Predictors of Diabetic Foot Ulcer

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ABSTRACT

Objective   To study the predictive factors and findings of diabetic foot ulcers.

Study design   Retrospective study.

Place & Duration of study   Department of Surgery, King Fahad Hofuf Hospital Al-Ahsa, Kingdom of Saudi Arabia, from January 2019 to December 2020.

Methodology   The record of the patients admitted for diabetic foot ulcer (DFU) during the above study period was studied and analyzed. The demography, involvement of the areas of foot, complications like neuropathy, nephropathy, retinopathy, peripheral vascular ischemia, HbA1c level and their association with DFU/amputation were studied.

Results   Out of 83 patients having DFU, 43 (51.8%) were males and 40 (48.2%) females. Age was from 18 to 72 years (mean =49.52±8.6 year). The most common age group suffering from diabetes mellitus (DM) was above 40 years of age. Their ankle-brachial systolic pressure index (ABPI) ranged from 0.6 to 1.0 (mean=0.91±0.2). Big toes and the plantar surfaces of forefeet were the common areas affected by DFU. Forty-eight (57.83%) ulcers were infected. Staphylococcus aureus was the most common microorganism. Fifty-four (65%) patients with DFU had amputations. Forty (48.2%) patients were suffering from DM-associated neuropathy, 22 (26.5%) had retinopathy, 9 (10.8%) nephropathy, and 1 (1.2%) cataract. The mean of glycosylated hemoglobin (HbA1c) noted was 8.9±1.28%.

Conclusions   DFU most commonly affects the big toes and planter surface of forefeet. Role of limb ischemia as shown by the ABPI and continuous monitoring and control of DM as shown by the HbA1c play a pivotal role in prevention of DFU. Staphylococcus aureus is the most common infecting microorganism.

Key words   Diabetic foot ulcer, Amputation of foot, Diabetic neuropathy, Nephropathy, Retinopathy, Ankle-brachial pressure index.

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INTRODUCTION:

Diabetic foot ulcer is a serious medical condition, which may lead to amputation. Other complications of the diabetes mellitus (DM) in foot may include infection and gangrene. These conditions need hospitalization and cause economic burden on the personal income and national exchequer. The main pathophysiological factors of the condition are neuropathy, infection and arterial occlusive disease.[1,2] The lifetime risk of a diabetic patient to develop DFU is 25% approximately.[3,4]

DFU involves almost all the tissues of the foot, including skin, subcutaneous tissue, muscles, joints, bones, nerves and blood vessels. Superimposed infection may further aggravate the condition. It is therefore necessary to understand the factors causing this problem, which will help to make better strategies to prevent or treat it effectively.[5] In developing countries, lack of education, low socio-economic status, habit of bare-foot walking and ignoring the proper foot-care are the additional factors causing DFU. In this regard, the role of health-care providers to educate the patients is fundamental.[6] This study was conducted to document our experience in a tertiary care hospital of management of this condition.

METHODOLOGY:

This was a retrospective observational study conducted at the Department of Surgery, King Fahad Hofuf Hospital Al-Ahsa, Kingdom of Saudi Arabia. The medical record of the patients admitted to the hospital from January 2019 to December 2020 were retrieved from hospital database.

The demographic data collected included their age, gender and body mass index (BMI). A detailed history of DM associated with comorbidity like hypertension, cardiac disease, or other and recent foot trauma were noted. History of smoking and alcohol consumption was also recorded. General physical and local examination of both lower limbs were done with special attention to palpation of the pulses and signs of inflammation around the ulcer. The location of the ulcer(s) was recorded at the areas of both feet as individual toes, forefoot and the heel. The neurologic examination included checking the sense of vibration, light touch, pinprick, temperature and position sense in the toes. An ophthalmologist performed fundoscopy of every patient. The record of previous admission(s) to the hospital for the treatment of DFU and for any type of amputation done previously was also noted.

The investigations done included fasting/random blood sugar, HbA1c, CBC, blood urea, serum creatinine, electrolytes, ECG, x-ray of the involved foot, Doppler ultrasound, ankle-brachial systolic pressure index in all and MRI of the involved foot in selected cases. The type and duration of the treatment for the control of DM like oral hypoglycemic drugs (OHDs), insulin or both was also noted. Wound swab was taken for culture of organisms.

Patients were divided into different age groups. The complications associated with DM were noted which included nephropathy, retinopathy, neuropathy and others. The wounds were managed by dressings, systemic antibiotics, debridement as per condition and switching all the patients to short acting insulin. Those patients whose ulcers did not achieve healing, the amputation was performed according to the need. A multidisciplinary team, which included general surgeon, diabetologist, vascular surgeon, a nurse educator and primary health care physician, were involved in the management of the patients. All the data were put in SPSS 20 and analyzed by One-Sample and Independent-Samples t Tests.

RESULTS:

Total number of the patients included in the study was 83. Gender distribution was almost equal with 43 (51.8%) males and 40 (48.2%) females. Age was from 18 to 72 years with the mean age of 49.52±8.6 year. The mean BMI was 31.51±3.9 (Kg/m^2). Sixty-nine (83.1%) patients were non-smokers. None of the patients gave history of alcohol consumption (table I). The most common age groups suffering from DM were between 40-49 and 50-59 years. It included 40 (48.2%) and 30 (36.1%) patients respectively (table. II).

Ankle-brachial pressure index was measured in all patients. It ranged from 0.60 to 1.0 (mean 0.91±0.2). It was observed that the patients who had amputations, their ABPI was at lower range. Different areas of the feet were affected by the DFUs in different patients. Twenty-six (31.32%) had more than one area involved with ulcer in the foot. Right big toe 27 (32.5%), plantar surface of the right forefoot 15 (18.1%), left big toe 9 (10.8%), left 2nd toe 11 (13.3%) and plantar surface of the left forefoot 14 (16.9%) were the most frequent areas involved. Forty-three (51.8%) patients had wet, 38 (45.8%) dry and 2 (2.4%) mixed type of ulcers. Forty-eight (57.83%) ulcers were infected with variable microorganisms including Staphylococcus aureus in 31 (37.3%), E coli in 6 (7.2%), Pseudomonas aeruginosa in 4 (4.8%), mixed infection in 4 (4.8%) and other rare microorganisms in 3 (3.6%).

Sixty-five (78.3%) patients were taking oral hypoglycemic drugs (OHDs), 10 (12%) insulin and 8 (9.6%) taking both OHDs and insulin. The HBA1c values were between 6 – 12% with the mean of 8.92 ±1.28. Thirty-seven (44.6%) patients were first time admitted to the hospital due to DM and went for amputation of some or the other part of the foot (toe/trans-metatarsal). Seventeen (20.5%) patients had already some amputation in the past. Hence, the total 54 (65%) patients had some procedure of amputation. The amputation ranged from single to multiple toes or mid-tarsal. The period from the

Table I: Demographic Characteristics of the Patients				
Age (Year)	Gender n (%)	BMI (Kg/m^2)	Comorbid n (%)	History of Smoking n (%)
18-72	Male 43 (51.8)	20-40	Hypertension 37 (44.6)	No = 69 (83.1)
Mean 49.52±8.6	Female 40 (48.2)	Mean 31.51±3.9	Cardiac disease 1 (1.2)	Yes = 14 (16.9)
Median = 48		Median = 30.0	Dyslipidemia 2 (2.4)	

Table II: Age Groups of the Patients			
Age Group (Year)	No. of Patients n(%)	Duration of DM (Year)	n (%)
<20	1 (1.2)	<5	1 (1.2)
20-29	1 (1.2)	5-9	6 (7.2)
30-39	4 (4.8)	10-14	23 (27.7)
40-49	40 (48.2)	15-19	19 (22.9)
50-59	30 (36.1)	20-24	22 (26.5)
60-69	6 (7.2)	25-29	5 (6.0)
>70	1 (1.2)	>30	7 (8.4)

diagnosis of DM to the amputation ranged from 1 to 66 (mean 9.38±13.96) months. Forty (48.2%) patients were suffering from DM-associated neuropathy, 22 (26.5%) retinopathy, 9 (10.8%) nephropathy, and 1 (1.2%) cataract. The relation between HbA1c and the DM-associated complications and the amputation were found significant (p = 0.01). The mean of the first time admission of the diabetic patients after the diagnosis of DM was 8.12±11.76 months.

DISCUSSION:
Knowledge of the factors causing DFU and consequently leading to amputation are having pivotal role in its management. It will help to reduce the number of patients suffering from this ailment and workload on the health facilities and national economy. In Saudi Arabia, DM is prevalent in 25% of adults. More than 44% of patients older than 55 years in Saudi Arabia suffered from long-term complications related to severe or uncontrolled DM.[7] This study showed that out of 83 patients of DFU, 54 (65%) underwent amputation depending upon site of the lesion. This can be significantly reduced if the factors involved are well known and managed promptly by a multi-disciplinary team to treat the DM patients and proper education of the patients about their disease process.

Many factors are important to know and achieve these objectives. Age is considered as an independent factor for DM.[8] The older diabetic patients are more prone to develop the neuropathy, vascular involvement and nephropathy depending upon the duration of DM. In this study, 6 (7.23%) patients were up to the age of 39 years, while 77 (92.77%) were above the age of 40 years. This showed that most of the patients suffering from DFU were middle aged. Hence, the patients above 40 should keep their DM well-controlled without even occasional fluctuation and must get regular checkup of their feet.

It is reported in literature that females suffer less than males with DFU due to less severe neuropathy, better joint mobility and low foot pressure.[9,10] In this study the difference was not significant. Obesity and higher BMI is considered as major risk factor to develop DM and its complications.[11] The patients in this study had the mean BMI of 31.51 Kg/m^2. HbA1c denotes the glycemic control in the patients of DM. Patients with poor glycemic control have 2-4 fold increased risk of DFU.[12] This study also showed that the patients suffering from DFU had poor glycemic control. Their mean HbA1c was 8.92%. Therefore, the best glycemic control significantly affects the outcome of DM-related complications, including DFU.

The complications of the DM are directly proportional to the duration of DM. Longer duration of DM leads to increased degree of development of micro- and macro-vascular abnormalities, which is the cause of DFU.[13] This study shows that the majority of the patients with DFU had the duration of DM more than 10 years. Though the role of cigarette smoking is unclear, it is considered as an independent factor

for the development of foot ulcers in diabetic patients.[14] In this study, the role of smoking in causing the DFU was not found significant. Similar findings are reported in other study.[15]

Loss or diminished neurological function of the foot predicts foot ulcer. It affects sensory, motor and autonomic functions.[1] This causes the patients of DM to be unaware of minor injuries to their feet. In this study, 48.2% patients showed signs of neuropathy, which was significant. Diabetic patients having associated nephropathy are at more risk of developing DFU and hence amputation.[16,17] The diabetic retinopathy affects the vision of the patient and they may not be able to examine their foot. It can be used as predictive sign of severity of DM.[18]

Among the risk factors of amputation that include soft tissue loss and invasive foot infection, ischemia has a vital role.[19] Hence, the peripheral vascular disease is an important factor for development of DFU.[20] ABPI is a good indicator to assess the blood supply to the foot. This study shows that 12 (14.45%) patients had ABPI equal or below 0.7. Wet ulcers are more prone to infection. Thus prompt control of infection is important.

CONCLUSIONS:
DFU most commonly affects the big toes and plantar surface of forefeet. Role of limb ischemia as shown by the ABPI and continuous monitoring and control of DM as shown by the HbA1c play a pivotal role in prevention of DFU. Staphylococcus aureus is the most common infecting microorganism.

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