Tibial and peroneal nerve conduction study (NCS): normative data for healthy individual

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Absctract

Context: NCS assess peripheral nerve functions & their parameters. It used to diagnosis of peripheral nerve disorders. So propose of study to establish normative values of Tibial & Peroneal NCV in healthy individuals.
Aims: determine nerve conduction data among asymptomatic, healthy individuals.
Objective: 1. Comparison of NCV between right, left & Gender of Peroneal & Tibial nerve. 2. To find out age matched NCV & comparisons among each group
Settings and Design: It was observational study conduct in Neuro Rehabilitation unit include 100 healthy individuals of age groups of 20-60 yr of either sex. The Purposive sampling technique was used.
Methods and Material: The protocol includes bilateral motor nerve conduction velocity of Tibial & Peroneal nerve; under standard laboratory condition by using RMS machine.
Statistical analysis used: The documented data was analyzed by using Stander Error Between Two Mean & Z test.
Results: As z values of right & left of Peroneal & Tibial Nerve 0.28 &1.8 respectively ($p<0.05$).
As z values of male &female of Peroneal & Tibial Nerve 0.28 &1.8 respectively, ($p<0.05$).
Age matched MNCV of age group 50-59 were shows highly significance as compare with Age Group 20-29, 30-39, 40-49.
Conclusions: Side wise & gender wise no statically significance difference was found in MNCV. However in age matched, MNCV of Group D reduced & statically significant as compare to other groups A, B & C groups.

Keywords: NCV, Peroneal & Tibial nerve.

Introduction

Electrodiagnosis is of value to the orthopedic surgeon &physician in diagnosis & prognosis of lower motor neuron lesion & in the localization of site of the lesion, whether in spinal cord, the peripheral axon, or the muscle. It has five main uses: to detect denervation; to detect reinnervation before the clinical sign are apparent; to assess the amount of denervation in muscle; to assess the progression of lesion – whether degenerating or recovering; & to find out if the lesion is in the anterior horn cell, the peripheral axon, the neuromuscular junction or muscle itself. It must be stressed that the greatest value is obtained from these test by completing the electrodiagnosis procedure, which includes faradic-galvanic test, SD curve, nerve conduction, Electromyography which indicated motor & sensory conduction time.[(1)] NCV is one of the reliable & less expensive method which can used for diagnostic procedure.

NCV can be easily measured on peripheral nerves. Sufficient stimuli from an electrical stimulator can be trigger nerve impulses.[(2)] Once the action potential threshold of a nerve fiber reached, its electrical impulses will propagate at a rate of hundred meter per second.[(3,4)] The velocity is directly depend on the diameter of fiber myelination & temperature.[(5,6)] NCV helpful in diagnosing condition of rediculopathis, plexopathies & proximal mononeuropathies,[(7)] It enables clinicians to differentiate the two major groups of peripheral diseases: demyelization & axonal degeneration.[(8)]

Age-matched "Normal" values for NCV parameter derived from studies of groups of neurologically normal subjects or culled from the literature.[(9)] Many studies have been published from western countries regarding normative data for nerves of upper & lower limbs.[(10,11,12,13,14,15)] Unfortunately, in India such studies are limited. Last few decades, electrophysiology laboratories have been applying standard values used by Kimura[(16)] to diagnose different neurological problem. This study is therefore intended to obtain a set of data from a large scale of healthy Indian in order to establish reference values for local NCV laboratory & to compare Indian values with world wide data. There are a number of physical parameter that require correlation or allowance for when establishing normative electrophysiological data. The most important is temperature i.e. the motor nerve conduction velocity is reduced by approximately 1m/s per ^{0}c temperature fall.[(16)] Finally nerve conduction slows by 0.4-1.7m/s per decade after 20 years & sensory by 2-4 m/s[16].

Recently, there has been increased attention to quality of normative data against which test results are compared. It make difficult to interpret data related to pathological conditions involving peripheral nerves. In patients with Diabetes Mellitus lower extremity is more commonly affected as compared to upper extremity. So

also, motor affection is not noticed by the patients in early stages as compared to sensory affection. Also there is scarcity of data depicting the normal values of conduction velocity of Tibial & Peroneal nerves. Hence This study was conducted as a pilot study for establishing the baseline for comparison of NCV in patients with Diabetes Mellitus. So propose of study to establish normative values of Tibial & Peroneal NCV in healthy individuals of different age groups using standard protocol.

Material & Methodology

It was cross section observational study conducted to establish normative values of Tibial & Peroneal NCV in 100 healthy individuals of 20-60 yr different age groups. They are divided according gender & different age group as follows: Age 20-29, 30-39, 40-49 & 50-59 names as Group A, B, C & D respectively. The Purposive sampling technique used excluding any symptoms in foot or leg, known case of diabetes pt, current pregnancy, gout, rheumatoid arthritis, thyroid dysfunction, polyneuropathy, any lower motor neuron diseases & Traumatic palsy. The study carried out at 610 bedded tertiary care teaching hospital with well equipped EMG laboratory unit. Four channel electromyography machine(RMS) was used.

Procedure: The synopsis of the study was submitted to the institutional Ethical committee (IEC) for approval. After obtaining ethical committee approval subjects were selected on the basis of selection criteria. The procedure& purpose of the study was explained to the subjects and they were informed about their right to opt out of the study anytime, during the course of the study, without giving reason for doing so. A written informed consent (vernacular language) was obtained from subject who voluntarily agreed for inclusion in the proposed study.

A basic neurological examination was performed to assess muscle power & sensation both superficial & deep.[16] Room temperature was maintained between 21-23^{0}C.[16] The NCV study was performed with the subject lying comfortably in supine position. A standardized technique was used to obtain & record action potential for motor nerve conduction. Data was collected on following parameter: Age, sex, Latency, Compound muscle action potential (CMAP) & from these MNCV calculated by the fallowing formula: of Bilateral Peroneal & Tibial Nerve

$$\text{Conduction velocity} = \frac{\text{Distance between proximal \& Distal stimulation in mm}}{\text{Proximal latency in ms - distal latency in ms}}$$

Stimulation & recording sites of motor nerves[16]

Motor nerve	Site of stimulation		Recoding site
	Proximal	Distal	
Peroneal Nerve	Neck of fibula	Anterior ankle	Abductor Hallucis Brevis
Tibial Nerve	Popliteal fossa	Medial ankle	Extensor Digitorum Brevis

Data collection: Between September 2011 to September 2012 a observational study carried out in healthy individuals who fitted in selection criteria.

1. Side wise (Rt vs Lf) comparison done of each Peroneal nerve & Tibial Nerve.
2. Gender wise(male Vs Female) comparison done of bilateral Peroneal & Tibial Nerve
3. Age matched comparisons was donei.e Group A compare with Group B, C & D. Group B compare with C & D; Group C compare with Group D.

Data analysis: Data of all subject based on NCV were entered into computer database & analyzed with SPSS package (version 14.0).

1. The comparison between Rt & Lf Peroneal & Tibial N nerve Standard error between two mean of NCV & Z valus calculated.
2. To find out gender wise difference of Peroneal & Tibial Nerve Standard error between the mean of rt male Peroneal & rt female Peroneal compare; Lf male Peroneal & Lf female Peroneal compare; rt male Tibial & rt female Female compare & Lf male Tibial & rt female Tibial compare & Z values calculated.
3. To find out age matched NCV, Mean& S.D were calculated of each group. Then stander error between two mean & Z values calculated of fallowing groups. AB, AC, AD, BC, BD & CD

Results

Side Wise Mean & S.D Of Tibial & Peroneal N Along With S.E & Z Values Across Age Groups

	Peroneal N				*Tibial N*			
	Rt	Lf			Rt	Lf		z
Age	Mean±S.D	Mean±S.D	SE	Z test	Mean±S.D	Mean±S.D	SE	test
20-60	43.39 +9.03	42.99+ 10.93	1.41	0.28	49.02±5.07	47.27±8.44	0.97	1.8

As z values of Peroneal & Tibial Nerve 0.28 &1.8 respectively, as both values are less than 2 ($p<0.05$), hence it is non significant as compare to sidewise of both nerve.

Gender Wise Mean & S.D of Tibial & Peroneal N Along With S.E & Z Values

		Peroneal N		***Tibial N***	
		Male	**Female**	**Male**	**Female**
Right	Mean±S.D	46.33±**7.5**	44.95±9.3	47.88±7.7	49.71±11.4
	S.E	1.19		1.37	
	Z Test	1.15		-1.33	
Left	Mean±S.D	45.15±11.63	42.32±10.5	47.32	47.25±9.1
	S.E	1.56		1.16	
	Z Test	1.81		0.06	

As they are compare between male & female, so it is statistically not significant($p<0.05$) of B/L Peroneal & Tibial N.

Age Matched Mean & S.D of Rt & Lf T & P.N

	Peroneal N		***Tibial N***	
	Rt	**Lf**	**Rt**	**Lf**
Age	**Mean±S.D**	**Mean±S.D**	**Mean±S.D**	**Mean±S.D**
20-29	46.98±11.62	45.35±11.91	46.9±10.62	46.12±4.17
30-39	45.16±8.57	45±12.01	45.91±4.18	45.69±4.06
40-49	44.61±6.2	43.56±13.03	45.85±8.8	44.83±8.7
50-59	41.58±9.01	41.15±6.94	41.13±6.27	40±10.23

S. E & z values between corresponding the age groups

Nerve		**SE**	**Z Test**	**SE**	**Z test**	**SE**	**Z Test**
	Age	**30-39**		**40-49**		**50-59**	
Rt P. N	20-29	1.44	1.26 (NS)	1.31	1.8 (NS)	1.48	3.64 (HS)
	30-39	-	-	1.05	0.52 (NS)	1.24	2.88 (HS)
	40-50	-	-	-	-	1.09	2.77 (HS)
LF P.N	20-29	1.68	0.2 (NS)	1.76	1.01 (NS)	1.37	3.06 (HS)
	30-39	-	-	1.76	0.81 (NS)	1.38	2.78 (HS)
	40-50	-	-	-	-	1.47	2.63 (HS)
Rt T.N	20-29	1.13	0.87 (NS)	1.34	0.78 (NS)	1.22	4.72 (HS)
	30-39	-	-	0.93	0.06 (NS)	0.74	6.45 (HS)
	40-50	-	-	-	-	0.67	7.04 (HS)
Lf T.N	20-29	0.57	0.75 (NS)	0.95	1.35 (NS)	1.1	5.5 (HS)
	30-39	-	-	0.95	0.9 (NS)	1.09	5.22 (HS)
	40-50	-	-	-	-	1.33	3.63 (HS)

SE between two means of corresponding age groups was tested for significance with the help of Z test at p=0.01. SE & Z value of ages 20-29(A), were compared with SE & Z value of group of 30-39(B), that of 40-49(C) & 50-59(D) yrs.

- For Right Peroneal N, these were 1.26(NS), 1.8(NS), & 3.64(HS).
- For Lf Peroneal N, tese values were 0.2(NS), (1.01NS) & 3.06(HS)
- For Rt Tibial N, these values were (0.87NS), (0.78NS), (4.72HS)
- For Lf Tibial N, these values were (0.75NS), (1.35NS), (5.5HS)

SE between two means of corresponding age groups was tested for significance with the help of Z test at p=0.01. SE & Z value of ages 30-39(B), were compared with SE & Z value of group of 40-49(C) & 50-59(D) yrs.

- For lf Peroneal N, these values were 0.52(NS), 2.88(HS)
- For Lf Peroneal N, these values were 0.81(NS), 2.78(HS)
- For Rt Tibial N, these values were 0.06 (NS), 6.45(HS)
- For Lf Tibial N, these values were 0.9(NS), 5.22(HS)

SE between two means of corresponding age groups was tested for significance with the help of Z test at p=0.01. SE & Z value of ages 40-49(C), were compared with SE & Z value of group of 50-59(D) yrs.

- For lf Peroneal N, these values were 2.77 (HS)
- For Lf Peroneal N, these values were 2.63 (HS)
- For Rt Tibial N, these values were 7.04 (HS)
- For Lf Tibial N, these values were 3.63 (HS)

Discussion

The present study was carried out with the aim to determine nerve conduction data among the asymptomatic, healthy individuals of 20-60 yr age groups. Objective were 1. Comparison of NCV between right & left Peroneal & Tibial nerve. 2. Gender wise difference of Peroneal & Tibial Nerve. 3. To find out age matched NCV. Results of present study As compare within right & left side of Peroneal & Tibial Nerve, as z values are 0.28 & 1.8 respectively. These are < 2.00 so it is not statistically significance. It shows that there no difference of NCV in sidewise. As in lower limb no relation with dominancy. Hence mean of Rt & lf Peroneal N is 43.19±0.28 & mean values of Rt & Lf Tibial is 48.14± 0.47can be used as reference value. Our study in accordance with Ramji Sing. He measured NCV in Indian population in 175 healthy volunteers of age group 18 to 66 yr (2012). concluded that various parameter of NCV can be affected by BMI, however no Rt& Lf side difference in NCV values.[17] In similar study conducted in upper limb BY Tan U.[18] He measured the velocities of motor conduction in median & ulnar on left & rt arms. He found no statically significance difference in nerve conduction velocity on left & right side these subjects. It was suggested that the mechanism of handeness do not contribute to the difference in NCV. In similar study done by Hennessey et al (1994) NCV in young adult concluded that handedness has no effect on nerve conduction parameter.[10] Another study conduted by Navin Gupta (2008) also demonstrated that there is no significance difference in MNCV of right & left nerve.[19]

Contrary to above studies in the study of Seema Bhorania. She conduted effect of limb dominance on MNCV, she concluded that there was no significant difference in velocities between the dominant & non dominant limbs of same individuals, but nerve conduction in right hands subject was more as compared to their counterparts for both dominant & non dominant limbs.[20] Another study done by Anuradha et al in 1990 showed a definite relationship between limb dominance & median nerve conduction although the results are not so clear in case of Ulnar nerve. The reason may be purely anatomical in that the median nerve has greater dermato-myotomal distribution that the Ulnar nerve.[21]

As gender wise comparison of rt& Lf of Peroneal & Tibial nerve Z values are 1.15, 1.81, 1.33 & 0.06 respectively These are < 2.00 so it is not statistically significance. We found that NCV in male of Rt Peroneal(46.33±**7.5**), Lf Peroneal(45.15±11.63), rt Tibial(47.88±7.7) & Lf Tibial (47.32±7.4) & in female Rt Peroneal(44.95±9.3), Lf Peroneal(42.32±10.5), rt Tibial(49.71±11.4) & Lf Tibial (47.25±9.1). Shows NCV values in male is greater than female except Rt Tibial N. but this difference is not statically significant because in our study we did not include Body mass index & height. As inverse relation between height & nerve conduct slower than shorter nerves.[22]

Age matched NCV. It shows statically not significant as compare AB, AC, BC however AD, BD, CD are statically highly significant Z values >2.00 (P=0.005). The conduction velocity in full term infant is nearly half of adult value. As the myelination progresses, the nerve conduction velocity attains the adult value by 3-5 yr of age.[16] The conduction velocity begins to decline after 30-40 yr of age but the values normally change by less than 10 M/S at the 6th or even in the eight decade.[24,25] Many laboratories have produced normative nerve conduction velocity values which are divided according to age groups. Many investigator have attempted to study the association between aging, nerve velocities & motor velocities. Our results shows NCV of Group D (50-59) shows reduced as compare to other groups, & it statically significant as compare with A, B & C groups. Reason behind that with normal aging, subjects with older age had longer latencies than younger age group.[26] In support to our study, Bushbacher in his study, shows decrease in CMAP amplitude of Tibial Nerve innervating the abductor Hallucis in older age had smaller amplitude compared to younger age group.[26] With normal aging, probably there may be decrease in motor unit size.[27,28,29] Hennessey et al also found similar decrease in CAMP amplitude of the median nerve in older age group.[10] Similarly, Buschbacher in his study of Peroneal nerve motor conduction to the Extensor Digitorum Brevis found decrease to younger individuals.[30] A similar observation was made by Stalberg & Flack for motor nerve conduction.[6]

Conclusion

Normative Conduction parameter of Peroneal Nerve & Tibial nerve were established, which we used for our further research of NCV in Diabetes mellitus. We Found the side wise & gender wise no statically significance difference. However in age matched, the MNCV of Group D reduced as compare to other groups, & it statically significant as compare with A, B & C groups.

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