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Assessment of the outcome of diabetic foot in AL- Muthanna government

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Abstract--Background: Diabetic foot ulcers are one of the most severe and costly complications of diabetes. Foot ulcers result from a combination of multiple causes including peripheral neuropathy and peripheral arterial disease. Patients with diabetic foot ulcers frequently require amputation of the lower limb. Objective and problem: The aim of this study was to assess the outcome of diabetic foot ulcers patients in AL-Muthanna Government and to examine the effect of some risk factors on healing of the ulcer. Patients and methods: A cohort study was conducted on 50 patients from 18th of December, 2021 to 20th of April, 2022 at Al-Hussein teaching hospital, AL-Muthanna, Iraq. Results: A total of 50 patients with diabetic foot ulcers were included. The ulcers of 28% of the patients healed, whereas 16% persisted unhealed; 34% of the patients had a minor amputation, 22% had a major amputation and 1% had recurrent ulcers. The study showed statistically significant associations between diabetic foot ulcer healing and the following variables: patients' age, glycated HbA1c, duration of diabetes, complications of diabetes like peripheral neuropathy. Conclusions: Diabetic foot ulcer outcomes can be predicted by several factors, some of which are modifiable. Modification of the modifiable factors, such as better control of diabetes, treatment of peripheral neuropathy, and early management of ulcers, may improve the outcome and facilitate healing.

Keywords--diabetic foot, patients, neuropathy, amputation.

Introduction

Anatomy of the foot

The feet are flexible structures of bones, joints, muscles, and soft tissues that let us stand upright and perform activities like walking, running, and jumping. The feet are divided into three sections:

- The forefoot contains the five toes (phalanges) and the five longer bones (metatarsals).
- The midfoot is a pyramid-like collection of bones that form the arches of the feet. These include the three cuneiform bones, the cuboid bone, and the navicular bone.
- The hindfoot forms the heel and ankle. The talus bone supports the leg bones (tibia and fibula), forming the ankle. The calcaneus (heel bone) is the largest bone in the foot. [1]

Muscles, tendons, and ligaments run along the surfaces of the feet, allowing the complex movements needed for motion and balance. The Achilles tendon connects the heel to the calf muscle and is essential for running, jumping, and standing on the toes. [2]

Diabetic foot

- Infection, ulceration or destruction of deep tissues associated with neurological abnormalities & various degrees of peripheral vascular diseases in the lower limb (based on WHO definition).
- It is a common serious condition affecting about 15% of diabetic patients in their life.
- Usually affecting the feet of long standing neglected diabetic patients which are more liable for macroangiopathy (atherosclerosis), microangiopathy, peripheral neuropathy, trophic changes in the feet, exposure to trauma, ulceration, infection & finally gangrene. [3]

Epidemiology

- 13% of the population > 20 years of age.
- 25% of Diabetic patient experience foot problem in their lifetime.
- Risk of Amputation 40 times high Compared to Non Diabetics. 6
- 75% of all lower limb Amputation are performed in Diabetics.
- 85% of diabetic related foot amputation are preceded by foot ulcer.
- 4 out of 5 ulcer in diabetics are precipitated by trauma. [4], [5], [6]

Aetiology

Aetiology of diabetic foot is multi-factorial:

- **Diabetic macroangiopathy** : The following risk factors accelerate early severe atherosclerosis: 1. High incidence of hypertension. 2. High plasma levels of cholesterol & triglycerides. 3. Genetic predisposition.
- **Diabetic microangiopathy**: occludes distal arterioles and capillaries with thickening of basement membrane → impair tissue perfusion & low O₂ level → loss of viability of tissues & impairs delivery of leucocytes, antibodies and antibiotics.
- **Ischaemia**: Due to atherosclerosis & microangiopathy.
- **Infection**: It is common in poorly controlled diabetics due to : 1) Poor general resistance. 2) Ketoacidosis inhibit antibody formation, produce WBCs dysfunction & lower the local resistance of the tissues. 3) Diabetic neuropathy. 4) Diabetic microangiopathy. 5) High glucose level in the tissues is a good medium for bacteria.
- **Diabetic Neuropathy**: • It is due to prolonged hyperglycemia, the neuropathy may be : 1- Sensory neuropathy; so the patients are unaware of injurious insults. 2- Motor neuropathy leading to paralysis of intrinsic muscles of the foot. 3- Autonomic neuropathy leading to peripheral cutaneous vasodilatation and suppression of sweating leading to cracking & fissuring of the skin. [7] 7

Pathology and clinical picture

Diabetic gangrene may be one of the following types:

Infective diabetic gangrene

- It is the commonest type of gangrene.
- There are severe spreading infection leading to cellulitis, necrosis of muscle, tendons & osteomyelitis → rapid spreading moist septic gangrene in toes & foot.
- Usually after history of minor trauma e.g. Careless nail cutting, interdigital infections ..etc, the following occurs :
 - **General**: severe toxemia
 - **Local**: 1- Severe foot infection with moist septic gangrene and offensive odour and discharge. 2- The line of demarcation is poor with tendency to spread. 3- The surrounding viable tissue show severe inflammation. 4- Palpable distal pulsations (no history of claudication).

Ischaemic Atherosclerotic gangrene

- Atherosclerosis occurs at younger age, more common, more diffuse & more severe in patients with D.M.
- In patients with D.M. the disease affects large, medium & small sized arteries.
- In non diabetics, tibial & peroneal arteries are rarely affected for a short distance while in diabetics tibial & peroneal arteries are heavily affected down to the ankle.
- There is previous history of chronic ischaemia.
- There is affection of large vessels → loss of pulsations.

- Dry gangrene. 8

Peripheral neuropathy

- It is very common in D.M, plays a major role in the development of infective diabetic gangrene.
- It produces loss of sensation in the form of gloves & stockings → exposure to trauma → trophic ulcers, on the sole, which are ignored by the patient → more liable for trauma & infection → Neuropathic ulcers.
- Paralysis of muscles of feet with loss of reflexes.
- **Neuropathic joints & Charcot's joints** with multiple foot deformities (clawing of toes, subluxation of metatarso-phalangeal joints with prominent metatarsal heads).
- **Neuropathic ulcer is painless**, usually on the plantar surface of the head of metatarsal bones or heel with sensory loss & warm dry skin (autosympathectomy).

Mixed type of gangrene. [8], [9]

Wagner classification

The Wagner classification is based mainly on ulcer depth and consists of 6 wound grades. These include:

- grade 0 : intact skin.
- grade 1 : superficial ulcer .
- grade 2 : deep ulcer to tendon, bone or joint .
- grade 3 : deep ulcer with abscess or osteomyelitis.
- grade 4 : forefoot gangrene . ▪ grade 5 : whole foot gangrene. [10]

Investigations

- Urine & blood sugar and HbA1c for D.M.
- Culture and sensitivity for discharge.
- Foot X-ray for osteomyelitis. (If osteomyelitis occurs, ulcers & infection never heal & amputation is indicated), pathological fracture, deformed joints or gas in the soft tissues.
- Doppler & Duplex ultrasound.
- CT angiography if there is any manifestations of ischemia.
- MRI to assess the condition of the soft tissues. [11]

Treatment

Prophylactic

Prevention of injury, daily self foot examination & meticulous foot care.

Curative

Proper control of D.M. with regular insulin.

Infective diabetic type

- Hospitalization.
- Rest in bed & elevation of the foot.
- Avoid weight bearing & pressure on the affected area.
- Proper antibiotic according to culture and sensitivity.
- Drainage of infection & debridement (excision of dead tissues & sloughs) leaving clean well drained raw area. Then frequent dressings and local antibiotic are essential.
- When the wound becomes free from infection and contain only viable tissue, plastic skin coverage can be performed to shorten the recovery time.
- Amputation:
 - Minor foot amputation if there is osteomyelitis.
 - Urgent below or above knee amputation (according to the condition of popliteal artery) may be indicated in rapidly progressive gangrene or uncontrollable toxemia endangering

Atherosclerosis

Endovascular therapy or arterial reconstruction, if possible, should be done. 10

Neuropathic ulcer

- Avoid weight bearing, local cleanliness, dressing and protection from trauma.
- Proper antibiotic according to culture & sensitivity.
- Excision of the ulcer with grafting in resistant cases.
- Amputation: If the underlying joints & bones are affected. [8], [12], [13], [14]

Aim of the study

The aim of this study was to assess the outcomes of DFUs in Iraqi patients with diabetes, classifying them into the following categories: healing, persisting unhealed, minor amputation, major amputation, recurrence, and death. Also, it aimed at examining the effects of some risk factors on ulcer healing, such as patient age, HbA1c, duration of diabetes, complications of diabetes like peripheral neuropathy 11

Patients and Method

This was a cohort study including patients who attended Al-Hussein teaching hospital from 18th of December, 2021 to 20th of April, 2022. All patients with diabetes aged (30-80) years and having DFUs were included. Those who had diabetic foot lesions other than ulcers or those who had no diabetes were excluded from the study. A total of 50 patients with DFUs were included in this study. The demographic data and duration of diabetes were recorded. The diagnosis of peripheral neuropathy was based on clinical signs and symptoms, in addition to insensitivity of the foot and the absence of ankle reflexes. The diagnosis of ischemia in the foot was based on bedside examination, by looking for specific presenting signs and symptoms (dry, shiny, hairless skin on the

affected limb; brittle nails; and skin which is cool to touch) with measurement of the Posterior tibial and dosalis pedis arteries. A laboratory blood test for HbA1c was ordered. [15] In addition, a clinical examination of the ulcer and measurement of its size were done. After that, treatment was started with surgical debridement to remove all nonviable tissue. [15] Follow-up was conducted weekly for 6 months and the outcomes were classified into one of the following six categories: 1. Healing, defined as a continuous viable epithelial covering over the entire, previously open wound. [16] 2. Persisting unhealed, defined as incomplete re-epithelialization of the wound. [16] 3. Minor amputation, defined as amputation restricted to the foot, not affecting walking ability (transmetatarsal, tarso-metatarsal, or Lisfranc's 12 amputation). [17] 4. Major amputation, defined as amputation performed above the level of the ankle. [17] 5. Recurrence, defined as re-ulceration, most commonly occurring on the same foot. [18] 6. Death. Data is reported as counts and percentages, as illustrated in table (1) :

Table 1
Patients' characteristics

Variables	No. of patients	Percentage
Gender		
Female	21	42 %
Male	29	58 %
B.M.I		
Normal	38	76 %
Overweight	10	20 %
Obese	2	4 %
Age (year)		
30 – 40	2	4 %
40 – 50	5	10 %
50 – 60	12	24 %
60 – 70	20	40 %
70 – 80	11	22 %
Type of D.M		
Type 1	4	8 %
Type 2	46	92 %
HbA1c		
< 7%	12	24 %
> 7%	8	16 %

Results

A total of 50 patients were included in this study. Of them, 29 were male and 21 female. The mean age of the participants was 55 years. 24% percent of the participants were overweight or obese. Only 16% of the studied population were smokers, while 46% of them have hypertension (Table 1). Many risk factors can contribute or exacerbate the foot ulcer, as illustrated in table (2).

Table 2
Risk factors of diabetic foot

Variables	No. of patients	Percentage
Increased B.M.I	12	24 %
History of trauma	23	46 %
Hypertension	23	46 %
Smoking	8	16 %
Stroke	2	4 %

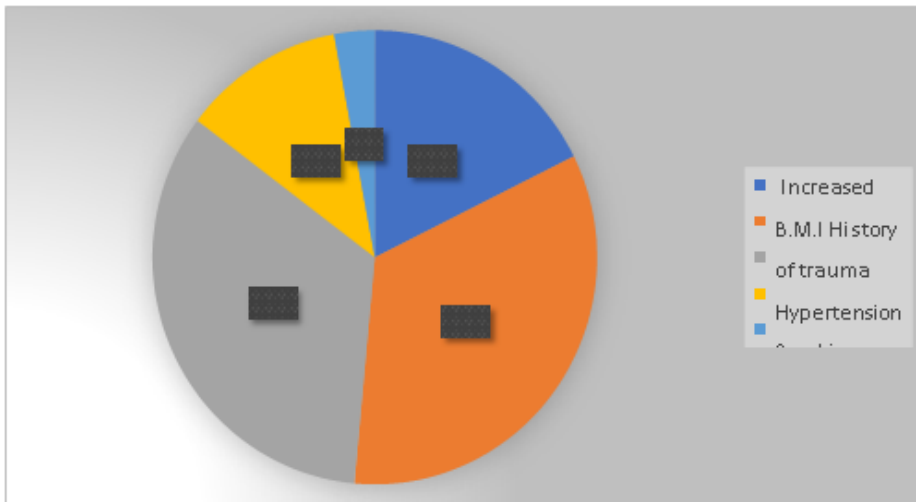


Figure 1. Risk factors of diabetic foot

The majority of them had type 2 diabetes. All of them were on insulin combined with oral or IV antibiotics drugs.

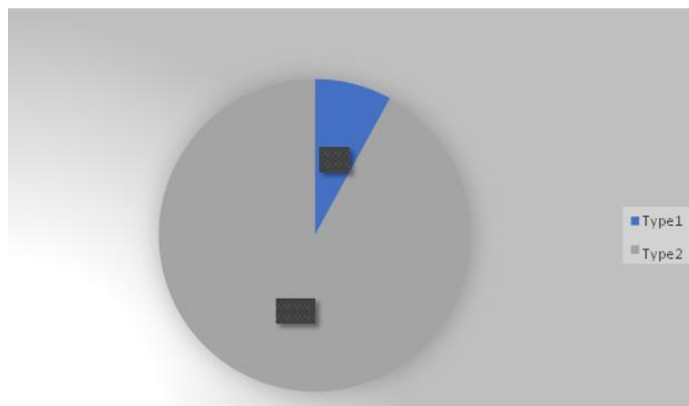


Figure 2. Association between type of D.M and DFU

We classified the participants into three age groups: 30–50, 51–65, and ≥ 65 years. The majority (54%) of the patients were in the age group of (51–65) years. 22% of these patients had healed, 22% unhealed, 45% of them undergoing a minor amputation and about 11% undergoing a major amputation. While the age group

(>65) years had poor outcomes, with 57% of them undergoing a major amputation, 22% undergoing a minor amputation, 14% healed, and 7% unhealed. However, in patients with the age group (30-50) there were 45% of them healed, 22% unhealed, 11% undergoing a minor amputation and 22% undergoing a major amputation. As shown in Figure (3)

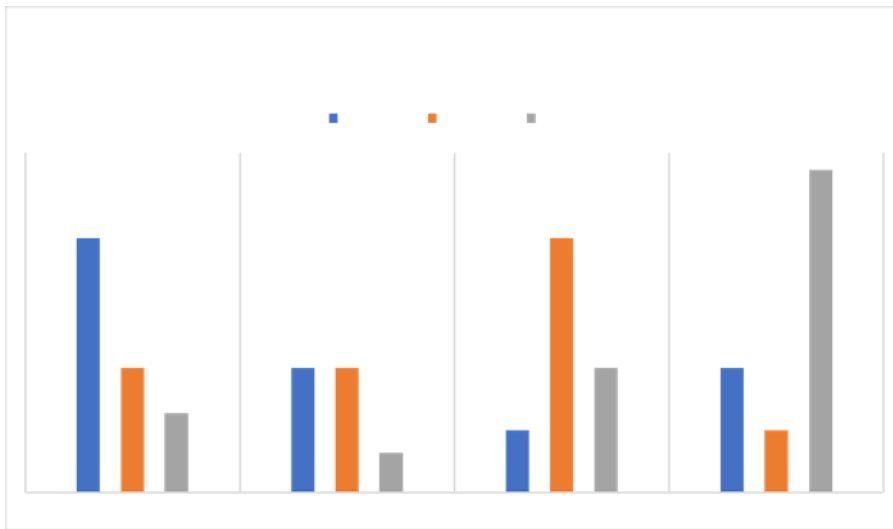


Figure 3. Percentage of association between age groups and diabetic foot ulcer outcome

Regarding the association between peripheral neuropathy and DFU outcome, more than half of patients (about 60%) have peripheral neuropathy. 33% healed, 10% unhealed, 27% undergoing a minor amputation and 30% undergoing a major amputation. As shown in Figure (4).

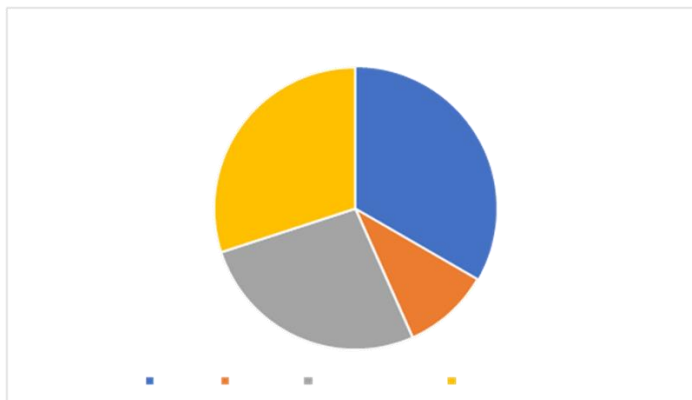
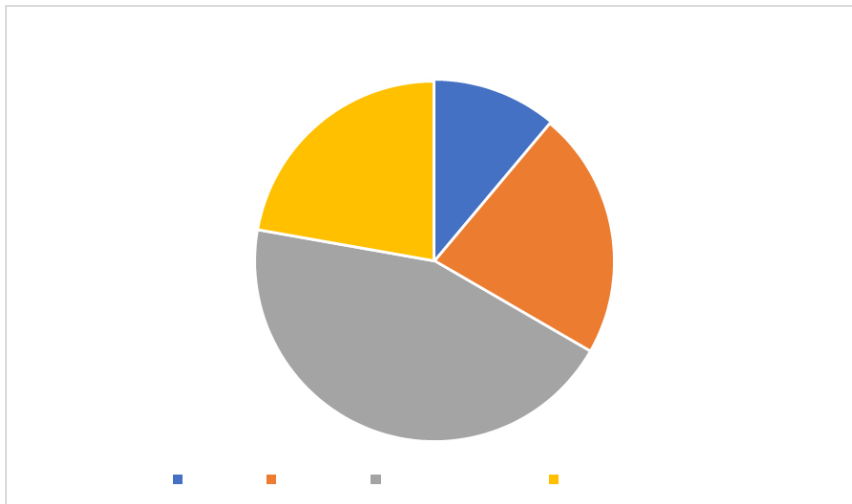


Figure 4. Association between peripheral neuropathy and DFU outcome.

Regarding the association between peripheral vascular disease and DFU, about 45% of patients undergoing a minor amputation, 22% undergoing a major amputation while 22% of them had healed and only 11% of them remained unhealed. As shown in Figure (5) :



Discussion

This study was conducted on 50 patients with DFUs attending Al-Hussein teaching hospital. There was slight gender difference, and the majority of the participants were in the middle age group. Most of the participants had type 2 DM, which is more common than type 1 DM. In addition, around more than two-thirds were on insulin, which may reflect the long duration of diabetes among the patients. The study shows that patients ≥ 65 years old have a poor outcome compared with other age groups; this finding is similar to what has been reported in the study by Katsilambros et al. [19], which revealed that the amputation rate increased with age, being 1.6% in the age group of 18–44 years, 3.4% in the age group of 45–64 years, and 3.6% in patients ≥ 65 years. As people become older, the wound healing process is impaired, due to many factors such as peripheral arterial disease, decreased defense mechanisms, and impaired immunity.

Both microvascular and macrovascular complications of DM are directly related to the duration of the disease. The study showed that those with poorly controlled DM, as reflected in an HbA1c $>7\%$, had a poor outcome with regard to DFUs. This is similar to the results of a study from India that showed a clear and significant relation between diabetic foot complications and the degree of glycemic control [20]. Poor glycemic control is the main risk factor for developing diabetic complications. Consequently, optimal control of plasma glucose will halt the progression of all complications including DFUs. Peripheral neuropathy is one of the major risk factors for all foot complications. The study showed that all those who had no peripheral neuropathy achieved ulcer healing without complications. This strong association of peripheral neuropathy with diabetic foot complications has been also reported in a study from Saudi Arabia, where 33% of their diabetic patients were suffering from chronic nerve compression [21]. Peripheral neuropathy exposes the afflicted patient to repetitive trauma to the feet. In addition, it increases the duration of pressure over the area without the patient noticing it.

Conclusion

The DFU outcome can be predicted from the age of the patient, duration of diabetes, glycemic control, ulcer size, and presence of complications such as peripheral neuropathy and peripheral vascular disease.

Recommendation

Optimal glycemic control, patients' education about the importance of foot care, and increasing the awareness of health care providers in order to diagnose DFUs in the early stages and to prevent the development of high-grade wounds are very important steps to reduce the burden of DFUs and their effect on the quality of life of people with DM. Promotion of the role of primary health care providers in Iraq in screening for diabetic foot by using foot screening tools as well as patient education (advising them regarding diet and physical activity, foot hygiene, nail cutting, treatment of calluses, and appropriate footwear) are recommended. Early diagnosis and management of DFUs is crucial. Special care should be provided to those at risk of DFU complications, such as elderly people and those with poorly controlled or longer-lasting DM, larger ulcers, and peripheral neuropathy.

References

1. Bito T, Tashiro Y, Suzuki Y, et al. Forefoot transverse arch height asymmetry is associated with foot injuries in athletes participating in college track events. *J Phys Ther Sci.* 2018;30(8):978–983. doi:10.1589/jpts.30.978
2. Freedman BR, Gordon JA, Soslowsky LJ. The Achilles tendon: fundamental properties and mechanisms governing healing. *Muscles Ligaments Tendons J.* 2014;4(2):245–255. PMID: 25332943
3. Abetz L, Sutton M, Brady L, McNulty P, Gagnon DD. The Diabetic Foot Ulcer Scale
4. (DFS): a quality of life instrument for use in clinical trials. *Pract Diabetes Int.* 2002;19(6):167–75.
5. Singh N, Armstrong DG, Lipsky BA. Preventing foot ulcers in patients with diabetes. *JAMA.* 2005 Jan;293(2):217–28.
6. Hinchliffe RJ, Andros G, Apelqvist J, Bakker K, Friederichs S, Lammer J, et al. A systematic review of the effectiveness of revascularization of the ulcerated foot in patients with diabetes and peripheral arterial disease. *Diabetes Metab Res Rev.* 2012 Feb;28 Suppl 1:179–217.
7. Rice JB, Desai U, Cummings AK, Birnbaum HG, Skornicki M, Parsons NB. Burden of diabetic foot ulcers for medicare and private insurers. *Diabetes Care.* 2014;37(3):651–8.
8. Apelqvist J, Bakker K, van Houtum WH, Schaper NC; International Working Group on the Diabetic Foot (IWGDF) Editorial Board. Practical guidelines on the management and prevention of the diabetic foot: based upon the International Consensus on the Diabetic Foot (2007) Prepared by the International Working Group on the Diabetic Foot. *Diabetes Metab Res Rev.* 2008 May-Jun;24 Suppl 1:S181–7.
9. Frykberg RG, Armstrong DG, Giurini J, Edwards A, Kravette M, Kravitz S, et al. Diabetic foot disorders: a clinical practice guideline. American College of Foot and Ankle Surgeons. *J Foot Ankle Surg.* 2000;39(5 suppl):S1–60.

10. Pecoraro RE, Reiber GE, Burgess EM. Pathways to diabetic limb amputation. Basis for prevention. *Diabetes Care*. 1990;13:513–21.
11. Oyibo SO, Jude EB, Tarawneh I, Nguyen HC, Harkless LB, Boulton AJ. A comparison of two diabetic foot ulcer classification systems: the Wagner and
12. Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2021). The COVID-19 pandemic. *International Journal of Health Sciences*, 5(2), vi-ix. <https://doi.org/10.53730/ijhs.v5n2.2937>
13. Khidoyatova, M. R., Kayumov, U. K., Inoyatova, F. K., Fozilov, K. G., Khamidullaeva, G. A., & Eshpulatov, A. S. (2022). Clinical status of patients with coronary artery disease post COVID-19. *International Journal of Health & Medical Sciences*, 5(1), 137-144. <https://doi.org/10.21744/ijhms.v5n1.1858>