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EFFECT OF BODY MASS INDEX ON PARAMETERS OF NERVE CONDUCTION STUDY IN INDIAN POPULATION

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Abstract : As the adipose tissue in epineurium is related to some extent to amount of body fat, it is possible that the amount of such fat may affect the nerve conduction. In this study, we have analyzed effect of Body Mass Index (BMI) on various parameters of nerve conduction study in one hundred seventy five healthy volunteers between ages of 18 and 66 years. BMI was determined and nerve conduction studies were performed prospectively in all the subjects using standardized techniques. Prolongation of distal motor latency (DML) was observed with increasing BMI except in motor Peroneal nerve. (In Median Nerve, P<0.05). F- Wave minimum latency was also found to be significantly prolonged in (P<0.05) in motor Tibial nerve. Higher BMI was found to be non-significantly associated with lower amplitude (both sensory and motor) except for peroneal nerve. Motor as well as sensory conduction velocity showed non-significant slowing along increasing BMI except sural and motor-sensory ulnar nerve in younger age group. This study demonstrated that various parameters of nerve conduction study can be affected by BMI. So, this biological factor has to be taken into consideration while interpreting nerve conduction studies.

Key words : conduction velocity nerve conduction study body mass index distal motor latency amplitude

INTRODUCTION

Nerve conduction study helps in differentiating two major groups of peripheral nerve diseases – demyelination and axonal degeneration. It helps to delineate the extent and distribution of neural lesion (l). High and low body mass index (BMI) have been reported as risk factor for ulnar neuropathy at elbow and high BMI as risk factor for carpel tunnel syndrome (2). BMI was also found to have negative correlation with sensory nerve action potential amplitude (3). In assessment of diabetic peripheral neuropathy, BMI is very important factor to be taken into consideration (4). Thus, influence of BMI on nerve conduction study is crucial which has

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to be taken into consideration while interpreting nerve conduction studies. Several studies (5-7) evaluated influence of age, height and BMI on nerve conduction velocity, however, majority of these studies are based on Caucasian subjects. Currently the same normative values are used both for thin and obese subjects during interpretation of nerve conduction study. As the adipose tissue in epineurium may be related to some extent to amount of body fat (8), it is reasonable that the amount of such fat may affect the nerve conduction. While using normative reference data for making diagnosis, it is preferable to have these data derived on a population that closely relate in demographic profile to the patients being studied. Therefore, this study is aimed at studying the effect of BMI on nerve conduction parameters among healthy Central Indian rural subjects.

MATERIALS AND METHODS

One hundred seventy five healthy volunteers between ages of 18 and 66 years were included in the study after getting their informed written consent to participate. All participants were examined to exclude history of systemic or neuromuscular disorders. Relevant clinical history was taken and neurological examination was done. Subjects were excluded if reported a history of neuropathy, limb injury or ulcer, neuromuscular transmission disorder, myopathy and alcohol abuse. Institutional Ethics Committee's approval was obtained and study was conducted at fixed room temperature of 30°C.

Electrophysiological methods

For all subjects the following were recorded: age, sex, height (in cm), and weight (in kg). Body mass index (BMI) was calculated as weight divided by height in meters square (kg/m^2). Nerve conduction study was done on RMS EMG EP Mark-II. For motor nerve study, duration was kept at 200 µs, filter was between 2 Hz to 10 KHz and sweep speed was 5 ms/D for lower limb and at 100 µs, 2 Hz-5 KHz, 5 ms/D respectively for upper limb. For sensory nerve study, duration was 100 us, sweep speed 2 ms/D and filter was between 20 Hz to 3 KHz. Motor nerve tested were Median, Ulnar, Peroneal, Tibial and sensory study was done on Median, Ulnar and Sural nerve. Parameters studied for motor nerves were distal motor latency (DML), amplitude and conduction velocity (CV) whereas for sensory nerves were amplitude and conduction velocity. The sites of stimulation for motor Peroneal, Tibial nerves were ankle and at or below popliteal fossa and recording site were motor point of Extensor digitorum brevis and Abductor Hallucis respectively. Reference electrode was placed 4 cm distally over 4th metatarso-phalangeal joint for peroneal nerve and over 1st metatarso-phalangeal joint for Tibial nerve. The site of stimulation for motor median, ulnar nerves were the wrist and elbow and recording site were motor point of abductor pollicis brevis and abductor digiti minimi respectively. Reference electrode was placed 4 cm distally over the 1st metacarpo-phalangeal joint for median nerve and over 5th metacarpo-phalangeal joint for ulnar nerve. Belly tendon montage was used with cathode and anode 3 cm apart. For sensory nerves, antidromic study was done. Sensory nerve action potential amplitude was taken from peak to base. Ground electrode was placed between stimulating and recording electrodes. Recording surface disc electrode was placed below lateral malleolus of ankle for sural nerve.

F-wave study involved supramaximal stimulation of motor nerves. A large compound muscle action potential (CMAP) followed by small irregular shaped CMAPs were elicited. Minimum 10 stimuli were passed to obtain F-wave on raster scale and minimum F-wave latency (F-min lat) was noted. For F-wave, setting was done as duration of 100 us, sweep speed of 10 ms/D and filter was between 2 Hz to 10 KHz.

Statistical methods

Statistical analysis was done using Statistical Package for Social Sciences (SPSS) 10.0 version. Values obtained were expressed in the form of mean and standard deviation (SD). Data has been presented in three groups of BMI. Inter-group comparison of data between three groups of BMI has been done. Analysis of data was done by one-way ANOVA and post-hoc by Tuky-Krammer test. P value was taken as significant if found to be less than 0.05.

RESULTS

One hundred seventy five volunteers aged 18-66 years (mean BMI 20.58±3.02) were included in the study. BMI ranged from 13.49 to 27.08 kg/m^2. There was 144 males (mean

TABLE I: Body Mass Index wise distribution in younger age group (18-45 years) [Right side].

Nerve	*Parameters*	*BMI in wt/ht m²*			*P value*
		<18	*18-22.9*	*23-27.9*	
Motor Median	DML	3.13±0.47	3.16±0.49	3.39±0.48	0.038*
	AMP	14.34±4.28	13.87±3.81	14.41±4.21	0.738
	CV	56.54±4.14	56.47±4.77	57.10±4.58	0.778
	F-Min	25.80±2.35	25.55±2.12	26.17±1.73	0.340
Motor Ulnar	DML	2.29±0.44	2.27±0.29	2.31±0.47	0.899
	AMP	13.46±3.24	12.98±2.58	13.43±2.82	0.593
	CV	58.10±5.23	58.54±4.50	58.63±4.91	0.872
	F-Min	26.29±2.72	26.34±2.61	26.75±1.79	0.653
Motor Tibial	DML	3.57±0.63	3.64±0.81	3.69±0.68	0.767
	AMP	20.79±6.36	18.71±6.21	19.04±5.35	0.226
	CV	50.04±3.83	49.24±3.75	49.48±3.54	0.569
	F-Min	43.75±3.89	45.37±3.99	46.90±2.93	0.002*
Motor Peroneal	DML	4.28±0.71	4.10±0.74	4.15±0.66**	0.448
	AMP	7.22±2.45	8.23±3.15	8.49±2.95	0.144
	CV	52.07±4.98	51.82±4.48	51.82±5.00	0.961
	F-Min	42.64±3.51	43.34±4.34	43.61±3.24	0.543
Sensory Median	AMP	41.21±13.87	38.42±13.50	36.14±12.19	0.267
	CV	59.31±5.04	59.48±5.57	58.24±6.37	0.536
Sensory Ulnar	AMP	32.39±17.20	28.29±12.75	26.71±12.44	0.190
	CV	57.85±7.61	58.01±6.34	59.92±6.48	0.302
Sensory Sural	AMP	20.96±9.66	19±9.77	19.01±6.52*	0.528
	CV	51.43±5.88	51.76±6.55	52.10±5.66	0.896

Nerve conduction was also performed in left side limbs, and data was similar to that of right side. Data presented are mean±SD. Analysis of data was done by one-way ANOVA and post-hoc by Tuky-Krammer test. The ** depicts comparison of BMI < 18 with BMI 23–27.9. *P<0.05; **P<0.05.

MNCS: motor nerve conduction studies; SNCS: sensory nerve conduction studies; DML: distal motor latency in millisecond; AMP: amplitude in mV (motor nerve); in µV (sensory nerve); CV: conduction velocity in m/s; F-Min: F-min latency in millisecond; BMI : Body Mass Index.

BMI 20.62±2.85 kg/m^2) and 31 women (mean BMI 20.44±3.74 kg/m^2). Descriptive statistics of BMI wise distribution for right sided motor and sensory nerves in younger (18-45 years) and older age groups (46-66 years) are shown in Tables I and II. Nerve conduction was also performed on left side limbs and as the data was similar to that of right side; only right sided values were depicted. In both age groups, prolongation of distal motor latency (DML) was observed with increasing BMI except in motor Peroneal nerve. (In Median Nerve, P<0.05). F-wave minimum latency was also found to be significantly prolonged in (P<0.05) in motor Tibial nerve, however ,in rest of the tested nerves, similar finding is non-significant in younger age group. In older age group, F-wave minimum latency showed non-significant decrease with increasing BMI in Peroneal and Tibial nerve. In both younger and older age group, higher BMI was found to be non-significantly associated with lower amplitude (both sensory and motor) except for peroneal nerve. However magnitude of decrease of amplitude on sensory side is greater as compare to motor side. Motor as well as sensory conduction velocity (CV) showed nonsignificant slowing along increasing BMI except in sural and motor-sensory ulnar nerve in younger age group, however, in older age group conduction velocity was found to be increasing with higher BMI (motor ulnar nerve, P<0.05).

TABLE II: Body Mass Index wise distribution in older age group (46-66 years) [Right side].

Nerve	*Parameters*	*BMI in wt/ht m²*			*P value*
		<18	*18-22.9*	*23-27.9*	
Motor Median	DML	3.23±0.51	3.53±0.42	3.50±0.56	0.567
	AMP	15.42±2.05	11.27±5.13	12.40±3.75	0.282
	CV	55,04±2.07	53.71±4.73	54.59±4.22	0.832
	F-Min	27.05±3.47	26.62±1.88	28.05±2.99	0.507
Motor Ulnar	DML	2.55±0.34	2.55±0.33	2.22±0.34	0.118
	AMP	11.87±1.62	12.81±1.83	10.63±2.53	0.104
	CV	52.47±2.22	56.43±3.22	59.48±4.12**	0.011*
	F-Min	28.55±3.23	27.50±1.40	27.45±2.15	0.644
Motor Tibial	DML	3.36±0.71	3.96±0.96	3.59±0.98	0.496
	AMP	11.47±6.18	15.40±4.99	16.86±5.65	0.287
	CV	45.31±2.59	44.40±2.01	46.48±4.24	0.363
	F-Min	50.85±7.02	50.22±2.57	46.37±4.53	0.118
Motor Peroneal	DML	4.37±0.78	4.07±0.71	3.97±0.52	0.617
	AMP	6.15±2.38	6.97±2.08	6.96±2.83	0.829
	CV	49.10±6.61	48.25±3.99	52.46±5.75	0.222
	F-Min	49.55±7.62	45.38±3.92	43.22±9.23	0.336
Sensory Median	AMP	30.62±12.39	28.36±10.80	31.57±15.28	0.858
	CV	54.27±5.57	53.44±6.16	58.66±5.21	0.162
Sensory Ulnar	AMP	23.05±15.96	21.57±6.36	29.60±15.96	0.368
	CV	56.31±9.08	58.26±7.21	56.28±5.18	0.794
Sensory Sural	AMP	15.55±10.54	16.90±9.35	11.68±5.67	0.425
	CV	49.68±8.50	51.07±5.42	52.30±4.39	0.747

Nerve conduction was also performed in left side limbs, and data was similar to that of right side. Data presented are mean±SD. Analysis of data was done by one-way ANOVA and post-hoc by Tuky-Krammer test. The ** depicts comparison of BMI < 18 with BMI 23-27.9. *P<0.05; **P<0.05.

MNCS: motor nerve conduction studies; SNCS: sensory nerve conduction studies; DML: distal motor latency in millisecond; AMP: amplitude in mV (motor nerve); in μV (sensory nerve); CV: conduction velocity in m/s; F-Min: F-min latency in millisecond; BMI: Body Mass Index.

DISCUSSION

Normal values are needed for clinical evaluation of individual patient and as control data for epidemiological studies. This study examined the influence of body mass index (BMI) on nerve conduction parameters of commonly studied upper and lower limb nerves. Results were statistically analyzed to provide reference values for the healthy adult population of Central India. Our observation are in agreement with Awang MS et al (1) who observed slowing of conduction velocity (CV) with increasing BMI in median nerve (motor and sensory) and peroneal nerves. They also have noticed no observable trend in sensory ulnar nerve CV. However, in contrast to their findings, we reported no observable fixed trend in CV of motor Ulnar and Sural nerves. In older age group CV was found to be increasing with higher BMI in motor Ulnar nerve. This observation, though statistically significant, is of little clinical significance and in absence of a trend among the other nerves is of doubtful importance. Our findings are in contrast with Baqai HZ et al (9) who reported no effect of BMI on nerve conduction studies. Buschbacher RM et al (10) found longer latency association with lower BMI in motor ulnar and peroneal nerves. This coincides with our findings. This observation might be due to the fact that more superficial peroneal nerve is more dependent on subcutaneus fat thermal insulation to maintain higher perineural temperature and thus thinner individual may have a lower temperature around this nerve than would a heavier person. This could account for longer latency in thinner people (10). They also reported significant association between latency and BMI in sensory Radial and Ulnar nerves. In all other sensory nerves and in median, tibial (motor) nerves no statistically significant difference was observed in latency, amplitude and CV with varying BMI. In all sensory nerves, amplitude was found to be varying with BMI (higher BMI associated with lower amplitude). Our observation was similar to them. In present study, we found influence of BMI greater on sensory nerve conduction study as compared to motor study. Sensory studies exhibited same trend of greater amplitude with lower BMI. Similar were the findings reported by Hasanzadeh P et al (3). This observation might be due to amplitude attenuation by thicker subcutaneous tissue in the person with higher BMI (10). Sensory amplitude are decreased but motor amplitudes are spared with changing BMI, this is probably due to the thousand fold difference in sensory and motor amplitude (10). The fastest fibers conduct equally quickly in thin and heavy individuals; this could be the explanation why did not we notice observable fixed trends in regard with distal motor latency (DML) and F-wave minimum latency with varying BMI. In conclusion, this study demonstrates that various parameters of nerve conduction study can be affected by BMI. So, this biological factor must be taken into consideration while interpreting nerve conduction studies.

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