	Right	Left	P value (t test)	Muhammad Amir Mustaffa et al (n=101) mean ± SD
Motor deep peroneal (n=18)	DML sole of foot	3.73±0.74	4.08±1.23	0.35	3.95 ± 0.08
	DML head of fibula	10.21±1.88	9.92±1.41	0.63	
	Amp sole of foot	3.46±2.11	3.19±2.73	0.77	4.74 ± 0.17
	Amp head of fibula	3.45±2.05	3.69±3.43	0.87	
	NCV	51.69±3.45	52.7±5.25	0.60	47.88 ± 0.46

Significance of P value is <0.05. Data presented as mean ± SD. DML: Distal motor latency; Amp: Amplitude

Mean and standard deviation for latency, amplitude and NCV for different nerves are depicted in figure 1 , 2 , 3 ; Their values are mentioned in table 5,6,7.

Figure 1: mean and standard deviation for latency; latency distal right , latency distal left, latency proximal right, latency proximal left stand for motor nerve



rt : right; Lt : left;

Table 5

	Latency distal motor right (ms)	Latency distal motor left (ms)	Latency proximal motor right (ms)	Latency proximal motor left (ms)	Latency sensory right (ms)	Latency sensory left (ms)
Median	3.08 ±0.61	3 ± 0.74	7.05 ± 1.00	6.93 ± 1.14	2.34 ± 0.38	2.13 ± 0.43
Ulnar	2.61± 0.45	2.68 ± 0.53	6.7 ± 1.09	6.4 ± 1.10	2.3 ± 0.86	2.14 ± 0.63
Deep peroneal	3.73 ± 0.74	4.08 ± 1.23	10.21 ± 1.88	9.92 ± 1.41	2.64 ± 2.42	2.45 ± 1.15
Tibial	3.44 ± 0.74	3.42 ± 0.57	11.56 ± 2.04	11.18 ± 1.65		

Table 6

	Amplitude distal motor right	Amplitude distal motor left	Amplitude proximal motor right	Amplitude proximal motor left	Amplitude sensory right	Amplitude sensory left
Median	6.21 ± 2.07	6.48 ± 2.30	5.89 ± 1.70	6.6 ± 2.29	5.68 ± 2.09	8.75 ± 6.29
Ulnar	8.1 ± 1.65	7.84 ± 2.39	7.15 ± 2.16	7.75 ± 0.49	11.9 ± 3.82	8.25 ± 5.44
Deep peroneal	3.46 ± 2.11	3.12 ± 2.73	3.45 ± 2.05	3.69 ± 3.43	4.72 ± 2.93	4.94 ± 2.72
Tibial	7.04 ± 3.29	6.66 ± 3.72	5.84 ± 2.99	5.15 ± 3.26		

Figure 2: mean and standard deviation for amplitude; Amplitude distal rt, amplitude distal left, amplitude proximal right , amplitude proximal left stand for motor nerve

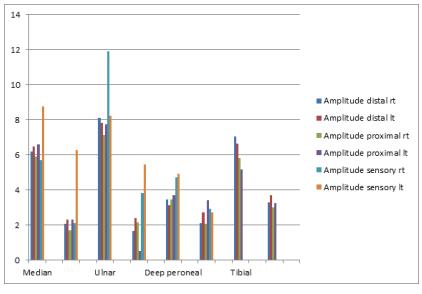


Figure 3: mean and standard deviation for NCV ;NCV rt and NCV lt stand for motor NCV

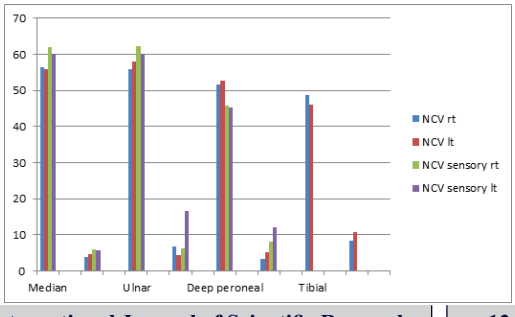


Table 7

	NCV motor right	NCV motor left	NCV sensory right	NCV sensory left
Median	56.29 ± 4.00	55.99 ± 4.68	62.11 ± 5.99	60.14 ± 5.81
Ulnar	55.9 ± 6.75	58 ± 4.53	62.33 ± 6.33	60.1 ± 16.55
Deep peroneal	51.69 ± 3.50	52.7 ± 5.25	45.92 ± 8.14	45.2 ± 12.05
Tibial	48.72 ± 8.46	46.09 ± 10.68		

DISCUSSION

This study evaluates nerve conduction parameters for median, ulnar, deep peroneal and tibial nerve (both motor and sensory) in normal healthy population of Bihar. These values differ from population to population which necessitates the evaluation of these values. Similar studies were conducted by **Hennesey et al, Robinson et al, Abhishek et al and Muhammad Amir Mustaffa et al.** Their data and this study data were compared and similar values were found. The finding are in agreement with the findings of these other studies in literature except for sensory nerve amplitude parameters which could be due to rejection of values on higher side as they may involve motor artifact. Also, the amplitude recorded in this study was from peak to baseline, however, other studies measured it from negative peak to positive peak. The parameters were compared for both right and left side and no statistically significant difference was found in between right and left side. Other studies also found no statistically significant difference in between right and left side but for F min latency, motor conduction velocity and compound muscle action potential amplitude.

Certain studies included narrow age group of young adults also [19]. They showed decreased latency. Age of the participants included in the present study may have contributed to the increased latency in the results. There is evidence to suggest that nerve conduction slows down with advancing age.[16,17,18] The present study included a broad age group, which might have led to the increase in latency values with consequent reduction of the velocity values in their participants, thereby creating discrepancies between their results and our own.

Another major reason for the observed differences is that since most of the available studies are western, hence the consequent methodology and geographical differences as well as the variations in the lifestyle, dietary, and morphological characteristics of study participants might also have influenced the study results.

In conclusion, nerve conduction parameters of commonly tested parameters could be used be used for peripheral nerve injuries. Overall sensory and motor nerve conduction parameters were comparable with existing literature data. Parameters of right and left were similar.

REFERENCES

1. Karl E M & Thomas C; Essentials of ClinicalNeurophysiology.
2. Trojaborg W, Sindrup D H; Motor and sensory conduction in different segments of the radial nerve in normal subjects; J Neurol. NeurosurgPsychiat; 1969;32: 354-359.
3. Douglas W M, Timothy P T, Dorothy E; EMG scanning: Normative data; Journal of Psychopathology and Behavioral Assessment; March 1988; 10(1):20.
4. Johnson EW, Olsen KJ. Clinical value of motor nerve conduction velocity determination. JAMA ; 1960;172:2030-5.
5. Edvard E, Petr R, Pavel U, Radim M, Marie N and Bohumír P et al; Ulnar nerve at the elbow – normative nerve conduction study; Journal of Brachial Plexus and Peripheral Nerve Injury; December 2013; 8:2
6. Michael B, Joanne WLimin P; Reference data for commonly used sensory and motor nerve conduction studies; Muscle and Nerve; Nov 2009; 40(5):772-794.
7. Falco, Frank J E MD; Hennessey, William J. MD; Goldberg, Gary MD; Braddom, Randall L. MD; Standardized nerve conduction studies in the lower limb of the healthy elderly; American Journal of Physical Medicine & Rehabilitation: June 1994
8. John V B; Electromyography comes of ages; Science;May 1972; 176(4035): 603-609
9. Matheson, D.W., Toben, T.P. & de la Cruz, D.E. EMG scanning: Normative data; J PsychopatholBehav Assess (1988) 10: 9. March 1988, 10(1):9–20.
10. Feistner H1, Münte TF, Strempel J, Heinze HJ; Experience with computer-assisted EMG analysis: reference values for four muscles; NeurophysiolClin. 1997 Jun;27(3):200-3.
11. Liguori R, Fuglsang-Frederiksen A, Nix W, Fawcett PR, Andersen K; Electromyography in myopathy; Technol Health Care. 2010;18(6):443-58.
12. Hasan A,Zainulabdeen A, Farah A,Atheer S; Normative Data of Needle Electromyography, What Is Different in Iraqi Patients?1991 Jun;22(2):70-6.
13. Dia k S; Normative Data of Nerve Conduction Studies in the Upper Limb in Kuwait: Are They Different from the Western Data? Med Principles Pract 1998;7:203–208
14. Abhishek K , Anjali P; Nerve conduction velocity in median nerve and tibial nerve of healthy adult population with respect to gender ; National journal of physiology, pharmacology, and pharmacy.
15. Muhammad A M , Shagufta K , Muhammad A A , Abdul H S , Muhammad I S, Syed N F et al; Study of Nerve Conduction Parameters of Common Peroneal Nerve from Tibialis Anterior Muscle in Neuropathic Patients; Saudi Journal of Medicine ISSN 2518-3397 (Online) Dubai, UAE
16. 25. Falco FJ, Hennessey WJ, Braddom RL, Goldberg G. Standardized nerve conduction studies in the upper limb of the healthy elderly. Am J Phys Med Rehabil. 1992;71:263–71
17. 27. Owolabi LF, Adebisi SS, Danborno BS, Buraimoh AA. Median nerve conduction in healthy Nigerians: Normative data. Ann Med Health Sci Res. 2016;6:85–9.
18. 28. Huang CR, Chang WN, Chang HW, Tsai NW, Lu CH. Effects of age, gender, height, and weight on late responses and nerve conduction study parameters. Acta Neurol Taiwan. 2009;18:242–9.
19. Manjinder S, Sharat G, Kamal D S, and Avnish K; Normative Data for Median Nerve Conduction in Healthy Young Adults from Punjab, India; J Neurosci Rural Pract. 2017 Aug; 8(Suppl 1): S83–S88.