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Research Article

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

of physical as well as socioeconomic burden to both the patient and the nation.

Foot complications are a major cause of hospital admission for people with diabetes. The presence of foot complications increase 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.[1] The prevalence of diabetic foot complication has been observed to be higher among rural peoples compared to the people dwelling in urban settings.[2] 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.[3]

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.[4] 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 was examined for presence of glucose by titrating urine with benedicts' solution and there by 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 was also examined for presence or absence of protein and microscopic examination for any abnormal findings.
- A peripheral smear was made and examined for microfilaria in suspected cases.
- X-ray of affected limb was done to rule out osteomylitic 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.

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

Table 2: Distribution of cases according to age and sex.

Age group (years)	Male		Female		Total	
	No.	%	No.	%	No.	%
35-50	26	36.62	15	45.45	41	39.42
51-65	29	40.84	11	33.33	40	38.46
>65	16	22.54	7	21.22	23	22.12
Total	71	68.26	33	31.74	104	100

Table 3: Distribution of cases according to residence.

Residence	No. of cases	Percentage
Rural	86	82.7%
Urban	18	17.3%
Total	104	100%

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.

Duration (in years)	No. of cases	Percentage
Diagnosed at Adm.	23	22.11
<5 years	39	37.51
5-10 years	17	16.35
>10 years	25	24.03
Total	104	100

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

		Number	Percentage
Trauma	Total	27	25.96
	Thorne prick	19	18.26
	Glass	3	2.88
	Stones	5	4.81
Previous foot ulcer		37	35.56
Neuropathic symptoms		23	22.11
Pain while walking		61	58.65
Amputation		06	5.76
Deformity		08	7.69
Cardiovascular symptoms		06	5.76
Visual symptoms		24	23.07
Weight loss		39	37.5
Family history		19	18.27

Table 6: Distribution of cases according to hospital stay.

Hospital stay (Days)	No. of cases	Percentage
<7	32	30.76
8-14	45	43.27
>14	27	25.97
Total	104	100

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

Grade	No. of Cases	Percentage
I	32	30.77
II	24	23.07
III	15	14.42
IV	31	29.81
V	02	1.93
Total	104	100

Table 8: Distribution of cases according to antibiotics used.

Antibiotics	No. of cases	Percentage

Piperacillin	30	28.85
Cephalosporins + amikacin + metronidazole	12	11.54
Linezolide	14	13.46
Linezolide + piperacillin	15	14.42
Amoxicillin + clavulinic Acid	19	18.26
Cephalosporins + linezolid	05	4.81
Clindamycin	9	8.66
Total	104	100

Table 9: Distribution of cases according to surgical treatment.

Treatment	No. of cases	Percentage
Wound debridement	69	60.52
Incision and drainage	28	24.56
Amputation of toe	12	10.52
Below knee amputations	02	1.75
Amputation of foot	03	2.65
Total	114*	100

*Note-Some patients undergone more than one treatment options

Table 10: Distribution of cases according to pathogens found in ulcer (Pus culture).

Organisms isolated	At day 1 (n=85)		At day 7 (n=51)	
	No.	%	No.	%
Staphylococcus	52	61.17	4	7.84
Klebsiella	14	16.47	6	11.76
Pseudomonas	6	7.05	1	1.96
Polymicrobial	8	9.41	0	0.0
Sterile	5	5.9	40	78.44
Total	85	100	51	100

Table 11: Antibiotic sensitivity pattern of isolated organisms (n=80).

Strains	<5 Antibiotics	>5 Antibiotics
Staphylococcus	00	52
Klebsiella	06	08
Pseudomonas	00	06
Polymicrobial	00	08
Total	06	74

Table 12: Distribution of patients according to outcome (follow up = 46).

Category	Number	Percentage
Healed	22	47.82
Hypergranulation	16	34.78
Reinfection	08	17.41
Total	46	100

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[5] 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 4^{th} 5^{th} and 6^{th} decade of life, findings consistent with Acharya et al[6]. B.R. Mehra et al[7] 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[7] 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[6] who reported 88% in his study.

Results of our study shows rural mostly affected may be as our hospital mostly caters rural population.

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 natures 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,[8] 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 al[9] 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 Acker[10] 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 al[9] 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 al[11] found Polymicrobial aetiology in 69 (64.4%) and single aetiology in 21 (19.6%). Shankar EM et al[12] gram-negative bacteria (57.6%) were isolated more often than gram-positive ones (42.3%) in the patients screened. Lipsky BA et al[13] found most DFIs are Polymicrobial, with aerobic gram-positive *cocci*, and especially staphylococci most common. Ertugrul BM et al[14] reported pseudomonas most frequently isolated species. Tiwari S et al[15] 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 quinolones.

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 amoxyclav or clindamycin as reviewed by Caputo[16].

Uncomplicated not clinically infected neuropathic ulcers should heal provided there is adequate wound care and pressure relief without need of antibiotic (Chanteleau et al[17]. Santoso M et al[18] 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 parentally. 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[6] 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[5] 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 seen 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 patient 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 micro-organism 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.

- Piperacillin (28.85%) and metronidazole was most commonly used followed by linizolid (27.88%), metronidazole, amoxicillin-clavulanic acid (18.26) and clindamycin (8.66%). Clinically maximum response was seen with piperacillin tazobactum so was most commonly used in our hospital,
- Majority of the patients were treated conservatively by surgical debridement (60.52%), while amputations were performed in 17 patients (16.3%). Majority of them were minor amputations 2 patient needed below knee amputation and 3 patients undergone amputation of foot.
- Most of the patients stayed in the hospital for a period of up to 14 days (43.27%).
- Most of the cases were relieved (77.88%) while 10.57% were transferred to department of medicine for uncontrolled diabetes.
- Only two case fatality(1.92%) occurred during study period.

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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