Journal of Medical Genetics and Clinical Biology
Homepage : https://journal.antispublisher.id/index.php/JMGCB
Email : admin@antispublisher.com

e-ISSN : 3032-1085
JMGCB, Vol. 2, No. 2, February 2025
Page 79-88

Pathogenesis of Diabetic Polyneuropathy and Modern Solutions for Clinical Diagnosis

Nematullayev Dilmurod Do'stmamat O'g'li[1], Qodirov Umid Arzikulovich[2], Khakimova Sokhiba Ziyadulloyevna[3]
[1,2,3] Samarkand State Medical University, Uzbekistan

Check for updates OPEN ACCESS

DOI : https://doi.org/10.61796/jmgcb.v2i2.1177

Sections Info

Article history:
Submitted: December 27, 2024
Final Revised: December 27, 2024
Accepted: December 28, 2024
Published: December 28, 2024

Keywords:
Motor
Sensory
Pathogenesis of the disease
Developmental factors
Statistics

ABSTRACT

Objective: *Diabetic polyneuropathy encompasses a spectrum of symptoms signaling damage to nerve fibers and impaired functionality, primarily driven by prolonged hyperglycemia.* ***Methods:*** *This condition arises due to metabolic dysfunction in the body, often linked to decompensated diabetes mellitus, leading to progressive nerve cell deterioration.* ***Results: :*** *Patients exhibit reduced limb sensitivity, which, in severe cases, may escalate to complete sensory loss.* ***Novelty:*** *The study underscores the intricate relationship between sustained hyperglycemia and the gradual degeneration of nerve cells, highlighting the critical need for targeted interventions to prevent or mitigate nerve damage in diabetic patients.*

INTRODUCTION

A. Other Names for the Disease: DPN

Main symptoms is hyperesthesia, sensitivity disorders, pathological reactions to external stimuli, impaired stability and coordination of movements, burning in the legs, discoloration of the skin of the lower extremities, deterioration of the appearance of nails. Treatment is performed by a neurologist [1], [2].

An article for patients with a medical condition diagnosed by a doctor. It does not replace a doctor's appointment and should not be used for self-diagnosis [3], [4].

B. Statistics

The most common complication of diabetes is polyneuropathy. According to statistics, it develops in 54% of patients with type 1 diabetes, as well as in 45% of patients with type 2 disease. In the total mass of neuropathies, diabetic variants are found in 30% of clinical cases [5], [6], [7].

Diabetic neuropathy is often asymptomatic. In this case, it can only be detected by a doctor during routine examinations, as well as with the help of instrumental examinations. In 20% of cases, the complication is accompanied by severe pain, which is recognized as one of the most painful types of pain caused by this disease. Important is approximately 50% of non-traumatic amputations are related to diabetic neuropathy [8].

C. Development factors

What factors contribute to the development of diabetic polyneuropathy? Diabetes mellitus disrupts not only carbohydrate metabolism, but also other metabolic processes

occurring in the human body [9], [10]. As a result of the disease, a long-term and stable increase in blood glucose levels occurs (this condition is called hyperglycemia). This leads to gradual damage to internal organs and tissues.

RESEARCH METHOD

A. Diagnostics

A distinctive feature of diabetic neuropathy is that in the early stages the disease practically does not manifest itself, it can be detected only after a comprehensive clinical examination; Neurologists use the following diagnostic methods in their work [11].

B. Basic inspection

First, the specialist will ask the patient about the symptoms that are bothering them, as well as how long ago they began [12], [13]. Next, the doctor will study the person's medical history and use special questionnaires and scales to determine the affected nerve fibers and the severity of the clinical condition [14].

The doctor pays special attention to examining the problem area [15]. He determines the anatomical features of the feet and palms, notes possible pathological changes, studies the condition of the sweat glands, the presence of calluses, peeling, corns, ulcers and inflammation [16]. The presence of these signs may indicate the development of neuropathies.

C. Instrumental research

Next, the neurologist proceeds to instrumental studies, the main ones being:

Determination of the level of vibration sensitivity, in this case, the instrument is a special tuning fork. The specialist strikes the steel fork, causing it to vibrate. Next, the device is applied to different areas of the foot, and then the patient's reaction to the stimulus is assessed. If there are no reactions to the frequency of 128 Hz, doctors can assume the presence of polyneuropathy [17].

Determination of the level of tactile sensitivity, this is done using a monofilament - a device to which a thick fishing line is attached. The doctor presses the tip to problem areas of the skin. Based on the person's reaction, the specialist determines the level of numbness of the skin. In some cases, the test is performed using cotton balls or cotton swabs [18], [19], [20].

Determining the level of temperature sensitivity, the neuropathologist uses a cylindrical device, half of which is metal and the other half is plastic. The doctor alternately touches the skin with different sides of the device. Patients with diabetic neuropathy do not feel the difference in temperature between materials [21].

Determining the level of pain sensitivity, the doctor works with a blunt neurological needle, toothpick or toothed wheel. During the test, the patient closes his eyes. His task is to name the areas that the specialist will act on with the help of the instrument. If there is a disease, the person will feel not injections, but simple touches [22].

Reflex assessment, this is a standard type of test in which a specialist assesses the knee and Achilles reflexes. In a healthy person, when the kneecap is lightly tapped with

a hammer, the quadriceps muscle contracts. When the Achilles tendon is tapped, the foot flexes [23].

Often, as part of a comprehensive diagnosis, electroneurography is performed, which is aimed at studying the speed of impulse communication between the muscles and the brain [24], [25]. During the examination, sensors are attached to the patient's skin surface, and electrodes in the form of thin needles are inserted into the muscles. Weak currents pass through them. Skin sensors record the nerve signal and transmit it for processing. With polyneuropathy, signals are delayed in the nerve trunks, and some muscles react incorrectly to electrical stimulation.

RESULTS AND DISCUSSION

Excess glucose affects the mechanisms of this substance's processing. Toxic metabolic products accumulate inside cells, causing oxidative stress - cell damage due to oxidation [26, [27]. At the same time, the work of nerve fibers is disrupted: they lose their functions and stop recovering and growing. The situation is aggravated by a slowdown in the production of substances that maintain peripheral nerves in a normal state. The listed changes in nerve endings lead to the development of neuropathic pain, as well as partial numbness of the legs. As the condition worsens, the nerve fibers that provide communication between the nervous system and important internal organs also undergo changes.

A. Pathogenesis of the Disease

The development of diabetic polyneuropathy is a complex process. The complications of diabetes are formed due to a combination of various mechanisms. They are activated by hyperglycemia, which leads to various metabolic disorders in the body.

The metabolic theory remains the main one in the formation of the diabetic form of polyneuropathy. It is based on the fact that there is a relative / absolute lack of insulin, which occurs against the background of a constantly elevated glucose level. The enzymes involved in its processing are depleted. Subsequently, the human body triggers alternative mechanisms of oxidation, which lead to an increase in the production of toxic products. They, in turn, lead to the accumulation of excess water in the cells and their subsequent death. Among other pathological processes that can lead to complications, consider the following:

1. Oxidative stress

This condition is characterized by the production of poorly oxidized components during metabolism. They have an aggressive effect on cell and tissue structures, leading to their death.

2. Endothelial dysfunction

A lack of nitric oxide (NO) leads to the inability of the smooth muscles of blood vessels to relax normally. There is also a vascular theory of the development of the disease. Its pathogenetic mechanism is based on the accumulation of "bad" cholesterol in the vascular walls, which leads to the activation of oxidative degradation of lipids. Due

to the increase in the amount of free radicals, the work of blood vessels that supply all the necessary components to the peripheral nerves is disrupted. As a result, pathological changes in the endoneurium capillaries and nerve ischemia occur.

3. Types and characteristics

The symptoms of diabetic polyneuropathy depend on the type and stage of the underlying disease. Currently, it is divided into several types.

B. Touch

It is characterized by symmetrical damage to the nerves, leading to a deterioration in facial sensitivity, as well as the lower and upper extremities. This form of the disease has several clear signs:

1. Hyperesthesia

This is an exaggerated reaction to certain stimuli. Pathologies of nerve fibers lead to incorrect transmission of signals from skin receptors to the brain. As a result, the patient may experience sudden and sharp pains, tingling sensations, unpleasant pins and needles, burning and "coldness".

Pathological reaction to external stimuli. A person begins to experience pain even with a light touch to the surface of the skin (for example, a slight tingling sensation and even stroking). The patient also often experiences altered sensations: tinnitus when exposed to bright light, the appearance of foreign tastes, smells, etc.

Impaired or complete loss of sensation. Damage to the nerves due to diabetes limits the transmission of tactile impulses to the brain. This condition is often called "sock and glove" syndrome: a person feels "phantom" gloves on their hands when shaking hands, and also when wearing socks during steps and other movements.

C. Engine

In this case, the nerves responsible for connecting the brain and muscles are affected. Symptoms develop gradually, with the signs of the disease most clearly manifested during rest or night sleep. The main ones are:

1. Loss of stability in the legs due to muscle atrophy, as well as deterioration of the sensitivity of the lower extremities.
2. Disturbance of motor coordination resulting from pathological changes in the cranial nerves and, as a result, deterioration in the transmission of signals from the vestibular apparatus to the brain.
3. Reduced mobility of the joints, swelling and deformities. Occurs due to regular fluctuations in sugar levels, problems with blood microcirculation and metabolic disorders. First of all, the pathology affects the condition of the toes and hands.

General muscle weakness, as well as a significant loss of muscle strength in the legs and arms. It develops due to impaired innervation and blood circulation. This leads to swelling of the muscles, as well as a decrease in their volume. If not treated in time, their atrophy occurs.

D. Sensor Motor

A more complete name is diabetic distal sensory polyneuropathy. The condition is characterized by loss of sensitivity to pressure, temperature changes, and other external factors. Another symptom is the appearance of sharp pain in the legs, which is especially severe at night.

Later, patients with diabetic sensorimotor polyneuropathy experience musculoskeletal dysfunction. This is caused by muscular dystrophy and bone deformity. The skin becomes excessively dry, reddish, and covered with dark pigmented spots. The sweat glands gradually stop working.

In advanced forms of diabetic distal polyneuropathy, ulcers form on the feet and in the interdigital area. They are painless due to progressive loss of sensation. However, the inflammation caused by the ulcers may lead to the need for amputation of the affected limb.

E. Diabetes

In the early stages, diabetic polyneuropathy of the lower extremities causes the following symptoms:

1. Goosebumps.
2. Regular numbness of the lower extremities.
3. Pain in the ankles and feet that worsens at night.
4. Burning sensation in the legs.

Deterioration of sensitivity to temperature changes, as well as mechanical effects on the skin of the feet.

Gradually, the disease leads to the appearance of constant pain during rest, sleep, as well as during stress and overwork. In this case, only walking helps to reduce pain. If left untreated, the patient may face dangerous complications, such as:

1. Lethargy or atrophy of the muscles of the lower extremities

Redness of the skin of the legs with the formation of dark pigmented spots. Thickening or thinning of nails, osteoarthropathy of the foot, severe ankle deformity, transverse extension of the foot, flat feet, and absence of palpation pulses in the affected area. Chronic, in the chronic inflammatory demineralization form of the disease, autoimmune damage to the peripheral nerves occurs. This primarily affects their myelin protective sheath. The problem is characterized by weakness of the limbs and a decrease in their sensitivity, instability of the person when walking, atrophy and decreased muscle tone.

2. Other classification options

Diabetic neuropathies are classified as abnormalities of the peripheral nervous system. Accordingly, they are also divided into several categories:

a. Focal: Characterized by the negative impact on individual nerves. Focal neuropathies are classified into mononeuropathy (1 nerve affected), radiculopathy (spinal roots affected), and plexopathy (nerve plexuses affected).

b. Multiple (or multifocal): Characterized by pathological changes in several nerves at the same time.

c. Polyneuropathies (diffuse): Such polyneuropathies in diabetes mellitus negatively affect all nerve fibers in certain areas of the patient's body. This is the most common form of complication in diabetes.

d. Clinical manifestations: Polyneuropathies are reversible and progressive, the first category includes acute painful, sensory, and transient hyperglycemic neuropathy. Progressive ones include autonomic, distal sensorimotor, or proximal motor neuropathy.

3. Stages

Diabetic polyneuropathy is characterized by 3 stages of development:

a. First: Otherwise it is called subclinical. There are no characteristic symptoms, so the problem can only be identified in a clinical setting with the help of special studies.

b. Secondly: It is also clinical. In this case, the manifestation of the disease is determined by its form and severity. In the chronic form of polyneuropathy, symptoms are more pronounced in the evening. Patients complain of a significant decrease in sensitivity, decreased reflexes, as well as unpleasant sensations: tingling, burning, etc. In the acute form of the disease, sensitivity is practically not impaired. At the same time, people experience hyperesthesia and allodynia - pain when exposed to painless stimuli. If the form is painless, people have a decrease in sensitivity and tendon reflexes. In some cases, they disappear completely.

c. Third: This is a severe stage of polyneuropathy development, characterized by severe sensory/sensorimotor deficits that threaten the patient's disability. People also complain of mild pain, autonomic disorders, and complications: trophic ulcers, diabetic foot, and neuroarthropathy.

F. Treatment

Treatment methods for diabetic polyneuropathy are selected individually for each patient. Doctors are guided by the characteristics of the person's condition, his age, the degree of neglect of the disease and other factors.

The main condition in the treatment process is to achieve normalization of the patient's blood sugar level through the use of medications. First of all, these are preoral hypoglycemic agents and insulin. At the same time, the diabetes therapy prescribed by the attending physician remains unchanged. Maintaining normal blood glucose levels is also a preventive measure that prevents the further development of neuropathy.

As for neuropathic pain, its occurrence has a different nature, so the treatment is based on the use of drugs from different prescription groups. They can only be taken under the supervision of an experienced specialist. Classic painkillers (for example, analgesics or NSAIDs) will not have the desired effect.

G. Symptom-modifying Medications

Such drugs do not affect the development of the pathological process, but only cover the symptoms that torment the patient. The main ones are:

Anticonvulsants. They are prescribed for severe pain because they provide nerve stabilization and, as a result, eliminate pain. Some drugs of this type have a significant analgesic effect and are included in the first-line group for the relief of neuropathic pain.

Antidepressants. They also have an analgesic effect by reducing the concentration of serotonin in the human central nervous system. In addition, antidepressants stimulate the body's production of opioid substances.

Local anesthetics. These treatments are available in the form of modified patches (otherwise known as transdermal therapeutic systems). When applied to the problem area, they have a sufficient analgesic effect.

H. Disease-modifying Drugs

Also, modern medicine uses drugs that directly affect the mechanism of development of distal symmetrical sensorimotor polyneuropathy and its other types:

Lipoic acid-based drugs. Provide complex effects: neuroprotective and antioxidant. Fibrates, they interfere with lipid metabolism, thereby normalizing cholesterol levels and lowering blood sugar levels. Thanks to fibrates, the likelihood of developing diabetic neuropathy is reduced, and in some cases they help reverse the development of pathology.

B vitamins are often used as supportive agents because they have a beneficial effect on the metabolic processes of nervous tissue. Non-drug options, hysiotherapeutic methods are prescribed at different stages of the disease. They have an analgesic, regenerative and neuroprotective effect. With their help, blood circulation improves and sensitivity of the affected areas is restored. This is due to the restoration of nerve conduction, the supply of nerves and surrounding tissues with nutrients.

I. The most effective methods of physiotherapy:

a. Electrophoresis: In this case, medicinal substances are introduced into the body under the influence of direct current. As a result, patients note a decrease in the intensity of pain.

b. Magnetotherapy: Exposure to magnetic fields has a protective effect on nerves and blood vessels, and additionally has an analgesic effect. The procedure restores nerve fibers and stimulates the nutrition of adjacent tissues. In the initial stages, patients note a decrease in pain, the elimination of cramps, increased muscle activity and sensitivity.

c. Massage: Manual impact on biologically active points stimulates the natural processes of nerve fiber regeneration. Also, during the procedures, blood circulation in the upper and lower extremities improves, the cells receive a sufficient amount of necessary components, and unpleasant sensations of tingling, burning, and goosebumps disappear.

CONCLUSION

Fundamental Finding : Diabetic polyneuropathy (DPN) is a prevalent complication of diabetes, significantly affecting patients' quality of life. It stems from hyperglycemia-induced metabolic disturbances, leading to nerve fiber dysfunction and oxidative stress. The research highlights the progressive nature of DPN, with symptoms ranging from sensory loss and neuropathic pain to motor impairments and potential disability. Early diagnosis through clinical and instrumental methods is critical for effective management. Additionally, maintaining blood glucose levels and employing symptom-modifying and disease-modifying treatments are essential in reducing complications. **Implication :** The findings emphasize the urgent need for integrated medical approaches in managing diabetic polyneuropathy. Healthcare providers must prioritize routine screenings for early-stage DPN to prevent irreversible complications. This research also underscores the importance of educating patients on the risks associated with uncontrolled diabetes and promoting multidisciplinary care to address both metabolic and neurological aspects. Additionally, advancements in physiotherapeutic interventions could offer non-invasive options for symptom relief and nerve regeneration. **Limitation :** The research is limited by its focus on general diagnostic and treatment approaches without delving deeply into patient-specific outcomes or regional healthcare disparities. Furthermore, while various diagnostic tools are highlighted, their comparative effectiveness remains unexplored. The reliance on traditional therapeutic measures limits the integration of emerging technologies or personalized medicine in addressing DPN progression. **Future Research :** Future studies should explore personalized medicine approaches for DPN management, considering genetic and environmental factors. Investigations into novel diagnostic tools, such as biomarker-based assessments, could enhance early detection accuracy. Additionally, research on advanced therapeutic interventions, including regenerative medicine and neuroprotective agents, holds promise for reversing nerve damage and improving long-term outcomes for diabetic polyneuropathy patients.

REFERENCES

[1] S. Andryev et al., "Experience with the use of memantine in the treatment of cognitive disorders," *Science and Innovation*, vol. 2, no. D11, pp. 282-288, 2023.

[2] S. Antsiborov et al., "Association of dopaminergic receptors of peripheral blood lymphocytes with a risk of developing antipsychotic extrapyramidal diseases," *Science and Innovation*, vol. 2, no. D11, pp. 29-35, 2023.

[3] R. Asanova et al., "Features of the treatment of patients with mental disorders and cardiovascular pathology," *Science and Innovation*, vol. 2, no. D12, pp. 545-550, 2023.

[4] M. Begbudiyev et al., "Integration of psychiatric care into primary care," *Science and Innovation*, vol. 2, no. D12, pp. 551-557, 2023.

[5] B. Bo'Riyev et al., "Features of clinical and psychopathological examination of young children," *Science and Innovation*, vol. 2, no. D12, pp. 558-563, 2023.

[6] Y. Borisova et al., "Concomitant mental disorders and social functioning of adults with high-functioning autism/Asperger syndrome," *Science and Innovation*, vol. 2, no. D11, pp. 36-41, 2023.

[7] U. A. Ivanovich et al., "Efficacy and tolerance of pharmacotherapy with antidepressants in non-psychotic depressions in combination with chronic brain ischemia," *Science and Innovation*, vol. 2, no. 12, pp. 409-414, 2023.

[8] R. A. Nikolaevich et al., "Comparative effectiveness of treatment of somatoform diseases in psychotherapeutic practice," *Science and Innovation*, vol. 2, no. 12, pp. 898-903, 2023.

[9] A. Novikov et al., "Alcohol dependence and manifestation of autoaggressive behavior in patients of different types," *Science and Innovation*, vol. 2, no. D11, pp. 413-419, 2023.

[10] Y. Pachulia et al., "Assessment of the effect of psychopathic disorders on the dynamics of withdrawal syndrome in synthetic cannabinoid addiction," *Science and Innovation*, vol. 2, no. D12, pp. 240-244, 2023.

[11] Y. Pachulia et al., "Neurobiological indicators of clinical status and prognosis of therapeutic response in patients with paroxysmal schizophrenia," *Science and Innovation*, vol. 2, no. D12, pp. 385-391, 2023.

[12] A. Pogosov et al., "Multidisciplinary approach to the rehabilitation of patients with somatized personality development," *Science and Innovation*, vol. 2, no. D12, pp. 245-251, 2023.

[13] A. Pogosov et al., "Rational choice of pharmacotherapy for senile dementia," *Science and Innovation*, vol. 2, no. D12, pp. 230-235, 2023.

[14] S. Pogosov et al., "Gnostic disorders and their compensation in neuropsychological syndrome of vascular cognitive disorders in old age," *Science and Innovation*, vol. 2, no. D12, pp. 258-264, 2023.

[15] S. Pogosov et al., "Prevention of adolescent drug abuse and prevention of iatrogenia during prophylaxis," *Science and Innovation*, vol. 2, no. D12, pp. 392-397, 2023.

[16] S. Pogosov et al., "Psychogenetic properties of drug patients as risk factors for the formation of addiction," *Science and Innovation*, vol. 2, no. D12, pp. 186-191, 2023.

[17] N. Prostyakova et al., "Changes in the postpsychotic period after acute polymorphic disorder," *Science and Innovation*, vol. 2, no. D12, pp. 356-360, 2023.

[18] N. Prostyakova et al., "Issues of professional ethics in the treatment and management of patients with late dementia," *Science and Innovation*, vol. 2, no. D12, pp. 158-165, 2023.

[19] N. Prostyakova et al., "Sadness and loss reactions as a risk of forming a relationship together," *Science and Innovation*, vol. 2, no. D12, pp. 252-257, 2023.

[20] N. Prostyakova et al., "Strategy for early diagnosis with cardiovascular disease-isomatized mental disorders," *Science and Innovation*, vol. 2, no. D12, pp. 166-172, 2023.

[21] A. Rotanov et al., "Comparative effectiveness of treatment of somatoform diseases in psychotherapeutic practice," *Science and Innovation*, vol. 2, no. D12, pp. 267-272, 2023.

[22] A. Rotanov et al., "Diagnosis of depressive and suicidal spectrum disorders in students of a secondary special education institution," *Science and Innovation*, vol. 2, no. D11, pp. 309-315, 2023.

[23] A. Rotanov et al., "Elderly epilepsy: neurophysiological aspects of non-psychotic mental disorders," *Science and Innovation*, vol. 2, no. D12, pp. 192-197, 2023.

[24] A. Rotanov et al., "Social, socio-cultural and behavioral risk factors for the spread of HIV infection," *Science and Innovation*, vol. 2, no. D11, pp. 49-55, 2023.

[25] A. Rotanov et al., "Suicide and epidemiology and risk factors in oncological diseases," *Science and Innovation*, vol. 2, no. D12, pp. 398-403, 2023.
[26] V. Sedenkov et al., "Clinical and socio-demographic characteristics of elderly patients with suicide attempts," *Science and Innovation*, vol. 2, no. D12, pp. 273-277, 2023.
[27] V. Sedenkov et al., "Modern methods of diagnosing depressive disorders in neurotic and affective disorders," *Science and Innovation*, vol. 2, no. D12, pp. 361-366, 2023.

***Nematullayev Dilmurod Do'stmamat O'g'li (Corresponding Author)**
Samarkand State Medical University, Uzbekistan

Qodirov Umid Arzikulovich
Samarkand State Medical University, Uzbekistan

Khakimova Sokhiba Ziyadulloyevna
Samarkand State Medical University, Uzbekistan