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Proprioceptive and Sympathetic Nerve Fibers Affection in Guillain-Barre Syndrome

Ibrahim K. Ibrahim, MD, PhD[1], Mowaffak M. Abulhamid, MD, PhD[2], Mohamed H. Imam, MD, PhD[3], Naglaa A. Hussein, MD, PhD[4], Radwa M. Awad, MD[5]

[1]Professor & Chairman of Physical medicine, Rheumatology & Rehabilitation, Alexandria University, Member of IFCN

[2]Professor of Physical medicine, Rheumatology & Rehabilitation, Alexandria University

[3]Professor of Physical medicine, Rheumatology & Rehabilitation, Alexandria University

[4]Assistant Prof. of Physical Medicine, Rheumatology &Rehabilitation, Alexandria University

[5]Master of Physical Medicine, Rheumatology & Rehabilitation, Alexandria University

Corresponding Author

Naglaa A. Hussein, MD, PhD
Assistant Prof. of Physical Medicine, Rheumatology &Rehabilitation
Alexandria University
Senior resident of PM&R, Albert Einstein College of medicine 2015-2016
Member of AAPM&R
E mail: nagla_kashif@hotmail.com

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Abstract: ***Background:*** *autonomic affection is well known in Guillain Barre'. However, exact affection of proprioceptive fibers and sympathetic fibers are still not documented.* ***Aim:*** *to investigate the magnitude of proprioceptive and sympathetic fibers involvement in patients with Guillan Barre' syndrome (GBS) electrophysiologically.* ***Design:*** *cross sectional study.* ***Setting:*** *outpatient setting.* ***Population:*** *twenty patients diagnosed as GBS and 20 healthy matched controls were included.* ***Methods:*** *The proprioceptive Ia afferent fibers conduction velocity using electrically induced reflex activity (R1) and sympathetic skin response (SSR) were studied in upper and lower limbs of 20 patients fulfilling the criteria of GBS and 20 healthy volunteers.* ***Results:*** *Median nerve proprioceptive Ia afferent fibers CV showed significant slowing in patients: 29.5±17.4 m/s compared to control subjects: 68.1±16.8m/s. Posterior tibial nerve proprioceptive Ia afferent fibers CV showed significant slowing in patients: 30±19.1m/s compared to control subjects: 57.4±16.1m/s. Nine patients (45%) showed absent SSR in the hand, while 12 patients (60%) showed absent SSR in the foot. Hand SSR showed significant delay: 1.26±0.3 sec and decrease amplitude: 54.2±43.8µv in patients compared to control:1.08±0.2 sec, 99.4±64.4 µv. Foot SSR showed significant delay:1.8 µv0.6 sec and decrease of amplitude: 16.5 ±6.2 µv in patients compared to control: 1.6 ±0.2 sec, 36.5 ±23.8 µv.* ***Conclusions:*** *The study of electrically induced reflex activity revealed significant involvement of proprioceptive Ia afferent fibers in patients with GBS and was correlated significantly with the severity of neuropathy. SSR study showed significant involvement of sympathetic fibers in patients with GBS but not correlated with the severity of neuropathy.*

1. Introduction

Guillian Barre syndrome (GBS) is a polyneuropathy that presents with acute flaccid paralysis[1,2]. Occasionally, patients with GBS present with weakness associated with postural instability. The explanation for this postural instability is still controversial. Some authors interpreted it as a manifestation of disturbance of peripheral neurons[3,4,5]. Other authors suggested that it is due to lesion in cerebellar pathway causing cerebellar ataxia[6,7,8].

Electrophysiological tests to detect proprioceptive involvement in GBS is lacking in literature. Methods that have been reported to detect proprioceptive fibers affection in diseases other than GBS include recording H reflex by stimulation of the tibial nerve at the popliteal fossa[9] and somatosensory evoked potential(SEP) recorded at cortical level following repetitive electrical stimulation of the posterior nerve at the ankle[9,10]. The study of proprioceptive Ia afferent fibers using an electrically induced reflex activity has been also reported in normal subjects and patients with spastic hemiplegia[11,12].

Autonomic dysfunction is a common complication in GBS. It occurs in the form of inadequate activity of sympathetic and /or parasympathetic nervous system[13,14]. Proprioception loss is frequently responsible for dysautonomia and predicts it independently from the severity of weakness[15,16]. Sympathetic skin response (SSR) and quantitative sudomotor axon reflex test are common electrophysiological studies to assess autonomic dysfunction[17].

This study was carried out to investigate the magnitude of proprioceptive and sympathetic fibers involvement in patients with GBS electrophysiologically.

2. Subjects and Methods

The study was approved by Alexandria university medical ethics committee that follow Helsinki declaration. All patients and control volunteers involved in this study were informed about the nature and details of the work and an informed consent to be involved in the study was obtained from each one of them.

Twenty patients fulfilling the criteria for diagnosis of GBS (group I) were enrolled in the study. Patients were excluded from the study if they had any of the following: Diabetes mellitus, neuromuscular diseases other than GBS, patients with GBS with duration of illness more than 2 weeks, patients with GBS who received any specific treatment for the disease, patients with GBS with distal muscle weakness less than grade 2 (muscle power grading was examined according to medical research council (MRC) scale [18]).

Twenty healthy volunteers of matching age and sex constituted group II.

All patients have been subjected to the following: I- Clinical assessment including: Demographic data, history of the present condition concerning; onset, duration, course, progression, history of preceding infection. Past medical history of any metabolic, autoimmune, or neurologic diseases that could affect the peripheral nerves. Clinical examination with detailed neurological examination.[18]

II Electrophysiological studies including: Motor conduction study for posterior tibial nerve, common peroneal nerve, median nerve and ulnar nerve.[19], sensory conduction study for median and sural nerves.[19], sympathetic skin response of hand and foot.[20,21], study of the proprioceptive Ia afferent conduction velocity (CV) using electrically induced reflex activity in the upper and lower limbs (Stanley E, 1978 and Ibrahim et al., 1993).[(11,12)]

All electrophysiological studies were carried out on Neuropack 2 electromyograph apparatus from Nihon Kohden (Japan).

Study of the proprioceptive Ia afferent fibers CV:[(11,12)]

To assess the conduction of the Ia afferent fibers, an electrically evoked short latency reflex response (R1) of the abductor pollicis brevis (APB) along the median nerve of the right hand and R1 of the abductor hallucis brevis (AHB) along the posterior tibial nerve of the right foot were recorded.

Upper Limb Examination

- **Stimulation and Recording:**

The subject seated comfortably and his right arm was secured, palm up, to a board. The technique was modified after Stanley 1978. For recording, surface electrodes were positioned with the active recording electrode over the belly of the APB and the reference electrode at the metacarpophalengeal joint of the thumb. A surface ground electrode was placed around the wrist between the stimulating and the recording electrodes.

Stimulation of the median nerve distally (at the wrist; 8 cm from the active electrode) and proximally (at the antecubital fossa; over the brachial artery pulse) was performed using stimulating electrode, with the cathode directed proximally. A submaximal, suprathreshold current intensity (just evoked a weak visible muscle contraction) was used (3-10 mA). The stimuli were rectangular pulses of 0.5 ms duration and delivered at a rate of 0.5 Hz. The recorded potentials were amplified (filter setting was 15 Hz-5 KHz), and averaged automatically time locked to each stimulus (30-250 responses were averaged).

During the test, the subject was instructed to contract his APB mildly (about 20% of the maximum voluntary contraction) and to make the contraction as isometric as possible by maintaining the force.

Measurements:

The latency of the early reflex response was measured in milliseconds. The CV of the Ia afferent fibers was calculated between the 2 sites of stimulation of right median nerve.

Lower Limb Examination

- **Stimulation and recording:**

The subject lay prone and relaxed. Surface electrodes were positioned with the active recording electrode 1 cm proximal and inferior to the navicular bone and the reference electrode at the metatarsophalengeal joint of the big toe. A surface ground electrode was placed around the ankle between the stimulating and the recording electrodes.

Stimulation of the posterior tibial nerve distally (above and posterior to the medial malleolus 9 cm from the active electrode) and proximally (at the popliteal fossa over the popliteal pulse) was performed using stimulating electrode, with the cathode directed proximally. A submaximal, suprathreshold current intensity (just evoked a weak visible muscle contraction) was used (3-10 mA). The stimuli were rectangular pulses of 0.5 ms duration and delivered at a rate of 0.5 Hz. The recorded potentials were amplified (filter setting was 15 Hz - 5 KHz), and averaged automatically time locked to each stimulus (30-250 responses were averaged).

During the test, the subject was instructed to contract his AHB mildly (about 20% of the maximum voluntary contraction) and to make the contraction as isometric as possible by maintaining the force.

- **Measurements:** The latency of the early reflex response was measured in milliseconds. The CV of the Ia afferent fibers was calculated between the 2 sites of stimulation of right posterior tibial nerve.

The short latency reflex response and the SSR were studied in the right hand and foot of each patient and healthy volunteer.

Statistical Analysis

Statistical analysis was done using SPSS program" version 18". Quantitative data were described by mean and median as measure of central tendency and standard deviation, minimum and maximum as measure of dispersion, while qualitative variables were summarized by frequency and percent, Pie and simple bar charts.

Mann whitney test was used to compare the median of quantitative variables between patients and controls to detect statistical significance at level of 0.05. The use of non parametric test was due to abnormally distributed variables.

Chisquare test was used to study association between two qualitative variables. Montecarlo test was used if more than 20% of expected cell counts were <5 at 0.05 level of significance.

Spearman correlation test was done to study significant linear relationship between two quantitative variables. Significant results were summarized by scatter plot chart.

The cut off points of SSR latency of hand and foot were calculated as mean + 2 SD while the cut off points of SSR amplitude of hand and foot and proprioceptive Ia afferent fibers CV of median and posterior tibial nerves were calculated as mean – 2 SD of the normal control group meas.

3. Results

There were no significant difference between patients (group I) and control (groupII) regarding age, sex, height and leg segment length (table I). At time of examination the mean duration of symptoms was 7 days (3-10 days).Based on electrophysiologic studies, according to neurophysiologic criteria of GBS as demyelinating or axonal[22], the majority of patients (14 patients 70%) presented with demyelinating variant, acute inflammatory demyelinating (AIDP). Five patients (25%) presented acute motor axonal neuropathy variant (AMAN). While only 1 patient (5%) presented with acute motor sensory axonal neuropathy variant (AMSAN).

The evaluation of the electrophysiological recordings in patients is based on reference values from comparison to a control group. (Table 2). The cut off values of the conduction parameters were calculated using mean ±2SD of the matched control.

Table 3 demonstrates comparison between motor conduction parameters of the studied nerves among patient and control. There was statistically significant difference between both groups regarding the studied parameters ($p<0.001$).

F wave abnormalities either prolonged or absent response were noted in all patients (100%). H reflex was absent in 17 patients (85%) and prolonged in 3 patients (15%).

Table 4 demonstrates comparison between sensory conduction parameters among patients and control. There were statistical significant reductions of conduction velocity of both median and sural nerves. There was also significant reduction in amplitude of sural nerve. Absent median SNAP were present in 5 patients (25%) and absent sural SNAP in 7 patients (35%).

There were significant reductions of both hand and foot SSR amplitude among the patients (table 5). Also there was statistical significant slowing in cv of Ia afferent fibers of the median and posterior tibial nerves (table 5).

There was no statistical significant association between any of the SSR parameters of hand and foot or proprioceptive Ia afferent fibers CV and different variants of GBS among studied patients.(table 6).

The conduction parameters of the studied motor and sensory nerves showed no significant correlation with SSR parameters of hand and foot in group I. There was no significant correlation between Ia afferent fibers CV of the median nerve and the median and ulnar nerves SCV and MCV.

Figure 1 shows that there was significant positive linear correlation between the posterior tibial MCV and its Ia afferent fibers CV ($rs =0.782, p=0.008$). Also, there was positive linear correlation between common peroneal motor nerve MCV and Ia afferent fibers CV of the posterior tibial nerve (figure 2), ($r=0.830, p=0.003$).

There was no significant correlation between Ia afferent fibers cv of the posterior tibial nerve and the sural nerve scv.

Figure 3 demonstrates significant negative linear correlation between motor distal latency of the posterior tibial nerve and its I a afferent fibers CV ($r =-0.547$, $p=0.013$). No correlation was found between motor distal latency of median nerves and its Ia afferent fibers CV ($r=-0.471$, $p=0.143$). Figure 4 showed example of patient graph with slowing of Ia fibers.

There was no statistical significant association between SSR parameters of the hand and proprioceptive Ia afferent fibers CV of the median nerve among studied patients. (Table 7). Also no statistical significant association between SSR parameters of the foot and proprioceptive Ia afferent fibers CV of the posterior tibial nerve among studied patients.(table 8).

4. Discussion

Electrodiagnostic studies are essential to establish the diagnosis of GBS, identify the GBS subtype and help to exclude mimic disorders. Seventy percent of patients presented with AIDP variant, 30% were presented with AMAN variant, while only 1 patient (5%) was presented

with AMSAN variant of GBS. This is in agreement with many other studies[23,24]. This demonstrates the predominance of the demyelinating pathology of the disease.

In the present study, there was significant slowing of motor and sensory conduction studies reflecting the predominance of demyelinating pathology. However, only sural SNAP amplitude showed significant reduction rather than that of median nerve. This may be due to lower limb nerves are involved before upper limb nerves and are more severely affected.

In the present study, abnormalities of late responses were the most frequent finding followed by reduced distal CMAP amplitude. These findings were in accordance with Gordon et al[25]. Vucic et al[26] who reported also that late response abnormalities were the most frequent findings but they were followed by slowed CV and prolonged motor distal latency. This difference may be due to that all studied patients in the latter study presented with AIDP variant of GBS in which feature of demyelination were predominant.

Pathologic temporal dispersion of the distal CMAP responses was detected in 13out of 14 patients of AIDP variant (93%). This is in accordance with Clouston et al[27] who considered this finding as sensitive indicator of distal demyelination in early AIDP.

Conduction block was present in many patients most frequently in leg segment of posterior tibial nerves followed by forearm segment of ulnar nerve. This is in agreement with the study of Vucic et al [26]. as regard sensory conduction study, reduced SNAPs amplitude was the most frequent finding. This was in agreement with Vucic et al[26]. In the present study absent SNAP were present in sural nerve more than median nerve. This may be due to the ascending pattern of GBS. However, many studies reported abnormal ULS SNAP with intact sural response[25,26]. This difference between our study and the others may be due to small sample size.

Sympathetic skin response was carried out to demonstrate symapathetic nerve fibers involvement in GBS. However, no statistical significant change of SSR latency was found. This finding was supported by some authors [21,28]. This was explained by SSR is mediated in its efferent arc by unmyelinated C fibers and so demyelinating pathology is not reflected in non myelinated fibers[29]. On the other hand, we found significant decrease in the amplitude of SSR of hand and foot. This may reflect axonopathy[30]. As the SSR amplitude is variable, some authors did not consider its measurment[31], while others considered it relaiable[32]. It is reported that the abnormality of SSR may be relevant to the existence of pain in GBS similar to cases of reflex sympathetic pain in which nerve signals arising from sites of nerve injury lead to central changes including sensory and sympathetic pathways[33,34]. These changes might contribute to amplification and persistence of pain and paresthesia[35].

In the present study, high number of patients who presented with absent SSR response in feet (60%) than in hands (45%) may be due to ascending progression of GBS.

Among patients with AMAN variant, two patients had normal SSR in both feet and hands, while three patients showed abnormal SSR response. Normal SSR may be due to sparing of sudomotor reflex pathway[20] Arunodaya and. Taly [29] reported that all their patients of AMAN variant showed normal SSR responses. It appears that the sympathetic abnormality is variable in GBS and that peripheral nerve fiber subtypes are not uniformly affected.

There was no significant correlation between SSR parameters and motor and sensory conduction studies. Similar results were found in the literature[29]. This means that involvement of sympathetic nerve fibers does not depend on involvement of any type of nerve fibers.

In previous literatures, it was reported that many patients of GBS may present with postural instability which is not consistent with muscle weaknes,[6-8,] This raises the possibility of proprioceptive nerve fibers involvement in GBS patients. In the present study, the proprioceptive Ia afferent fibers of the median and posterior tibial nerves have been studied by recording the short latency electrically evoked reflex. This technique has not been employed previously to study GBS patients.

The results showed significant slowing of CV of Ia afferent fibers of both median and posterior tibial nerves in comparison to the control group. There was no significant correlation between Ia afferent fibers CV of the median and median and ulnar sensory and motor CVs. While there was significant positive linear correlation between Ia afferent fibers of the posterior tibial nerve and each of the posterior tibial and common peroneal MCV. This may be due to ascending progression of GBS. Knowing that LL nerves are severely affected than ULs nerves, the resultant correlation may reflect relation with disease severity.

There was no significant correlation between the Ia afferent fibers CV of the posterior tibial nerve and the sural nerve SCV. This may be due to large number of absent sural SNAP in this study which may lead to beta error in statistics. Alternatively, it may reflect variation of involvement of different subtypes of sensory nerves.

This study revealed no significant association between different types of GBS and SSR parameters as well as I a afferent fibers Cv of median and posterior tibial nerves. Arunodaya Get al[36]reported no relation between different types of GBS and SSR parameters.

This means that involvement of sympathetic fibers and Ia afferent fibers do not depend on the pattern of pathology of GBS.

There was no significant association between SSR parameters and proprioceptive Ia afferent fibers CV among the studied patients. This means that their involvement is independent to each other.

5. Conclusion

The study of electrically induced reflex activity can reveal significant involvement of proprioceptive Ia afferent fibers in GBS patients and this is proportionate to the severity of peripheral neuropathy. Sympathetic skin response shows significant involvement of sympathetic fibers in some patients with GBS but this is not related to the severity of peripheral neuropathy. In addition, there is no relation between affection of proprioceptive Ia afferent fibers and sympathetic nerve fibers in GBS and neither of them is not related to type of GBS.

Authorship Contribution

First author: Idea owner, conduction of all electrophysiological tests, revision of manuscript.

Second author: Contribute to the idea, referral of patients, revision of raw data & results, manuscript revision.

Third author: Revision of raw data & results, manuscript revision.

Fourth author: Revising all results, writing all the manuscript

Fifth author: Gathering all patients and control, performing all clinical exam, collection of raw data

References

[1] Gurwood A, Drake J. Guillain-Barré Syndrome. Optometry 2006; 77:540-6.
[2] Vucic S, Kiernan M, Cornblath D. Guillain-Barré syndrome. Journal of Clinical Neuroscience 2009; 16:733-41.
[3] Mori M, Kuwabara S, Koga M, Asahina M, Ogawara K, Hattori T, et al. IgG anti-GQ1b positive acute ataxia without ophthamoplegia.J Neurol Neurosurg Psychiatry 1999;67:668-70.
[4] Liu J, Willison H, Pedrosa-Domellof F. Immunolocalization of GQ1b and related gangliosides in human extraocular neuromuscular junctions and muscle spindles. Invest Ophthalmol Vis Sci 2009; 50:3226-32.
[5] Ito M, Matsuno K, Sakumoto Y, Hirata K, Yuki N. Ataxic Guillain- Barre' syndrome and acute sensory ataxic neuropathy from a continuous spectrum. J Neurol Neurosurg Pschiatry 2011;82:294-9
[6] Ritcher R. The ataxic form of polyradiculoneuritis(Landry Guillian Barre' syndrome). Neuropathol Exp Neurol 1962; 21:171-84.
[7] Sugimoto H, Wakata N, Kishi M, Fujioka T, Kurihara T, Irie Y, et al. A case of Guillain –Barre' associated with cerebellar ataxia and positive serum anti-GD1b Ig G antibody. J Neurol 2002; 249(3):346-7.
[8] Odaka M, Yuki N, Tatsumoto M, Tateno M, Hirata K. Ataxic Guillain-Barre' syndrome associated with anti-GM1b and anti-GalNAc-GD1a antibodies. J Neurol 2004; 251(1):24-9.
[9] Lefaucheur J, Creange A. Neurophysiological testing correlates with clinical examination according to fiber type involvement and severity in sensory neuropathy. J Neurol Neurosurg Pschiatry 2004; 75:417-22.
[10] Velasco F, Velasco M. A reticulothalamic system mediating proprioceptive attention and tremor in man. Neurosurgery 1979; 4(1):30-6.
[11] Stanley E. Reflexes evoked in human thenar muscles during voluntary activity and their conduction pathways. J Neurol Neurosurg Psychiatry 1978; 41(11):1016-23.
[12] Ibrahim I, El-Abd M, Dietz V. Patients with spastic hemiplegia at different recovery stages: evidence of reciprocal modulation of early/ late reflex response. J Neurol Neurosurg Psychiatry 1993;56(4):386-92.
[13] Sykora M, Diedler J, Hacke W. Intrapulomary right-left shunts in Guillain-Barre' syndrome with severe dysautonomia. Neurocrit care 2008; 9(3):374-7.
[14] Pfeiffer G, Schiller B, Kruse J. Indicators of dysautonomia in severe Guillain- Barre' syndrome: an update. J Neurol 1999;246:1015-22
[15] Pfeiffer G. Dysautonomia in Guillain-Barré syndrome. Nervenartz 1999; 70(2):136-48.
[16] Lanello S. Guillain-Barré syndrome in elderly patients. Guillain-Barré syndrome: pathological, clinical and therapeutic aspects.New York: Nova publishers 2004:99- 102.
[17] Freeman R. Autonomic peripheral neuropathy. Lancet 2005; 365:1259-70.
[18] McRae R. General priniciples in examination. In McRae R, (ed). Clinical orthopedic examination. 5th ed. London:Churchill-Livingstone; 2004.pp 1-32.
[19] Preston D, Shapiro B. Basic nerve conduction studies. In: Preston D, Shapiro B, (eds). Electromyography and neuromuscular disorders. Philadelphia: Elsevier Health Sciences; 2005.pp.25-46.
[20] Taly A, Arunodaya G, Rao S. Sympathetic skin response in Guillain Barre' syndrome. Clin Auton Res 1995; 5:215-20.
[21] 21-Shahani B, Halperin J, Boulu P. Symapathetic skin response –a method of assessing unmyelinated axon dysfunction in peripheral neuropathies. J Neurol Neurosurg Psychiatry 1984; 47: 536-42.
[22] Hadden R, Cornblath D, Hughes R, Zielasek J, Hartung H, Toyka K, et al. Electrophysiological classification of Guillain –Barre' syndrome: clinical associations and outcome. Ann Neurol 1998; 44:780-8.
[23] Bogliun G, Beghi E. Incidence and clinical features of acute inflammatory polyradiculoneuropathy in Lombardy, Italy. Acta Neurol Scand 2004; 110(2):100-6.
[24] Kalita J, Misra U, Das M. Neurophysiological criteria in the diagnosis of different clinical types of Guillain Barre' syndrome. J Neurol Neurosurg Psychiatry 2008; 79: 289-93.
[25] Gordon P, Wilbourn A. Early electrodiagnostic findings in Guillain-Barre' syndrome. Arch Neurol 2001; 58:913-7.
[26] Vucic S, Cairns K, Black K, Chong P, Cros D.Neurophysiologic findings in early acute inflammatory demyelinating polyradiculoneuropathy. Clin Neurophysiol 2004; 115(10): 2329-35.

[27] Clouston P,Kiers L, Zuniga G, Cros D. Quantitative analysis of the compound muscle action potential in early acute inflammatory demyelinating polyneuropathy. Electroencephalogr Clin Neurophysiol 1994; 93(4): 245-54.
[28] Knezevic W, Bajada S. Peripheral autonomic surface potential: a quantitative technique for recording sympathetic conduction in man. J Neurol Sci 1985;67 (2):239-51
[29] Arunodaya G, Taly A. Sympathetic skin response: a decade later. J Neurol Sci. 1995; 129(2):81-9.
[30] Watahiki Y, Baba M, Matsunaga M, Takebe K, Onuma T. Symapathetic skin response in diabetic neuropathy. Electromyogr Clin Neurophysiol 1989; 29(3):155-9.
[31] Drory V, Korczyn A. Sympathetic skin response: age effect. Neurology 1993; 43(9):1818-20.
[32] Elie B, Guiheneuc P. Sympathetic sskin response: normal results in different experimental conditions. Electroencephalogr Clin Neurophysiol 1990; 76(3):258-67.
[33] Ren K, Dubner R. Central nervous system plasticity and persistent pain. J Orofac Pain 1999; 13 (3):155-63.
[34] Ren K, Dubner R. Descending modulation in persistent pain: an update. Pain 2002; 100(1):1-6.
[35] Dunber R. The neurobiology of persistent pain and its clinical implications. Clin Neurophysiol 2004; 57:3-7.
[36] Shargall Y, Spratt E, Zeldin RA. Hyperhidrosis: what is it and why does it occur? Thorac Surg Clin 2008; 18(2):125-32.

Table 1: Demographic characteristic of the patients and control

	Patients Group I	Control Group II	Test of Significance
Age Range mean±SD median	16-61 31.5±16.35 26.5	22-50 27.4±6.62 25	U=79 P=0.596
Sex Male female	11(55%) 9(45%)	13(65%) 7(35%)	X^2=0.305 P=0.581
Total height(cm) Mean (range)	165.8 (152-189)	167 (152-186)	U=52 P=0.306
Leg segment length(cm) mean (range)	39.6 36-44	40 35-45	U=65 P=0.496

U: Mann Whitney test
Statistically significant at $p \leq 0.05$

Table 2: The determined cut-off values of the motor & sensory conduction parameters, F wave of minimal latency, H reflex latency, SSR and proprioceptive Ia afferent fiber CV the studied nerves

Variable	Cut-off value	Variable	Cut-off value
Median nerve:		**Common peroneal nerve:**	
Distal latency (ms):	3.82	Distal latency (ms):	5.5
Amplitude (mV):	12.17	Amplitude (mV):	7.7
Conduction velocity (m/s):	52.75	Conduction velocity (m/s):	45.6
Ulnar nerve:		**Posterior tibial nerve:**	
Distal latency (ms):	2.99	Distal latency (ms):	4.33
Amplitude (mV):	11.5	Amplitude (mV):	9.35
Conduction velocity (m/s):	49.39	Conduction velocity (m/s):	43.5
Median nerve sensory conduction		**Sural nerve sensory conduction**	
Amplitude (µV)	20.65	Amplitude (µV)	7.25
Conduction velocity (m/s):	49.72	Conduction velocity (m/s):	42.1
F wave minimal latency (ms)			
Median nerve	25.5		
Ulnar nerve	26.33	**H reflex latency (ms)**	32.82
Posterior tibial nerve	48.6		
Common peroneal nerve	49.7		
Hand SSR Latency	1.52 sec.	**Hand SSR Amplitude**	30.7 µV *
Foot SSR Latency	2.21 sec.	**Foot SSR Amplitude**	11.7 µV *
Proprioceptive Ia afferent fibers CV of median nerve	54.4 m/s	**Proprioceptive Ia afferent fiber CV of postetrior tibial nerve CV (Rt tibial N)**	45.7 m/s

ms: milliseconds, mV: milliVolt, m/s: meter per second
*: The value calculated by using the least value among control group.
SSR: sympathetic skin response, sec.: seconds, µV: microVolt, m/s: meter per second

Table 3: Comparison between motor conduction parameters of studied nerves among patient and control groups

Motor nerve	Distal latency (ms)		Amplitude (mV)		MCV (m/s)	
	Patients	Controls	Patients	Controls	Patients	Controls
Median nerve Range	3.45 –22.1	3.05- 3.95	0.18 –12.6	11.35 –20.65	14.95-56.7	48.85 –62.55
Mean ± SD	7.57 ± 4.9	3.56 ±0.28	3.62 ± 3.47	15.15 ±2.98	35.08±9.6	56.63 ±3.88
Median	6.13	3.65	2.95	15.10	35.38	56.65
U (P)	**33 (<0.001*)**		**9 (<0.001*)**		**11 (<0.001*)**	
Ulnar nerve Range	2.55 –21.9	1.90 –3.10	0.29 – 14.8	10.0 – 18.60	14.40-55.3	46.20 – 69
Mean ± SD	5.78 ±4.29	2.61 ±0.38	3.75 ± 3.8	13.76 ± 2.24	33.3±10.9	55.93 ± 6.54
Median	4.93	2.60	2.98	13.85	35.63	54.40
U (P)	**25 (<0.001*)**		**18 (<0.001*)**		**11 (<0.001*)**	
Common personal nerve Range	3.60 - 30.1	4.5 -5.9	0.19 – 1.99	4 - 12	12.3-42.05	43.5-61.9
Mean ± SD	8.78 ±6.05	4.9 ± 0.6	1.11 ± 0.58	9.6 ± 2.2	32.8± 7.84	50 ± 4.4
Median	6.70	5.1	1.16	9.81	34.85	50.9
U (P)	**12 (<0.001*)**		**4 (<0.001*)**		**9 (<0.001*)**	
Posterior tibial nerve Range	3.95 –31.6	3.25 – 4.2	0.10 – 7.74	9.32 – 13.15	17.1- 44.6	43.10 – 49.9
Mean ± SD	9.66 ±6.78	3.77 ±0.28	1.79 ± 1.86	14.86 ± 5.51	30.28 ±8.5	45.90 ± 2.37
Median	6.55	3.78	1.09	13.42	29.23	45.33
U (P)	**9 (<0.001*)**		**0 (<0.001*)**		**10 (<0.001*)**	

U: value for Mann Whitney test. *: Statistically significant at $p \leq 0.05$. ms: milliseconds, mV: milliVolt, m/s: meter per second

Table 4: Comparison between sensory conduction parameters among patient and control groups

Sensory nerve	Amplitude (μV)		Conduction Velocity (m/s)	
	Patients	Control	Patients	Control
Median nerve Range Mean ± SD Median	2.68 – 61.5 24.35 ± 18.42 23.20	19.28 – 34.25 25.43 ± 4.78 26.45	20.60 – 60.85 44.01 ± 11.72 44.80	49.60 – 60.85 53.64 ± 3.92 52.05
U (P)	**124 (0. 385)**		**79 (0. 018*)**	
Sural nerve Range Mean ± SD Median	2.17 – 15.55 6.02 ± 4.01 4.48	5.97 – 17.0 10.31 ± 3.06 9.85	31.05 – 50.10 41.55 ± 6.54 41.0	42.60 – 71.75 51.30 ± 9.20 47.45
U (P)	**45 (0. 002*)**		**56 (0. 006*)**	

p: p value for Mann Whitney test
*: Statistically significant at $p \leq 0.05$
μV: microvolt. m/s: meter per second

Table 5: The mean value of SSR and proprioceptive Ia afferent fibers conduction velocity among patients and control group

Variable	Patients	Controls	Statistical significance
	Median (min-max) Mean ± SD		
Hand SSR latency (sec.)	1.27 (0.8-1.7) 1.26±0.38	1.08 (0.75-1.4) 1.08±0.22	U=69 P=0.090
Hand SSR amplitude (µV)	41.7 (16.7-165) 54.2±43.83	75 (30.7-280) 99.42±64.91	U=51 P=0.015*
Foot SSR latency (sec.)	1.65 (1.07-2.58) 1.8±0.61	1.66 (1.28-2.1) 1.67±0.27	U=71 P=0.665
Foot SSR amplitude (µV)	15.15 (5.33-26) 16.5±6.28	29.15 (11.7-96.7) 36.56±23.84	U=29 P=0.009*
Proprioceptive Ia afferent fibers CV of median nerve (m/s)	25 (6.75-56) 29.5±17.44	67.6 (54.5-77.6) 68.1±6.84	U=2 P<0.001*
Proprioceptive Ia afferent fibers CV of posterior tibial nerve (m/s)	24.55 (6.29-63.6) 30.35±19.99	57.15 (50-75) 57.96±6.13	U=32 P=0.003*

U: Mann Whitney test, min: minimum, max: maximum, SSR: sympathetic skin response, sec.: seconds, µV: microvolt. *results ≤ 0.05 are significant

Table 6: The relationship between different types of GBS and the abnormalities of SSR of hand and foot and proprioceptive Ia afferent fibers CV of median and posterior tibial nerves among studied patients

Variable		Type			Total	Statistical significance
		AIDP	**AMAN**	**AMSAN**		
Hand SSR latency	Normal Abnormal	7 (87.5%) 10 (83.3%)	1(12.5 %) 1 (8.3%)	0 1 (8.3%)	8 12	X^2= 0.760 P = 1.000
Hand SSR amplitude	Normal Abnormal	7 (87.5%) 10(83.3%)	1(12.5%) 1 (8.3%)	0 1(8.3%)	8 12	X^2= 0.760 P = 1.000
Foot SSR latency	Normal Abnormal	5 (100%) 12 (80%)	0 2 (13.3%)	0 1 (6.7%)	5 15	X^2= 1.176 P = 0.688
Foot SSR amplitude	Normal Abnormal	6 (85.7%) 11 (84.6%)	1 (14.3%) 1 (7.7%)	0 1 (7.7%)	7 13	X^2= 0.737 P= 1.000
Ia afferent fibers CV of median nerve	Normal Abnormal	2 (100%) 15 (83.3%)	0 2 (11.1%)	0 1 (5.6%)	2 18	X^2 = 0.392 P = 1.000
Ia afferent fibers CV of posterior tibial nerve	Normal Abnormal	1 (100%) 16 (84.2%)	0 2 (10.5%)	0 1 (5.3%)	1 19	X^2=0.186 P = 1.000

X^2: Chisquare test. Results ≤ 0.05 are significant.
SSR: sympathetic skin response, AIDP: Acute inflammatory demyelinating polyneuropathy, AMAN: Acute motor axonal neuropathy, AMSAN: Acute motor and sensory axonal neuropathy, CV: conduction velocity

Table 7: The relationship between SSR parameters of the hand and proprioceptive Ia afferent fibers CV of the median nerve among studied patients

Variable		**Ia afferent fibers CV of median nerve**		Total	Statistical significance
		Normal	Abnormal		
Hand SSR latency	Normal Abnormal	1 (12.5%) 0	7 (87.5%) 12 (100%)	8 12	X^2= 1.579 P= 0.400
Hand SSR amplitude	Normal Abnormal	1 (12.5%) 0	7 (87.5%) 12 (100%)	8 12	X^2= 1.579 P= 0.400

X^2: Chisquare test
Results ≤ 0.05 are significant,
SSR: sympathetic skin response, CV: conduction velocity

Table 8: The relationship between SSR parameters of the foot and proprioceptive Ia afferent fibers CV of the posterior tibial nerve among studied patients

Variable		Ia afferent fibers CV of posterior tibial nerve		Total	Statistical significance
		Normal	Abnormal		
Foot SSR latency	Normal	2 (40%)	3 (60%)	5	$X^2 = 6.667$
	Abnormal	0	15 (100%)	15	P = 0.053
Foot SSR amplitude	Normal	2 (28.6%)	5 (71.4%)	7	$X^2 = 4.127$
	Abnormal	0	13 (100%)	13	P = 0.111

X^2: Chisquare test. Statistically significant ≤ 0.05. SSR: sympathetic skin response, CV: conduction velocity

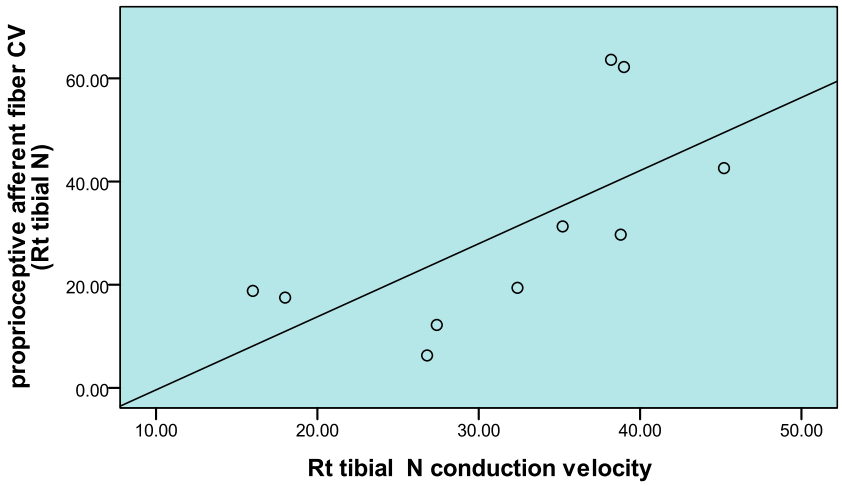


Figure 1: Scatter plot showing positive linear correlation between Ia afferent fibers CV of the posterior tibial nerve and the posterior tibial MCV (leg segment)

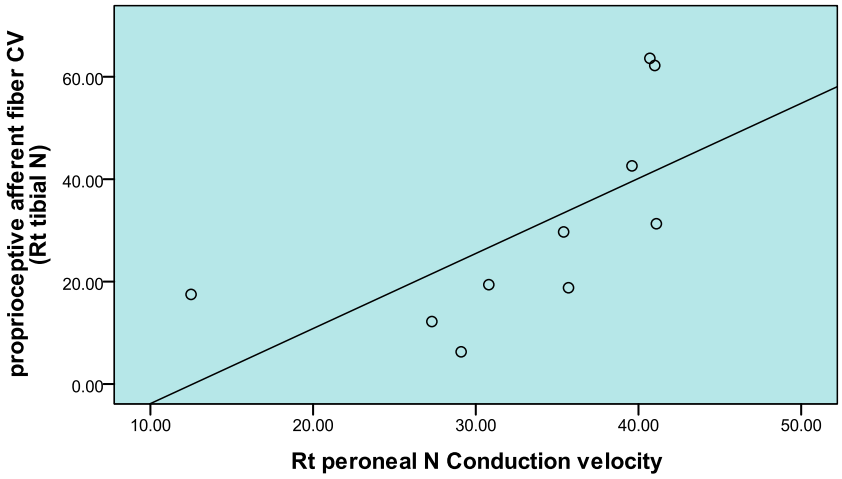


Figure 2: Scatter plot showing positive linear correlation between Ia afferent fibers CV of the posterior tibial nerve and the common peroneal nerve MCV (leg segment)

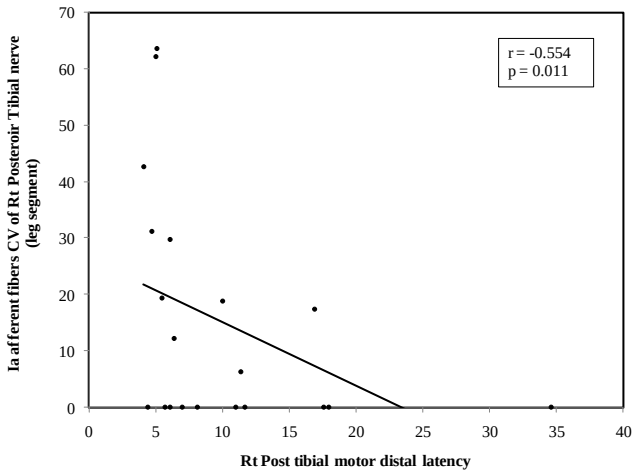
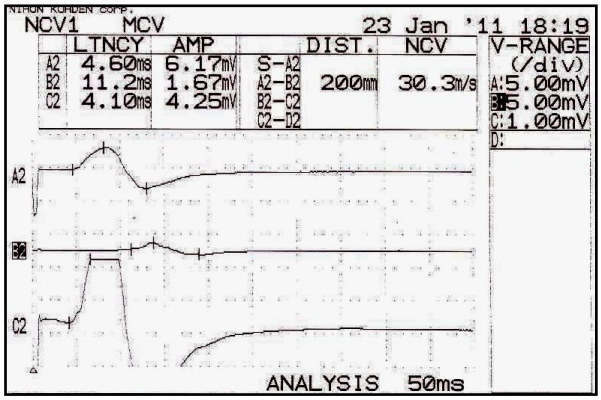
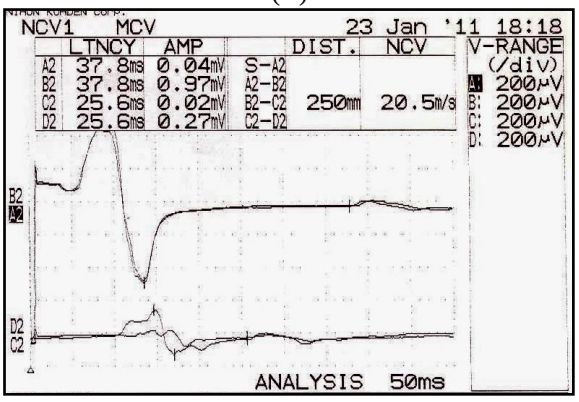


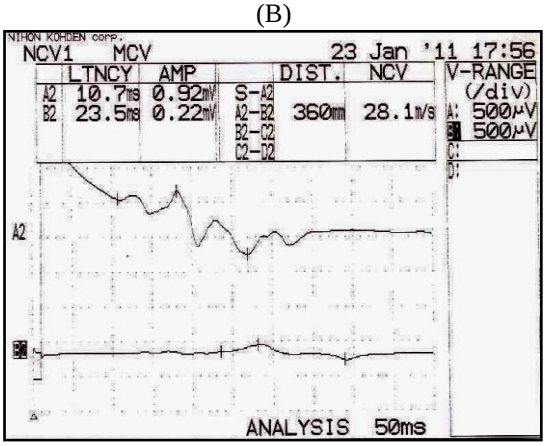
Figure 3: Scatter plot showing negative linear correlation between posterior tibial motor distal latency and its Ia afferent fibers CV



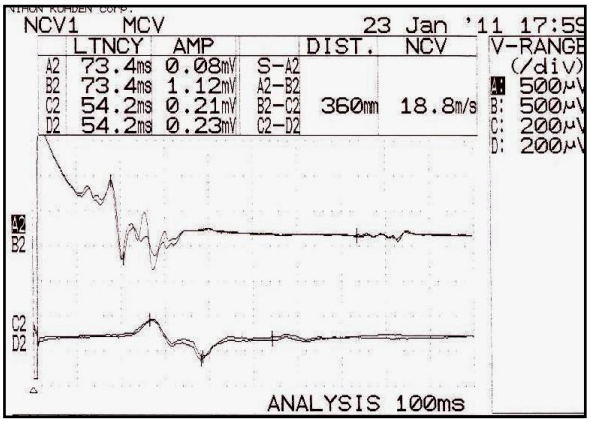
(A)



(B)



(C)



(D)

Figure 4: A patient with AIDP presented with: (A): Abnormal motor conduction of the median nerve (delayed latency, low amplitude, slowing of the CV, and conduction block in the forearm segment). (B): Slowing of its Ia afferent fibers CV. (C): Abnormal motor conduction of the posterior tibial nerve (delayed latency, low amplitude, slowing of the CV, and temporal dispersion). (D): Slowing of its Ia afferent fibers CV