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CHARCOT FOOT, A RARE AND SEVERE COMPLICATION OF DIABETES MELLITUS

ALIN MIHEȚIU[1], IOANA MATEI[2], ALEXANDRA SANDU[3], ELENA RIZEA[4], SÎNZIANA NICOLAE[5]

[1,3] *"Lucian Blaga" of Sibiu,* [1,2,4,5] *Sibiu County Clinical Emergency Hospital*

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Abstract: *Charcot foot or Charcot neuropathy is a rare disease found in patients with diabetes mellitus and is characterized by bone damage to the foot leading to deformities, instability, functional impotence and even amputation. The mechanism is still under discussion, without a consensus regarding the pathophysiology of this condition. The treatment is a complex one, non-surgical and surgical, the non-surgical one addressing especially the acute phase of the disease, the surgical one being complex and ranging from osteotomy, debridement, arthrodesis, internal or external fixation or even amputation. A good management of diabetes, of its peripheral complications, an early recognition of the Charcot type foot, prevents the evolution towards this serious condition.*

INTRODUCTION

The prevalence of diabetes worldwide is steadily increasing in both developing and developed countries.

The multiple complications associated with this condition make diabetes considered a major health issue around the world.(1)

Diabetic foot is the most common cause of hospitalization in patients with diabetes, half of the non-traumatic amputations being associated with the diabetic foot, considering that every 30 seconds a segment of the lower limb is amputated due to this disease.(2)

The overall prevalence of diabetic foot in some studies and meta-analyzes is around 6.3%, more common among males (4.5%), being more common among patients with type 2 diabetes.

Prevalence is lower in Oceania (3%) and higher in North America (13%), with Europe at the middle of the ranking (5.5%).(3)

In Romania, the incidence of diabetic foot in patients with diabetes is 14.85% - far above the European average, even higher than in North America, 3.6% of these patients suffering at some point in the evolution of the disease, an amputation.(4)

It is therefore by the unpredictable evolution, by the complications that it can associate and by the impact that it has on the sick person, a matter of public health.

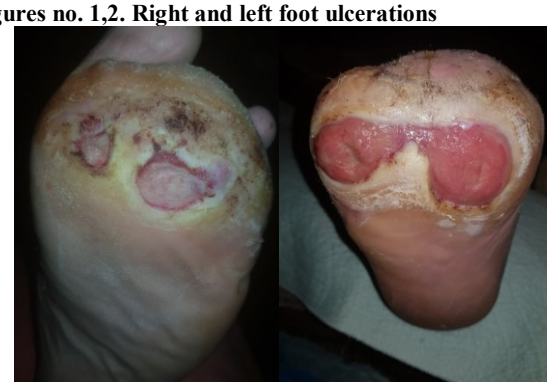
CASE REPORT

We present a case of a 73-year-old male patient with 10-year history of type 2 diabetes mellitus and 7 years of insulin treatment, diabetic peripheral neuropathy.

He had a right lower limb toes amputation, amputation of the second and third toes in the left lower limb.

He was also operated for bilateral plantar foot ulcerations and multiple abscesses that required surgical debridement and removal of bone fragments affected by osteitis, its history of plantar ulcers dating from two years before current admission.

Figures no. 1,2. Right and left foot ulcerations



He was hospitalized for severe pain in the left foot, purulent secretions, inability to move and fever.

A complete physical examination identified typical findings of a Charcot foot: fever, swollen and painful masses in the left foot and ankle, erythema, warmth, left foot plantar abscess with cellulitis, joint deformity and instability. Laboratory tests indicated elevated levels of inflammatory markers such as C-reactive protein (CRP) (154.64 mg/dl), erythrocyte sedimentation rate (71mm/h) and fibrinogen (786mg/dl). Other modified parameters: white blood cell count (WBC) 12.86 (10^3/µL), Hgb 10.5 g/dl, serum iron 15µg/dl, thrombocytes 617 (10^3/µL), serum total protein 8.5 g/dl, albumin 38.9%, gamma-globulin 28.5%, IgG 1853 mg/dl. Samples were gathered from the left forefoot wound and the outcome of bacteriological examination revealed: germ growth on culture - Staphylococcus aureus.

X-Rays were effective in identifying characteristic deformities of Charcot neuropathy: osteolytic abnormalities in left forefoot and midfoot (tarsometatarsal joints), radiographic appearance of osteitis at the same level, old fracture of the first

[1]Corresponding author: Alin Miheţiu, B-dul Corneliu Coposu, Nr. 2-4, Sibiu, România, E-mail: alin_mihetiu@yahoo.com, Phone: +40751 619292
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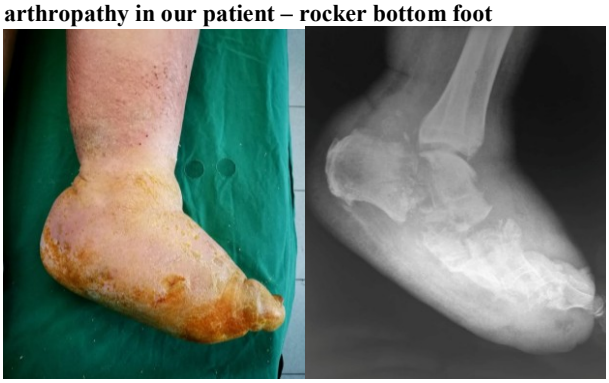
metatarsal head, arthritis of the left hallux (metatarsophalangeal joint), little areas of osteocondensation, marginal bone proliferation.

Figures no. 3,4. Radiological and clinical aspect of Charcot arthropathy in our patient – rocker bottom foot



Vascular ultrasound was performed showing atherosclerotic calcifications of femoral artery in Hunter's canal and also of the left popliteal artery. Peroneal artery was unsatisfactorily visualized. Subcutaneous tissue of the upper third leg appeared edematous with significant lymphostasis.

Taking into consideration all the aforementioned findings and following thorough discussions on treatment modalities, the patient and an interdisciplinary team decided that surgical intervention was necessary. Due to advanced stage of the disease - Eichenholtz IV, and because of the functional impotence of the limb, and also due to local and systemic infection signs, the amputation was decided.

The patient was led to the surgical room where he was subjected to trans tibial amputation. Postoperative course was uneventful, favourable evolution occurred slowly with discharge on the 10th day postoperatively.

DISCUSSIONS

From the pathophysiological point of view, the diabetic foot is the result of several factors acting simultaneously, the major factors being peripheral vascular ischemia and neuropathy. In neuropathy, hyperglycemic status causes an increase in the activation of aldose reductose and sorbitol dehydrogenase enzymes, which determines the intracellular transformation of glucose into sorbitol and fructose. It results in a decrease in myoinositol - necessary for proper nerve conduction.

The chemical conversion of glucose also causes an increase of oxidative stress with vasoconstriction and peripheral ischemia and with consecutive nerve damage. The impairment of the intrinsic leg muscles due to neuropathy causes imbalances between flexion and extension, which will affect gait biomechanics and anatomy of the foot with the appearance of areas of bone prominence and pressure points that will eventually lead to ulcers. Glandular secretion regulated by the autonomic nerve suffers with the appearance of dry skin and predisposes to injury - risk of infection. Diabetic microagiopathy has as main mechanism the endothelial cell dysfunction due to hyperglycemic status, which will lead to a decrease of vasodilator factors with associated vasoconstriction. In addition, high blood sugar levels trigger the release of thromboxane A2, which is a vasoconstrictor and a stimulator of platelet aggregation.(5,6,7,8)

The most common foot deformities encountered in the diabetic foot are those of the claw toe deformity type, the Charcot arthropathy being a rarer evolutionary complication.

In 1868, Jean-Martin Charcot, a neurologist, first described this condition in a group of patients with syphilis (tabes dorsalis). The one who will establish the association between diabetes and this type of neuroarthropathy was William Jordan in 1968.

It is a rare and debilitating condition that causes joint and bone lesions that can develop into fractures, deformities and even amputations in severe cases. Although most commonly seen in patients with diabetic foot, Charcot's disease may occur in syphilis, leprosy, neurological injury, syringo-myelia, ethylism, sarcoidosis, HIV, Parkinson's disease or rheumatoid disease.(9)

Any neuropathy can determine under certain conditions the evolution towards Charcot foot, the incidence of this condition among patients with diabetes being between 0.1% -7.5%.(10)

The mechanism of appearance of Charcot foot is one still debated, besides the conventional theories - the neurovascular (Charcot), or the neurotraumatic (Volkmann and Virchow), other pathophysiological mechanisms such as inflammatory cytokines, their reactions, calcitonin, genes polymorphisms, interleukins or vitamin D3 levels have been recently highlighted.(11,12,13)

The neurovascular theory is based on the opening of arterio-venous shunts, secondary to lesions of trophic or vasomotors nerves. This opening of the shunts results in an additional vascular contribution with the increase of the quantity of monocytes and osteoclasts that will cause bone resorption. Paradoxically, microangiopathy through low blood supply is a factor in preventing evolution towards Charcot foot.

Neurotraumatic theory states that repeated microtraumas in patients with sensitive neuropathy cause bone destruction.

In fact, the pathogenesis of Charcot neuropathy associates both theories with additional blood supply, monocytes, osteoclasts producing bone demineralization while the absence of normal physiological sensation in repeated trauma, associated with muscle weakness, determines joint instability with abnormal plantar pressure values.(14,15)

The inflammatory status is maintained by repeated microtraumas, hyperglycemia causes a boost of inflammatory markers of the cytokines TNFα, IL- 1β and IL 6, cytokines that will cause changes in the balance of osteoblast - osteoclast homeostasis. Thus, bone destruction occurs by accentuating osteoclastogenesis, a destruction that will potentiate the inflammatory response with entry into a vicious circle.(12,16)

Hyperglycemia causes the growth of the nonenzymatic process and the formation of Amadori products. These are combined with other proteins and amino compounds resulting in advanced glycation end products (AGEs). AGEs determine the increase of nitric oxide expression through endothelial damage, and also determine osteoclasto-genesis through the receptor activator of nuclear factor kappa-B ligand RANKL / NF-kB pathway, affecting osteoblasts and decreasing bone remodeling.Also in normal neurons, calcitonin gene-related peptide (CGRP) is secreted and antagonizes RANKL expression, which results in inhibition of osteoclastogenesis. CGRP production is reduced in diabetic neuropathy.(9)

All these complex mechanisms of regulation / counter-regulation, activation / inactivation are in a balance, a balance that is no longer found in the diabetic foot.

From clinical point of view, the Charcot type leg can be classified into two phases - the acute phase and the chronic phase. In the acute - active phase, the foot is red, warm and edematous. Most patients experience pain, some just discomfort; pain when it is not the same expression as in a patient without neuropathy. The local temperature is higher by 2-6 0 C compared to the other foot.

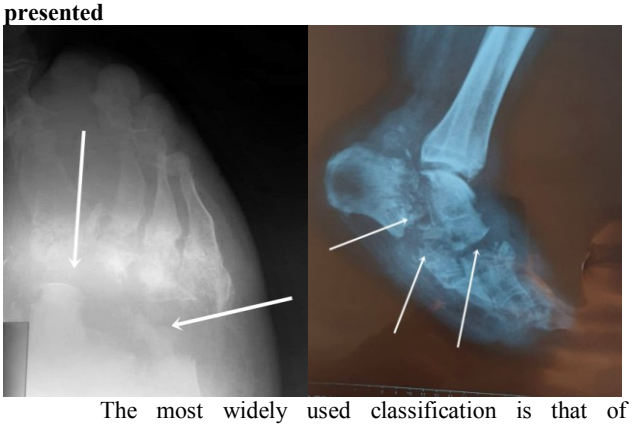
In the chronic phase, inflammatory signs are reduced

or absent. The X-ray shows arthrosis, tarsus-metatarsal dislocations, osteophytes and joint destruction. Bone deformity initially begins with collapse of the medial column and continues with lateral column

The typical rocker bottom foot appearance begins with the collapse of the navicular joint. In the advanced stage the talus is completely dislocated by the navicular with the destruction of the heel.

Imaging diagnosis is made by X-ray and MRI, rarely with CT scan.

Figures no. 5,6. Severe bone and joint destructions in patient presented



The most widely used classification is that of Eichenholtz, being improved over time by adding to the radiological image, clinical symptomatology.

Stage 0 - hyperthermic foot, painful, swollen without radiological changes.

Stage I - acute stage - radiologically osteopenia, periarticular fragmentation, subluxations or articular dislocations occur. Clinically the foot is warm, with edema and ligamentous hyperlaxity.

Stage II - subacute - coalescence phase, absence of inflammation and bone neoformation.

Stage III - the consolidation phase - the absence of inflammation with the stabilization of the foot, but sometimes in deformed version.(17)

The treatment is complex, pharmacological, orthopedic and surgical.

Pharmacological therapy involves antiresorptive drugs, first-generation bisphosphonates, and, more recently, second or third generation (alendronate, pamidronate, ibandronate, risedronate).

Calcitonin treatment is more effective than bisphosphonates, and can be given in patients with renal impairment, acting directly by inhibiting the osteoclast pathway.

Bone stimulation implies the use of magnetic field bone stimulation, noting that it may be an effective adjuvant treatment modality.(18)

Non-surgical treatment - mainly used in acute phases, has as an offloading component of the foot, considered as an essential step in strengthening the foot and preventing the evolution towards deformity. Total contact casting reduces mechanical forces, inflammation and edema, redistributing local pressure and limiting bone-joint destruction.(19)

After the acute phase is completed, a dedicated orthotic walker can be used, also total contact casting but even removable walker braces being used in some cases of Charcot neuropathy.

The surgical treatment is varied and dependent on the clinical and evolutionary stage of the case.

Exostectomy is used to remove ulcerated bony proeminence, with 90% success rates, in some studies.(20)

In patients with equinus contracture, the extension of the Achilles tendon may decrease the pressure in the foot.

In patients with instability in the limb, pain, recurrent ulcers, arthrodesis with internal fixation or arthrodesis with external fixation is used. The first is used in stage 3 Eichenholtz, and can be performed in a single step or in serial interventions.

Arthrodesis with external fixation has the advantage that it is a less invasive technique, it can be performed in one stage, ulcerative lesions, suppurated areas can be easily monitored and treated.

In the advanced forms of the Charcot leg, arthrodesis can be performed combined initially external, then internal.

Amputation is reserved for severe cases of Charcot leg, with high instability, functional impotence, recurrent ulcers or in case of arthrodesis failure.

The options can be varied, either addressing strictly the foot (Boyd procedure, Syme procedure), but more commonly transtibial amputation due to the higher success rate and the possibility of prosthesis.(20)

CONCLUSIONS

Although not very common, Charcot foot is a redoubtable complication of the diabetic patient. With an incomplete pathogenic mechanism elucidated, a sometimes ambiguous clinical diagnosis and complex therapy, this condition is a challenge for doctor and for the patient.

Preventing the complications of diabetes by controlling blood sugar levels, as well as early recognition of the disease in the onset phase are the main mechanisms that can help prevent the worsening of the disease and even limb salvage.

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