



RESEARCH ARTICLE

DIABETIC FOOT: AN INTERRUPTIBLE BUT NEVER ENDING STORY OF DIABETES MELLITUS

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ABSTRACT

Introduction: Diabetes mellitus (DM) is a worldwide problem. The incidence of diabetes is increasing globally. DM is known for its micro and macro vascular complications like retinopathy, neuropathy, nephropathy, cardiovascular and peripheral vascular diseases. Diabetic foot complications are responsible for more than 50% of major limb amputations.

Aims: to study the clinical pattern of foot infections in diabetic patients, analyze the risk factors, outcome of treatment modalities and to educate the patient about taking care of feet and preventive care.

Results: Diabetic foot showed male to female ratio of 5:1 with age varying from 16 to >65 years. Occupation had statistical significant role in diabetic foot. Trivial trauma was associated with diabetic foot in more than 50% of cases. Debridement was the most common surgical intervention performed. Amputation was the last resort in saving patients life from diabetic foot complications.

Conclusion: DM is one of the common metabolic disorders faced by surgeons. Diabetic foot a common entity in India due to complications of uncontrolled DM, can present as cellulitis, abscess, ulcer and even gangrene. Diabetic foot has high morbidity to patients. Even the diabetic foot is common complication of DM, it is preventable disorder with strict adherence of patients to foot care policies and aggressive approach of treating physician and surgeons.

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INTRODUCTION

Diabetes mellitus (DM) is a worldwide problem. The incidence of diabetes is increasing globally. DM is characterized by chronic hyperglycemia and disturbance of carbohydrate, fat and protein metabolism associated with absolute or relative deficiency in insulin secretion and/or insulin action (Kahn *et al.*, 1994). DM is known for its micro and macro vascular complications like retinopathy, neuropathy, nephropathy, cardiovascular and peripheral vascular diseases. Diabetic foot complications are responsible for more than 50% of major limb amputations. Ulceration, infection, gangrene and amputation are significant complication of the disease. "The diabetic foot may be defined as a group of syndromes in which neuropathy, ischemia and infection lead to tissue breakdown resulting in morbidity and possible amputation (Krans *et al.*, 2nd editon)." The most common cause of amputation of the lower limb is DM.

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Currently foot problems are an important cause of morbidity in diabetes. Diabetes accounts for up to 50% of non-traumatic leg amputations and 1% of diabetic people have undergone amputation (about 15 times the rate in the general population) (Reiber *et al.*, 1992). Rapid assessment and timely intervention can make the difference between limb salvage and limb loss. Where diabetic care is poor, the role of a surgeon is as an amputator; and where care is good the role is as a debrider vascular reconstructor. According to Modi *et al.* overall incidence of diabetes in India is 1.2 percent. The death in each year is due to its complications which are usually common in the age group 40 to 60 years affecting both sexes equally. Prevalence of diabetics in adult worldwide was estimated to be 4 percent in 1995 and is expected to rise to 5.4 percent by the year 2025. The number of adults with diabetes in the world will rise from 135 million in 1995 to 300 million in the year 2025. There will be a 42 percent increase from 51 to 72 million in the year 2025 in the developed countries and a 170 percent increase from 84 to 228 million in the developing countries. The countries with the largest number of people with diabetes are and will be in the year 2025 India, China and the USA (King *et al.*, 1998).

In India alone, diabetes is expected to increase from 40.6 million in 2006 to 79.4 million by 2030 (Reed, 2008). India presently has the largest number of diabetic patients in the world and India is thus designated to become the "diabetes capital of the world". Diabetic foot ulcers occur mostly among elderly people, and elderly diabetics have twice the risk of developing foot ulcers, three times the risk of developing a foot abscess and four times the risk of developing osteomyelitis (Reed, 2008). Every 30 seconds a lower limb or a part of lower limb is lost somewhere in the world as a consequence of diabetes. Every year approximately 4 million people develop a new diabetic foot ulcer. The Diabetes mellitus is the fourth to fifth leading cause of death in the developed countries (Reed, 2008). Diabetic foot ulcers occur mostly among elderly and elderly diabetics have twice the risk of developing foot ulcers, three times the risk of developing a foot abscess, and four times the risk of developing osteomyelitis (Lipsky *et al.*, 1990). The diabetic foot is mainly because of peripheral neuropathy, arteriopathy and superimposed infection and a need for study is important from the clinician point of view. The insensate foot in diabetes resembles the loss of sensation in Hansens disease and is referred to as second epidemic of Hansen. The most common and classical lesion however is the infected diabetic "mal perforans" foot ulcer where sepsis starts under a hyperkeratotic plaque in the plantar aspect of first metatarsal head. Staphylococcus aureus and beta hemolytic streptococci are the most commonly isolated pathogens. Bacteroides fragilis is an important bone pathogen in chronic osteomyelitis in patients with diabetes (Wheel Lock, 1969). Diabetic foot disease is due to a wide variety of etiological features and hence clinical approach must evaluate all the factors. Neuropathy is present in about 75% of the cases and hence extent of neuropathy is first evaluated. The extent of ischemia is next ruled out by the bedside pocket Doppler and the first set of investigation are bacterial culture and X ray of the foot.

Many agents that promote wound healing are used which include collagen sheets, powders, phenytoin powder, silver dressing, living human skin equivalent and growth factors. New technologies include growth factors, living skin equivalents, electrical stimulation, cold laser and heat. Recombinant platelet derived growth factor for the topical treatment of diabetic foot ulcers shows a modest benefit if used with adequate off loading, debridement and control of infection. Surgeons operating on patients with diabetes mellitus must have a sound knowledge of the pathophysiology and practical management of the disease. Multiple organ dysfunction due to the sheer duration of diabetes must be borne in mind. Comorbid states must be thoroughly evaluated. Nephrotoxic antibiotics must be avoided. Stop OHAs and switch over to rapidly acting insulin. Antibiotic prophylaxis must be initiated. Preoperative starvation to be supplemented with parenteral glucose. Hypoglycaemia should be taken care during anesthesia. The key to successful management of diabetic foot is individualizing the therapy and also winning the confidence of the patient. The lesions being chronic in nature treatment often extends to months. The patient must be briefed and must be involved in all management decisions. The comprehensive lower extremity amputation prevention is a program dedicated to reducing the rate of lower extremity amputations.

MATERIALS AND METHODS

This study was conducted on 200 patients of diabetic foot in the Department of General Surgery S.P. Medical College and P.B.M. Associated Group of Hospitals, Bikaner. All patients were studied and clinical findings were recorded as per performa case sheet and data analyzed and necessary investigations were done as per required and treatment was given. The predisposing factors, complications, treatment and sequel were studied and analyzed. All Patients were admitted with diabetes mellitus suffering from foot ulcers and infections, aged above 15 years. Patients with gangrenous foot, complicated by diabetes were also included in the study. All the patients less than 15 years and patients with foot infections without diabetes mellitus were excluded.

Observations

In present study, most common age group was 51-70 years where total 108 patients were found. Out of these 108 patients, abscess was present in 20 patients, cellulitis was present in 36 patients, gangrene was present in 24 patients and ulcer was present in 28 cases. Out of total 200 patients, 32 patients had abscess, 72 patients had cellulitis, 52 patients had gangrene and 44 patients had ulcer.

Our study was a male dominance study where out of total 200 patients 168 were male and 32 females. Out of total 32 abscess patients all were male, while 72 cellulitis patients 12 and 60 were female and male respectively.

In present study, out of total 200 patients, 116 were came from rural area while remaining 84 were came from urban area. This difference was also found statistically insignificant ($p > 0.05$).

In present study, most common lesion was right dorsum of foot (24%), followed by left toe (16%), and right toe (12%), right fore foot (8%) and left fore foot (6%).

History of trauma was present in total 120 patients out of the 200 patients, out of these 120 patients, 20, 36, 32 and 32 had abscess, cellulitis, gangrene and ulcer. On applying chi square test, the difference was found statistically insignificant ($p > 0.05$).

According to above table, neuropathy was present in total 200 patients and out of them 12, 28, 52 and 20 had abscess, cellulitis, gangrene and ulcer respectively and on applying chi square test, the difference was found statistically significant ($p < 0.05$).

Ischemia was present in total 80 patients and out of them 48 and 32 had gangrene and ulcer while no patient had abscess and cellulitis. On applying chi square test, the difference was found statistically highly significant ($p < 0.001$).

In present study, out of total 200 patients, 160 patients had infection and out of them 28, 68, 20 and 44 had abscess, cellulitis, gangrene and ulcer respectively and on applying chi square test, the difference was found statistically significant ($p < 0.001$).

Table 1. Distribution of Cases according to age group in relation to chief complaints

Age Group (years)	Chief Complaints								Total	
	Cellulitis		Abscess		Ulcer		Gangrene		No.	%
	No.	%	No.	%	No.	%	No.	%		
≤30	12	16.7	0	-	4	9.1	0	-	16	8.0
31-50	12	16.7	4	12.5	8	18.2	24	46.2	48	24.0
51-70	36	50.0	20	62.5	28	63.6	24	46.2	108	54.0
>70	12	16.7	8	25.0	4	9.1	4	7.7	28	14.0
Total	72	100	32	100	44	100	52	100	200	100
Mean	55.82		53.44		63.00		56.46		55.82	
SD	18.33		20.07		10.80		13.58		18.33	
P	0.625									

Table 2. Distribution of Cases according to Sex in relation to chief complaints

Sex	Chief Complaints								Total	
	Cellulitis		Abscess		Ulcer		Gangrene		No.	%
	No.	%	No.	%	No.	%	No.	%		
Female	12	16.7	0	-	8	18.2	12	23.1	32	16.0
Male	60	83.3	32	100	36	81.8	40	76.9	168	84.0
Total	72	100	32	100	44	100	52	100	200	100
χ²	2.053									
SD	0.561									

Table 3. Distribution of Cases according to Residential Area in relation to chief complaints

Area	Chief Complaints								Total	
	Cellulitis		Abscess		Ulcer		Gangrene		No.	%
	No.	%	No.	%	No.	%	No.	%		
Rural	44	61.1	20	62.5	24	54.5	28	53.8	116	58.0
Urban	28	38.9	12	37.5	20	45.5	24	46.2	84	42.0
Total	72	100	32	100	44	100	52	100	200	100
χ²	0.284									
SD	0.963									

Table 4. Distribution of Cases according to Lesion Involved in relation to chief complaints

Lesion	Chief Complaints								Total	
	Cellulitis		Abscess		Ulcer		Gangrene		No.	%
	No.	%	No.	%	No.	%	No.	%		
Lt Dorsum of Foot	8	11.2	4	12.5	0	-	0	-	12	6.0
Lt Toe	4	5.6	8	25.0	4	9.1	16	30.8	32	16.0
Lt Fore Foot	8	11.2	0	-	4	9.1	0	-	12	6.0
Lt Planter Foot	4	5.6	0	-	0	-	0	-	4	2.0
Lt Whole Foot	4	5.6	0	-	0	-	4	7.7	8	4.0
Rt Dorsum of Foot	20	27.7	16	50.0	4	9.1	8	15.4	48	24.0
Rt Fore Foot	8	11.1	0	-	8	18.2	0	-	16	8.0
Rt Toe	0	-	12	37.5	0	-	12	23.1	24	12.0
Rt Heel	8	11.1	0	-	4	9.1	0	-	12	6.0
Rt Planter Foot	8	11.1	0	-	4	9.1	0	-	12	6.0
Rt Whole Foot	4	5.6	0	-	0	-	16	30.8	20	10.0

Table 5. Distribution of Cases according to History of Trauma in relation to chief complaints

H/O Trauma	Chief Complaints								Total	
	Cellulitis		Abscess		Ulcer		Gangrene		No.	%
	No.	%	No.	%	No.	%	No.	%		
Present	36	50.0	20	62.5	32	72.7	32	61.5	120	60.0
Absent	36	50.0	12	37.5	12	27.3	20	38.5	80	40.0
Total	72	100	32	100	44	100	52	100	200	100
χ²	1.526									
SD	0.676									

Table 6. Distribution of Cases according to Neuropathy in relation to chief complaints

Neuropathy	Chief Complaints								Total	
	Cellulitis		Abscess		Ulcer		Gangrene		No.	%
	No.	%	No.	%	No.	%	No.	%		
Present	28	38.9	12	37.5	20	45.5	52	100	112	56.0
Absent	44	61.1	20	62.5	24	54.5	0	-	78	44.0
Total	72	100	32	100	44	100	52	100	200	100
χ²	13.961									
SD	0.003									

Table 7. Distribution of Cases according to Ischemia in relation to chief complaints

Ischemia	Chief Complaints								Total	
	Cellulitis		Abscess		Ulcer		Gangrene		No.	%
	No.	%	No.	%	No.	%	No.	%		
Present	0	-	0	-	32	72.7	48	92.3	80	40.0
Absent	72	100	32	100	12	27.3	4	7.7	120	60.0
Total	72	100	32	100	44	100	52	100	200	100
χ^2	37.063									
SD	<0.001									

Table 8. Distribution of Cases according to Infection in relation to chief complaints

Infection	Chief Complaints								Total	
	Cellulitis		Abscess		Ulcer		Gangrene		No.	%
	No.	%	No.	%	No.	%	No.	%		
Present	68	94.4	28	87.5	44	100	20	38.5	160	80.0
Absent	4	5.6	04	12.5	0	-	32	61.5	40	20.0
Total	72	100	32	100	44	100	52	100	200	100
χ^2	19.398									
SD	<0.001									

Table 9. Distribution of Cases according to Procedure in relation to chief complaints

Procedure	Chief Complaints								Total	
	Cellulitis		Abscess		Ulcer		Gangrene		No.	%
	No.	%	No.	%	No.	%	No.	%		
B/K Amputation	0	-	0	-	0	-	20	38.5	20	10.0
Debridement	32	44.4	0	-	28	63.6	4	7.7	64	32.0
I&D	16	22.2	24	75.0	4	9.1	0	-	44	22.0
Mid Thigh Amp	0	-	0	-	0	-	4	7.7	4	2.0
Slough Excision of Dressing	20	27.8	4	12.5	8	18.2	0	-	32	16.0
Toe Amputation	0	-	4	12.5	4	9.1	28	53.9	36	18.0

Most common procedure in our study was debridement with total 64 patients. Out of them 32, 4 and 28 had cellulitis, gangrene and ulcer respectively. Followed by I&D with total 44 patients, of them 24, 16 and 4 had abscess, cellulitis and ulcer. Slough excision and dressing was present in 32 patients while toe amputation was present in 36 patients, B/K Amputation was present in total 5 patients while 1 patient had mid thigh amputation.

DISCUSSION

The present study had the youngest age with diabetic foot was 16 years and the oldest age was 81 years and the most common age group was 51-70 years where total 108 patients were found in this age group. Wheel Lock (1969) study had the youngest age with diabetic foot at 32 years and the oldest age was 89 years. When compared with Wheel Lock (1969) series, there was not much difference in the oldest group but the youngest patient was found to be 16 years younger than the compared study. In our study, 168 were males and 32 were females. The male: female ratio was 5.25:1. The incidence is more common among males probably as they were breadwinners of the family and were mostly working outdoor, which makes them more vulnerable for trauma and its sequelae. Mayfield *et al.* (1996) study had 53% males and 47% females. There was similarity among the studies but proportion was far different. In this study the minimum stay in hospital was for the patients who had abscess or cellulites in which the most common procedure performed was I&D and debridement and the maximum stay of patients where for patients with gangrene

who had to stay for a longer period of time as they required amputation and regional anesthesia. In 200 patients 32 patients had abscess, 72 patients had cellulites, 52 patients had gangrene and 44 patients had ulcer. This incidence of gangrene was in par to that of the Bell (1957) series of 1960. Bell (1957) study had 946 cases with diabetic foot, of which 236 cases (24.9%) presented with gangrene and in Diabetic research centre (2005) study among 1319 cases, 64 cases (5%) had gangrene. Among the 200 cases of this study, 64 cases (28%) involved the toes, 60 cases (30%) involved the dorsum of foot, 16 cases (8%) involved the plantar foot and 28 (14%) cases involved the forefoot. The most common site of occurrence of ulcer was on the dorsum of the foot which was 30 percent where as in Apelquist *et al.* (1993) and Reiber *et al.* (1998) study the common site was toes which was 51 percent and 52 percent. These results were not in par with above studies. Apelquist *et al.* (1993) study had 51% involving the toes, 14 % dorsum of foot and 9 % involving the plantar heel. Reiber *et al.* (1998) study had 52 % involving the toes, 11% dorsum of foot and 18% plantar heel. 60 percent of the cases in this series had a history of trauma before the onset of the lesion. Mayfield *et al.* (1996) study, there was no significant percentage of cases with respect to history of trauma prior to occurrence of diabetic foot lesion. Only 44% (27 cases) had history of trauma in Mayfield *et al.* (1996) study. In majority of the cases of surgical complications of diabetes, some kind of trauma is the beginning of the problem.

In Wheel Locked (1969) series, out of 3175 cases, 1206 cases (37.99%) were found to have neuropathy and in Duncam

(1969) study, out of 354 cases, 125 cases (35.31%) were found to have neuropathy. Among 200 cases in this study, 56 percent (108 cases) of patients were found to have neuropathy. The majority of patients had history of diabetes of more than 5 years. This shows that peripheral neuropathy is common in long standing diabetic patients. The most common procedure in our study was debridement done in 64 patients followed by I&D in 44 patients, Slough excision was done in 32 patients and amputation was done in 60 patients (B/K amputation 20 patients, toe amputation in 36 patients and 4 mid thigh amputation). Amputations were seen in 38.6% cases and 52% cases in Collen's (1962) and Osakakosainekin (2005) study.

The amputation rate was comparable to the Collens (1962) series but was much lower compared to the Osakakosainekin (2005) Hospital study where 52 percent of patients underwent amputation.

Summary

- Diabetes is a lifelong problem, and the incidence of diabetic foot complications increases with age and duration of the disease. By identifying high-risk patient and tailoring a total foot care prevention program accordingly, the incidences of ulceration and lower extremity amputations can be reduced.
- Males are affected five times more than females (males are more vulnerable to trauma).
- Most common occupation in the present study were farmers followed by businessmen and housewives which depicts that the complications are more common among those people who are exposed to the risk of trauma and injury during their work. Thus it is evident that the surgical complications are common those profession's exposing them to the risk of trauma and injuries and thus make them susceptible to the complications of diabetic foot.
- Trivial trauma of some kind was the initiating factor in nearly half of the cases.
- Commonest site of lesion was dorsum of foot followed by toes.
- Commonest presenting lesion was cellulites (36%) followed by gangrene (26%), ulcer (22%) and abscess (16%)
- More than half of the patients have infection in addition to ischemia or neuropathy.
- Conservative treatment consisting of control of diabetes with insulin, oral hypoglycemic drugs along with appropriate oral/ i.v antibiotic are effective in some cases. Wound debridement, slough excision followed by dressing resulted in healing in most cases. Split skin grafting, disarticulation, below knee amputation and above knee amputation was the other modes of treatment.

Conclusion

Foot care programs emphasizing preventive management can reduce the incidence of foot ulceration through modification of self-care practices, appropriate evaluation of risk factors, and formulation of treatment protocols aimed at early intervention, limb preservation, and prevention of new lesions. A significant reduction in both major and minor diabetic limb amputations is certainly attainable if clinicians embrace these principles and incorporate them into daily patient care.

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