THE ASSESSMENT OF RISK FACTORS FOR DIABETIC FOOT INFECTIONS

Pavelina Mihaela ANDREI[1] and Constantin IONESCU-TÎRGOVIŞTE[2]

[1] "Carol Davila" University of Medicine and Pharmacy, Faculty of Medicine, Bucharest, Romania
[2] N. C. Paulescu National Institute of Diabetes, Nutrition and Metabolic Diseases, Bucharest, Romania

Corresponding author: Constantin Ionescu-Tîrgovişte, E-mail: cit@paulescu.ro

Objective: We aimed to identify the factors that are associated with ulcers, cellulitis and gangrene in patients with diabetic foot. *Methods:* In this, observational retrospective study, we aimed to determine the association between major complications of diabetic foot infections such as ulcers, cellulitis, gangrene and the presence of other related factors. A descriptive analysis of the clinical-demographic parameters with possible influence on plantar lesions in diabetes mellitus was performed. The presence of ulcers, cellulitis and gangrene were the dependent variables for a univariate ordinal logistic regression with the independent variables of the clinical-demographic parameters. One hundred and sixteen patients with diabetes were surveyed at the Diabetic Outpatient Clinic at the University Hospital. *Results:* Eighty (69%) patients had major foot complications ulcers, cellulitis and gangrene. Older age, small body mass index, high blood glucose value, administration of insulin and an elevated number of leukocytes all of these are associated with an increase in the severity of the lesions, the effect being statistically significant with p value < 0.05. *Conclusions:* This study highlights the importance of early nursing educational intervention to improve patients' daily life style for prevention of risk factors that induce diabetic foot ulcers. The management of foot ulceration in people with diabetes requires an interdisciplinary approach that addresses glycemic control, infection, offloading of high-pressure areas, lower-extremity vascular status and local wound care.

Keywords: diabetic foot; risk factors; infection; foot care.

INTRODUCTION

More than 170 million people worldwide have diabetes mellitus (DM), and this number is projected to increase to nearly 370 million people by 2030[1]. Foot infection is a major complication of diabetes mellitus that need intensive treatment and hospitalization. The healing often takes months or years and significantly affects the quality life of patients. An infection is considered mild when there is no damage to tissue structures. The moderate classification is when there is involvement of tissue structures with risk of lower limb amputation. Also an infection is severe when, is associated with generalized sepsis and severe hemodynamic disorders that progress to mortality[2].

Hyperglycaemia, impaired immunologic responses, neuropathy, and peripheral arterial disease are the major predisposing factors leading to ulcers, cellulitis and gangrene[3]. Peripheral artery disease can impair blood flow necessary for healing of ulcers and infections. Before leading to loss of protective sensation the peripheral neuropathy in patients must have a long evolution. The consequent physical and thermal injuries of patients with peripheral neuropathy increases the risk of foot ulceration.

Neurological foot testing: monofilament, pinprick sensation, ankle reflexes and vibration perception threshold.

Foot shape: prominent metatarsal heads/claw toes, hallux valgus, muscle wasting or Charcot deformity[4].

Dermatological: callus, erythema, sweating, hyperkeratosis, xerosis, onychomycosis, dry or fissured skin, tinea. Vascular: foot pulses, ankle brachial index and Doppler wave.

Neuropathy, which is present in over 80 percent of diabetic patients with foot ulcers, promotes ulcer formation, by causing anatomic deformities (such as hammer toes from greater flexor muscle tone compared with extensor tone, loss of arch, and rocker bottom feet associated with Charcot foot[5]), and by impairing the microcirculation and the integrity of the skin[6]. Once ulcers form, recupera-

tion or cicatrization may be delayed and if infection is localized in deeper skin structures, healing is difficult to achieve. Such infections can subsequently extend to joints, bones, and the systemic circulation. Cutaneous bullae, soft tissue gas, skin discoloration, or a foul odor may occur in necrotizing infections. Findings of gangrene, severe ischemia, or tissue necrosis may denote the presence of a limb-threatening infection[7]. Systemic signs such as fever, chills, hypotension, and tachycardia may accompany local signs of infection, and their presence indicates an infection of increased severity.

MATERIALS AND METHODS

This was a retrospective study that was carried out for a duration of four year from 2014 to 2019. We evaluate a hundred and sixteen patients diagnosed with type 1 or type 2 diabetes mellitus admitted to our clinic in a partial hospitalisation service. The purpose of this study was to analyse the risk factors for diabetic foot infections, thus, the major inclusion criteria included the foot infections. Thereby, we divided our patients into two groups according to the presence of foot infections: 80 patients with foot infections and 36 with no infections. The severity score for diabetic foot infections was calculated based on the correlation report predicted with the clinical demographic and laboratory parameters. Data was analysed using the R program, version 3.5.3 (2019-03-11) and also the Copyright (C) 2019 The R Foundation for Statistical Computing and R Core Team (2019).

Demographic characteristics were recorded, including age, gender, duration of diabetes mellitus, type of diabetes, antidiabetic agents and/or insulin use, comorbidities (hypertension, myocardial infarction, renal insufficiency, psychiatric disorder, smokers, alcohol), blood data (hemoglobin, platelets, leukocytes, neutrophils), inflammatory markers such as C-reactive protein levels, erythrocyte sedimentation rate and fibrinogen). Skin manifestations of diabetes mellitus: xerosis, rash, onychomycosis, ulcers, cellulitis and gangrene.

RESULTS AND DISCUSSION

We included all the one hundred and sixteen patients, who were seen in the ambulatory diabetic clinic in this study. Of these, 80 (69%) patients had infections and 36 (31%) did not. The mean age for major complications of diabetic foot from our study was 62.96 ± 9.20 years. We analyzed the clinical-demographic parameters with possible influence on the plantar lesions patients with diabetes mellitus.

Advanced age is associated with an increase in the severity of the lesions, the effect being statistically significant p values < 0.05; OR 1.04 [95%], CI [1.01 − 1.08]. The history of cigarette smoking is associated with an increased risk of peripheral artery diseases and consequences of major complications in diabetic foot[8], but in our study, smoking did not appear to influence the severity of plantar injury p> 0.05; OR 0.55 [95%], CI [0.28 − 1.08]. At the time of diagnosis of type 2 diabetes, many patients already have one or more risk factors for macrovascular disease (obesity, hypertension, dyslipidemia, smoking) and many have evidence of overt atherosclerosis (past myocardial infarction, ischemic changes on electrocardiogram, or peripheral vascular disease)[9]. In our study it was found that a small body mass index is associated with an unfavorable evolution of lesions, the effect being with statistical significance p < 0.05; OR 0.92 [95%], CI [0.85 - 0.99] and the presence of a history of acute myocardial infarction does not seem to influence the risk of adverse evolution (p> 0.05)

By improving glycemic control (even with blood glucose monitoring or measure glycated hemoglobin every three months) and lifestyle changes is reduced the development of major complications[10]. Hyperglycaemia and elevated glycated hemoglobin are risk factors for greater severity of lesions with p< 0.05 OR 1.01 [95%], CI [1.002 − 1.02].

Patients with diabetes mellitus who use insulin are associated with greater severity of lesions, with a p value < 0.05; OR 2.10 [95%], CI [1.07–4.16].

The increased number of leukocytes is associated with an unfavourable evolution of the lesions and is one of the important markers of inflammation in infections, p< 0.05, OR 1.19 [95%], CI [1.02 − 1.41] . As expected, infection patients present an increased number of neutrophils, which is associated with a risk of more serious injury with a p value <0.05; OR 1.19 [95%], CI [1.04 − 1.37]. Platelet count is not associated with a higher risk of injury p>0.05, OR 1.00 [95%], CI [0.99-1.01]. Increased inflammatory markers are associated with major complications of the diabetic foot as expected[11]. A higher level of C reactive protein value is associated with an increased risk of more serious injuries with p <0.01, OR 1.45 [95%]; CI [1.16 − 1.82].

The diagnosis of peripheral artery disease is established with the measurement of the ankle-brachial index. The ankle-brachial index is a comparison of the higher posterior tibial or dorsalis pedis systolic blood pressure in each leg divided by the higher of the right or left arm systolic blood pressure. An ABI ≤0.90 is sensitive and specific for arterial stenosis and is diagnostic for peripheral artery disease[12]. A high value of ankle-brachial index is associated with a reduced risk of injuries like in our study with a p value <0.01; OR 0.05 [95%], IC [0.01 – 0.35].

The intensity and quality of the continuous wave Doppler signal can give an indication of the severity of vascular disease[13] and in this study we see that vascular stenosis is associated with serious injury with a p value <0.0; OR 7.21 [95%], CI [1.40 – 15.94].

CONCLUSIONS

Several risk factors are predictive of ulcers and amputation. Early recognition and management of this factors is important for reducing foot ulceration morbidity. Most are readily identifiable from the history or physical examination[13].

The most important risk factors are : previous foot ulceration, neuropathy (loss of protective sensation), foot deformity and vascular disease[14]. Regular foot examination and evaluation of amputation risk, regular callus debridement, patient education, professionally fitted therapeutic footwear to reduce plantar pressure and accommodate foot deformities, and early detection and treatment of diabetic foot ulcers; these measures that can be taken to prevent complications that lead to amputation. People at high risk of foot ulceration and amputation should receive foot care education (including counselling to avoid foot trauma), professionally fitted footwear[15].

A daily foot examination should be incorporated into the patient's everyday activities[16].

REFERENCE

1. Wild Sarah, R. G. Global prevalence of diabetes: Estimates for the year 2000 and projections for 2030. *Diabetes Care* **27**, (2004).
2. Altay, F. A. *et al.* Predicting diabetic foot ulcer infection using the neutrophil-to-lymphocyte ratio: a prospective study. *J. Wound Care* **28**, 2019, 601-607.
3. Hokkam, E. N. Assessment of risk factors in diabetic foot ulceration and their impact on the outcome of the disease. *Prim. Care Diabetes* **3**, 2009, 219-224.
4. Tesfaye, S. *et al.* Diabetic neuropathies: Update on definitions, diagnostic criteria, estimation of severity, and treatments. *Diabetes Care* **33**, 2010, 2285-2293.
5. Wanzou, J. P. V., Sekimpi, P., Komagum, J. O., Nakwagala, F. & Mwaka, E. S. Charcot arthropathy of the diabetic foot in a sub-Saharan tertiary hospital: A cross-sectional study. *J. Foot Ankle Res.* **12**, 2019, 1-9.
6. Takehara, K. *et al.* Factors associated with presence and severity of toenail onychomycosis in patients with diabetes: A cross-sectional study. *Int. J. Nurs. Stud.* **48**, 2011, 1101-1108.
7. De Macedo, G. M. C., Nunes, S. & Barreto, T. Skin disorders in diabetes mellitus: An epidemiology and physiopathology review. *Diabetol. Metab. Syndr.* **8**, 2016, 1-8.
8. Edward J. Boyho, MD, M. *et al.* A Prospective Study of Risk Factors for Diabetic Foot Ulcer. *Diabetes Care* **22**, 1999, 1036-1042.
9. Zhong, A. *et al.* The risks and external effects of diabetic foot ulcer on diabetic patients: A hospital-based survey in Wuhan area, China. *Wound Repair Regen.* **25**, 2017, 858-863.
10. Valensi, P., Giroux, C., Seeboth-Ghalayini, B. & Attali, J. R. Diabetic peripheral neuropathy: Effects of age, duration of diabetes, glycemic control, and vascular factors. *J. Diabetes Complications* **11**, 1997, 27-34.
11. Noor, S. *et al.* Inflammatory Markers as Risk Factors for Infection with Multidrug-resistant Microbes in Diabetic Foot Subjects. *Foot* 2017.
12. Taylor-Piliae, R. E. *et al.* Ankle brachial index screening in asymptomatic older adults. *Am. Heart J.* **161**, 2011, 979-985.
13. Singh, N., Armstrong, D. G. & Lipsky, B. A. Preventing foot ulcers. *J. Am. Med. Assoc.* **293**, 2005, 94-96.
14. Ionescu-Târgovişte, C. *Istoria neuropatiei diabetice in Romania*. (2013).
15. Bowering, K. & Embil, J. M. Foot Care. *Can. J. Diabetes* **37**, 2013, S145-S149.
16. Howarth, D. Preventing foot complications in people with diabetes mellitus. *Nurs. Stand.* **34**, 2019, 69-74.