Original Research Article

A comparative study of diabetic and non-diabetic foot infections with reference to etiopathogenesis, clinical features, and outcome

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Abstract: The present study was conducted in Mamata medical college, Khammam, Telangana state. The principle aim of the study was to compare foot infections among diabetic and non-diabetic patients. It is comprised of 100 cases admitted to surgical wards with foot infections from August 2012 to September 2014. In diabetics 5th decade and in non-diabetics 4th decade was the most common age group presenting with foot infections. 65% of patients with foot infections were males, showing a male predominance in both diabetes (68%) and non-diabetic (62%) patients. Cellulitis of the foot was the most common in both diabetics (40%) and non-diabetics (52%). The incidence of gangrene of foot was considerably higher in diabetics (20%) than in non-diabetics (6%). Trauma was the most common etiologic factor accounting for 76% in diabetics and 86% in non-diabetics. The maximum number of patients presented with Wagner's grade 3 lesions both in diabetics (46%) and non-diabetics (54%). However Wagner's grade 4 lesions were more common in diabetics (26%) than in non-diabetics (6%). The most common site of lesion in diabetics was dorsum (42%) and in non-diabetics was toes (40%). The incidence of peripheral vascular disease was significantly higher in diabetics (36%) than in non-diabetics (12%). The incidence of neuropathy was significantly higher in diabetics (74%) than in non-diabetics (18%). Most common organism isolated in culture was Staphylococcus aureus in both diabetics (64%) and non-diabetics (41%). Rate of amputation was high in diabetics (12%) compared to non-diabetics (6%). The average number days in a hospital stay in diabetics was 40.57 days and in non-diabetics it was 29.16 days. This study concludes that diabetic patients have increased severity of infections, delayed healing process, need more active interventions. As compared to the non-diabetic patients, they do show high risk of amputations and prolonged hospital stay.
Keywords: Diabetes, foot infections, neuropathy, peripheral vascular disease, clinical features, outcome

INTRODUCTION

Infections in the foot were more common with a significant proportion of the world's population remaining barefoot, minor skin trauma was a frequent cause of local infection. Foot problems in diabetic patients remain a major public health issue, was the most common reason for hospitalization [1]. A foot complication severe enough to require hospitalization will develop in approximately 15% of the diabetic population during their lifetime [2]. Neuropathic foot ulcers remain the prime precipitant of diabetes-related lower limb amputations, thus impacting an individual's quality of life [1]. Sensory neuropathy was often a major component in the critical pathway for the development of diabetic ulcers and amputations. Pain was one of the primary natural warning systems that alert individuals to take action and seek medical care. Since this early warning system was faulty, individuals with diabetic neuropathy can sustain injuries that are not recognized until they were so severe that full-thickness neuropathic wounds result [3].

It is not surprising that the legs, as they are exposed and having a circulation strained by upright posture of human beings should be the site of infection and ulcers of many types. The diagnosis of a foot infection was initially a clinical diagnosis and was supported by laboratory findings. Most diabetic foot infections were polymicrobial. The microbiology of diabetic foot wounds was variable and often depends on the extent and severity of the infection. A great deal of attention had been placed on the treatment of diabetic foot wounds whereas less attention has focused on the appropriate therapy for non-diabetic foot wounds. Diabetic foot infections have been classified to be treated differently than nondiabetic foot infections due

to the progression of the disease. Diabetic foot ulcers were disabling and frequently lead to amputation of the lower extremities.

The study conducted to investigate the outcome of foot infections in patients with and without diabetes. It has been documented in literature that diabetic persons are more likely to get infections and more susceptible to certain organisms than non-diabetic patients. The most appropriate mode and duration of therapy for foot infection had not been well defined.

This study can predict, identify people at risk of foot infections and educate them to take preventive measure and treatment of underlying pathology. The aim was to study the various foot infections and compare the findings in diabetic and non-diabetic patients with reference to the etiopathogenesis, clinical features, management, days of hospital stay and outcome.

MATERIALS AND METHODS
This study was conducted at the Surgical Department, Mamata General Hospital, Khammam, Telangana state during the period of 2 years from August 2012 to September 2014. After obtaining permission from hospital ethical committee 100 cases were considered for this study. They were divided into 2 groups. Group A includes 50 patients with diabetic foot infections and group B includes 50 patients with non-diabetic foot infection. These groups were diversified and included patients of both sex, of all age

groups above 11 years, all religion and economic strata. Immunocompromised patients were excluded in this study.

Data was collected by detailed history taking, thorough physical examination, routine investigations, relevant special investigations, choosing the appropriate line of treatment and assessment of patients following treatment at regular intervals in comparison to his/her pre-treatment with regards to symptoms. All patients were studied and clinical findings were recorded as per proforma. Case sheet data was analysed and necessary investigations done as per required and treatment given. Predisposing factors, complications, treatment and sequel were studied, analysed and discussed. Statistical data was analysed using Chi-square values and P-values.

RESULTS
This study analysed the various foot infections and compared the findings in diabetic and non-diabetic patients with reference to the etiopathogenesis, clinical features, management, days of hospital stay and outcome.

Age
In the present study, incidences of foot infections were most common in age group of 51-60 years. In the diabetic group most common age group was 51-60 years and in non-diabetic group it was 41-50 years (Table 1).

Table 1: Comparison of age in two groups

Age group (In years)	Group-A Diabetic group	Group-B Non diabetic group	Total
11-20	0	2	2
21-30	0	9	9
31-40	8	7	15
41-50	11	16	27
51-60	19	11	30
61-70	6	3	9
71-80	4	2	6
>80	2	0	2

Sex
In the present study of 100 patients, 65% were males and 35% were females. In diabetic group 68% were males and 32% were females, in non-diabetic

group 62% were males and 38% were females (Table 2). There was a marked male predominance in both the groups

Table 2: Comparison of age in two groups

Sex	Group-A Diabetic group	Group-B Non diabetic group	Total
Males	34(68%)	31(62%)	65(65%)
Females	16(32%)	19(38%)	35(35%)
Total	50	50	100

Mode of presentation

In the present study, common presentation of foot infections was cellulitis (46%) and most common presentation in both diabetic and non-diabetic groups were also cellulitis, 40% and 52% respectively (Table 3). Gangrene was significantly high in diabetics (20%) than in non-diabetics (6%).

Table 3: Comparision of presentation in two groups

Mode of onset	Group-A Diabetic group	Group-B Non-diabetic group	Total
Ulcer	13(26%)	10(20%)	23%
Cellulitis	20(40%)	26(52%)	46%
Abscess	7(14%)	11(22%)	18%
Gangrene	10(20%)	3(6%)	13%
Total	50	50	100

History of trauma

In the present study, history of trauma was present in 81% of total patients. 76% of diabetics and 86% of non-diabetics had a history of trauma (table 4). Statistically it was insignificant.

Table 4: History of trauma in two groups

H\o trauma	Group-A Diabetic group	Group-B Non-diabetic group	Total
Present	38(76%)	43(86%)	81%
Absent	12(24%)	7(14%)	19%
Total	50	50	100

Wagner's grading

In the present study, 52% of patients presented with Wagner's grade 3 lesions, 32% presented with grade 2 lesions and 16% with grade 4 lesions (Table 5). In diabetic patients 46% presented with Wagner's grade 3, 28% with grade 2 and 26% with grade 4 lesions. In non-diabetic group, 58% presented with Wagner's grade 3, 36% with grade 2 and 6% with grade 4 lesions. The results were in comparison with each other.

Table 5: Wagner's grade in two groups

Wagner's grade	Diabetic group	Non-diabetic group	Total
1	0(0%)	0(0%)	0
2	14(28%)	18(36%)	32
3	23(46%)	29(54%)	52
4	13(26%)	3(6%)	16
5	0(0%)	0(0%)	0

Site of lesion

In the present study, 37% of foot infections were seen over the dorsum of the foot, 30% over the sole and 33% over the toes. Among diabetics, dorsum (42%) of the foot was the most common site of infection and in non-diabetics toes (40%) were most commonly involved.

Features of peripheral vascular disease (PVD)

In the present study, 24% of the total patients had features of PVD (Table 6). 36% of diabetics and 12% of non-diabetics presented with PVD which was statistically significant.

Table 6: Peripheral vascular disease in two groups

Peripheral vascular disease	Group-A Diabetic group	Group-B Non-diabetics	Total
Present	18(36%)	6(12%)	24%
Absent	32(64%)	44(88%)	76%
Total	50	50	100

Features of neuropathy

In the present study, 46% patients presented with neuropathy (Table 7). 74% of diabetic patients and 18% of non-diabetic patients presented with neuropathy which was highly significant.

Table 7: Neuropathy in two groups

Neuropathy	Diabetics	Non-diabetics	Total
Present	37(74%)	9(18%)	46%
Absent	13(26%)	41(82%)	54%
Total	50	50	100

Organisms isolated in culture

In the present study, staphylococcus species were isolated in 53% of patients with foot infections (Table 8). Staphylococcus was the most common organism in both the groups. Pseudomonas was the 2nd most common organism with high prevalence in non-diabetic group.

Table 8: Microorganisms isolated in two groups

Organism in C\S	Group-A Diabetic group	Group-B Non-diabetic group	Total
Staphylococcus	32(64%)	21(41%)	53%
Pseudomonas	7(14%)	15(30%)	22%
E.coli	6(12%)	6(12%)	12%
Klebsiella	4(8%)	6(12%)	10%
Proteus	1(2%)	2(4%)	3%
Total	50	50	100

Management of foot infections

In the present study, 38% of patients with foot infections underwent debridement, dressings and SSG, 35% underwent fasciotomy / I &D and 9% had major amputations (Table 9).

In diabetic group, 40% of patients underwent debridement, dressing and SSG, 28% underwent fasciotomy / I&D and 12% underwent major amputations. In non-diabetic group, 42% patients underwent fasciotomy / I&D, 36% underwent debridement, dressing and SSG and 6% underwent amputations.

Table 9: Management of foot infections in two groups

Management	Group-A Diabetic group	Group-B Non-diabetic group	Total
Debridement, dressing &SSG	20(40%)	18(36%)	38%
Fasciotomy or I&D	14(28%)	21(42%)	35%
Disarticulation	10(20%)	8(16%)	18%
Major amputations	6(12%)	3(6%)	9%
Total	50	50	100

Duration of hospital stay

In the present study most patients (36%) were discharged in less than 20 days, but in diabetic group, 44% were discharged in 41 to 60 days of hospital stay unlike the non-diabetic group where 54% were discharged in less than 20 days. The average number of days of hospital stay in diabetics is 40.57 days and in non-diabetics it is 29.16 days (Table 10).

Table 10: Duration of hospital stay in two groups

Hospital stay (In days)	Group-A Diabetic group	Group-B Non-diabetic group	Total
0-20 days	9(18%)	27(54%)	36%
21-40 days	12(24%)	10(20%)	22%
41-60 days	22(44%)	12(24%)	34%
61-80 days	5(10%)	1(2%)	6%
>80 days	2(4%)	0(0%)	2%
Total	50	50	100

DISCUSSION

Diabetic foot infections were common, serious, and diverse in the microbiology of the organism. There was uncertainty about optimal antibiotic treatment and probably there was a substantial variation in treatment of a diabetic versus non-diabetic patients. The pathogenesis of foot infection is complex with variable clinical presentations

and management requires early expert assessment. Interventions should be directed at treating infection, peripheral ischemia and abnormal pressure loading caused by peripheral neuropathy and limited joint mobility.

Age

Most common age group presented with diabetic foot in the present study was between 51 – 60 years with an average of 57.8 years. According to a study by Ellis *et al.;* the highest incidence of foot infections was seen in the age group of 45 to 64 years [4]

Sex

In the present study there was a marked male predominance in both the groups (diabetic and non-diabetic). Male preponderance in the present study was due to more exposure to injuries during their occupational and recreational activities. This was comparable to diabetic research centre, Chennai study 2005[5]. In a study done in Canada, the ratio of male to female diabetic patients was 2.82:1[6]. For non-diabetic patients, the male to female ratio was 0.5:163. Similar results were seen in the present study with a ratio of 2.1:1 in diabetics and 1.12:1 in non-diabetic patients. Another study by Alvarsson *et al.;* in diabetics, males were 62% and females were 38%, similarly in non-diabetic group males were 49% and females were 51% [7].

Mode of clinical presentation

In the present study, out of 100 patients, 46% presented with cellulitis; 23% presented with ulcer; 18% presented with abscess and 13% presented with gangrene. The findings of the present study were comparable with other study [8].

History of trauma

In the present study, 81% of patients presented with history of trauma and it was no history of trauma in 19% of the remaining patients. This is comparable to Reiber *et al.;* [9] series in which 77% of patients had a history of trauma. The high percentage of trauma seen in this study is due to lack of proper hygiene, barefoot walking, low socioeconomic status and lack of access to proper health care system. Because of sensory neuropathy diabetics will be having insensate foot, so they are predisposed to repetitive unrecognized minor trauma and abnormal distribution of pressure on the feet. Hence it emerges as a principle factor in causing foot ulcers.

Site of lesion

The most common site of lesion was dorsum of foot (37%). In the present study most common site of the lesion was dorsum (42%) in diabetic and in non-diabetic patients most comment site of lesion was sole (40%).In a study by Apelquistin 2000, the incidence of foot infections over the toes was 51%; over the sole was 28%; over the dorsum was 14%[10].

Wagner's grading

In the present study, 32% of patients presented with Wagner's grade 2, 52% with grade 3 and 16% with grade 4. In the diabetic group, 24% of patients presented with Wagner's grade 2 lesions, 46% with grade 3 lesions and 26% with grade 4 lesions which is comparable to other studies [4]

Atherosclerosis or peripheral vascular disease

In patients with atherosclerosis or PVD, the limb was under perfused hence impairing the healing process. In the present study, 24% of patients were diagnosed to have peripheral vascular disease. The incidence of PVD in the present study was about 36% in diabetic patients and 12% in non-diabetic patients. In a study by Walter, atherosclerosis was present in 24.2% of patients with foot infections [11].There was no difference in the frequency of symptomatic peripheral vascular disease or the site of occlusion between diabetic and non-diabetic subjects with peripheral vascular disease. Age, cerebrovascular disease, coronary artery disease, plasma glucose, body mass index, and cholesterol in Type 2 diabetes and age and proteinuria in Type 2 diabetes were significant predictors of peripheral vascular disease. In the non-diabetic group, age and cigarettes smoked were significant variables. These findings suggest that the clinical features of peripheral vascular disease in diabetic and non-diabetic subjects were similar but risk determinants may be different [12].

Neuropathy

Neuropathy was a major risk factor for foot ulcers. It results in loss of sensation and the patient will be unaware of the injury and neglects it, which results in ulcer and infection. Autonomic neuropathy increases the risk of ulceration by causing anhidrosis, edema of the foot and peripheral sensory polyneuropathy reducing the protective sensation of the distal limbs. Furthermore, the nervous system interacts with the immune system suggesting that the local immunity of diabetic patients with neuropathy may be altered [13].

Culture and sensitivity

In the present study, the commonest organism found in culture was staphylococcus aureus (53%) which is comparable to study conducted by Ialsaimary study [14].Infection was the 3rd most common factor responsible in the pathogenesis of diabetic foot lesion. When associated with ischemia, it frequently leads to amputation. In a study by Khan *et al.;* staphylococcus was seen in 65% of the cases [15].

Treatment

There were various modalities of treatment available for foot infections. In the present study, 38% patients had debridement and dressing followed by split skin grafts, 35% underwent fasciotomy /I&D, 18% underwent disarticulations and 9% underwent below knee amputations. In a multinational study showed that vascular complications and their risk factors were associated with the occurrence of amputations in both type 1 and type 2 diabetes [16]. In a recent study from Sudan, it was reported that significant factors associated with major lower extremity amputations were ischemia, neuropathy, depth of the wound and grade of the infection [17]. Significant reductions in amputations can be achieved by well-organized diabetic foot care teams with podiatric specialists, good glycemic control and by educating patients on foot care [18]. Prevention of foot ulceration is possible by simple interventions which can reduce amputations up to 80% [19]. Globally, in many countries including Sweden, Netherlands and the United Kingdom, multidisciplinary foot care centres have been shown to be very effective in the reduction of foot amputations [20]. In India, implementation of preventive strategies such as intensive management and foot care education were helpful in preventing newer problems and surgery in diabetic foot disease [16].

Hospital stay

The duration of hospital stay was related to the type of presentation, extent of involvement, severity of disease, glycemic control (in diabetic group), the response of the patient to treatment, other co-morbid conditions and patient's awareness towards the condition.

In the present study, the average duration of hospital stay in diabetic patients was 40.57 days and in non-diabetic group was 29.16 days. Despite of meticulous surgical interventions, daily dressings and appropriate antibiotic therapy, there was a significant difference in the number of days of hospital stay between diabetics and non-diabetics. Use of collagen dressings for promoting faster granulation tissue formation has been proved [21]. The average hospital stay could be reduced by 9% by the use of collagen dressings in place of conventional dressings. Exudative wounds, such as leg ulcers, pressure sores and infected surgical wounds are extensively treated with alginate dressings, primarily made of calcium alginate fibres. VAC therapy increases wound blood flow, speeds the formation of granulation tissue, promoting angiogenesis and decreases the accumulation of fluid and bacteria and accelerate healing. Growth hormones are polypeptides that initiate the growth and proliferation of the cells. PDGF54, Granulocyte colony-stimulating factor, vascular endothelial growth factor, epidermal growth factor and fibroblast growth factor had been used in clinical trials on diabetic foot ulcers.

Foot care in individuals was dependent on multiple factors like socioeconomic status, education, occupation and knowledge of foot care. Educating the patients and creating awareness help in early wound healing.

CONCLUSION

The incidence of PVD and neuropathy was significantly higher in diabetics than in non-diabetics. Most common organism isolated in culture was Staphylococcus aureus in both diabetics (64%) and non-diabetics (41%). The incidence of Pseudomonas was also high among non-diabetics (30%). Rate of amputation was high in diabetics (12%) compared to non-diabetics (6%). The average number days in a hospital stay in diabetics was 40.57 days and in non-diabetics it was 29.16 days. Diabetics have a longer duration of hospital stay than non-diabetics. In order to diminish the detrimental consequences associated with diabetic foot ulcers a high standard of care must be provided. Many of the etiological factors contributing to the formation of diabetic foot ulceration may be identified using simple, inexpensive equipment in a clinical setting and early recognition of these factors along with prompt management of the ulcers were essential for a successful outcome. Aggressive treatment of infections, correction of vascular occlusive disease, adequate wound care and appropriate pressure mitigation were essential steps in the treatment protocol. Health education to all the patients with foot ulcers, particularly in case of diabetic patients suffering from PVD and neuropathy, finds an important cornerstone in the management of these patients and preventing their recurrence and dreaded complications.

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