Original Research Article

A study on microbiological profile in diabetic foot ulcers

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Abstract

Background: Diabetic patients are immunocompromised and are vulnerable to develop foot ulcers which get infected by a variety of organisms. These organisms invade the ulcer resulting in poor healing and spread to deeper tissues finally resulting in major tissue loss or amputation.
Materials and methods: The aim of this study was to identify the prevalent and the common organisms occurring in these diabetic foot ulcers and to assess the sensitive antibiotic for controlling the infection. In this study, 100 patients presenting with diabetic foot ulcers to the Department of General Surgery, SBMCH were selected classified according to IDSA classification and wound swabs were taken from the ulcers and studied.
Results: Most common and prevalent organisms were gram negative rods and gram positive cocci. Pseudomonas aeruginosa followed by proteus mirablis were the most common gram negative organisms and Methicillin sensitive staphylococcus aureus was the most common gram positive cocci. Piperacillin tazobactam and third generation cephalosporins were the sensitive antibiotics.
Conclusion: It has been concluded that strict glycemic control, foot care, use of foot wear, regular dressings for foot ulcers, wise use of antibiotics, to prevent the development of resistance and proper education is essential for a diabetic patient.

Key words

Diabetic foot, Ulcers, Organisms, Antibiotic sensitivity, Diabetes.

Introduction

Diabetes mellitus is the most common metabolic disease in India. India is the diabetic capital of the world. Complications related to diabetes are the most common cause of morbidity and mortality.

Diabetic foot ulcers are one of the most important complications leading to major

medical and financial burden causing 20% of health care costs to the patient. Diabetic patients have 25% risk of developing Diabetic foot ulcers [1-5]. This may be due to peripheral neuropathy, microangiopathy, peripheral arterial disease, prolonged duration of the disease and poor glycemic control.

According to WHO Diabetic foot is defined as the foot of a diabetic patient that has risk of pathological consequences, including infection, ulceration or destruction of tissues associated with neurological abnormalities, various degrees of peripheral vascular disease and metabolic complications of diabetes in lower limb [5].

Organisms invading diabetic foot ulcers either interfere with or prolong the wound healing process leading to the spread of the ulcer and tissue destruction.

This study aims at identifying the organisms occurring in the diabetic foot ulcers, empirical and sensitive antibiotic therapy and ways to prevent.

Aim

- To study the bacteriological profile in diabetic foot ulcers.
- To assess Sensitive antibiotics.

Materials and methods

Patient selection: Patients presenting with diabetic foot ulcers to the OPD were selected, daily dressings or wound debridement and in few cases grafting were done. Patients were followed until wound healed.

Sample size: 100 patients.
Study area: Department of General surgery, SBMCH, Chennai, Tamil Nadu, India.

Inclusion criteria

- Age 30-80 years.
- Patients presenting with diabetic foot ulcers (IDSA Classification).

Exclusion criteria

- Ulcers other than in foot.
- Vasculitis

Methodology

It was a prospective study. 100 patients presenting with diabetic foot ulcers were subjected to history and complete examination of the general condition, the affected limb and the ulcer. Also these patients were subjected to investigations like routine blood investigations and X-ray. Wound swabs were taken before starting empirical antibiotic therapy.

According to International Working Group on the Diabetic Foot, Diabetic Foot Ulcer is defined as a full-thickness wound penetrating the dermis located below ankle in a diabetic patient.

Classification of ulcers

IDSA classification was as per **Table – 1**.

Wound swab

Wound was thoroughly washed with Normal saline and swab taken from the deep tissues and sent for microbiological testing. Cultures were available after 48 hours.

Results

Females were predominant in the study accounting for 54% and the rest 46% were males presenting with diabetic foot ulcers. Patients presenting were mostly within the age group of 51 to 60 years (40%) followed by 41 to 70 years - 43%. In this study female patients were predominant than male patients also presented at a later stage with IDSA stage 2 or 3.

Duration of diabetes played a significant role in development of diabetic related complications like neuropathy and peripheral vascular disease and followed by development of ulcers. More the duration more was the risk of developing complications and foot ulcers. Most patients developed foot ulcers with duration of diabetes between 6 to 15 years (**Figure – 1**).

Table – 1: IDSA classification.

Clinical manifestation	**Infection severity**	**PEDIS grade**
Wound lacking purulence or any manifestations of inflammation	Uninflected	1
Presence of > 2 manifestations of inflammation (purulence or erythema, tenderness, warmth or induration), but any cellulitis/ erythema extends <2 cm around the ulcer and infection is limited to skin or superficial subcutaneous tissues, no other local complications or systemic illness	Mild	2
Infection as above in a patient who is systematically well and metabolically stable but which has > 1 of the following: Cellulitis extending > 2cm Lymphangitic streaking Spread beneth the superficial fascia Deep tissue abscess Gangrene Involvement of muscle, tendon, joint or bone.	Moderate	3
Infection in a patient with systemic toxicity or metabolic instability (fever, tachycardia, hypotension, confusion, vomiting, leukocytes is, acidosis, severe hyperglycaemia or azotemia).	Severe	4

Figure – 1: Duration of diabetes.

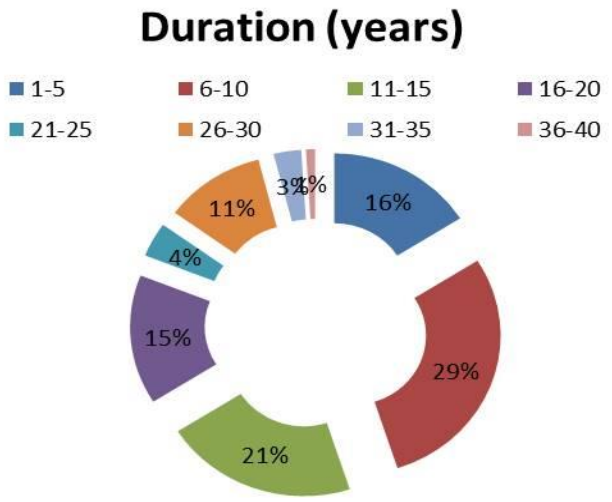


Figure - 2: Areas involved.

Figure - 3: Use of Foot wear.

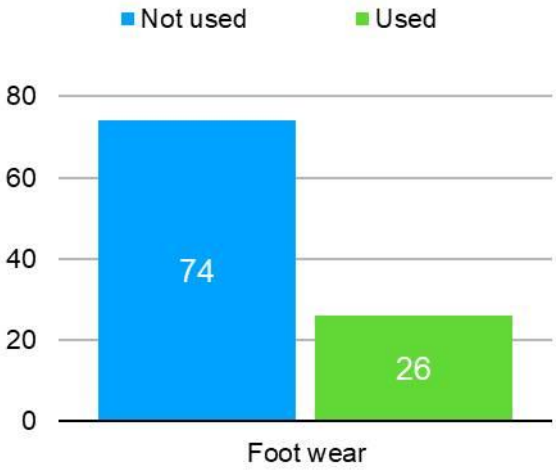


Figure – 4: Number of patients under IDSA grading.

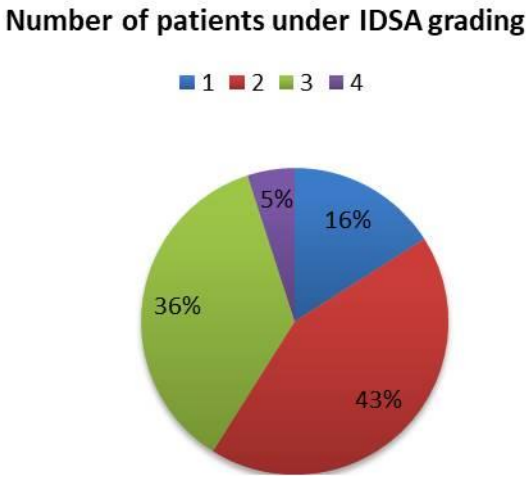
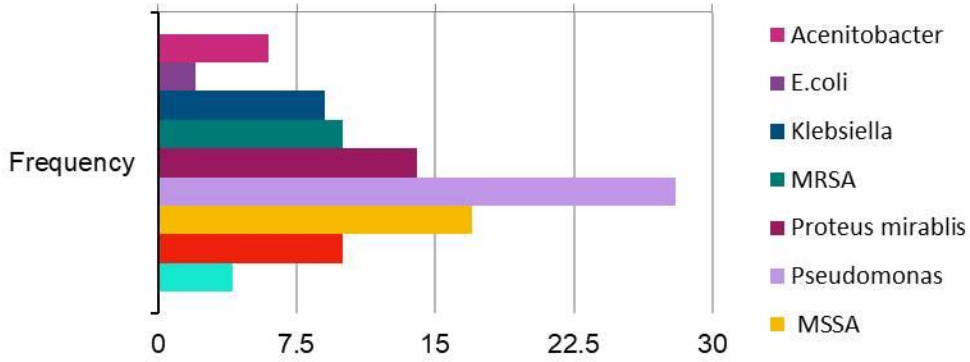


Figure - 5: Prevalent organisms.



Development of diabetic foot infection and ulcers was related to foot care and use of foot wear. Most of the patients who developed infection did not use foot wear (74%) and most commonly affected area was plantar aspect of toes (34%) followed by plantar aspect of foot - over the soles (25%) as per **Figure – 2, 3**.

Number of patients under IDSA grading was as per **Figure – 4**. Microbiological profile was as per **Table – 2**, **Figure – 5**.

Table – 2: Microbiological profile.

Organism	Frequency	Percentage
Acinetobacter	6	6%
E.coli	2	2%
Klebsiella	9	9%
MRSA	10	10%
Proteus mirablis	14	14%
Pseudomonas aeruginosa	28	28%
MSSA	17	17%
Streptococcus	10	10%
No growth	4	4%
Total	100	100%

In this study, most common organisms that occurred in diabetic foot ulcers were gram negative species. Monomicrobial growth was 62% and polymicrobial growth was 38%. Pseudomonas aeruginosa was the predominant species (28%). Previous study has shown that these species are more common in Southern part of India [4]. It has acquired many antibiotic resistance and exhibited virulence in some cases. Methicillin sensitive Staphylococcus aureus accounted for 17% was gram positive cocci was the second most commonly occurring organism mostly in superficial wounds.

MRSA which was on a rising trend accounted for 10% in our study. Treatment of MRSA ulcers and use of antibiotics were done with precaution and dressings were done under most sterile conditions. In a previous study MRSA accounted for 10.3% of all the organisms [3].

Other gram negative organisms like Proteus mirabilis 14%, klebsiella 9%, acinetobacter 6% and E.coli 2% were also commonly occurring and were treated meticulously. There was no fungal growth in our study.

Antibiotic sensitivity

In this study, Pseudomonas aeruginosa was the most commonly occurring organism. These organisms were mostly sensitive to penicillin group like piperacillin tazobactam and cabapenems like meropenem/ imepenem. They were also sensitive to aminoglycosides like amikacin, gentamicin and most of the third generation cephalosporins like ceftazidime, cefuroxime and ceftriaxone; showed variable sensitivity to cefepime, quinolones, tigecycline, astreonam and colistin. They usually showed resistance to amoxicillin clavulanate. They were mostly responding to a combined therapy with third generation cephalosporins with aminoglycosides.

Other gram negative bacteria like proteus mirabilis were susceptible to all the broad spectrum antibiotics and also quinolones and third generation cephalosporins. They were resistant to ampicillin and amoxicillin.

Acinetobacter species were usually sensitive to tobramycin, tetracycline and doxycycline and variable sensitivity to ceftriaxone, quinolones, cotrimoxazole. They were resistant to other cephalosporins, aminoglycosides and amoxicillin.

Klebsiella species showed sensitivity to mostly tigecycline, tobramycin and colistin and variable sensitivity to all other antibiotics like pipracillin tazobactam, carbapenems, third generation cephalosporins, cotrimoxazole and quinolones. Few species also showed sensitivity to aminoglysides. They were mostly resistant to ampicillin and amoxicillin clavulanate. Carbapenems were used for ESBL (Extended spectrum Beta Lactamase) producing Klebsiella or E.coli.

Gram positive organisms were uniformly sensitive to amoxicillin clavulanate, quinolones, cotrimoxazole and linezolid and variable sensitivity to clindamycin and macrolides. Virulent species were susceptible to broad spectrum antibiotics.

MRSA (Methicillin Resistant Staphylococcus aureus) is always a pathogen of concern. These species were sensitive to vancomycin, linezolid, cotrimoxazole, doxycycline and resistant to Clindamycin, penicillin and erythromycin.

According to this study all organisms were mostly sensitive of all the broad spectrum antibiotics. Gram negative organisms showed sensitivity and variable sensitivity to most of the organisms and were resistant to amoxicillin and ampicillin drugs. Gram positive organisms were sensitive to amoxicillin and ampicillin. Out of broad spectrum antibiotics piperacillin tazobactam, meropenem and third generation cephalosporins played a major role. Third generation cephalosporins were active against organisms resistant to other betalactam antibiotics. Aminoglycosides were also sensitive to many organisms but used with caution due to its toxicity. Quinolones were used intravenously for healing ulcers and orally for superficial infections. Cotrimoxazole was used orally for healing and superficial ulcers. Few combination antibiotics like piperacillin tazobactam used with aminoglycosides were given for gram positive and gram negative cover for ulcer healing.

Discussion

Diabetic foot ulcers are one of the most common complications of Diabetes mellitus. It is a major medical and socioeconomic problem. People walking and working barefoot mainly due to poverty and lack of education don't have a proper foot care and acquire infection due to low immune status caused by diabetes and poor glycemic control.

Initially they try home remedies and there is delay in presentation and accessing health care. This leads to prolonged hospital stay, expenditure and inconstant periods of disability and impairment.

Diabetic foot ulcers usually presents with cellulitis, abscess, ulcer, gangrene or necrotising fasciitis. [1]. Ashwin Alva, et al. reported that most common presentation of diabetic foot is abscess followed by cellulitis and ulcer [1].

The infection causing organism produces virulent factors like hemolysin, proteases, collagenases, short chain fatty acids and other factors which slow down or inhibit the wound healing process and leads to chronic infection and non-healing deep seated ulcers. Virulent and resistant organisms cause more and rapid tissue destruction leading to amputation [2, 3].

Patients who presented with IDSA grade 3 and grade 4 ulcers required immediate wound debridement along with collection of samples for culture and were started on empirical antibiotics. Foot ulcers with gangrene and osteomyelitic changes required amputations at various levels depending on tissue destruction.

Empirical antibiotics were selected based on clinical features, disease severity and local antimicrobial resistance patterns. Empirical antibiotics were continued or modified based on sensitivity and response. Duration of antibiotic administration was ascertained according to the clinical situation. Usually antibiotics were given for 1-2 weeks for IDSA grade 1 and for up to 3 to 4 weeks for IDSA 2, 3 [8, 9, 11, 12].

Patients with small superficial ulcers were started on oral Clindamycin. Deep seated ulcers were started on broad spectrum antibiotics like piperacillin tazobactam or third generation cephalosporins.

Most of the foot ulcers were monomicrobial in this study. Diabetic foot ulcers are polymicrobial to begin with but because of improper antibiotic exposure without assessing sensitivity few organisms are killed resulting in monomicrobial

growth which are resistant to low level narrow spectrum antibiotics used as emperical antibiotics in the past. At present there is shift in choice of empirical antibiotics from quinolones to third generation cephalosporins [8, 9].

The most common organism occurred in this study is Pseudomonas aeruginosa followed by Staphylococcus aureus and Proteus mirablis. Gram negative organisms occurred more frequently than gram positive organisms and were more virulent [1].

Priyadarshini Shanmugam, et al. concluded that Gram negative bacilli and gram positive cocci were more prevalent and predominant among monobacterial isolates. Streptococcus and Staphylococcal species were predominant in polymicrobial growth [4]. Selection of appropriate sensitive antibiotics is essential in controlling infection and also preventing antibiotic resistance.

Tamil Selvi, et al. reported Pseudomonas aeruginosa showed 100% resistance to Amoxicillin and Norfloxacin [10]. Bansal, et al. [13] and Ashwin Alva, et al. [1] concluded that most of the isolates grew gram negative organisms and most common were Pseudomonas followed by gram positive cocci Staphyloccous which correlated with our study. Selection and use of empirical and sensitive antibiotic is essential in prevention of resistance which is an important concern.

Diane M Citron, et al. concluded that Piperacillin tazobactam can be used as an empirical antibiotic which covers most of the organisms except MRSA [3]. In a study conducted by Vijayasarathy, et al. [7], they reported most prevalent organisms were gram negative aerobes which correlated with our study and most commonly used empirical antibiotic were cephalosporins and aminoglycosides. Discrepancy in results was attributed to varying geography and infection severity in different hospitals [7].

Gadepalli, et al. described multiple drug resistant organisms (MDRO) were extremely common in hospitalized patients with diabetic foot ulcers including patient factors like poor glycemic control, ulcer size of more than 4 cm sq and osteomyelitis. Patients with these organisms MDRO required multiple wound debridements and prolonged hospital stay [2].

Prevention and proper management of diabetic foot ulcers is necessary to reduce the burden on diabetic patients.

Proper education about foot care of diabetic patients is needed to prevent the development of ulcers. Regular self-examination of skin of feet for cracks or small ulcerations and use of appropriate footwear and strict glycemic control should be advised and is recommended for diabetic patients. Identification and proper treatment of pre ulcerative lesions like removing of callous, draining blisters, removing ingrown toe nail with proper use of topical and oral antibiotics for initial stages of ulcers is essential in prevention development of infections and ulcer.

When a diabetic patient develops foot ulcer proper education is essential for early health care access with regular debridements, dressing, use of appropriate antibiotics and diabetic control to reduce the disease and socioeconomic burden on diabetic patients.

Conclusion

Our study concluded that the most common organisms occurring in diabetic foot ulcers are gram negative aerobes followed by gram positive cocci being the most prevalent. Piperacillin tazobactam and third generation cephalosporins were the sensitive antibiotics. The broad spectrum empirical antibiotics should be used wisely to prevent the development of resistance. Strict glycemic control and good foot care is essential to prevent the development of diabetic foot ulcers.

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