Screening of Diabetic Foot in Surgical Inpatients: A Hospital-Based Study in Saudi Arabia

Mohamed A. Elsharawy, MD, FRCS, FACA, JMHPE¹ Khairi Hassan, FRCSI¹ Naif AlAwad, CABS¹
Ali Kredees, CABS, FRCSI¹ Abdelmohsen Almulhim, FRCSI¹

¹ Department of Surgery, University of Dammam, Al-Khobar, Kingdom of Saudi Arabia

Int J Angiol 2012;21:213–216.

Address for correspondence and reprint requests Mohamed A. Elsharawy, MBBCh, MS, MD, FRCS, FACA, JMHPE, Department of Vascular Surgery, University of Dammam, P.O. Box 40081, Al-Khobar 31952, Eastern Province, Kingdom of Saudi Arabia (e-mail: elsharawya@yahoo.co.uk).

Abstract

Previous reports found that identification of diabetic patients at high risk of foot ulcers, and managing the risk factors early, lower extremity amputations could be prevented. The aim of this study is to determine the value of screening diabetics in estimating the risk of foot ulceration among surgical inpatients. This is a prospective study on all diabetic patients admitted to the surgical department, King Fahd Hospital of the University, Saudi Arabia, during the year 2011. Patients were screened for the presence of diabetic foot. They were classified according to the international working group on the diabetic foot into four grades [0 (lowest risk patients), 1, 2, 3 (highest risk patients)]. During the study period, 391 patients had diabetes mellitus (DM), of these 73 (19%) had active ulcer and were excluded from the study and the rest were screened. Grade 0 was in 174 (54.5%) patients, the rest were grades 1, 2, and 3. There was significant difference between low-risk groups (grades 0, 1) and high-risk groups (grades 2, 3) as regards age, smoking and duration of DM. This study indicates that prevalence of diabetic patients with risk of foot ulceration in surgical inpatients was high. Routine screening of diabetic foot is recommended specially in old patients.

Keywords

- diabetes mellitus
- foot ulcer
- ankle-brachial index

The incidence of diabetes is high among Saudi population and represents a major clinical and public health problem.¹ The prevalence of foot ulcers ranges from 5 to 15% among diabetic persons.^{2–4} Prevention of foot ulceration and amputation mandates early identification of risk factors, based on annual foot screening of all diabetic patients.^{5,6} Previous reports found that identification of people at high risk of foot problems, and managing the risk factors early, lower extremity amputations and foot ulcerations could be prevented.^{7–9} The aim of this study is to determine the predictive value of screening diabetics in estimating the risk of foot ulceration among surgical inpatients.

Patients and Methods

This is a prospective study on all diabetic patients admitted to the surgical department, King Fahd Hospital of the University,

Al-Khobar, Saudi Arabia, during the year 2011. Patients were invited to be screened for the presence of diabetic foot. Informed consent was obtained from all patients. Patients were classified according to the international working group¹⁰ on the diabetic foot into four grades (0 [lowest risk patients]: subjects without significant peripheral neuropathy or peripheral arterial disease [PAD], 1: patients with isolated peripheral neuropathy, 2: neuropathic patients with foot deformity or PAD, 3 [highest risk patients]: those with a history of foot ulceration or a lower limb amputation).

All patients underwent evaluation of other risk factors for atherosclerosis, for example, smoking, dyslipidemia, hypertension, and family history of cardiovascular disease. Information on age, gender, and duration of diabetes was recorded.

Diabetes was defined as self-reported physician diagnosis, use of diabetes medication, fasting glucose of ≥ 126 mg/dL in two separate occasions, or 2 hours post 75 g oral glucose

Fig. 1 Distribution of the study population according to international working group classification.

tolerance test of ≥ 200 mg/dL in two separate occasions or random blood glucose ≥ 200 mg/dL in the presence of classical symptoms of hyperglycemia. Hypertension was defined as mean systolic blood pressure of ≥ 140 mm Hg, mean diastolic blood pressure of ≥ 90 mm Hg, physician diagnosis, or medication use. Average blood pressure was composed of up to four readings on two separate occasions. Dyslipidemia was defined as triglyceride level ≥ 150 mg/dL and/or HDL level ≤ 40 mg/dL in male or ≤ 50 mg/dL in female and/or LDL level ≥ 100 mg/dL and/or physician diagnosis or medication use.

All patients were subjected to a comprehensive physical examination especially vascular assessment of foot pulses. The foot was examined for the condition of the skin and presence of callosities, bunions, lesser toe deformities, and Charcot joint disease. Neurologic assessment included 10 g monofilament testing and vibration perception using tuning fork. Measuring the ankle-brachial index (ABI) was obtained from each extremity using a Multi Doppler II Advanced Bi-directional Doppler (Huntleigh, UK). The higher of arm and ankle pressures (dorsalis pedis or posterior tibial) was used to calculate ABI. Patients were considered to have PAD if the ABI was < 0.9 .

The blood pressure was measured by a trained nurse and the ABI by a consultant or senior registrar in vascular surgery.

Statistical Analysis

Comparison between low-risk groups (grades 0, 1) and high-risk groups (grades 2, 3) was done. Data for groups were summarized either as the mean $\pm$ standard deviation (SD)

Table 1 Patients characteristics

No.	318
Age (mean $\pm$ SD)	56.9 $\pm$ 6.27
Male/female	138/180
Duration of diabetes (mean in years $\pm$ SD)	12.4 $\pm$ 4.2
Smoking	81 (25%)
Hypertension	137 (43%)
Dyslipidemia	151 (47%)
Family history of cardiovascular disease	55 (17%)

Abbreviation: SD, standard deviation.

or as percentage of the risk factors. Differences between the groups were tested for statistical significance using *t* test, chi-square test, or Fisher exact test as appropriate. Significance was set at $p < 0.05$ for all comparisons. Statistical analyses were performed using SPSS 15 software (SPSS Inc., Chicago, IL).

Results

During the study period, 391 diabetic patients were admitted to the department of surgery, PAD was present in 82 (21%) patients and 176 (45%) patients had neuropathy. Active ulcers were the most frequent reason for hospitalization in diabetic patients being present in 73 (19%) patients. This group was excluded from the study. The rest (318 patients) was screened. Most of patients were female (180 patients) with mean age ($\pm$ SD) 56.9 $\pm$ 6.27 ($\rightarrow$ **Table 1**). According to international working group classification, 174 (54.5%) patients were grade 0, 88 (28%) patients were grade 1, 43 (13.5%) patients were grade 2, and 13 (4%) patients were grade 3 ($\rightarrow$ **Fig. 1**). There was significant difference between low-risk groups (grades 0, 1) and high-risk groups (grades 2, 3) as regards age, smoking, and duration of diabetes mellitus (DM) ($\rightarrow$ **Table 2**). Most of patients above 60 years were high-risk patients ($\rightarrow$ **Fig. 2**).

Discussion

Foot ulceration is one of the most common complications of DM.¹¹ It was found that the incidence of major amputations

Table 2 Comparison between low-risk group (grades 0, 1) and high-risk group (grades 2, 3)

	Low-risk group (no. = 262)	High-risk group (no. = 56)	<i>p</i> value
Age mean ($\pm$ SD)	48.2 ($\pm$ 11.8)	59.9 ($\pm$ 11.7)	< 0.001
Male (%)	112 (43)	26 (46)	0.66
Duration of DM ($\pm$ SD)	9.9 $\pm$ 3.2	13 $\pm$ 2	< 0.001
Smoking (%)	59 (23)	22 (39)	0.01
Dyslipidemia (%)	122 (43)	29 (52)	0.55
Hypertension (%)	117 (45)	20 (36)	0.23
Family history of cardiovascular disease (%)	42 (16)	13 (23)	0.25

Abbreviations: DM, diabetes mellitus; SD, standard deviation.

Fig. 2 Age distribution according to risk groups.

(below and above knee) is 27.2% in diabetics with foot complications.¹² This represents considerable patient morbidity and is associated with substantial health care costs. It was shown that 84% of all lower limb amputations were due to ulceration, 61% due to sensory neuropathy, and 46% due to ischaemia.¹³ The present study revealed high incidence of diabetic foot at risk of ulceration (45%) compared with 34% in others.¹⁴ This difference may be explained by including outpatient in the latter studies.¹⁴ Despite the high incidence of diabetic foot in our study, only 4% of our patients had history of ulceration and/or amputation (group 3, very high risk of ulceration) compared with 5 to 7.5% in other studies.¹⁴

In present study, 10-g monofilament was used for screening sensory neuropathy. Its advantages include simplicity, rapidity, low cost, and reasonable reproducibility¹⁵ making it an accurate tool for routine screening.¹⁶ A previous study¹⁷ has shown that conventional clinical examination of the diabetic foot for sensory neuropathy such as pin prick sensation, proprioception tests, vibration perception testing, and ankle reflex was found to have low reproducibility and accuracy compared with monofilament testing. Another prospective study showed that insensitivity to the monofilament appeared as the only clinical criterion predictive of foot ulceration.¹⁸ Incidence of sensory neuropathy was 45% in our study compared with 27¹⁴ to 33%¹⁹ in previous studies. The difference between these studies may be due to the experience of the personnel performing the foot screening. A previous study²⁰ showed that there was variability in the results of foot screening depending on whether it was performed by primary care providers or by foot care providers. In the present study, it was performed by experienced doctors.

Several studies confirmed the role of screening lower limbs for PAD in diabetic patients.²¹ Its detection will help in early management and prevention of complications.²² Measuring the ABI is an easy and accurate screening method in patients at risk of developing PAD.^{23,24} No previous systemic study gave a basis for ABI cutoff level in screening for PAD. Most of the recent studies²⁵ including ours used 0.9 as a cutoff to indicate PAD.²⁵ Previous studies from the western countries revealed that the incidence of PAD in asymptomatic diabetic patients is 26 to 33%^{26,27} compared with 17%^{28,29} among Arabs. The reason for this difference may be due to variation in race

and lower age population in the Arab studies.²⁹ The incidence of PAD in the present study was 21%, which is higher than our previous study (17%)²⁹ that included outpatients only.

Similar to others^{14,30-32} our study has shown that patients who had diabetes for longer period were at more risk significantly for developing ulcers than those who did not. Others³³ found that this effect was not statistically significant. The effect of duration of DM on the risk of ulcer may be explained by previous study²⁸ that showed increasing duration of diabetes increases the incidence of PAD. Similar to others^{10,14} our study showed age was one of the factors that increased the risk of ulcer. This may be explained by the fact that elderly patients usually have longer duration of diabetes. The present study has shown that smoking increases the risk of ulceration. This may be explained by the previous study²⁸ that showed smoking plus diabetes augment the risk of PAD.

In conclusion, this study indicates that prevalence of diabetic patients with risk of foot ulceration in surgical inpatients was high. Routine ABI measurement and monofilament test in diabetic patients is recommended specially in elderly. These tests will allow early detection of PAD, sensory neuropathy, and foot at risk of ulceration. Prompt management of these cases would decrease the possibility of developing foot complications. Further longitudinal study is warranted to check the prevalence of future foot ulceration in diabetic patients with high risk.

Note

Paper was presented at the International Society for Vascular Surgery Congress, March 2012, Miami, FL.

References

- Alqurashi KA, Aljabri KS, Bokhari SA. Prevalence of diabetes mellitus in a Saudi community. *Ann Saudi Med* 2011;31(1):19-23
- Kumar S, Ashe HA, Parnell LN, et al. The prevalence of foot ulceration and its correlates in type 2 diabetic patients: a population-based study. *Diabet Med* 1994;11(5):480-484
- Singh N, Armstrong DG, Lipsky BA. Preventing foot ulcers in patients with diabetes. *JAMA* 2005;293(2):217-228
- Reiber GE. The epidemiology of diabetic foot problems. *Diabet Med* 1996;13(Suppl 1):S6-S11
- Nather A, Bee CS, Huak CY, et al. Epidemiology of diabetic foot problems and predictive factors for limb loss. *J Diabetes Complications* 2008;22(2):77-82
- Rathur HM, Boulton AJM. The neuropathic diabetic foot. *Nat Clin Pract Endocrinol Metab* 2007;3(1):14-25
- Ogrin R, Sands A. Foot assessment in patients with diabetes. *Aust Fam Physician* 2006;35(6):419-421
- Schwegler B, Böni T, Furrer J, Spinas GA, Lehmann R. [Practical management of diabetic foot]. *Ther Umsch* 2002;59(8):435-442
- Wu SC, Crews RT, Armstrong DG. The pivotal role of offloading in the management of neuropathic foot ulceration. *Curr Diab Rep* 2005;5(6):423-429
- 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;24(Suppl 1): S181–S187
- 11 Pinzur MS, Slovenkai MP, Trepman E, Shields NN; Diabetes Committee of American Orthopaedic Foot and Ankle Society. Guidelines for diabetic foot care: recommendations endorsed by the Diabetes Committee of the American Orthopaedic Foot and Ankle Society. *Foot Ankle Int* 2005;26(1):113–119
 - 12 Nather A, Bee CS, Huak CY, et al. Epidemiology of diabetic foot problems and predictive factors for limb loss. *J Diabetes Complications* 2008;22(2):77–82
 - 13 Pecoraro RE, Reiber GE, Burgess EM. Pathways to diabetic limb amputation. Basis for prevention. *Diabetes Care* 1990;13(5):513–521
 - 14 Malgrange D, Richard JL, Leymarie F; French Working Group On The Diabetic Foot. Screening diabetic patients at risk for foot ulceration. A multi-centre hospital-based study in France. *Diabetes Metab* 2003;29(3):261–268
 - 15 Kumar S, Fernando DJ, Veves A, Knowles EA, Young MJ, Boulton AJ. Semmes-Weinstein monofilaments: a simple, effective and inexpensive screening device for identifying diabetic patients at risk of foot ulceration. *Diabetes Res Clin Pract* 1991;13(1-2):63–67
 - 16 Pham H, Armstrong DG, Harvey C, Harkless LB, Giurini JM, Veves A. Screening techniques to identify people at high risk for diabetic foot ulceration: a prospective multicenter trial. *Diabetes Care* 2000;23(5):606–611
 - 17 Smieja M, Hunt DL, Edelman D, Etchells E, Cornuz J, Simel DL; International Cooperative Group for Clinical Examination Research. Clinical examination for the detection of protective sensation in the feet of diabetic patients. *J Gen Intern Med* 1999;14(7):418–424
 - 18 Litzelman DK, Marriott DJ, Vinicor F. Independent physiological predictors of foot lesions in patients with NIDDM. *Diabetes Care* 1997;20(8):1273–1278
 - 19 Nather A, Chionh SB, Tay PL, et al. Foot screening for diabetics. *Ann Acad Med Singapore* 2010;39(6):472–475
 - 20 Edelman D, Sanders LJ, Pogach L. Reproducibility and accuracy among primary care providers of a screening examination for foot ulcer risk among diabetic patients. *Prev Med* 1998;27(2):274–278
 - 21 Hiatt WR, Marshall JA, Baxter J, et al. Diagnostic methods for peripheral arterial disease in the San Luis Valley Diabetes Study. *J Clin Epidemiol* 1990;43(6):597–606
 - 22 Khammash MR, Obeidat KA, El-Qarqas EA. Screening of hospitalised diabetic patients for lower limb ischaemia: is it necessary? *Singapore Med J* 2008;49(2):110–113
 - 23 Brooks B, Dean R, Patel S, Wu B, Molyneaux L, Yue DK. TBI or not TBI: that is the question. Is it better to measure toe pressure than ankle pressure in diabetic patients? *Diabet Med* 2001;18(7):528–532
 - 24 Shinozaki T, Hasegawa T, Yano EJ. Ankle-arm index as an indicator of atherosclerosis: its application as a screening method. *J Clin Epidemiol* 1998;51(12):1263–1269
 - 25 Bagheri R, Schutta M, Cumarantunge RG, et al. Value of electrocardiographic and ankle-brachial index abnormalities for prediction of coronary atherosclerosis in asymptomatic subjects with type 2 diabetes mellitus. *Am J Cardiol* 2007;99(7):951–955
 - 26 Lacroix P, Aboyans V, Criqui MH, et al. Type-2 diabetes and carotid stenosis: a proposal for a screening strategy in asymptomatic patients. *Vasc Med* 2006;11(2):93–99
 - 27 Shinozaki T, Hasegawa T, Yano E. Ankle-arm index as an indicator of atherosclerosis: its application as a screening method. *J Clin Epidemiol* 1998;51(12):1263–1269
 - 28 Elsharawy MA, Alkhadra AH, Ibrahim MF, et al. Impact of atherosclerosis risk factors on the clinical presentation of arterial occlusive disease in Arabic patients. *Int J Angiol* 2008;17(4):203–206
 - 29 Elsharawy MA, Al-Elq AH, Alkhadra AH, Moghazy KM, Elsaid AS. Screening for asymptomatic cardiovascular disease in Arab patients with diabetes. *Int Angiol* 2011;30(1):52–57
 - 30 Kästenbauer T, Sauseng S, Sokol G, Auinger M, Irsigler K. A prospective study of predictors for foot ulceration in type 2 diabetes. *J Am Podiatr Med Assoc* 2001;91(7):343–350
 - 31 Lavery LA, Armstrong DG, Wunderlich RP, Tredwell J, Boulton AJ. Predictive value of foot pressure assessment as part of a population-based diabetes disease management program. *Diabetes Care* 2003;26(4):1069–1073
 - 32 Peters EJG, Lavery LA; International Working Group on the Diabetic Foot. Effectiveness of the diabetic foot risk classification system of the International Working Group on the Diabetic Foot. *Diabetes Care* 2001;24(8):1442–1447
 - 33 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* 1998;158(2):157–162