

Nerve Conductin Velocity & Amplitude of Action Potential in Sensory Peripheral Nerves of Upper & Lower Limbs in Normal Subjects

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ABSTRACT

Objectives: To provide the reference electrophysiological data for commonly tested sensory nerves of upper and lower limbs.

Place & Duration: Experimental Observational Study, carried out in the Department of Physical Medicine and Rehabilitation, Jinnah Postgraduate Medical Centre, Karachi, from Nov. 2011 – Nov. 2013.

Material and Methods: Nerve conduction data was recorded from normal healthy volunteer [n=80; males(m) n= 36 and females(f) n=44], age range (20-60yrs) with normal neurological examination and no known risk factor or symptoms to suggest the disease of peripheral nervous system. Subjects were further grouped: 20-30 years m (n=10)/f (n=16), 31-40 years m (n=10)/f (n=12), 41-50 years m (n=10)/f (n=10) and 51-60 years m (n=6)/f (n=6). Radial nerve, sensory median (finger III), sensory ulnar (finger V) nerves of upper limbs and Sural nerve of lower limb were studied using standard recording technique. The physiological variables recorded from these nerves include nerve conduction velocity (NCV) and amplitude of sensory action potential (SAP). Data was analyzed statistically on SPSS version 17.0.

Results: No statistically significant difference was found in conduction velocity and amplitudes of upper and lower sensory peripheral nerves by gender. However, a significant decrease in the NCV and SAP of radial nerve and sensory median was observed in both genders in the age group 51-60yrs. In the same age group a significant decrease in the NCV and SAP were observed in sensory ulnar and the sural nerve in males only.

Conclusion: We designated the normative reference values of the sensory peripheral nerves in healthy subjects which have value to determine neuropathy in early stage of disease.

Key words: Nerve conduction, Sensory nerve conduction velocity, Sensory nerve action potential, Peripheral sensory nerves

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INTRODUCTION

Nerve conduction studies (NCS) are commonly used in the diagnosis of peripheral nerve disorders, and results are routinely compared to normative values to discern abnormalities. For this reason, proper comparison values are critical for valid interpretation¹ Electro-diagnostic assessment of sensory nerve action potential (SNAP) and sensory nerve conduction velocity (SNCV) help to characterize the sensory functions in peripheral nerves². Reference values are used to define the limits of normal function, with test values outside the range suggesting the presence of some form of neuropathy³.

Previous studies have reported differences in function related to ethnicity and demographic factors^{4,5}. It is also widely accepted that nerve conduction study (NCS) parameters changes with age⁶⁻⁹. Usually electro-diagnostic laboratories have tables of normative values that are divided by age groups. The concepts suggests that normal nerve functioning in a normal individual changes with age. For this reason, proper comparison values are critical for valid interpretation¹⁰. Recently, there has been increased attention to the quality of normative data against which test results are compared^{11,12}.

The aim of this study was to generate reference data for a wide range sensory nerve conduction studies that are commonly used in routine electro-diagnostic practice. The median (sensory), ulnar (sensory) and radial nerves are the three most commonly tested nerves in the upper limb and sural nerve in lower limb are selected for this purpose. Data was analyzed statistically on SPSS version 17.0.

METHODS:

NCS data were collected from eighty normal healthy volunteer including 36 male and 44 female with age range 20-60 years with a normal neurological examination and no known risk factors or symptoms to suggest disease of the peripheral nervous system. Subjects were further grouped; 20-30 years m (n=10)/f (n=16), 31-40 years m (n=10)/f (n=12), 41-50years m (n=10)/f (n=10) and 51-60years m (n=6)/f(n=6).

Sensory NCS are performed by electrical stimulation of a peripheral nerve and recording from a purely-sensory portion of the nerve, such as radial nerve, sensory median (finger III), sensory ulnar (finger V) nerves of upper limbs and Sural nerve of lower limb were studied using standard recording technique. The physiological variables recorded from these nerves include, nerve conduction velocity (NCV) measured in m/sec and amplitude of sensory action potential (SAP) measures in micro-volts (uv) bilaterally. A supra maximal stimulus 20-70 μ v for the duration of 0.2 m.sec was applied in each case. The action potential evoked and displayed over oscilloscope,

from which the latency or time of onset of action potential and amplitude (peak to peak) were recorded. The sensory NCV is calculated based upon the latency and the distance between the stimulating and recording electrode¹³.

RESULTS:

The detail results of sensory nerve conduction velocity (NCV) and sensory action potential (SAP) of 80 normal healthy volunteer summarized in tables 2-5.

Table -1 shows the age and sex distribution of subjects assessed.

Table-2 and Table-3 shows comparative values of Sensory Nerve Conduction Velocity of Median (Finger I11), Ulnar (Finger V), Radial and Sural nerve in normal healthy male and female subjects respectively with their age group. No significant differences (p=0.55) were observed between the right and left sides by gender. However significant decrease (P 0.05) in the NCV of all nerves was found in male with the age group 51-60yrs. In the same age group a significant decrease (P 0.05) in the NCV were observed in sensory median and radial nerves in female Table-4 and Table-5 shows comparative values of Sensory Action Potential (SAP) of Median (Finger 111), Ulnar (Finger V), Radial and Sural nerve in normal healthy male and female subjects respectively with their age group. No significant differences (p=0.55) were observed between the right and left sides by gender. However, a significant decrease (P 0.05) in the SAP of ulnar nerve and Sural was observed in males with age group 51-60yrs.

DISCUSSION:

In the recent years electro-diagnostic studies play a key role in evaluation of patients with various neuro-muscular disorders. The nerve conduction velocity (NCV) and amplitude of SAP are useful extension of the neurological examination and can efficiently and safely answer specific questions in certain clinical scenarios, which should be contextual and hypothesis driven. The goal of this study was to generate reference data of sensory nerve conduction studies (NCS)

Table 1: Age & Sex distribution of subjects assessed:

Sex	20-30 Years	31-40 Years	41-50 Years	51-60 Years
Male	n=10	n=10	n=10	n=06
Female	n=16	n=12	n=10	n=06
Total(n=80)	26	22	20	12

TABLE- 2

Comparative Values of Sensory Nerve Conduction Velocity of Median (Finger 111), Ulnar (Finger V), Radial and Sural nerve in normal healthy male subjects with age group.

Age Group	Side	Median Sensory (Finger iii)	Ulnar Sensory (Finger v)	Radial	Sural
		SNCV (m/sec)	SNCV (m/sec)	SNCV (m/sec)	SNCV (m/sec)
20-30 Years (n=10)	Right	54.90± 1.14	54.00±1.00	57.40±0.90	52.22± 1.22
	Left	54.60± 1.03	54.50 ±0.92	57.40±1.00	52.70± 1.30
31-40 Years (n=10)	Right	54.28± 2.00	53.88±1.90	57.21±1.00	52.00± 1.00
	Left	54.40± 1.00	54.00±1.00	57.28±1.03	52.09± 1.05
41-50 Years (n=10)	Right	54.00±1.91	54.00±1.92	57.01±1.00	52.00± 1.11
	Left	54.57±2.00	54.80±2.00	57.21±1.00	52.00± 1.00
51-60 Years (n=06)	Right	46±2.44**	48.70±1.40**	47.12±0.90**	45.75±2.22**
	Left	46±2.41**	48.00±1.92**	47.00±1.00**	47.00±2.12**

Table-3

Comparative Values of Sensory Nerve Conduction Velocity of Median (Finger 111), Ulnar (Finger V), Radial and Sural nerve in normal healthy female subjects with age group.

Age Group	Side	Median Sensory (Finger iii)	Ulnar Sensory (Finger v)	Radial	Sural
		SNCV (m/sec)	SNCV (m/sec)	SNCV (m/sec)	SNCV (m/sec)
20-30 Years (n=16)	Right	54.22± 1.12	53.33 ± 0.72	57.47 ± 0.93	51.22 ± 0.97
	Left	54.58± 1.31	53.50 ± 0.54	57.50 ± 0.61	51.40 ± 0.39
31-40 Years (n=12)	Right	53.99 ± 1.12	53.30 ± 0.70	57.49 ±0.96	54.00 ± 0.99
	Left	53.96 ±1.40	53.40 ± 1.72	57.43 ±0.53	54.17 ±0.30
41-50 Years (n=10)	Right	54.00 ± 1.10	52.94 ± 1.06	55.80 ± 0.94	53.80 ± 0.90
	Left	54.40 ± 1.13	52.95 ± 1.53	56.31 ± 6.72	53.81 ± 0.06
51-60 Years (n=10)	Right	49.40 ± 0.75**	50.00 ± 0.09	46.00 ± 82**	52.50 ± 0.33
	Left	49.08 ±0.61**	51.40 ± 0.32	46.60 ± 54**	52.00 ± 0.12

Table-4

Comparative Values of Sensory Action Potential of median (Finger 111), Ulnar (Finger V), Radial and Sural nerve in normal healthy male subjects with age group.

Age Group	Side	Median Sensory (Finger iii)	Ulnar Sensory (Finger v)	Radial	Sural
		SAP (μV)	SAP (μV)	SAP (μV)	SAP (μV)
20-30 Years (n=10)	Right	28.00 \pm 1.40	18.01 \pm 0.92	37.52 \pm 2.92	29.00 \pm 1.00
	Left	28.30 \pm 1.00	18.03 \pm 0.90	37.81 \pm 2.90	29.09 \pm 0.90
31-40 Years (n=10)	Right	28.20 \pm 2.00	18.25 \pm 1.95	38.00 \pm 0.29	28.89 \pm 2.00
	Left	28.69 \pm 1.75	18.24 \pm 1.82	38.22 \pm 0.14	29.90 \pm 2.35
41-50 Years (n=10)	Right	28.00 \pm 1.98	18.00 \pm 0.90	37.00 \pm 1.29	28.00 \pm 1.82
	Left	28.20 \pm 1.45	18.23 \pm 0.89	38.00 \pm 2.09	28.06 \pm 2.00
51-60 Years (n=06)	Right	29.10 \pm 2.30	10.16 \pm 1.00**	37.33 \pm 2.48	20.92 \pm 2.20**
	Left	28.30 \pm 1.59	10.17 \pm 1.01**	37.60 \pm 2.50	21.79. \pm 2.59**

Table-5

Comparative Values of Sensory Action Potential of median (Finger 111), Ulnar (Finger V), Radial and Sural nerve in normal healthy female subjects with age group.

Age Group	Side	Median Sensory (Finger iii)	Ulnar Sensory (Finger v)	Radial	Sural
		SAP (μV)	SAP (μV)	SAP (μV)	SAP (μV)
20-30 Years (n=16)	Right	27.90 \pm 2.40	13.00 \pm 1.00	37.22 \pm 3.14	28.28 \pm 2.18
	Left	27.28 \pm 2.12	13.18 \pm 1.40	37.34 \pm 3.21	28.40 \pm 2.02
31-40 Years (n=12)	Right	27.78 \pm 2.48	13.50 \pm 1.08	37.00 \pm 2.80	28.01 \pm 2.00
	Left	27.72 \pm 2.04	13.29 \pm 1.71	37.07 \pm 2.53	28.80 \pm 1.99
41-50 Years (n=10)	Right	26.95 \pm 1.35	13.00 \pm 0.01	36.70 \pm 1.29	26.01 \pm 0.93
	Left	26.73 \pm 1.25	13.13 \pm 0.11	36.09 \pm 1.50	26.33 \pm 1.11
51-60 Years (n=06)	Right	24.00 \pm 1.12**	11.95 \pm 1.20	29.33 \pm 1.20**	25.82 \pm 1.20
	Left	24.10 \pm 1.14**	11.87 \pm 1.04	29.16 \pm 4.59**	26.66 \pm 1.37

that are commonly used in routine electro-diagnostic practice. In this study no statistically significant difference was found in conduction velocity and amplitudes of action potential in sensory peripheral nerves of upper and lower limb (right and left side) by gender, as it is found by Benatar et al.¹ and Kwon et al.³ in their study.

We also found that there is a significant and substantial decline in values of sensory nerve conduction velocity of all the sensory nerves of upper and lower limbs with increasing age in men. In support of our study, McKnight et al.⁴, Tong et al.⁷, and Awang et al.⁸ in their study, showed decrease in NCV in older age group as compared to the younger individuals. Changes occur at a greater rate in median and radial nerve in both male and female due to increased susceptibility of the median nerve to repetitive motion trauma^{9,10} or higher intracarpal canal pressure with contract stress and awkward wrist posture^{11,12}. It is widely accepted that electro physiological changes are probably related to the normal histological ageing changes in peripheral nerves^{13,14}.

Further, we found decreased amplitude of SAP in median and ulnar nerves in female with age group 51-60 years, whereas reduced amplitude of SAP were found in ulnar and sural nerves in males with same age group. Ivner et al.¹² in his study found that the subjects with older age had smaller amplitudes compared to the younger age group. With normal aging, probably there may be decrease in amplitude of SAP in older age individuals may be due to decrease or loss in the number of nerve fibers. Similar decrease in SAP amplitude of the median, ulnar, radial and sural nerves also found in older individuals. This may be due to loss of nerve fibers in older individuals^{15,16}.

CONCLUSION:

Efforts to develop reference data require careful selection of study subjects; sufficient sample size; adjustment for relevant covariates; and appropriate statistical methods for analysis. Reference data that cannot be estimated reliably due to absent potentials or data variability must be

interpreted with caution. We present data for a range of clinically applicable reference

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