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Research Article

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A study on the relation of the severity of diabetic foot ulcers with the type of bacterial flora isolated from the wounds

Bikramjit Pal*, Sumit Kumar Gupta

Assistant Professor, Department of Surgery, KPC Medical College, Jadavpur, Kolkata, India

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*Correspondence: Dr. Bikramjit Pal,

E-mail: bikramjit_paul@yahoo.co.in

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ABSTRACT

Background: The study is to determine the relation between severity of the diabetic foot ulcers and the organisms isolated from the wounds; its implications and prognosis with particular reference to the differences in the final outcome depending upon the type of organism infecting the wound. The study try to correlate the severity of the diabetic foot infection according to Meggit-Wagner classification, the incidence of amputation and the impact on the hospital stay with the difference of bacterial flora isolated from the wounds. This is an observational study done in 53 patients who were admitted in the surgical ward of a large private medical college in Jadavpur, India. It has been found from this study that the incidence and severity of diabetic foot ulcer is more in patients with some particular type of bacteria found in their wounds. A strong correlation is found in patients whose wounds were infected with some particular bacteria had resulted in more severe type of foot ulcers with higher incidence of amputation and concomitant longer hospital stay.

Methods: An observational study was done in 53 patients who were admitted in the surgical ward of a teaching hospital in Kolkata, India. The youngest patient was aged 28 years and the oldest patient was 83 years of age. All of them presented with clinically infected foot ulcers. The patients were explained about the study methods in their own language and due consent was taken. A standardized proforma in English, Hindi and the vernacular languages was made for recording the necessary data. The standard X-ray plates were taken into consideration for determination of the involvement of underlying bones. The microbiological studies were done in all patients from the wound swabs of the foot ulcers. The outcome of the diabetic foot ulcer was assessed from the severity of the disease, the presence of the different bacterial flora in their wounds, the incidence of amputation and the duration of hospital stay.

Results: The positive wound culture was found in 67.92 of patients, Methicillin resistant *Staph. aureus* (MRSA) was the commonest isolated organism (44.44%) followed by mixed bacterial flora (*Staph. aureus*, *Streptococcus epidermidis*, *Peptococcus*, and *Bacteroides fragilis*) in 16.98% of patients. ESBL *Klebsiella* was found in 13.89% of patients, *Pseudomonas aeruginosa* and *Enterococcus feacalis* were isolated in 8.33% of patients. 80% of ESBL infected wounds presented with Grade IV ulcers. The incidence of amputation was highest in patients whose wounds were colonized by MRSA and 60% of patients with ESBL *Klebsiella* infected wounds had hospital stay of more than three weeks.

Conclusions: The study observed that the prognosis and outcome of a diabetic foot ulcer vary considerably with the specific type of bacteria colonizing the wound.

Keywords: Diabetic foot ulcer, Wagner classification of diabetic foot ulcers, Bacterial flora and diabetic wounds, Amputation and diabetic foot ulcer disease, Hospital stay and diabetic foot ulcer disease

INTRODUCTION

Diabetic foot infection may be defined most simply as any acute or chronic inflammatory response to a microbial invasion in the infra-malleolar area in a person with diabetes. Because of the comorbidities associated with diabetes, these infections may begin as a seemingly minor problem but often progress, sometimes rapidly, if not managed appropriately. Proper treatment often requires appropriate wound care (usually including debridement) as well as antimicrobial therapy. Most often antibiotic therapy must be initiated empirically in persons with diabetic foot infection while awaiting the results of wound cultures. A diabetic patient has a life time risk of one out of four patients developing foot ulcer disease, which often lead to amputations, the incidence of which is quite high (one out of five patients) in India. The foot readily becomes infected with a variety of pathogens like gram positive and gram negative aerobes, a host of anaerobes and in some studies, polymicrobial invasion is very common. Most of the amputations due to diabetes mellitus are preceded by foot ulcers.^{2,4} The risk of amputation in these patients depends upon the pathogenicity of the bacteria complicated by the resistance to the antibiotics due to the ever changing strains of MRSA and ESBL producer bacteria. This translates into increased morbidity with prolonged hospital stay and a huge financial burden on the patients.

Objectives

- 1. To correlate and compare the severity, prognosis and outcome of the diabetic foot ulcer disease in presence of different bacterial flora in the wounds.
- To assess and observe the impact of some particular organisms with development of more severe type of ulcer and ultimately resulting in higher incidence of amputation and longer hospital stay.

METHODS

The following criteria were used for the inclusion of the patients in the study:

- (a) The patients were suffering from diabetes mellitus
- (b) Mandatory wound swab for bacterial culture was taken on the first day of admission
- (c) Treatment of diabetes mellitus was with Insulin only during the hospital stay.

The patients who were acutely ill, patients who were aged less than 18 years of age and patients who were pregnant are excluded from the study. The foot ulcers in diabetic patients are classified into six grades based on Meggit-Wagner classification - Grade 0 to Grade 5.³ Our criteria for inclusion was patients with foot ulcer of Grade II to Grade IV.

RESULTS

The study was conducted on 53 patients, 32 were male patients and the rest were female patients. Voulgari et al and Larsson et al found a higher prevalence of foot ulcers in men than women, may be due to the increased risk of trauma in males.^{5,6} Most of the patients were elderly (above 60 years) and presented mainly with Grade II and III foot ulcer disease. The patients who were below 60 years of age, more commonly presented with late stage disease (Grade IV). None of our patients had undergone below knee amputation. A study by Boulton et al showed that Native American patients had the highest percentage of below knee amputations whereas Asian patients were much more likely to have toe amputations. Asians had a 69% lower risk of amputation when compared with whites as per findings of Boulton et al.⁷ In our study, 27 patients (50.94%) had undergone amputation of toes, out of them 15 were female patients (55.56%) and 12 were male patients (44.44%). The incidence of amputation was more common in female patients (15 out of 21 patients or 71.43%) than male patients (12 out of 32 patients or 37.50%). The higher incidence of amputation in the female patients may be attributed to their late admission in the hospital with more severe form of the diabetic foot disease.

Of the total number of 53 patients, positive wound culture was found in 36 cases (67.92%). Methicillin Resistant Staph. aureus (MRSA) was isolated from the wounds of 16 patients (44.44%), mixed bacterial flora (Staph. aureus, Streptococcus epidermidis, Peptococcus, and Bacteroides fragilis) was found in 9 cases (16.98%), ESBL Klebsiella found in 5 cases (13.89%), Pseudomonas aeruginosa was found in 3 cases (8.33%) and Enterococcus feacalis was isolated in 3 cases (8.33%). The study revealed the commonest organism to be found in the wounds was MRSA which is consistent with the findings reported worldwide. Some studies showed mixed infection (aerobes and anaerobes) as the predominant isolate from the wounds but most of them also contain MRSA as the principal organism. In our study, mixed infection came second with isolation of multiple bacteria including Bacteroides species in 9 cases. Umadevi et al⁸ demonstrated that 65.5% of S. aureus were MRSA positive, 56% of Enterobacteriaceae member were ESBL producers, in which 62.5% of Proteus species were ESBL positive followed by Klebsiella pneumoniae (60%) and Escherichia coli (56%). In our study, ESBL Klebsiella was found in 5 patients, all of them were transferred from ITU. It seems that nosocomial infection may be the reason for the isolation of ESBL Klebsiella in these patients. Babypadmini and Appalaraju have shown 40% of K. pneumoniae isolates and 41% of them were ESBL producers in their study from Vellore, India. The prevalence of ESBL producing isolates show significant differences among geographical locations within India, and other parts of world ranging from 0% in Iceland to less than 1% in Estonia, 41% in Romania, 16.8% in Iran, 25.2% in Tiruchirapalli, South India, and 31.86% in Turkey. 10-13 Pseudomonas was found in 3 cases, all of them had a long history of diabetes mellitus with poor glycaemic control. The data is consistent with the findings of Ramani A et al and Bansal E et al. 14,15

In our study, Wagner Grade II foot infections were found mostly in patients who had negative wound swab culture (22.64%) and only in 3 patients with MRSA (5.66%). Patients with positive wound culture mostly presented with more severe foot infections (Wagner Grade III and IV). Grade III foot infections were mostly associated with MRSA (18.87%), Mixed (7.55%) and *E. faecalis* (5.66%). *P. aeruginosa* infected wounds mostly presented with Wagner Grade III foot ulcers (66.67%) followed by MRSA (62.5%) and Mixed variety (44.44%). Grade IV foot infections were more commonly found in wounds infected with Mixed variety (9.43%), ESBL *Kleb* (7.55), MRSA (5.66%) and even in 5.66% of patients whose wound swab culture were negative. This particular category of patients whose wound swab culture were

negative and presented with Grade IV foot ulcers, had significantly longer hospital stay. Patients who had wounds infected with ESBL *Kleb*, 80% presented with Grade IV foot infections. Similar high incidence of Grade IV wound ulcers were found in patients with mixed variety (55.56%).

In our study, the higher incidence of amputations was found in patients whose wounds were infected with MRSA, mixed variety and ESBL *Kleb* (28.30%, 9.43% & 7.55% respectively). Out of 16 patients who had MRSA in their wounds, amputations had to be done in 15 (93.75%) of them, closely followed by ESBL *Kleb* infected wounds (4 out of 5 patients or 80%), *P. aeruginosa* infected wounds (2 out of 3 patients or 66.67%) and Mixed variety (5 out of 9 patients or 55.56%). Amputation was done in only 1 patient who had negative wound swab culture and none in patients with *E. faecalis* in their wounds. The incidence of amputation was more in females (15 out of 27 or 55.56%) in comparison to males (12 out of 27 or 44.44%).

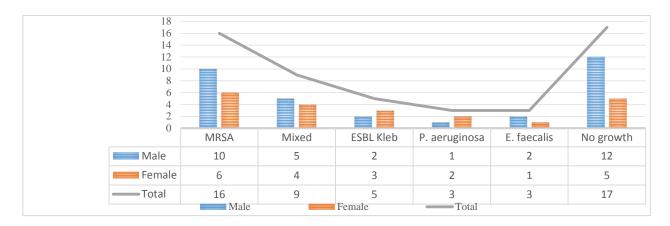


Figure 1: Wound swab reports.

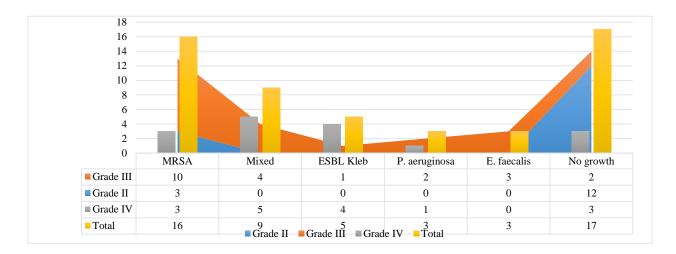


Figure 2: Severity of foot ulcer with the isolated organism.

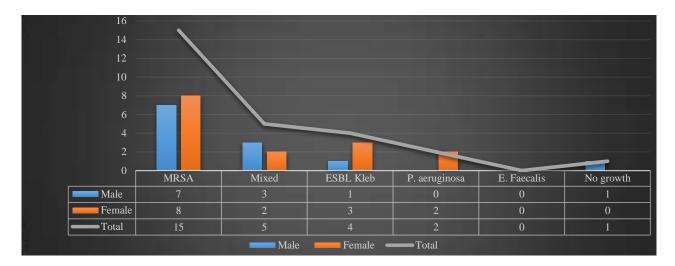


Figure 3: Amputations performed.

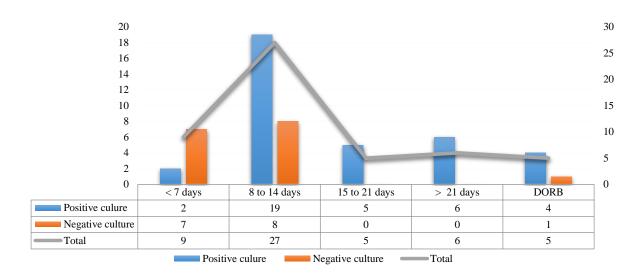


Figure 4: Hospital stay in relation to the wound culture report.

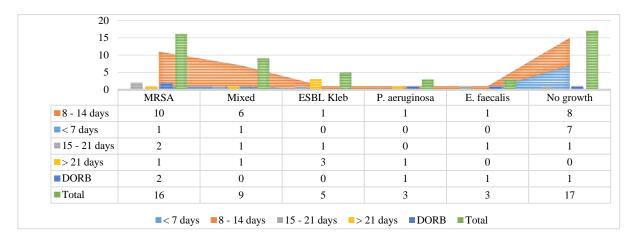


Figure 5: Hospital stay in relation to the specific organism isolated from the wound.

Most of the patients had a hospital stay of 8 to 14 days (50.94%) and 19 (70.37%) of these patients had positive wound swab culture. The remaining 11 patients (20.75%) who stayed for more than 15 days had positive wound swab culture. 5 (9.43%) patients had to be discharged with risk bond (DORB), 4 of them in the first week due to their financial constraints and 1 patient after 2 weeks as he was not happy with our treatment protocol. 9 patients (16.98%) had hospital stay of less than 7 days and out of them, only 2 patients had positive wound swab culture reports (one each MRSA and Mixed variety infected wounds).

Out of the 27 patients whose hospital stay were for 8 to 14 days, 10 (37.04%) had MRSA, no growth was found in wounds of 8 patients (29.63%), 6 patients (22.22%) had Mixed variety of infections and 1 patient (3.70%) had either ESBL *Kleb*, *P. aeruginosa* or *E. faecalis* in their wounds. Longer hospital stays of more than 15 days were common in patients with ESBL *Kleb* (7.54%) and MRSA (5.66%). A significant number of patients (60%) with ESBL *Kleb* infected wounds had a longer hospital stay of more than 21 days.

DISCUSSION

In our study, we try to determine the relative significance, prognosis and outcome of the diabetic foot ulcer disease with the specific type of bacterial flora invading the wounds. The bacteria could be cultured from the wounds in 36 patients (67.92%). We found that excepting patients whose wounds were infected with E. faecalis, all other species of bacteria (MRSA, ESBL Kleb, P. aeruginosa and mixed variety) resulted in poor outcome with more incidence of amputations and longer hospital stay. The infections were more severe (Wagner Grade IV) with ESBL Kleb (4 out of 5 patients or 80%), followed by mixed variety (5 out of 9 patients or 55.56%). Wagner Grade III wounds were commonly due to MRSA (10 out of 16 or 62.50%) and mixed variety (4 out of 9 or 44.44%). The only bacteria cultured from Wagner Grade II wounds were MRSA (3 out of 16 patients or 18.75%). The overall incidence of amputation was 50.94% but significantly higher in females (71.43%) than males (38.71%). MRSA was the commonest bacteria that was found in the wounds of 16 patients (30.19%), and significantly, 15 (93.75%) of them had underwent amputation. MRSA is an increasing problem in industrialized and developing countries. It is commonly believed to be an important cause of poor outcome, increased duration of hospital stay, increased cost and increased mortality. The second commonest bacteria isolated from the wounds was Mixed variety (16.98%) leading to amputation in 5 patients (55.56%). ESBL Kleb infected wounds also resulted in a very high incidence of amputation (80%). Detection of ESBL producing strains is of vital importance as they are responsible for the spread of resistance among different bacteria.^{20,21} A combination of factors such as co-selection due to MDR phenotypes, virulence factors, mobile genetic elements,

clonal spread of virulent strains and the acquisition of diverse ESBL-bearing plasmids may facilitate the spread of ESBL strains. ESBL producing bacteria are emerging as a worldwide clinical threat.²¹ The wide spread resistance to the drugs including the Carbapenams in wounds infected by ESBL strains may be the reason for the fulminant infections and resulting in increased incidence of amputation. On the other hand, none of the patient who had E. faecalis in their wounds had undergone amputation. The incidence of amputation with MRSA and Mixed variety infected wounds was almost same in males and females but more females underwent amputation with wounds infected with P. aeruginosa and ESBL Kleb. One of the reasons for the high incidence of amputations in females may be due to less awareness about the disease and concomitant delay in attending the hospital. 27 patients (50.94%) had hospital stay of 8 to 14 days and 19 (70.37%) of these patients had positive wound swab culture. 11 patients (20.75%) had longer hospital stay (more than 15 days) and all of them had positive culture from their wounds, mostly ESBL Kleb (4 out of 12 patients or 33.33%) and MRSA (3 out of 12 patients or 25%). Our study observed that the outcome in a diabetic foot ulcer disease, specifically, the severity of the disease, the incidence of amputation and prolonged hospital stay may significantly vary with the different types of bacterial flora isolated from the wounds.

CONCLUSION

The study observed that the prognosis and outcome of a diabetic foot ulcer vary considerably with the specific type of bacteria colonizing the wound.

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