

A Review of The Risk Factors For Diabetic Foot Ulceration

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Abstract

Background: The incidence of ulceration of foot in diabetic patients ranges from 4-13%. The financial burden is also very high. The cost of treating a single foot ulcer in the United States approach 28000\$ over a period of two years. The main risk factors for diabetic foot ulcers include sensory neuropathy, lower limb ischemia, and trauma. However, these risk factors are to some degree preventable.

Objective: To know the risk factors for the development of diabetic foot ulcers.

Patients and Methods: A cross sectional study done in Baquba teaching hospital over a period of one year (August 2016 – August 2017). One hundred patients complaining from diabetic foot ulcer (with or without infection and/or gangrene) admitted to Baquba teaching hospital. A forma containing a list of risk factors, both local and general made for each patient and the risk factors documented. The forma used in the study mention the name of the patient, gender, age, and the local and general risk factors for the development of the diabetic foot ulcer. The percentage of occurrence of each of the risk factors calculated. Such risk factors include are local risk factors as, peripheral sensory neuropathy, vascular insufficiency, history foot ulcer/amputation, limited joint mobility, presence of callus, structural foot deformity, trauma and improperly fitted shoes. General risk factors include as impaired vision, poor glycemic control, peripheral vascular disease, renal impairment, and older age. Ages older than sixty years is considered as older age group.

Results: The study revealed that the main two factors are peripheral sensory neuropathy (94%) and poor glycemic control (78%). These are followed by three common risk factors which are history of foot ulcer/amputation (66%), impaired vision (60%), and older age (57%). Other risk factors in order of frequency of occurrence are trauma and improperly fitted shoes (56%), prolonged elevated pressure (50%), presence of callus (36%), structural foot deformity (24%), vascular insufficiency (20%), and renal impairment (11%).

Conclusion: Most of the risk factors are preventable by good glycemic control and awaring the patient of these factors to avoid lower limb amputation. Therefore early identification of risk factors for the development of ulceration of diabetic foot and initiation of appropriate treatment decrease the occurrence of complications, including the need for amputation. Also, knowing the risk factors for foot ulceration in diabetic patient is of utmost importance for early and better treatment of diabetic foot ulcers. There is an evolved need to educate and make awareness of diabetes and its associated complications, especially among populations living in the rural areas.

Key words: Diabetic foot, foot ulcer.

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Introduction

Ulceration and infection of the foot are two serious complications in patients with diabetes mellitus which can very frequently cause gangrene ending with minor or major amputation of the lower limb. Ulcerations is one cause for hospitalization for those with diabetes and expenditure of billions of dollars in the United States annually. In spite of inability to prevent all of the complications related to the foot in patient with diabetes, dramatic decrease in the frequency of occurrence can be achieved through the involvement of a multidisciplinary team that approach the management of the patient. It is very important to prevent ulceration effectively as they are a leading source of lower limb amputation in patient with diabetes [1- 3].

Foot ulceration in patient with diabetes is the most common complication. About 15% of patients with diabetes will sooner or later develop a foot ulcer throughout the course of the disease. Many report studies which are population based revealed a yearly cumulative incidence of about 2-4% for developing diabetic foot ulceration. In a British study of large numbers of patients with neuropathies, there was 8% incidence of first foot ulcer yearly. It was reported that the prevalence of diabetic foot ulcer in many populations ranged between 4% and 11%. Many studies revealed a cumulative effects of neuropathy, high plantar pressure, deformity, limited joint mobility, duration of diabetes. Poor glucose control, history of prior ulcers and or amputations, older age group, blindness, renal impairment and sex

group are all contributory factors for ulceration of the foot [4-6].

While the majority of ulcers can be successfully treated as an outpatient, ischaemic and or infected ulcers are a major cause for hospitalization. Discharging data put by the National hospitals indicate an average hospital length of stay for patients with the diagnosis of ulceration of the lower extremity reach 59% longer than in diabetics discharged without ulcers. Ulceration of the foot is considered to be the cause of about 87% of amputation of the lower limb in diabetic patients [7-10].

Peripheral sensory neuropathy with inability to perceive injuries is a major factor that is leading to ulceration of foets in diabetic patients. About 45-61% of all diabetic ulcerations are purely neuropathic. On the other hand, 47% have ischaemic and neuropathic components[11].

Deformities of the foot caused by neuropathy, congenital abnormalities, abnormal biomechanics and/or prior limb surgeries result in high pressures locally in the foot. All of these predispose the foot for ulceration, mainly at the plantar area and the medial and the dorsal surfaces of the foot which the later result from footwear irritation. Such deformities may include previous amputations of the foot, hammertoes prominent metatarsal heads, hallux valgus or Charcot arthropathy[12-14].

Motor neuropathy that is causing atrophy of the anterior crural muscle or cause wasting of the intrinsic muscles lead to foot deformities as foot drop, hammertoes,

equinus and prominent plantar metatarsal heads [15].

Autonomic neuropathy might result in drying of the skin causing fissuring creating a source of entry for microorganism. Failure of the sympathetic system, and microvascular thermoregulatory disorders cause impairment of perfusion of normal tissue and responses to injury at the microvascular level[15-16].

Foot trauma in association with peripheral sensory neuropathy is significant component that is causing ulcerations. A prominent insult that is leading to foot ulceration is repetitive stress resulting from walking or daily activity. This is usually manifest itself as formation of callus under the metatarsal heads. Trauma related to shoe has been known as a frequent precursor to ulceration of the foot [17, 18].

Peripheral vascular disease by it's own rarely directly leads to foot ulcerations. However, when ulceration develops, this arterial insufficiency will cause prolonged healing time and increase the risk for amputation. Also an attempts to resolve infection will be impaired because of lack of oxygenation and impairment in the delivery of antibiotics to the infected site. Therefore early recognition and treatment of ischemia of the lower extremity is very important to save the lower limb[19, 20]. Limited joint mobility is also regarded as a potential risk factor for diabetic foot ulcerations. What is happening is that a collagen glycosylation resulting from long-standing diabetes may cause stiffening of the structures of the ligaments and capsule (cheiroarthropathy).

This result in subsequent decrease in the mobility of the subtalar, ankle, and first metatarsophalangeal (MTP) joint. This result in high plantar pressures with subsequent increased risk of ulceration[21 – 23].

Other factors often associated with heightened risk for foot ulceration include: poor glycemic control, nephropathy, advanced age, blindness, and poor nutrition [24-26].

Patients and Methods

This is a cross sectional study done in Baquba teaching hospital over a period of one year (August 2016 – August 2017).

One hundred patients complaining from diabetic foot ulcer (with or without infection and/or gangrene) admitted to Baquba teaching hospital. A forma containing a list of risk factors, both local and general made for each patient and the risk factors documented. The forma used in the study mention the name of the patient, gender, age group and the local and general risk factors for the development of the diabetic foot ulcer. The percentage of occurrence of each of the risk factors calculated.

Such risk factors include

Local risk factors as, peripheral sensory neuropathy, vascular insufficiency, history foot ulcer/amputation, limited joint mobility, presence of callus, structural foot deformity, trauma and improperly fitted shoes.

General risk factors include as impaired vision, poor glycemic control, peripheral vascular disease, renal impairment, and older age. Age group of older than sixty years is considered as older age group.

Statistical Analysis

The data results are obtained through calculating the number and the percentage using Microsoft office excel 2017.

Table (1): Distribution of the patients according to sex group.

| Sex | Number | Percentage |
|--------|--------|------------|
| Male | 56 | 56% |
| Female | 44 | 44% |
| Total | 100 | 100% |

Regarding the distribution of the patients according to their sex group, fifty six (56%) patients were male and the other 44 (44%) patients were female.

Table (2): Distribution of the patients according to the age group.

| Age group | 20-29 | 30-39 | 40-49 | 50-59 | 60-69 | 70-79 | 80-89 | Total |
|-----------|-------|-------|-------|-------|-------|-------|-------|-------|
| Number | 0 | 6 | 12 | 25 | 43 | 9 | 5 | 100 |

Regarding classifying the patients according to their age group, they were as follow; six patients were in the age group 30-39 years, twelve patients were in the age group 40-49 years, twenty five patients were in the age group 50-59 years, forty three patients were in the age group 60-69 years, nine patients were in the age group 70-79 years, and five patients were in the age group 80-89 years. No one was below 29 years. As we see the main age group affected by foot ulcers are older than sixty.

Table (3): The distribution of the patients according to the risk factors they have.

| Risk factor | Number of patients | (%) |
|------------------------------------|--------------------|-----|
| peripheral sensory neuropathy | 94 | 94% |
| Vascular insufficiency | 20 | 20% |
| History foot ulcer/amputation | 66 | 66% |
| Limited joint mobility | 18 | 18% |
| Presence of callus | 36 | 36% |
| Structural foot deformity | 24 | 24% |
| Prolonged elevated pressure | 50 | 50% |
| Trauma and improperly fitted shoes | 56 | 56% |
| Poor glyceemic control | 78 | 78% |
| Impaired vision | 60 | 60% |
| Renal impairment | 11 | 11% |
| Older age | 57 | 57% |

Regarding the frequency of the risk factors, the study revealed that the main two factors are peripheral sensory neuropathy (94%) and poor glyceemic control (78%). These are followed by three common risk factors which are history of foot

ulcer/amputation (66%), impaired vision (60%), and older age (57%). Other risk factors in order of frequency of occurrence are trauma and improperly fitted shoes (56%), prolonged elevated pressure (50%), presence of callus (36%), structural foot deformity (24%), vascular insufficiency (20%), and renal impairment (11%).

Discussion

The study revealed that the main risk factors for the development of diabetic foot ulceration is peripheral sensory neuropathy (94%). This is in accordance with those of Al-Wakeel JS et.al and Parkhouse, N., Le Quesne, P.M. who also revealed peripheral sensory neuropathy with the inability to perceive trauma is a major cause for the development of diabetic foot ulceration [20, 27].

Poor glycemic control is the next risk factor in frequency of occurrence (78%). This is in acceptance with that revealed by American Diabetes Association. In fact poor glycemic control is the main cause of all of the complications related to diabetic patient [28].

History of foot ulcer/amputation present in 66%, this also seen by Lavery LA et.al who revealed that 69% of patients presented with diabetic foot ulcers had history of previous ulceration and/or amputation of one or more toes. This indicate the persistence of the primary cause for the development of foot ulceration[29].

Impaired vision found in 60% of those presented with diabetic foot ulcers. Impaired vision indicate poor glycemic control which eventually end with foot complications in

diabetic patients. This is also proved by Flynn, M.D. and Tooke, J.E. who revealed that 64% of diabetic patients with foot ulcers have problems with their vision[19].

The current study revealed that prolonged elevated pressure present in 50% of the patients presented with diabetic foot ulceration. Prolonged elevated pressure at the metatarsal heads and medial and the dorsal surfaces of the foot result in the development of foot ulcers. This also seen by Veves, A. et al. and Schoenhaus, H.D. *et al* [12,14].

Trauma and improperly fitted shoes seen in 56% of the patients. This is supported by a study done by Brand, P.W. who revealed that repetitive pressure due to improperly fitted shoes is one risk factor for the development of foot ulcers[18].

Older age group as a risk factor present in 57%. This is also revealed by Boulton AJ *et al*[30]. Presence of callus found in 36%. This is in concordance with that revealed by Young, M.J. *et.al* [24].

Limited joint mobility present in 18% of patients with foot ulcer in the current study. This is in acceptance with that of Fernando, D.J.S,et.al, Mueller,et.tal and Delbridge, L., who all found that limited joint mobility found in 22% of patients presented with diabetic foot ulcers[21-23].

Structural foot deformity found in 24%. This is also found in study done by Veves, A.*et.al* who found that structural foot deformity resulted from previous minor amputations and valgus lead to uneven distribution of the body pressure over the

plantar surface and eventually end with ulcer development[30].

Vascular insufficiency present in 20% of patients in the current study. Vascular insufficiency delay ulcer healing and regarded as a significant risk factor for amputation. This is supported by studies done by Al-Wakeel JS,et.al and Flynn, M.D., Tooke, J.E[19,27].

Conclusion

Most of the risk factors are preventable by good glycemic control and awaring the patient of these factors to avoid lower limb amputation. Therefore early identification of risk factors for the development of ulceration of diabetic foot and initiation of appropriate treatment decrease the occurrence of complications, including the need for amputation.

Knowing the risk factors for foot ulceration in diabetic patient is of utmost importance for early and better treatment of diabetic foot ulcers. There is an evolved need to educate and make awareness of diabetes and its associated complications, especially among populations living in the rural areas. In the neuro-ischaemic foot, wound infection is correlated with delayed wound healing and can give rapidly to spreading of infection such as cellulitis that can progress to tissue necrosis and gangrene requiring surgical intervention and possible amputation.

References

[1] Ramsey, S.D., Newton, K., Blough, D., McCulloch, D.K., Sandhu, N., Reiber, G.E., Wagner, E.H. Incidence, outcomes, and cost of foot ulcers in patients with diabetes.

Diabetes Care 22:382–387, 1999. Abbott, C.A., Vileikyte, L., Williamson, S., Carrington, A.L., Boulton, A.J.M. Multicenter study of the incidence and predictive risk factors for diabetic neuropathic foot ulceration. Diabetes Care 21:1071–1075, 1998.

[2] Walters, D.P., Gatling, W., Mullee, M.A., Hill, R.D. The distribution and severity of diabetic foot disease: a community study with comparison to a non-diabetic group. Diabetic Med. 9:354–358, 1992.

[3] Reiber, G.E., Vileikyte, L., Boyko, E.J., Del Aguila, M., Smith, D.G., Lavery, L.A., Boulton, A.J.M. Causal pathways for incident lower-extremity ulcers in patients with diabetes from two settings. Diabetes Care 22:157–162, 1999.

[4] Reiber, G.E., Boyko, E.J., Smith, D.G. Lower extremity foot ulcers and amputations in diabetes. In: Diabetes in America, 2nd ed. (NIH publ. no. 95–1468), edited by M.I. Harris, C. Cowie, and M.P. Stern, U.S. Government Printing Office, Washington, DC, 1995.

[5] Frykberg, R.G., Habershaw, G.M., Chrzan, J.S. Epidemiology of the diabetic foot: ulcerations and amputations. In: Contemporary Endocrinology: Clinical Management of Diabetic Neuropathy, p. 273, edited by A Veves, Humana Press, Totowa, NJ, 1998.

[6] Reiber, G.E., Boyko, E.J., Smith, D.G. Lower extremity foot ulcers and amputations in diabetes. In: Diabetes in America, 2nd ed. (NIH publ. no. 95–1468), edited by M.I. Harris, C. Cowie, and M.P. Stern, U.S.

- Government Printing Office, Washington, DC, 1995.
- [7] Frykberg, R.G. Diabetic foot ulcers: current concepts. *J. Foot Ankle Surg.* 37:440–446,1998.
- [8] Gibbons, G.W., Eliopoulos, G.M. Infection of the diabetic foot. In: *Management of Diabetic Foot Problems*, p. 121, edited by G.P. Kozak, D.R. Campbell, R.G. Frykberg, and G.M. Habershaw, WB Saunders, Philadelphia, 1995.
- [9] Levin, M.E. Foot lesions in patients with diabetes mellitus. *Endocrin. Metab. Clin. North Am.* 25:447–462, 1996.
- [10] Pecoraro, R.E., Reiber, G., Burgess, E.M. Pathways to diabetic limb amputation: basis for prevention. *Diabetes Care* 13:513, 1990.
- [11] Larsson, J., Agardh, C.-D., Apelqvist, J., Stenstrom, A. Long term prognosis after healed amputation in patients with diabetes. *Clin. Orthop.* 350:149–158, 1998.
- [12] American diabetes association. Consensus development conference on diabetic foot wound care. *Diabetes Care* 22:1354–1360, 1999.
- [13] Shaw, J.E., Boulton, A.J.M. The pathogenesis of diabetic foot problems. An overview. *Diabetes* 46 (suppl.):S58–S61, 1997.
- [14] Boulton, A.J., Meneses, P., Ennis, W.J. Diabetic foot ulcers. A framework for prevention and care. *Wound Rep. Reg.* 7:7–17, 1999.
- [15] International Working Group on the Diabetic Foot. International Consensus on the Diabetic Foot, Amsterdam, the Netherlands, 1999.
- [16] Frykberg, R.G. Diabetic foot ulcerations. In: *The High Risk Foot in Diabetes Mellitus*, p. 151, edited by R.G. Frykberg, Churchill Livingstone, New York, 1991.
- [17] Frykberg, R.G., Lavery, L., Pham, H., Harvey, C., Harkless, L., Veves, A. Role of neuropathy and high foot pressures in diabetic foot ulceration. *Diabetes Care* 21:1714–1719, 1998.
- [18] Schoenhaus, H.D., Wernick, E., Cohen, R. Biomechanics of the diabetic foot. In: *The High Risk Foot in Diabetes Mellitus*, p. 125, edited by R.G. Frykberg, Churchill Livingstone, New York, 1991.
- [19] Frykberg, R.G. Biomechanical considerations of the diabetic foot. *Lower Extremity.* 207-214:1995.
- [20] Veves, A., Murray, H., Young, M.J., et al. The risk of foot ulceration in diabetic patients with high foot pressure: a prospective study. *Diabetologia* 35:660, 1992.
- [21] Apelqvist, J., Larsson, J., Agardh, C.D. The influence of external precipitating factors and peripheral neuropathy.
- [22] Caputo, G.M., Cavanagh, P.R., Ulbrecht, J.S., Gibbons, G.W., Karchmer, A.W. Assessment and management of foot disease in patients with diabetes. *N. Engl. J. Med.* 331:854-860:1994.
- [23] Boulton, A.J.M. The pathogenesis of diabetic foot problems: an overview. *Diabetic Med.* S12–S16, 1996.
- [24] Brand, P.W. Repetitive stress in the development of diabetic foot ulcers. In: *The*

Diabetic Foot, 4th ed., pp. 83–90, edited by M.E. Levin, and J.K. Davidson, Mosby, St Louis, MO, 1988. S50 Diabetic Foot Disorders: A Clinical Practice Guideline.

[25] Flynn, M.D., Tooke, J.E. Aetiology of diabetic foot ulceration: a role for the microcirculation? *Diabetic Med.* 8:320–329, 1992.

[26] Parkhouse, N., Le Quesne, P.M. Impaired neurogenic vascular response in patients with diabetes and neuropathic foot lesions. *N. Engl. J. Med.* 318:1306, 1988.

[27] Fernando, D.J.S, Masson, E.A., Veves, A., Boulton, A.J.M. Relationship of limited joint mobility to abnormal foot pressures and diabetic foot ulceration. *Diabetes Care* 14:8,1992.

[28] Mueller, M.J., Diamond, J., Delitto, A., Sinacore, D.R. Insensitivity, limited joint mobility, and plantar ulcers in patients with diabetes mellitus. *Phys. Ther.* 69:453, 1989.

[29] Delbridge, L., Perry, P., Marr, S., Arnold, N., Yue, D.K., Turtle, J.R., Reeve, T.S. Limited joint mobility in the diabetic foot: relationship to neuropathic ulceration. *Diabetic Med.* 5:333–337, 1988.

[30] 24) Young, M.J., Cavanagh, P.R., Thomas, G., Johnson, M.M., Murray, H., Boulton, A.J.M. The effect of callus removal on dynamic plantar foot pressures in diabetic

patients. *Diabetes Med. Suppl.* 9:55–57, 1992.

[31] Boulton, A.J.M. The pathway to ulceration. In: *The Foot in Diabetes*, 3rd ed., pp. 19–31, edited by A.J.M. Boulton, H. Connor, and P.R. Cavanagh, John Wiley & Sons, Chichester, UK, 2000.

[32] Ahroni, J.H., Boyko, E.J., Forsberg, R.C. Clinical correlates of plantar pressure among diabetic veterans. *Diabetes Care* 22:965–972, 1999.

[33] Al-Wakeel JS, Hammad D, AlSuwaida A, Mitwalli AH, Memon NA, Sulimani F. Microvascular, macrovascular complications in diabetic nephropathy patients referred to nephrology clinic. *Saudi J Kidney Dis Transpl.* 2009;20(1):77-85.

[34] American Diabetes Association. Implications of the Diabetes Control and Complications Trial. *Diabetes Care* 23(Suppl. 1):S24–S26, 2000.

[35] Lavery LA, Armstrong DG, Vela SA, Quebedeaux TL, Fleischli JG: Practical criteria for screening patients at high risk for diabetic foot ulceration. *Arch Intern Med* 158:157–162, 1998.

[36] Boulton AJ et al. The global burden of diabetic foot disease. *Lancet.* 2005, 366: 1719-1724.