ORIGINAL ARTICLE

NERVE CONDUCTION STUDY AMONG HEALTHY MALAYS. THE INFLUENCE OF AGE, HEIGHT AND BODY MASS INDEX ON MEDIAN, ULNAR, COMMON PERONEAL AND SURAL NERVES

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Nerve conduction study is essential in the diagnosis of focal neuropathies and diffuse polyneuropathies. Age, height and body mass index (BMI) can affect nerve velocities as reported by previous studies. We studied the effect of these factors on median, ulnar, common peroneal and sural nerves among healthy Malay subjects. We observed slowing of nerve conduction velocities (NCVs) with increasing age and BMI (except ulnar sensory velocities). No demonstrable trend can be seen across different height groups except in common peroneal nerve.

Key words *: nerve conduction velocity (NCV), nerve conduction study (NCS)*

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Introduction

Nerve conduction velocities (NCVs) can be easily measured on peripheral nerves. Sufficient stimuli from an electrical stimulator can trigger nerve impulses. Once the action potential threshold of a nerve fiber is reached, its electrical impulses will propagate at a rate of hundred metres per second (1,2). The velocity is directly dependent on the diameter of fibre myelination and temperature (8,15).

Nerve conduction study (NCS) helps in delineating the extent and distribution of neural lesions. It enables clinicians to differentiate the two

Table 1 : Showing different age, BMI and height groups

Age (years)	Group 1. 20-29 Group 2. 30-39 Group 3. 40-49 Group 4. 50-59
BMI (kg/m^2)	Group 1. < 18.9 Group 2. 19-24.9 Group 3. 25-29.9 Group 4. > 30
Height (cm)	Group 1. < 160 Group 2. 160-169 Group 3. 170-179 Group 4. > 180

Table 2 : The sites of stimulation and recording of the nerves

Nerve	Stimulation	Recording
Median		
Motor	Wrist, Elbow	Thenar muscle
Sensory	Wrist	Index finger
Ulnar		
Motor	Wrist, Elbow	Hypothenar muscle
Sensory	Wrist	Little finger
Common Peroneal		
Motor	Ankle, Fibula Head	Extensor digitorum brevis
Sural		
Sensory	Calf	Lateral malleolus

major groups of peripheral diseases: demyelination and axonal degeneration (9)

Orthodromic is when the propagation of action potential is recorded in the physiological direction whereas antidromic is when the recording is opposite to the physiological direction (7).

Median and ulnar nerves are two important nerves in the upper limb. They are responsible for the movements as well as sensation of the hand. Entrapment of these nerves will cause reduction in these modalities, for instance in carpal tunnel syndrome. Nerve conduction study (NCS) helps in localizing the site of the lesion (6, 17). The common peroneal and sural nerves are among the nerves commonly studied in the lower limbs. They supply some of the muscles and cutaneous sensation of the lower limbs (4).

There are many studies which evaluate the influence of specific personal factors such as age, height and body mass index on nerve velocities (5,16,20). However, the majority of these studies are based on Caucasian subjects.

Therefore, this study is designed to study the effect of these specific factors (age, height and BMI) on NCVs of median, ulnar, common peroneal and sural nerves among healthy Malay subjects.

Table 3 : Conduction velocities of median and ulnar nerves for both motor and sensory, across different ages, BMIs and height groups

		Median		Ulnar	
		Conduction Motor (m/s)	Conduction Sensory (m/s)	Conduction Motor (m/s)	Conduction Sensory (m/s)
Age	**Groups**				
	1	57.56 ± 5.70	56.49 ± 6.15	62.15 ± 4.68	53.87 ± 6.33
	2	55.97 ± 4.32	54.55 ± 7.46	60.78 ± 6.09	52.99 ± 7.13
	3	54.21 ± 5.26	52.73 ± 5.67	60.25 ± 4.43	52.87 ± 4.78
	4	50.95 ± 5.28	52.30 ± 7.90	59.05 ± 4.13	52.74 ± 4.97
BMI (kg/m^2)	1	57.00 ± 5.36	56.16 ± 6.35	61.39 ± 5.14	52.21 ± 5.24
	2	54.81 ± 5.67	53.79 ± 6.81	60.92 ± 5.24	52.47 ± 6.11
	3	53.89 ± 5.37	53.66 ± 7.29	59.39 ± 7.29	53.92 ± 5.67
	4	52.15 ± 6.09	52.78 ± 8.36	59.00 ± 4.76	54.15 ± 6.17
Height (cm)	1	54.09 ± 5.85	52.45 ± 7.88	61.38 ± 5.58	52.19 ± 5.79
	2	55.68 ± 4.79	53.90 ± 6.04	59.89 ± 4.94	52.40 ± 5.26
	3	53.89 ± 6.42	54.77 ± 6.78	60.58 ± 4.66	53.37 ± 5.36
	4	55.05 ± 5.63	55.03 ± 7.27	60.55 ± 4.78	53.78 ± 7.07

Table 4 : Conduction velocities of common peroneal (motor) and sural (sensory) nerves across different ages, BMIs and height groups

		Common Peroneal	**Sural**
		Conduction Motor (m/s)	Conduction Sensory (m/s)
Age	**Groups**		
	1	51.95 ± 4.11	48.29 ± 3.86
	2	51.69 ± 4.28	48.22 ± 4.58
	3	50.17 ± 4.37	48.06 ± 4.53
	4	49.13 ± 4.01	47.32 ± 4.47
BMI (kg/m^2)	1	51.00 ± 5.10	49.00 ± 4.70
	2	50.97 ± 4.21	48.63 ± 4.00
	3	50.43 ± 3.79	48.17 ± 4.72
	4	50.20 ± 5.12	48.00 ± 4.69
Height (cm)	1	51.46 ± 4.79	47.90 ± 4.45
	2	50.78 ± 4.05	48.13 ± 4.98
	3	50.65 ± 4.18	47.85 ± 3.88
	4	50.15 ± 4.29	48.02 ± 4.07

Methods

Two hundred and fifty subjects were recruited in this study . They were hospital staff including doctors, nurses, medical assistants and attendants. The age, sex, height and weight of the subjects were recorded. Subjects were divided into different age, body mass index (BMI) and height groups as shown in Table 1. All the subjects do not suffer from any known neuromuscular or musculoskeletal diseases. The ethical approval for the study was obtained from the ethical committee.

The nerves tested were the median ,ulnar, common peroneal and sural nerves (both right and left). The sites of stimulation and recording are shown in the Table 2. In each subject, orthodromic motor and antidromic sensory parameters of the nerves were measured.

We used surface electrodes. The recording electrodes were fixed to the subject's skin using adhesive tape. No special skin preparation was needed. The targeted nerve was supramaximally stimulated using a square wave current with a duration of 0.2ms and the action potential was picked up by the recording electrode. The length of each nerve was estimated with a flexible measuring tape. For safety, a ground electrode was placed in between the stimulating and recording electrodes. The room temperature was kept constant above 29^o C for upper extremities and 27^o C for lower extremities and measured using a room thermometer.

Results

Of 250 subjects, 137 subjects (55%) were male and 112 (45%) were females. The average age, height and BMI were 34.38 ± 10.79, 159.45± 8.53 (cm) and 24.01± 4.20 (kg/ m^2) respectively.

The mean velocities for median and ulnar nerves both motor and sensory were: 54.71± 5.69m/s (motor) and 54.04±7.02m/s for the median nerve and 60.57± 5.00 m/s (motor) and 52.92± 5.89 m/s for the ulnar nerve. The mean velocities for the common peroneal (motor) and sural (sensory) nerves were 50.73± 4.60m/s and 47.97± 4.48m/s respectively.

The conduction velocities of median and ulnar nerves, both motor and sensory across different age, BMI and height groups are summarized in Table 3 and for common peroneal and sural nerves, the conduction velocities are tabulated in Table 4.

Discussion

Nerve conduction study is an important method used in clinical practice and has been thoroughly validated (1,2,3,11,14).There are many studies and reviews on nerve conduction studies that have been published. These include the factors that affect nerve velocities. These factors can be divided into biological factors (age, height, gender) and physical factors which are related to the physical state of the nerve and muscle (10, 15,16). Our focus was on the effect of biological factors (age, height and BMI) on NCV. Other factors like temperature for instance was kept at the recommended level by most neurophysiology laboratories in order to reduce variabilities.

Flack et al (7) described that age has a significant effect on sensory nerve conduction. The conduction velocity in newborns is approximately 50% of adult values and progressively increases and reaches the adult value at the age of three. Later in adulthood , the nerve velocity decreases with age, more so in the lower than upper limbs. A similar observation was made by Stalberg and Flack (15) for motor nerve conduction.Tong et al (19) in their study on the effect of aging on sensory NCV noted that the rate of change in parameters was significantly greater in the median nerve than with ulnar nerve.

Our study showed slowing of nerve velocities with increasing age in the median nerve. Similar observations were noted both in the motor and sensory velocities of the ulnar nerve. We also observed a similar trend of velocities with increasing age in both the common peroneal and sural nerves.

Many studies have shown that NCV both motor and sensory are relatively slower in taller subjects. It is estimated that the velocity decreases by 2-3 m/s per 100mm in height (7,8,13,16,21, 22).

Soudmand et al (18) found that peroneal and sural nerves conduction velocities were correlated inversely with height and no significant relationship could be seen in median nerve(both motor and sensory) NCV. In comparison, we could not demonstrate any obvious trend of NCVs in median and ulnar nerves across different height groups. We observed slowing of NCVs in common peroneal nerve with increasing height. However, no demonstrable patterns were seen for the sural nerve.

Buschbacher (1) performed a study to determine the effect of body mass index on NCV. The investigator concluded that there was no correlation note between BMI and NCV plus H reflex latency. We found slowing of NCVs across different BMI groups. In median nerve, both motor and sensory conduction showed reduction in the velocities with increasing BMI. The motor conduction velocities in the ulnar nerve also showed similar pattern. However, no observable trend can be seen in the sensory conduction velocities of the ulnar nerve. We observed slowing of conduction velocities with increasing BMI for both common peroneal and sural nerves.

In conclusion, age and BMI can affect the conduction velocities. We observed reduction in velocities of the median, ulnar (except sensory conduction), common peroneal and sural nerves across different age and BMI groups. Further studies are needed to clarify the inconsistency in the pattern of conduction velocities across different height groups in these subjects.

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