NORMATIVE DATA ON MEDIAN AND ULNAR NERVE CONDUCTION STUDIES FOR YOUNG ADULT MALES AT NEPAL MEDICAL COLLEGE, KATHMANDU

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ABSTRACT

Nerve conduction study (NCS) is very useful in evaluating peripheral nerve abnormality. The primary purpose of this study was to provide normative electrophysiological data for commonly tested upper limb nerves in healthy young adult males. NCSs were perfomed in median and ulnar nerves, right and left sides, of 54 consenting healthy volunteers who were associated with Nepal Medical College (NMC) and aged between 18-36 years (median age= 20 years). The overall conduction velocities (m/s) for median sensory, median motor, ulnar sensory, and ulnar motor nerves were 59.86±9.19, 61.26±6.77, 55.6±11.79, and 58.09±8.75 respectively. Similarly, sensory nerve action potential (SNAP) amplitudes (μV) were 24.92±9.64 and 20.35±10.1, SNAP latencies (ms) were 2.5±0.37 and 2.4±0.75, compound motor action potential (CMAP) amplitudes (mV) were 19.27±4.28 and 13.46±2.6, and CMAP distal latencies (ms) were 3.26±0.45 and 2.64±0.76 for median and ulnar nerves respectively. When comparing right and left sides, significant difference was observed only for CMAP amplitude of ulnar nerve (right = 14.79±2.52 vs left = 12.49±2.78, p=0.000). Generally, no significant correlations were noted for nerve conduction velocities with age, height, weight, and body mass index. The values generated in this study could be useful as reference normative data for evaluating nerve conduction disorders in patients attending the NMC Teaching Hospital.

KEYWORDS

Median nerve, nerve conduction study, normative data, ulnar nerve.

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INTRODUCTION

Nerve pathology can occur anywhere along the course of the peripheral nerve – from the anterior horn cell, nerve root, peripheral nerve, or neuromuscular junction to the muscle. Nerve conduction studies (NCSs) are very useful in diagnosing and following up different disorders of the peripheral nerves and muscles.[1,2] NCSs evaluate the function of a particular nerve (motor, sensory, or mixed) by electrically stimulating the nerve and recording the response either in the muscle or nerve. They are valuable adjunct to the clinical examination, localizing abnormalities along peripheral nerves or lower motor neurons.

NCSs are influenced by number of physiological and technical variables such as standardized measurements, temperature, height, the gender and age of normal healthy individuals and parameters like the nerve diameter and myelination.[1,3] Stetson *et al* showed that the age, height, and the index finger circummference were found to be important predictors of the median, ulnar, and sural nerve conduction measures in randomly selected adults without an occupational exposure to high forces or repetitive hand exertions.[4]

It is desirable for each NCS laboratory to develop its own normative values for reference in its research studies and clinical services.[5] However, there is a paucity of such reports for the Nepalese population, and Kathmandu in particular. This study aimed to provide normative electrophysiological data for commonly tested upper limb nerves in a population of young adult males.

MATERIALS AND METHODS

The study was conducted in apparantly healthy adult males in the Electroneurophysiology Lab of the Department of Physiology, Nepal Medical College, Kathmandu, Nepal in the period of July-October, 2018. A standardized interview and physical/neurological examination were conducted to screen the participants for any history of drugs/alcohol intake or medical illness likely to affect the NCS parameters.

Of the total 60 individuals who volunteered for the study, only age up to 40 years were considered (young adults), thus excluding six individuals aged above 40 years. Those taking any medication at the time of study were also excluded. Informed written consent was obtained from the subjects; the study was approved by the Research and Ethical Subcommittee of the Nepal Medical College.

Recording Procedure

The study was performed with the NeuroStim® NCV/EMG machine (Model NS-2, MedicAid, India), with the manufacturer-recommended setting of the equipment. The records were done in the afternoon hours; room temperature was maintained at the thermoneutral zone (i.e., 26±2°C). The subject was seated in upright position, hand resting comfortably on a front table.The ground electrode was placed on the anterior aspect of the left forearm. The nerves studied were median and ulnar - right and left sides. Supramaximal stimuli were used. Standard recommmended techniques were followed in performing the motor and sensory NCSs.[6-8]

Motor NCS: The recording electrodes were placed using 'belly-tendon montage'. The active electrode was placed over the motor point of the abductor pollicis brevis (for the median nerve) or over the abductor digiti minimi (for the ulnar nerve). The reference electrode was placed 4 cm distally over the 1st and 5th metacarpophalangeal joints for median and ulnar nerves respectively. The sites of stimulation were wrist and elbow for both nerves. For median nerve, the distal stimulation was at the wrist, 3 cm proximal to the distal wrist crease, between the flexor carpi radialis and palmaris longus tendons; the proximal stimulation was medial to the biceps tendon, on the volar crease of the brachial artery pulse. For ulnar nerve, the distal stimulation was at the wrist, 3 cm proximal to the distal wrist crease, posterior to the flexor carpi ulnaris tendon; the proximal stimulation was 3-4 cm proximal to the medial epicondyle, with the elbow at suitably flexed position.

Sensory NCS: The nerves were examined antidromically, with proximal stimulation at the wrist, 14 cm from the active electrode. The nerve was stimulated medial to the flexor carpi radialis tendon for the median and posterior to the flexor carpi ulnaris tendon for ulnar nerve. The active ring electrode was placed in the 2nd (for median) or 5th (for ulnar) digit; the reference electrode was placed about 4 cm distal to the active electrode.

Data collected were first entered in the Microsoft Excel Worksheet and then statistically analysed using SPSS 16.0 version. Values on right and left sides were compared by paired t test; correlation with different characteristics were determined by Pearson's correlation coefficient (r). Level of significance was set at P value < 0.05.

RESULTS

Table 1: General characteristics of the participants (n=54)

	Mean±SD	Median	Lowest-highest range
Age (years completed)	22.09±4.34	20.0	18-36
Height (centimeters, cms)	169.39±5.76	169.75	157-185
Weight (kilograms, Kg)	65.86±10.23	63.7	44-94.7
Body mass index (BMI, Kg/m^2)	22.9±2.91	22.55	17.92-34.78

Table 2: NCS parameters and comparisons between right and left sides (Paired t test)

Nerve	Parameters	Median (mean±SD)				Ulnar (mean±SD)			
		Right	Left	t	p	Right	Left	t	p
Sensory	Latency (ms)	2.48 ±0.35	2.51 ±0.39	-0.581	0.564	2.4 ±0.63	2.4 ±0.86	0.041	0.968
	Amplitude (μV)	24.81 ±9.88	25.04 ±9.48	-0.137	0.892	19.26 ±9.87	21.45 ±10.3	-1.191	0.239
	Conduction velocity m/s)	60.1 ±8.52	59.61 ±9.89	0.311	0.757	55.87 ±11.7	55.34 ±11.99	0.268	0.790
Motor	Latency (ms)	3.24 ±0.44	3.28 ±0.46	-0.636	0.527	2.69 ±0.68	2.64 ±0.83	0.721	0.474
	Amplitude (mV)	19.62 ±4.39	18.91 ±4.17	1.134	0.262	14.79 ±2.52	12.49 ±2.78	4.853	*0.000
	Duration (ms)	11.46 ±1.33	11.52 ±1.67	-0.299	0.766	12.71 ±1.96	12.39 ±2.38	0.902	0.371
	Conduction velocity (m/s)	62.41 ±8.18	60.11 ±4.8	1.901	0.063	59.76 ±8.76	56.92 ±8.12	1.774	0.082
	F wave min latency (ms)	25.12 ±2.64	24.53 ±2.57	1.23	0.224	24.73 ±2.11	24.47 ±2.66	0.558	0.580

Table 3: Comparison of median nerve parameters with previous studies

Nerve	Parameter	Misra and Kalita[6] (n=30)	Kimura[3]	Hennessey[9] (n=44)	Garg[10] (n=50, Males)	Hamdan[11] (n=1110, age 21-30 y)	This study (n=54)
Sensory	Latency (ms)	3.06±0.41	2.84±0.34	2.5±0.2	2.05±0.35	1.87±0.18	2.5±0.37
	Amplitude (μV)	8.91±4.48	38.5±15.6	31.4±8.7	59.32±16.39	61.1±29.57	24.92±9.64
	Conduction velocity (m/s)	45.45±9.40	56.2±5.8	61.2±4.3	53.43±3.56	52.98±3.83	59.86±9.19
Motor	Distal latency (ms)	3.77±0.40	3.49±0.34	3.2±0.4	3.45±0.21	3.34±0.45	3.26±0.45
	Distal amplitude (mV)	8.10±2.62	7.0±3.0	12.1±3.8	10.8±2.81	15.83±5.57	19.27±4.28
	Conduction velocity (m/s)	58.52±3.76	57.7±4.9	59.5±4.4	55.62±2.52	59.72±4.39	61.26±6.77

Fifty four individuals (all males), aged 18-36 years, participated in the study (Table 1). By the body mass index (BMI) categories, most of the participants were of normal weight (81.5%, n=44) while 13% (n=7) were overweight, 3.7% (n=2) were underrweight, and 1.9% (n=1) was obese.

The NCS parameters of sensory and motor components of median and ulnar nerves were recorded. Comparing the right and left sides (Table 2), the conduction velocity in motor component of both the nerves were found to be lower on the left side as compared to the right, although the difference was of borderline significance. The left ulnar compound motor action potential (CMAP)

Table 4: Comparison of ulnar nerve parameters with previous studies

Nerve	Parameter	Misra and Kalita (n=30)	Kimura[3]	Hennessey[9] (n=44)	Garg[10] (n=50, Males)	Hamdan[11] (n=1213, age=21-30 y)	This study (n=54)
Sensory	Latency (ms)	2.83±0.40	2.54±0.29	2.4±0.2	1.85±0.25	1.9±0.2	2.4±0.75
	Amplitude (μV)	5.54±2.37	35.0±14.7	27.0±13.9	55.51±18.43	55.57±24.99	20.35±10.1
	Conduction velocity (m/s)	54.17±6.10	54.8±5.3	64.0±6.9	55.7±4.13	55.25±3.66	55.6±11.79
Motor	Distal latency (ms)	2.59±0.40	2.59±0.39	2.6±0.3	2.34±0.25	2.3±0.39	2.64±0.76
	Distal amplitude (mV)	8.51±2.03	5.7±2.0	12.6±2.3	9.85±2.56	15.95±5.37	13.46±2.69
	Conduction velocity (m/s)	61.45±5.73	58.7±5.1	63.0±4.8	63.41±3.08	64.27±5.73	58.09±8.75

Table 5: Correlating anthropometric parameters with nerve conduction velocities (Pearson's correlation)

Nerve	Component	Age		Height		Weight		BMI	
		Correlation	P	Correlation	P	Correlation	P	Correlation	P
Right median	Sensory	0.046	0.739	0.046	0.739	-0.122	0.379	-0.031	0.822
	Motor	0.062	0.657	0.062	0.657	0.016	0.908	0.055	0.691
Right ulnar	Sensory	-0.281	*0.039	-0.071	0.608	0.031	0.821	0.08	0.565
	Motor	0.052	0.707	0.052	0.707	-0.082	0.554	-0.126	0.365
Left median	Sensory	-0.073	0.602	-0.073	0.602	-0.029	0.838	-0.027	0.847
	Motor	-0.205	0.138	-0.205	0.138	0.064	0.645	-0.014	0.921
Left ulnar	Sensory	-0.072	0.605	-0.072	0.605	-0.048	0.731	0.072	0.603
	Motor	-0.097	0.487	-0.097	0.487	-0.047	0.733	-0.079	0.569

amplitude was significantly lower than the amplitude on right side. Regarding all other CMAP parameters and all sensory nerve action potential (SNAP) parameters, the two sides were comparable for both the nerves.

The mean values of NCS parameters (right and left sides combined) were compared with the values of previous studies (Table 3 and 4). There is most wide variation in the SNAP and CMAP amplitudes among different studies and the values of this study are within that variation.

This study sought the correlation of various anthropometric variables with the conduction velocities and found that there is mostly no significant correlation (Table 5). Statistically significant correlation (Pearson's correlation) was found only for age with conduction velocity of the sensory component of right ulnar, conduction being slower in older age.

DISCUSSION

This study examined the nerve conduction parameters of commonly tested nerves in the upper limb of a healthy young-adult population in order to provide normative and reference values in our Lab (Department of Physiology, Nepal Medical College, Kathmandu, Nepal). A comparison was made between the results of this study and existing studies published in the literature (Tables 3 and 4). The values of NCS parameters in this study are within normal recommended limits.[7] Also, there are generally similar values on the right and left sides.

There are variations in the values of different parameters in different studies and the values of this study are in mixed agreement.[12-17] The latency times for the median nerve are identical and conduction velocities are very close to that reported by Hennessey

et al.[9] Misra and Kalita have reported longer latency and slower conduction velocity.[6] Hamdan observed shorter latency and slow conduction velocity for the median sensory while values are closer to this study for median motor.[11] In the ulnar nerve, latency times are similar to those of Hennessey *et al*[9] but not conduction velocities which are less in this study and more close to values reported by Kimura.[3] Most varied measurement is the amplitude, for sensory as well as motor components of both nerves. Owing to these wide variations, it has been recommended for each NCS laboratory to develop its own normative values, while also recommending lower limits (such as conduction velocity) or upper limits (latency times).

One study had presented the NCS parameters for right and left sides and showed no significant differences.[15] In this study also, there were no significant differences between the sides.

Studies report that nerve conduction velocity has negative correlation with age, height, and BMI.[4,18] In this study, significant correlation was found with age (negative correlation), which is a recognized relationship. This observation was yet observed only in a single nerve – right ulnar sensory. Most of the participants of this study were medical students of early years of the program. This relative lack of age variation in sample size could make it a confounding factor, so that a generalization of the observation is debatable. We did not observe significantly strong correlation of NCV to weight or BMI, which is also similar observation as reported by Werner *et al*.[19]

Besides anthropometric influences, gender is a known factor to affect NCS parameters. Males have higher amplitude and longer latencies as compared to females.[14,20] As this study was done in the male population only, continuation of this study in females is warranted in order to have normative data for female population as well and to explore gender variation.

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REFERENCES

1. Huynh W, Kiernan MC. Nerve conduction studies. *Aust Fam Physician* 2011; 40: 693–7.
2. Mallik A, Weir AI. Nerve conduction studies: essentials and pitfalls in practice. *J Neurol Neurosurg Psychiatry* 2005; 76 (suppl_2): ii23-ii31. Available from: http://jnnp.bmj.com/cgi/doi/10.1136/jnnp.2005.069138 (accessed on: 2017 Oct 16).
3. Kimura J. Principle and Pitfalls of Nerve Conduction Studies. Ann Neurol 1984; 16: 415–29. Available from:http://citeseerx.ist.psu.edu/viewdoc/ownload?doi=10.1.1.551.8921&rep=rep1&type=pdf (accessed on: 2017 Oct 16).
4. Stetson DS, Albers JW, Barbara A, Wolfe RA. Effects of age, sex, and anthropometric factors on nerve conduction measures. *Muscle Nerve* 1992; 15: 1095–104. Available from: https://deepblue.lib.umich.edu/bitstream/handle/2027.42/50152/880151007_ftp.pdf?sequence=1 (accessed on: 2018 Mar 1).
5. Lee DH, Claussen GC, Oh S. Clinical Nerve Conduction and Needle Electromyography Studies. *J Am Acad Orthop Surg* 2004; 12: 276–87. Available from: http://content.wkhealth.com/linkback/l?sid=WKPTLP:landingpage&an=00124635-200407000-00008 (accessed on: 2017 Apr 2).
6. Misra UK, Kalita J. Clinical Neuropysiology. 2nd ed. New Delhi: Elsevier 2012; 21-46.
7. Buschbacher RM, Prahlow ND. Manual of nerve conduction studies.2nd ed. Demos Medical Publishing, LLC, New York; 2006.
8. Caress JB, Esper GJ, Rutkove SB. Neurophysiology of nerve conduction studies. In: Blum AS, Rutkove SK, editors. The Clinical Neurophysiology Primer. Humana Press Inc, Totowa, NJ 2007; 207–16.
9. Hennessey WJ, Falco FJE, Braddom RL. Median and ulnar nerve conduction studies: Normative data for young adults. *Arch Phys Med Rehabil* 1994; 75: 259–64.
10. Garg R, Bansal N, Kaur H, Arora KS. Nerve conduction studies in the upper limb in the Malwa region-normative data. *J Clin Diagnostic Res* 2013; 7: 201–4.
11. Hamdan FB. Nerve Conduction Studies in Healthy Iraqis : Normative Data. *Iraqi J Med Sci* 2009; 7: 75–92.
12. Ahammed Naseem VH, Govindan R, Zubaida PA, Jose J. Normative data of upper limb motor nerve conduction in Northern Kerala population and effect of height on motor nerve conduction velocity. *Natl J Physiol Pharm Pharmacol* 2016; 6: 340–4.
13. Bania D, Barua P, Barua G. Normative Data of Upper Limb Nerve Conduction in Young Population in and Around Barpeta Town, Assam. *J Evid Based Med Health* 2015; 2: 8777–80. Available from: http://www.jebmh.com/data_pdf/05 - Dipti Bania--FINAL.pdf (accessed on: 2018 Mar 22).
14. Gakhar M, Verma S, Lehri A. A Comparison of Nerve Conduction Properties in Male and Female of 20 to 30 Years of Age Group. *J Exerc Sci Physiother* 2014; 10: 16–20.
15. Pawar SM, Taksande AB, Singh R. Normative data of upper limb nerve conduction in central India. *Indian J Physiol Pharmacol* 2011; 55: 241–5.
16. Shahabuddin S, Badar D, Moizuddin K, Sami LB, Solepure AB. Normative Values for Nerve

Conduction Study among healthy subjects from Aurangabad , India. *Int J Recent Trends Sci Technol* 2013; 8: 56–61.

17. 17. Shehab DK. Normative data of nerve conduction studies in the upper limb in Kuwait: Are they different from the Western data? *Med Princ Pract* 1998; 7: 203–8.

18. 18. Jagga M, Lehri A, Verma SK. Effect of aging and anthropometric measurements on nerve conduction properties – A Review. *J Exerc Sci Physiother* 2011; 7: 1–10. Available from: medind.nic.in/jau/t11/i1/jaut11i1p1.pdf (accessed on: 2018 Mar 17)

19. 19. Werner RA, Jacobson JA, Jamadar DA. Influence of body mass index on median nerve function, carpal canal pressure, and cross-sectional area of the median nerve. *Muscle Nerve* 2004; 30: 481–5.

20. 20. Thakur D, Paudel BH, Bajaj BK, Jha CB. Nerve Conduction Study in Healthy Individuals : a Gender Based Study. *Health Renaiss* 2010; 8: 169–75.