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A RETROSPECTIVE STUDY OF MANAGEMENT AND OUTCOME OF DIABETIC FOOT INFECTIONS IN A TERTIARY CARE MEDICAL COLLEGE HOSPITAL, ANDHRA PRADESH

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ABSTRACT

Background: Diabetic foot infection (Diabetic foot infection) is one of the most feared complications of diabetes. In India, the number of cases and the problems associated with diabetic foot infections increased in recent years.

Objectives: 1) To enumerate diabetic foot infections.2) To study the outcome of diabetic foot infections. 3)To determine the microbiological profile and antimicrobial susceptibility pattern of organisms isolated from patients with diabetic foot infections

.**Materials and methods:** Retrospective study done in **104** Patients with diabetic foot infections admitted in department of general surgery. All medical records of patients with diabetic foot infections during the period of 2 years were reviewed using data collection sheet. The collected data were analyzed using Statistical Package for Social Sciences.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 01, 2023

Results: Monobacterial and polybacterial culture reports are obtained nearly equal in patients. Among them, the gram-negative organisms were more frequent and isolated from about 82 (78.8%) cultures. Gram-negative organisms included *E. coli* 47 (57.3%), *Proteus spp.* 19(23%), *Klebsiella spp.* 11(13.4%), and *Pseudomonas aeruginosa* 5(6%).

E. coli showed 100% sensitivity Meropenem, Ceftriaxone, Amikacin. However, *E. coli* was highly resistant to Amoxicillin/Clavulanic acid. On the other hand, isolated gram-positive strains were found in 44 (42%) that included *S. aureus* 28(63.6%) and *E. fecalis* 16(36.4%). Regarding gram-positive isolates, all *S. aureus* isolates were sensitive to Ciprofloxacin, Amikacin, resistance rates of *S. aureus* isolates were resistant to Amoxicillin/Clavulanic acid Co-trimoxazole and Amikacin 100% sensitivity against *E. fecalis*. 81% of patients were in poor diabetic control showing increased HbA1C in these cases.

Conclusion: Among the studied samples, gram-negative bacteria were found to be more common in diabetic foot infections patients, *E coli spp.* and *S. aureus* were the most common microorganisms. Moreover, different isolated microorganisms showed to have different degrees of resistance and sensitivity to various antibacterial drugs.

Keywords:

INTRODUCTION:

Diabetes mellitus is assuming epidemic with that an increasing burden of diabetic foot complications. Diabetic foot infections (DFIs) contribute not only to morbidity, amputation, and increased health-care costs but also to mortality.(1) Diabetic foot infections include paronychia, cellulitis, myositis, abscesses, necrotizing fasciitis, septic arthritis, tendonitis and osteomyelitis. Severe infections in the foot may lead to leg amputations. Foot ulceration is one of the most common complication of diabetes, estimated affecting 15% of diabetic patients during their lifetime (2) Prevalence of DFU ranges from 4% to 10% (3) It is estimated that diabetes accounts for more than 50% of amputation,(4,5) of which 85% of lower amputation in diabetes patients are preceded by foot ulcers.(6) The pathophysiology of foot infections in persons with diabetes is quite complex, but their prevalence and severity are largely a consequence of host-related disturbances (immunopathy, neuropathy and arteriopathy) and secondarily pathogen-related factors (virulence, antibiotic-resistance and microbial load) (7) 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.(8) With impetuous use of available antibiotics, antibiotic resistance has become a universal issue in healthcare institutions.(9) This study was conducted as there are no studies from this region which have formulated an empiric therapy for diabetic foot infections, knowledge of antibiotic sensitivity pattern would help make empiric antibiotic treatment protocol for this region and help primary care physicians as well as specialists in initiating more effective empiric antibiotic therapy which in turn may reduce antibiotic resistance and cost of treatment to patients. Objectives of the study were 1)

To enumerate diabetic foot infections.2) To study the outcome of diabetic foot infections.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 01, 2023

3)To determine the microbiological profile and antimicrobial susceptibility pattern of organisms isolated from patients with diabetic foot infections

MATERIALS AND METHODS

Study setting: This study was conducted in SVIMS – SPMCW, Tirupati, Chittoor District, Andhra Pradesh.

Study subjects: Patients with diabetic foot infections admitted at SPMCH, SVIMS, Tirupati

Study period: From May 2020 - May 2022.

Sample size: 104 patients with diabetic foot infections admitted at SVIMS – SPMCW, Tirupati from May 2020 - May 2022.

Study design: Retrospective study.

Inclusion criteria: All patients of diabetic foot infections were included in the study.

Exclusion criteria: Patients having ischemic ulcers due to peripheral arterial disease (atherosclerotic arterial disease and burgers disease) with or without gangrene of the limb, decubitus ulcers with diabetes, tropic ulcers due to leprosy and venous ulcers were excluded from the study.

Ethical approval from Institutional Ethics committee was taken before conducting the study.

Designing of proforma: A validated questionnaire was used to collect data.

Analysis of data: Data was entered in MS Excel and analysed by using SPSS Version 26. Distribution of diabetic foot infections patients according to type, site ,outcome and sensitivity and resistance pattern of microorganisms was calculated.

RESULTS

In total 104 patients of diabetic foot infections 82 were males and 22 were females. Most common presentation of diabetic foot was found to be abscess (75%) (Table 1). Hind Foot (41.3%) was the most common site than other sites (Table 2) Debridement (40.3%) was done in most of patients with diabetic foot (Table 3). Monobacterial and polybacterial culture reports were nearly equal in patients of diabetic foot infections (Table 4). Among all patients admitted , the gram-negative organisms were more frequent and isolated from.About 82(78.8%) cultures. Gram-negative organisms included *E. coli* 47 (57.3%), *Proteusspp.* 19(23%), *Klebsiella spp.* 11(13.4%), and *Pseudomonas aeruginosa* 5(6%). Furthermore, *Klebsilla* isolates showed 100% sensitivity to Meropenem, Amikacin and Co-trimoxazole, but very high resistance rates to ceftriaxone and Amoxicillin/Clavulanic acid. *Pseudomonas aeruginosa* isolates revealed sensitivity to Co-trimoxazole and Amikacin, and all isolates were resistant to Ampicillin and Amoxicillin/Clavulanic acid. *E. coli* showed 100% sensitivity to Meropenem, Ceftriaxone, Amikacin. However, *E. coli* was highly resistant to erythromycin , ampicillin, Amoxicillin/Clavulanic acid Whereas all *Proteus* isolates showed were sensitive to Co-trimoxazole, Amikacin.(Table 5). On the other hand, isolated gram-positive strains were found in 44 (42%) that included *S. aureus* 28(63.6%) (and *E. fecalis* 16 (36.4%). Regarding gram-positive isolates, all *S. aureus* isolates were sensitive to ciprofloxacin, amikacin, resistance rates of *S. aureus* isolates were resistant to Amoxicillin/Clavulanic acid, *E. fecalis were 100% sensitive to* Co-trimoxazole and Amikacin (Table 6). Most of the patients (81%) are in poor diabetic control showing increased HbA1C in these cases (Table 7).

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 01, 2023

Table-1: Distribution of presentation of diabetic foot infections

Presentation	Number of cases	Percentage
Abscess	78	75
Cellulitis	25	24
Wet Gangrene	10	9.6
Necrotising Facsiitis	3	2.9
Charcot Foot	2	1.9
Dry Gangrene	1	0.9

Table-2: Site of presentation of diabetic foot infections

Site	**Number of cases**	**Percentage**
Fore Foot	29	27.9
Mid Foot	32	30.8
Hind Foot	43	41.3

Table-3: Surgical intervention underwent

Incision And Drainage	**Number of cases**	**Percentage**
Fasciotomy	14	13.45
Debridement	42	40.34
Toe Amputation	16	15.4
Below Knee Amputation	23	22
Above Knee Amputation	9	8.6

Table-4: Culture reports in present study

Culture	**Number of cases**	**Percentage**
Monobacterial	45	43.3
Polybacterial	46	44.2
No Growth	13	12.5

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 01, 2023

Table-5: Sensitivity and resistance pattern of gram-negative microorganisms

Microorganism	**Antibiotics (number of tested isolate)**	**Sensitivity test**	
		Sensitive N(%)	**Resistant N(%)**
Klebsiella species (*n* = 11)	Meropenem (1)	1(100%)	0
	Ceftriaxone (1)	0	1(100%)
	Ampicillin (4)	2(50%)	2(50%)
	Amoxicillin/Clavulanic acid (3)	1(25%)	2(75%)
	Co-trimoxazole (1)	1(100%)	1(100%)
	Amikacin (1)	1(100%)	0
Pseudomonas species (*n* = 5)	Ampicillin (2)	1(50%)	1(50%)
	Amoxicillin/Clavulanic acid (1)	0	1(100%)
	Co-trimoxazole (1)	1(100%)	0
	Amikacin (1)	1(100%)	0
Escherichia coli (*n* = 47)	Meropenem (1)	1(100%)	0
	Ceftriaxone (1)	1(100%)	0
	Ampicillin (13)	6(46%)	7(54%)
	Amoxicillin/Clavulanic acid (17)	9(53%)	8(47%)
	Co-trimoxazole (9)	7(77%)	2(23%)
	Amikacin (4)	4(100%)	0
	Ciprofloxacin (2)	2(50%)	1(50%)
	Erythromycin (1)		1(100%)
Proteus species (*n* = 19)			
	Amoxicillin/Clavulanic acid (5)	1(20%)	4(80%)
	Co-trimoxazole (7)	5(71%)	2(29%)
	Amikacin (3)	1(33%)	2(66%)
	Ciprofloxacin (4)	2(50%)	2(50%)

Table-6: Sensitivity and resistance pattern of gram-positive microorganisms

Microorganism	**Antibiotics (number of tested isolate)**	**Sensitivity test**	
		Sensitive N(%)	Resistant N(%)
Staphylococcus aureus (*n* = 28)	Ampicillin (2)	1(50%)	1(50%)
	Amoxicillin/Clavulanic acid (3)	1(33%)	2(66%)
	Co-trimoxazole (8)	5(62%)	3(38%)
	Amikacin (6)	6(100%)	0
	Ciprofloxacin (9)	9(100%)	0

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 01, 2023

Enterococcus faecalis (*n* = 16)	Ampicillin (7) Amoxicillin/Clavulanic acid (7) Co-trimoxazole (1) Amikacin (1)	5(71%) 4(57%) 1(100%) 1(100%)	2(29%) 3(43%) 0 0

Table-7: Diabetic control in present study

HBA1C	Number of cases	Percentage
<5.6%	**3**	2.8
5.7-7.1%	16	15.4
7.1-10%	40	38.5
>10%	45	43.3

DISCUSSION

Diabetes and its associated complications, including foot diseases, are increasing at an alarming pace in India and putting enormous burden on our limited health care resources. Diabetic foot ulcer and diabetic foot infections have long-term implications for persons living with diabetes in the form of morbidity and mortality. The World Health Organization (WHO) defines the diabetic foot as infection, ulceration, and/or destruction of deep tissues associated with neurological and various degrees of peripheral vascular disease in the lower limb (10). Furthermore, diabetic ulcers have 30 times higher risk of limb amputation when compared with foot ulcers due to other causes. The number of cases and the problems associated with diabetic foot infections (DFIs) have dramatically increased in recent years Abbott et al. [11] reported that more than 2% of diabetic patients will develop new foot ulcers annually. The prevalence of DFU varied between 4% and 20.4% among hospital-based studies in individuals with diabetes [12].

In our study in total 104 patients of diabetic foot 82 are male and 22 are females and mean age 55.4 years showing middle-aged men more in number it could be attributed to the fact that males are more exposed to hard works in the outer environment. Moreover, most diabetic foot infections patients were aged between 45 and 65 years and had diabetes for more than 10 years, this because the age increases the chance of getting diabetic foot infections, and diabetic complications are directly proportional to the duration of DM. These findings are similar to the results of studies conducted by Umasankari et al. and Bentkover et al. [13,14]. On the other hand, most of the participants in the current study have poor to moderate socioeconomic status, which may contribute to the development of antimicrobial-resistant due to the high cost of antimicrobial drugs.

In our report, infection was present invariably in nearly all patients and Gram-negative bacteria were the most commonly isolated. *E coli spp*. was the most predominant anaerobic

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 01, 2023

isolates, which is in accordance to the previous bacteriologic study from Singapore [15] or other tertiary care hospital in India [16].

With regards to diabetes control, 81% of patients had poor glycemic control, i.e. HbA1c > 8%. For a variety of reasons, good glucose control is not easily obtained in many Indonesian patients [16]; poor drug compliance, lack of financial resources, and poor access to medical facilities may all compound this problem. It is known that hyperglycemia increases pathogenic bacteria's virulence and may contribute to the development of severe infection, immune system impairment, and antibiotic resistance [17].
Maram H. Hamid et al [18] study showed 87.2% of participants had HgbA1c levels of more than 7%, indicating poor control of blood glucose.

In our study Monobacterial and polybacterial culture reports are obtained nearly equal in patients.
Even though many reports indicated that diabetic foot infections are mostly poly-microbial in the Middle East and North Africa countries [19] this finding is in line with the results of studies conducted by Dhanasekaran et al. and Tiwari et al. [20,21]. Moreover, there is a significant association between the presence of polymicrobial infection and the grade of the ulcer, and it is quite logical as the deepness and severity of the ulcer increase the risk of poly-microbial infections, these results similar to those shown by Shankar et al. and by Gadepalli et al. [22,23]. Furthermore, as many previous reports, our study indicated that gram-negative organisms were present in higher numbers than gram-positive organisms.

Among gram-negative isolates, *E Coli spp.* was the most frequent bacterium, In contrast to our findings, previous studies by Citron et al. and Sivanmaliappan et al. [24], reported that *Pseudomonas aeruginosa* was the most predominant microorganism. On the other hand, *S. aurerus* was the major causative gram-positive bacterium comparable with the findings of Lipsky et al. and Gu et al. [25,26]. Importantly, in agreement with the study, which concluded that diabetic foot ulcers had a high frequency of colonization with antimicrobial-resistant organisms.
Concerning the sensitivity to different antibacterial drugs, unexpectedly, all tested gram-positive and gram-negative bacteria were found to be higly resistant to different cephalosporin drugs such as cefepime, cefixime, cefuroxime, and cefotaxime. This could be attributed to the irrational use of these antibiotics. In our study *E. coli* showed 100% sensitivity Meropenem, Ceftriaxone, amikacin. However, *E. coli* was highly resistant to Amoxicillin/Clavulanic acid. On the other hand, isolated gram-positive strains were found in 44 (42%) that included *S. aureus* 28(63.6%) and *E. fecalis* 16(36.4%). Regarding gram-positive isolates, all *S. aureus* isolates were sensitive to ciprofloxacin, amikacin, resistance rates of *S. aureus* isolates were resistant to Amoxicillin/Clavulanic acid Co-trimoxazole and Amikacin 100% sensitivity against *E. fecalis*. The findings of Hefni AA *el al* who reported 100% sensitivity to imipenem, vancomycin, and amikacin [27]. Although *MERSA* sensitivity to results is in line with those reported by Abdulrazaka et al., in that both studies showed 100% sensitivity to vancomycin, imipenem, meropenem, a difference was observed for

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susceptibility to amikacin [28]. While they reported high sensitivity of *MRSA* to Amikcacin, in the current study, resistance to amikacin was about 67%. Finally, *E. fecalis* isolates showed high resistance to tetracycline, gentamicin, co-trimoxazole, and ciprofloxacin, and highly sensitive to vancomycin, this sensitivity pattern is similar to those reported by Lee JH et al. [29]. The emergence of resistance to this group of antibiotics leaves little options for treating such life-threatening infections, as seen in the current study.

Overall mean HbA1c in this study was 11.2%, higher than what Hartemann-Heutier et al. [30] and Ozkara et al. [31] have shown (mean HbA1c 8.7% and 10.3%, respectively). Thewjitcharoen et al. [32] found that approximately 56.8% of DFU patients had neuropathy only and another 29.3% had neuroischemic ulcers (42.9% and 29.9%, respectively, in our study). Of note, pure ischemic ulcers usually present in lower percentage (10.7% in our study).

In the developing countries, community-acquired and hospital-acquired infections are characterized by high rate of antibiotic resistance, which may lead to continuous changes in the selection of empirical therapy. Furthermore, there is a direct relationship between the total amount of a specific antibiotic used in a particular hospital during a certain period of time and the number of resistant strains that emerge

In addition, low cost and availability of antibiotics in community pharmacies without restricting regulations may cause some patients with diabetic foot infections to skip the culture and sensitivity testing, resort to cheap antibiotics, or even do the test but never complete the antibiotic course. Even though no optimal antimicrobial therapy was established for diabetic foot infections up to date, management of these infections requires isolation and identification of the microbial flora, appropriate antibiotic therapy, according to the sensitivity patterns, and precise selection and identification of the chronic complications and rational surgical intervention for complications. Early recognition, classification, diagnosis, and treatment of foot complications are needed to optimize outcomes in patients with diabetes. There is a need to promote diabetic foot awareness and implement foot-care strategies to prevent diabetic foot and effectively manage this condition.

CONCLUSION

Among diabetic foot infections studied samples, gram-negative bacteria were more commonly isolated than gram-positive bacteria. The most frequently isolated organisms were *E. coli*. For the gram-negative bacteria and *S. aureus* for gram-positive bacteria. All isolates were found to be completely resistant to different cephalosporin drugs and highly sensitive to Meropenem, Amikacin and Co-trimoxazole, but very high resistance rates to Amoxicillin/Clavulanic acid. The surveillance of antimicrobial resistance is necessary, and antibiotic policy should be formulated in the hospital.

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