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Nerve conduction study in different clinical grades of diabetic foot

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Abstract
Aim: Study of nerve conduction in different clinical grades of diabetic foot.
Material and Method: Diabetic foot without ulceration but with one or more risk factors which include; clinically significant sensory neuropathy, bony deformities, atrophic fat pad, plantarflexed metatarsals, peripheral vascular disease, charcot joint disease; also certain dermatological conditions like dry, scaly skin with fissures or thickened, discoloured nail plates. All patients diagnosed as diabetic foot were sent for Nerve Conduction Study after obtaining their written informed consent. Three nerves were studied; two motor nerves, common peroneal and tibial nerves; and one purely sensory nerve, sural nerve. After obtaining their nerve conduction study values, their results of nerve conduction study were tabulated according to the clinical grades of diabetic foot. The data collected was subjected to statistical analysis to detect the differences in the nerve conduction study in different grades.
Result: Number of male patients were more than twice the number of female patients in my study. The number of patients with bilateral neuropathy detected by NCV study is more than that detected clinically. By applying test of significance, chi significant. Hence, NCV is a better study to detect nerve conduction abnormalities than clinical examination.
Conclusion: Mixed type of neuropathy was the most common in my study with respect to sensory and motor types of neuropathy; and also axonal and demyelinating types of neuropathy. Number of patients with bilateral neuropathy detected by NCV study in my study is more than that detected clinically and the difference is significant by applying the test of significance.

Keywords: Diabetic Foot, Nerve Conduction

Introduction
Diabetes mellitus is a metabolic disorder characterised by hyperglycemia resulting from defects in insulin secretion, insulin action or both. It may be accompanied by other biochemical disturbances and the presence of progressive diabetic tissue damage with micro and macrovascular complications. Diabetes is the leading cause of end-stage renal disease, a major cause of non-traumatic amputations, responsible for 30% of the preventable blindness and a leading cause of cardiovascular mortality [1].
Diabetes mellitus is broadly classified into two types. Type 1 diabetes which is either immune mediated or idiopathic resulting in absolute insulin deficiency. Type 2 diabetes which ranges from predominantly insulin resistance with relative insulin deficiency to a predominantly secretory defect with insulin resistance. Certain other specific types include various causes like diseases of the exocrine 2 pancreas, endocrinopathies, drug-induced, infection-induced or genetic defects [2].
A small-pain-fibers nerve conduction study (spf-NCS) method came into practice. This method uses an electrical stimulus with a neuroselective frequency to determine the minimum voltage causing conduction. Rather than comparing the data with population averages on a bell-shaped curve, which at best has about 65% sensitivity, the patientwas used as his own control. In a three year, LSU (*Louisiana State University)* Pain Center study, it was found that the nerve requiring the greatest voltage to cause conduction of the A-delta (fast pain) fibers identified nerve root pathology with 95% sensitivity. Besides being painless, the test is fast. A new version, uses a potentiometer to objectively measure the amplitude of the action potential at a distant site along the nerve being tested.

The previous version relied on the patient reporting a sensation when the nerve fired. The spf-NCS does not require myelin loss to detect function change, so velocity is not measured [3].

The nerve conduction study is sometimes combined with electromyography. Other special nerve conduction studies that are occasionally performed include double stimuli and repetitive stimulation. NCV study has certain pre-requisites. Patients with any electrical device in situ such as cardiac pacemakers cannot be included in the NCV study [4]. There are also certain drawbacks like pain while doing EMG (Electromyography) in NCV study and electrical stimulation and the site of stimulating electrode that may not be tolerable for the patient Nerve conduction velocity studies are of use in firming up the diagnosis of diabetic neuropathy. The aim of our study is to study the nerve conduction in various clinical grades of diabetic foot.

Material and Method

This proposed study was carried out as a prospective, randomized clinical trial in 50 patients diagnosed diabetic foot; in department of Surgery, Krishna Institute of Medical Sciences, Karad after getting approval from Ethics Committee.

At risk foot: Diabetic foot without ulceration but with one or more risk factors which include; clinically significant sensory neuropathy, bony deformities, atrophic fat pad, plantarflexed metatarsals, peripheral vascular disease, charcot joint disease; also certain dermatological conditions like dry, scaly skin with fissures or thickened, discoloured nail plates. All patients diagnosed as diabetic foot were sent for Nerve Conduction Study after obtaining their written informed consent. Three nerves were studied; two motor nerves, common peroneal and tibial nerves; and one purely sensory nerve, sural nerve. After obtaining their nerve conduction study values, their results of nerve conduction study were tabulated according to the clinical grades of diabetic foot. The data collected was subjected to statistical analysis to detect the differences in the nerve conduction study in different grades.

All facilities and equipments were available in the institute. The Nerve Conduction Study was assessed objectively by using Nerve Conduction Study Machine, which gives the exact velocity of conduction of impulse along the nerve and other parameters like amplitude, latency and F wave.

Result

This proposed study was carried out as a prospective, randomized clinical trial in 50 patients diagnosed diabetic foot; in department of surgery, Krishna Institute of Medical Sciences, Karad after getting approval from Ethics Committee.

Mixed type of neuropathy is the most common neuropathy. (Table 1)

Table 1

Type of neuropathy	Number of patients
Axonal	8
Demyelinating	3
Mixed	38
Normal	1

Number of male patients were more than twice the number of female patients in my study. The number of patients with bilateral neuropathy detected by NCV study is more than that detected clinically. By applying test of significance, chi significant. Hence, NCV is a better study to detect nerve conduction abnormalities than clinical examination.

Discussion

The principal pathogenic mechanisms in diabetic foot disease are ischemia, neuropathy and infection; acting together they contribute to the sequence of tissue necrosis, ulceration and gangrene. Neuropathy affects around 50% to 60% of all the patients and more than 80% of diabetic patients with foot lesions. Broadly the neuropathies are classified as focal and diffuse, the later more common and include the autonomic and chronic sensorimotor polyneuropathies, which both contribute to foot ulceration. Sensorimotor neuropathy initially involves the distal lower extremities, progress centrally and is typically symmetric [4]. Sensory nerve fiber involvement leads to loss of the protective sensation of pain, whereas motor-fiber destruction results in small-muscle atrophy in the foot. The spectrum of infection in diabetic foot ranges from superficial ulceration to extensive gangrene with fulminant sepsis. The majority of infections are polymicrobic with the most common pathogens being staphylococci and streptococci. Potential sources of diabetic foot infection include a simple puncture wound or ulcer, the nail plate and the interdigital web space.

A proper evaluation for underlying vascular disease is essential for limb salvage in patients with diabetic foot ulceration, even when neuropathy and infection are present. There are two types of vascular disease in patients with diabetes; one, the non-occlusive microcirculatory impairment involving the capillaries and arterioles of the kidneys, retina and peripheral nerves; second, macroangiopathy characterized by atherosclerotic lesions of the coronary and peripheral arterial circulation. The single most important indicator of adequate perfusion is the presence of palpable pedal pulses [6].

Peripheral sensory neuropathy has been identified as the major risk for diabetic foot ulceration and also for amputation [5]. The inability of diabetic patients to feel pain places him or her at significant risk for future problems. Diabetic neuropathies have many phenotypes. Distal sensory neuropathy is the most common variety of neuropathy with mild distal sensory impairment and minimal motor deficits and comprises greater than 50% of all diabetic neuropathies. Distal small fibre neuropathy is the other variety, characterized by distal positive symptoms including painfulness and impairment in both pain and temperature sensation [6].

Hyperglycemia is now well established as a risk factor in both patients with type 1 diabetes and type 2 diabetes. Other correlates and associations include age, duration of diabetes, quality of metabolic control, height, the presence of background or proliferaive diabetic retinopathy, cigarette smoking, high-density lipoprotein cholesterol and the presence of cardiovascular disease [7].

Both lightly myelinated and unmyelinated small nerve fibers an demyelinated large nerve fibers are affected. Dysfunction of small and large fibers occurs in varying combinations; however in most cases the earliest deficits involve the small nerve fiber. Features characteristic of a small-fiber peripheral neuropathy include deficits in pain and temperature perception, paresthesias and dysesthesias, pain, deficits in the perception of visceral pain. Dysautonomia and predisposition to foot ulceration. Proprioception and deep tendon reflexes are relatively preserved [8]. Nerve conduction studies may be

normal or minimally abnormal when small fiber features dominate since these measurements are dependent on conduction in the surviving large, myelinated nerve fibers. Once established, sensory and ensorimotor distal neuropathy is a permanent condition; although the course of painful manifestations is highly variable [9].

Although selected large fiber neuropathies might be expected to cause muscle weakness, painless loss of vibration and position sense, and impaired tendon reflexes, pathologic, clinical and quantitative sensory studies have not demonstrated pure loss of large fibers in diabetic peripheral neuropathy [10].

Foot ulceration and neuropathic arthropathy are two of the more dreaded complications of diabetic neuropathy [11]. Foot ulcers usually occur in patients with small- or large- fiber neuropathy. Painless ulcers in weight-bearing areas occur on a background of insensitivity to pain, impaired proprioception, atrophy of intrinsic foot muscles, and the consequent maldistribution of weight-bearing, disturbed sweating, impaired capillary blood flow caused by autonomic neuropathy and noninflammatory edema [12].

Numbness and paresthesia begin in the toes and gradually and insidiously ascend to involve the feet and lower legs. Sensory deficit usually occurs symmetrically in the distal territory of overlapping nerves, but not infrequently, asymmetric patterns of sensory loss in root or nerve distribution may be superimposed on this distal symmetric pattern of sensory loss [13]. Because the distal portion of longer nerves are affected first, the feet and lower legs are involved before the hands, producing the typical "stocking-and-glove" pattern of sensory deficit. Nerve conduction velocity studies are of use in firming up the diagnosis of diabetic neuropathy [14].

Clinically, the patients in my study "Nerve Conduction Study in Different Clinical Grades of Diabetic Foot" were assigned into different grades according to Wagner and Brodsky Depth-Ischemia Classification of Diabetic Foot Lesions. Maximum number of patients in my study were found to be in the 0-A grade. Mixed type of neuropathy was the most common in my study with respect to sensory and motor types of neuropathy; and also axonal and demyelinating types of neuropathy. Maximum number of patients in my study were from the age group 61 to 65 years.

Number of patients with bilateral neuropathy detected by NCV study is more than that detected clinically and the difference is significant by applying the test of significance. Hence, NCV is a better study to detect nerve conduction abnormalities than clinical examination.

Conclusions

All 50 patients were examined clinically and were investigated with NCV (Nerve Conduction Velocity) study. Three nerves were studied; two motor nerves, common peroneal and tibial nerves; and one purely sensory nerve, sural nerve. Clinically, the patients were assigned into different grades according to Wagner and Brodsky Depth-Ischemia Classification of Diabetic Foot Lesions. Maximum number of patients in my study were found to be in the 0-A grade. Maximum number of patients were from the age-group 61-65 years. Mixed type of neuropathy was the most common in my study with respect to sensory and motor types of neuropathy; and also axonal and demyelinating types of neuropathy. Number of patients with bilateral neuropathy detected by NCV study in my study is more than that detected clinically and the difference is significant by applying the test of significance. Hence, NCV is a better study to detect nerve conduction abnormalities than clinical examination in diabetic foot.

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