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NERVE CONDUCTION PARAMETERS OF LOWER LIMBS OF HEALTHY INDIVIDUALS: EFFECT OF ANTHROPOMETRIC VARIABLES

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ABSTRACT

Background: Nerve conduction studies (NCS) are conventionally performed with electromyography (EMG), which is electro diagnostic studies, provides a comprehensive evaluation of suspected nerve, muscle and/or neuromuscular impairment. Several studies had shown a significant effect of anthropometric variables on nerve conduction variables. Thus, we would like to study the nerve conduction parameters of lower limbs and also, to study the effect of anthropometric variables on it. **Objectives:** To study the nerve conduction parameters of lower limbs and to study the effect of anthropometric variables on it. **Material and methods**: This study was done on twenty seven consenting male healthy volunteers of age 21-35 years selected from BPKIHS by a convenient sampling method. Anthropometric variables such as age, height, weight, BMI were recorded. Motor and sensory nerve conduction parameters of lower limbs were recorded using standard techniques in Neurophysiology Lab II, Department of Basic and Clinical Physiology, B.P Koirala Institute of Health Sciences, Dharan, Nepal. The data obtained were entered into MS Excel sheet and further analyzed using SPSS 11.5. Descriptive analysis was done. Pearson's correlation was applied between anthropometric and nerve conduction variables. **Results:** Mean age, height, weight, BMI and lower limb length of subjects were 26.78±3.87 years, 169.30±6.91 cm, 67.96±7.38 kg, 23.66±1.61kg/m^2 and 98.74±5.23 cm respectively. Similarly, mean and SD were derived for nerve conduction parameters. Height showed a significant positive correlation for latencies of most of the examined motor nerves ($p<0.05$) while a negative correlation with conduction velocities with bilateral common peroneal and left tibial nerves ($p<0.05$). Subjects with higher weights showed longer latencies while lesser conduction velocities than those subjects with lower weights ($p<0.05$). Left tibial nerve conduction velocity showed a negative correlation with BMI. **Conclusion:** Height, weight and BMI showed a significant relationship with nerve conduction parameters of lower limbs in healthy subjects. Thus, these factors must be considered while reporting nerve conduction studies.

KEYWORDS: Anthropometric, nerve conduction studies.

INTRODUCTION

Nerve conduction studies (NCS) are the most sensitive and reproducible measure of peripheral nerve functions. These can define and quantities normal nerve activity.[1] These tests examine the state of rapidly conducting myelinated fibers in a peripheral nerve.[2] NCS are conventionally performed with electromyography (EMG), which are electro diagnostic studies; provide a comprehensive evaluation of a suspected nerve, muscle or neuromuscular impairment.[3] NCS is a part of electro diagnostic procedures that help in establishing the type and nature of the nerves by evaluating their function. NCS assesses three types of nerves: motor, sensory and mixed. Motor NCS includes the assessment of the compound muscle action potential (CMAP), whereas sensory NCS include the assessment of the sensory nerve action potential (SNAP) of the peripheral nerves in the upper and lower limbs. The median, ulnar, radial, common peroneal, tibial, and sural are the commonly examined nerves. Latency, amplitude and conduction velocity of CMAP and SNAP responses are measured. Minimum F wave latency of the late response is routinely measured.[4] Nerve conduction variables are affected by physiological and technical variables. Physiological variables such as age, height, gender, weight, body mass index (BMI), temperature affect conduction velocity. Diameter and myelination of the nerve fibers are strong physiological factors that affect NCV.[3]

Dilip et al showed a substantial positive correlation between height and F wave latencies of all motor nerves, except the left common peroneal nerve and with the SNAP latencies of the right radial and sural sensory nerves.[5] There is a significant slowing of conduction velocities and increase in sensory latencies with increasing age and more height.[6] Similarly, some other studies had shown a significant effect of anthropometric variables on nerve conduction parameters.[7,8,9]

Thus, we aimed to study the nerve conduction parameters of lower limbs of healthy subjects and also, to evaluate the impact of anthropometric factors like age, height, weight, BMI on nerve conduction. As such, appropriate adjustments may be considered while finding normal values.

MATERIAL AND METHODS

Electro diagnostic studies are powerful tools used to objectively examine the physiologic status of a peripheral nerve and muscles. NCS evaluates motor and sensory parameters of the nerve. In motor NCS, bilateral common peroneal and tibial nerves while in sensory NCS, bilateral sural nerves were assessed. We conducted the study at Neurophysiology Lab II of BPKIHS. Twenty-seven healthy male subjects of 20-35 years from the institute were selected by a convenient sampling method. Those subjects with history of diabetes, neuropathy or neuromuscular disorder were excluded. Ethical clearance was taken from the institute ethical review board. Subjects were explained about the study procedure in detail and informed written consent was taken before the electrophysiological test. Anthropometric and NCS variables were studied. NCS of lower limbs were recorded using Digital Nihon Kohden (NM-420S, H36, Japan). The test was performed by placing the participants in a lying down position.

Recording of motor NCS[3]

The stimulator with water soaked tips was used for nerve stimulation. The stimulating electrodes were placed on the skin overlying the nerve at two sites along the course of a nerve. The recording and reference electrodes were placed over the muscle supplied by the nerve being tested using a belly tendon montage i.e. active electrode placed on the center of the muscle belly and the reference electrode placed distally, over the tendon of the muscle. The ground electrode was placed between stimulating and recording electrodes. The current of stimulator was initially set to zero, then gradually increased with successive stimuli. A CMAP appeared that grew larger and larger with the increasing current. 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 nerve, latency, and amplitude of CMAP were recorded. The trace was stored and the stimulating electrode moved proximally to a second stimulation site. Distance between the two sites was measured and fed into the machine for calculation of nerve conduction velocity (NCV).

For the recording of F waves of motor nerve, the stimulator was placed at the distal site of stimulation with cathode facing proximally. Minimum, maximum and mean latencies of F waves were recorded.

Recording of sensory NCS[3]

Antidromic method of stimulation was employed for sural sensory nerve. Twenty stimuli were averaged. Onset latency, SNAP amplitude and NCV were recorded.

The data were entered into MS Excel and analyzed by SPSS 11.5 version. Descriptive analysis was done for anthropometric and nerve conduction variables while Pearson's correlation was applied between anthropometric and nerve conduction variables.

RESULTS

Mean and SD were calculated for anthropometric and nerve conduction variables of tibial, common peroneal and sural nerves as shown in tables 1-5. Left tibial nerve conduction velocity showed a positive correlation with height while it is negatively correlated with weight, BMI and lower limb length of the subject. Right common peroneal nerves nerve conduction velocity showed a negative correlation with height and lower limb length while nerve conduction velocity of left common peroneal nerve was negatively correlated with height and weight. Proximal latencies of bilateral common peroneal nerves were positively correlated with height and also, proximal latency of left common peroneal nerve is correlated with weight. Similarly, minimum F wave latency of left tibial and common peroneal nerve is positively correlated with height and also, minimum F wave latency of left tibial nerve is positively correlated with weight. (as shown in table 6).

Table 1: Anthropometric variables.

	Age (years)	Weight (kg)	Height (m)	BMI (kg/m^2)	LL (cm)
Mean±SD	26.78±3.87	67.96±7.38	1.69±0.06	23.66±1.61	98.74±5.23

BMI- body mass index, kg- kilogram, m-meter, cm meter, LL- lower limb length.

Table 2: Nerve conduction parameters of tibial nerves.

Variables	Mean± SD
RTDL (ms)	3.53±0.86
RTPL (ms)	11.39±1.45
RTDA (mv)	14.15±3.94
RTPA (mv)	11.77±3.54
RTNCV (m/s)	43.27±5.20
LTDL (ms)	3.50±0.92
LTPL (ms)	11.19±1.85
LTDA (mv)	13.32±4.65
LTPA (mv)	11.11±3.67
LTNCV (m/s)	43.84±6.09

ms-millisecond, mv-millivolt, m/s-meter/second, RTDL- right tibial distal latency, RTPL- right tibial proximal latency, RTDA-right tibial distal amplitude, RTPA- right tibial proximal amplitude, RTNCV- right tibial nerve conduction velocity, LTDL- left tibial distal latency, LTPL- left tibial proximal latency, LTDA- left tibial distal amplitude, LTPA-left tibial proximal amplitude, LTNCV- left tibial nerve conduction velocity.

Table 3: Nerve conduction parameters of common peroneal nerves.

Variables	Mean ±SD
RCPDL (ms)	3.30±0.64
RCPPL (ms)	10.29±1.25
RCPDA (mv)	7.01±2.72
RCPPA (mv)	6.17±2.41
RCPNCV (m/s)	48.0±6.40
LCPDL (ms)	3.30±0.66
LCPPL (ms)	10.14±1.06
LCPDA (mv)	6.21±2.26
LCPPA (mv)	5.27±2.18
LCPNCV (m/s)	49.01±7.29

RCPDL- right common peroneal distal latency, RCPPL- right common peroneal proximal latency, RCPDA- right common peroneal distal amplitude, RCPPA- right common peroneal proximal amplitude, RCPNCV-right common peroneal nerve conduction velocity, LCPDL- left common peroneal distal latency, LCPPL- left common peroneal proximal latency, LCPDA- left common peroneal distal amplitude, LCPPA- left common peroneal proximal amplitude, LCPNCV- left common peroneal nerve conduction velocity.

Table 4: Nerve conduction parameters of sural nerves.

Variables	Mean ±SD
RSOL (ms)	2.52±0.46
RSA (µv)	21.07±7.59
RSNCV (m/s)	56.92±11.13
LSOL (ms)	2.65±0.60
LSA (µv)	18.41±6.46
LSNCV (m/s)	55.29±13.24

µv- microvolt, RSOL- right sural onset latency, RSA- right sural amplitude, RSNCV- right sural nerve conduction velocity, LSOL- left sural onset latency, LSA- left sural amplitude, LSNCV- left sural nerve conduction velocity.

5. F wave variables of tibial and common peroneal nerves.

Variables	Mean± SD
RTFmin (ms)	43.25±4.08
LTFmin (ms)	42.96±4.18
RCPFmin (ms)	43.27±6.24
LCPFmin (ms)	42.39±4.99

RTFmin- right tibial F wave minimum latency, LTFmin- left tibial F wave minimum latency, RCPFmin- right common peroneal F wave minimum latency, LCPFmin- left common peroneal F wave minimum latency.

6. Pearson's correlation of anthropometric variables with nerve conduction variables.

	(r) correlation (p value)	Age (years)	Height (m)	Weight (kg)	BMI (kg/m^2)	LL (cm)
RTDL	r P	-0.1 0.619	0.152 0.45	-0.018 0.93	-0.202 0.313	-0.077 0.702
RTPL	r P	-0.327 0.09	0.236 0.236	0.112 0.577	-0.087 0.667	0.075 0.708
RTDA	r p	-0.343 0.079	-0.077 0.704	-0.033 0.87	0.047 0.815	0.182 0.364
RTPA	r p	-0.265 0.182	0.053 0.791	0.08 0.693	0.075 0.71	0.212 0.288
RTNCV	r p	0.197 0.325	-0.236 0.236	-0.227 0.255	-0.097 0.629	-0.251 0.206
LTDL	r p	0.114 0.573	0.121 0.548	-0.059 0.772	-0.203 0.311	-0.059 0.771
LTPL	r p	-0.136 0.498	0.253 0.203	0.188 0.349	0.021 0.916	0.206 0.303
LTDA	r p	-0.817 0.351	-0.323 0.1	-0.123 0.542	0.181 0.366	-0.147 0.466
LTPA	r p	-0.246 0.216	-0.236 0.235	-0.055 0.787	0.189 0.345	-0.175 0.381
LTNCV	r p	-0.079 0.697	-.446* 0.02	-.571** 0.002	-.384* 0.048	-.401* 0.038
RCPDL	r p	0.195 0.329	0.069 0.734	0.172 0.392	0.199 0.321	-0.135 0.501
RCPPL	r p	0.087 0.667	.425* 0.027	0.343 0.08	0.06 0.766	0.274 0.167
RCPDA	r p	-0.224 0.261	-0.069 0.731	-0.076 0.707	0.002 0.99	-0.017 0.932
RCPPA	r p	-0.264 0.184	-0.042 0.834	-0.026 0.897	0.04 0.844	-0.004 0.984
RCPNCV	r p	-0.01 0.961	-.572** 0.002	-0.357 0.067	0.083 0.682	-.500** 0.008
LCPDL	r p	0.034 0.867	0.338 0.085	0.26 0.189	0 0.998	0.08 0.69
LCPPL	r p	-0.082 0.684	.606** 0.001	.557** 0.003	0.18 0.369	0.356 0.069
LCPDA	r p	-0.136 0.497	-0.158 0.432	-0.015 0.943	0.206 0.302	-0.03 0.884
LCPPA	r p	-0.205 0.305	-0.201 0.315	-0.04 0.844	0.22 0.27	-0.091 0.65
LCPNCV	r p	0.099 0.622	-.392* 0.043	-.399 0.039	-0.198 0.321	-0.331 0.091
RSOL	r p	-0.257 0.195	0.235 0.238	0.318 0.106	0.241 0.226	-0.02 0.922
RSA	r p	-0.062 0.758	-0.143 0.477	0.032 0.874	0.214 0.285	0.09 0.655
RSNCV	r p	0.221 0.269	-0.26 0.19	-0.353 0.071	-0.26 0.19	-0.049 0.809
LSOL	r p	-0.173 0.338	-0.064 0.753	0.177 0.376	0.378 0.052	-0.121 0.548
LSA	r p	-0.121 0.547	-0.021 0.919	-0.193 0.335	-0.295 0.136	0.11 0.586
LSNCV	r p	0.166 0.409	0.075 0.711	-0.154 0.444	-0.347 0.076	0.134 0.506
RTFmin	r p	0.255 0.199	0.248 0.212	0.316 0.108	0.224 0.261	0.014 0.945
LTFmin	r p	0.09 0.654	.430* 0.025	.439* 0.022	0.205 0.305	0.302 0.126
RCPFmin	r p	-0.308 0.357	0.414 0.206	0.544 0.084	0.232 0.493	0.478 0.137
LCPFmin	r p	-0.607 0.836	.601* 0.039	0.494 0.102	-0.123 0.703	0.427 0.166

** *Correlation is significant at the 0.01 level (2-tailed).*
* *Correlation is significant at the 0.05 level (2-tailed).*

DISCUSSION

Mean and SD for nerve conduction parameters of bilateral tibial, common peroneal and sural nerves of lower limbs were derived. Our study showed a significant positive correlation of the height with latencies and a significant negative correlation with nerve conduction velocity for most of the nerves. Weight showed a significant positive correlation with latency for left common peroneal nerve and left tibial F wave while a negative correlation for left tibial & common peroneal conduction velocity. Left tibial nerve conduction velocity showed a negative correlation with BMI. Lower limb length was negatively correlated with left tibial and right common peroneal conduction velocity.

Diana S et al found a negative correlation with height and amplitude of median, ulnar and sural sensory nerves and a positive association with median, ulnar and sural sensory latencies.[10] A study done by Soudmand et al on 41 normal healthy subjects found a negative correlation of height with peroneal and sural conduction velocity while there was no association of height with median motor and sensory nerve conduction velocity.[11]

Peioglou HS et al and Lin KP et al found a strong positive correlation between the F wave latencies and height.[12,13] In a study done by Puksa et al, the minimal latency of the F wave was found to increase with height in studies on the upper and lower limbs.[14]

Rivner MH et al reported a positive correlation of height with the latencies of the sural, peroneal, tibial and median nerves.[15] The study also showed a negative correlation with the conduction velocities of the bilateral ulnar motor and the left median sensory nerves. Takono et al supported the possibility of an inverse correlation of the conduction velocity of the ulnar nerve with height.[16] Saaed et al found an increase of the latency of sural sensory nerve with increasing height.[17]

A negative correlation between distal fiber diameter and height may best explain both decreased conduction velocity and amplitude. Campbell proposed that a decrease in diameter occurs abruptly at a given distance from the cell body.[18]

Our results are along with many other studies who have found a strong negative correlation between height and either sural or peroneal conduction velocity.

Our study showed a longer latency of left tibial F waves and left common peroneal nerves for subjects with higher body weight and also showed a negative correlation of weight with conduction velocities left tibial and common peroneal nerves. These findings are supported by Chang et al who reported a lower median and ulnar SNAP amplitude in subjects with larger weights and a positive correlation of weight with latencies of median, peroneal and tibial F waves.[19] Pawar et al reported a larger distal motor latency of median, ulnar and tibial nerves with increasing BMI however, they showed a non significant slowing of motor and sensory conduction velocities for median and tibial nerves with increasing BMI.[20] Likewise, Buschbacher et al reported a non significant correlation of BMI and nerve conduction velocity.[21] However, our study showed a significant negative correlation of BMI with nerve conduction velocity of left tibial nerve.

Like other studies, our study also showed a significant relationship of anthropometric variables with nerve conduction variables especially with the height and weight of the individual. Since, these anthropometric variables affect the nerve conduction parameters, these variables must be taken into account while reporting nerve conduction test.

CONCLUSION

Height and weight showed a significant relationship with the nerve conduction parameters of most of the peripheral nerves of lower limbs. Thus, appropriate adjustments for height and weight must be considered while reporting nerve conduction studies.

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