A Clinico Microbiological Profile of Diabetic Foot Patients

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Abstract

Introduction: Diabetic foot syndrome (DFS), a complex disorder, affects diabetics. It is the unique anatomy of the foot that leads to potentially serious infection. Three cardinal aetiological factors that predispose to diabetic foot ulcers are ischaemia, neuropathy and infection. DFUs are challenging to cure as often the diagnosis is delayed; there is presence of ischaemia, infection with multidrug-resistant organism and extension of infection to the bones. This study was conducted with the aim to determine the clinical and microbiological profile of diabetic foot patients and to assess their outcome.

Methodology: Sixty five male and female patients of 18 and above age that presented with diabetic foot ulcers were enrolled over a period of 18 months.

Results: Of the 65 patients enrolled, 70.77% (n=46) were males while 29.23% (n=19) were females. Male to female ratio was 2.4:1. Diabetic foot ulcers are common in elderly population. Most commonly seen in the age group of 51 to 60 years. When we evaluated the Wagner grade of the ulcers, it was observed that majority of the patients had Wagner grade III ulcer (44.62%) followed by grade II ulcer in 24.62% of the patients. None of the patients enrolled in the present study had wagner grade I ulcer. When the risk factors presence was evaluated in the patients, 63.08% patient had suffered trauma, this was followed by peripheral neuropathy which was present in 60.00% patients. Among the patient enrolled, 36.92% were smokers. 63.08% patients had diabetes for more than 10years while 20% had diabetes of 5-10 years duration and only 16.92% patients had diabetes of less than 5 years. We observed that USG showed presence peripheral vascular disease in 41.54% patients, which is considerably high. In the present study X-ray showed presence of Charcot's joint, osteomyelitis, fracture and osteoporosis in 10.77%, 24.62%, 3.08% and 4.62% patients respectively. We observed that in our study, anemia was present in large proportion of patients, 67.69%, in the present study. In the present study, ulcer was managed conservatively in 38.46% of the patients. I & D was performed in 35.38% of the patients. While amputation was performed in 12.31% of the patients. In the present study, the following organisms were isolated: Staphylococcus aureus, Pseudomonas *Aeruginosa,* Klebsiella pneumonia, Streptococcus pyogenes and Proteus Mirabilis were present in 36.92%, 9.23%, 13.85%, 18.46% and 10.77% patients, respectively. Thus the most common isolate was Staphylococcus aureus followed by Klebsiella pneumonia. We observed that 50% staphylococcus aureus isolates were resistant to methicillin, that is methicillin resistant staphylococcus aureus. However, the isolated staphylococcus did not demonstrate resistance to vancomycin or linezolid. Gram negative organisms showed no resistance to Piperacillin+tazobactum,

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Imipenem and Meropenem in the present study. Amputation was performed in all the patients with Wagner grade IV and V ulcers, while it occurred in 48.15% patients with vasculopathy and 33.33% patients with neuropathy. It was also observed that in those patients with proteus infection, amputation had to be performed in 100% patients.

Conclusion: Diabetic foot ulcers pose a significant burden on the patients and on the health care system. The cost of disability, loss of work and lower extremity amputation extends beyond the economic impact, with regards to patient quality of life.

Proper management of diabetic infections requires appropriate antibiotic selection based on culture and antimicrobial susceptibility results; however, initial management comprises empirical antimicrobial therapy, which is often based on susceptibility data extrapolated from studies performed on general clinical isolates.

Keywords: *Diabetic foot, diabetes, microorganisms.*

Introduction

Diabetes: Amongone of the oldest known diseasesis diabetes.[1]

Diabetesmellitusametabolicdisorderthatischaracterised by impairedcarbohydratemetabolismafflictslargenumber of peopleofallsocialconditionsthroughouttheworldandiscauseoflargemanynumber of complications; thusposingsignificantthreattohealthresourcesglobally. It results incomplications, suchasdiabeticnephropathy, neuropathyandretinopathy.[2,3] Diabetesareuniquegroupinthewaythattheyaremorepronetodevelopinfectionsthanothers.

Epidemiology: Around 422 millionpatientsofdiabetesexitsglobally.[4] By 2030 this number may double.[2] Asper International Diabetes Federation, 7.1% of the adults are affectedwithdiabetes.[5] In the USA, around 8.3% populationisdiabetic.[2] ItisalsoacommonprobleminIndia where 8.7%diabeticpopulationexists.[6] Asoftoday, Aug 2019, around 72.94 millionpeopleinIndiahavediabetesand this will worsen with time.[7] Theproblemisdiabeticsareata 10 foldhigherchanceofhospitalizationduevariousinfections.[8]

Diabetic footulcer: Within creased prevalence of diabetes globally, there is increaseinits complications too.[9] Diabetic foot syndrome (DFS), a complex disorder, affects diabetics.[10,11] The common estulcersiteisdorsalorplantar regions followed by heel and plantar metatarsals.[12] Ulcers classification is as in the table 1 below:

Table 1. Wagner's Classification of Diabeticfootulcers (Wagner, 1987).[13]

Grade	Description
0	Whenthereisnoulcereveninahigh-riskfoot
1	Thesearesuperficialulcerthatinvolvethefullthicknessoftheskinbutdoesnotextendtounderlyingtissues
2	Thesearedeepulcerulcersthatextendtillligamentsandmusclehowevertheboneisnotinvolvedandalsothereisnoformationofabscess
3	Thesearedeepulcerthatareassociatedwithcellulitisorabscessformationandareoftenassociatedwithosteomyelitis
4	Inthisthereislocalgangrene
5	Thewholefootisgangrenous

It is the unique anatomy of the foot that leads to potentially serious infection. Diabetic foot ulcers (DFUs) arise due to its two major complications:

(i) Neuropathy

(ii) Vasculopathy (microaswellasmacro)

Neuropathy makes the foot insensate to chronic or acute injuries. Diabetic suffer from repeated traumas that go non-recognized. This results in development of causes callosities, cracks, fissures, and ulcerformation.

The diabetic foot ulcers are complex from other ulcersin away because micro-vascularcirculationisimpairedduet-oatherosclerosisthatlimitsthebloodcausingischemiaand-decreaseaccessofphagocyticcellsandantibioticstoinfecte-darea.[14]

DFUs are infection prone as high blood sugar levels provide ideal media for the organisms growth. As the immune system is compromised in diabetics there is rapid and relentless growth of organism resulting in local sepsis and sometimes lifethreatening septicemia. The infection causes further ischemia by microthrombi formation that result in necrosis and gangrene. Sometimes the infection is so severe that it calls for limb amputation.[15]

DFUs are chronic in nature, requiring repeated hospitalization. The patient is sometimes exposed to several antibiotics thereby increasing risk of multidrugresistant infection development.

Epidemiology of DFU: India has 3.6% prevalence of diabetic foot ulcers.[6] Between 12%–25% of diabetics are at its risk.[16-18] Around 40%–80% DFUs are associated with morbidity and mortality.

Problem Statement: DFUs have become a source of morbidity and are a leading cause of hospitalization in diabetics to the extent that 20% of hospital admissions in diabetics are due to DFU. These can also lead to infection, gangrene, amputation and sometimes even death in the absence of necessary care.[2]

Chronic DFU is one that fails to heal within 30 days and is a precipitator of amputation.[19] Amputation of even one limb significantly increases the cardiac risk of the patients. Thus, it is utmost necessary to save limb, not only from the view point of mobility and morbidity but also the view point of cardiac safety.

To decrease the burden of DFUs and increase the awareness among the masses, a novel project 'Step- by-Step Improving diabetes Foot care in the developing world' has been initiated in India, it also trains people on treatment of trivial foot lesions.[20]

Three cardinal aetiological factors that predispose to diabetic foot ulcers are ischaemia, neuropathy and infection. DFUs are challenging to cure as often the diagnosis is delayed; there is presence of ischaemia, infection with multidrug-resistant organism and extension of infection to the bones. Fetid foot is combined infection involving bone and soft tissue.[21]

Proper management of diabetic foot infection is a difficult and debatable. It is necessary to isolate and identify the causative microbial flora and initiate appropriate antibiotic therapy. A multidisciplinary approach is required to manage the DFU and its infections.[21]

The infections are usually caused by polymicobials thus requiring proper management with appropriate antibiotic selection.[15] Identification of the causative organism is must for the optimal management. Certain factors like microbes in lower limb, metabolic factors, earlier use of antibiotics and hygiene of feet play an important role in this. [12] Under some specific conditions even fungal infection of diabetic foot can occur.

Infection by multi-drug resistant organisms (MDROs) is common in diabetics and this makes them recalcitrant to healing. [22]

Pathogens such as methicillin resistant *S aureus* (MRSA) or vancomycin-resistant *Enterococci*, are commonly isolated and are usuall resistant to most antimicrobial agents. [2] Presence os MDRO infection is influenced by previous use of antibiotic and the duration for which they were administered, hospitalization frequency and duration, presence of osteomyelitis and proliferative retinopathy. [2]

Predominantly the aerobes that are commonly seen in patients with infected DFUs are *Staphylococcus aureus*, coagulasenegative *staphylococci*, *Streptococcus* species, *Enterococcus* species, *Corynebacterium* species, *Enterobacteriaceae* and *Pseudomonas aeruginosa*. However, many infections are polymicrobial and sometimes even fungi may be present. [2] Fungi are common in chronic foot ulcers in elderly diabetics having high Wagener grade and poor glycemic control.

This study was conducted with the aim to determine the clinical and microbiological profile of diabetic foot patients and to assess their outcome.

Materials and Method

This prospective, interventional study was carried out in the General Surgery Department of Dhiraj Hospital, for one year and half year from April 2018 to September 2019. Those patients that had diabetic foot ulcers were enrolled in the study which was conducted as per Ethical guidelines and local regulatory guidelines.

Inclusion Criteria:

1. Patients of both the sexes that had an age of 18 years or older.
2. All patients who reported to surgery department with diabetic foot ulcers.
3. Patient who gave written informed consent.

Exclusion Criteria:

1. Patients who did not agree to give consent for participation in the study.

Results and Discussion

In the present study 65 patients that had diabetic foot ulcer and had presented to the general surgery department were enrolled.

1. **Gender Distribution:** Of the 65 patients enrolled, 70.77% (n=46) were males while 29.23% (n=19) were females. (Table 1, graph 1) Male to female ration was 2.4:1. Relatively, males spend more time outdoors exposing them to risk of trauma and subsequent ulcer, this could be one of the reasons for male preponderance.Another reason could be that our hospital receives patients from rural background who have a habit of walking barefoot, thus exposing themselves to injuries and contamination of wound.
2. **Age Distribution:**

   Mean population age = 50.88± 16.42years.

   Patients age range= 21-80 years.

   Majority of the patients were found to be of 51 to 60 years.

   Diabetic foot ulcers are common in elderly population. The reasons for the same may be that skin softens with age and can easily break even with trivial trauma. [20] The ability of the cells to proliferate decreases as age progresses, response to stress and also immune response is diminished. Also the complications of diabetes that is neuropathy, vasculopathy worsen as the duration of uncontrolled diabetes increases.

3. **Wagner Grading:** Majority of the patients had Wagner grade III ulcer (44.62%) followed by grade II ulcer in 24.62% of the patients. None of the patients enrolled in the present study had wagner grade I ulcer.
4. **Risk Factors:** When the risk factors presence was evaluated in the patients, 63.08% patient had suffered trauma, this was followed by peripheral neuropathy which was present in 60.00% patients. Among the patient enrolled, 36.92% were smokers. Considering the risk involved, 63.08% patient had suffered trauma, this was followed by peripheral neuropathy which was present in 60.00% patients. Among the patient enrolled, 36.92% were smokers. Neuropathy is a known precursor of trauma as it makes patient unaware of the trivial traumas that occur on daily basis and thus result in ulceration.
5. **Duration of Diabetes:** We classified the population on the basis of duration of diabetes diagnosis it was observed that 63.08% patients had diabetes for more than 10 years. It can be seen that as the duration of diseases increases so is the incidence of the ulceration, the reason for the same could be as follows, as the duration of disease increases so is the degree/severity of neuropathy and vasculopathy and thus predisposing the patients to ulceration that are resistant to heal. Patients are exposed to repeated traumas that cause ulcers to increase in size.

Table 2: Duration of diagnosis of diabetes

Duration of diagnosis of diabetes	Wagner grade								Total	
	II		III		IV		V			
	N	%	N	%	N	%	N	%	N	%
≤5 years	2	3.08%	6	9.23%	3	4.62%	0	0.00%	11	16.92%
>5 to ≤ 10 years	3	4.62%	5	7.69%	3	4.62%	2	3.08%	13	20.00%
≥10 years	11	16.92%	18	27.69%	9	13.85%	3	4.62%	41	63.08%
Total									**65**	**100%**

6. **USG Findings:** USG showed presence peripheral vascular disease in 41.54% patients. vasculopathy predisposes to ischemic changes and ulcerations and reduce reduced host response to infections.
7. **X-Ray Findings:** X-ray showed presence of Charcot's joint, osteomyelitis, fracture and osteoporosis in 10.77%, 24.62%, 3.08% and 4.62% patients.
8. **Incidence of Anaemia:** Anemia was present in significant proportion of patients, 67.69%, in the present study.
9. **Management of Ulcer:** Ulcer was managed conservatively in 38.46% of the patients. I & D was performed in 35.38% of the patients. While amputation was performed in 12.31% of the patients.
10. **Distribution of Bacterial Isolates:** Staphylococcus aureus, Pseudomonas *Aeruginosa,* Klebsiella pneumonia, Streptococcus pyogenes and Proteus Mirabilis was present in 36.92%, 9.23%, 13.85%, 18.46% and 10.77% patients, respectively.

Table 3: Distribution of the bacterial isolates

Bacterial isolates	Wagner grade								Total	
	II		III		IV		V			
	N	%	N	%	N	%	N	%	N	%
Staphylococcus aureus	9	13.85%	12	18.46%	2	3.08%	1	1.54%	24	36.92%
Pseudomonas *aeruginosa*	2	3.08%	3	4.62%	0	0.00%	1	1.54%	6	9.23%
Klebsiella pneumonia	2	3.08%	3	4.62%	3	4.62%	1	1.54%	9	13.85%
Streptococcus pyogenes	1	1.54%	5	7.69%	5	7.69%	1	1.54%	12	18.46%
Proteus mirabilis	1	1.54%	0	0.00%	5	7.69%	1	1.54%	7	10.77%
None	1	1.54%	6	9.23%	0	0.00%	0	0.00%	7	10.77%
Total	**16**	**24.62%**	**29**	**44.62%**	**15**	**23.08%**	**5**	**7.69%**	**65**	**100%**

11 **Association of Amputation and Comorbid Conditions:** It was observed that amputation was performed in all the patients with Wagner grade IV and V ulcers, while it occurred in 48.15% patients with vasculopathy and 33.33% patients with neuropathy. It was also observed that in those patients with proteus infection, amputation had to be performed in 100% patients.

Table 4: Association of amputation in patients with the various factors

Factor	Total No.	No. undergoing Amputation	Percentage
Neuropathy	39	13	33.33%
Vasculopathy	27	13	48.15%
WAGNER Grade			
Grade II	16	1	6.25%
Grade III	29	2	6.90%
Grade IV	15	15	100.00%
Grade V	5	5	100.00%
Wound site infections with			
Staphylococcus aureus	24	3	12.50%
Pseudomonas *aeruginosa*	6	2	33.33%
Klebsiella pneumonia	9	4	44.44%
Streptococcus pyogenes	12	7	58.33%
Proteus mirabilis	7	7	100.00%

12. Resistance Pattern: Resistance pattern of the gram positive organisms was as shown in the table 12. No resistance was observed to vancomycin and linezolid.

Table 5: Resistance pattern seen in organisms that are gram positive.

	Staphylococcus Aureus (n=20)		Streptococcus pyogenes (n=16)	
	N	%	N	%
Methicillin	10	50.00%	4	25.00%
Gentamycin	9	45.00%	6	37.50%
Amikacin	17	85.00%	6	37.50%
Ceftriaxone	13	65.00%	7	43.75%
Amoxy/clav	17	85.00%	6	37.50%
Cotrimoxazole	19	95.00%	15	93.75%
Ciprofloxacin	14	70.00%	13	81.25%
Ampicillin	19	95.00%	8	50.00%
Tetracycline	19	95.00%	15	93.75%
Clindamycin	4	20.00%	1	6.25%
Erythromycin	8	40.00%	5	31.25%
Vancomycin	0	0.00%	0	0.00%
Linezolid	0	0.00%	0	0.00%

Resistance pattern of the gram negative organisms was as shown in the table 13. No resistance was observed to Piperacillin+tazobactum, Imipenem and Meropenem.

Table 6: Resistance pattern of the gram negative organisms

	Klebsiella pneumonia		Pseudomonas		Proteus	
	N	%	N	%	N	%
Gentamycin	7	78%	3	50%	6	86%
Amikacin	5	56%	3	50%	2	29%
Ciprofloxacin	5	56%	5	83%	5	71%
Ampicillin+ Clavulanic acid	7	78%	2	33%	2	29%
Sulphomethoxazole/Trimethoprim	3	33%	3	50%	1	14%
Piperacillin+tazobactum	0	0%	0	0%	0	0%
Cefotaxime	6	67%	5	83%	7	100%
Ceftazidime	4	44%	5	83%	4	57%
Imipenem	0	0%	0	0%	0	0%
Meropenem	0	0%	0	0%	0	0%

Ethics Committee Aprocal: Yes form Sviec

Source of Funding: Nil

Conflict of Interest: Nil

Conclusion

Diabetic foot ulcers pose a significant burden on the patients and on the health care system. The cost of disability, loss of work and lower extremity amputation extends beyond the economic impact, with regards to patient quality of life.

Proper management of diabetic infections requires appropriate antibiotic selection based on culture and antimicrobial susceptibility results; however, initial

management comprises empirical antimicrobial therapy, which is often based on susceptibility data extrapolated from studies performed on general clinical isolates.

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