The Diabetic Foot: A Review

Carlos Javier Vizcaíno Guerrero[1*], María Alejandra Bastidas Piraquive[2], Edwin Leandro Sosa Saboyá[2], Jairo Esteban Velásquez Pedraza[3], Ana María Herrera Parra[4], Reagee Myke Arnoldth Gómez Álvarez[4], Edwin Alejandro Barón Muñoz[4] and Leidy Joe Smith Giraldo Quintero[5]

[1]*Universidad Metropolitana, Barranquilla, Colombia*
[2]*Fundación Universitaria de Ciencias de la Salud (FUCS), Bogotá, Colombia*
[3]*Universidad de Ciencias Aplicadas y Ambientales (U.D.C.A), Bogotá, Colombia*
[4]*Fundación Universitaria Juan N Corpas, Bogotá, Colombia*
[5]*Universidad Libre, Cali, Colombia*

*__Corresponding author:__ Dr. Carlos Javier Vizcaíno Guerrero, Universidad Metropolitana, Barranquilla, Colombia, E-mail: Published0409@outlook.com

Abstract

Introduction: The prevalence of diabetes continues to be a growing problem throughout the developed world and contributes significantly to the health care burden; the fifteen percent of all people with diabetes will develop diabetic foot ulcers. A severe diabetic foot infection has approximately a 25% risk of ultimately requiring a major lower extremity amputation.

Objective: To conduct a review of Diabetic foot.

Methodology: The search was performed in the databases PUBMED/MEDLINE, EMBASE and Google Scholar with the search terms: Diabetes, Diabetic foot, Neuropathy, Foot ulcers. We selected the most relevant studies on Diabetic foot.

Results: We provided a general description of the epidemiology, pathophysiology, clinical examination, classifications and treatment of Diabetic foot. Diabetic foot ulcer is defined as a full-thickness wound that destroys the deep tissues and develops at a level distal to the ankle and is associated with neurological abnormalities in patients with diabetes. These ulcers can be classified as neuropathic, ischemic or neuro-ischemic. Neuropathy and macroangiopathy are the two main causal mechanisms, while injuries are often the events that precipitate an acute lesión. The main aim of the examination of a diabetic foot is to assess the risk factors for foot ulceration. Imaging modalities used in the evaluation of the diabetic foot include conventional radiography, CT, nuclear medicine scintigraphy, MRI, ultrasonography, angiography and positron emission tomography combined with CT scanning. Uncomplicated neuropathic ulcers will often heal with restriction of weight bearing of the involved extremity and topical therapy with saline impregnated gauze, topical antibiotic ointments, or other similar agents. Those patients who have ulcers with localized signs of clinical infection (mild category) may be treated with oral antibiotics on an outpatient basis, wounds associated with limb-threatening or life-threatening infections (categories moderate or severe) require hospitalization, parenteral antibiotics, vascular and surgical consultation to define revasculation, debridement, or amputation.

Conclusion: The Diabetic foot should be diagnosed and treated effectively to reduce morbidity and mortality.

Keywords: Diabetes; Diabetic foot; Neuropathy; Foot ulcers

Introduction

Diabetes is the seventh leading cause of death in the United States. In this country about 6% of the population have diabetes. Each year, practitioners diagnose roughly 800,000 new cases of diabetes and fifteen percent of all people with diabetes will develop diabetic

foot ulcers [1]. The prevalence of diabetes continues to be a growing problem throughout the developed world and contributes significantly to the health care burden [2]. Diabetic foot ulcer is defined as a full-thickness wound that destroys the deep tissues and develops at a level distal to the ankle and is associated with neurological abnormalities in patients with diabetes. These ulcers can be classified as neuropathic, ischemic or neuro-ischemic [3]. Lower extremity foot and ankle ulcerations, wounds, infections, and amputations have increased dramatically with the increased prevalence of diabetes in our society. Approximately 1% to 4% of patients with diabetes develop new foot ulceration every year [4]. The incidence of diabetes with foot complications has risen significantly during the past decade. A severe diabetic foot infection has approximately a 25% risk of ultimately requiring a major lower extremity amputation [5]. Approximately 592,000 patients with diabetes were living with a lower extremity amputation in 2005, and 60% of these were major amputations. The number of people living with an amputation is expected to increase by 70% by 2020 [6,7]. It is likely that substantial contemporary advances have been made in the treatment of diabetic foot disease with respect to patient education, preventative measures, early intervention, and prophylactic procedures, it is still unfortunately that the patients still frequently present to emergency departments with acute infectious events and resultant tissue necrosis [8,9].

Epidemiology

The population of Europe is expected to grow from 891 million in 2010 to 897 million in 2030, and the number of diabetics is expected to reach 66.5 million. It is estimated that 15% of diabetics develop at least one foot ulcer in their lifetime [10] and the foot ulcers are more common in men and in patients older than 60 years. Annual incidence rates in neuropathic individuals vary from 5% to over 7% [11]. Developing countries spend almost 40% of their health expenditure on diabetics; in developed countries, it accounts for approximately 12%-15% of health spend [10].

Pathophysiology

Neuropathy and macroangiopathy are the 2 main causal mechanisms, while injuries are often the events that precipitate an acute lesión. Between 60% and 70% of diabetic patients have some form of neuropathy. The most common forms are distal symmetric polyneuropathy, delayed esophageal transit, carpal tunnel syndrome, and erectile dysfunction [12]. The role of neuropathy in the pathogenesis of foot ulcers is complex [13]. The chronic hyperglycemia leads to the loss of myelinated and unmyelinated fibers, Wallerian degeneration, and blunted nerve fiber production; others proposed mechanisms to the development of diabetic neuropathy include nonenzymatic glycosylation, increases in oxidative stress, neuroinflammation, and activation of the polyol and protein kinase C pathways [14]. Peripheral neuropathy can be broadly classified in 3 ways: sensory, motor, and autonomic, sensory neuropathy causes the loss of touch and pain sensation, which are essential for the avoidance of excessive foot pressure and shear stress. Motor neuropathy causes foot muscle atrophy and thus favours limited joint mobility and foot deformities [13]. Peripheral vascular disease is common in patients with diabetes, in the pathogenesis of ulceration, peripheral vascular disease in isolation is rarely a cause of ulceration: as with neuropathy, a combination of risk factors with minor trauma more commonly leads to ulceration. A frequent scenario is a minor injury and subsequent infection, both of which go unnoticed because of coexistent neuropathy that increases the demand for blood supply beyond the circulatory capacity; neuroischemic or ischemic ulceration, and the risk of amputation, follow [15].

Clinical examination and classifications

The diagnosis of diabetic foot infection is based on clinical findings (i.e. redness, warmth, induration, pain/tenderness, and loss of function) [16], screening of diabetic patients is a crucial in prevention, warning signs can be found in multiple systems, most importantly the vascular and neurologic areas [17]. The main aim of the examination of a diabetic foot is to assess the risk factors for foot ulceration, the pulse palpation is the cornerstone of vascular examination, delayed discolouration or venous refilling>5 s on dependency may indicate poor arterial perfusión. Sensory loss tested by pressure perception with a 10 gram, Semmes—Weinstein monofilament is the most important single test [18]. There are alternative signs that suggest infection (e.g. purulent and nonpurulent discharge, fetid odor, necrosis, undermining of wound edges, poor granulation tissue and lack of wound healing) [16]. Several classifications have been published internationally; Wagner's classification, the Texas classification, Mike Edmonds' classification and the PEDIS classification. Wagner classifies lesions in six grades of increasing severity, 0-5. Grades 1 to 3 are basically neuropathic ulcers of increasing severity according to depth and infection, while grades 4 and 5 are vascular lesions [19]. The PEDIS classification is based on five parameters (Perfusion, Extent, Depth, Infection and Sensitivity); the classification is thus more precise than Wagner's [20].

Medical Imaging and diagnostic tests

Imaging modalities used in the evaluation of the diabetic foot include conventional radiography, CT, nuclear medicine scintigraphy, MRI, ultrasonography, angiography and positron emission tomography combined with CT scanning [21]. Conventional radiography is a means of documenting major structural changes, distal symmetric neuroarthropathy, leads to destruction and deformity of the bones and joints. The forefoot and midfoot are the most frequent sites of involvement; however, the early subtle changes of neuroarthropathy such as micro fractures may not be obvious and soft tissue problems such as cellulitis, fasciitis, pyomyositis and abscesses are not as easily appreciated [21,22]. Radiographs should be examined for the presence of boney erosions, periosteal reaction, or the presence of gas in the soft tissues. Plain radiographic changes often lag behind the onset of boney involvement by 10 to 14 days. In the diagnosis of osteomyelitis or soft tissue abscess, CT may be used effectively. MRI has a highly sensitive diagnostic tool (up to 100%) but is only about 80% specific because osteomyelitis and fracture may have similar appearances [23]. An elevated white blood cell count with a left shift suggests a severe infection; however, the absence of an elevated WBC count does not preclude a severe infection. A random glucose level and glycosolated hemoglobin (Hg A-1C) should be obtained to evaluate for severe hyperglycemia. Elevated inflammatory markers, such as an erythrocyte sedimentation rate (ESR) above 70 mm/hour, are highly suggestive of osteomyelitis but C-reactive protein is more sensitive than ESR. Specimens for cultures should be processed for aerobic, anaerobic, and fungal organisms. Antibiotic therapy should be reassessed when cultures and sensitivities are available [24].

Treatments

Primary prevention involves aggressive glycemic control (goal hemoglobin A1C 6.5% to 7.0%); management of risk factors such as hypertension, obesity, hyperlipidemia and smoking. Uncomplicated neuropathic ulcers will often heal with restriction of weight bearing of the involved extremity and topical therapy with saline impregnated gauze, topical antibiotic ointments, or other similar agents. Heavy callus around the edges of the lesion should be trimmed away to reduce peak plantar pressure, and shoes should be replaced with a stiff-soled "sandal" [23]. In patients with either an ankle pressure<50 mm Hg or ABI<0.5 consider urgent vascular imaging and, when appropriate, revascularisation. [25]. Those

patients who have ulcers with localized signs of clinical infection (mild category) may be treated with oral antibiotics on an outpatient basis. The recent prevalence of methacillin-resistant staphylococcus aureus (MRSA) in the outpatient setting has changed the empiric use of antibiotics toward trimethoprim sulfamethoxazole, doxcycline, clindamycin and levofloxacin rather than cephlexin, amoxacillin/clavulanate [26]. Moderate infections present with cellulitis extending more than 2 cm and have evidence of significant proximal spread. There is extension beneath superficial fascia to involve joint, muscle or bone. The patient is systemically and metabolically stable. Severe infections are defined as a patient who is septic, has severe peripheral arterial insufficiency or metabolic imbalance [27]. Wounds associated with limb-threatening or life-threatening infections (categories moderate or severe) require hospitalization, parenteral antibiotics and surgical consultation. Soft-tissue infections of the diabetic foot are often poly microbial with gram-positive species as well as gram negative bacteria, whereas bone infections are mono microbial; this includes staphylococcal and streptococcal species as well as *Pseudomonas* and *Escherichia coli* [28]. Patients with severe infections may benefit from initial treatment with intravenous therapy including vancomycin in combination with a beta-lactam and beta-lactamase inhibitor (e.g. piperacillin-tazobactam) or a carbapenem (e.g. ertapenem, meropenem). Once a specific microbial pathogen(s) has been identified, antimicrobial therapy should be directed toward that pathogen [29]. Debridement is a key intervention for wound care and healing, this may be obtained via sharp debridement or other intensive surgical interventions. Innovative wound care strategies including hyperbaric oxygen therapy [30], vacuum assisted wound closure [31], granulocyte colony-stimulating factor, and novel wound dressings may have increasing roles in the prevention develop foot ulcer as well as diabetic foot infections management. The partial limb amputation may be necessary in cases of severe necrosis, gangrene, or resistant infection [29].

Conclusion

The diabetic foot should be diagnosed and treated effectively to reduce morbidity and mortality.

Conflicts of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that be construed as a potential conflict of interest.

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