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Original Research Article

Motor nerve conduction study parameters in healthy individuals: effect of limb dominance

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ABSTRACT

Background: Nerve conduction study (NCS) is useful for evaluation of nerve, muscle, and/or neuromuscular function. Neurophysiologist interprets NCS with consideration of various anthropometric and technical parameters viz. age, gender, height, temperature etc. apart from the underlying pathology. Fewer studies have reported the effect of limb dominance on NCS. Moreover, the findings are controversial. Therefore, author aimed to investigate the effect of limb dominance on motor nerve conduction study parameters.
Methods: This cross-sectional comparative study included sixty healthy individuals (44 right and 16 left handed) of either sex with age 18 to 30 years. The NCS parameters of median and ulnar nerves were assessed by stimulating it and recording from the muscle and skin overlying the nerve respectively using Digital Nihon Kohden machine. The obtained data were analyzed using independent sample t-test.
Results: Right ulnar nerve onset latency was significantly longer in left-handed individuals (1.85±0.508 ms vs 1.62±0.195 ms, p=0.012). The left ulnar nerve F wave minimum latency (25.88±0.74 ms vs 24.46±2.64 ms, p=0.002) was significantly longer in left-handed individuals. Likewise, right ulnar nerve distal latency (2.45±0.76 ms vs 2.14±0.39 ms, p=0.044), and right ulnar nerve F wave minimum (25.9±1.21 ms vs 24.85 ms±1.74, p=0.030) were significantly high in left-handed individuals.
Conclusions: NCS parameters in terms of latencies were longer in left-handed individuals. Therefore, limb dominance seems to be an important factor one should pay attention during bilateral comparison of obtained data in neurophysiological reporting of referred cases.

Keywords: Limb dominance, Motor nerves, Nerve conduction study

INTRODUCTION

Almost all people have a right and left upper limb, one of which is usually preferred to the other for making different kinds of complex movements. If right upper limb is preferred over the left upper limb to perform such complex movements then the individual is right-handed and vice versa. Dominance of specific cerebral hemisphere is known for handedness although peripheral factors may also be involved. Genetic theory is well known in explaining the onset of lateralization.[1] Nerve Conduction Studies (NCS) is a routine electrophysiological evoked potential study for

evaluation of neuromuscular function. It supports and confirms the diagnosis and prognostication of peripheral neuropathies of varied etiologies. NCS includes assessment of motor and sensory nerves function by recording and analyzing the compound muscle action potential (CMAP) and sensory nerve action potentials (SNAP) respectively. Median, ulnar, radial, common peroneal, tibial and sural are the most commonly examined peripheral nerves. Motor NCS require stimulation of a peripheral nerve while recording from a muscle innervated by the nerve whereas sensory NCS are performed by stimulating a mixed nerve or cutaneous nerve and recording from the skin overlying the nerve.[2] The effect of limb dominance (handedness) on such evoked potential study may be significant, however, documented evidences are less.

Thus, this study aimed to investigate the effect of limb dominance (handedness) on nerve conduction study parameters at BPKIHS, Dharan, Nepal. Moreover, the relationship of the study with respect to handedness was interesting to explore and the study may secondarily provide preliminary normative data on nerve conduction study parameters that shall be useful for clinical purpose through electrophysiological evaluation.

METHODS

Subjects selection

This cross-sectional comparative study included sixty healthy individuals which was right-handed (n=44) and left-handed (n=16) based on inclusion and exclusion criteria. Convenient sampling was the method adopted for subject selection. Informed written consent of subjects was mandatory for inclusion in the study done at Neurophysiology Laboratory of Department of Basic and Clinical Physiology, BPKIHS, Dharan, Nepal.

Inclusion criteria

- Healthy right-handed and left-handed individuals,
- Both male and female of age group 18-30 years.

Exclusion criteria

- Individuals with clinically diagnosed systemic diseases like hypertension, diabetes, any neuropathic diseases, cardiovascular diseases, smokers and alcoholics,
- Subjects on medication likely to affect the NCS,
- Mixed-handed individuals.

The sampling technique were convenient sampling method.

Pre-recording procedure

The healthy right and left-handed individual's selected were the students and staffs residing at BPKIHS, Dharan, Nepal. The consented subjects were explained in detail regarding the study/procedure. The pre-recording procedure included detailed medical history and clinical examination to ensure their healthy status.

Recorded parameters

The recorded parameters of the subjects were anthropometric (height, weight, body mass index), cardio respiratory, nerve conduction study (NCS) parameters. The recorded NCS parameters were of bilateral upper limbs.

Motor nerve conduction study (MNCS) variables

- Compound muscle action potential (CMAP),
- Latency,
- Onset latency,
- Amplitude,
- Conduction velocity,
- F-waves latency.

Recording procedure

After recording the anthropometric and cardio respiratory variables, the subjects were asked to sit comfortably on the bed for recording the different NCS parameters. These parameters were recorded using Nihon Kohden machine (NM420S_H636, Japan). A pillow was placed on the lap with the upper limbs placed over it so that limbs were in relaxed position. Then motor NCS was done followed by sensory NCS.

Detailed recording procedures

Motor nerve conduction studies recording

For motor NCS, the stimulator with water soaked felt tips were used for surface stimulation. The stimulating electrodes were placed on the skin overlying the nerve at two or more sites along the course of nerve. The recording and reference electrodes were placed on specific site for different nerves using belly tendon montage (Table 1).[4]

Table 1: Stimulation and recording sites of motor nerves.

Motor nerve	Site of stimulation		Recording site
	Proximal	Distal	
Median	Antecubital fossa	Wrist	Abductor pollicis brevis
Ulnar	Below elbow	Medial wrist	Abductor digiti minimi

After cleaning the site with skin purifier, recording electrodes were placed close to estimated end plate site with the active electrodes over the mid belly of the muscle, as close to the estimated end plate site as

possible. The ground electrode was placed between stimulating and recording electrodes before applying electrical stimulus. The gain was set at 2-5 mV per division. Stimulation duration was in the range of 50-300 microseconds and the amount of current never exceeded more than 50 mA because i.e. upper limit available in the machine.

The current of stimulator was initially set to zero, then gradually increased with successive stimuli. A CMAP appeared that grew larger with the increasing stimulus voltage. When current was increased to the point that CMAP was no longer increasing in size the current was increased by another 20% to ensure supra-maximal stimulation. For each stimulation site, latency and amplitude were recorded.

Once a good recording was made, the trace was stored for later analysis and the stimulating electrode moved proximally to a second stimulation site. Distance between the two sites of stimulation was measured and fed into the machine for calculation of nerve conduction velocity.[3]

For recording F response of each motor nerve, the stimulator was placed at the distal site of stimulation with cathode facing proximally. Minimum, maximum and mean F-wave latencies were recorded. The obtained data was noted and printed for further analysis.

RESULTS

Sixty healthy individuals were included in the study. Among them, right-handed (n=44) and left-handed (n=16) were recruited for the study.

Anthropometric parameters

In the course of the study, author compared various anthropometric parameters between right and left-handed individuals. However, author found out that there were no significant differences in any anthropometric parameters between right-handed individuals and left-handed individuals in terms of their age, height, weight, body mass index (BMI), upper limb length and lower limb length (Table 2).

Table 2: Comparison of anthropometric parameters between right-handed and left-handed individuals.

Anthropometric parameters	Right-handed (Mean±SD)	Left-handed (Mean±SD)	P value
Age (years)	23.91±5.01	22.56±4.58	NS
Height (cm)	165.34±8.61	167.00±4.88	NS
Weight (kg)	61.66±9.28	64.91±6.67	NS
Body mass index (kg/m^2)	22.53±2.69	23.22±1.43	NS
Upper limb length (cm)	74.36±3.16	75.50±2.25	NS
Lower limb length (cm)	95.20±5.48	94.62±2.68	NS

Table 3: Comparison of motor NCS parameters of left median nerve between right-handed and left-handed individuals.

Motor NCS parameters	Right-handed (Mean±SD)	Left-handed (Mean±SD)	p-value
LMNPRONLAT (ms)	6.92±0.843	7.04±0.759	NS
LMNDSONLAT (ms)	2.81±0.275	2.91±0.34	NS
LMNPRAMP (mV)	10.65±2.74	10.39±3.87	NS
LMNDSAMP (mV)	11.31±2.46	11.12±3.53	NS
LMNCV (m/s)	55.87±14.73	54.56±8.75	NS
LMNFWMAX (ms)	29.65±8.21	31.12±7.25	NS
LMNFWMIN (ms)	24.55±3.56	24.43±1.706	NS
LMNFMEAN (ms)	26.19±4.27	26.57±2.61	NS

*p <0.05: considered statistically significant, NS: No significant differences.
LMNPRONLAT: Left median nerve proximal onset latency, LMNDSONLAT: Left median nerve distal onset latency, LMNPRAMP: Left median nerve proximal amplitude, LMNDSAMP: Left median nerve distal amplitude, LMNCV: Left median nerve conduction velocity, LMNFWMAX: Left median nerve maximum F-waves, LMNFWMIN: Left median nerve minimum F-waves, LMNFMEAN: Left median nerve mean F-waves.

Nerve conduction study (NCS) parameters

The data collected for various motor nerve conduction study parameters were normally distributed. Independent sample-'t' test was applied for comparing NCS parameters between right-handed and left-handed individuals. Nerve conduction study parameters were recorded for different nerves of the upper limbs. One of

the nerves involved in the study was the median nerve and when author compared the motor nerve conduction study parameters of the left median nerve between the right and left-handed individuals, author found that there were no statistically significant differences between the motor NCS parameters of left median nerve of right and left-handed individuals (Table 3). Likewise, author also recorded the various motor nerve conduction study parameters for the right median nerve of both right and left-handed individuals. The results author obtained were different than that for the left median nerve. In case of the right median nerve, author found that right median nerve F wave maximum and right median nerve F wave mean were significantly high in left-handed individuals as compared to right-handed individuals (Table 4).

Table 4: Comparison of motor NCS parameters of right median nerve between right-handed and left-handed individuals.

Motor NCS parameters	Right-handed (Mean±SD)	Left-handed (Mean±SD)	p-value
RMNPRONLAT (ms)	7.02±0.67	7.01±0.76	NS
RMNDSONLAT (ms)	2.88±0.54	2.69±0.33	NS
RMNPRAMP (mV)	9.8±2.41	9.53±4.05	NS
RMNDSAMP (mV)	11.44±2.78	10.2±3.74	NS
RMNCV (m/s)	54.3±9.03	51.97±7.90	NS
RMNFWMAX (ms)	28.46±5.21	32.88±8.74	0.020
RMNFWMIN (ms)	24.35±1.75	25.08±2.55	NS
RMNFMEAN (ms)	25.88±2.46	27.47±2.86	0.039

*p<0.05: considered statistically significant, NS: No significant differences.
RMNPRONLAT: Right median nerve proximal onset latency, RMNDSONLAT: Right median nerve distal onset latency, RMNPRAMP: Right median nerve proximal amplitude, RMNDSAMP: Right median nerve distal amplitude, RMNCV: Right median nerve conduction velocity, RMNFWMAX: Right median nerve F-waves maximum, RMNFWMIN: Right median nerve minimum F-waves, RMNFWMEAN: Right median nerve mean.

The other nerve included in the study was the ulnar nerve. Author recorded various motor nerve conduction study parameters for the left ulnar nerve in both right and left-handed individuals. When author compared the motor NCS parameters of the left ulnar nerve between the right and left-handed individuals author found statistically significant difference. Left ulnar nerve F-waves maximum, left ulnar nerve F-waves minimum and left ulnar nerve F-waves mean were also significantly high in left-handed individuals (Table 5).

Table 5: Comparison of motor NCS parameters of left ulnar nerve between right-handed and left-handed individuals.

Motor NCS parameters	Right-handed (Mean±SD)	Left-handed (Mean±SD)	p-value
LUNPRONLAT (ms)	6.07±0.82	6.58±1.48	NS
LUNDSONLAT (ms)	2.29±0.74	2.68±0.86	NS
LUNPRAMP (mV)	8.1±1.55	8.12±1.27	NS
LUNDSAMP (mV)	8.16±1.80	7.84±1.77	NS
LUNCV (m/s)	62.99±23.48	60.23±17.44	NS
LUNFWMAX (ms)	29.33±9.35	40.74±16.78	0.019
LUNFWMIN (ms)	24.46±2.64	25.88±0.74	0.002
LUNMEAN (ms)	26.49±4.07	30.01±4.27	0.005

*p<0.05: considered statistically significant, NS: No significant differences.
LUNPRONLAT: Left ulnar nerve proximal onset latency, LUNDSONLAT: Left ulnar nerve distal onset latency, LUNPRAMP: Left ulnar nerve proximal amplitude, LUNDSAMP: Left ulnar nerve distal amplitude, LUNCV: Left ulnar nerve conduction velocity, LUNFWMAX :Left ulnar nerve F-waves maximum, LUNFWMIN: Left ulnar nerve F-waves minimum, LUNMEAN: Left ulnar nerve F-waves mean.

Author continued this study by comparing the motor NCS parameters of the right ulnar nerve between the right and left-handed individuals. Statistically significant differences were found when author compared the motor

NCS parameters of the right ulnar nerve between the right and left-handed individuals. Right ulnar nerve distal latency, right ulnar nerve F-waves minimum and right ulnar nerve F-waves mean were significantly high in left-handed individuals (Table 6).

Table 6: Comparison of motor NCS parameters of right ulnar nerve between right-handed and left-handed individuals.

Motor NCS parameters	Right-handed (Mean±SD)	Left-handed (Mean±SD)	p-value
RUNPRONLAT (ms)	5.94±0.69	6.4±1.05	NS
RUNDSONLAT (ms)	2.14±0.39	2.45±0.76	0.044
RUNPRAMP (mV)	9.13±2.02	8.02±2.18	NS
RUNDSAMP (mV)	9.56±2.38	8.85±1.89	NS
RUNCV (m/s)	106.55±323.04	57.61±11.7	NS
RUNFWMAX (ms)	31.58±11.15	36.85±16.60	NS
RUNFWMIN (ms)	24.85±1.74	25.9±1.21	0.030
RUNFWMEAN (ms)	27.1±3.14	29.52±4.92	0.028

*p<0.05: considered statistically significant, NS: No significant differences.
RUNPRONLAT: Right ulnar nerve proximal amplitude, RUNDSONLAT: Right ulnar nerve distal onset latency, RUNPRAMP: Right ulnar nerve proximal amplitude, RUNDSAMP: Right ulnar nerve distal amplitude, RUNCV: Right ulnar nerve conduction velocity, RUNFWMAX: Right ulnar nerve maximum F-waves, RUNFWMIN: Right ulnar nerve F-waves minimum, RUNFWMEAN: Right ulnar nerve F-waves mean.

DISCUSSION

This study carried out on healthy right-handed individuals (n=44) and left-handed individuals (n=16) of either sex with age ranging from 18-30 years aimed to investigate the effect of limb dominance (handedness). The lesser number of left-handers enrolled may be due to their less frequent encounter in the study population. Previous studies dealing with limb dominance supports this limitation.[5] The effect of handedness on nerve conduction was not much clear.[6] Thus, NCS data obtained were interpreted in reference to limb dominance (handedness).

Anthropometric and cardio-respiratory variables

There were no significant differences in any anthropometric parameters between right-handed and left-handed individuals in terms of their age, height, weight, body mass index (BMI), upper limb length, and lower limb length. Similarly, there were no significant changes in cardio-respiratory variables between right-handed and left-handed individuals. The comparable anthropometric and cardio-respiratory findings reduced the possibility of acting it as a confounder.

Nerve conduction variables

The motor NCS parameters showed significantly longer right median F-waves maximum (P=0.020) and F-waves mean (P=0.039) in left-handed individuals. Likewise, the left ulnar F-waves maximum (P=0.019), F-waves minimum (P=0.002) and F-waves mean (P=0.005) were also significantly longer in left-handed individuals. The right ulnar CMAP distal latency (P=0.044), F-waves minimum (P=0.030) and F-waves mean (P=0.028) were significantly longer in left-handed individuals. Contrary to the findings, the previous studies did not find significant differences in CMAP and F-waves latencies.[6]

Gupta N et al, found motor conduction velocity of right and left median nerve was not significantly different in left-handed subjects as compared with right-handed subjects.[6] These findings were in agreement with ours. Moreover, these findings were supported by Tan U who measured the motor and sensory conduction velocities of median and ulnar nerves on right-handed and left-handed individuals. There were no statistically significant differences in the nerve conduction velocities between the right and left-handed individuals.[7] In a similar study done by Hennessey WJ et al, on median and ulnar nerve conduction in young adults concluded that handedness has no effect on the nerve conduction parameters.[8]

Bhorania S et al, also had performed a similar study where he found that nerve conduction velocity in the right handed subjects was more as compared to their counterparts.[9] Another study done by Anuradha S et al, showed a definite relationship between limb dominance and median nerve conduction although the results are not so clear in case of ulnar nerve.[10]

Tayade MC et al, had performed a similar study to assess the effect of limb dominance on motor as well as sensory nerve conduction velocities of median nerve on healthy medical students. The study concluded that sensory nerve conduction velocity in the left-handed subjects was found more than the right-handed subjects.[11]

CONCLUSION

NCS parameters in terms of latencies were longer in left-handed individuals. Therefore, limb dominance seems to be an important factor one should pay attention during bilateral comparison of obtained data in neuro-physiological reporting of referred cases.

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