

ORIGINAL ARTICLE

Correlation between Nerve Conduction Studies and Neurological Scores According to Fibre Type in Patients with Diabetic Sensorimotor Polyneuropathy

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ABSTRACT

Objective: Purpose of this study was to determine association between nerve conduction studies and neurological examination scores in patients with diabetes who had known detectable sensorimotor neuropathy.

Study Design: Cross sectional descriptive study.

Place and Duration of Study: This study was conducted at the Islamic International Medical College, Combined Military Hospital and Armed Forces Institute of Rehabilitative Medicine in Rawalpindi, Pakistan, from January 2006 to January 2015.

Materials and Methods: Patients with confirmed diabetes (n=30) and clinically detectable sensorimotor polyneuropathy according to clinical scores were selected for inclusion. The type of fiber involved was determined on the basis of the modified Diabetic Neuropathy Symptom (DNS) score and modified Diabetic Neuropathy Examination (DNE) score.

Results: Neuropathy Disability Score results showed a significant positive correlation with the results of nerve conduction studies in both large and small types of fiber.

Conclusion: In patients with type 2 diabetes and advanced neuropathy, association among the results of Neuropathy Disability scores and nerve conduction studies indicates the impaired functioning of both small and large nerve fiber.

Key Words: Diabetes, Diabetic Neuropathy, Diabetes Mellitus.

Introduction

In 2014, the nationwide prevalence of diabetes mellitus was estimated at 6.8% in Pakistan.¹ Uncontrolled diabetes mellitus may lead to neuropathy, retinopathy and macrovascular disease. If these complications are left unchecked, then they may lead to blindness,² foot ulcers³ and sexual dysfunction.⁴ Diabetic neuropathy, one of the complications of diabetes, arises due to derangements in the levels of insulin and glucose.

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This results in abnormal flow in ion channels such as sodium potassium pumps, sodium channels or calcium channels, and these disruptions can cause abnormal nerve conduction.^{5,6,7}

The Diabetic Neuropathy Symptom (DNS) and Diabetic Neuropathy Examination (DNE) scores can be used to detect diabetic polyneuropathy.⁵ The clinical diagnosis can be confirmed by scoring systems such as the Neuropathy Disability Score (NDS) and Neuropathy Symptom Score (NSS). Hence, for our study DNS and DNE scores are used whereas, clinical diagnosis is confirmed by NDS and NSS.

Clinically, large-fiber neuropathies can be distinguished from small-fiber neuropathies during neurologic testing. If tendon reflexes or vibration sense are impaired, Aa or Ab fibers are involved,⁶ whereas if pain or thermal sensation are impaired, Ad or C fibers are involved. The American Academy of Neurology has suggested that a combination of clinical symptoms and signs with electrodiagnostic findings provides the most accurate diagnosis of distal symmetric polyneuropathy.⁷

In previous studies, a significant correlation was

found between clinical findings and neurophysiological test results depending on the fiber type. Unlike earlier studies, however, our approach included four known neurological scoring systems and compared their scores according to fiber type. The objective of this study was to search for correlations between the results of nerve conduction studies and neurological examination scores in clinically detectable sensorimotor neuropathy in patients with type 2 diabetes, according to the type of fibre involved.

Materials and Methods

This cross-sectional descriptive study was conducted from January 2006 to January 2015. Purposive sampling was used to select 30 patients diagnosed as having type 2 diabetes from outpatients who had clinically detectable peripheral neuropathy (n=30) on the basis of Diabetic Neuropathy Symptom (DNS) and Diabetic Neuropathy Examination (DNE) scores. The inclusion criteria were age between 25 and 61 years (male or female) and duration of known diabetes greater than 1 year. Patients with any other type of neuropathy or musculoskeletal disorder, and patients, who were taking medications that could affect the course of neuropathy, were excluded from the study.

Diabetic neuropathy was confirmed by history and by DNS and DNE scores. Neuropathy was graded on the basis of the modified Neuropathy Disability Score (NDS) and Neuropathy Symptom Score (NSS) results. Physical examination was done, including tendon reflexes and vibration sense. If tendon reflexes or vibration sense was impaired, the patient was considered to have large-fiber neuropathy; if pain or thermal sensation was impaired, the patient was considered to have small-fiber involvement. If both types of impairment were observed, the patient was considered to have both large- and small-fiber neuropathy.

A simplified protocol for nerve conduction studies was used to record amplitudes, velocities and latencies from a minimum of two and a maximum of six nerves. Amplitudes, velocities and latencies were measured individually, and were assigned numerical grades of severity according to their values. Then a net score was assigned to each variable, and each value was labeled as normal, mild, moderate, or severe neuropathy based on the average value

recorded from two to six nerves. The presence or absence of neuropathy was recorded as an outcome. An overall score (grade) of normal, mild, moderate or severe neuropathy was assigned to the results of nerve conduction studies on the basis of the recorded amplitudes, velocities and latencies. F wave and H reflex were tested only if needed distinguish between types of neuropathy.

Fasting and random blood glucose were measured by glucometer. Hemoglobin (HbA1c) was measured using High performance liquid chromatography (HPLC) in AFIP laboratory to check long-term blood glucose control. Means and standard deviations of fasting blood glucose, random blood glucose and HbA1c were calculated. Spearman's rho test was used to estimate the correlation between nerve conduction measures and neurological examination scores according to the fiber type. The data were analyzed with SPSS v.20.0 software.

Results

Each neurological score was compared to different components of nerve conduction studies in all 30 patients. The laboratory profile of the patients was fasting blood glucose (mmol/L) 9.05 ± 3.8 (mean \pm SD), random blood glucose (mmol/L) 13.49 ± 4.65 (mean \pm SD), and Hb A1c (%) 6.82 ± 1.36 (mean \pm SD). Correlations were calculated for neuropathies involving large fibers and both fiber types, but could not be calculated for small-fiber neuropathies because none of the patients in this study had exclusively small-fiber involvement. Among the 30 patients, both fiber types were involved in 12 (40%), large-fiber neuropathy was identified in 17 (56.7%), and the fiber type in 1 patient (3.3%) could not be determined.

Regardless of the type of fiber involved, NDS correlated with the findings of nerve conduction studies. The other scores, i.e. DNS, DNE and NSS, did not correlate significantly with components of nerve conduction studies regardless of whether small, large or both types of fiber were involved. Details of these results are shown in Table I.

The positive correlations between NDS scores and different components of nerve conduction studies are shown in Figures 1-4.

Table I: Correlation between neurological scores and nerve conduction studies according to type of fiber

12 out of 30					
Nerve conduction study variables	Value	DNS	NSS	NDS	DNE
Nerve conduction study scores	r	-0.058	-0.323	0.727	-0.046
	p	0.857	0.306	0.007**	0.886
Nerve score amplitudes	r	-0.058	-0.323	0.727	0.093
	p	0.857	0.306	0.007**	0.775
Nerve score velocities	r	0.266	-0.023	0.551	-0.018
	p	0.404	0.942	0.063	0.957
Nerve score latencies	r	0.122	-0.313	0.697	-0.048
	p	0.706	0.321	0.012*	0.881

*Correlation significant at the 0.05 level (2-tailed)

**Correlation significant at the 0.01level (2-tailed)

DNS: Diabetic Neuropathy Symptom score.

DNE: Diabetic Neuropathy Examination score.

NSS: Neuropathy Symptom Score.

NDS: Neuropathy Disability Score

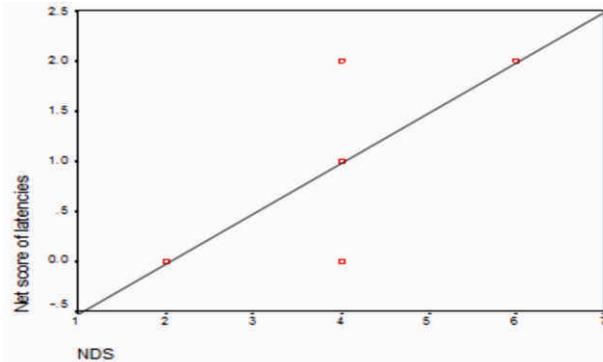


Fig 1: Correlation between Neuropathy Disability Score and net score of latencies found in nerve conduction studies (n=30) in persons with type 2 diabetes. Scatter plot showing significant positive correlation between Neuropathy Disability Score and latencies in nerve conduction studies in both types of fiber.

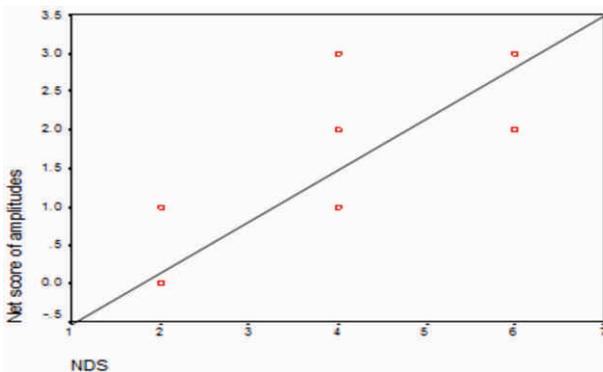


Fig 2: Correlation between Neuropathy Disability Score and net score of amplitudes found in nerve conduction studies (n=30) in persons with type 2 diabetes. Scatter plot showing significant positive correlation between Neuropathy Disability Score and amplitudes in nerve conduction studies in both types of fiber

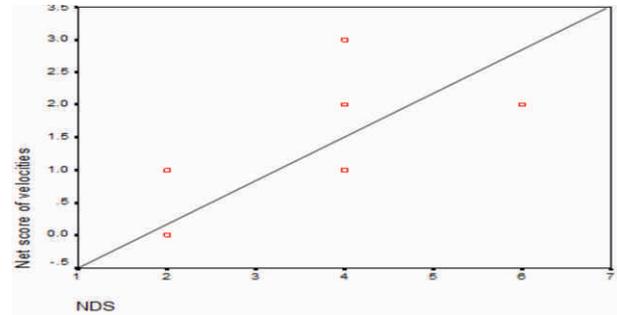


Fig 3: Correlation between Neuropathy Disability Score and net score of velocities found in nerve conduction studies (n=30) in persons with type 2 diabetes. Scatter plot showing nonsignificant positive correlation between Neuropathy Disability Score and velocities found in nerve conduction studies in both types of fiber.

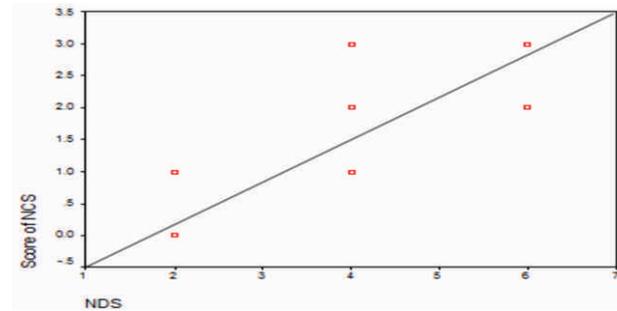


Fig 4: The correlation between Neuropathy Disability Score and score of nerve conduction studies (n=30) in persons with type 2 diabetes. Scatter plot showing significant positive correlation between Neuropathy Disability Score and in nerve conduction studies in both types of fiber

In patients with disorders affecting only large fiber, DNS, DNE, NSS and NDS results showed correlations with components of nerve conduction studies. These results are summarized in Table II.

Table II: Correlation between neurological scores and nerve conduction studies for large fiber type
Correlations were not significant.

17 out of 30					
Nerve conduction study variables	Value	DNS	NSS	NDS	DNE
Nerve conduction study scores	r	-0.225	0.085	0.229	0.169
	p	0.385	0.745	0.377	0.518
Nerve score amplitudes	r	-0.168	0.185	0.303	0.444
	p	0.519	0.476	0.237	0.074
Nerve score velocities	r	-0.139	0.146	0.147	0.050
	p	0.594	0.577	0.572	0.849
Nerve score latencies	r	-0.079	0.068	0.071	-0.051
	p	0.763	0.796	0.785	0.845

DNS: Diabetic Neuropathy Symptom score.

DNE: Diabetic Neuropathy Examination score

NSS: Neuropathy Symptom Score

NDS: Neuropathy Disability Score

Discussion

Our study shows a significant positive correlation between NDS and components of nerve conduction studies in patients with large- and small-fiber impairment. The clinical examination scoring systems we used were carefully selected to identify the type of fiber involved, and to allow the major components of neuropathy to be studied with straightforward clinical examination.⁸

Franssen et al. showed that amplitude in nerve conduction studies correlates with axonal neuropathy, which is highly predominant in our patients.⁹ Latency can also show significant correlation with axonal neuropathies, especially in advanced cases. Velocity, in contrast, was not affected much – an unsurprising lack of association with axonal neuropathies, as pointed out by Malik, et al.¹⁰ Although we found correlations between NDS scores and velocity in nerve conduction studies regardless of fiber type, this result may be due to advanced neuropathy in which demyelination has started in addition to axonal loss.

Feki et al. found a significant correlation between NDS results and nerve conduction findings, as well as between NSS and nerve conduction results, but they also found, as we did, that the former correlation was more significant.¹¹ Although 12 of our patients had deranged nerve conduction findings consistent with small-fiber disorders, their clinical scores reflected signs of both small- and large-fiber neuropathy; therefore, these patients were considered to have impairments in both types of fiber.

Lefaucheur et al. found a significant correlation between clinical findings and neurophysiological test results according to fiber type. These authors first determined the type of fiber involved on the basis of nerve conduction studies and clinical examination independently, and then looked for correlations.¹²

We determined which type of fiber was involved by clinical examination and then looked for correlations between the clinical examination results and nerve conduction studies according to fiber type. Unlike earlier studies, however, our approach included four known neurological scoring systems and compared their scores according to fiber type. Regarding NDS, we found that the scores correlated with nerve conduction findings, although this correlation was confirmed only in patients with neuropathy that

affected both types of fiber.

Liu et al. showed that the most common clinical and electrophysiological manifestation of diabetic neuropathy is a sensory disturbance, which is more severe in the lower limbs.¹³ However, when sensory symptoms are considered, electrophysiological changes are not always consistent with clinical manifestations.¹⁴

Symptom scores are not always reliable because they focus on symptoms alone. The exploration of symptoms is always patient-dependent and is affected by many confounding factors such as the patient's mental state, literacy level and attitude toward being labeled neuropathic or not. Symptom scores are thus unreliable when used alone to assess neuropathy, at least in the examination protocols currently in use. In many neuropathies, the pathophysiological and clinical profiles may be heterogeneous across patients.¹⁵ This variability may be responsible for the differences in results when patients are examined with two or more different techniques, as each technique focuses on a specific aspect of the patient's illness.

Our impression is that if a more comprehensive battery of symptoms were used to assess neuropathy, the results may be more reliable. Searching for correlations between the findings from neurological examination and nerve conduction studies is a way to explore two different aspects of neuropathy. Nerve conduction studies measure the strength of local signal transport, whereas neurological examination assesses the overall function of the nerve as well as the muscles involved. However, abnormal findings in nerve conduction studies also eventually point to impaired overall nerve functioning. We found that in patients with both small and large fiber involvement, the correlation between these two sources of information was indicative of more advanced neuropathy.

If carefully examined and investigated, many idiopathic neuropathies can be assigned to known causes of neuropathy after appropriate testing.¹⁶ The findings of patient assessment by clinical examination also depend on normal receptor functioning, which is not the case with nerve conduction studies.

Rota et al. correlated clinical neuropathy with the

results of electrophysiological tests, but did not categorize patients according to severity.¹⁷ They investigated only persons with impaired neurological scores according to the NDS and NSS, and who also had impaired nerve conduction. Their results are consistent with our findings. In the present study we also recorded nerve conduction in those patients who did not have positive findings on clinical examination, and found neuropathy in many of these patients. This aspect of our study is important in establishing the value of nerve conduction studies in patients like the ones enrolled in our study.

An important difference between our study and others is that usually a full battery of NDS and NSS is claimed to have been tested, which is rather impractical in daily clinical practice both for the physician and for outpatients, especially in settings with a heavy patient turnover.^{18,19} A complete battery of scoring systems assesses many components which are not related to peripheral neuropathy, and so are not relevant to the aims of the present study. We have, however, included modified forms of both examination systems, with the aim of testing related components of nerve functioning in an effort to search for an approach to clinical diagnosis that would be practical for the physician.

In Pakistan it is common practice to perform neurological examination and nerve conduction studies in centers where both facilities are available. To date, however, the correlations between these two methods have not been analyzed either directly (in comparison to clinical examination findings) or according to the type of fiber involved.

In our sample we are unable to confirm significant correlations between clinical signs of neuropathy documented with different scoring systems and evidence of impaired nerve functioning obtained with nerve conduction studies in patients with small-fiber dysfunction, but the correlations are significant in those with large-fiber or mixed large- and small-fiber dysfunction. Our findings give us insight into the reasons for differences in the performance of various scoring systems used to detect neuropathy. However, the influence of confounding factors such as the subjectivity of clinical assessments needs to be taken into account. Future studies should include more specific variables. Moreover, many patients do not recognize their symptoms unless asked about

them through direct questioning. This aspect may also contribute to discrepancies between the results of sensory clinical scoring systems and nerve conduction studies among patients with diabetic sensorimotor polyneuropathy involving different types of nerve fibers.

According to our results, more patients had large- or mixed-fiber impairment rather than only small-fiber impairment. This finding needs to be investigated further in patients with newly-diagnosed diabetes to determine whether small or large fibers are initially affected, and follow-up studies will be needed to determine whether impairment in one type of fiber evolves toward impairment in the other type. It is also possible that small fibers, if affected early, may recover earlier during treatment for hyperglycemia, whereas mainly large fiber impairment appears later, or remains detectable for longer during the course of diabetes.

Conclusion

In patients with type 2 diabetes and advanced neuropathy, our use of more objective examination tools showed that the correlation between the findings of nerve conduction studies and neurological examination scores indicative of sensorimotor neuropathy reflects the involvement of a specific type of nerve fiber. For patients with both small- and large-fiber neuropathy, objective tests such as the NDS also correlate with nerve conduction study results.

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