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Study of Clinico Microbiological Profile of Diabetic Patients with Foot Ulcer

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Abstract: ***Background: Diabetes mellitus is a very serious disease and a major global cause of morbidity and mortality. Diabetic foot ulcers are the most common complications. Multi drug resistant pathogens with diabetic foot ulcers further complicates the treating diabetic ulcers leading to amputation. The microbiology and antibiotic resistance pattern have been evidenced to be varying with the demographic area. Hence, there is need for clinical studies at different demography in order to determine and observe the antimicrobial sensitivity pattern for early management of the DFUs. Objectives: 1) To identify the aerobic, gram negative and gram - positive bacteria causing wound infections in diabetic patients in our hospital. 2) To determine the antimicrobial susceptibility pattern of the frequently isolated Bacteria. 3) To assess risk factors responsible for causing diabetic foot ulcer in diabetic patients. Material and methods: Prospective, observational study was conducted at SRI SIDDHARTHA MEDICAL COLLEGE AND RESEARCH INSTITUTE, TUMKUR from 1st Jan 2021 to 30th Dec 2022 on 91 patients diagnosed with diabetic foot ulcers. Results: Average age of our study population was 59.1±9.5 years. The most common affected group was aged between 58 to 67 years, accounting for about 39.6% (36/91).68 (74.7%) were males and 23 (25.3%) females were present. Majority of them were suffering from DM since 5 to 10 years. There was significantly increased average blood glucose parameter. HbA1c >8 was higher. Also, significant number of patients had been found with neuropathy and loss of sensory as well as motor reflexes. Neuropathy was manifested in 61% of the population.12 (13.2%) samples did not show any growth on pus culture. Staphylococcus was yielded in 19.8% (18) samples followed by 13 (14.3%) with pseudomonas organism. We observed 100% sensitivity for cotrimoxazole, Ampicillin+sulbactum, Imipenem and meropenem followed by 92.4% were sensitive for ceftriaxone. Conclusion: Staphylococcus was the commonest organism causing diabetic foot ulcers in our study area followed by pseudomonas.100% of the organisms were sensitive forcotrimoxazole, Ampicillin+sulbactum, Imipenem and meropenem followed by 92.4% were sensitive for ceftriaxone.***

Keywords: Diabetic foot ulcer, Culture sensitivity, Complication of Diabetes, Antibiotic sensitivity

1. Introduction

Diabetes mellitus is a very serious disease and a major global cause of morbidity and mortality. Based on the survey data by National non communicable disease, the prevalence of diabetes and impaired glucose tolerance has been estimated to be around 9.3% and 24.5% respectively.[1]

Diabetic foot is one of the most feared complications of diabetes. Foot disorders are a leading cause of hospitalization for patients with diabetes.

There is a 25% chance that a diabetic person might develop a foot ulcer in his life time. Ischaemia, neuropathy and infection are the three cardinal etiological factors pre disposing to diabetic foot ulcers.[2, 3]

Diabetic foot infection is defined as the presence of a non - healing wound with evidences of inflammation with or without systemic toxicity and with a definite growth on culture that corelated with the gram's stain.[4]

Common pathophysiology behind the diabetic foot is hyperglycaemia causing microvascular complications, including neuropathy, retinopathy and nephropathy. The primary function of normal, intact skin is to control microbial populations that live on the skin surface and to prevent underlying tissues from becoming colonized and invaded by potential pathogens.[4, 5]

In diabetes, a loss of sensation in the lower extremities may occur, which is known as neuropathy. Neuropathic individuals are highly prone to physical injuries in their lower extremities. Any such injury is a potential cause of a DFU, since hyperglycemia reduces blood flow and the phagocytic activity of neutrophils and macrophages. The progression and chronicity of the wounds can be co related with the duration of diabetes mellitus.[6]

Diabetic foot infections are often polymicrobial caused by aerobic gram positive cocci like S. aureus, Streptococcus. Gram - negative bacilli like Pseudomonas, E - coli klebsiella and proteus.[7] Also, the ignored organisms which are fungus could be the causative organism too.

Initial treatment of diabetic foot infection is often empirical because reliable culture data is inaccessible.[8]

Beta lactam antibiotics are most commonly used antibiotics for bacterial infections. However, the accelerated emergence of antibiotic resistance to these group of drugs among the prevalent pathogens is the most serious threat to the management of such infections, these isolates are usually multi drug resistant.[9] Multi drug resistant pathogens with diabetic foot ulcers further complicates the treating diabetic ulcers leading to amputation.[10]

2. Materials and Methods

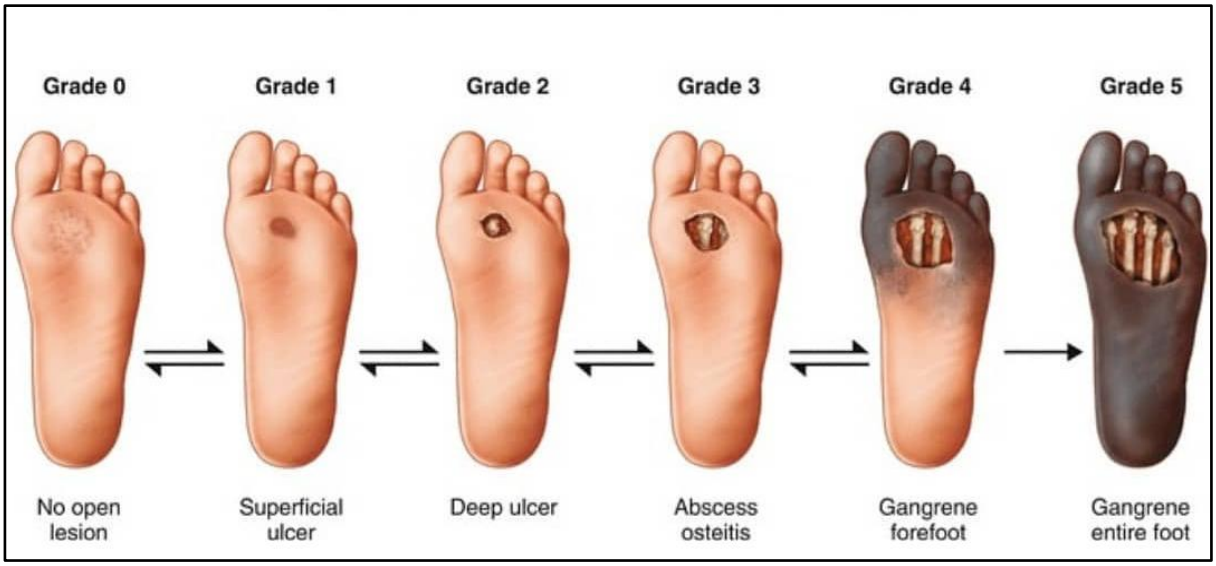
The study was conducted on patients admitted with diabetic foot ulcers at Sri Siddhartha Medical College Hospital and Research Centre, Tumkur, from January 2021 to December 2022. The study was approved by the ethical committee of the institute. A total sample size of 91 with diabetic foot ulcer were included in this cross sectional study who satisfied both inclusion and exclusion criteria. A detailed history was obtained and assessment of clinical symptoms and signs were made.

Diabetic Foot Ulcers

Ulceration of the foot in diabetes is common and Mortality is high and healed ulcers often recur. The pathogenesis of foot ulceration is complex, clinical presentation variable, and management requires early expert assessment. Interventions should be done during infection, peripheral ischaemia, and abnormal pressure loading caused by peripheral neuropathy and limited joint mobility. Despite treatment, ulcers readily become chronic wounds among diabetic patients.

Meggitt - Wagner system, one of the most commonly used classification.1[1]

Grade	Feature of the wound	Preferred management
Grade 0	Pre ulcerative or post ulcerative site	Prevention of the risk
Grade 1	Superficial ulcer	Antibiotics & glycaemic control
Grade 2	Ulcer penetrating to tendon or joint capsule	Debridement, Antibiotics and glycaemic control
Grade 3	Lesion involving deeper tissues	Debridement, some form of amputation
Grade 4	Forefoot gangrene	Wide debridement and amputation
Grade 5	Whole foot gangrene involving more than two thirds of the foot	Below knee amputation



3. Results

Distribution of microbial agents

Organism	N	%
Haemolytic streptococcal	2	2.2%
Enterococcus	2	2.2%
ESBL	2	2.2%
Streptococcal	3	3.3%
Acinetobacter	7	7.7%
Citrobacter	9	9.9%
Proteus	11	12.1%
Klebsiella	12	13.2%
No growth	12	13.2%
Pseudomonas	13	14.3%
Staphylococcal	18	19.8%

Out of 91 pus culture, 12 (13.2%) samples did not show any growth. Out of 79 culture grown, Staphylococcus was the predominant organism found in our culture samples, accounting for about 18 (19.8%) followed by 13 (14.3%) were yielded pseudomonas organism.12 (13.2%) was klebsiella, 11 (12.1%) proteus, 9 (9.9%) Citrobacter, 7 (7.7%) Acinetobacter, 3 (3.3%) streptococcal. Then 2 each were grown ESBL, Enterococcus and haemolytic streptococcal agents.

Distribution of antimicrobial sensitivity

Out of 79 organisms showed culture positivity, all those had been subjected for anti - microbial sensitivity pattern. The obtained result is represented as below.

Antimicrobial agents	Number of cultures showing sensitivity	In %
Amoxicillin+ clavulanic acid	12	15.2%
Amikacin	9	11.4%
Imipenem	79	100.0%
Ceftriaxone	73	92.4%
Ceftazidime	68	86.1%
Cefoperazone+ Sulbactum	59	74.7%
Ofloxacin and other fluroquinolones	13	16.5%
Piperacillin+ Tazobactam	68	86.1%
Meropenem	79	100%
Nitrofurantoin	63	79.7%
Ampicillin+Sulbactum	79	100.0%
Cotrimoxazole	79	100.0%

We observed 100% sensitivity for cotrimoxazole, Ampicillin+sulbactum, Imipenem and meropenem.92.4% were sensitive for ceftriaxone.68 (86.1%) cultures were sensitive for Piperacillin+ Tazobactam and Ceftazidime.63 (79.7%) were sensitive for nitrofurantoin.59 (74.7%) were found to be sensitive for cefoperazone+ sulbactum. Rest of the antimicrobial agents such as fluroquinolones, amikacin and amoxicillin + clavulunic acid had minor sensitivity profile.

Distribution of gender

Gender	N	%
Male	68	74.7%
Female	23	25.3%

In our study, 68 (74.7%) were males and 23 (25.3%) were females.

Duration of duration of diabetes

Duration	N	%
<5 years	18	19.8%
5 to 10 years	48	52.7%
>10 years	25	27.5%

p value <0.001

Out of 91 patients with diabetic foot ulcer in our study, 48 (52.7%) of them were suffering from diabetes since 5 to 10 years followed by 25/91 (27.5%) for >10 years. The rest 18 (19.8%) gave history of diabetes for 5 years. Patients with history of DM >5 years had significant association.

Distribution of habitual history

Habits	N	%
Smoking	41	45.1%
Alcoholism	56	61.5%

In our study population, 56 (61.5%) had history of chronic alcoholism and few of them were smokers too with the incidence of about 45.1%.

Distribution of peripheral neuropathy

Neuropathy	N	%
Present	56	61.5%
Absent	35	38.5%

61.5% were presented with peripheral neuropathy.

Interpretation of Peripheral pulses

Pulse	Present	In %	Absent	In %
Dorsalis Pedis Artery	21	23.1%	70	76.9%
Posterior Tibial Artery	51	56.0%	40	44.0%
Anterior Tibial Artery	35	38.5%	56	61.5%
Popliteal Artery	54	59.3%	37	40.7%

From the above table we can find that 70 (76.9%) of the patients had lost Dorsalis Pedis Artery pulsations followed by 61.5% (56) with loss of Anterior Tibial Artery pulse.44% (40) and 40.7% (37) had lost the pulse for Posterior Tibial artery pulsation and Popliteal Artery respectively.

Distribution of loss of sensations

Sensations	Present	In %	Absent	In %
Temperature	46	50.5%	45	49.5%
Vibration	63	69.2%	28	30.8%
Touch	57	62.6%	34	37.4%
Ankle Jerk	39	42.9%	52	57.1%
Knee Jerk	50	54.9%	41	45.1%
Superficial Plantar Reflex	53	58.2%	38	41.8%

From the above table, we could observe that majority of our patients had observed to be presented with loss of ankle jerk, which was accounted for about 57.1% of the overall population followed by 49.5% with loss of sensation for temperature.

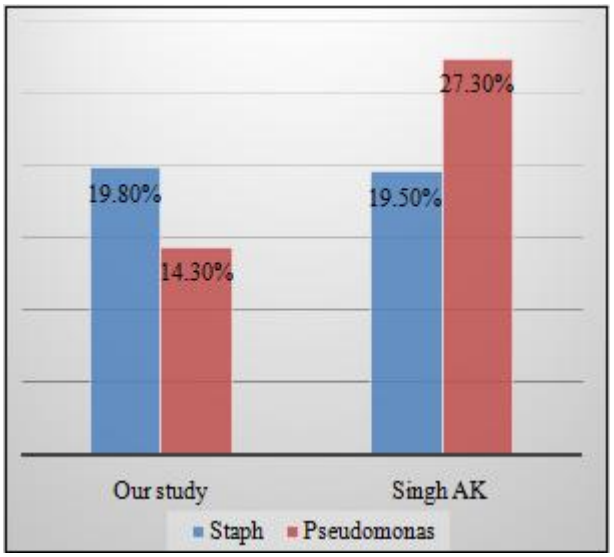
4. Discussion

In the present study, we had included 91 patients presented with diabetic foot ulcer. Majority of the patients were aged between 58 to 67 years, accounting for about 39.6% (36/91) followed by 24.2% aged between 48 to 57 years.14.3%, 13.2% and 8.8% were aged between 38 to 47 years, >67 years and 28 to 37 years. Similar study by **Singh AK et al** reported that Maximum number of cases were in 45–54 year and 55–64 years group (27.6% each), followed by 65–74 years group (20%), then 35–44 years group (16.2%), and lastly 75–84 years (8.6%). The mean age of the population was 57.56 ± 12.5 years.[12]. Even the study by **Anyim et al** had reported that 47.8±12.7years was the mean age of their study population.[13]

Out of 91 pus culture, 12 (13.2%) samples did not show any growth, these could be fungal infection but we could not assess as we do not have fungal culture available. This finding was almost similar with **Hamid MH et al**[14]who reported that the negative growth observed in their study being 10.4%.

Out of 79 culture grown, Staphylococcus was the predominant organism found in our culture samples, accounting for about 18 (19.8%) followed by 13 (14.3%) were yielded pseudomonas organism.12 (13.2%) was klebsiella, 11 (12.1%) proteus, 9 (9.9%) Citrobacter, 7 (7.7%) Acinetobacter, 3 (3.3%) streptococcal. Then 2 each were grown ESBL, Enterococcus and haemolytic streptococcal agents. Similar to our observations, **Banu A et al** also have found *Staphylococcus aureus and Ecoli were the* predominant (24.4%) each organism obtained by the culture samples of their study participants followed by *Pseudomonas aeruginosa (17.1%) but the sensitivity pattern was not part of their objectives.*[15]

Unlike our findings, **Singh AK et al,** 7.62% culture samples were sterile, 48.6% samples showed growth of single organism, two organisms were grown in 28.6% of samples and polymicrobial growth was observed in 15.2% of tissue samples. *Pseudomonas* (27.3%) was the most common single bacterial isolate followed by *Staphylococcus aureus* (19.05%) and E coli (15.5%), which is compared in the graph as below.



Out of 79 organisms showed culture positivity, all those had been subjected for anti - microbial sensitivity pattern. The obtained result is represented as below.

We observed 100% sensitivity for cotrimoxazole, Ampicillin+sulbactum, Imipenem and meropenem.92.4% were sensitive for ceftriaxone.68 (86.1%) cultures were sensitive for Piperacillin+ Tazobactam and Ceftazidime.63 (79.7%) were sensitive for nitrofurantoin.59 (74.7%) were found to be sensitive for cefoperazone+ sulbactum. Rest of the antimicrobial agents such as fluroquinolones, amikacin and amoxicillin + clavulunic acid had minor sensitivity profile. This antimicrobial profile was comparatively different in **Singh AK et al,** in which 100% sensitivity was observed for amikacin and gentamicin. Ofloxacin (90%), Vancomycin (85%), ampicillin, ciprofloxacin, erythromycin was 80% each, amoxicillin - clavulanic acid was 75% and Clindamycin was 70% sensitive.[12] Also, imipenem had maximum sensitivity against all group of organisms in their study too.

Hamid MH et al had tested sensitivity for almost 22 anti - microbial agents. Of these, gram - negative and gram - positive microorganisms were 100% sensitive to imipenem, with the exception of *Pseudomonas aeruginosa* that exhibited 93.3% sensitivity to imipenem. All tested gram - negative and gram - positive, and bacteria were found to be 100% resistant to a different cephalosporins.[14]**Gadepalli R et al** had mentioned that ESBL production and methicillin resistance was noted in 44.7 and 56.0% of bacterial isolates obtained from the pus culture of their study population respectively.[16] Similar to our observation, incidence of Imepenem and meropenem sensitive organisms were higher in their study too which was followed by Ticarcillin - clavum, Cefperazone - sulbactam and ciprofloxacin. In **Anyim O et al**[13] had also observed >80% sensitivity for Imipinem and Ampicillin/Sulbactam. Irrespective of these evidences, the incidence of fungal infections in DFUs was about 31.7% in microbiological pattern of **Kandregula S et al**, they had not analysed for the other organisms. Still the proportion of fungal infection based on their study seems to be higher and almost similar to the bacteriological etiology.[17]

With the above discussion, we can analyse that the clinical and microbiological pattern of diabetic foot ulcers varies with demography. Hence, there is need for more clinical studies to identify the common microbial pattern and the sensitivity pattern at each epidemiological area in order to reduce the resistance pattern and also provide the early antimicrobial management. With this we could understand that the present study has been fulfilled the criteria.

5. Conclusion

Incidence of diabetic foot ulcers was higher among the patients aged between 58 to 67 years with male predominance and those suffering from diabetes for >5 years. Significant proportion of the patients had history of alcoholism and smoking. We did not find any association between the education, occupation and socio - economic status. HbA1c >8 was higher. Neuropathy was manifested in 61% of the population.12 (13.2%) samples did not show any growth on pus culture. Staphylococcus was yielded in 19.8% (18) samples followed by 13 (14.3%) with pseudomonas organism. We observed 100% sensitivity for cotrimoxazole, Ampicillin+sulbactum, Imipenem and meropenem followed by 92.4% were sensitive for ceftriaxone.

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