

Original Research Article

Clinical and microbiological profile of diabetic foot ulcers in a tertiary care setup: a cross sectional analysis

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ABSTRACT

Background: Diabetes associated neuropathy and vasculopathy leads to development of diabetic foot ulcers (DFU). They are responsible for considerable morbidity and a significant cost of health-care worldwide. The magnitude of the problem becomes worse in regions where foot care is inadequate like in our country. The aim of the study to determine the microbiological profile and antimicrobial susceptibility pattern of organisms isolated from patients with diabetic foot ulcers.

Methods: The study was a cross sectional study done at King George's Medical College, Lucknow from 2012-2014 in Lucknow, Uttar Pradesh. Based on the inclusion criteria sample were collected from 112 patients. The standard protocol for the identification of microorganisms was followed. A descriptive analysis of the data was done.

Results: Out of the 112 ulcers total 180 isolates were found. Of the 112 cases, 78 were monomicrobial, 32 were polymicrobial, and 2 cases were sterile on culture. The most common bacteria found was *Staphylococcus aureus*. Most of the staphylococcus isolated were sensitive to vancomycin, teicoplanin, cephalosporins, linezolid levofloxacin and piperacillin-tazobactam. Nearly 65% of *S. aureus* were methicillin-resistant *S. aureus*.

Conclusions: This study compiled clinical and microbiological profile of diabetic foot ulcers along with their antibiotic susceptibility patterns. Our study illuminates light on a high figure of neglected and poorly treated NHUs which could have been managed well and early treatment will prevent devastating consequences such as sepsis and amputation.

Keywords: Diabetic foot ulcer, Diabetes mellitus, Non-healing ulcer, Diabetic foot

INTRODUCTION

India is the diabetic capital of the world, the diabetic population in the country is close to hitting the alarming mark of 69.9 million by 2025 and 80 million by 2030.¹ In diabetic population, the lifetime risk of a diabetic foot ulcer (DFU) is 15% and around 28% of them may require some form of amputation.² Chronic diabetes causes macro and microangiopathy and peripheral sensory and motor

neuropathy. These neuropathies lead to foot deformities, in turn escalates to ischemia, and foot infection.³ DFUs are responsible for considerable morbidity and a significant cost of health-care worldwide.⁴

Foot infections account for 20% of hospitalization of diabetic patients yearly.⁵ Presence of superimposed infection in an already existing DFU, not only delays healing but also poses risk of systemic infection,

septicaemia and amputation. Management principles for DFUs are strict glycaemic control, wound care and debridement, pressure off-loading, revascularization procedures and limited amputation. In addition, an important component of management is infection control by identifying the causative microorganism and starting appropriate antibiotics. The magnitude of the problem becomes worse in regions where foot care is inadequate like in our country.⁶

The aim of the study was to determine the microbiological profile and antimicrobial susceptibility pattern of organisms isolated from patients with diabetic foot ulcers.

METHODS

Study design

The study was a cross sectional observational study done at a tertiary level hospital, King George's Medical College, Lucknow from 2012-2014 in Lucknow, Uttar Pradesh.

Aim

This study was designed to understand the demographic and microbiological profile of diabetic foot ulcers. The aim of the study was to identify the most common organisms and to identify their antibiotic susceptibility patterns.

Inclusion criteria

All patients with confirmed chronic Diabetic foot ulcers (DFU), of duration more than 4 weeks, attending the OPD of the Department of Physical Medicine and Rehabilitation, and willing to participate in the study were included. Age group selected was 18-65 years of age.

Exclusion criteria

Those with critical illness and having sepsis or gangrene of feet were excluded.

A total of 112 patients with DFUs, were included in the study after taking proper informed consent from them and clearance from the institution ethics committee. A detailed clinical history including personal history, family history was taken from each patient. Details like age, duration of ulcer, type and duration of diabetes and presence of any other comorbidities were noted. Detailed examination of involved foot was done to determine the ulcer location, size, shape, any discharge, floor and base of ulcer. Ulcers were graded according to Wagner's Ulcer Classification System.⁷ Neuropathic involvement of the feet was determined by the absence of perception of Semmes Weinstein monofilament at least 2 of the 10 standard plantar sites on either foot.⁸ Clinical signs of infection like swelling, exudates, cellulitis, odour, tissue necrosis and pyrexia was also noted. Blood samples were taken to get the haemoglobin, total leucocyte count, random blood

sugars and HbA1c. Then ulcers were rinsed with normal saline and swabs were collected from the ulcer base or a deep edge after scrapping with a sterile curette. The swab was sent to microbiology laboratory in a Robertson's cooked meat broth as a transport media for isolation of infesting bacteria and fungi.

Antimicrobial susceptibility testing of isolate was done by the standard disc diffusion method as recommended by the national committee for clinical laboratory standards.

Statistics

Quantitative data was expressed as mean±SD. Qualitative variables were expressed as percentage. A descriptive analysis of the data was done.

RESULTS

Duration of our study was 2 years from 2012-2014. There were total 112 patients with chronic non-healing ulcers. Out of these, 63 were males and 49 females (Table 1). Sixty-six patients belonged to the lower socio-economic status. Majority of 39 patients were educated up to primary class. The mean age of the patients was 36.60±18.80 years. Mean duration of ulcer was 8.2±2.6 months. Mean duration of the disease was 9.8±4.5 years. Out of the 112 diabetic patients, 45 had nephropathy, 25 had retinopathy and 92 were hypertensive. Thirty-six patients had associated foot deformities like equino-varus, flat foot and hallux valgus.

Ulcers were graded according to the Wagner's Ulcer Classification System and they ranged from grade 1-4. No cases of grade 5 were present, majority of 45% (50) of ulcers belonged to grade 3, followed by 25% of grade 2 ulcers (28), 20% of grade 4 (22) and 10% of grade 1 (12) ulcers (Table 2). Average haemoglobin of the patients was 10.54±0.85 gm%. Mean blood sugar was 221±5.64 gm/dl.

Out of the 112 ulcers total 180 isolates were found. Of the 112 cases, 78 (69.6%) were monomicrobial, 32 (28.6%) were polymicrobial, and 2 cases were sterile on culture. There were 8 cases which showed fungal growth. Of the bacterial cases of 102, 84 were due to aerobes (82%), 12 cases were having anaerobes (11.7%) and 6 cases had both aerobes as well as anaerobes (6.3%). The most common bacteria found was *Staphylococcus aureus* in 24 samples (23.5%), followed by *Pseudomonas aeruginosa* in 16 samples (15.6%) and *Enterococcus coli* in 12 cases (11.7%), *Enterococcus faecalis* in 7 cases (6.8%), *Klebsiella pneumoniae* in 9 cases (8.8%), *Proteus spp* in 6 cases (5.8%), and *Citrobacter freundii* in 4 cases (3.9%), *Acinetobacter baumannii* in 4 cases (3.9%), and β haemolytic streptococci in 2 cases (1.96%). Amongst the anaerobes *Peptostreptococcus spp* was seen in 5 cases (4.9%) and was commonest, followed by *Bacteroides spp* 4 cases (3.9%), *Clostridium sporogenes* in 2 cases (1.96%) and *Clostridium perfringens* in 1 case (0.98%). Eight cases were found to be infected with fungal pathogen.

Four samples had *Candida albicans* and two samples were found to have *Aspergillus fumigatus*.

Most of the *staphylococcus* isolated were sensitive to vancomycin (94%), teicoplanin (90%), cephalosporins (93%), linezolid (93%) levofloxacin (89%) and piperacillin-tazobactam (88%). Nearly 65% of *S. aureus* were methicillin-resistant *S. aureus* (MRSA).

All the *Enterococcus* spp were sensitive to cefuroxime, amikacin, vancomycin, netilmycin and levofloxacin.

Table 1: Socio demographic profile of the participants.

Socio-demographic profile	No. (N=112)	Percentage (%)
Age in years		
Mean±SD	36.60±18.80	
Sex		
Male	63	56.7
Female	49	43.3
Religion		
Hindu	89	83.3
Muslim	23	16.7
Marital status		
Married	65	63.3
Unmarried	47	36.7
Occupation		
Student	02	1.78
Housewife	47	41.9
Unskilled worker	48	42.8
Skilled worker	15	13.39
Economic status		
Upto 5000	66	50.0
5000-10000	40	30.0
>10000	6	20.0
Education		
Illiterate	22	19.64
Primary	39	34.82
Highschool	28	25
Inter	22	19.64
Graduate	01	0.89

Table 2: Wagner's Ulcer Classification System grading of the ulcers.

Wagner ulcer classification system	Number of ulcers	Percentage of total (%)
Grade 1	12	10
Grade 2	28	25
Grade 3	50	45
Grade 4	22	20
Grade 5	0	0

DISCUSSION

Diabetic foot ulcers are non-healing ulcers which show no tendency towards healing. Diabetic neuropathy leads to sensory loss hence acute or chronic skin trauma may go unrecognised for hours or days. Autonomic nerve loss contributes to skin breakdown by producing dry, inelastic skin due to loss of oil and sweat from glands.⁹ Also ulceration can develop as a result of weakness of the small muscles of the foot and modification of gait. There may be a sharp increase of pressure under the forefoot with very high pressures localized to under the metatarsal heads and the heel.¹⁰ Suppressed immunity, late diagnosis, lack of proper treatment for infection or suboptimal antimicrobial treatment are the factors which ultimately lead to flaring of infection.¹¹

We studied total 112 patients who were diabetics and having DFUs. Several international studies found such ulcers to be more common in the elderly population.¹²⁻¹⁵ However in our study majority of the patients were young and belonged to the age group bracket of 30-40 years. This is similar to other Indian studies on diabetic foot ulcers.^{16,17} Majority of our patients developed ulcers after 8-10 years of diabetes. Long standing diabetes leads to development of peripheral neuropathy and vasculopathy. Males outnumbered females, which was similar to various other Indian studies.¹⁴⁻²⁰ The reason probably could be due to long standing and outdoor working conditions for males. Majority of the ulcers belonged to Wagner Ulcer Classification grade 2 (28%) and 3 (50%), similar to the study by Anjana et al.¹⁵

We found 98% of the ulcers in study were infected which was more than in a study done by Pritilata et al (45.8%).¹⁶ This could be attributed to the lack of proper hygiene and open wounds by the majority of the study population which came from the lower socioeconomic and rural background. Our study is similar to studies done by Zubair M et al and Raja NS et al and Anjana et al with respect to wound culture isolates being more monomicrobial (69%) than polymicrobial.^{15,21,22} This could be because of more ulcers being superficial and not very deep. Out of the 112 cases, 2 cases were sterile. It was probably due to prior treatment with broad spectrum antibiotics elsewhere.

We found 1.6 organisms isolated per ulcer, similar to work by Sarita et al and Anjana et al.^{15,23} This number was lower than many other studies.^{14,24} Ulcers which are deeper and presented late are more often colonised by multiple organisms.²³ Often there is a symbiotic relationship between multiple organisms in the wound leading to complex infections. Aerobic pathogens consume oxygen and create a favourable environment for anaerobic pathogens.²⁵ We found 11.7% of the cases were infected with anaerobic organisms and 6% of cases were infected with both aerobes as well as anaerobes. However, some studies have said they have more anaerobe isolates than aerobes.^{24,26,27}

We found among the aerobes the commonest infecting bacteria was *Staphylococcus aureus* (28%), followed by *Pseudomonas aeruginosa* (20%), *E. coli* (12%), *Klebsiella* (9%), *E. faecalis* (7%), *Proteus* (6%) and *Citrobacter* (4%). *Peptostreptococcus* spp (5%), *Bacteroides* (4%) and *Clostridium* (3%) were common anaerobe pathogens in our study which is similar to some of the other studies.^{16,18} Ravishekhar et al in their study found *S. aureus* was the most frequent pathogen, found in nearly 14% of infections.¹⁴ Rahim et al found the common bacteria associated with DFU as *Staphylococcus*, *Pseudomonas*, *Peptoniphilus*, *Enterobacter*, *Stenotrophomonas*, *Finegoldia*, and *Serratia*.²⁸ Bessa et al. in their study, noted common presence of bacterial species such as *S. aureus*, *P. aeruginosa*, *Proteus mirabilis*, *E. coli*, and *Corynebacterium* spp. in chronic wounds.²⁵ Bowler and Davies, found *Peptostreptococcus* spp, *Clostridium* spp, pigmented *Prevotella* and *Porphyromonas* to be more prevalent in chronic DFUs.²⁹ In a study conducted by Johnson et al *Peptostreptococci* were the most frequently isolated anaerobic bacteria.³⁰ Sapico et al found *Bacteroides* and anaerobic streptococci as the most common bacterial pathogens in their study.³¹ Anandi et al found the most common anaerobic isolates in their study to be *C. perfringens*.²⁴ Pritilata et al found anaerobes in 10.7% of their cases and *Peptostreptococcus* and *Bacteroides* as most common anaerobes in their study.¹⁶

Most studies have found yeast as the most common fungal pathogen associated with DFUs than filamentous fungi.^{32,33} We found 7% of total cases infested with *Candida* spp and *Aspergillus* spp. Pritilata et al found 5% of fungal infestation with *Candida* as the most common fungal isolate.¹⁶ Chellan et al found 27.2% fungi in their study with *C. parapsilosis* as the most common isolate.³⁴ Veraldi et al found *Candida albicans* as the commonest fungal pathogen in their study.³³

Antibiotic resistance is the most rampant and worrisome issue which has plagued the entire world, more so after the COVID-19 pandemic. So, the most relevant question is, 'When should antibiotics be used?' Lema et al have tried to answer this, quoting two general rules. The first one states to not use antibiotics as a routine. The second rule states to use the appropriate ones, when needed.³⁵ Ulcers with osteomyelitis however do need treatment with antibiotics.³⁶ Most of the *Staphylococcus* was mostly sensitive to vancomycin (94%), teicoplanin (90%), cephalosporins (93%), linezolid (93%) levofloxacin (89%) and piperacillin-tazobactam (88%). Nearly 65% of *Staphylococcus* isolated was found to be MRSA. In other studies, it usually ranges from 10-75%.^{16,22,24,27,33}

Many of the patients in previous studies, discovered that they suffer from diabetes after developing the foot ulcers. This fact emphasises the fact that many of the people might not be aware of the signs and symptoms of diabetes and reiterates the need to raise general awareness about the highly prevalent disease.¹⁸ This study can also be used to come to an empirical treatment for most of the non-healing

ulcers, if culture is not possible especially in rural settings. In such cases antibiotic options like vancomycin, teicoplanin, cephalosporins, linezolid, levofloxacin and piperacillin-tazobactam can be used. Another most important component, apart from antibiotic treatment is daily ulcer care and footwear modifications.³⁶

Limitations

The findings of this study cannot be generalised to the general population due to relatively small sample. The diagnosis was based on standard laboratory methods and no genetic analysis like polymerase chain reaction was used, so the time required for diagnosis was longer.

CONCLUSION

This study compiles clinical and microbiological profile of diabetic foot ulcers in OPD patients. Our study throws light on a high figure of neglected and poorly treated NHUs which could have been managed well and are avoidable. The prevalence of high rate of MRSA is also disturbing and needs more prospective multicentre trials to assess the appropriate and empirical antibiotic planning for diabetic foot ulcers. More studies are required to understand the role of antifungals in diabetic wound healing. Besides we strongly recommend teaching patients with chronic diabetes to identify signs of neuropathy early and techniques of foot care in prevention of ulcers.

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