

RISK FACTORS STRATIFICATION IN 100 PATIENTS WITH DIABETIC FOOT

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ABSTRACT

Objective: To find out the relative frequencies of various risk factors associated with diabetic foot.

Material and Methods: This prospective observational study was conducted at Govt. Lady Reading Hospital Peshawar and Khyber Teaching Hospital Peshawar Pakistan from January 2004 to February 2005. A total number of 100 patients with diabetic foot were included in the study. A questionnaire was designed comprising detailed history, general physical and neurological examinations. The association of different risk factors with diabetic foot was studied.

Results: Out of 100 patients (52 males and 48 females), 76 had type-2 diabetes and 24 had type-1 diabetes. Mean age for type 1 diabetes was 40 ± 10.9 years and for type 2 diabetes was 59.8 ± 5.8 years. Patient's education is the mainstay in the prevention of foot ulcer. In this study, 99% patients did not know how to take care of their feet. Sensory neuropathy was present in 90% of diabetic foot patients. Poor glycemic status (HbA1C > 7) was present in 82% cases. Diabetic retinopathy occurred in 73%, autonomic neuropathy in 48% and peripheral vascular disease in 43% of cases with diabetic foot. Radiological evidence of osteomyelitis was reported in 40% cases, callosities in 43% and foot deformities like claw toes or hammer toes in 27% patients.

Conclusion: Main risk factors for diabetic foot are poor education of diabetic foot care, poor glycemic control, long term complications of diabetes mellitus and foot deformity and callosities on pressure areas. Diabetic foot complications can be prevented by modification of these risk factors.

Keywords: Diabetic foot, Diabetes mellitus, Risk Factors.

INTRODUCTION

Diabetes mellitus is a group of metabolic disorders characterized by hyperglycemia resulting from defects in insulin secretion, insulin action or both.¹ The term "Diabetes" is Ionic Greek and means "to run through a siphon" was first used by Aretaeus of Cappadocia (81-138 A.D). William Cullen (1710-1790) added a Latin word "mellitus" means "honey" to diabetes due to the sweet taste of urine of the diabetic patients.²

Diabetes mellitus is the commonest endocrine disorder and one of the major health problems. The estimated prevalence of diabetes among adult population is 7.6% in 2000, which is expected to rise to 9% in 2025.³ The prevalence of diabetes in some part of the world like Pacific

Island population is very high (about 35%).⁴ In Pakistan various studies have reported prevalence between 5-7%.⁵ Type 2 Diabetes is 7-8 times more common than type 1 Diabetes, but this ratio varies with age being lower in young population and higher in elder age group.⁶

The diabetic patient is susceptible to a series of complications that cause morbidity and premature mortality.⁶ The chronic hyperglycemia is the cause of dysfunction, damage and failure of various organs like eyes, kidneys, nerves, heart and blood vessels.⁷

Atherosclerosis is more extensive and occurs earlier in diabetic than general population. Coronary artery disease and stroke are common. There is also intermittent claudication and

MEGGITT AND WAGNER'S CLASSIFICATION OF DIABETIC FOOT^{9,10}

Grade	Description
Grade 0	This is high risk foot having no ulcer.
Grade 1	The ulcer is superficial but still full thickness skin loss.
Grade 2	Deep Ulcer, also involving the subcutaneous tissue but no bony involvement. Often associated with local infection or cellulitis.
Grade 3	At this stage ulcer is associated with osteomyelitis.
Grade 4	There is gangrene of the toes, part of the fore-foot or the heel.
Grade 5	Extensive gangrene of the entire foot.

Table 1

gangrene. Diabetes mellitus due to microvascular damage leads to retinopathy, nephropathy and neuropathy. Diabetic neuropathy may affect every part of the nervous system with possible exception of the brain. Presentation can be different like polyneuropathy, mono neuropathy, radiculopathy or autonomic neuropathy.

The term diabetic foot includes any pathology that results directly from diabetes or its long-term complication (neuropathy and/or vasculopathy). Diabetic foot ulcers or amputations are a major cause of morbidity, disability as well as emotional and physical costs. Fifteen percent of individuals with diabetes are likely to develop foot ulcers in their life time and approximately 15-20% of these ulcers are estimated to result in lower extremity amputations. Infection in diabetic foot is a secondary phenomenon, which follows ulceration of the protective epidermis due to trauma. Pure ischemic ulcers probably represents only 10% of diabetic foot ulcers, the remaining 90% are caused by neuropathy alone or with ischemia (Neuro-Ischemic Ulcers)⁸. Diabetic foot ulcer is more common in men and in patients above 60 years of age. Foot lesions may be the presenting feature of type 2 DM. Diabetic foot wounds have been classified by many but one proposed by Meggitt⁹ in 1976 and popularized by Wagner¹⁰ in 1981 is most widely used.

Diabetic peripheral neuropathy and peripheral vascular disease are the most important etiologic factors, but there is a complex interplay between these abnormalities and a number of other contributory factors. The identification of these factors and their contributory factors is fundamental for effective foot-care in diabetic patients. The following factors are independently related to foot ulcer risk.

- Foot insensitivity
- Past history of amputation or foot ulcer
- Charcot deformity

- Obesity (20 kg higher body weight)
- Poor vision
- 13mm Hg orthostatic blood pressure fall

Higher ulcers risk is associated with hammer/claw toe deformity.

Clinical examination is a sensitive test in identifying patients at risk of foot ulcer. These high risk conditions can be detected by feet examination, for which specific intervention have been shown to be effective in reducing amputation risk.¹¹

Patient education is a fundamental aspect of the management of diabetic foot ulcers. Teaching issues need to be adopted into the following three stages.¹²

- A. Before: Prevention of foot ulcers in the high risk patients.
- B. Acute: Prevention of extension of an existing ulcers.
- C. After: Prevention of recurrence.

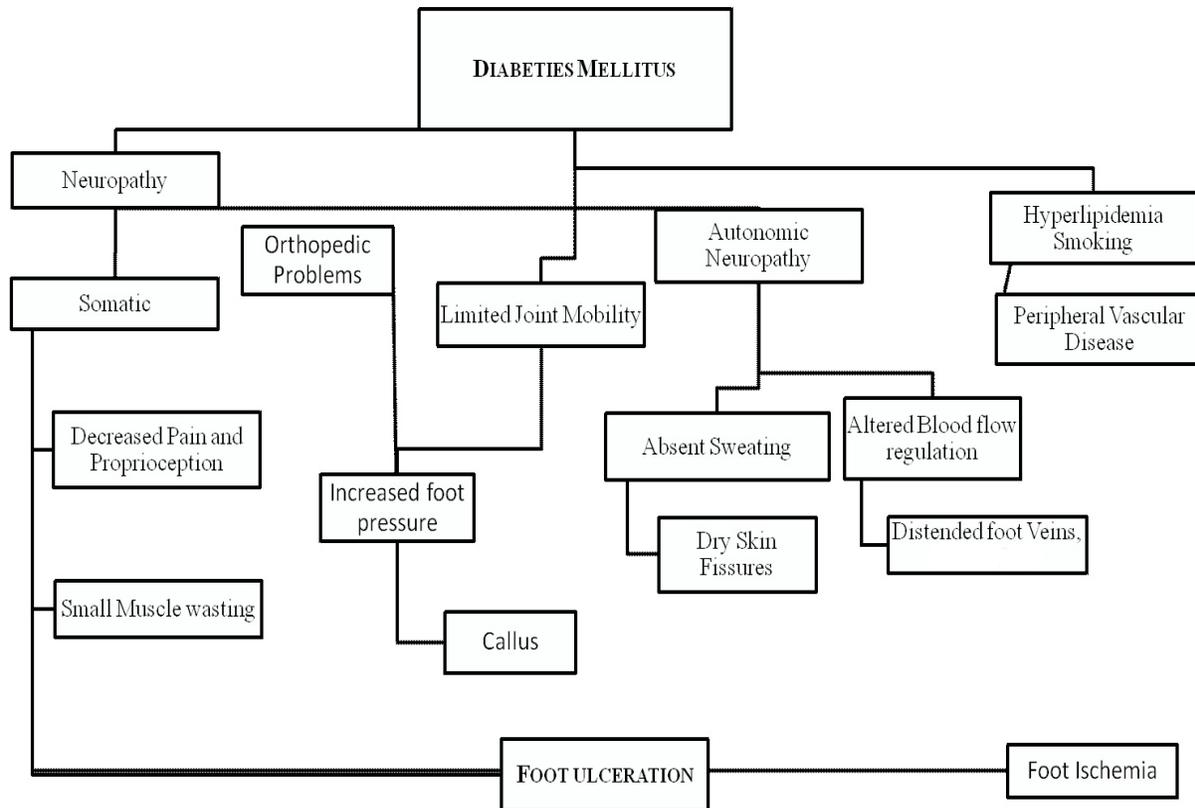
This study was conducted to find out the relative frequencies of various risk factors associated with diabetic foot in patients presenting to a tertiary care unit with diabetic foot.

MATERIAL AND METHODS

This study was conducted in the Departments of Medicine and Orthopedic Post Graduate Medical Institute Lady Reading Hospital Peshawar and Khyber Teaching Hospital Peshawar from January 2004 to February 2005. A total of 100 patients, 52 males and 48 females with diabetic foot were included in the study.

Diabetic foot includes any pathology that results directly from Diabetes or its long term complications.¹

Inclusion criteria were all the patients meeting the criteria for Diabetic foot as defined,



PATHOGENESIS OF DIABETIC FOOT¹³

irrespective of sex and age, admitted in the Department of Medicine, PGMI, Govt. LRH, Peshawar.

Exclusion criteria were all the patients with foot lesions or foot ulcer but not diabetic.

All the information were collected according to a standardized questionnaire. Age, sex, weight and height of all the patients were noted. A detail history of each patient was taken.

It included the type of Diabetes mellitus, duration of Diabetes mellitus and history of diabetic foot, history of trauma, boil, pain in the ulcer, numbness in the feet, claudication of lower limbs, history of poor vision and previous history of diabetic foot or lower extremity amputation. These patients were also asked about the type of shoes they use and also about their awareness regarding Diabetes mellitus and foot care. Drug history was also taken.

These patients were examined generally. Their pulse rate and rhythm and postural hypotension noted. Local examination of the feet done. On inspection feet were looked for callus at pressure areas, distended veins, dryness and deformity particularly claw toe/hammer toe deformity. Peripheral pulses of lower extremity like Dorsalis pedis, Posterior tibial and Popliteal

arteries were palpated. Absent Dorsalis pedis and Posterior tibial arteries pulses were considered as vasculopathy. Different sensory modalities like touch and pain sense, position, vibration and temp senses were examined. Touch and pain sensation were checked with cotton wool and paper pin. New pins were used for each patient. Ten recommended sites on each foot were examined. These sites are first, third and fifth digits and metatarsal on plantar medial and lateral mid foot, the planter heel and the dorsal first web-space (between first and second toe). Absent sensation at four or more sites were considered as sensory neuropathy. Vibration sense examined with 128 Hz tuning fork at both malleoli of each foot. Those patients who had postural hypotension (in the absence of other causes) of 10mm Hg or more in their systolic blood pressure and had dry, warm feet and distended veins were considered as having autonomic neuropathy. Fundoscopy of each patient was done for evidence of diabetic retinopathy.

Random blood sugar and HbA1C were done in all patients and a level of more than 7% of HbA1C was considered poor glycemic control. X-Rays of the affected feet were also done for evidence of osteomyelitis. Statistical analysis of the results was performed by utilizing SPSS version 10.

CLINICAL PRESENTATIONS OF DIABETIC FOOT TOTAL NO. 100

PRESENTATION	TYPE2 DM (n=76)	TYPE1 DM (n=24)	TOTAL% (n=100)
History of trauma	11 (14.5%)	14 (58.5%)	25
History of Boil	38 (50%)	11 (45.8%)	49
Pain in the Ulcer	14 (18.4%)	14 (58.5%)	28
Numbness	57 (75%)	7 (29.2%)	64
Claudication	30 (39.5%)	8 (33.3%)	38
Poor vision	62 (81.6%)	14 (58.5%)	76
Past hx of diabetic foot or amputation	27 (35.5%)	5 (20.8%)	32
Education about D.M	5 (6.6%)	6 (25%)	11
Education about foot care	0	1 (4.2%)	1
History of using Hard shoes	38 (50%)	14 (58.5%)	52

Table 2

RESULTS

Out of 100 patients, 52 were male and 48 were female. The ratio is 1.08:1. Seventy Six patients had type 2 DM and 24 had type 1 DM. In type 2 Diabetes, 33 patients (43.42%) were males and 43 (56.58%) were females. In 24 type 1 Diabetic patients, males were 19 (79.16%) and females were 5 (20.84%).

The age range was 22 years to 70 years. For type 1 Diabetes, the range was 22-55 years and for type 2 Diabetes 52-70 years. 7Seventy nine percent were above 50 years of age. In these 79 patients, 68 (86.08%) were having type 2 DM and 11(13.92%) were having type 1DM. The mean age for type2 DM was 59.8±5.8 years and for type 1 DM it was 40.9± 10.9 years. In males the mean age was 52.1 years and was 55.5 year in female patients.

Right foot was affected in 48% and left in 41%. 11% were having ulcers on both feet.

Duration of Diabetes mellitus was ranging from 7 days to 22 years. The mean duration of Diabetes was 10.9 years. It was (11.7) years for type1 DM and was 10.1 years for type 2DM. Forty six percent were having history of more than 10 years duration. Out of these, 35(76.08%) were having type 2DM and 11(23.92%) were having type 1DM.

The time between the start of ulcer and presentation to hospital was from 2 days to 6 months. The mean time of the presentation was 41 days. It was 46 days for type 1 DM and 36 days for type 2 DM.

History of trauma was present in 25% patients. Past history of diabetic foot or lower

extremity amputation was positive in 32%.

History of wearing hard and ill-fitting shoes, were present in 52% of patients.

Only 11% of patients were having some knowledge of diabetes mellitus, diabetic diet and importance of blood sugar control.

Only one (1%) of patients was knowing the importance of foot care in diabetes mellitus. 99% did not know how to take care of their feet and so to prevent occurrence of diabetic foot. (Table 2)

On clinical examination of the feet, it was found that 27 patients had some degree of deformity like claw toe or hammer toe. Callus was present in 43 patients. Ninety percent patients were having sensory neuropathy, in which 33% had associated vasculopathy as well. Ten percent patients were having vasculopathy only. Autonomic neuropathy was present in 48 patients. (Fig: 1)

On eye examination, 73 patients were found having evidence of diabetic retinopathy ranging from back ground diabetic retinopathy to proliferative retinopathy and/or maculopathy. HbA_{1c} level of 7% or more (marker of poor glycemic control) were present in 82 patient. Mean HbA_{1c} level was 8.5%. Radiological evidence of osteomyelitis were present in 11 patients.

Eleven male patients (21.2%) had BMI of 27 or more and 21 female patients (43.75%) had BMI of 25 or more. Body mass index of 27 or more was considered as marker of obesity in male and in female BMI of 25 or more.

Mean BMI for male was 23.9 while the mean BMI for female was 22.5kg/m²

CLINICAL FINDINGS ON FEET EXAMINATION

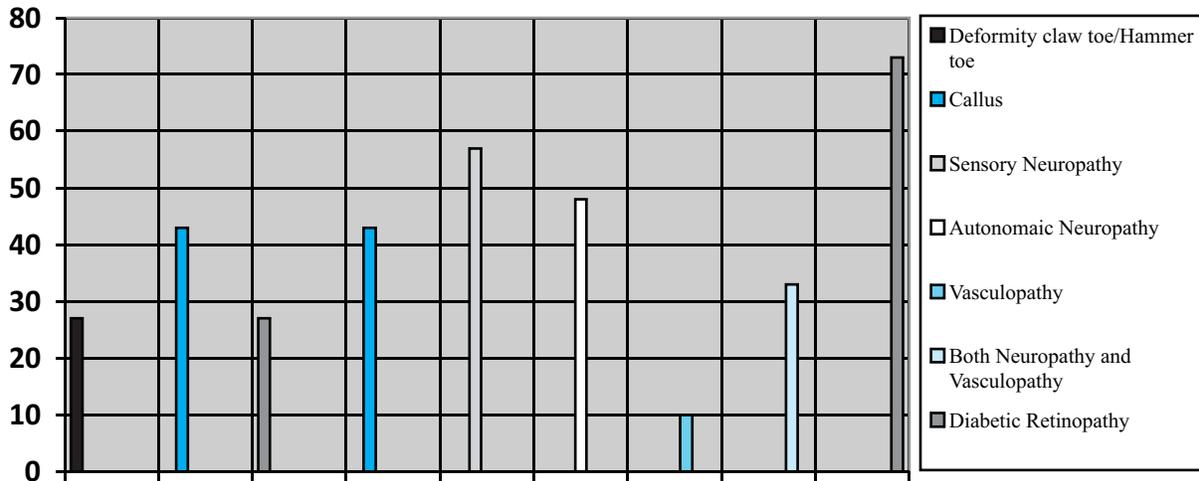


Fig.1

DISCUSSION:

Diabetic foot ulceration is a preventable long term complication of diabetes¹³. Its devastating consequence is lower limb amputation and people with diabetes are 10-15 times more likely to have a lower limb amputation than non-diabetics¹⁴.

The etiology of lower limb amputation involves contributions from peripheral vascular disease, peripheral neuropathy, minor trauma, infections, impaired wound healing and limited joint mobility.

This was a descriptive study of 100 randomized patients of diabetic foot. The male to female ratio was 1.08:1. In the position statement of American Diabetes Association on the foot care in diabetic patients, the males are at more risk than female.³ A study conducted by Summerson JH¹⁵ in United States, the female sex are more prone to develop complication in type 2 diabetes mellitus. In our study, the difference in both sexes is insignificant and both are almost equally exposed to develop foot ulcer, it may be because of small sample.

In this study 76% patients were with type 2 DM and 24% were having type 1DM. This ratio is a true fact, and so the type of diabetes mellitus is not a risk factor of foot ulcer. The prevalence of type 2DM in Pakistan is 94.8% among all Diabetics in a study done in 1981 by Haider Z and Obaidullah¹⁶, and another study done in 1987-88 by Khan N¹⁷, the prevalence of type 2DM is 84.5%.

The older people are at high risk of foot ulcer. This is evident from the studies of Lipsky-BA¹⁸ and apelquist J¹⁹. In our study 79% patients

were having age more than 50 years, 20% were above 60 years of age. The mean age was 53.8 ± 15.7 years.

The duration of diabetes mellitus has a strong direct association with its chronic complications. M. Shafique in 1998 in Lahore showed in their study that the micro vascular complications i.e. neuropathy, retinopathy and nephropathy in type 2 diabetic patients has a significant association with the duration of diabetes mellitus²⁰. In the American Diabetes Association statement on foot care those patients are at risk of developing diabetic foot whose duration of diabetes mellitus was more than 10 years³. In this study 45% patients were having diabetes for more than 10 years and 83% were having it for more than 5 years. The mean duration was 10.9 years.

The diabetic foot patients usually present late to the hospital. This late presentation is a major factor in the poor healing and amputations in these patients²¹. In this study only 17% came to hospital within the first week of their illness. Fifty three percent presented after 21 days of the development of their foot ulcer.

Any one of the feet can be involved. No study has shown that one foot is more prone than the other. In our study 48% patient had ulcer on their right foot, 41% have left foot ulcer, while 11% having ulcers on both the feet. Although right foot ulcers appears slight more than the left but the difference is not statistically significant.

In the studied patients, 52% were having history of using hard and ill fitting shoes. In these type of shoes the insensitive foot is persistently exposed to trauma and can result in the diabetic foot and later on amputation. Muller MJ in his

study showed that using therapeutic foot-wear can help in preventing lower extremity amputation in diabetic patients²².

Past history of foot ulcer or amputation in diabetic patients are prone to develop foot ulcer again. This fact is discussed by Lavery-LA²³. In our study 32% were having history of diabetic foot or amputation in the past. Anni L also noticed that 27% of the patients they studied who have already been undergone amputation of one limb, had evidence of foot-ulcer on the other side or remaining stump²⁴. This shows that the recurrence of foot ulcer is common. However, unfortunately even in these patients the level of education and awareness about diabetic foot care was very low.

Patient education is one of the important step in the management of Diabetes mellitus. All the diabetic patients must be educated about their disease, the importance of diet therapy, the good compliance of anti-diabetic drugs and the role of good glycemic control. The diabetic patients must also be taught the methods to prevent the acute as well as chronic complications, of which the important one, which can be prevented by self-care is foot ulcer²⁵. In the sample studied only 11% were having knowledge of their disease (Diabetes mellitus) and only one patient (1%) was aware of the importance of foot care in this disease.

The prevalence of polyneuropathy in diabetic patients is 22.3% in a study done by Rizwan Hashim²⁶. In his article AJ Boulton mentioned that neuropathy is present in 90% of diabetic foot patients¹¹. Pham H²⁷ showed 99% prevalence of neuropathy and in the Seattle Diabetic Foot Study 95% patient had neuropathy²⁸. In our study of diabetic foot patients 90% were having clinical evidence of sensory neuropathy. This result is the same as discussed by A.J. Boulton⁷ but some what lower than the Pham H²⁷ and the Seattle Diabetic Foot²⁸ studies. This may be due to the fact that they used quite sensitive methods for assessing neuropathy like, neuropathy symptoms scoring, neuropathy disability scoring, vibration perception threshold and they also used Simmes-Weinstein monofilament instead of common pin and cotton wool.

Autonomic neuropathy is also considered a risk factor for the causation of foot ulcer. This is discussed in the Seattle Diabetic Foot Study. In our study 48% of diabetic foot patients were having evidence of autonomic neuropathy. This high percentage signifies its relation with diabetic foot.

The foot ischemia caused by peripheral vascular disease is an important risk of foot ulcer in diabetic patients and also one of the factor of

poor healing of the wound. Forty three percent of patients were having evidence of peripheral vascular disease. Boyko EJ²⁸ in their Seattle Diabetic Foot Study claimed that 49.1% of diabetic foot ulcer patients have clinical evidence of peripheral vascular disease. This slight higher percentage than our study is not statistically significant.

Foot deformity is common in diabetic patients because of charcot joints and motor neuropathy. Claw toe/Hammer toe is common than other deformities. Twenty seven percent of patients were having foot deformity (Claw toe/hammer toe). In other studies, the deformity is considered a high risk of diabetic foot.^{11,27,28} Claw toe/Hammer toe deformity was present in 29.5% of diabetic foot ulcer patient in the study of Boyko EJ.²⁸ This result is nearly the same as our study showed.

Callus, which is a hyperkeratinized area at pressure sites, was present in 43% of patients. AJ Boulton also considered that callus is a risk of diabetic foot.¹¹ This study also indicates that callus was present in nearly half diabetic foot patients.

The prevalence of diabetic retinopathy is 18.8% - 26% in Pakistan^{29,30}. In a study done by Rizwan Hashim, it is represented as 30%.²⁵ In our study the diabetic retinopathy was present in 73% of diabetic foot patients. This high percentage than those in general diabetic patients signifies it as a risk of foot ulcer. These patients having poor vision can not take care of their insensitive feet and usually injure their feet during nail cutting or scraping the callosities. In the Seattle Diabetic Foot Study the percentage of poor vision in patient with foot ulcers was 50.6%. This low percentage may be due to the criteria of visual acuity less than 20/40 by them, while in our study the diabetic retinopathy also include the patients who had background diabetic retinopathy, in the visual acuity may not be so low.²⁷

A near normal glycemic control is pivotal for the prevention of chronic complications of diabetic mellitus. This is the message of DCCT which was performed in 1993 and then reviewed in 1998. In DCCT HbA1C of less than 7% was considered a good glycemic level. In our study 82% of patients were having HbA1C level of more than 8%. The mean level was 8.5%. This is also stated by Lavery²³ that HbA1C of more than 9% is a risk of diabetic foot.

The obese diabetic patients are at high risk of developing complications than non-obese diabetic. In our study only 11(21.2%) male patients were obese and 21(43.7%) female patients were obese. Lavery also discussed that obesity is not a risk of foot ulcer²³ but the Seattle Diabetic Foot

Study shows that patient with 20kg higher body weight than normal is at risk of diabetic foot.²⁸ This discrepancy was also observed in our study because of less percentage in male than female.

CONCLUSION

Main risk factors for diabetic foot are poor education of diabetic foot care, poor glycemic control, long term complications of diabetes mellitus and foot deformity and callosities on pressure areas. Diabetic foot complications can be prevented by modification of these risk factors.

1. Patients need education about diabetes and its long term complications. The most important point in the prevention of foot ulcer is to educate the patients about foot care and maintain a good glycemic control. These must be done by the doctor attending the patient. The diabetic patients must not walk barefoot, not wash their feet with warm water and must not sit near the fire or heater etc. Nail cutting must be done by some other person. The shoes must be soft and loose.
2. The good glycemic control must be achieved by good diet therapy and anti-diabetic agents. The patient must know the importance of good glycemic control so that the compliance of drug is good, the follow-up is maintained.

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