

Single-fiber Electromyography in Patients with Diabetic Neuropathy

Zahid Mohammad Kadhim, Ihsan Abood Ajeena¹, Moahmmmed Jaber Al-Maamory²

Department of Physiology, College of Medicine, University of Babylon, ¹College of Medicine, University of Kufa, ²Babylon Health Directorate, Iraq

Abstract

Diabetic peripheral neuropathy (DPN) is the most common microvascular complication of diabetes mellitus. Clinically, it affects the most distal extremities, first resulting in a stock and glove pattern of sensory loss. It affects both small fibers (myelinated and unmyelinated) and large myelinated nerve fibers. However, the earliest manifestations might be due to small fiber dysfunction. The diagnosis of DPN relies largely on typical history and physical examination and supported by the conventional nerve conduction study (NCS) and electromyography (EMG). However, a large number of cases might be missed from diagnosis due to small fiber involvement that manifests before large fibers. This necessitates the use of other diagnostic strategies such as single-fiber EMG, which is helpful in deciphering small fiber dysfunction and DPN earlier than NCS.

Keywords: Diabetic neuropathy, electromyography, nerve conduction study, single-fiber EMG

DIABETIC NEUROPATHY

Diabetic neuropathy is a descriptive term that encompasses a spectrum of clinical and subclinical syndromes with differing anatomical distributions, clinical courses, and possibly differing underlying pathogenetic mechanisms. Each is characterized by diffuse or focal damage to peripheral somatic or autonomic nerve fibers resulting from diabetes mellitus (DM), although indistinguishable syndromes may occur idiopathically or in association with other disorders in non-diabetic individuals.^[1]

Diabetic neuropathies are the most common types of neuropathies worldwide,^[2] and it is the most common microvascular complication of DM reaching 45–50% prevalence when compared with 25–30% of retinopathy and 20% of nephropathy. The prevalence of diabetic peripheral neuropathy (DPN) is similar in males and females,^[3] and it increases with age and duration of diabetes and tends to be more common in patients with type 2 DM than in those with type 1 DM. The prevalence of neuropathy is estimated to be about 8% in newly diagnosed diabetics (at the time of diagnosis of DM)^[4] and greater than 50% in patients who had diabetes longer than 25 years with an average prevalence of 30%.

DPN typically affects the most distal extremities, first resulting in a stocking pattern of sensory loss with the toes affected first and the process then extends up the legs. Only later, the upper extremities may be involved beginning with the fingertips and in very severe cases the disease may also affect the anterior portions of the chest and abdomen.^[5]

DIAGNOSIS

DPN has an insidious onset and most patients are usually asymptomatic or mildly symptomatic, and it may only be detected with careful physical examination supported by electrophysiological testing.^[6]

Other means for diagnosing DPN are nerve biopsy, skin punch biopsy, imaging of peripheral nerve by ultrasound or magnetic resonance imaging, and quantitative sensory testing.

Address for correspondence: Dr. Zahid Mohammad Kadhim,
Department of Physiology, College of Medicine, University of Babylon, Iraq.
E-mail: med.zahid@uobabylon.edu.iq

Submission: 25-May-2022 **Accepted:** 27-Jun-2022 **Published:** 09-Jan-2023

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: Kadhim ZM, Ajeena IA, Al-Maamory MJ. Single-fiber electromyography in patients with diabetic neuropathy. Med J Babylon 2022;19:511-3.

Access this article online

Quick Response Code:



Website:
www.medjbabylon.org

DOI:
10.4103/MJBL.MJBL_76_22

ELECTROPHYSIOLOGICAL DIAGNOSIS

Nerve conduction study (NCS) is the most reliable, accurate, informative, and sensitive measure of peripheral nerve functions. Furthermore, these tests have long been considered as the gold standard for the diagnosis of all neuropathies and are usually considered as an extension of the clinical neurological examination. The sensitivity of NCS in the identification of neuropathy is extremely high, being about 90% in most focal and diffuse neuropathies if proper tests are selected for a given disorder and the testing is technically satisfactory.^[7]

The usefulness of NCS can be summarized as follows:

1. Detecting and documenting peripheral abnormalities and its precise localization (neuronal cell body, roots, plexus, or peripheral nerve);
2. Confirming anatomic distribution of a neuropathy as mononeuropathy, multiple mononeuropathy (mononeuritis multiplex), or symmetric polyneuropathy;
3. Most importantly, electrodiagnostic studies can determine the form of the underlying pathological process, which affects primarily the axons, their myelin sheaths, or both and its distribution (focal, multifocal, or generalized);
4. Following the course of a peripheral neuropathy, they may aid in the assessment, prognosis, and the effect of treatments;
- 5- Stating the severity of the disease process.^[6]

LIMITATION OF THE CONVENTIONAL NERVE CONDUCTION STUDY IN THE DIAGNOSIS OF DIABETIC PERIPHERAL NEUROPATHY

The pathophysiology of DPN usually includes a progressive axonopathy of dying-back type, characterized by myelinated fiber loss and decreased fiber regeneration. The corresponding electrophysiological changes are documented by NCS and routine concentric needle electromyography (EMG). Nerve conduction velocities readily study the demyelinating features of neuropathy, but are limited in assessing axonal properties or nerve regeneration. In addition, only large fibers are tested in nerve conduction velocity studies.^[8]

As the variability in nerve conduction velocity on repeated examinations with rigorously controlled procedures is 5 m/s, this procedure is limited in detecting small-magnitude changes. Also, small-magnitude changes related to re-innervation are difficult to detect by the conventional NCS. Furthermore, only small fiber might be affected in early disease.^[9]

Conventional techniques to assess conduction block are usually based on the comparison of surface motor responses, obtained by the stimulation of the nerve in

different sites looking for a 50% drop in amplitude of proximal response when compared with the distal one. In spite of the generally good sensitivity of the conventional nerve conduction evaluation, normal findings are still observed in a number of patients, with clinical data strongly suggesting the presence of conduction block. This usually occurs if only a short segment of the axon is affected (minimal conduction block).^[10]

Therefore, an electrophysiological parameter reflecting something other than axonal loss or demyelination would be useful in the study of diabetic neuropathy, especially in early disease stages. Such parameters would be particularly relevant in monitoring the efficacy of new therapeutic approaches to this common disorder.^[11]

SINGLE-FIBER ELECTROMYOGRAPHY (SFEMG)

It is a selective recording technique in which a specially constructed concentric needle electrode (single-fiber needle) is used to record action potentials from a single muscle fiber.^[12] The selectivity of the technique results from the small recording surface (25 µm in diameter) and is further heightened by using a high-pass filter of 500 Hz. It is thus important to filter the low-frequency components which predominantly attenuate signals from distant fibers and so only signals from near fibers are recorded with high amplitudes.

The SFEMG findings (both jitter and fiber density) were correlated with the duration of diabetes in the form that longer duration of diabetes has higher jitter and fiber density values when compared with shorter duration. Similarly, signal block during jitter measurement (which indicates significant neuromuscular compromise) is seen in diabetic patients with the duration of diabetes longer than 11 years. On the contrary, the studies showed no correlation between jitter and fiber density values with the levels of HbA1c.

It has been demonstrated that SFEMG parameters are good indicators for peripheral nerve and neuromuscular junction function, and any derangement in these physiologic functions will be manifested as abnormal jitter and fiber density. Also the SFEMG changes were correlated mainly with abnormalities of the sural nerve conduction parameters and that they could reflect the severity of neuropathy.^[13]

Furthermore, SFEMG is capable of showing nerve fiber regeneration and re-innervation in patients with DPN more efficiently than conventional NCS can. Bril *et al.*^[13] found that jitter is increased only with elevated fiber density and that both jitter and fiber density are reflective of re-innervation activity and so the degree of SFEMG abnormality might help to assess the degree of nerve regeneration. Thus, SFEMG may provide a way to follow responses to therapy in patients with diabetic neuropathy,

as a more precise electrophysiological tool to study nerve regeneration than conventional NCSs.^[14]

Many studies expressed that there is a positive correlation between jitter value and fiber density in type 2 DM with HbA1c and that SFEMG is helpful in the diagnosis of DPN and might detect subclinical nerve derangement.^[15] On the contrary, a study done by Bril *et al.* in 1996^[13] on diabetic patients found that the correlation of the jitter and fiber density with the HbA1c was present only in type 1 DM. Other researchers as Padua *et al.*^[16] stated that single-fiber conduction velocity was able to detect mild myelin damage (partial conduction block) with higher sensitivity than the conventional NCS. Diabetic neuropathy in patients with diabetes mellitus has also been reported by several authors in different parts in Iraq.^[17,18]

CONCLUSION

SFEMG examination in diabetic patients is important in showing degree of re-innervation and regeneration, and it is valuable to diagnose subclinical nerve derangement.

Ethical consideration

No applicable.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Sima AAF. Diabetic neuropathy in type 1 and type 2 diabetes and the effect of C-peptide. *J Clin Sci* 2004;220:133-6.
2. Matuszewska W, Bandurska-Stankiewicz E, Wiatr-Bykowska D, Myszkowska K, Kamińska U. Diabetic neuropathy. *Pol Ann Med* 2013;20:154-9.
3. Yagihashi S, Yamagishi S, Wada R. Pathology and pathogenetic mechanisms of diabetic neuropathy: Correlation with clinical signs and symptoms. *Diabet Res Clin Pract* 2007;77:184-9.
4. Kostev K, Jockwig A, Hallwachsc A, Rathmann W. Prevalence and risk factors of neuropathy in newly diagnosed type 2 diabetes in primary care practices: A retrospective database analysis in Germany and UK. *Care Diab* 2014;8:250-5.
5. De Visser A, Hemming A, Yang C, Zaver S, Dhaliwal R, Jawed Z, *et al.* The adjuvant effect of hypertension upon diabetic peripheral neuropathy in experimental type 2 diabetes. *Neurobiol Dis* 2014;62:18-30.
6. Greene DA, Stevens MJ, Feldman EL. Diabetic neuropathy: Scope of the syndrome. *Am J Med* 1999;107:2S-8S.
7. Yamagishi S, Maeda S, Matsui T, Ueda S, Fukami K, Okuda S. Role of advanced glycation end products (AGEs) and oxidative stress in vascular complications in diabetes. *Biochim Biophys Acta* 2013;1820:663-71.
8. Arnold R, Kwai NC, Krishnan AV. Mechanisms of axonal dysfunction in diabetic and uraemic neuropathies. *Clin Neurophysiol* 2013;124:2079-90.
9. Koo YS, Jung KY, Lee SH, Cho CS, Yang KS, Jang JH, *et al.* Multichannel surface electrodes increase the sensitivity of diagnosis of neuropathy in diabetic patients. *J Electromyogr Kinesiol* 2013;23:1057-64.
10. Blum AS, Rutkove SB. *The Clinical Neurophysiology Primer*. 1st ed. Totowa, NJ: Humana Press Inc.; 2007. p. 355-67.
11. Park TS, Baek HS, Park JK. Advanced diagnostic methods of small fiber diabetic peripheral neuropathy. *Diabet Res Clin Pract* 2007;77:190-3.
12. Kouyoumdjian JA, Stålberg EV. Concentric needle single fiber electromyography: Comparative jitter on voluntary-activated and stimulated extensor digitorum communis. *Clin Neurophysiol* 2008;119:1614-8.
13. Bril V, Werb MR, Greene DA, Sima AF. Single fiber electromyography in diabetic peripheral polyneuropathy. *Muscle Nerve* 1996;19:2-2.
14. Stancaelli A, Nolano M, Provitera V, Caporaso G, Santoro L. Epidermal nerve fiber quantification in immunofluorescence with and without confocal microscopy. *J Clin Neurophysiol* 2013;124:198-223.
15. Zhenzhen W, Wenming C, Zuneng L. Diagnostic value of single fiber electromyography in diabetic peripheral neuropathy. *Clin Neurol* 2012;2001:5.
16. Padua L, Stålberg E, Caliendo P, Muscogiuri G, Pazzaglia C, Sorice GP, *et al.* Single-fiber conduction velocity test allows earlier detection of abnormalities in diabetes. *Muscle Nerve* 2011;43:652-6.
17. Abbas ZA, El-Yassin HD. The impact of glycemic control on procalcitonin level in patients with type ii diabetes. *Med J Babylon* 2022;19:391-5.
18. Abdullah WH, Kadhum AJ, Baghdadi GA. Diabetic nephropathy in children with type 1 diabetes mellitus with vitamin D deficiency and dyslipidemia as associated risk factors. *Med J Babylon* 2022;19:294-8.