Determination of normal values of nerve conduction of Tibial and Peroneal nerves among normal healthy subjects

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Abstract

Nerve conductive studies are the most informative portion of the electrodiagnostic evaluation for a peripheral neuropathy. It is preferable to design a nerve conductive study for each type of disease or syndrome in our locality by answering specific questions. Recently, there is increased interest in quality of normative values for each test result and compare should be done between normal and patients regarding specific disease. So, the aim of the present study is to determine the normal values of nerve conductive study of tibial and peroneal nerves among normal healthy subjects in Tikrit city. The study has been conducted at rheumatology department neurophysiology unit at Tikrit teaching hospital at the period from 15th November 2011 to 15th of May 2012. Two hundred and ten (210) normal healthy volunteers from medical students & medical staff from Tikrit teaching hospital (TTH) participates in the present study to evaluate the normal values of NCS for different age groups. The normal healthy subjects consist of 210 volunteers according to age groups:

Group 1- Ninety subjects aged 20 to 29 years (50 male 40 female). Group 2- Forty subjects aged 30 to 39 years (20 male 20 female). Group 3- Forty subjects aged 40 to 49 years (20 male 20 female). Group 4- Forty subjects aged 50 to 59 years (20 male 20 female). The NCS was done by NIHON KOHDEN / Neuropack S1 EMG / EP Measuring System MEB-9400 Model 2009. In male subjects, there is no significant difference regarding conductive velocity between right & left tibial nerves at age group 30-39 as compare to 20-29 years.

However, there is significant reduction in NCV of both right & left tibial nerves at age group 40-49 years as compare to age group 20-29 years. Also, there significant reduction in NCV of right & left tibial nerves at age group 50-59 years (42.85 ± 9.1 * & 40.2 ± 5.8 ** respectively) as compare with right & left tibal nerves at age group 20-29 years (47.81 ± 5.41 & 46.84 ± 2.2 respectively). In female subjects, there is no significant difference regarding conductive velocity of left tibial nerve at age group 30-39 as compare with age group 20-29 years. However, there is significant reduction in NCV of right tibial nerve at age group 30-39 years (42.01 ± 5.3** p=0.01) as compare to the same nerve at age group 20-29 years, (47.54 ± 5.33 m/sec). While, there is significant reduction in NCV of both right & left tibial nerves at age group 40-49 years (34.85 ± 9.5**, 37.46 ± 5.65** respectively) as compare to age group 20-29 years (47.54 ± 5.33 m/sec, 46.41 ± 2.53 respectively). Also, there significant reduction in NCV of right & left tibial nerves at age group 50-59 years (40.15 ± 9.1 * & 40.55 ± 7.46 ** m/sec respectively) as compare with right & left tibal nerves at age group 20-29 years (47.54 ± 5.33 & 46.41 ± 2.53 m/sec respectively).

Key words: Tibial, peroneal nerves, conduction velocity, men, women, Iraq.

Introduction

Nerve conduction study (NCS) is a test commonly used to evaluate the function, especially the ability of electrical conduction, of the motor and sensory nerves of the human body (1). Nerve

conductive study helps in delineating the extent distribution of neural lesion , also it used in the diagnosis of peripheral nerve disorders, it enables clinicians to differentiate the two major groups of peripheral diseases: demyelination and axonal degeneration (2,3,4).

Nerve conductive studies are the most informative portion of the electrodiagnostic evaluation for a peripheral neuropathy. It is preferable to design a nerve conductive study for each type of disease or syndrome in our locality by answering specific questions, (6-8).

Recently, there is increased interest in quality of normative values for each test result and compare should be done between normal and patients regarding specific disease, (9-11). So, the information obtain narrows the differential diagnosis and helps to plan treatment and determine the prognosis, (1-3).

The classification of biological conditions into normal and abnormal are the principle basis of medical science. without it, there could be no health serves (1, 12).

Yet none of standard books of physiology and medical textbook provides clear definition of normality. 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, (13-15).

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 interpretation, (16-18).

Recently, there has been increased attention to the quality of normative data against which test results are compared, because there is no normal values for NCS in Iraq, (9-11).

So, the aim of the present study is to determine the normal values of nerve conductive study of Tibial and peroneal nerves among normal healthy subjects in Tikrit city.

Subjects & Methods

The study has been conducted at rheumatology department neurophysiology unit at Tikrit teaching hospital at the period from 15th November 2011 to 15th of May 2012

Two hundred and ten (210) normal healthy volunteers from medical students & medical staff from Tikrit teaching hospital (TTH) participates in the present study to evaluate the normal values of NCS for different age groups.

The normal healthy subjects consist of 210 volunteers according to age groups:

Group 1- Ninety subjects aged 20 to 29 years (50 male 40 female)

Group 2- Forty subjects aged 30 to 39 years (20 male 20 female).

Group 3- Forty subjects aged 40 to 49 years (20 male 20 female).

Group 4- Forty subjects aged 50 to 59 years (20 male 20 female).

Body height: measured by digital height scale to the nearest centimeter **Body weight:** measured by digital weight scale to nearest 100 gram. Body mass index: calculated by the formula (Kg/m^2) weight in kilogram divided by height in meter square.

The nerve conduction studies were done for Tibial & peroneal nerves & performed as compound muscle action potentials (CMAPs) for motor nerves, sensory nerve action potentials (SNAPs) for sensory nerves.

Motor parameters were as follows: 1- Distal latency; 2-Amplitude: 3- Conduction velocity (CV) : is how fast the nerve is propagating an action potential measured by meter/second.

All data were presented as a mean and standard deviation (S.D). Unpaired T test was used to compare between means groups. P value less than 0.01 and 0.05 were accepted as significant value.

Results

Two hundred & ten subjects were participated in this study (110 male & 100 female subjects) of different age groups.

Table 1 shows the age, body weight, height & body mass index (BMI) of all subjects classify according to gender.

Table 2 shows the characteristic features of male subjects distributed according to age groups. Also, table 2 showed the mean & standard deviation of age, body weight, height & BMI of male subjects distributed according to age groups.

There are no significant differences regarding body height between subjects at different age groups.

Although, table 3 shows the mean & standard deviation of age, body weight, height & BMI of female subjects distributed according to age groups.

Result of men conductive velocity

The result of conduction velocity was compare between age groups, the age group 20-to 29 years regarded as control group to other groups.

In male subjects, there is no significant difference regarding conductive velocity between right & left tibial nerves at age group 30-39 as compare to 20-29 years.

However, there is significant reduction in NCV of both right & left tibial nerves at age group 40-49 years as compare to age group 20-29 years, (table 4).

Also, there significant reduction in NCV of right & left tibial nerves at age group 50-59 years (42.85 ± 9.1 * & 40.2 ± 5.8 ** respectively) as compare with right & left tibal nerves at age group 20-29 years (47.81 ± 5.41 & 46.84 ± 2.2 respectively), table 4.

Moreover, in male subjects, table 4 shows that there is no significant difference regarding conductive velocity of right & left peroneal nerves in men at age group 20-29 as compare to 30-39 years.

However, there is significant reduction in NCV of both right & left peritoneal nerves at age group 40-49 years (39.82 ± 7.98** & 43.07 ± 6.6* respectively) as compare to same nerve at age group 20-29 years (46.65 ± 8.4 & 48.1 ± 5.55 respectively), (table 4).

Also, there significant reduction in NCV of right & left peritoneal nerves of both right & left at age group 50-59 years (40.2 ± 5.8 * & 37.77 ± 8.8 ** respectively) as compare with right & left tibal nerves at age group 20-29 years (46.65 ± 8.4 & 48.1 ± 5.55 respectively), table 4.

Result of conductive velocity in female subjects (table 5)

The result of conduction velocity was compare between age groups, the age group 20-to 29 years regarded as control group to other groups.

In female subjects, there is no significant difference regarding conductive velocity of left tibial nerve at age group 30-39 as compare with age group 20-29 years.

However, there is significant reduction in NCV of right tibial nerve at age group 30-39 years (42.01 ± 5.3** p=0.01) as compare to the same nerve at age group 20-29 years, (47.54 ± 5.33 m/sec), (table 5)

While, there is significant reduction in NCV of both right & left tibial nerves at age group 40-49 years (34.85 ± 9.5**, 37.46 ± 5.65** respectively) as compare to age group 20-29 years (47.54 ± 5.33 m/sec, 46.41 ± 2.53 respectively), (table 5).

Also, there significant reduction in NCV of right & left tibial nerves at age group 50-59 years (40.15 ± 9.1 * & 40.55 ± 7.46 ** m/sec respectively) as compare with right & left tibal nerves at age group 20-29 years (47.54 ± 5.33 & 46.41 ± 2.53 m/sec respectively), table 5.

Moreover, in female subjects, table 5 shows that there is no significant difference regarding conductive velocity of right & left peroneal nerves at age group 30-39 years as compare to the same nerve at age group 20-29 years.

However, there is significant reduction in NCV of both right & left peritoneal nerves at age group 40-49 years (42.14 ± 9.43** & 40.17 ± 4.2* respectively) as compare to same nerve at age group 20-29 years (48.70 ± 4.0 & 49.62 ± 6.12 respectively), (table 5).

Also, there significant reduction in NCV of right & left peritoneal nerves of both right & left at age group 50-59 years (33.39 ± 8.7 ** & 42.97 ± 11.6 ** respectively) as compare with right & left tibal nerves at age group 20-29 years (48.70 ± 4.0 & 49.62 ± 6.12 m/sec, respectively), table 5.

Discussion

The introduction of techniques of measuring nerve conduction velocity in human in vivo was important milestone in the evaluation of patients with neuromuscular disorders, (19-20).

The categorizations of biological phenomena into normal & abnormal are at the foundation of medical practice. Without it, there could be no health services. It is therefore of fundamental consequence to know what this dichotomy is based. Yet, none of standard physiology & medical textbooks provides a clear & un ambiguous definition of normality, (13-14).

The present study is the first study that investigates the influence of specific personal factors age, BMI, gender, were evaluate on nerve velocity of Tibial & peroneal nerves among normal healthy subjects in Tikrit city.

There are many studies on nerve conduction study that have been done elsewhere. These include the factors that affect nerve velocity. These factors can be divided into biological factors (age, height, gender) & physical factors which are related to the physical state of nerve & muscle, (21-23).

The present study showed that conduction velocity of motor fibers of tibial nerve is similar in female as compare with male counterpart in all age groups.

The same finding was true for motor activities of peroneal nerve at all age groups.

The low value of nerve conduction velocity of motor fiber of peroneal nerve

of right dominant leg in men & women as a compare to left leg may be explain there is significant delay in conduction velocity as physical activity & repetitive motion may cause stretching of nerve with unyielding musculotendinous compartments followed by fascicular thickening, (24-25).

Nerve conduction velocity can be easily measured on peripheral nerves. The velocity is directly depended on the diameter of fiber myelination & temperature, (26-28).

In the present study, there is significant decrease in nerve conduction velocity Tibial & Peroneal nerves in male and female subjects at age above 50 to 59 years old as compare with subjects at age of 20-30 years old.

Flack et al found that age has a significant effect on sensory nerve conduction velocity, (29). Also, previous results showed that conduction velocity of median nerve in newborns is approximately 50% of adult values & progressively increase and reaches the adult value at the age of three. Later, in adulthood, the nerve velocity decrease with age, more in the lower than in upper limbs, (26-31).

A similar observation was made by stalberg and Flack for motor nerve conduction, (30).

Also, Tong et al 2004 in their study in the effect of aging on sensory nerve conduction study noticed that the rate of change in parameters was significantly greater in median nerve than ulnar nerve, (31).

Moreover, Awang et al (2006) showed slowing of nerve velocity with increasing age in median nerve. Similar observation was noticed in the motor and sensory velocity of the ulnar nerve, (27). It was found a significant reduction in motor median nerve conduction velocity at 50 years and above (50.9±5.3 m/s) as compare with subjects at age 20-30 years (57.6±5.7m/s).

Conduction velocity begin to decline after 30-40 years of age, but the values normally changes by less than 10 m/s by the sixtieth years, or even the eightieth years (31-32). The result of other study showed that a reduction in the mean of conduction rate of about 10 % at 60 years of age, (33-34).

Leelasamran et al (2005) found in study on 100 adult volunteers aged 30 to 40 years, (35). They showed that tibial motor nerve at age 30-40 years had a conduction velocity of (58.0±3.7 m/s), distal latency (3.6±0.4 ms) & amplitude of (10.7±3.1 m v).

The present study conclude that there are a reduction in nerve conduction velocities of both tibial & peroneal nerves with advance in age especially above 50 years.

This reduction in NCV with age is attributed to decrease number of nerve fibers, a reduction in fiber diameters and change in fiber membranes, (36-38).

References

1- Koelslag, GH. What is normal? South African Medical J. 1993; 83: 47-50.

2- Mavor H, Libman I. Motor nerve conduction velocity measurement as a diagnostic tool. Neurology. 1962; 12: 733-44.

3. Mavor, H., libman. motor nerve conduction velocity measurement. as a diagnostic tool. Neurology 1962; 12: 733-44.

4. Tetro, Am., Evanott, BA., Hollstein, SB., Gelberman, RH. A new provocative test for CTS. J. Bone and Joint surgery 1998; 80 (3); 493 - 8.

5. Ali , SH. Clinical electrophysiological demylinaty polyneuropathy. Ph.D Thesis. University. of Al - Mustansiriyah . 2007.

6. Al- Fiadh., AK. Evolution and clinical tests FICM specialization in fracture and orthopedic surgery Thesis. 2002.

7. Sulaiman, MG. NCS and EMG in rheumatoid arthritis patients. A case control study. M.Sc. Thesis. university of Mosul. 2010.

8. Jun Kimura M.D. Electrodiagnosis in disease of nerve and Muscle. principles and practice 2nd. edition. 2001.

9. Jaffer, HA., Marbut MM., AL- Samarai, AG. Electromyography and Nerve conductive studies in the diagnosis of lumbosacral radiculopathies. Tikrit medical Journal. 1999; 5; 235 -239.

10. Ismaeel, UT. Determination of normal values of median and ulnar nerve conduction study among normal healthy subjects. M.Sc thesis of Tikrit 2012.

11. Abod, MA. Clinical of nerve conduction study governorate. finding in diabetic neuropathy patients in Salah Aldeen governorate M.Sc Thesis submitted to college of medicine. university of Tikrit. 2012.

12- Barrette, KE., Barman, sm., Boitnus, B, Brooks. HL. Ganong's Review medical physiology. 23 edition. McGraw Hill company. 2010 ; p 97 - 100.

13. Guyton and Hill. Text book of medical physiology 12th edition. NY. Saunders. 2001; p.73- 74.

14. Tonzola, RF., Ackil, AA., Shahani, BT. Usefulness of Electrophysiological studies in the diagnoses of lumbosacral root diseases . Ann. Neurol. 1981; 9 : 305-8.

15. Lange, DL., Lator, N., A. Multifocal motor neuropathy with conductive block. Neurology. 1992; 42:497 - 505

16. Berger., AR., Bradley, WC., Brannagen, E. Guidelines for diagnosis and treatment of chronic inflammatory demyelinating polyneuropathy. J. Peripher. Nerve Sys. 2003; 8: 282 - 4.

17. Hughes. Clinical evaluation of investigation of neuropathy. JNWP. 2003; 74: 3-8.

18. Lindin, HP. Electromyography in practice. Stuttgart. 2nd edition. 2003; 17 - 70.

19. Katz., Js., Saperstation, DS., Amato., A., of Barohn, Rj. Distal acquired demyelination symmetric neuropathy. 2000; 54; 615- 20.

20-Bjorn, FE., Stalberg, E., Biscoff, C. Sensory nerve conduction studies with surface electrodes. methods in Clinical neurophysiology. 1994; s; 1- 20.

21. Umara, MU. Design of new model for detecting the presence of presence of peripheral diabetic neuropathy in Iraqi subjects. M.Sc thesis submitted to the college of medicine, Al - Mustansiryah university 2005; p 6.

22. Perajan, JH. Clinical electromyographic studies of diseases of the motor unit. Clin. Neurophysiol. 1947; 36: 395 - 401.

23. Miched, J. Elecrodiagnoses in clinical Neurology 2nd edition. NY., Churchill Livingstone. 1986;

24. Ghosh, EH. A practical definition of conductive block. JNNP. 2005; 376: 1264 - 68.

25. Oh, SJ ., Kim, DE, Kuruoghu, HR. what is the best diagnostic index of conduction block of temporal disperation? . Muscle and nerve. 1994; 17; 489- 93.

26-Stetson DS, Albert JW, Wolfe RA. Effect of age, sex & anthropometric factors on nerve conduction measurements. Muscle & Nerve. 1992; 15:1095-1104.

27- Awang MS, Abdullah JM, Tahir A, Razak SM. Nerve conduction study among healthy Malays. The effect of age, height & BMI on median & ulnar nerves. Malaysian J. Medical science. 2006; 13: 19-23.

28- Buschbacher RM. Body mass index effect on common nerve conduction study measurements. Muscle & nerve. 1988; 21(1): 1348-404.

29-Flack B, Stalberg E, Bischoff C. Sensory nerve conduction study with surface electrodes. Methods in clinical neurophysiology. 1994; 5; 1-20.

30- Stalberg E, Flack B. Clinical motor nerve conduction studies. Methods in Clinical Neurophysiology. 1993; 4: 61-80.

31-Tong HC, Werner RA, Franblau A. Effect of aging on sensory nerve conduction study parameters. Muscle & Nerve. 2004; 29 (5): 716-20.

32- Taylor PK. Non-linar effect of age on nerve conduction in adults. J. Neurol. Sci. 1984; 66: 223-234.

33- Johnson EW, Olsen KJ. Clinical value of motor nerve conduction velocity determination. JAMA. 1960; 2030-35.

34-Flaco FJE, Hennessey WJ, Goldberg G. Standardized nerve conduction studies in the upper limb of the healthy elderly. Am. J. Phys. Med. Rehabil. 1992; 71: 263-271.

35- Leelasamran W, Permisirvanich w, Boonmeeprakob A. Conduction velocity studies of median nerve. Songlanagarind Medical J. 2005; 23(6): 1635-40.

36- Melsbach G, Wohlschlager A, Spiess M. Morphological asymmetries of motor neurons innervating upper extremities. Int. J. Neeuroscience. 1996; 86: 217-20.

37- Tan U. Velocity of motor & sensory nerve conduction are the same for right and left arms of normal subjects. Percept Motor Skills. 1985; 60: 625-29.

38- Seema B, Rati B. Effect of limb dominance on motor nerve conduction. Indian J. Physiolo. Pharma. 2009; 53(3): 279 - 82.

Table (1): Characteristic features of all subjects according to gender

	Male subjects	Female subjects
Number	110	100
Age (years)	35.4 ± 12.31	36.6 ± 12.87
Body Weight (kg)	81.5 ± 14.7	73.6 ± 15.9
Height (cm)	175.1 ± 7.8	159.8 ± 16.7
BMI (kg/m2)	26.6 ± 4.7	28.4 ± 5.3

Table (2): Characteristic features of male subjects according to age groups

	20-29 years	30-39 years	40-4 years	50-59 years
Number	50	20	20	20
Age (years)	24.08 ± 2.84	35.2 ± 3.0	44.5 ± 2.8	54.85 ± 3.01
Body Weight (Kg)	73.2 ± 11.2	87.4 ± 10.5	82.7 ± 14.01	95.2 ± 13.8
Height (cm)	174.6 ± 8.19	177.6 ± 7.11	174.4 ± 8.7	174.6 ± 6.90
BMI (Kg/M^2)	24.04 ± 3.7	27.7 ± 3.57	27.17 ± 4.21	31.3 ± 4.37

Table (3): Characteristic features of female subjects according to age groups

	20-29 years	30-39 years	40-49 years	50-59 years
Number	40	20	20	20
Age (years)	23.7 ± 2.83	34.8 ± 2.7	45.05 ± 3.1	55.9 ± 2.4
Body Weight Kg	64.5 ± 13.8	71.6 ± 9.17	79.55 ± 11.6	88.1 ± 16.6
Height (cm)	156.7 ± 25.5	162.05 ± 4.7	161.05 ± 5.67	162.8 ± 5.8
BMI kg/m^2	25.5 ± 3.6	27.3 ± 3.7	30.7 ± 4.9	33.2 ± 5.75

Table (4) show comparison of conduction velocity of motor of Tibial & peritoneal nerves between right & left leg according to age groups in men.

Motor activity of Tibial nerve	20-29 years	30-39 years	40-49 years	50-59 years
Conduction velocity of right leg (m/sec)	47.81 ± 5.41	46.68 ± 5.1	40.17 ± 9.1 **	42.85 ± 9.1 *
Conduction velocity of left leg (m/sec)	46.84 ± 2.26	46.94 ± 4.7	39.82 ± 7.9 **	40.2 ± 5.8 **
Motor activity of Perioneal Nerve.				
Conduction velocity of right leg (m/sec)	46.65 ± 8.4	46.94 ± 4.7	39.82 ± 7.98**	40.2 ± 5.8**
Conduction velocity of left leg (m/sec)	48.1 ± 5.55	48.36 ± 6.4	43.07 ± 6.6*	37.77 ± 8.8**

Table (5) show comparison of conduction velocity of motor of Tibial & Perioneal nerves between right & left nerves according to age groups in women.

Motor activity of Tibial nerve	20-29 years	30-39 years	40-49 years	50-59 years
Conduction velocity of right leg (m/sec)	47.54 ± 5.33	42.01 ± 5.3**	34.85 ± 9.5**	40.16 ± 9.1**
Conduction velocity of left leg (m/sec)	46.41 ± 2.53	45.61 ± 2.13	37.46 ± 5.65**	40.55 ± 7.46**
Motor activity of Peroneal Nerve.				
Conduction velocity of right leg (m/sec)	48.70 ± 4.0	45.77 ± 6.4	42.14 ± 9.43**	32.39 ± 8.7**
Conduction velocity of left leg (m/sec)	49.62 ± 6.12	47.62 ± 6.1	40.17 ± 4.2**	42.97 ± 11.67**