Original Article

Median Nerve Conduction in Healthy Nigerians: Normative Data

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Abstract

Background: Because of lack of local normative data, electrodiagnostic laboratories in Nigeria apply standard values generated in the USA and Europe to diagnose different median nerve abnormalities. **Aim:** To develop normative values for motor and sensory median nerve conduction studies (NCSs) in Nigerian population. **Subjects and Methods:** In a cross-sectional study design, a total of 200 healthy volunteers were selected after clinical evaluation to exclude systemic or neuromuscular disorders. NCS of the median nerves was conducted on all the healthy volunteers according to a standardized protocol. The data included in the final analysis were amplitude, latency, and nerve conduction velocity. Ethical approval was obtained for the study. **Results:** The reference range for median nerve (motor) velocity, distal latency, and amplitude were 49.48–66.92, 1.95–4.52, and 4.3–11.3, respectively. The reference range for median nerve F-wave latency was 44.8–70.5. The reference range for median nerve (sensory) velocity, distal latency, and amplitude were 44.8–70.5, 1.98–4.52, and 16.6–58.4, respectively. **Conclusion:** Reference values for the nerve conduction parameters of the median (motor and sensory) in the study population were similar to those obtained in the literature.

Keywords: Median nerve, Nerve conduction studies, Normal values

Introduction

Nerve conduction study (NCS) is, to a large extent, an extension of the clinical history and examination. It can be extremely useful for localizing lesions and determining the pathological processes.

The median motor study is one of the most commonly performed tests in electrodiagnosis. It has been extensively used in the research field as well as in clinical practice.[1] Data on peripheral nervous system function may be of use in providing diagnosis, description of the disease state, monitoring of median nerve disease using multiple studies, and rendering advice on prognosis and management based on the test results and the disease detected.[2-7]

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It is obviously preferable in a clinical setting to have reference data derived from a sample population that approximates, as closely as possible, the demographic characteristics of the patient being tested.[8]

Many studies have been published from the Western and Middle East countries regarding normative data for median nerve.[9-14] However, to the best of our knowledge, there has not been such study from Nigeria in the literature. Thus, the very few electrodiagnostic laboratories available in the country have been applying standard values generated in the USA and Europe to diagnose different median nerve abnormalities.

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The study was, therefore, designed to obtain a set of data of median motor and sensory nerve conduction from healthy Nigerians to establish normative data for the local electromyography (EMG) laboratories and to compare the Nigerian values with worldwide published data.

Subjects and Methods

In a cross-sectional study design, a total of 200 healthy volunteers, calculated using Cochran's sample size formula for continuous data[14] were selected using simple random sampling technique. The data were collected over a 6-month period at the neuro-diagnostic laboratory of the Aminu Kano Teaching Hospital, Bayero University, Kano, Nigeria. All individuals were screened for inclusion criteria that comprised normal neurological physical examination, the absence of symptoms of neuropathy from any cause and absence of alcohol use.

A standardized questionnaire was used to exclude those with a history of systemic or neuromuscular diseases. Individuals that were excluded included those with a history of alcohol abuse or medications that might affect the results, and those with a history of diabetes, hypothyroidism, and systemic diseases. None of the individuals was taking any medication at the time of conducting the EMG study. A basic neurological examination was performed to assess muscle power, stretch reflexes, and sensations.

The EMG study was performed with the subject lying comfortably in the supine position. A standardized technique was used to obtain and record action potentials for motor and sensory functions.[15] The protocol adopted in the current study was like that elsewhere, with minor alteration.[16] The setting for a four-channel EMG machine (Nihoen Kohden) used in the study was as follows: For median motor nerve conduction, the low cut filter was 2–5 Hz and the high cut was 10 KHz. Regarding sensory median nerve conduction, low cut was set at 5–10 Hz, high cut was set at 2–3 KHz; the amplification between 20,000 and 100,000 times; electrode impedance was kept below 5 kΩ and the sweep speed for sensory nerve conduction was maintained at 1–2 ms/division while for motor nerve conduction: 2–5 ms/division; and a stimulus duration of 50 μs to 1000 μs and current 0–50 mA were used for effective nerve stimulation. Supramaximal stimulation (20–30% more than the current required for maximal action potential) was used.

Data were collected for proximal and distal latency measured from the onset of the action potential, conduction velocity, and amplitude of compound muscle action potential and sensory nerve action potential were measured from positive peak to the negative peak. All the studies were performed with surface recordings and stimulations.

Proximal median nerve stimulation was performed medial to biceps brachii tendon at the elbow crease whereas the distal median stimulations were performed 10–13 cm proximal to the active surface electrode. The site was medial to flexor carpi radialis tendon for the median nerve.

The median motor nerve was examined orthodromically. The nerve was stimulated with bipolar surface stimulating electrode at two points along its course. The action potential was recorded with a surface electrode placed close to the motor point of abductor policis brevis muscle. A ground electrode was placed between the stimulating and recording electrodes.

Sensory nerve conduction was measured antidromically. The sensory nerve conduction velocity (NCV) was measured by stimulating at a single site. The sensory conduction velocity was calculated by dividing the distance between the stimulating and the recording sites by latency.

Skin surface temperatures were measured over the dorsum of the hand.

All data generated were collated, checked, and analyzed using a computer-based Statistical Package for the Social Sciences version 20 (SPSS Inc. Chicago, IL, USA). Quantitative variables were described using mean with standard deviation and median with a range in the case of parametric and nonparametric data, respectively. The normal reference range of nerve conduction values was set by the 2½ and 97½ percentiles so that reference ranges contain the central 95% of the distribution.

Informed Consent was taken from each of the participants, and ethical approval was obtained from the Ethical Review Committee of the Aminu Kano Teaching Hospital Kano.

Results

Two hundred healthy volunteers comprising 116 (58 %) males and 84 (42%) females were evaluated. Their ages ranged between 11 years and 91 years with a mean age of 44.95 (20.7) years. One hundred and thirteen (56.5%) of them were within the age bracket of 30 and 59 years. Table 1 shows age by sex distribution of the study volunteers.

The mean median nerve motor velocity in the healthy volunteers was 64.26 (4.9) with 2.5 and 97.5 percentile of

Table 1: Age distribution of the healthy volunteers

Age group	Male	Female	Total
10-19	18	8	26
20-29	12	9	21
30-39	27	8	35
40-49	7	26	33
50-59	25	20	45
60-69	10	4	14
70-79	0	3	3
80-89	13	6	19
90-99	4	0	4
Total	116	84	200

49.48 and 66.92, respectively. The mean latency of median nerve in the healthy volunteers was 3.0 (0.5) with 2.5 and 97.5 percentile of 1.95 and 4.52, respectively. The mean amplitude of median nerve in the healthy volunteers was 7.7 (1.95) with 2.5 and 97.5 percentile of 4.3 and 11.3, respectively [Table 2]. The median F-wave latency of median nerve (motor) in the healthy volunteers was 57.5 with 2.5 and 97.5 percentile of 44.8 and 70.5, respectively [Table 2].

The average median nerve sensory velocity in the healthy volunteers was 58.35 (6.79) with 2.5 and 97.5 percentile of 44.8 and 70.5, respectively. The mean latency of median nerve (sensory) in the healthy volunteers was 2.89 (0.64) with 2.5 and 97.5 percentile of 1.98 and 4.52, respectively. The mean amplitude of median nerve (sensory) in the healthy volunteers was 37.25 (9.93) with 2.5 and 97.5 percentile of 16.6 and 58.4, respectively [Table 3]. There was a fair increase in latency and a reduction in amplitude and velocity with increasing age [Table 4]. Table 5 shows a comparison of the values of median nerve conduction parameters to findings elsewhere.

Table 2: Velocity, latency, and amplitude of median nerve (motor) in healthy volunteers

Median nerve (motor)	Velocity	Distal latency	Proximal latency	Amplitude	F-wave latency
Mean	62.46	3.05	6.8	7.7	57.5*
SD	4.9	0.5	0.8	1.95	-
2.5 percentile	49.48	1.95	5.0	4.3	44.8
97.5 percentile	66.92	4.52	8.9	11.3	70.5

*Median. SD: Standard deviation

Table 3: Velocity, latency, and amplitude of median nerve (sensory) in healthy volunteers

Median nerve (sensory)	Velocity (m/s)	Latency (ms)	Amplitude (μv)
Mean	58.35	2.89	37.25
SD	6.79	0.64	9.93
2.5 percentile	44.8	1.98	16.6
97.5 Percentile	70.5	4.52	58.4

SD: Standard deviation

Table 4: Nerve conduction parameters across age groups

Age group (year)	Median nerve conduction parameters mean (SD)			
	Latency (ms) (SD)	Amplitude (mv or microV) (SD)	Velocity (m/s) (SD)	F-wave latency (ms) (SD)
Motor				
<20	3.19 (3.2)	9.31 (2.0)	66.24 (4.3)	28.17 (4.2)
21-40	2.90 (0.3)	7.85 (1.6)	64.24 (2.8)	26.38 (4.0)
41-60	2.82 (0.4)	7.12 (1.5)	62.26 (3.1)	25.97 (5.2)
61-80	3.09 (0.4)	6.52 (0.6)	60.16 (4.5)	27.24 (6.4)
>80	4.20 (0.1)	4.90 (0.3)	51.87 (4.0)	25.78 (4.7)
Sensory				
<20	2.73 (0.6)	38.12 (9.9)	61.17 (6.1)	
21-40	2.77 (0.5)	39.70 (9.4)	59.55 (7.0)	
41-60	3.01 (0.7)	34.20 (10.8)	57.84 (4.6)	
61-80	3.19 (0.7)	39.70 (6.9)	54.49 (7.6)	
>80	3.10 (0.1)	28.80 (7.9)	50.50 (6.2)	

SD: Standard deviation

Discussion

Normal data of motor and sensory NCSs for median nerve were provided through this study. The results of the motor parameters of the median nerve was similar to the motor nerve conduction parameters reported by Hennessey *et al*.,[11] Shehab,[20] and Karagoz *et al*.[21]

The median nerve motor action potential amplitude in the current study was similar to that of Mishra and Kalita[22] and Shehab,[20] but higher than that of Kimura[15] and Karagoz *et al*.[21] Similarly, the median motor conduction velocity as well as distal latency were all in agreement earlier observations reported in the literature.[20,21]

Conduction velocities are usually used to assess the relative health of the nerve. Any disorder that affects the median nerve, for instance, by damaging the myelin sheaths or destroying the membranes or membrane transport, or impinging on the nerve could be reflected by an alteration in NCV of the patient. Examples of conditions that can affect the median nerve, such as other peripheral nerves in the body, include carpal tunnel syndrome (CTS), traumatic median nerve damage, acute inflammatory polyneuropathy, chronic inflammatory polyneuropathy, diabetic polyneuropathy, drug-induced median nerve palsy, etc.

F-wave latency in the current study is also in agreemen with studies elsewhere.[23] Although the exact mechanism responsible for the F-wave is unknown. The F-wave, which was first labeled by Magladery and McDougal and first thought to be reflex in origin,[24] is generally accepted as resulting from antidromic activation of alpha motoneurons.[25,26] Some authors reported that the antidromic impulse caused depolarization of the alpha motoneuron's soma-dendritic membrane and subsequent orthodromic impulse propagation after a brief central delay at the cell body.[18]

Some authors have attempted to use F-wave conduction values as diagnostic means in conditions that involve the proximal parts of peripheral nerves. It has been reported to be useful in the assessment of conditions such as Charcot–Marie–Tooth disease,[19] Guillain–Barre syndrome,[27] chronic renal failure,[17] entrapment neuropathies,[28] radicular injury,[29] motor neuron disease,[30] diabetes,[31] and hemiplegia.[32] However, a lot of controversy surround the acceptance of its use for clinical assessment, on the ground that its variability in latency, the shape of waveform, occurrence, and the potential technical errors have some bearing on the calculation of the conduction velocity of the F-wave.[33]

For the median sensory parameters, the sensory NCV is less than that reported by Hennessey *et al*.[11] and Karagoz *et al*.[21]

Table 5: Comparison of median motor nerve conduction study parameters to studies elsewhere

Study	Sample size	Age group	Distal latency (SD)*	Amplitude (SD)*	Velocity (SD)
Kimura 1986[15]	61	11-74	3.49 (0.34)	7.00 (3.0)	57.70 (4.9)
Mishra and Kalita[17][22]	26	16-59	3.77 (0.40)	8.10 (2.6)	58.52 (8.3)
Magladery and McDougal[24]	21	26-55	3.20 (0.40)	12.10 (3.8)	45.1-54.4
Buschbacher, Ralph[1]	249	Adult	3.7 (0.5)	10.2 (3.6)	57.0 (5)
Hennessey and Falco[9]	44	Young adult	3.70 (0.50)	10.20 (3.6)	57.00 (5.00)
Current study	200	11-86	3.00 (0.50)	7.70 (2.0)	62.5 (4.90)

*At wrist. SD: Standard deviation

but similar to the results of Shehab,[20] Awang *et al*.[34] and Kimura.[15] Nonetheless, it should be noted that the median nerve sensory amplitude reported in our study was peak-to-peak amplitude which should be higher than base-to-peak amplitude. For instance, the mean value of the median sensory nerve amplitude obtained in the current study was 37.25 μv which is comparable to 38.55 μv obtained by Kimura[15] in his study because peak-to-peak amplitude was measured in both cases. This figure, however, was higher than 8.91 μv reported by Mishra and Kalita[22] which was base-to-peak amplitude.

The median nerve of the hand, whose integrity is central to normal hand function, can be damaged by metabolic disturbances, entrapment neuropathies and/or ischemia. Nonetheless, abnormality in this nerve frequently goes unrecognized as the signs of CTS are found in 20–30% of diabetic patients on electrophysiological examination,[35] whereas clinical signs are seen in only 5.8% of patients.[36] Besides, CTS occurs 3 times more often in diabetes than in the general population.[37] Diabetes mellitus can affect the median nerve as a mononeuropathy or as part of a systemic polyneuropathy, both conditions being associated with widespread nerve damage, not confined to the carpal region.[37]

In this study, there was a fair increase in latency and a reduction in amplitude and velocity with increasing age. Previous studies indicate that NCV decreases with age,[38,39] but the relationship between age and NCV or which nerves are most involved remains unclear. There is little agreement on equations to correct for age, similarly, distal latency was reported to vary with age.[40]

NCS normative values are used to define the limits of normal function, with test values outside the range, suggesting the presence of some form of neuropathy. For NCS, reference values should be established from the local population because previous studies have shown differences in NCS function related to ethnicity and demographic factors.[5,6]

Judgment on whether the value derived from an assessment of median nerve, in a patient from a particular population, is normal or not is anchored on what is normal for that population. It is, therefore, reasonable in a clinical setting to generate normative data derived from a sample population that approximates, as closely as possible, the demographic characteristics of the patient being tested. This study has come up with such data for the median nerve in a Nigerian Population. We are hopeful that these data will be of use in making clinical decision as regards median nerve conduction in our setting.

However, it is worthy of note that there are many sources of error which need be taken into consideration while interpreting NCS parameter from any nerve. The temperature affect NCS, but in our study, temperature control parameter was not taken into consideration, thus, these results might directly be applicable to patients seen in routine EMG laboratories in resource-poor setting where facilities for temperature control is not available.

Conclusion

Normative conduction parameters of median nerve were established for Nigerian population. The overall mean sensory and motor nerve conduction parameters for the median nerve compared favorably with the existing literature data.

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Conflicts of interest

There are no conflicts of interest.

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