ORIGINAL ARTICLE

Bacterial Organisms and their antimicrobial sensitivity in Diabetic Foot Infection of Wagner Grade 1 and 2

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ABSTRACT

Objective: To determine the causative bacterial organisms and their antimicrobial sensitivity among patients of diabetic foot infection of Wagner's grade 1 and II.

Methodology: This descriptive case study was conducted in medical OPD and wards of Liaquat University Hospital Hyderabad/Jamshoro; during August 2007 to July 2008. All diabetic patients with Wagner's grade 1 and 2 foot infections were enrolled in this study. The ulcerated foot specimens were collected under clear vision through scraping the ulcer base or possibly deepest section of wound edge using sterile cotton swab. The specimens were sent towards hospital laboratory as soon as possible for sensitivity and culture. All the data was collected via study proforma and analysis was done by using SPSS version 20.

Results: A total of 60 diabetic patients with Wagner's grade 1 and 2 foot ulcers were studied, their mean age was 50.65±11.36 years and males were in majority (70%). Most of patients (71.7%) had Gram-positive species, Gram negative culture was found in 20% of the patients and 8.3% had mixed infection. Of all isolates, the most common organism was Staphylococcus aureus (50%), followed by Streptococci 11.7% and Enterococci 10%, of the patients, Pseudomonas remained the commonest gram-negative species in 10% cases followed by Klebsiella 5%, E.coli 3.3% and Proteus 1.7%. In 5(8.3%) of the patients, there was a mixed trend of both gram-positive and gram-negative aerobes. Amoxicillin/clavulanate, ampicillin, imipenem, vancomycin, amikacin, and erythromycin were all found to be effective against Staphylococcus aureus, Enterococci, and Streptococci. Ceftazidime, ciprofloxacin, tazobactam/piperacillin, and ceftriaxone were all effective against Gram negative Pseudomonas, E. coli, Klebsiella, and Proteus. All gram-positive species were resistant against Clindamycin and Metronidazole, while all gram-negative species were resistant against Penicillin G, Imipenem, and Erythromycin.

Conclusion: The most common specie was Staphylococcus aureus, followed by Streptococci, Enterococci, and Pseudomonas, E.coli, Klebsiella, and Proteus. imipenem, clavulanate/amoxicillin, vancomycin, erythromycin, ampicillin, and Amikacin were found to be the most sensitive against gram-positive aerobes. 3rd generation cephalosporins (ceftazidime and ceftriaxone) were the most sensitive antibiotics against gram-negative bacteria, followed by ciprofloxacin, tazobactam/piperacillin, and Amikacin.

Keywords: Diabetes, foot, infection, Antimicrobial sensitivity.

INTRODUCTION

Diabetes is a chronic disease that affects a significant percentage of the population of the world.[1] Diabetic foot has been reported to be among the most noticeable complications. Diabetes-associated complications of lower extremity has affected an estimated 131 million (1.8%) people globally.[2] Around 15% of diabetes patients are at risk of developing an ulcer, and 10-30% of diabetic foot ulcers (DFUs) cases will require amputation.[1] The manifestations of Lower-extremity remain a considerable socioeconomic and health challenge, affecting the patient's standard of living and creating a significant financial burden. It can result in a long stay in the hospital in addition to home care and rehabilitative services.[3] In patients struggling with chronic diabetes, the lifetime risk of developing DFUs has been reported to be up to 25%.[4,5] Furthermore, about 50% of these ulcers will get infected.[6] Increased mortality and amputation are closely linked to the diagnosis of DFUs. There are many different factors due to which diabetic foot ulcers may develop like peripheral arterial disease, neuropathy, trauma, pressure overload and foot pathologies such callosities and fissures.[7] Infections are challenging to treat in people with diabetes as their microvascular circulation is impaired, limiting antibiotic concentrations and phagocytic cell in infected region.[1] Ideal administration of diabetic foot infection has the ability to minimise infection-related morbidity, hospitalisation time, major limb amputations, and management costs.[1,8] To successfully manage infection among diabetic patients, adequate wound cultures must be collected, and antibiotic therapy must be guided by the results of these cultures for a good outcome.[9] There have been several classification schemes proposed to include this common language. Wagner's grouping is the most commonly used rating scheme for diabetic foot lesions.[10] Most infections in this group of patients remain polymicrobial, and with the rise in antibiotic-resistant pathogenic strains, it's essential that such patients get adequate antibiotic exposure.[8] As a result, this research was conducted to assess the antimicrobial sensitivity and bacteriology of Wagner's grade 1 & 2 diabetic foot infectious diseases in order to adjust

antimicrobial treatment, which aids not only in earlier rehabilitation but also helps in preventing negative outcomes.

MATERIAL AND METHODS

This descriptive case study was undertaken in medical OPD and wards of Liaquat University Hospital Hyderabad/Jamshoro; during August 2007 to July 2008. After receiving informed consent, all diabetic patients with Wagner's grade 1 and 2 foot infections were enrolled in this study. A detailed medical history was obtained, including the extent, duration, and type of the foot infection, as well as any diabetes medications and prior glycemic control interventions. A physical assessment was performed, involving peripheral pulses, temperature, blood pressure, and a local evaluation of the diabetic foot, with Meggitt Wagner's system of classification used for scoring.[10] The ulcerated foot specimens were collected under clear vision through scraping the ulcer base or possibly deepest section of wound edge using sterile cotton swab. The specimens were sent towards hospital laboratory as soon as possible (within thirty min) using a transport medium for sensitivity and culture. For culture, the samples were inoculated on Chocolate agar, Mac Conkey agar, Blood agar, and Nutrient agar for 24 hours at 37 ^{o}C. To separate and classify gram positive & gram negative species, biochemical tests including catalase, urease tests, coagulase, citrate, indole tests, and triple sugar iron (TSI) were used. Kirby Bauer Disc Diffusion was used for measuring and interpreting sensitivity. Statistical package for social science version 20 was used to analyze the data.

RESULTS

A total of 60 diabetic patients with Wagner's grade 1 and 2 foot ulcers were studied, their mean age stood at 50.6511.36 years. There were 42 (70%) males and 18 (30%) females. The average time spent with diabetes was 10.27±4.75 years. The majority of the 58 patients (96.7%) had type-2 diabetes. Peripheral neuropathy was the most common potential biomarker in 25 (41.7%) of cases, followed by trauma (10%) and ischemia (8.3%). Several predisposing factors were found in 15 (25%) of the patients, with peripheral neuropathy, poor hygiene, and trauma being the most common. The most popular mode of infectious diabetic foot presentation was ulcer 30(50%), followed by plantar abscess in 13(21.7 %). Seventy percent of the cases had infection grade I, while thirty percent had grade-II infection. Table.1

Most of patients (71.7%) had Gram-positive species, with 33.3 percent having grade 1 and 38.3 percent having grade 2. Gram negative bacteria were found in 12 (20%) of the patients, all of whom were in grade 2. Five patients (8.3%) had both gram-positive and gram-negative aerobes, both of which were grade 2. The most common organism was Staphylococcus aureus, which was responsible for 30 (50%) of all isolates, followed by 7 cases of Streptococci (11.7%) and 6 cases of Enterococci (10%). In 6 (10%) of the patients, Pseudomonas remained the commonest gram-negative species. In 5(8.3%) of the patients, there was a mixed trend of both gram-positive and gram-negative aerobes. No anaerobes were discovered in any of the cultured wounds. (Table-II).

Amoxicillin/clavulanate, ampicillin, imipenem, vancomycin, amikacin, and erythromycin were all found to be effective against Staphylococcus aureus, Enterococci, and Streptococci. Ceftazidime, ciprofloxacin, tazobactam/piperacillin, and ceftriaxone were all effective against Gram negative Pseudomonas, E. coli, Klebsiella, and Proteus. The majority of the drugs were effective against Proteus. All gram-positive species were sensitive towards Imipenem, Clavualnate/Amoxicillin, and Ampicillin, while all gram-negative species causing diabetic foot were sensitive towards tazobactam/piperacillin, Metronidazole, and Cephradin. All gram-positive species were resistant against Clindamycin and Metronidazole, while all gram-negative species were resistant against Penicillin G, Imipenem, and Erythromycin. Table.III

Table-I: Descriptive statistics of demographic characteristics of patients with diabetic foot infections (n=60)

Variables		Statistics
Age	Mean±SD	50.65±11.36 years
Duration of ulcer	Mean±SD	10.27±4.75 years
Type of Diabetes	Type I Type II	2 (3.3) 58 (96.7)
Duration of Diabetes	< 5 years 5-10 years 11-20 years >20 years Undiagnosed	4 (6.7%) 20 (33.3) 30 (50) 3 (5) 3 (5)
Compliance of Hypoglycemic agents	Good Poor	7 (12) 53 (88)
Mode of Presentation	Ulcer Plantar abscess Cellulitis Paronychia Dorsal abscess Web space abscess	30 (50.0) 13 (21.7) 5 (8.3) 5 (8.3) 4 (6.7) 3 (5)
Foot involvement	Right Left Bilateral	34 (56.7) 21 (35) 5 (8.3)
Grade of Infection	Grade 1 Grade 2	42 (70) 18 (30)

Table-II: Organisms cultured from diabetic foot n=(60)

Organism	**Grade 1 n**	**Grade 2 n**	**Total n (%)**
Gram positive organisms	20	23	43(71.7)
Staphylococcus Aureus	13	17	30(50)
Streptococci	3	4	7(11.7)
Enterococci	4	2	6(10)
Gram negative organisms	0	12	12(20)
Pseudomonas	0	6	6(10)
Klebsiella	0	3	3(5)
E.Coli	0	2	2(3.3)
Proteus	0	1	1(1.7)
Mixed infection	0	5	5(8.3)
Staphylococcus & Klebsiella	0	3	3(5)
Staphylococcus & Pseudomonas	0	2	2(3.3)

Table-III. Antimicrobial Sensitivity of Organism involved in Diabetic foot infections

	Gram Positive Organism			Gram Negative Organism			
Antibiotics	**Staphylococcus n=30 (%)**	**Streptococci n=7 (%)**	**Enterococci n=6 (%)**	**Pseudomonas n=6 (%)**	**Klebsiella n=3 (%)**	**E.Coli n=2(%)**	**Proteus n=1(%)**
Penicillin G	01 (3.3)	07 (100)	06 (100)	0 (0)	0 (0)	0 (0)	0 (0)
Ampicillin	20 (66.7)	07 (100)	06 (100)	0 (0)	0 (0)	1 (50)	0 (0)
Amoxicillin/Clavualnate	30 (100)	07 (100)	06 (100)	0 (0)	2 (67)	0 (0)	1(100)
Oxacillin	26 (86.6)	05 (71)	0 (0)	5 (83)	2 (67)	1 (50)	1(100)
Piperacillin/tazobactam	0 (0)	04 (57)	03 (50)	6 (100)	3 (100)	2(100)	1(100)
Cephradin	10 (33.3)	0 (0)	0 (0)	6 (100)	3 (100)	2(100)	1(100)
Ceftazidime	04 (13.3)	01 (14)	0 (0)	2 (33)	3 (100)	2(100)	1(100)
Gentamycin	20 (66.7)	03 (43)	05 (83)	4 (67)	3 (100)	1 (50)	1(100)
Amikacin	25 (83.3)	03 (43)	06 (100)	5 (83)	2 (67)	1 (50)	1(100)
Erythromycin	24 (80)	07 (100)	04 (67)	0 (0)	0 (0)	0 (0)	0 (0)
Ciprofloxacin	21 (70)	0 (0)	0 (0)	5 (83)	2 (67)	2(100)	1(100)
Sparfloxacin	19 (63.3)	01 (14)	0 (0)	5 (83)	2 (67)	1 (50)	1(100)
Vancomycin	30 (100)	07 (100)	05 (83)	6 (100)	2 (67)	0 (0)	1(100)
Imipenem	30 (100)	07 (100)	06 (100)	0 (0)	0 (0)	0 (0)	0 (0)
Metronidazole	0 (0)	0 (0)	0 (0)	6 (100)	3(100)	2(100)	1(100)
Clindamycin	0 (0)	0 (0)	0 (0)	3 (50)	1 (33)	2(100)	0 (0)

DISCUSSION

Diabetic foot ulcers (DFU) are one of the most debilitating complications that diabetics may experience, and they may quickly become severe. Males are more likely than females to have diabetic foot infection, and similar to the findings of Nageen A. et al[11], this study discovered that DFU was higher in males as compared to females. Zhang Y et al[2], on the other hand, discovered similar results, as in their study males are mostly often more frequently affected by this disease, which is likely due to the fact that the most of those affected are farmers or labourers who come from low-income families as well as work barefoot on farms where they suffer frequent minor traumas along with penetrating injuries.

In this study, Staphylococcus aureus, Streptococci, and Enterococci were the most common species (50 %, 11.7% and 10 % respectively). Gram negative species were less common as Pseudomonas were found in 10% of cases, Klebsiella in 5%, E.coli in 3.3%, and Proteus in 1.7% of cases. The bacteriological factors isolated in current study were almost identical to the study of Lipsky et al[9] as well as Gerding[12], who studied mild to moderate cases of localized infections, similar to Wagner's 1 & 2 classification.[12] Boutoilte[13] reported in their study that nearly all of the diabetic foot superficial infections were caused by Staphylococcus aureus as well as to a lesser level by Streptococci. Raymundo[14] studied Wagner's grade 1 and 2 patients and reported that Staph. aureus was predominant followed by Enterococci. Staph. aureus, Enterococci, and Streptococcus (42.8%, 21.4% and 14.3% respectively) were the most common gram-positive species isolated from Wagner's grade 1 lesions, accounting for 78% of the total isolates. Gram-negative bacterial isolates made up just 12%, with Klebsiella accounting for 7.14%. Staph. aureus accounting for 20.5%, Enterococci accounting for 8.22%, and Streptococci accounting for 4.11 % were the most common gram-positive species in Wagner's class 2 of lesions. In that research, the occurrence of gram-negative species in grade 1 wounds as well as a higher incidence of gram-positive species in grade 2 did not align with our findings, which revealed no gram- negative species in grade 1. This distinction may be attributed to the reason that the previously reported research used a unique specimen collection method and was conducted in a different setting and had a larger sample size than ours. However, inconsistently Xie X et al[15] reported that Gram-negative bacteria was found to be higher 54.1%, as compared to Gram-positive bacteria as 45.9% out of total 207.

In this study, Amoxicillin/clavulanate, ampicillin, imipenem, vancomycin, Amikacin, and erythromycin were all found to be effective against Staphylococcus aureus, Enterococci and Streptococci. Ceftazidime, ciprofloxacin, tazobactam/piperacillin, and ceftriaxone were all effective against Gram negative Pseudomonas, E. coli, Klebsiella, and Proteus and the majority of the drugs were effective against Proteus. On the other hand as per a Malaysian study the gram negative aerobes showed sensitivity to Amikacin and imipenem.[16] All gram-positive species were sensitive towards Imipenem, Clavualnate/Amoxicillin, and Ampicillin, while all gram-negative species causing diabetic foot were sensitive towards tazobactam/piperacillin, Metronidazole, and Cephradin. All gram-positive species were resistant against Clindamycin and Metronidazole, while all gram-negative species were resistant against Penicillin G, Imipenem, and Erythromycin. On other hand in the study of Jaju K et al[1] reported that Gram-positive aerobes had 100% sensitivity to linezolid and resistance profile was 97.5% to penicillin, followed by Gentamicin 76.32% and resistant vancomycine was 70%. However imipenem was found to be most sensitive 75.70% to gram-negative bacteria, followed by 46.73% resistant to Amikacin and most of the gram negative bacteria found to be resistant to tetracycline, levofloxacin, gentamicin, Cotrimoxazole and zther antimicrobial agents tested. However in the study of Xie X et al[15] observed that the different bacteria's had types of antibiotics sensitivity in different Wagner's classification and types of diabetic foot ulcer. It is very essential for the compliance of the cases as cost is one of the most important factors for not following to prescribed management in our area. However future studies are recommended in order to assess the particular bacterial isolates and its antimicrobial susceptibility pattern in the ulcer of the diabetic foot superficially specially in our local population.

CONCLUSION

Diabetic foot infections were commonly found to have a monomicrobial pattern, with no anaerobes present. The most common species was Staphylococcus aureus, which was followed by Streptococci, Enterococci, and Pseudomonas, E.coli, Klebsiella, and Proteus. Imipenem, clavulanate/amoxicillin, vancomycin, erythromycin, ampicillin, and amikacin were found to be the most sensitive against gram-positive aerobes. 3rd generation cephalosporins (ceftazidime and ceftriaxone) were the most sensitive antibiotics against gram-negative bacteria, followed by ciprofloxacin, tazobactam/piperacillin, and amikacin. Early recovery can be assured, and complications such as gangrene and advancement to partial or full limb amputation could be avoided, if antimicrobial therapy is timely adjusted according to sensitivity findings. Combination treatment with cephalosporins (ceftazidime and ceftriaxone) and clavulanate/amoxicillin or ampicillin, ciprofloxacin, imepenim, or vancomycin can be a successful empirical regimen for fresh cases with Wagner's grade 1 and 2 diabetic foot infections, saving patients expenditure on sensitivity and culture testing in our setting.

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