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RESEARCH ARTICLE

DIABETIC FOOT INFECTIONS – AN ONGOING BATTLE

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ABSTRACT

Background: Diabetic foot disease has a major impact on the morbidity and mortality of patients. It is a complex clinical problem which needs multi disciplinary approach and well defined principles of treatment. One of the key components of treating these patients is the prudent selection of antibiotics based on deep tissue cultures. This reduces the associated morbidity and risk of major limb amputations. Methods: This clinical study was done in our tertiary level referral hospital. It is a cross sectional retrospective microbiological and clinical study done over a period of 12 months. It explores the associations between several variables (risk factors, severity of infection, development of complications and clinical outcomes) and the microbiological profile of the diabetic foot infections. Results: 90% of the patients had peripheral mixed neuropathy while 26% had a documented diabetic nephropathy. Most patients (61%) had a poor glycemic control with a HbA1c>7 while 39% had well controlled diabetes with HbA1c<7. Gram negative organisms were grown in 60% of surface swabs and 71% of intra operative specimens. Gram positive organisms were grown in 30% of surface swabs and 29% of intra operative specimens. 10% of the surface swabs had a mixed growth whereas none of the intra operative specimens had a mixed growth.The outcomes comprised of minor amputations of toe(s) and at trans metatarsal levels in 8 patients and major amputations above or below knee in 5 patients. None of the patients who had a positive culture of ESBL and MDR underwent major amputations. Conclusion: The judicious use of antibiotics based on deep tissue cultures can reduce the risk of major amputations. The role of revascularisation is pivotal in patients with peripheral arterial disease complicated by diabetic foot ulcers. The multi disciplinary approach is necessary to address the variables which effect the outcome of these patients.

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INTRODUCTION

Any infection below the level of the malleoli in a patient with diabetes mellitus is termed as a diabetic foot infection. It is a common cause of morbidity, increased duration of hospital stay and increased healthcare cost for diabetic patients in India and worldwide[1]. Diabetic foot infections are associated with prolonged course of illness and reduced quality of life. They require attention to local (foot) and systemic issues and coordinated management by a dedicated team. Accurate identification of organisms can aid the surgeon to select a specific antibiotic therapy thereby improving the outcomes in these cases. Infection with drug resistant organisms is currently a major concern. These infections are difficult to treat and need a dedicated team of specialists to ensure a good result and better quality of life for patients. This is a comprehensive study that will examine the microbiological profile and antibiotic resistance patterns of aerobic bacterial pathogens causing diabetic foot infections in an Indian referral hospital. It explores the associations between several variables (risk factors, severity of infection, development of complications and clinical outcomes) and the microbiological profile of the diabetic foot infections.

Aims:

- To study the risk factors associated with development of diabetic foot infections.
- To correlate the isolates from surface swab and deep tissue cultures and identify the aerobic bacterial pathogens causing diabetic foot infections.
- To examine the antibiotic resistance patterns of these pathogens and identify multi-drug resistant organisms.
- To evaluate the importance of treating peripheral arterial disease in these patients.

Study Design: It is a cross sectional retrospective microbiological and clinical study done over a period of 12 months in an Indian referral hospital. It includes 80 patients

who underwent surgical debridement with or without revascularisation. This study was approved by the institutional ethics committee of our hospital.

Inclusion Criteria: The study involves analysis of the clinical histories, the results of clinical examinations, and the laboratory investigations of all patients with Type 1 and Type 2 diabetes mellitus with foot infections, including paronychia, infected foot ulcers, cellulitis, myositis, abscesses, necrotizing fasciitis, septic arthritis, tendonitis and osteomyelitis. The depth and extent of the wound were classified using the University of Texas classification system. Deep tissue cultures were taken from the wounds intra operatively.

It includes patients with and without the following risk factors for infections:

- Poor glycaemic control ($HbA_1C \geq 7\%$);
- Peripheral neuropathy (loss of vibratory and pinprick sensations over either hallux, and absence of ankle reflexes);
- Peripheral vascular disease (ischemic symptoms and intermittent claudication or rest pain, with or without pedal pulses, ankle brachial pressure index < 0.9, duplex or angiogram confirmed peripheral vascular disease);
- Nephropathy (serum creatinine $\geq$ 1.4 mg/dl and/or presence of micro or macroalbuminuria);
- Patients with disabilities, like limited joint mobility, neuro-osteoarthropathic deformities and previous amputations.

Exclusion Criteria:

- Patients with foot infections without Type 1 or Type 2 diabetes mellitus.
- Patients with Type 1 or Type 2 diabetes mellitus without foot infections.
- Patients with complications of Type 1 or Type 2 diabetes mellitus without foot infections.
- Patients with diabetic foot infections caused by anaerobes.

MICROBIOLOGICAL METHODS

Culture specimens were obtained from the patients during the time of admission. Specimens included pus drained from abscesses; slough and tissue specimens obtained by scraping the ulcer base or the deep portion of the wound edge with a sterile curette following wound wash and debridement of superficial exudates. These were considered surface swabs. During surgical debridement deep tissue cultures including bone chips were collected. These specimens were promptly sent to the laboratory. Isolation and identification of aerobic bacteria were carried out using the BD Phoenix™ Automated Microbiology System (Becton, Dickinson and Company, USA). Antibiotic susceptibility testing was carried out for the different isolates partly by the Kirby Bauer disc diffusion method, and partly using the BD Phoenix™ Automated Microbiology System (Becton, Dickinson and Company, USA), as per CLSI guidelines. (17) Multidrug resistant organisms include MRSA, ESBL producing Gram negative bacteria, Gram negative bacteria resistant to carbapenems, and MR-CONS. (12,13)

Statistical analysis: Statistical analysis will be carried out using GraphPad InStat version 3.10 for Windows 7 (GraphPad Software, USA).

RESULTS

Of the 80 patients with diabetic foot infections, there was a male preponderance with a Male to Female ratio of 2.5. The average age of the patients was 63.4 yr. They had an average duration of diagnosed Type 1 or Type 2 Diabetes Mellitus of 14.65yr. 90% of the patients had peripheral mixed neuropathy while 26% had a documented diabetic nephropathy. Most patients (61%) had a poor glycemic control with a HbA1c>7 while 39% had well controlled diabetes with HbA1c<7. The wounds of the patients were classified during the first visit using University of Texas Classification. The majority of patients (35 patients) had a class 3B wound which is wound(s) penetrating to bone or joint with infection. 22 patients had a class 3D wound which is wound(s) penetrating to bone or joint with infection and ischemia. 4 patients had class 1B wounds, 2 patients had class 1D wounds, 7 patients had class 2B wounds, 1 patient had class 2C wound, 7 patients had class 2D wounds and 2 patients had class 3C wounds. It was our routine practice to obtain appropriate deep tissue specimen for cultures prior to starting empirical antibiotic therapy in all cases. These intra operative specimens included pus, bone chips and tissue samples collected during surgical debridement. On examining these culture results, 10 patients had no growth, Acinetobacter baumanii complex in 2 patients, Enterobacter in 3 patients, MRSA in 6 patients, Enterococcus in 3, Escherichia coli in 8, ESBL in 5, Pseudomonas aeruginosa in 5, Klebsiella pneumoniae in 2, Morganella morganii in 6, Proteus in 4, Psedomonas aeruginosa in 6, Staphylococcus aureus in 4, Streptococcus species in 5 and MDR in 2 patients.

Gram negative organisms were grown in 60% of surface swabs and 71% of intra operative specimens. Gram positive organisms were grown in 30% of surface swabs and 29% of intra operative specimens. 10% of the surface swabs had a mixed growth whereas none of the intra operative specimens had a mixed growth. Revascularisation in the ischemic diabetic foot infections plays a pivotal role in wound healing. In our study 26 patients underwent revascularisation which included open surgical, endovascular and hybrid procedures. 13 patients had infra inguinal percutaneous trans femoral catheter imaging and angioplasty without stenting. These were mainly in the infra popliteal segment disease. 3 patients had angioplasty with stenting of the femoro- popliteal segment. 1 patient underwent axillobifemoral bypass, 1 patient had an aortobifemoral bypass and 4 patients had a femoro distal bypass with reverse vein conduit. A total of 4 patients had hybrid revascularisation procedures - 3 with femoro distal bypass with angioplasty and 1 with femoro distal bypass with iliac stenting. The outcomes comprised of minor amputations of toe(s) and at trans metatarsal levels in 8 patients and major amputations above or below knee in 5 patients. None of the patients who had a positive culture of ESBL and MDR underwent major amputations. This was due to the judicious and timely use of appropriate and complete antibiotic regimens which were recommended by our Infectious Disease specialists. Of the 5 patients who had major amputations, 2 had Morganellamorgagni, 1 had Pseudomonas, 1 had Proteus and only 1 patient had grown MRSA.

There were no mortalities recorded during the study and the average length of stay in hospital was 3-7 days.

DISCUSSION

The risk factors for diabetic foot infections include poor glycemic control, peripheral neuropathy, peripheral arterial disease, nephropathy and neuroarthropathic joints with limited mobility. Aerobic as well as anaerobic organisms have been shown to cause diabetic foot infections, with aerobes being more common. (1,2,4,5) Gram positive organisms, especially *Staphylococcus aureus*, have traditionally been labelled as the most common cause of diabetic foot infections. (1,4,6,7) In recent years however, a number of studies from Asia, India in particular, have reported Gram negative organisms, especially *Enterobacteriaceae* and *Pseudomonas aeruginosa*, as being the most common cause of diabetic foot infections. (2,3,5,8-11) Infection with multidrug resistant organisms (MDROs) is currently a major concern. These include methicillin resistant *Staphylococcus aureus* (MRSA), Extended Spectrum Beta Lactamase (ESBL) producing Gram negative bacteria, Gram negative bacteria resistant to carbapenems, and methicillin resistant coagulase-negative Staphylococci (MR-CONS). (12,13) These infections are seen mainly in patients with a history of antibiotic intake or previous hospitalization. (1,14) The other risk factors associated with MDRO infection are the presence of neuropathy, large ulcer size and osteomyelitis. (2) These infections are difficult to treat and therefore linked to a greater requirement for surgical treatment and protracted hospital stay (2,12,15). Deep wound cultures provide a sensitive method in assessing and targeting the pathogens that cause diabetic foot infections. This will aid the diabetic foot surgeons in guiding antibiotic therapy and reduce the emergence of organisms which have multi drug resistance. The multidisciplinary team approach which includes an Infectious Disease specialist is needed to manage the emergence of multi drug resistant (MDR) organisms, extended spectrum beta lactamase (ESBL) producing bacteria and Methicillin resistant Staphylococcus aureus (MRSA). This approach has allowed us to salvage many limbs in our ongoing battle against diabetic foot infections.

CONCLUSION

The identification of risk factors is key in management of diabetic foot infections. Intraoperative deep tissue samples should be obtained in all possible cases. With targeted antibiotic therapy the morbidity of the disease can be reduced. And role of revascularisation in ischemic diabetic foot infections is pivotal.

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