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Perspectives of Rehabilitation in Diabetic Neuropathy

TROFIN Dan [1], MATEI Daniela [1, 2, *], STAMATE Teodor[1, 3], WALTHER Bild[1, 4], TROFIN Daniela Marilena[1, 5]

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Corresponding author: **MATEI Daniela,** E-mail: dvm2202@yahoo.com

[1]University of Medicine and Pharmacy "Grigore T. Popa" Iași, Romania,
[2]Department of Biomedical Sciences, Faculty of Medical Bioengineering,
[3]Department of Plastic and Recontructive Surgery, "Sf. Spiridon" Emergency Hospital, Iași
[4]Departament of Human Physiology,
[5]Departament of Neurology, The Rehabilitation Hospital, Iași;

Abstract

Diabetic Neuropathy (DN) is a complication that affects at least half of the patients with Diabetes Mellitus. Unlike other symptoms and signs that may sooner alarm the patients, DN manifestations tend to be rather silent, and so usually neglected by the patient for a long period of time, which can last for years. Therefore it's a "hidden complication of diabetes" label. Unfortunately, it is only when symptoms already affect the quality of life that the treatment becomes challenging when it comes to speaking of either etiological, symptomatic or rehabilitation strategies. Early diagnosis can also be tricky while aiming for lifestyle corrections and proper individualized treatment strategies. Rehabilitation methods for DN aim especially towards the improvement of articulation mobility and muscular strength amelioration, the suggested brief review of literature promoting this part of therapy essential for both prevention and amelioration of overall morbidity.

Keywords: *diabetic neuropathy, physical therapy, interdisciplinary approach, quality of life,*

Introduction

Whereas there are many definitions and classifications for the concept of Diabetic Neuropathy (DN), we align to the ones that consider it a generic notion which includes different types of neuropathies, as neither one of them is present exclusively in Diabetes Mellitus (DM) (1). DN can manifest by either sensory, sensory-motor or autonomic polyneuropathies, as well mononeuropathies (carpal tunnel syndrome, cubital nerve neuropathy, peroneal neuropathy, cranial nerves III, IV, VI or VII affectation) or different forms of radiculopathies and plexopathies (1,2).

Usual neuropathies have various manifestations such as numbness in the distal part of the limbs, unpleasant subjective sensations that are more evident at rest or during night time, as well as pain and discomfort along the anatomical tract of one or more peripheral nerves. It can also manifest as muscle pain, muscle loss, cramps, various non-specific autonomic or cranial nerves symptoms (3-5). Clinically, osteotendinous reflexes in the lower limbs can be diminished or absent, there can be signs of muscle atrophy, or even deformities of the feet (3,5).

Diagnosis is usually established clinically, however there are cases in which paraclinical testing can provide useful information the etiology, in case of doubt (asymmetrical or predominantly motor signs, rapid progressing disease or positive family history of neuropathy). In such situations, electromyography usually orientates the differential diagnosis (1). Nevertheless, there are situations when the clinician must be well oriented and able to use whatever exploratory methods available. We recall the particular situation when one of our patients couldn't benefit from electromyographic testing due to technical issues, and underwent thermographic scanning of the lower limbs instead. Thermography, as an additional diagnosis tool, provided information related to the specific affectation of neurons and vasa nervorum endothelium. Thermography could be combined with other image processing techniques, for instance using directional two-dimensional filters (6), (7), in order to detect and extract various relevant details from the analyzed images.

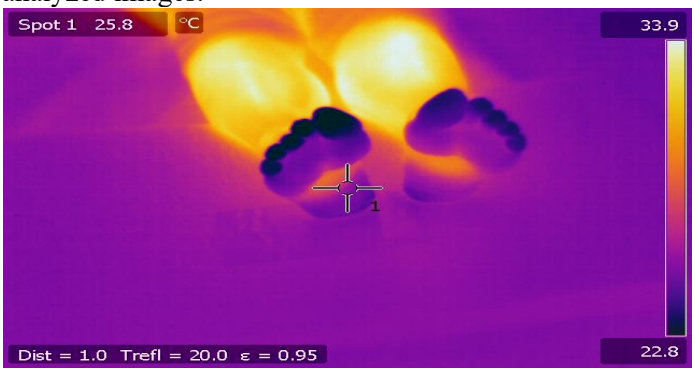

Fig. 1 Thermography: Specific thermal patterns in feet affected by diabetic neuropathy (yellow – normal temperature, tones of blue – metabolic and vascular affectation)

Nowadays, the spectrum of diverse available diagnostic tools provide utility in postponing the progression of symptoms and signs, as the evolution of DN eventually leads to morbidity and negative impact on quality of life. This occurs especially by the development of diabetic foot, which requires interdisciplinary therapeutic approach, from a mixed team including diabetologist, neurologist and surgeon. Rehabilitation techniques emerge as necessary interventional treatments of ameliorating walking, pacing, overall muscle strength and improvement of mobility, for preventing or correcting further disability (and eventual potential progressive risk for amputations associated with the diabetic foot).

Aspects of clinical neurorehabilitation in Diabetic Neuropathy

Neurorehabilitation techniques complete a therapeutic algorithm including nutritional support, long-term satisfactory glycemic control and efficient anti-diabetic treatment. The interdisciplinary approach to the patient with DN also includes a physical therapist, a podiatrist and masseur technician, as functional reeducation implies: electrotherapy, varieties of kinetotherapy (neuro-functional stimulation, proprioceptive neuromuscular facilitation, progressive resistance based active exercises), balneotherapy, sensory rehabilitation or tonifying massage (8).

Rehabilitation of DN applies to sensorial dysfunctions, motor impairment, autonomic neuropathy and ameliorating pain. The available body of data is suggestive for the benefits of physical therapy, and promotes rehabilitation techniques as necessary for completing both the pharmaceutical approach and the nutritional adjustments (9-11).

a. Rehabilitation treatment for sensorial impairment

A sensory deficit oriented treatment usually starts with pressure and pain training, aims towards improvements in differentiation between cold and warm stimuli and eventually deals with amelioration of stereognosis (8). Sensorial deficits usually take a long period to be corrected; nevertheless it is essential that correction should be recommended for preventing further morbidity. A recommended strategy is to deal with pain sensitivity first, followed by the tactile and the temperature recognition. These are the first actions to take for eventually regaining stereognosis (12, 13). Step by step, the patient will be able to recognize the correct site where the skin is touched by the examinator's tip of the finger, sensations of warm/cold, will perceive pain caused by a needle and will regain detection of vibrations (13,14).

Kinetotherapy techniques, both active and passive, provide opportunity for improving stereognosis. The patient will initially observe how the kinetotherapist applies different stimuli, afterwards he will try to be aware of the sensations without visual contact, as part of the so called sensory rehabilitation exercises, which are recommended to last 5 or 10 minutes, and can be repeated several times during 24 hours (13-15).

Passive, postural and global rehabilitation programs may also benefit from the use of occupational therapy (15,16). On the other hand, the reorganization of sensitivity could occur with aberrations, such as perceiving a certain stimulus on a total different site than the one stimulated. In this situation, repetition of exercises will finally contribute to repairing the correspondence between the excitation site and the cortical perception (13).

b. Rehabilitation for motor functions

Ameliorating muscle strength and improving joints motility, stance and gait, has a major utility in delaying the evolution towards articular rigidity, muscle atrophies, also with benefit upon vascular function (13, 15). A program designed for motor function will first assess passive mobilizations, up to 4 times a day. As soon as stability is overall improved, the active measures will aim an increase in muscle strength and resistance, with respect to the articular pain threshold and thus, progressively increasing the difficulty. When using stance exercises, the patient can be challenged to maintain balance in different situations, which will further improve the ankle stability (13, 15).

Therapeutic recommendations must always be adapted to the patient's cardiologic comorbidities (e.g. chronic miocardic ischaemia), associated respiratory and orthopedic pathologies, as well as the degree de sedentary lifestyle. Exercises can be adapted for increasing adaptability to effort and can include: walking, going up stairs or ramps, medicinal bike, swimming and occupational therapy (starting with daily household activities) (11-16). Promoting everyday lifestyle-based activities is an important fundament of compliance to the rehabilitation process. The most accessible cardio exercise is walking, especially that today pedometers and heart rate monitoring applications/ devices are neither expensive, nor by any means inaccessible. This way, both the patient and the physician can be involved in the diabetic patient's lifestyle optimization program (13, 17).

Exercises based on plantar flexion varieties have been proven to improve articular stability, muscle strength and ambulation (10). Dynamic or static stretching exercises, tai chi, and yoga, as well as swimming or aqua gym derived movements also help. Precautions must be taken in case of patients with plantar ulcerations, and all these techniques can only be practiced under supervision and coordination from recognized teachers/ technicians. This also mandatory for other types of exercises that may positively impact DN, such as ayurveda, qigong or wai tan kung (11).

Although exercises destined to increase effort tolerability are known to improve the distance of ambulation, they do not necessary influence the velocity of walking; nevertheless overall results of physical therapy have a profound positive impact on the quality of life (18).

c. Physical therapy in autonomic neuropathy

Diabetic autonomic neuropathy can affect the quality of life through various cardiovascular, urological, sexual and ophthalmological manifestations, not to mention digestive or sudorimotor issues. Generally speaking, all of these benefit more or less from available drugs and by the means of interdisciplinary approach to the patient.

Physical exercise can positively influence the course of autonomic dysfunctions in DM. It can reduce dyslipidemia and the HbA1c value by increasing glycogen at muscular level, due to volume growth of muscle fibers. Practicing physical exercises impacts insuline resistance and regulates levels of ICAM-1, VCAM-1, E-selectine (adherence molecules, normally associated with endothelial dysfunction). There is also a favorable effect upon atherosclerosis (11).

Patients with DN are capable of improving their quality of life by walking, as there seems to be a connection between the intramuscular adipose tissue volume (IMAT) and the daily number of steps (19). Motor rehabilitation techniques also have a positive impact upon ventricular contraction, ameliorate oxygen diffusion by increasing the alveolar surface and increases oxygen extraction within tissues, as well as it influences fibrinolosis and coagulation processes (13). Orthostatism with eyes closed can be improved by moderate intensity cardio exercises (20). Physical exercises also improve reaction time, stance and gait, but not necessarily ameliorate the risk for falls (21).

For safety considerations of the physical exercises, parameters such as: frequency, intensity and type of exercise should be adapted to the patient's abilities, for better compliance during the so often long term rehabilitation process (11, 22). For all that, a well structured and individualized training program will have the intended results, unlike working predominantly on force or combined force-endurance exercises, which seem to have rather modest benefits (23).

d. Physical therapy as preventive care for diabetic foot ulcers

Ameliorating peripheral circulation reduces the risk for complications that might require surgical treatment and even amputations. For this matter, peripheral arteriopathy with associated progressing infection is an indicator for non-healing ulcer in the lower extremities (24). Sometimes the degree of affectation is so important that the only solution left is amputation, followed by regaining mobility with an artificial limb. The peripheral arterial disease can be so evident in the foot, when irreversible, that changes of color (dark blue – tones of black) visible at thermographic scan could actually orientate the level for amputation.

On every possible occasion, the surgeon will first take into consideration the possibility of revascularization with minimum surgery trauma. This is the context in which endovascular procedures are considered to be the future standard in the treatment of diabetic peripheral arterial disease (25). Nevertheless, it is always easier to prevent that to treat. Peripheral arterial disease, beside general recommendations such as stopping smoking, correct glycemic control and antiplatelet treatment; also benefits from walking. Before any kind of physical indication, an effort test should be recommended for patients with history of cardiovascular disease (11).

Cardio exercises have the potential of improving endothelial functions, as observed with Doppler ultrasound. Muscle strength can be increased by neuropropioceptive facilitation exercises and also training the healthy restant muscle fibers. Extension exercises aiming to correct the external rotation of the feet, as well as stretching maneuvers, passive movements for articular preservation and facilitation exercises for both proprio and exteroceptive perceptions, will result in prevention of muscle and tendon retractions and articular deformations (24).

Preventing foot ulcerations sometimes requires adequate shoes and devices, as well as educating the patient to examine and take care of his feet daily (11). This way the feet will be safe during exercises and normal everyday activities.

Electrotherapy and other methods

Neuropathic pain can be ameliorated by physical exercise, therefore improving the quality of life (26). Therapies based on low frequency currents add up especially to alleviating pain. One of the most known and used technique is the transcutaneous electric nervous stimulation (TENS). TENS act by presynaptic inhibition of the dorsal horn and direct inhibition of the abnormal excited nerve (8).

TENS is based on using surface electrodes that stimulate the painful area with high frequency and low intensity stimuli (aims A beta fibers, for 40-50 minutes, 50-100 Hz, impulses of 30-200 msec, intensity of 10-40 mA) or low frequency and high intensity stimuli (A delta, 1-5 Hz, 200-500 msec, 50-100 mA, for 30 minutes), either way, followed by a short term amelioration of pain. A intense variety of TENS is based on short term intense stimulation with currents of 100-150 Hz, 250-500 msec impulse, for 15-30 seconds. This effect lasts for 2 hours, by the stimulation of cutaneous A delta fibers and activation of inhibitory diffuse control of nociception (8), (27-29).

PENS (Percutaneus Electrical Nerve Stimulation) is TENS type techique that implies the use of needle electrodes, that will be placed in the painful dermatome (8).

Although there is some degree of pain amelioration, the physiological mechanisms implied are still not fully known. TENS is still an efficient method, useful at this moment, although without a set of parameters unanimously accepted, nor long term proof of efficacy (27-29).

High frecquency current can be an alternative by HF/HTEMS/EMS (High Frequency External Muscle Stimulation, High-Tone External Muscle Stimulation and External Muscle Stimulation) and FREMS (Frequency-modulated Electromagnetic Neural Stimulation), still in debate, possible efficient, although more difficult to tolerate (27).

Results in pain treatment can also be obtained by using laser therapy with biostimulatory effect, vasodilatation, analgesic and anti-inflammatory effects, by foton absorption in the mitochondria resulting in an increase of the energetic capacity of the cell (8).

Conclusions

Prevention of further complications in DN is the key for avoiding a great deal of morbidity, especially related to the diabetic foot. Clinical exams should be completed with additional explorations, if necessary. Prevention of diabetic foot ulcers can benefit from a interdisciplinary view, in which the surgical approach, other than the decision of amputation, could play a more important part in the future. All these along with instruction of patients, maintaining a good glycemic control, nutritional advising and compliance to treatment, can benefit from adding rehabilitation algorithms, all aiming towards an improved overall quality of life.

Among these measures, physical exercise can be the fundament of a rehabilitation program which will combine cardio, resistance and flexibility strategies, individually adapted to the patient's needs. Electrotherapy shows promising results as well.

Further understanding of physiopathological mechanisms will surely provide better rehabilitation strategies for the following years.

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