

# Prospective Study of Infections of Foot in Diabetic Patients

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## Research Article

**Abstract: Background:** Diabetes is one of the oldest diseases known to mankind. The Ebers Papyrus of 1500 B.C. mentions symptoms and suggests treatment of diabetes. The history of gangrene of the foot goes back to Biblical time, when, in Chronicles II, the first case of gangrene of the feet, perhaps due to diabetes, is described. **Cases:** We present a two year prospective study of 200 cases of diabetes mellitus having foot infections. Patients with diabetes came with various forms of foot lesion like single toe cellulitis to deep plantar abscess and ulcer to extensive foot cellulitis and gangrene. Blood sugar level, culture and sensitivity test, colour doppler study done in these patients and appropriate treatment given. Patients were educated about proper foot care at time of admission, during treatment and at time of discharge and follow up of these patients was done on OPD basis during the time period of our study.

**Keywords:** prospective, infections, diabetes

### Introduction

Diabetic foot is one of the most feared complications of diabetes and is leading cause of repeated hospitalization in diabetic patients. Diabetic patients have life time risk as high as 25% for developing foot ulcerations.<sup>3</sup> Diabetes is common disease in India with a prevalence of almost 12% -17% in the Indian urban population and a prevalence of 2.5% in the rural population.<sup>11</sup> Foot infections are among the most common bacterial infections encountered in patients with diabetes mellitus.<sup>2</sup> Approximately, Dept. of Gen. Surgery, 15% of individual with diabetes mellitus having foot ulcer with

gross infection will ultimately undergo amputation. This can be easily attributed to factors such as barefoot walking, inadequate facilities for diabetes care, low socioeconomic status and illiteracy.<sup>10</sup> Long-term risk factors for foot ulcers and amputation include duration of diabetes, poor glycaemic control, microvascular complications (retinopathy, nephropathy, and neuropathy), peripheral vascular disease, foot deformities and previous foot ulceration or amputation.<sup>1,6,10,12,13</sup> Strong predictors of foot ulceration are altered foot sensation, foot deformities and previous foot ulcer or amputation of the other foot.<sup>1,6</sup> The etiology is multifactorial, but minor trauma in presence of peripheral sensory neuropathy remains primary culprit. Through appropriate education, the use of emollients, careful trimming of nails and the use of appropriate fitting shoes, morbidity and mortality can be reduced. Patient's education regarding this condition of foot infection, need of proper monitoring of blood sugar level and its control, early consultation to concerned specialist doctor is a must to prevent dreadful outcome.

### Cases Report

Study of 200 cases of diabetic foot infections presented to our department of General Surgery are as follows

### Observations and Results

**Table 1:** Age and sex distribution

Age group	Male	Female	Total
0 – 10 yrs	0	0	0 (0%)
11 – 20 yrs	2	0	2 (1%)
21 – 30 yrs	3	3	6 (3%)
31 – 40 yrs	6	4	10 (5%)
41 – 50 yrs	12	5	17 (8.5%)
51 - 60 yrs	75	50	125 (62.5%)
>60 yrs	27	13	40 (20%)
<b>Total</b>	<b>125</b>	<b>75</b>	<b>200 (100%)</b>

Chi-square=329.62, DF=5, p<0.01 in our study it is found that

1. Males are affected more than females; male:female is 1.67:1

2. Maximum incidence of diabetic foot is in 50 to 60 years (62.5%) which was found to be statistically significant

**Table 2:** Duration of Diabetes

Duration	No. of Patients
<5 yrs	50 (25%)
5 – 10 yrs	65 (32.5%)
>10 yrs	70 (35%)
Not known	15 (7.5%)

From the above table it is evident that 35% patients are known diabetic since more than 10 years in our study.

**Table3:**Glycosylated hemoglobin levels.

To assess diabetes control status

Control	No. of Patients
Good (8.0 – 9.0% )	60 (30%)
Fair (9.0 – 10% )	20 (10%)
Poor (more than 10% )	120 (60%)

Diabetic foot lesions were found more common in patients with poor glycaemic control. 60% patients had poor control of hyperglycaemia

**Table 4:** Diabetic vasculopathy

Following pulsations were absent

Bloodvesselsaffected	No. ofpatients
Femoral artery	0
Popliteal artery	8
Posterior tibial	25
Dorsalispedis	20
Dorsalispedis with Posterior tibial	25

Posterior tibial artery was most commonly found to be affected medium size artery in a diabetic patients followed by dorsalispedis artery in our study. While both dorsalispedis with posterior tibial artery were affected in 25 patients.

**Table5:**Diabetic neuropathy

Nerve system affected	No. of patients
Sensory	90 (45%)
Motor	40 (20%)
<b>Total</b>	<b>130</b>

Z=4.38, p<0.01In our study sensory neuropathy was most common neuropathy in detected diabetic patients affecting 45% of patients while 20% of patients had motor neuropathy. These finding were found to be statistically significant.

**Table 6:**Presentation of Diabetic foot in our study

Nature of Presentation	No. of patients	
Cellulitis with single toe involvement	25	12.5%
Cellulitis with multiple toes involvement	20	10%
Ulcer on dorsum of foot	10	5%
Deep ulcer	5	2.5%
Deep plantar abscess with areas of necrosis and bullae and sole ulcer	80	40%
Gangrene of single toe	20	10%
Gangrene of multiple toes	15	7.5%
Gangrene of foot	10	5%
Gangreneof foot with extensive cellulitis of leg	15	7.5%

Chi-square=182.5, DF=8, p<0.01From the above table it is evident that in our study the most common mode of presentation of diabetic foot was deep plantar abscess with ulcer on sole (40%) which was found to be statistically significant. It is followed by single toe cellulitis (12.5%) and gangrene of toe (10%).



Nonhealing ulcer over left heel regionGangrene of foot with ischaemic ulcer



Deep plantar abscess with ulcerDeep ulcer with bone involvement and abscess formation



Localized gangreneAdvanced gangrene.



Gangrene of foot and leg with extensive cellulitis

**Table 7:** Etiology of diabetic foot as per our study

Etiology	No. of patients	
Minor trauma	125	62.5%
Foot wear related injury	50	25%
Nail trimming (careless/excessive)	10	5%
Lacerations	8	4%
Burns	5	2.5%
Unknown bite	2	1%

Chi-square=349.54, DF=5,  $p < 0.01$ . In our patients unsupervised and careless attempts at nail removal, thorn or foreign body removal, minor trauma, fomentation, lacerations are the main precursors for variety of foot lesion. It is observed that custom of walking barefoot also increases the susceptibility to trauma with further progress in lesion.

**Table 8A:** Organism cultured in our study

Organism	No. of Patients	
E. coli	14	7%
Staphylococcus aureus	18	9%
Pseudomonas aeruginosa	20	10%
Proteus species	10	5%
Streptococcus	16	8%
Klebsiella species	12	6%
Mixed	102	51%
Fungal	4	2%
Sterile	4	2%

Chi-square=333.52, DF=8,  $p < 0.01$ , In our study the most common cause of infection in diabetic foot is found to be polymicrobial (mixed organism), isolated in 102 (51%) of patients<sup>8,9</sup> which was statistically significant ( $p < 0.01$ ). "Pseudomonas aeruginosa" is the most common single causative organism isolated from lesions of "diabetic foot".<sup>4,5</sup> The results were obtained by Chincholikar *et al.*<sup>4</sup> and Gadepalli *et al.*<sup>5</sup> were consistent with our study.

**Table 8B:** Commonly sensitive antibiotics found in our study

Antibiotics	Pseudomonas N=20	S.aureus N=18	Streptococcus N=16	E.coli N=14	Klebsiella N=12	Proteus sp N=10	Fungal N=4
Amikacin	6 , 30%	4 ,22%	7 , 43%	7,49%	7 , 56%	6 ,60%	
Imipenem	20 ,100%	15 ,83%	7 , 43%	9,63%	8 , 64%	8,80%	
Piperacillin-tazobactam	18 , 90%	9 ,50%	8 , 50%	10,70%	8 , 64%	5 , 50%	
Ciprofloxacin	2 , 10%	3 , 16%	8 , 50%	2,14%	1 , 8%		
Gentamycin		1 , 6%	3 , 18%	3,21%	4 ,32%	5 , 50%	
Erythromycin			6 , 36%				
Tetracycline	2 , 10%	1 , 6%	3 , 18%	2,14%			
Linezolid		5 , 28%					
Vancomycin		6 , 33%					
Fluconazole							4,100%

From the above table it is evident in our study that most common sensitive antibiotic to cultured bacteria is imipenem. It is followed by piperacillin-tazobactam combination and amikacin. While all four fungal infections were given fluconazole. Four patients culture report were sterile and were given combination of amoxicillin-clavulanic acid combination with amikacin and metronidazole.

**Table 9:** Surgeries done in our study

Treatment given	No. of cases
Debridement and dressing	124 (62%)
Ray's amputations	31 (15.5%)
Trans metatarsal amputations	10 (5%)
Below knee amputations	25 (12.5%)
Above knee amputations	10 (5%)

**Table 10:** Changes in insulin requirement

Total no. of patients	During treatment	On discharge	Insulin started for first time
200	4 decreased 165 increased 31 same	134 decreased 50 same 4 death 12 discharge against medical advise	15 newly diagnosed 40 on Oral hypoglycaemic drugs

**Table 11:** Resurgery done

Previous surgery	No. of Patients	Resurgery done
Debridement	30	20 Below knee amputations 10 Trans metatarsal amputations
Ray's amputations	15	Below knee amputations
Transmetatarsal amputations	8	Below knee amputations
Below knee amputations	10	Above knee amputations

Chi-square=18.84, DF=3, p<0.01, from the above table it is evident in our study that 63 patients required resurgery during course of their treatment. Below knee amputations is most commonly performed resurgery, done in 43 patients that are 68.25% (43/63). 10 (15.87%) patients required transmetatarsal amputation and 10 (15.87%) patients required above knee amputation. These findings were found to be statistically significant.

**Table 12:** Condition on discharge

	Improved	Not improved	Death	Discharged against medical advise
No. of patients	180	4	4	12

Case fatality rate = 4/200 = 2%. Foot lesions of 180 patients showed improvement and were healthy at the time of discharge, while 4 patients did not show much improvement in our study.

**Table 13:** Patients Education about Control of diabetes

Total no. of cases	Education given	Impact of prevention / control
200	184 discharged 4 Death 12 Discharged against medical advice	150 Improved 30 Same as at time of discharge 4 Didn't come for follow up

All 200 patients were educated about proper foot care on admission during course of their treatment as well as at the time of discharge. The reduced incidence of “diabetic

foot” in educated than in non-educated patients clearly shows the importance of foot care in preventing the foot lesion. 184 patients were discharged and advised for

regular follow up. Out of 184 patients discharged, 150 patients showed improvement in the foot lesions during follow up period with their wound were healing. Thirty patients wound status remained same as it was at time of discharge and four patients didn't come for follow up. Twelve patients who were discharged against medical advice and four dead patients could not be followed up.

## Results and Discussion

In the 200 diabetic foot patients studied, 125 (62.5%) were men and 75 (37.5%) were women, male-to-female ratio being 1.67 with maximum incidence between the ages ranged from 50 to 60 years (62.5%). Among the total patient population, 196 (98%) had type 2 diabetes mellitus, whereas only 4 (2%) patients had type 1 diabetes mellitus. While 70 (35%) of the patients were diagnosed to have diabetes mellitus for >10 years, 65 (32.5%) and 50 (25%) had diabetes for 5-10 years and < 5 years respectively, while 15 patients were diagnosed after admission. Of all the patients taking any kind of treatment for diabetes ( $n = 184$ ), 150 (75%) were fully compliant to their treatment whereas 30 (15%) were noncompliant to it. All the patients were evaluated for awareness about the complications related to diabetes. Poor glycemic control, i.e., random blood sugar (RBS) >200 mg/dL, was found in maximum patients and  $HbA_{1c} > 7$  was found in 60 (30%) patients. Maximum number of organisms were isolated from grade IV foot wounds ( $n = 65$ ). Patients were graded according to Meggit Wagner Classification<sup>3</sup> and their types of flora are given in [Table 2].

## Microbiological Observations

In majority of the lesion mixed flora (51%) was seen. This may be due to surface contamination of the wounds by other organisms. The microorganisms isolated most frequently was *P. aeruginosa* (10%), *S. aureus* (9%), *E. coli* (7%), *Klebsiella* sp. (6%), streptococci sp. (8%), *Proteus* sp. (5%), Fungal (2%). While in 4 patients culture came out to be sterile. All patients were started on empirical combination of antibiotics of amoxicillin-clavulanic acid + gentamycin/amikacin + metronidazole at the time of admission, till wound culture results were available. Eighteen patients (9%) were started on monotherapy and 182 (91%) patients were started on combination therapy of antibiotics as per their culture and sensitivity reports. Anti-anaerobes agents like metronidazole is used in all patients to decrease load of anaerobes and continued even after culture and sensitivity results made available, if anaerobes are suspected. In accordance with the sensitivity results, *Pseudomonas* infection showed respond better to imipenem (100%), piperacillin-tazobactam combination (90%) and amikacin (30%); MRSA accounted for 64% of isolated strains of *S.*

*aureus* and was commonly seen in patients with osteomyelitis. MRSA were found to be sensitive to imipenem (83%), vancomycin (33%), piperacillin-tazobactam (50%) and linezolid (28%) in our study. The streptococci species proved to be sensitive to aminoglycosides, ciprofloxacin (66%), piperacillin-tazobactam (50%) and imipenem (43%); Amikacin was a better choice of drug in infection caused by *E. coli*, *Proteus* and *Klebsiella*. 60-70% *E. coli* were resistant to commonly used ciprofloxacin and gentamycin. Enterobacteriaceae were resistant to ciprofloxacin. *Proteus* species were sensitive to imipenem (80%), amikacin (60%) and piperacillin-tazobactam (50%). *Klebsiella* species were sensitive to imipenem (64%), amikacin (56%) and piperacillin-tazobactam (64%). All of four fungal infections were given Fluconazole. 4 culture swabs were found to be sterile and were given combination of amoxicillin-clavulanic acid + gentamycin/amikacin + metronidazole.

## Clinical Presentation

Total 200 cases of diabetic foot were studied. These cases included in our study when there was significant ulceration, abscess formation and gangrene. Large number of our patients (40%) presented with deep plantar abscess with areas of necrosis and gangrene.

## Treatment of Diabetic Foot

This depends on number of clinical parameters which require day to day observations. Patients presenting with early symptoms like tingling numbness and hypo/hyperesthesia gets benefited by control of hyperglycaemia by diet, exercise and insulin.<sup>7</sup> Some patients may require insulin instead of oral hypoglycaemic drug. If a patient has a severe fulminating infection in a foot, urgent surgery may have to be undertaken. On the other hand patient with mild infection which appears to be controllable may be benefited with a brief period of conservative management to see how much foot can be salvaged.

## Operative Treatment

Two hundred cases of diabetic foot were treated during the period of December 2011 to August 2013. In this series the cases attended hospital after breach in the skin or till the lesion progressed to such an extent that it was incapacitating. Each case was individually assessed and treated accordingly. Conservative approach was taken by us and the clinical judgment was more relied upon than various criteria's followed by our department for treatment. The various procedure performed at their first presentation are debridement and dressing (124), Rays amputation (31), Trans metatarsal amputation (10), Below knee amputation (25), above knee amputation (10). During the course of their treatment 76 patients required further

treatment. Out of 130 patients debrided initially 20 required below knee amputation, 10 required Tran's metatarsal amputation. 15 cases of rays amputation and 8 cases of trans metatarsal amputation were further

undergone below knee amputation. 10 cases who had initially below knee amputation further required above knee amputation.



Ulcer after surgical debridement Ray's amputation of second toe with surgical debridement



Great toe amputation



After transmetatarsal amputation



Below knee amputation (with flaps closed)



Above knee amputation

## Conclusions

- I. In our study the most common causative cultured organism found is "polymicrobial" that is mixed group of infections which were found to be statistically significant ( $p < 0.01$ ). It is found in 51% (102/200) of patients and most common single causative organism is "Pseudomonas aeruginosa", found in 10% (20/200) of patients.
- II. In this study the commonly found sensitive antibiotics are of newer which generations includes imipenem, piperacillin-tazobactam combination and amikacin sensitive for most of commonly found causative organisms. While all 4 patients having fungal infections were given fluconazole.
- III. Even a minor trauma in uncontrolled diabetes mellitus can lead to significant lesions. These findings were found to be statistically significant ( $p < 0.01$ ). The blood

sugar levels at which infections occurred ranges between 200 to 300 mg/dl in our study. Patients having good glycaemic control healed.

- IV. Our study shows that single aggressive debridement achieves better control of the disease than multiple attempts at minor debridement. 94 of our debridements done aggressively healed well; while 30 other debridement procedure required a definitive amputation at a later date. In presence of fulminant cellulitis, extensive debridement of dead tissue is required as an emergency procedure to control infection.
- V. Among 200 cases of our study 52.5% (105/200) presented with extensive lesion in the form of deep plantar abscess with or without bone involvement and sole ulcer (80), gangrene of foot (10) and gangrene of foot with cellulitis (15). In these cases below knee amputation was done in 25 cases and

above knee amputation in 10 cases immediately on admission. Thus about 17.50% (35/200) of patients presented when no salvage procedure was feasible at time of their first presentation. On the other hand in the remaining group of patients, who attended hospital with what appeared to be a salvageable foot, 31 patients required a ray's amputation and 10 required Tran's metatarsal amputation. In this series it was possible to achieve 62% (124/200) salvage rate without tissue loss. In those who presented with early foot lesion, salvage rate was up to 82.5% (165/200). It shows importance of early treatment of "diabetic foot".

VI. In 65.76% (121/184) cases selection of primary procedure was adequate to control disease. In 34.23% (63/184) primary procedure was converted to a more proximal amputation which were found to be statistically significant ( $p < 0.01$ ). As 12 patients discharged against medical advice and 4 patients died.

VII. All the patients who had major tissue loss in our study having preceding history of tingling, numbness and hypo/hyperesthesia, if would have been properly educated about foot care and treated properly at early stage, further complications with tissue loss/amputations would have been prevented. The principles of treatment in preventive stage are proper foot care as per guidelines of podiatry and adequate control of hyperglycaemia. By prompt detection of infection and by shifting to insulin from oral hypoglycaemic drugs in the early stage of infection, tissue loss or amputations can be prevented.

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