

## Outcome and disability of diabetic patients with foot ulcers

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### Abstract:

**Objective:** The objective of this study was to evaluate major risk factors and management outcome of diabetic foot ulcers in order to prevent amputation.

**Study design:** Cross sectional descriptive study.

**Place and duration:** This study was conducted in Department of Surgery, Abbasi Shaheed Hospital, Karachi and Department of Orthopaedics, Hamdard University Hospital, Karachi from January, 2008 to September, 2010.

**Patient and Methods:** A total of 88 patients, mean age  $62.1 \pm 4.68$  years with diabetic foot ulcers were included in this study. Patients with foot ulcers of Wagner grade 1 to 4 were assessed at base line of demographic information, detailed history, peripheral pulses examination, neuropathy, retinopathy, nephropathy and frequency of other diabetic complications. Glycaemic control was determined on the basis of HbA1C levels. Patients were managed by appropriate medical and surgical treatment and followed up until healing or for six months as end point of study. Outcome of the treatment was recorded as healed, incompletely healed or amputated. **Results:** Males were predominant (70.5%) with male to female ratio 2.3:1, mean age was  $62.1 \pm 4.68$  years and majority of individuals had type – II diabetes (90.9%). Large number of patient were overweight with a mean body mass index  $28.21 \pm 2.05$ , hyperglycaemic (mean HbA1C =  $9.63 \pm 1.12$ ) and diabetes mellitus for more than 10 years with a mean duration of  $22.8 \pm 5.35$ . Seventy one (80.68%) patients had neuropathic ulcers while rest of the 17 (19.31%) had neuroischaemic ulcer. Culture and sensitivity examination of wounds revealed polymicrobial organisms, but stpylococcus aureus (71.6%) was the commonest bacteria. Diabetic foot ulcers of 73 (82.9%) patients healed with mean duration of ( $76.5 \pm 23.46$ ) days but 15 (17.1%) patients had end up in to amputation. 9 (10.2%) patients had minor amputation and 6 (6.8%) had major amputation.

A comparison was made between healed and amputated patients. Variables found to affect the outcome in terms of amputation were duration of diabetes and poor glycaemic control ( $p < 0.05$ ).

**Conclusion:** Foot ulcers in diabetic patients may lead to further complications resulting in lower limb amputation with significant morbidity, extensive period of hospitalization and mortality. In order to diminish the detrimental consequences associated with diabetic foot ulcer, effective glycaemic control, aggressive medical management, proper wound care and timely surgical intervention may decrease morbidity and disability with better outcome.

**Keywords:** Diabetic foot ulcer, Foot care protocol, Risk factors, Complications, Amputation

### Introduction:

Diabetes mellitus is a disease known with multifaceted complications and foot ulceration, which often results in amputation of the lower

extremity<sup>1,2,3,4</sup>. The prevalence of foot ulcers ranges from 4% to 10% among persons diagnosed with diabetes mellitus<sup>5</sup>. This translates to an annual population-based incidence of 1.0%

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to 4.1% and lifetime incidence may be as high as 25%<sup>5</sup>. Diabetic foot ulcers frequently become infected and are a major cause of hospital admission<sup>2,3,4</sup>. They also account for more than half of non-traumatic lower limb amputations in this patient population<sup>2,4</sup>. Ulcerations are pivotal events in limb loss. They allow an avenue for infection<sup>6</sup> and can cause progressive tissue necrosis and poor wound healing in the presence of critical limb ischaemia. Approximately 56% of diabetic foot ulcerations become infected<sup>7</sup> and 20% of these patients with infected foot wounds end up in some type of lower extremity amputation. Timely prevention and healing of diabetic ulcerations are recommended as fundamentals of amputation prevention<sup>8,9,10</sup>.

Complications affecting the lower limbs are among the most common manifestations of diabetes and it was found that 15% of diabetic patients will suffer from foot ulceration during their lifetime. These complications are a frequent cause of hospitalization and disability; with 1 in 5 hospitalizations among diabetic patients directly related to foot ulcers<sup>11</sup>. The treatment cost of these complications account for approximately 25% of total hospital costs of diabetes care according to some conservative estimates and the costs of which might be in order of magnitude higher<sup>12</sup>. It is generally believed that targeting patients at increased risk of developing foot ulcers constitute a cost effective strategy to control progression to end stage complications. Evidence in the literature suggests that the early detection and treatment of diabetic foot complications could reduce the prevalence of ulceration 44% to 85%<sup>13</sup>.

#### **Patient and methods:**

This was a cross sectional descriptive study conducted at department of Surgery, Abbasi Shaheed Hospital, Karachi and department of orthopaedics, Hamdard University Hospital, Karachi from January, 2008 to September, 2010. The sampling frame of this study included all consecutive adults diagnosed with type – I and type – II diabetes (according to WHO criteria) with diabetic foot ulcers of Wagner's grade<sup>14</sup> 1 to 4 were included in this study. Foot ulcer was

defined as full thickness skin break corresponding to at least Wagner's stage<sup>14</sup>, located distal to both malleoli. Patients with Wagner's grade 5 i.e gangrene of whole foot were not included in this study due to predictable outcome. After taking informed consent, diabetic patients were interviewed about DM type, duration, treatment profile, level of control, presence or absence of chronic DM complications including previous ulcer / amputation of lower limbs and presence of vascular symptoms of cramps and / or claudications, neuropathic symptoms of tingling, numbness and burning sensations with a "stock an glove" distribution. The WHO definition of hypertension was used in this study: systolic blood pressure 160 mm Hg or more, or going on treatment with antihypertensive drugs was considered as hypertensive patient. Body mass index (weight in kg divided by height in meter<sup>2</sup>) was calculated and WHO classification was used to estimate the degree of obesity. Fasting blood samples were taken to assess lipid profile, blood sugar and glycated haemoglobin (Hb A1C) levels. Total lipid profile {total cholesterol (TC), high density lipoprotein (HDL), TC/HDL ratio, low density protein (LDL) and triglyceride} was measured. Dyslipidaemia was taken to be present when total cholesterol was > 5.60 mmol/L, and /or LDL > 3.4 mmol /L and HDL < 0.91 mmol/L. Glycated haemoglobin (Hb A1 C) was measured and a value of less than 7% was taken to indicate good glycaemic control. Urinary albumin concentration was measured by semi-quantitative dry immune chemical screening strips on first morning urine collections and a value of more than 20 microgram / minute was judged as pathological.

Patient's both feet were examined for the signs of vasculopathy and neuropathy including skin status (dryness, colour, thickness, cracking, trophic changes, decreased growth of hair), nail status (colour, thickness, trophic changes) and deformities such as claw foot and hammer toes. Other associated conditions like oedema, infection, ulceration, callus formation, gangrene and amputation were also recorded. Femoral, popliteal, dorsalis pedis and posterior tibial pulses on both sides were palpated to assess peripheral arte-

rial status. Presence of 2 or fewer of the 4 pedal pulses either with or without the presence of oedema indicated peripheral arterial disease and it was further assessed by ankle-brachial index. An index value  $< 1.0$  was considered peripheral vascular disease.

Neuropathy was assessed by examination of both feet for pressure, pain vibration, and joint position sensitivities. For pressure perception, 10 g Semmes – Weinstein monofilament was used on 4 sites of the foot. These sites were without callus, notably the pulps of the hallux and metatarsal heads of first, third and fifth toes. Vibration perception was assessed by using a 128 Hz tuning fork; which was applied at 3 sites on the feet, the pulp of the hallux, the lateral and medial malleoli. Retinopathy was assessed by fundal examination of patient's both eyes after dilating the pupil. It was taken as positive if there was presence of microdots, hard exudates, soft exudates, vascular proliferation or maculopathy.

Statistical analysis was performed using statistical software package SPSS version 13. The normality of the distribution of each quantitative parameter was assessed using Kolmogorov-Smirnov test. If normality was established results were given as mean + SD, and comparisons were made using Student's t-test. Otherwise, the results were given as median (range), and comparisons were made using the non-parametric Mann-Whitney U test. Discrete variables were as percentages and analyzed by Chi-Square test. A p-value  $< 0.05$  was considered as statistically significant.

### Results:

Follow up data were obtained in 88 of 96 (91.6%) patients with diabetic foot ulcer. The main characteristics of the patients at inclusion are given in table – I. Male were predominant (70.5%) with male to female ratio 2.3:1. Most of the patients belonged to 6th decade of life with a mean age of  $62.1 + 4.68$  years. The majority of individuals had type –II diabetes (90.9%). Large number of patients were overweight with a mean body mass index  $28.21 + 2.05$  (Table-I). 7 (7.9%) patients were diagnosed the disease in-

Table 1: Patients base line characteristics (n = 88)

Age (years)	62.1 + 4.68
Sex	
Male	62 (70.5%)
Female	26 (29.5%)
Diabetes duration (years)	22.8 + 5.35
Type of Diabetes	
Type I	8 (9.1 %)
Type II	80 (90.9 %)
Past history of myocardial infarction	18 (20.5)
Past history of amputation	18 (20.5)
Wagner's classification	
Wagner 1	4 (4.5)
Wagner 2	24 (27.3)
Wagner 3	43 (48.9)
Wagner 4	17 (19.3)
Body mass index	28.21 + 2.05
Glycaemic control	9.63 + 1.12
Awareness of foot care	
Present	21 (23.9 %)
Absent	67 (76.1 %)
Hypertension	
Present	76 (86.4 %)
Absent	12 (13.6 %)
Retinopathy	
Present	69 (78.4 %)
Absent	19 (21.6 %)
Nephropathy	
Present	46 (52.3 %)
Absent	42 (47.2 %)
Dyslipidaemia	
Present	72 (81.1 %)
Absent	16 (18.2 %)

identally and most of them (773%) had the disease for more than 10 years with a mean duration of  $22.8 + 5.35$  years. Majority of patients had poor glycaemic control with a mean Hb A1 C level of  $9.63 + 1.12$ . Awareness about risk factors regarding foot care was lacking among majority of the patients and only 21 (23.9%) patients were aware about foot care. 53 (60.2%) patients had significant foot deformity and majority of them had hammer toes in this group of patients. There were 60 (68.2%) patients taking oral hypoglycaemic agents, while 18 (20.4%) were on Insulin and rest of them 10 (11.4%) were on

Table 2: Relationship between healed and amputated patients among variables

Variables	Outcome		p-value
	Healed Ulcers (n=73)	Amputation (n=15)	
Age of patients	61.6±4.4	64.6±5.2	0.06
Sex			0.79
Male	51 ± (69.8%)	11 (73.3%)	
Female	22 (30.2%)	4 (26.7%)	
Type of diabetes			0.183
Type - I	3 (4.1%)	1 (6.6%)	
Type - II	70 (95.5%)	14 (93.3%)	
Duration of DM (years)	21.7±4.7	28.1±5.3	<0.001
History of Myocardial Infarction	19 (26%)	4 (26.6%)	0.963
History of amputation	19 (26%)	5 (33.3%)	0.047
Body mass Index	28.26±2.104	28.02±1.87	0.683
Type of diabetic foot ulcer			< 0.001
Neuropathic	58 (79.4%)	13 (86.6)	
Neuroischaemic	15 (20.6%)	2 (13.3%)	
Glycaemic control	9.308±0.768	11.2±1.275	< 0.001
Awareness of foot care	56 (76.7%)	12 (80%)	0.783
Hypertension	63 (86.3%)	14 (93.3%)	0.109
Retinopathy	57 (78.1%)	13 (86.6%)	0.039
Nephropathy	40 (54.79%)	9 (60%)	0.226
Dyslipidaemia	60 (82.19%)	13(86.6%)	0.598
Wagner Classification			
1	4 (5.5%)	0	0.665
2	22 (30.1%)	2 (13.3%)	0.445
3	35 (47.9%)	8 (53.3%)	0.130
	12 (16.4%)	5 (35.3%)	0.131
Diabetes Treatment			
Oral hypoglycaemics	51 (69.9%)	9 (60%)	0.484
Insulin	14 (19.2%)	4 (26.7%)	0.175
Combination therapy	8 (11%)	2 (13.3%)	0.792

combined treatment. 36 (40.9%) patients had history of previous ulcer and 24 (27.3%) had history of amputation previously. Seventy one (80.7%) patients had neuropathic ulcers, while rest of the patients (19.3%) had neuroischaemic ulcers. None of them had ischaemic ulcer in this study.

Diabetic foot ulcers were classified using Wagner's classification (10)(I). The commonest grade among all these patients was grade 3 ulcer. Big toe and sole were most commonly involved parts of the foot. Although organisms isolated from ulcers were mixed in nature but staphylococcus aureus was the common-

est bacteria recovered in 63 (71.6%) patients. Other organisms isolated were Escherichia coli, Klebsiella pneumoniae, Proteus mirabilis, Pseudomonas aeruginosa and anaerobic bacteria. 76 (86.4%) patients were hypertensive and 16 (18.2%) had ischaemic heart disease in this series. So far as diabetic complications are concerned 69 (78.4%) retinopathy, 46 (52.3%) nephropathy and 72 (81.8%) patients had hyperlipidaemia.

Diabetic foot ulcers of 73(82.9%) patients healed without any complication with mean duration of 76.5 + 23.46 days of healing, but 15 (17.1%) patients had end up in to amputations. 9 (10.2%) had minor amputations and 6 (6.8%) had major amputation in this study.

A comparison was made between healed and amputated patients as shown in table – II. Variables found to affect the outcome in terms of amputation ( $p < 0.05$ ) were duration of diabetes and poor glycaemic control. Comparison in respect of different types of diabetic foot ulcers neuropathic and neuroischaemic was also found significant ( $p < 0.001$ ).

#### Discussion:

Diabetic foot ulceration is the most frequent cause of hospitalization among diabetic patients<sup>15</sup> and lower limb amputation is the most feared and costly consequence of foot ulceration<sup>16,17</sup>. This study shows that long duration of diabetes, poor glycaemic control, micro and macro vascular complications are risk factors for poor ulcers but firm adherence to foot care advice and prompt foot management of the ulcers reduces the overall rate of amputation as shown in other studies<sup>18,19</sup>.

In this study males were the prominent gender similar to several other studies<sup>20-26</sup>. There is increased prevalence of diabetic foot ulceration in males<sup>18,20,21</sup> and male gender is associated with 1.6 times increased risk of ulcers and 2.8-6.5 fold high risk of amputation<sup>18</sup>. Poor control of blood glucose level and long duration of diabetes were significant risk factors in relation to foot ulceration. Mean HbA1C level in this

group was  $9.63 \pm 1.12$  showing poor glycaemic control and 68 (77.3%) patients have history of diabetes longer than 10 years duration. This has been observed in other studies as well<sup>18,21,27</sup>. The risk of amputation increased 2-4 folds with both age and duration of diabetes<sup>18</sup>. Poor glycaemic control and high HbA1C levels are also found associated with increased incidence and progression of diabetic complications<sup>28,29</sup>. 48 (54.5%) patients had significant foot deformity in this study. Several studies<sup>30,31</sup> have reported that foot deformities are important contributory factors by predisposing skin to high pressure at the site of foot deformity.

Seventy one (80.7%) patients in this study had peripheral neuropathy similar to other studies<sup>18,32</sup>. Loss of sensation due to neuropathy predisposes the patient to unrecognized injury. Therefore, It is important for the physician to examine the patient's feet thoroughly and educate them regarding preventive measures of foot care. 34 (38.6%) patients had a past history foot ulceration. Many studies<sup>18,21,24,27</sup> have shown that a previous history of foot ulcer increases the risk of further lesions. Majority of patients (48.9%) had grade 3 ulcers similar to other studies. Khalid Mehmood<sup>19</sup>, Rooh- ul- Muqem<sup>23</sup> and Lianes<sup>26</sup> have reported grade 2 & 3 ulcers, while Balderas<sup>25</sup> found grade 2 ulcer the most prevalent ulcers in their study.

Wound culture report revealed a mixture of gram positive and gram negative organisms and *Staphylococcus aureus* was the most common organism isolated in 47 (53.4%) patients similar to other studies<sup>22,23,24</sup>. Other bacterias isolated were *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus mirabilis*, *Pseudomonas aeruginosa* and anaerobic bacteroides. Mixed infection in diabetic foot ulcers may contain 3 - 6 organisms creating a significant problem regarding a choice of antibiotics<sup>33</sup>. Therefore, detailed microbiological studies are required regarding the prevalence of microorganisms present in diabetic ulcers. 46 (52.3%) patients had nephropathy and 69 (78.4%) patients had been detected retinopathy in this study. Other studies have shown association between foot ulcers and micro/macro

vascular complications of diabetes<sup>18,24,27</sup>.

Management of diabetic ulcer was done by incision and drainage of abscess and debridement of necrotic tissue and callus, when surgical intervention was required. Effective blood sugar control with proper Insulin dosage and appropriate antibiotic therapy was the mainstay of medical management. Some pressure off-load method was also applied, where needed. 5 (29.4%) patients of grade 4 lesion needed amputation, while all grade 1 lesions have healed by conservative treatment. As 15 patients had amputation in this series, the rate of amputation was 17.1% while it was 14.7%, 21%, 30.5%, 43.8% and 48% in studies by Mahmood<sup>19</sup>, Ali<sup>24</sup>, Lianes<sup>26</sup>, Ghanassia<sup>34</sup> and Rooh-ul-muqem<sup>23</sup> respectively. Mayfield et al<sup>18</sup> have reported in their study that by adopting foot care management program, incidence of ulcer and amputation can be reduced by up to 44-85%. The present study also shows that by adherence to foot care advice and intensive management by multidisciplinary diabetic foot team, overall healing rate was increased and amputation rate has decreased.

There is a limitation in our study that individuals who were lost to follow up were excluded from the analysis as healing status could not be obtained. These patients were slightly old and had great incidence of heart failure, deep ulcers or ulcers with longer duration.

#### **Conclusion:**

There is a high occurrence of foot ulcers in diabetic patients. Foot ulceration may lead to infection and further complications resulting in lower limb amputation with significant morbidity, extensive period of hospitalization and mortality. In order to diminish the detrimental consequences associated with diabetic foot ulcers effective glycaemic control, aggressive medical management, optimal wound care and timely surgical intervention may decrease morbidity and disability with better outcome. There is a need to develop a multidisciplinary team in all medical institutions for better care of diabetic ulcers.

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