Original Research Article	**Surgery**

Patient with Diabetic Foot Ulcer Admitted in Surgery Ward; Risk Factors, Associations and Grades of Presentation

Dr. Shahin Reza[1*], Dr. Md. Mahbub Azad[2], Dr. Mohmmad Shahin Kabir[3], Dr. Md. Yeakub Hosain[4], Dr. Md. Jakir Hossain[5], Prof. Dr. Ganesh Kumar Agarwala[6]

[1]MBBS, MCPS(Surgery), FCPS(Surgery), Assistant Registrar (Surgery), Department of Surgery, Shaheed Ziaur Rahman Medical College Hospital, Bogura, Bangladesh
[2]MBBS, FCPS(Surgery), Medical Officer, Department of Surgery, Shaheed Ziaur Rahman Medical College Hospital, Bogura, Bangladesh
[3]MBBS, MS (General Surgery), Registrar (Surgery), Department of Surgery, Shaheed Ziaur Rahman Medical College Hospital, Bogura, Bangladesh
[4]MBBS, MS (General Surgery), Registrar (Surgery), Department of Surgery, Shaheed Ziaur Rahman Medical College Hospital, Bogura, Bangladesh
[5]MBBS, FCPS(Surgery), Emergency Medical Officer, Shaheed Ziaur Rahman Medical College Hospital, Bogura, Bangladesh
[6]MBBS, MCPS (Surgery), MS(Surgery), Professor and Head, Department of Surgery, Shaheed Ziaur Rahman Medical College, Bogura, Bangladesh

Corresponding author: Dr. Shahin Reza
MBBS, MCPS(Surgery), FCPS(Surgery), Assistant Registrar (Surgery), Department of Surgery, Shaheed Ziaur Rahman Medical College Hospital, Bogura, Bangladesh

Abstract

Background: The management of chronic diabetic foot ulcers (DFU) poses a great challenge to the treating physician and surgeon. The aim of this study was to identify the risk factors, clinical presentation, and outcomes associated with chronic DFU. *Objective:* To determine the various risk factors for diabetic foot ulcers and study their associations. To study the grades of diabetic foot ulcers at presentation. *Method:* Purposive sampling. This study was done in the Surgery department of Shaheed Ziaur Rahman Medical College Hospital (SZMCH), Bogura for period of twelve (12) months. 100 cases were selected after informed consent. Study group (A) comprises of 50 cases of type 2 diabetes with diabetic foot ulcer and control group (B) comprises of 50 cases of age and gender matched type 2 diabetics without foot ulcers. Patients having serious systemic illness, type I diabetics and non-diabetic patients presenting with foot ulcer were excluded. Age, gender, duration of diabetes, duration of ulcer, glycemic control, presence of neuropathy and vascular disease were documented. Grading and Staging of ulcer was done according to New University of Texas Diabetic Wound Classification. Various risk factors were compared between the two groups. Data analyzed via SPSS version 17 with significant *p*-value < 0.05. *Results:* Among 100 cases (64 % males & 36 % females); mean age was 58.50 ± 9.8 (group A) versus 50.40 ± 10.5 (group B). Mean duration of diabetes was longer in group A (10.49 ± 7.06 years) vs. group B (8.34 ± 4.83 years) ($p = 0.019$). Glycemic control was poor in group A (72 %) vs. group B (56 %) ($p = 0.045$). There was significantly more peripheral vascular disease in group A (50 %) vs. group B (32 %) ($p = 0.005$). Sensory neuropathy was more in group A (90 %) vs. group B (38 %) ($p < 0.0001$). Grade-I ulcer was present in 16 % cases, Grade-II in 38 % and Grade-III in 46 %. *Conclusion:* Neuropathy carries highest risk for diabetic foot ulcer, followed by peripheral vascular disease and poor glycemic control. Therefore, diabetic patient must be educated about these risk factors, foot care and self-examination and to have regular screening by clinician. Appropriate glycemic control and timely medical and surgical intervention may reduce morbidity in diabetics.
Keywords: Diabetic foot ulcer, Glycemic control, New University of Texas Diabetic Wound Classification, Peripheral Neuropathy, Peripheral Vascular Disease.

INTRODUCTION

Diabetic foot ulcer (DFU) and concomitant infection are one of the most frequent complications in patients with diabetes mellitus [1,2]. DFU affect approximately 12-25% of persons with diabetes mellitus throughout their lives [3]. Lower limb disease is the most common source of complications and hospitalization in the diabetic population [4]. Diabetics (7-10%) develop

chronic foot ulcers, a severe and expensive complication with life and/or limb threatening conditions [5]. Chronic DFU are one of the most common indications for hospitalization in diabetics, and almost 50% of all non-traumatic amputations are performed on diabetic patients [6]. It is now understood that the majority of diabetic lower extremity amputations are preceded by foot ulcers [1, 7].

Chronic DFU do not follow the well-described sequence of wound healing. Recent research has shown that true chronic wounds are biochemically different from acute wounds differing in their expression of growth factors, matrix metalloproteases, and various proteins. The most frequent chronic wounds are DFU, that is, ulcers due to peripheral arterial occlusive disease and/or venous disease [8, 9].

A chronic DFU is defined as a wound failing to heal after 4 weeks [9] and this definition was adopted by the American Diabetes Association [10]. It has been reported that a decrease in wound size by at least 0.7 mm per week is 80% sensitive and specific for ultimate wound closure, the opposite being a marker of chronicity [11]. Alternatively, a less than 10% decrease in wound surface per month may empirically be a predictor of poor healing, although reliability and predictive values are missing [8-11].

The aim of this study was to identify the risk factors, clinical presentation, and outcomes associated with chronic DFU in Bangladeshi population.

OBJECTIVE
- To determine the risk factors for diabetic foot ulcers.
- To study their associations with diabetic foot ulcers.
- To study the grades at presentation of diabetic foot ulcers.

METHODOLOGY
Study Design: Comparative descriptive study.

Place of Study: Department of Surgery, Shaheed Ziaur Rahman Medical College Hospital, Bogura.

Period of Study: May 2020 to May 2021.

Study Population: The study population will be all patient with diabetics who will be admitted during the study period in Shaheed Ziaur Rahman Medical College Hospital, Bogura.

Sample Population: The patients with diabetics admitted in the Department of Surgery, SZMCH, Bogura and fulfilling the inclusion and exclusion criteria were considered as sample.

Sample size: 100

Sample Technique: Sample techniques were non-probability and purposive.

Inclusion Criteria: Consecutive 100 cases with diabetic patient with or without foot ulcer who were willing to participate in the study.

Exclusion Criteria:
a. Patients who will not participate willingly.
b. Patients who will discontinued treatment in SZMCH.
c. Paediatric age group (≤18yrs).
d. Non diabetic group.

Data Collection
In a predesigned case record form detail history, physical examination, necessary laboratory and radiological investigations were recorded and the details of the operative findings and histopathological report were noted by structured questionnaire.

Study Procedure
Adult (> 18 years) type 2 diabetic patients presenting with recent diabetic foot ulcer (i.e. < 4 weeks) got admitted in surgery department, were included in group A (n=50) after informed consent and type 2 diabetic patient without foot ulcer cases were included in group B (n=50) as control. Diabetic foot was defined as foot ulcer, cellulitis or deep abscess in type 2 diabetes patients. Demographic information (i.e. age, gender and contact address) was obtained. Patients were clinically assessed for presence of sensory neuropathy by Semmes-Weinstein 10-g monofilament and for loss of vibratory sensation by 128 Hz tuning fork. Vascular insufficiency was assessed by clinical examination of lower limb pulses followed by arterial Doppler examination in those with weak or absent pulses. X-ray of the foot was advised as per indication to assess underlying bone involvement. On the basis of these, diabetic foot ulcer was classified according to New University of Texas (NUOT) Diabetic Wound Classification. All this information was documented on a specially designed proforma. Data was analyzed by Statistical Package for Social Sciences (SPSS) version 17. Mean and standard deviation was calculated for quantitative variables (i.e. age, duration of diabetes and duration of ulcer); and frequencies and percentages for qualitative variables (i.e. gender, glycemic control, previous history of hospitalization due to ulcer, sensory neuropathy, peripheral vascular disease and ulcer grade). Chi-square test was used to identify differences between gender, neuropathy, vascular insufficiency, mode of treatment for diabetes and un-satisfactory glycemic control. Independent sample t-test was used to compare mean age and duration of diabetes between two groups and results presented in the form of tables. P-value < 0.05 considered as statistically significant.

RESULTS

In this study the cases were collected from surgery wards of SZMCH. The study was carried out from May 2020 to May 2021.

Total 100 cases were included; 50 diabetics with foot ulcer (group A) and 50 diabetics without foot ulcer (group B). There were 17(34%) females and 33(66%) males in group A and 31(62%) males and 19(38%) females in group B giving insignificant difference in gender between the two groups ($p = 0.453$) **(figure 1)**. The glycemic control was un-satisfactory in group A (72 %) as compared to group B (56 %) ($p = 0.045$) **(figure 2)**.
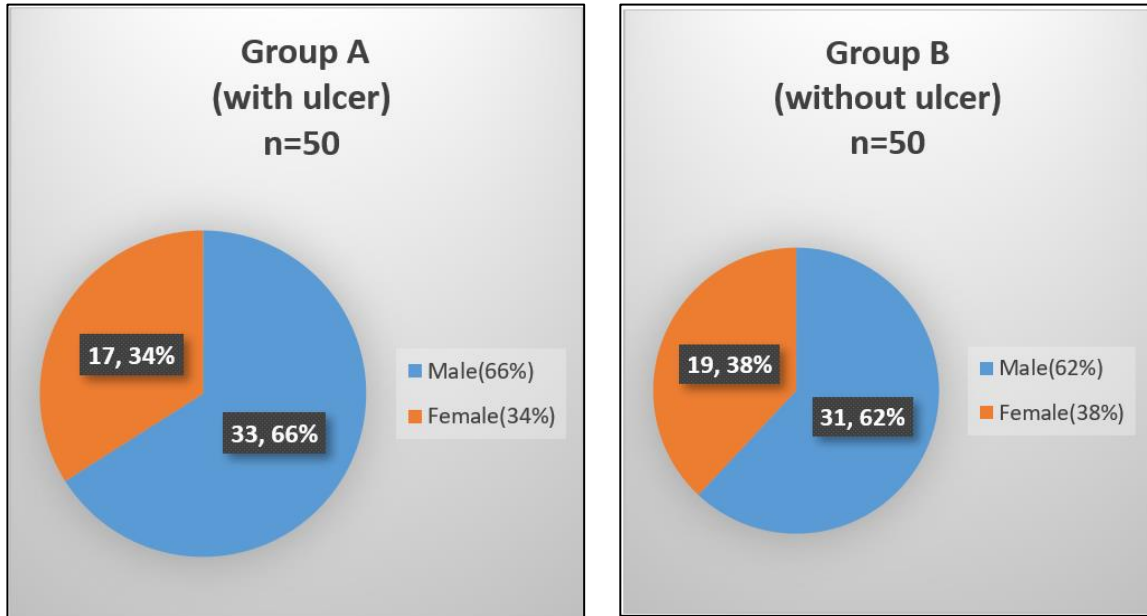

Figure 1: Distribution of the patients according to gender

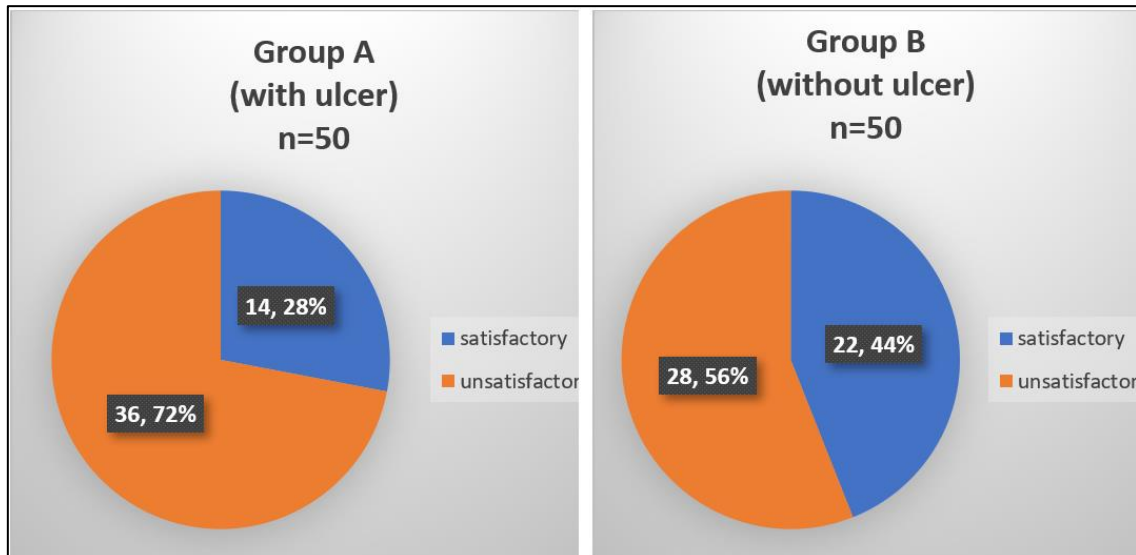**Figure 2: Distribution of the patients according to Glycemic control**

Table 1: Distribution of the patients according to Age

Variables	Group A (with ulcer) n=50	Group B (without ulcer) n=50	p- value
Age(yrs)Mean±SD	58.50±9.8	50.40±10.5	0.094

Independent sample t-test

Mean age was 58.50 ± 9.8 (group A) versus 50.40 ±10.5 years (group B) **(table 1)**.

Table 2: Distribution of the patients according to duration of diabeties

Variables	Group A (with ulcer) n=50	Group B (without ulcer) n=50	p- value
Duration of diabetes(years) Mean±SD	10.49±7.06	8.34±4.83	0.019

Independent sample t-test

Mean duration of diabetes was significantly longer in group A (10.49 ± 7.06 years) as compared to group B (8.34 ± 4.83 years) (*p* = 0.019) (**table 2**).

Table 3: Distribution of the patients according to peripheral neuropathy

Variables	Group A (with ulcer) n=50	Group B (without ulcer) n=50	p- value
Peripheral neuropathy n (%)	45(90%)	19(38%)	<0.0001

Chi-square test

Sensory neuropathy was significantly more in group A (90 %) vs group B (38 %) (*p* < 0.0001; (**table 3).**

Table 4: Peripheral vascular disease with respect to gender observed in patients With and without foot ulcer (n=100)

		With ulcer			Without ulcer			Total n=100
		Male n=33	Female n=17	total n=50	Male n=31	Female n=19	total n=50	
Peripheral vascular disease	Normal (0.90-1.30)	18 (54.54%)	7 (41.17%)	25 (50%)	22 (70.96%)	12 (63.15%)	34 (68%)	59 (59%)
	Mild (0.70-0.89)	5 (15.15%)	4 (23.52%)	9 (18%)	3 (9.67%)	5 (26.31%)	8 (16%)	17 (17%)
	Moderate (0.40-0.69)	7 (21.21%)	4 (23.52%)	11 (22%)	5 (16.12%)	2 (10.52%)	7 (14%)	18 (18%)
	Severe (<0.40)	3 (9.09%)	2 (11.76%)	5 (10%)	1 (3.22%)	0 (0%)	1 (2%)	6 (6%)
p-value		0.73			0.08			100 (100%)

Peripheral vascular disease was significantly more in group A (50 %) as compared to group B (32 %) (*p* = 0.005). On the basis of ankle brachial index (ABI) calculated by Doppler studies of group A, mild vascular disease was present in 18 %, moderate in 22 % and severe in 10 %. In group B, there was mild disease 16 %, moderate in 14 % and severe in 2 % **(table 4).**

Table 5: Patients with diabetic foot ulcer in different stages of ulcer according to New university of texas classification (n=50)

		Ulcer Grade			Total
		Grade-I	Grade-II	Grade-III	
Stage of ulcer	Stage-A	0(0%)	1(2%)	1(2%)	2(4%)
	Stage-B	5(10%)	13(26%)	11(22%)	29(58%)
	Stage-C	2(4%)	1(2%)	1(2%)	4(8%)
	Stage-D	1(2%)	4(8%)	10(20%)	15(30%)
Total		8(16%)	19(38%)	23(46%)	50(100%)

According to NUOT Classification, Grade-I ulcer was present in 16 % (0 % Stage I-A, 10 % Stage I-B, 4 % Stage I-C, 2 % Stage I-D); Grade-II in 38 % (2 % Stage II-A, 26 % Stage II-B, 2 % Stage II-C, 8 % Stage II-D); Grade-III in 46 % (2 % Stage III-A, 22 % Stage III-B, 2 % III-C, 10 % Stage III-D) (*p* = 0.004; **table 5**).

DISCUSSION

Diabetic foot ulcer is a frequent cause of morbidity in patients with diabetes mellitus and also the leading cause of lower extremity amputations.

Complications usually begin with an unrecognized foot ulcer in a diabetic patient with an insensitive foot that gets infected, leading to significant morbidity. The mean age of the patients with diabetic foot ulcer in current study was 58 years. Motley *et al.,* found mean age of 57.9 years in a study conducted in Texas USA [12]. Shahbazian *et al.,* also found comparable mean age of 53.8 years in an Iranian study [13]. These studies were performed in different health care centers with variation in quality of care; yet the comparable mean age suggests that diabetic foot ulcer is possibly time dependent with

contribution of environmental and local factors. Although the age of onset of diabetes varies in different continents across the world, however with the increasing age, skin becomes more fragile and less sensitive that may be the intrinsic contributory factor for development of chronic wounds. Among the patients presenting with diabetic foot, there were higher number of males (66%) as compared to females (34%). These results are comparable to an international study conducted by Mohanasoundaram *et al.,* that shows the prevalence of diabetic foot ulcer to be 65 % in males and 35 % in females [14]. The possible reasons could be the improper hygiene, inadequate foot care and type of foot wear among males. Current study also confirms this preponderance of men. The mean duration of diabetes was 9 years in patients with diabetic foot and it was significantly longer as compared to diabetics without ulcer. A study conducted by Hussain *et al.,* showed mean duration of diabetes to be 13 years in patients with foot ulcer and 9 years in patients without foot ulcer [15]. Zain *et al.,* concluded that long standing diabetes, male gender and overweight are risk factors for diabetic foot ulcers [16]. Thus, it can be conclude that with the longer duration of diabetes there are more chances of developing diabetes related complications like neuropathy and vascular insufficiency leading to vicious cycle of foot deformities, pressure areas and ultimately foot ulceration. Glycemic control was un-satisfactory in 72 % of diabetics with foot ulcer and 56 % of diabetics without foot ulcer. Study conducted by Ahmed *et al.,* in Jeddah Saudi Arabia showed poor glycemic control in 66 % of diabetics [17]. Over all glycemic control was poor in both study groups. Possible reasons could be noncompliance or improper management plan leading to development of complications at an early stage and making them prone to infections. Current study shows higher prevalence of sensory neuropathy in diabetics with foot ulcer (i.e. 90 %) vs. those without ulcer (38 %). Also, it was more commonly seen in 40-60 years age group. Neuropathy is a micro-vascular complication enhanced by poor glycemic control, and development of neuropathy can be delayed by good glycemic control. The patients with neuropathy had longer mean duration of ulcers, more advanced ulcer stage and higher mean glycated hemoglobin levels. Importance of good glycemic control has been emphasized by these findings as a key aspect of primary intervention in diabetic foot ulcer management. The detection of neuropathy before the development of its complications is the best way to prevent diabetic foot infections [18]. (Doppler studies, based on Ankle brachial index (ABI), showed peripheral vascular disease to be more common (50%) in diabetics with foot ulcer. These results are comparable with study by Prompers *et al.,* that found peripheral vascular disease in 49 % of patients with new foot ulcer [19]. The decreased circulation leads to poor tissue oxygenation and impaired wound healing. Moreover, infections in these patients are difficult to treat because of inappropriate therapeutic concentrations of antibiotic(s) in the infected tissue. It is open to speculation whether aggressive revascularization will improve control of infection in these patients. A significant relation between peripheral arterial disease, infection and poor outcome has also been observed in a study by Cardoso *et al.,* that suggested the peripheral arterial disease to be an independent predictor of infection related mortality in a large cohort of out patients with type 2 diabetes mellitus [20]. Early recognition and management of risk factors responsible for development and poor healing of diabetic foot ulcers is important for reducing morbidity in diabetics. The most important of these risk factors are prolonged history of diabetes, poor glycemic control, neuropathy (loss of protective sensation), foot deformity, and peripheral vascular disease. Predictors of amputation were foot ulceration, ankle brachial index < 0.9, elevated HbA1C and neuropathy. According to NUOT classification, majority of patients (46%) in our study presented late in due course of their disease with deep ulcerations i.e. Grade III, while 38% in Grade II & fewer patients (16%) presented with Grade I. This late presentation was also seen in a study by Edo *et al.,* where less than 10% of the patients presented to hospital within 7 days of developing a foot ulcer [21]. A regional study conducted by Ali *et al.,* in Karachi also found more diabetics with advanced grade of ulcer (62 % in Grade II; 29.9 % in Grade III) and very few presenting earlier (7 % in Grade I) [22]. Late presentation to health care facility may result from various factors notably ignorance of complications of diabetes like neuropathy, self care at home, patronage of chemist/pharmacist, lack of funds for health expenses, and fear of limb amputation if they came to the hospital. Also, in patients with diabetic neuropathy, ulcers usually remain unnoticed at an early stage due to blunted pain perception and present late once they penetrate deep producing pain and functional debility. The severity of foot ulcer at presentation is a major risk factor for limb amputations as previously shown in a study by Van Battum *et al.,* in which predictors of minor amputation were depth of the ulcer, peripheral arterial disease, infection and male gender. The rate of minor amputation correlated strongly with disease severity score at the moment of presentation to the foot clinic [23]. In view of these authors they recommend early access to health care facility by diabetics to reduce the risk of amputation by timely intervention. Current study provides opportunity to compare the risk factors between two groups and advanced investigations like Doppler ultrasound to assess the severity of vascular disease. Also we used New University of Texas (NUOT) classification which incorporates both the grading and staging of diabetic foot ulcer along with the presence or absence of infection. There are certain limitations of this study like lack of randomization and further prognosis or final outcome in the form of minor or major amputations, morbidity and mortality.

CONCLUSION

Very few diabetics present at initial stage of ulcer and there is need to educate patients to seek early

medical and surgical opinion. The patients having prolonged history of diabetes, poor glycemic control, neuropathy and peripheral vascular disease should be considered at risk for diabetic foot ulcer. The high prevalence of neuropathy and peripheral vascular disease observed in this study points to need for regular examination by clinician and to educate diabetics about foot care and daily self-examination. Appropriate preventive measures, good glycemic control and timely intervention may reduce the morbidity in diabetics.

REFERENCE

1. Boulton, A. J. M. (2004). The diabetic foot: from art to science. The 18th Camillo Golgi lecture. *Diabetologia*, *47*(8), 1343-1353.
2. Boulton, A. J., Vileikyte, L., Ragnarson-Tennvall, G., & Apelqvist, J. (2005). The global burden of diabetic foot disease. *The Lancet*, *366*(9498), 1719-1724.
3. Brem, H., Sheehan, P., Rosenberg, H. J., Schneider, J. S., & Boulton, A. J. (2006). Evidence-based protocol for diabetic foot ulcers. *Plastic and reconstructive surgery*, *117*(7S), 193S-209S.
4. Boyko, E. J., Ahroni, J. H., Cohen, V., Nelson, K. M., & Heagerty, P. J. (2006). Prediction of diabetic foot ulcer occurrence using commonly available clinical information: the Seattle Diabetic Foot Study. *Diabetes care*, *29*(6), 1202-1207.
5. Boyko, E. J., Ahroni, J. H., Cohen, V., Nelson, K. M., & Heagerty, P. J. (2006). Prediction of diabetic foot ulcer occurrence using commonly available clinical information: the Seattle Diabetic Foot Study. *Diabetes care*, *29*(6), 1202-1207.
6. Boulton, A.J., Connor, H. & Cavanagh, P.R. (2000). The foot in diabetes. *Chichester, UK: Wiley*; 245_60.
7. Reiber, G. E., Vileikyte, L. O. R. E. T. T. A., Boyko, E. D., Del Aguila, M., Smith, D. G., Lavery, L. A., & Boulton, A. J. (1999). Causal pathways for incident lower-extremity ulcers in patients with diabetes from two settings. *Diabetes care*, *22*(1), 157-162.
8. Köveker, G. B. (2000). Growth factors in clinical practice. *International journal of clinical practice*, *54*(9), 590-593.
9. Pfeffer, F., von Dobschuetz, E., Riediger, H., Moosmann, C., & Hopt, U. T. (2004). The non-healing wound. *MMW Fortschritte der Medizin*, *146*(44), 45-48.
10. Consensus Development Conference on Diabetic Foot Wound Care: 7_8 April 1999, Boston, Massachusetts. American Diabetes Association. Diabetes Care 1999; 22: 1354_60.
11. Ince, P., Kendrick, D., Game, F., & Jeffcoate, W. (2007). The association between baseline characteristics and the outcome of foot lesions in a UK population with diabetes. *Diabetic Medicine*, *24*(9), 977-981.
12. Motley, T. A., Gilligan, A. M., Lange, D. L., Waycaster, C. R., & Dickerson, J. E. (2015). Cost-effectiveness of clostridial collagenase ointment on wound closure in patients with diabetic foot ulcers: economic analysis of results from a multicenter, randomized, open-label trial. *Journal of Foot and Ankle Research*, *8*, 1-12.
13. Shahbazian, H., Yazdanpanah, L., & Latifi, S. M. (2013). Risk assessment of patients with diabetes for foot ulcers according to risk classification consensus of International Working Group on Diabetic Foot (IWGDF). *Pakistan journal of medical sciences*, *29*(3), 730.
14. Mohanasoundaram, K. M. (2012). The microbiological profile of diabetic foot infections.
15. Hussain, F., Sheikh, M. A., Jamil, A., & Nawaz, H. (2010). Advanced glycation end-products and foot ulceration in type 2 diabetic patients: a case control study. *Int. J. Agric. Biol*, *12*(1), 91-95.
16. Amjad, S. S., Shams, N., & Zahra, T. (2016). Diabetic Foot Ulcers in a Tertiary Care Hospital; Risk Factors, Associations and Grades of Presentation. *Journal of Liaquat University of Medical & Health Sciences*, *15*(1).
17. Haji Zaine, N., Burns, J., Vicaretti, M., Fletcher, J. P., Begg, L., & Hitos, K. (2014). Characteristics of diabetic foot ulcers in Western Sydney, Australia. *Journal of foot and ankle research*, *7*, 1-7.
18. Ahmed, A. A., Algamdi, S. A., Algurashi, A., Alzhrani, A. M., & Khalid, K. A. (2014). Risk factors for diabetic foot ulceration among patients attending primary health care services. *J Diabet Foot Complications*, *6*, 40-7.
19. Cardoso, C. R., & Salles, G. F. (2007). Macro and microvascular complications are determinants of increased infection-related mortality in Brazilian type 2 diabetes mellitus patients. *Diabetes research and clinical practice*, *75*(1), 51-58.
20. Edo, A. E., Edo, G. O., & Ezeani, I. U. (2013). Risk factors, ulcer grade and management outcome of diabetic foot ulcers in a Tropical Tertiary Care Hospital. *Nigerian Medical Journal*, *54*(1).
21. Ali, S. M., Basit, A., Fawwad, A., Ahmedani, M. Y., Miyan, Z., & Malik, R. A. (2008). Presentation and outcome of diabetic foot at a tertiary care unit. *Pak J Med Sci*, *24*(5), 651-656.
22. Diabetes Control and Complications Trial Research Group. (1993). The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *New England journal of medicine*, *329*(14), 977-986.
23. Prompers, L., Huijberts, M., Apelqvist, J., Jude, E., Piaggesi, A., Bakker, K., ... & Schaper, N. (2007). High prevalence of ischaemia, infection and serious comorbidity in patients with diabetic foot disease in Europe. Baseline results from the Eurodiale study. *Diabetologia*, *50*, 18-25.