A Comparative Study of Nerve Conduction Velocities in Human Beings of Different Age

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ABSTRACT

Introduction: Nerve conduction study is the most sensitive and reproducible measure of peripheral nerve function. The results of these motor and sensory nerve conduction studies are expressed as amplitudes, conduction velocities and distal latencies yield quantitative and qualitative observations regarding the waveform and dispersion of electrical impulses. Study aims and objectives were to establish the normal electrophysioligical values of the commonly tested median, ulnar, common peroneal, and sural nerves by age.
Materials and methods: Twenty five normal healthy adult male subjects aged between 21 – 30 years and twenty five normal adult male subjects aged between 51-60 years.
Results: The mean motor nerve conduction velocity of median nerve in the male subjects of 21-30 years of age was compared with the mean motor nerve conduction velocity of median nerve of 51-60 years, has increased by 10.62%.
Conclusion: This conduction phenomenon does do vary from our study and the earlier studies which proved that the length, thickness, metabolism, and temperature does do cause changes in the velocity of conduction.

Keywords: Nerve Conduction Velocity, Polyneuropathy

INTRODUCTION

Nerve conduction study is the most sensitive and reproducible measure of peripheral nerve function.[1] It involves the transcutaneous stimulation of motor or sensory nerves and recording of the elicited compound muscle action potential (CMAP), and the sensory nerve action potential (SNAP). The results of these motor and sensory nerve conduction studies are expressed as amplitudes, conduction velocities and distal latencies yield quantitative and qualitative observations regarding the waveform and dispersion of electrical impulses.
Hodes and coworkers in 1948 were the first to describe nerve conduction studies in patients. An accessible nerve is stimulated through the skin by surface electrodes, using a stimulus that is large enough to recruit all the available nerve fibers. The main characteristics of the conventional nerve conduction studies are:

Distal latencies, conduction times, and conduction velocities: The conduction times from the most distal stimulating electrode to the recording site, in milliseconds, is termed the distal latency. A stimulus may then be applied to the nerve at a second site more proximally and a conduction time can be measured over a longer segment of nerve. When the distance (in millimeters) between the two sites of stimulation is divided by the difference in conduction times (in milliseconds), one obtains a conduction velocity (in meters per second). These velocities in normal subjects vary from a minimum of 40 or 45 m/s to a maximum of 65 to 75 m/s, depending upon the nerve studied. Values are lower in infants, reaching the adult range by the age of 2 to 4 years and decline again slightly with advancing age.
Disease processes that preferentially injure the fastest conducting, large-diameter fibers in peripheral nerves reduce the maximal conduction velocity. In most neuropathies, all of the axons are affected either by a fairly uniform dying-back phenomenon or by Wallerian degeneration, and nerve conduction velocities are then less informative. This is true for typical alcoholic-nutritional, carcinomatous, uremic, diabetic, and other metabolic neuropathies, in which conduction velocities range from normal to mildly slowed. In these axonal neuropathies, the motor and sensory nerve amplitudes are diminished.
By contrast, demyelinating neuropathies of the acute (Guillain-Barre syndrome, diphtheria) and chronic types such as chronic inflammatory, metachromatic leukodystrophy, krabbe disease, and the common type of charco-marie-tooth disease shows marked slowing of conduction. In the case of the acquired demyelinating diseases, there is also dispersion of the action potential and conduction block.

Amplitude of the compound muscle action potential (CMAP) and sensory nerve action potential (SNAP): The amplitudes of the evoked potential yield valuable information about peripheral nerve function. Demyelinating lesions or axonal loss affecting the large, fast conducting fibers may be detected by the finding of differential slowing among various caliber fibers that causes a dispersal of the CMAP response. Reduction in motor and sensory amplitudes is more specific and sensitive indicator of axonal loss than is slowing of conduction velocity or prolongation of distal latencies. Prolonged distal latencies and slowed motor conduction velocities-as well as conduction blocks and dispersed responses- are the hallmarks of demyelinative lesions.
Sensory nerve potentials are sometimes very small or absent

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even when powerful computer-averaging techniques are used, and sensory conduction measurements may then be difficult to determine, as these must be recorded from nerve fibers themselves.

Conduction block: By stimulating a motor nerve at multiple sites along its course, it is possible to demonstrate segments in which conduction is partially blocked or is differentially slowed. Conduction block is demonstrated by a reduction in the amplitude of the CMAP elicited from the proximal site along nerve, compared to stimulation at a distal site. A 40 percent reduction in amplitude over a short distance of nerve, or 50 percent over a longer distance, qualifies as a block. One must also keep in mind that conduction block may be attributable simply to nerve compression at common sites (fibular head, across the elbow, flexor retinaculum at the wrist, etc.) rather than to an intrinsic disease of the peripheral nerves.

The finding of conduction block is a central feature of a number of acquired immune demyelinating neuropathies, including Guillain-Barre syndrome, chronic inflammatory demyelinating neuropathy, and multifocal conduction block associated with the GM[1] antibody.

Focal compression of a nerve may produce localized slowing or blocks in conduction, perhaps because of segmental demyelination at the site of compression.[2]

The routine nerve conduction study includes testing of the motor and sensory fibers of the median, ulnar, and radial nerves, and the motor fibers of the peroneal and tibial nerves, and the sensory fibers of the superficial peroneal and sural nerves.[3]

Every clinical neurophysiology lab need to set up its own normative data for its population required in clinical practice to identify the abnormal subjects. A normal range may be defined in different ways in clinical medicine, depending on the nature and purpose of the measurement. One approach is to obtain measurements from a large sample of randomly selected, asymptomatic subjects without known diseases associated with neuropathy, and to define values within the 95^{th}, 97.5^{th}, or 99^{th} percentiles as normal. Another approach is to use parametric analyses to define the normal range statistically as values within two standard deviations of the mean.[4]

There are several factors which may influence nerve conduction studies such as temperature, age, height, body mass index which have to be taken into consideration while doing nerve conduction studies. These factors vary according to different geographic regions.[5] Proper comparison values are critical for valid interpretation. Many studies have been published regarding normative data from western countries with cold climatic condition.[6]

The primary purpose of our study was to study the influence of height and age on nerve conduction velocity and to provide normative electrophysiological data for the commonly tested upper and lower limb nerves in carefully screened normal healthy adult male individuals using standard distances and temperature control.

Nerve conduction studies help in delineating the extent and distribution of neural lesions. It enables clinicians to differentiate the two major groups of peripheral nerve diseases like demyelination and axonal degeneration.[7] Conduction velocity has been also used in genetic and epidemiologic studies for detecting hereditary peripheral nerve disorder prior to development of clinical signs.[8]

Study aimed to check the relationship of the nerve conduction velocity of the commonly tested upper and lower limb nerves in comparison to age in healthy adult male subjects with the objectives to test for nerve conduction velocity in various age differences, to know the normal and abnormal velocities and to test for nerve conduction establish the normal electrophysioligical values of the commonly tested median, ulnar, common peroneal, and sural nerves by age.

MATERIAL AND METHODS

Twenty five normal healthy adult male subjects aged between 21 – 30 years and twenty five normal adult male subjects aged between 51-60 years volunteering for the study were included in the study by random sampling and after taking informed consent, and were divided into 2 groups.

Group I 21 – 30 years of age,

Group II 51 – 60 years of age,

Criteria for selection of study group

All individuals were screened, and inclusion criteria were healthy adult male subjects aged between 21 – 30 years and 51-60 years with no history of systemic or neuromuscular diseases, normal neurological examination and normal laboratory findings including blood sugar level, electrolytes and renal function.

A standard questionnaire was used to exclude those individuals with a history of systemic or neuromuscular diseases. The subjects having symptoms of peripheral sensory neuropathy, autonomic neuropathy, and excessive muscle weakness were not included. Alcoholics and individuals having nutritional deficiency or exposure to certain toxins were excluded. Subjects with history of nerve injury, entrapment neuropathies and cerebral stroke were also not included. Patients with endocrine disorders, advanced renal and liver diseases and inflammatory diseases were also not included.

Methodology

Electrophysiological methods

First of all a written consent was taken from each subject. Nerve conduction studies were conducted in Electromyograph (EMG) room of the Department of Neurology at Government General Hospital, Guntur on Electromyograph by medicaide system. The skin temperature was maintained within 36 – 38 degrees centigrade. No skin preparation was needed.

Filters were set at 2 Hertz to 5 Hertz and sweep speed was 5millisecond per division for motor study and for sensory study, filters were set at 20 Hertz to 3 Kilo Hertz and sweep speed was 2millisecond per division. Motor conduction study was performed on the median nerve in the upper limb and on common peroneal nerve in the lower limb. Sensory conduction study was performed on the ulnar nerve in the upper limb and on sural nerve in the lower limb. The targeted nerve was supra maximally stimulated using a square wave current with a duration of 0.2millisecond. The length of each nerve was estimated with a flexible measuring tape.

For median motor nerve conduction study, the recording electrode was placed close to the motor point of abductor pollicis brevis and reference electrode 3 centimeters distal at first metacarpophalangeal joint. The ground electrode is placed between the recording electrode and the stimulating electrode. A supra maximal stimulation is given at 3 centimeters proximal to the distal wrist crease and at the elbow. The distal latency, nerve conduction velocity of different segments and compound muscle action potentials are measured.

For the ulnar sensory nerve conduction the active ring electrode was placed over the fifth digit to record the responses, the reference electrode was placed 4 centimeters distal to the active electrode and the stimulation was performed 10 centimeters proximal to the active electrode and medial to the flexor Carpi ulnaris tendon. Latency and sensory nerve action potential (SNAP) amplitude were measured and nerve conduction velocity calculated.

For the motor peroneal nerve conduction study surface recordings are obtained from extensor digitorum brevis and stimulation is given at ankle, 2 centimeters distal to the fibular neck, at the fibula and 5 centimeters above the fibular neck. Latency and amplitude of compound muscle action potentials (CMAP) are measured and nerve conduction velocity calculated. Sural nerve is purely a sensory nerve. The sural nerve conduction velocity was measured antidromically. The active recording electrode was placed just below the lateral malleolus. The stimulating electrode was placed at a distance of 14 centimeters from the recording electrode. Latency and sensory nerve action potential amplitude were measured and nerve conduction velocity calculated.

STATISTICAL ANALYSIS

Statistical analysis was done with the help of Microsoft office 2007. Chi square test was used for the analysis.

RESULTS

The mean motor nerve conduction velocity of median nerve in the male subjects of 21-30 years of age was compared with the mean motor nerve conduction velocity of median nerve of 51-60 years, has increased by 10.62% ($P<0.001$, Table 1). The mean motor nerve conduction velocity of common peroneal nerve in the male subjects of 21-30 years of age was compared with the mean motor nerve conduction velocity of common peroneal nerve of 51-60 years, has decreased by 7.31% ($P<0.008$, Table 2).

The mean sensory nerve conduction velocity of ulnar nerve in the male subjects of 21-30 years of age was compared with the mean sensory nerve conduction velocity of ulnar nerve of

			Motor NCV (m/s)		Sensory ncv (m/s)	
S No	**Name**	**Age**	**Median nerve**	**CPN**	**Ulnar nerve**	**Sural nerve**
1	B. Ramesh	22	58.54	51.15	51.00	48.50
2	R. Ravi Kumar	26	57.75	45.82	52.00	41.54
3	S. Papa Rao	24	54.19	47.64	52.00	44.12
4	U. Suresh Kumar	28	56.16	42.98	52.88	42.00
5	Subba Rao	23	55.77	50.94	53.52	40.36
6	S.V.S. Prasad	29	60.25	53.45	49.75	41.00
7	K.sampath	26	59.39	52.18	51.00	44.48
8	E. Srinivas	28	54.17	48.99	54.00	42.98
9	Arun Kumar	30	57	53.64	51.00	41.00
10	Sridhra Rao	28	55.68	51.72	57.62	47.26
11	Gopinath	24	61.39	54.13	54.72	42.74
12	Lakshmn	29	57.19	52.78	52.64	41.82
13	K. Naga Raju	21	57.8	49.63	52.00	43.41
14	P. Krishna	25	54.90	51.72	54.65	42.00
15	Ramprasad	27	56.72	45.25	53.00	45.81
16	B. Dharmayya	29	63.11	53.63	50.00	44.44
17	Sri Hari Rao	22	58.4	48.97	52.82	41.00
18	Prasad K	26	59.1	49.38	49.46	42.34
19	Rajendra	24	55.5	55.46	53.00	44.24
20	Bhanu Prasad	28	57.7	52.74	52.68	40.86
21	K. Peddiraju	25	46.85	37.00	54.00	41.00
22	Siva Prasad	27	57.3	54.84	54.74	42.91
23	Vijay Kumar	23	65.4	45.86	52.68	41.64
24	Santosh Kumar	28	54.9	44.72	52.00	40.78
25	Prabhu Das	26	53.2	45.46	53.00	42.12
	Mean	26	57.13	49.60	52.64	42.81
	Standard Deviation	2.53	3.54	4.40	1.79	2.07

Table-1: Motor and sensory nerve conduction velocities in upper and lower limb in male subjects aged 21-30 years

			Motor NCV (m/s)		Sensory NCV (m/s)	
S. No	Name	Age	Median nerve	CPN	Ulnar nerve	Sural nerve
1	G. Mallikarjuna Rao	58	63.11	50.60	51.00	44.00
2	N. Srihari Rao	60	48.85	45.64	52.00	37.75
3	P. Sridhar	54	52.65	44.62	50.75	35.46
4	Meerja Anwar Ali	59	54.62	48.99	51.00	43.16
5	G. Seshu	51	52.42	40.52	50.94	40.86
6	K. Balakrishna	58	51.35	44.57	49.82	37.26
7	G. Vidya Sagar	53	50.46	49.86	52.65	42.10
8	M.venkateswara Rao	54	60.89	56.95	51.00	47.00
9	M. Ravi Kumar	55	45.82	47.43	50.94	42.21
10	R. Bhanu Prasad	59	53.21	39.81	52.00	42.34
11	K. Hanumantha Rao	60	52.53	42.85	51.00	35.24
12	K. Surya Prakasa Rao	57	51.25	45.96	52.15	41.21
13	E. Durga Prasad	55	49.85	49.85	51.00	41.00
14	T. Murali	51	51.64	44.34	51.00	42.13
15	S. Rama Rao	56	47.95	42.73	52.37	41.00
16	N. Jayaraj	58	48.72	43.47	51.45	42.25
17	P. Soma Raju	53	45.30	51.77	49.00	41.00
18	A. Mohan Rao	57	47.68	42.84	49.00	38.62
19	V. Narasimha Rao	55	50.29	44.04	49.00	35.26
20	P. Moshe	52	52.28	47.93	50.24	41.82
21	SK. Mahabube	56	55.44	49.28	54.55	42.76
22	B. Srinivasa Rao	51	49.12	45.92	52.48	37.96
23	A.S. Prasad	53	45.36	41.43	50.65	35.83
24	G. Prabhakar	59	50.98	45.09	53.66	41.30
25	B. Srinivasa Rao	55	44.73	42.85	49.84	37.15
	Mean	56	51.06	45.97	51.17	40.26
	Standard Deviation	2.87	4.36	3.96	1.36	3.06

Table-2: Motor and sensory nerve conduction velocities in upper and lower in male subjects aged 51-60 years

	21-30 Years		51-60 Years		T value	P value	Crude value	% ↑↓
	Mean	Sd	Mean	Sd				
Median nerve	57.13	3.54	51.06	4.36	4.733	0.0001	6.07	10.62
Common peroneal nerve	49.60	4.40	45.97	3.964	2.882	0.008	3.63	7.31
Ulnar nerve	52.64	1.79	51.17	1.36	3.762	0.001	1.47	2.79
Sural nerve	42.81	2.07	40.26	3.06	3.712	0.001	2.55	5.95

Table-3: Comparison of nerve conduction velocities in upper and lower limb in male subjects between 21-30 and 51-60 years of age

Image-1: Electromyograph (Medicaide system)

51-60 years, has decreased by 2.79% (P<0.001, Table 3). The mean sensory nerve conduction velocity of sural nerve in the male subjects of 21-30 years of age was compared with the mean sensory nerve conduction velocity of sural nerve of 51-60 years, has decreased by 5.95% (P<0.001, Figure-1).

DISCUSSION

The nerve conduction velocity values in our study on the

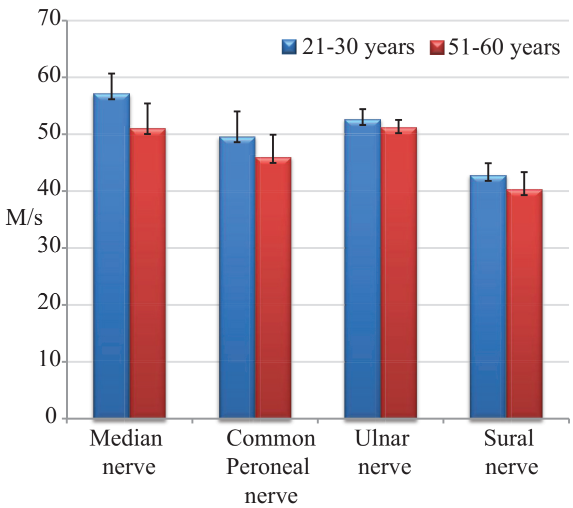

Figure-1: Comparison of nerve conduction velocities inupper and lower limb in male subjects between 21-30 and 51-60 years of age motor median, common peroneal nerves and sensory ulnar nerve and sural nerve in each age group reveal lower values as age advances which is consistent with the study done by Carl.W. Lafratta et al.[9]

Mean motor conduction velocity of the motor nerve showed a decrease in conduction velocity value per decade increase in age which is consistent with the study done by Diana S.Stetson[10] et al. Our study showed slowing of nerve conduction velocities with increasing age in all the nerves tested. We also found a similar trend of conduction velocities with increasing height in motor conduction velocities of median and common peroneal nerves which is consistent with the study done by Awang.M.S.[11]et al.

Our study showed a reduction in nerve conduction velocities of the median and common peroneal nerves with increasing age which is consistent with the study done by Farquad.B.Hamdan.[12]

Ulnar nerve conduction velocities and the sural sensory nerve conduction velocities are decreased in older age group in our study which is in accordance with the study done by Thakur.D[13] et al

There is slowing of conduction velocities in motor and sensory nerves median nerve, common peroneal, ulnar and sural nerves respectively in relation to age which is consistent with the review done by Jagga.M[14] et al

In our study older aged subjects had slower median and common peroneal nerve motor conduction velocities and ulnar and sural sensory nerve conduction velocities which is consistent with the study done by Chu-Ren Huang[15] et al.

In our study on motor conduction velocity of common peroneal nerve there is reduced value as the age advances which is consistent with the study done by Ernest.W.Johnson. MD[16] et al.

The motor nerve conduction study of median nerve showed a decline in conduction velocity as age advanced which is consistent with the study done by Sunil Chouhan.[8]

In our study on the effect of age on nerve conduction velocities of the nerves tested there is a decline in values as age increased which is consistent with study done by Trojaborg.W[17] et al.

In our study there is a decrease in nerve conduction velocities of motor median and common peroneal nerves and sensory ulnar and sural nerves in relation to age which is consistent with the study done by Richard.F.Mayer MD.[18]

Attributable factors that cause slowing of nerve conduction velocities as age advances are effects of nerve degeneration, decreased nerve fibres, reduction in nerve diameter and change in fibre membrane.

In clinical practice, there is usually no quantitative adjustment for age, sex, anthropometry or surface temperature. This practice continues despite mounting evidence that variables such as age and temperature need to be considered for accurate interpretation of results. Various studies have suggested that age, sex, body mass index,wrist ratio, oral contraceptive use, oophorectomy, weight, height are certain medical conditions may contribute valuable information about nerve function. Normal values that are not corrected have been cited as inadequate reference values.[4]

In conclusion, age can affect the conduction velocities. We observed reduction in motor conduction velocity of median and common peroneal nerves and sensory conduction velocity of ulnar and sural nerves across different age groups.

CONCLUSION

Nerve conduction is an electrophysiological mechanism and the conduction is an active physiological phenomenon. This conduction phenomenon does do vary from our study and the earlier studies which proved that the length, thickness, metabolism, and temperature does do cause changes in the velocity of conduction. This nerve conduction velocity determined does do help to detect prophylactically more neurological diseases (poly neuropathies) as we know the normal conduction velocities in various ages and length variations, hence it is more convenient to compare and detect the diseases.

REFERENCES

1. Saeed, S., and M. Akram. Impact of anthropometric measures on sural nerve conduction in healthy subjects. J Ayub Med Coll Abbottabad 2008;20:112-114.
2. Adams and Victor's Principles of Neurology – 8th edition by Allan Ropper. M.D and Robert J. Brown. M.D.
3. Chichkova R.I, Katzin L. EMG and Nerve Conduction Studies in Clinical Practice. Practical Neurology 2010;9:32-38.
4. Salerno D. F., Werner R. A., Albers J. W., Becker M. P., Armstrong T. J., et al. Reliability of nerve conduction studies among active workers. Muscle Nerve 1999;22: 1372-1379.
5. Pawar, Sachin.M, Avinash B, Taksande, and Ramji. Singh. Normative data of upper limb nerve conduction in Central India. Indian Journal of Physiology and Pharmacology 2011;55: 241-245.
6. Shehab, Dia K. Normative Data of Nerve Conduction Studies in the Upper Limb in Kuwait: Are They Different from the Western Data? Medical Principles and Practice 1998;7: 203-208.
7. Thakur, D., S. Jha, N.K. Pandey, C.B. Jha, B.K. Bajaj, and B.H. Paudel. Influence of height on the nerve conduction study parameters of the peripheral nerves. Journal of Clinical and Diagnostic Research 2011;5: 260-263.
8. Sunil chouhan, Motor nerve conduction studies of Median nerve in young adult group, Int J Biol Med Res. 2012; 3:1751-1753.
9. Lafratta, Carl W., and Otho H. Smith. A study of the relationship of motor nerve conduction velocity in the adult to age, sex, and handedness. Archives of physical medicine and rehabilitation 1964;45: 407-412.
10. Stetson, Diana S., James W. Albers, Barbara A. Silverstein, and Robert A. Wolfe. Effects of age, sex, and anthropometric factors on nerve conduction measures." Muscle and nerve 2004;15: 1095-1104.
11. Awang. Mohamed. Saufi, Jafri Malin Abdullah, Mohd Rusli Abdullah, John Tharakan, Atul Prasad, Zabidi Azhar Husin, Ahmad Munawir Hussin, Adnan Tahir, and Salmi Abdul Razak. Nerve conduction study among healthy malays. The influence of age, height and

body mass index on median, ulnar, common peroneal and sural nerves. The Malaysian Journal of Medical Sciences: MJMS 2006;13: 19-23.
12. Hamdan, Farqad B. Nerve Conduction Studies in Healthy Iraqis: Normative Data. Iraqi Journal of Medical Sciences: 2009; 7:75-92.
13. Thakur, D., B. H. Paudel, and C. B. Jha. Nerve Conduction study in healthy individuals, a preliminary age based study. Kathmandu University Medical Journal 2012;8: 311-316.
14. Jagga, M., A. Lehri, and S. K. Verma. Effect of aging and anthropometric measurements on nerve conduction properties–A Review. Journal of Exercise Science and Physiotherapy 2011;7:1-10.
15. Huang, Chi-Ren, Wen-Neng Chang, Hsueh-Wen Chang, Nai-Wen Tsai, and Cheng-Hsien Lu. Effects of age, gender, height, and weight on late responses and nerve conduction study parameters. Acta Neurol Taiwan 2009;18: 242-249.
16. Johnson, Ernest W., and Karl J. Olsen. Clinical value of motor nerve conduction velocity determination. JAMA: The Journal of the American Medical Association 1960;172: 2030-2035.
17. Trojaborg, Werner T., Agnes Moon, Birgitte B. Andersen, and Nanna S. Trojaborg. Sural nerve conduction parameters in normal subjects related to age, gender, temperature, and height: a reappraisal. Muscle and nerve 1992;15: 666-671.
18. Mayer, Richard F. Nerve conduction studies in man. Neurology 1963;13: 1021.

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