Clinico-bacteriological study of diabetic foot: an observational study

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ABSTRACT

Background: Diabetic foot is the most important surgical manifestation of diabetes. With foot infection a major cause of morbidity bacterial infection play an important role in diabetic foot ulcers. Aim of this study was proposed to establish the bacterial profile and anti-microbial pattern of ulcer in an attempt to evaluate the role of infection in the foot lesions of diabetic patient. Associated factors like incidence, age, sex, predisposing factors, duration of diabetes, ulcer grade, hospital stay, modes of treatment, antibiotics sensitivity and other outcomes were also evaluated.

Methods: This is a Prospective cohort study. The patients were admitted in surgical ward as provisional diagnosed cases of diabetic foot, were subjected to investigations including blood sugar (fasting, P.P, random), renal function test, x-ray of affected foot, fundus examination, grading of ulcer and various modes of treatment was given. Gross examination and culture from ulcers were done. Study was done in 104 patients over 1 year period.

Results: One hundred four patients with diabetic foot were evaluated. Incidence of diabetic foot was 1.26%. Majority of cases were from rural areas (82.7%). Newly diagnosed cases of diabetes at admission (22.11%), majority of cases culture was positive (94.1% of 85). Staphylococcus was the predominant organism (61.17%), there were patients who were not on any mode of treatment (29.8%).

Conclusions: Staphylococcus aureus a gram positive cocci was the most common micro-organism grown on culture from the ulcer (61.17%), next common micro-organism was Klebsiella (16.47%) gram negative bacilli. Piperacillin and metronidazole were most commonly used antibiotics. Diabetes was controlled by human actrapid (human regular insulin) in majority of the patients. Majority belonging to rural areas (82.7%). Most of the cases were relieved (77.88%). Only two cases fatality (1.92%) occurred during study period.

Keywords: Diabetic foot, Bacteriology, Insulin, Antibiotics

INTRODUCTION

Non-communicable diseases such as diabetes, hypertension and cardiovascular diseases have been emerging as major causes of morbidity and mortality worldwide in past few decades. Diabetes can be said of as a cluster of metabolic disorders comprising impairment of insulin secretion and metabolism, which ultimately leads to abnormal glucose level in the blood, in turn affecting all the vital organs such as heart, kidney, eyes and nerves. Hence diabetes can cause morbidity and mortality owing to the devastating consequences it has on the afflicted person. In this context, foot complications among people with diabetes are a huge challenge in terms...
Foot complications are a major cause of hospital admission for people with diabetes. The presence of foot complications increases health care costs and poses a heavy socioeconomic burden, both to the patient as well as to the nation. Data regarding the prevalence of diabetic foot in developing countries especially in India is sparse. The prevalence of diabetic foot complication has been observed to be higher among rural peoples compared to the people dwelling in urban settings. This situation further worsens the diabetic foot scenario since the rural areas have a lack of proper health care especially in managing diabetic foot.

India is a country with diverse cultures, religion practices and beliefs. These factors themselves are the major cause of diabetic foot complications among people with diabetes in India. Socio-cultural practices such as bare foot walking, religious practices like walking on fire, use of improper footwear and lack of knowledge regarding foot care attributes towards increase in the prevalence of foot complications.

The presence of foot complications increases health care costs and possess a heavy socio-economic burden both to the patient as well as the nation. In developing countries it has been estimated that foot problems may account for about 40% of the health care resources available. Keeping the problem in mind and scope of improvement, we undertook the study.

METHODS

The present study was conducted in 104 patients admitted in surgical wards of Department of Surgery in S.G.M. Hospitals associated with S.S. Medical College, Rewa (M.P.) during the period of August 2014 to July 2015.

The study was carried out in all patients of foot lesions with diabetes mellitus admitted in surgical wards.

Classification of ulcer was done according to Wagner classification

**Wagner classification of diabetic foot ulcers**

- **Grade 0**: No ulcer in a high risk foot.
- **Grade 1**: Superficial ulcer involving the full skin thickness but not underlying tissues.
- **Grade 2**: Deep ulcer, penetrating down to ligaments and muscle, but no bone involvement or abscess formation.
- **Grade 3**: Deep ulcer with cellulitis or abscess formation, often with osteomyelitis.
- **Grade 4**: Localized gangrene.
- **Grade 5**: Extensive gangrene involving the whole foot.

**Investigation**

The following investigations were carried out in patients included in the present study:

**Routine investigations**

Routine investigation of blood for hemoglobin, total and different leucocytes count, urine routine and microscopic examinations were carried out.

- **Blood sugar**: The blood sugar was estimated to know the severity of diabetes mellitus.
- **Urine**: Urine was examined for presence of glucose by titrating urine with benedicts’ solution and thereby monitoring urine sugar by urine ketodiastix. It was done frequently and at definite intervals daily to know the control of diabetes and to adjust the dose of insulin or hypoglycemic drugs.
- **Urine**: Urine was also examined for presence or absence of protein and microscopic examination for any abnormal findings.
- **A peripheral smear**: A peripheral smear was made and examined for microfilaria in suspected cases.
- **X-ray**: X-ray of affected limb was done to rule out osteomyelic changes in underlying bone.

**Special investigation**

The pus culture was sent on day 1 or in some cases day 2 to department of microbiology for culture of organism and their sensitivity to antibiotics and repeated subsequently as and when needed.

Radiological examination & fundus examination, urea and creatinine estimation, ECG, USG were done accordingly as indicated.

**Treatment**

**Control of diabetes**

Insulin is the gold standard in the management of diabetes in presence of complications. Patients with neuropathy were given B1, B6 and B12 intramuscularly.

**Antibiotics**

Majority of patients were kept initially on broad spectrum antibiotics preferably by parenteral administrations, which were further changed according to culture report.

**Local treatment**

- Wound Debridement
- Incision and drainage
• Dressing- Particularly all dressing in diabetic patient require a regular and sufficient dressing.
• Amputation - Amputation was indicated where conservative measures were not possible and foot could not be preserved.

Patients were discharged when wound was healthy and diabetes controlled.

Patients were instructed about foot care and prevention of foot infection Patients were followed up in the out patients department.

RESULTS

Table 1: Month wise admission and incidence of diabetic foot.

<table>
<thead>
<tr>
<th>Months and years</th>
<th>Total admission</th>
<th>Number of patients of diabetic foot</th>
<th>Total Among total admission</th>
</tr>
</thead>
<tbody>
<tr>
<td>August, 2014</td>
<td>723</td>
<td>13</td>
<td>1.79</td>
</tr>
<tr>
<td>September, 2014</td>
<td>741</td>
<td>12</td>
<td>1.62</td>
</tr>
<tr>
<td>October, 2014</td>
<td>730</td>
<td>10</td>
<td>1.37</td>
</tr>
<tr>
<td>November, 2014</td>
<td>673</td>
<td>10</td>
<td>1.48</td>
</tr>
<tr>
<td>December, 2014</td>
<td>731</td>
<td>8</td>
<td>1.09</td>
</tr>
<tr>
<td>January, 2015</td>
<td>590</td>
<td>6</td>
<td>1.02</td>
</tr>
<tr>
<td>February, 2015</td>
<td>679</td>
<td>6</td>
<td>0.88</td>
</tr>
<tr>
<td>March, 2015</td>
<td>608</td>
<td>7</td>
<td>1.15</td>
</tr>
<tr>
<td>April, 2015</td>
<td>624</td>
<td>10</td>
<td>1.60</td>
</tr>
<tr>
<td>May, 2015</td>
<td>638</td>
<td>7</td>
<td>1.09</td>
</tr>
<tr>
<td>June, 2015</td>
<td>716</td>
<td>5</td>
<td>0.69</td>
</tr>
<tr>
<td>July, 2015</td>
<td>836</td>
<td>10</td>
<td>1.19</td>
</tr>
<tr>
<td>Total</td>
<td>8289</td>
<td>104</td>
<td>1.26</td>
</tr>
</tbody>
</table>

As it is evident from the table, majority of the patients (82.7%) were from rural areas.

Table 4: Distribution of cases according to duration of diabetes.

<table>
<thead>
<tr>
<th>Duration (in years)</th>
<th>No. of cases</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnosed at Adm.</td>
<td>23</td>
<td>22.11</td>
</tr>
<tr>
<td>&lt;5 years</td>
<td>39</td>
<td>37.51</td>
</tr>
<tr>
<td>5-10 years</td>
<td>17</td>
<td>16.35</td>
</tr>
<tr>
<td>&gt;10 years</td>
<td>25</td>
<td>24.03</td>
</tr>
<tr>
<td>Total</td>
<td>104</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 5: Status of predisposing factors for lesion among patients.

<table>
<thead>
<tr>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thorne prick</td>
<td>19</td>
</tr>
<tr>
<td>Glass</td>
<td>3</td>
</tr>
<tr>
<td>Stones</td>
<td>5</td>
</tr>
<tr>
<td>Previous foot ulcer</td>
<td>37</td>
</tr>
<tr>
<td>Neuropathic symptoms</td>
<td>23</td>
</tr>
<tr>
<td>Pain while walking</td>
<td>61</td>
</tr>
<tr>
<td>Amputation</td>
<td>06</td>
</tr>
<tr>
<td>Deformity</td>
<td>08</td>
</tr>
<tr>
<td>Cardiovascular symptoms</td>
<td>06</td>
</tr>
<tr>
<td>Visual symptoms</td>
<td>24</td>
</tr>
<tr>
<td>Weight loss</td>
<td>39</td>
</tr>
<tr>
<td>Family history</td>
<td>19</td>
</tr>
</tbody>
</table>

Table 6: Distribution of cases according to hospital stay.

<table>
<thead>
<tr>
<th>Hospital stay (Days)</th>
<th>No. of cases</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;7</td>
<td>32</td>
<td>30.76</td>
</tr>
<tr>
<td>8-14</td>
<td>45</td>
<td>43.27</td>
</tr>
<tr>
<td>&gt;14</td>
<td>27</td>
<td>25.97</td>
</tr>
<tr>
<td>Total</td>
<td>104</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 7: Distribution of cases according to grade of Foot Lesion (Wagener’s classification).

<table>
<thead>
<tr>
<th>Grade</th>
<th>No. of Cases</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>32</td>
<td>30.77</td>
</tr>
<tr>
<td>II</td>
<td>24</td>
<td>23.07</td>
</tr>
<tr>
<td>III</td>
<td>15</td>
<td>14.42</td>
</tr>
<tr>
<td>IV</td>
<td>31</td>
<td>29.81</td>
</tr>
<tr>
<td>V</td>
<td>02</td>
<td>1.93</td>
</tr>
<tr>
<td>Total</td>
<td>104</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 8: Distribution of cases according to antibiotics used.

<table>
<thead>
<tr>
<th>Antibiotics</th>
<th>No. of cases</th>
<th>Percentage</th>
</tr>
</thead>
</table>

As it is evident from the table, piperacillin was the most commonly used (43% of total patients) antibiotic followed by linezolid.

**DISCUSSION**

Diabetic foot ulcers are the source of major suffering and very large cost for both the patient and the health-care system. These ulcers tend to heal slowly, need intensive care and healing can be complicated by infection and gangrene leading to long term in hospital treatment and/or amputation. Every 30 seconds, a leg is lost due to Diabetes somewhere in the world. Moreover, foot ulcers have a major negative effect on quality of life due to decrease mobility, loss of work & reduction in social activities. In India approximately 45,000 legs are amputated every year.

**Incidence**

The incidence of foot ulcer due to diabetes presented in surgical wards was 1.26% (104 cases while incidence of foot lesions was 4.73% of total admissions (8289), Das N et al. found the incidence of diabetic foot as 1.2%.

**Age**

In the present study the most common age group affected was 35-50 years in which 39.42% patients (41 cases) were affected. A significant number of patients (40 cases) constituting 38.46% were of age group 51-65 years. Thus most of the patients affected of diabetic foot belonged to 4th 5th and 6th decade of life, findings consistent with Acharya et al. B.R. Mehra et al. studied that in rural population age group affected most between 41-60 years.

**Sex**

The study performed by the authors revealed that diabetic foot syndrome dominated amongst males. The male to female ratio of the study was observed to be (2.15:1). B.R. Mehra et al. studied that 69.6% were male and 30.4% were female (500 cases) (Male:female ratio 2.2:1).

The higher incidence of foot affection among males may be explained by the fact that males are more prone to trauma owing to outdoor activities being more commonly performed by them.

**Residence**

82.7% of the patients affected of diabetic foot syndrome resided at some rural area, and the rest of patients belonged to semi urban areas mainly and only few resided in urban locality. This was consistent with finding of Acharya et al. who reported 88% in his study.
Occupation and socio economic status

The foot being distal end of lower extremity has to face all the assault from the surface in which body rests, and occupation effects patients’ life style, predisposing the foot to various nature of assaults not taken care of.

In the present study majority of patients 68.2% were farmers and labourer thus constituting more than half of the patients who were manual workers. A significant number of patients were house wife (18.27%) having sedentary life style but a few of them also had been involved in outdoor activities such as forest workers.

 Majority of patients belonged to lower & middle socio economic status (56.73% and 36.54% respectively) and only 6.83% (7 cases) belongs to highly affluent group. Findings of Das et al was in support 56%. This type of distribution in the study may be due to the reason that a large population of this part of region belongs to lower socio economic status and majority of them are either farmers or labourers.

In India no group is spare of diabetes mellitus and its complication

Predisposing factors

In the present series in majority of patients trauma was the mode for onset of long sequel of diabetic foot syndrome. 25.96% of patients inflicted trauma of one or other form. Wu S, et al,4 identified trauma is an important factor in the precipitation of diabetic foot ulcer.

Joslin in 1971 who pointed out that trauma is an important factor in the precipitation of diabetic foot syndrome.

History of previous foot ulcer was found in 35.56% which was much higher than value reported by Bustos-saldana et al6 i.e 10%.

Grade of ulcer (Wagner's grading)

In the present study, majority of ulcers were of grade I and IV (60.58%). The presentation of patients at higher grade of ulcer is probably due to late presentation and rapid progression of the disease.

The results of the present study, corresponds with the results obtained by K. Van Acker10 who found that majority of the patients had grade I and III ulcers (57.3% and 17%) respectively in their study of clinical profile of diabetic foot infection in South India.

Blood sugar levels

In the presence of infection control of blood sugar level towards normo glycaemic levels is important, in order to prevent rapid progression of infection but at the same time it is difficult also. Hyperglycaemia in the presence of infection cannot be controlled by either diet, exercise or oral hypoglycaemic agents,. Insulin remains the gold standard in such condition.

In present study 27.88% of cases were present with blood sugar level between 140-200 mg/dl, in 34.61% it was between 201-250 mg/dl and in 37.51% of cases it was >250 mg/dl at the time of admission. Almost no patient was present with good blood sugar control.

In this study 67.89% patients were known case of diabetes in which 65.75% patients were taking oral hypoglycaemic drug 15.07% of patients were taking insulin and in 19.18% of cases ayurvedic and dietary management was done to control diabetes.

Bustos-saldana et al9 reported deranged fasting blood sugar level in 78% of cases.

Bacteriology

The common causative organism implicated have been aerobes particularly Staphylococcus aureus as the most important organism. There are also evidences that anaerobes may play a role. The organisms seen are bacteroides, proteus, enterococcus, clostridia and E. coli. Synergism between anaerobes and aerobes is often the cause of rapid spread of infection and is associated with the foul odor characteristic of sepsis in diabetic foot.

In the present study Staphylococcus aureus was found to be the most important micro-organism (61.17%) when pus from ulcer was cultured on admission. The second common organism was found to be Klebsiella (16.47%) and mixed aerobe and anaerobes were found in 9.41% cases. C. Anandi et al11 found Polymicrobial aetiology in 69 (64.4%) and single aetiology in 21 (19.6%). Shankar EM et al12 gram-negative bacteria (57.6%) were isolated more often than gram-positive ones (42.3%) in the patients screened. Lipsky BA et al13 found most DFIs are Polymicrobial, with aerobic gram-positive cocci, and especially staphylococci most common. Ertugrul BM et al14 reported pseudomonas most frequently isolated species. Tiwari S et al15 reported mono-microbial infection more common.

The antibiotic sensitivity pattern was obtained whenever any micro-organism was cultured. It was found that all micro-organism showed satisfactory sensitivity to aminoglycosides and 3rd generation cephalosporines. In sufficient cases good sensitivity was still maintained to crystalline penicillin and quino lones.

It is found that staphylococcus was almost 98% sensitive to oxytetracyclin followed by amikacin, gentamycin. klebsiella was most sensitive to amikacin and erythromycin while pseudomonas was to amikacin, gentamycin, cotrimoxazole, cefotaxim and oxytetracyclin.
**Antibiotics**

Infection in diabetic foot is polymicrobial and need broad spectrum antibiotics, which are effective against commonly known pathogens. Clinically infected ulcers are generally treated by amoxyclov or clindamycin as reviewed by Caputo. Uncomplicated not clinically infected neuropathic ulcers should heal provided there is adequate wound care and pressure relief without need of antibiotic (Chanteleau et al. Santoso M et al. found Pseudomonas (40.9%) followed by Staphylococcus (29.5%).

In the present study majority of the ulcers were infected and were treated with a combination of antibiotic parenterally. For gram positive bacterial coverage most of them received piperacillin (28.85%)/linizolid 13.46% alone or in combination 14.42%. Cephalosporins, metronidazole and amikacin were used in 11.54% of the cases. Amikacin was used for gram negative coverage in cases were no renal impairment was found. Anaerobes was covered by metronidazole in all the cases. Clindamycin was used in 8.66% Patients.

**Duration of hospital stay**

In the present study, duration of hospital stay ranged from 3 days to 68 days while majority of patients stayed in hospital from 8-14 days (43.27%). Acharya et al. reported majority of cases stayed for 14-28 days.

**Mortality**

In present study mortality was 1.92% (2 patients). This patient was prolonged case of diabetes mellitus with uncontrolled diabetes. Septicemic shock and acute on chronic renal failure was the cause of death.

Das N et al. reported 6% mortality in his study and found septicemia as the most common cause of death of these patient.

**CONCLUSION**

The present study was conducted in 104 patients admitted in surgical wards of Department of Surgery in S.G.M. Hospitals associated with S.S. Medical College, Rewa (M.P.) during the period of August 2014 to July 2015.

Observations were drawn from the data collected. After appropriate review of literature available results were analyzed and following conclusions were drawn:

- The incidence of diabetic foot was 1.26% of total admissions and 26.5% of all foot lesions. However the incidence of infectious foot lesion during the same period was 4.73% of admission.
- The highest incidence(39.42) of diabetic foot was found between 35-50 yrs age group, while patients between 51-65yrs were found to be 38.46% and of age group >65yrs constituted 22.12% of cases.
- Majority of patients were males (68.26%). The male: female ratio was 2.15:1.
- Most of the patients of diabetic foot were from the rural areas (82.7%).
- Majority of the patients of diabetic foot were Labourers and farmers (35.58% and 32.7%) respectively.
- Majority of diabetic foot incidence was seen in lower and middle socio economic status (56.73% & 36.54% respectively).
- Among all diabetic foot cases 22.1% patients of diabetic foot were newly diagnosed cases of diabetes.
- Chronic diabetes mellitus of 5-10 years was present in 16.35% of the patients, 24.03% incidence was noted in those of duration >10years. History of diabetes mellitus less than 5yrs positive in 37.51% cases.
- Hypertension was found to be associated with 22.1% of Patient with CAD in 13.8% Patients.
- Retinal changes were found in 42.3% of the Patients of Diabetic foot.
- Majority of the patients of diabetic foot who were known cases were taking some oral hypoglycemic (65.75%) out of which(62.5%) were on regular treatment and 37.5% were irregular in treatment.
- In most of the patients trauma was the predisposing factor (25.9%) stones and glass were responsible for 7.69% of them while thorn prick for 18.26%. In 28% of the cases history of any initiating events was absent. Family history for diabetes was present in 18.27% of patients.
- The right foot was affected in 53.85% patients of diabetic foot while left foot was 39.42% and bilateral involvement in 6.73% of cases.
- Majority of the patients had lesion of Wagner’s grade I and IV 30.77% and 29.81% respectively and 14.42% grade III ulcer were present.
- Majority of the patients (37.51%) had severe degree of hyperglycaemia (blood sugar level >250 mg%) while about 34.61% of patients had blood glucose level 201-250 mg% at the time of admission.
- It was found that staphylococcus aureus a gram positive cocci was the most common microorganism grown on culture from the ulcer on admission (61.17%). Next common micro-organism was Klebsiella(16.47%) gram negative bacilli.
- The antibiotic sensitivity pattern revealed a high sensitivity of all micro-organism to aminoglycosides, third generation Cephalosporines and oxytetracyclins,
- Diabetes was controlled by human actrapid (human regular insulin) in most of the patients. It was adequately controlled in most of them.
- Majority of the patients were treated with broad spectrum antibiotics through intravenous route usually a combination of two antibiotics.
Foot of the diabetic patients is vulnerable due to loss and perversion of sensation superimposed by poor blood supply and dependent edema due to posture and associated nephropathy. Primary lesion in the foot is due to minor cracks, fissure, trivial trauma which is unnoticed because of parasthesia and ill-treated due to ignorance, illiteracy, poverty and lack of availability of expert medical services for control of diabetes and/or treatment of its complications.

Patients usually treat themselves for minor foot ulcer, cracks, fissure, corn and callosities. Diabetes is either not diagnosed or ill-treated/poorly controlled until the foot ulcer is complicated to spreading cellulitis, deep ulcer and/or gangrene leading to life saving amputation.

The health education of the patients and relatives is of paramount importance for prevention of complication of diabetes in general and foot in particular.

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**Conflict of interest:** None declared  
**Ethical approval:** The study was approved by the institutional ethics committee

**REFERENCES**
