Original Research Article

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Clinical study, management of diabetic foot and its complications

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ABSTRACT

Background: Diabetic foot infections are frequently polymicrobial. Hyperglycemia, impaired immunologic responses, neuropathy and peripheral arterial disease are the major predisposing factors leading to limb-threatening diabetic foot infections. The aim of the study was to study the benefit and outcome of the different treatment modalities for the diabetic foot.

Methods: This study was conducted comprising 100 patients with diabetic foot in the department of general surgery at Rajiv Gandhi government general hospital, MMC from January 2019 to June 2020, over 12 months. Data were collected by detailed history, clinical examination, wound or ulcer and were recorded in the pre-designed proforma. Wagner's classification, examination findings, blood investigations, renal function test, a swab of the wound, X-ray and treatment provided were collected.

Results: Commonest presenting lesion was ulcers (44%), followed by gangrene (24%) and cellulitis (20%). The commonest site of the lesion was the dorsum of the foot (32%), followed by forefoot (28%) and toes (22%). Trivial trauma is the initiating factor in more than half of the cases. More than half of the patients, 82% had an infection. The most common microorganism grown from culture was *Staphylococcus aureus* (30%).

Conclusions: Diabetic patients at risk for foot lesions must be educated about risk factors. The multidisciplinary team approach diabetic foot disorders has been demonstrated as the optimal method to achieve favorable rates of limb salvage in a high-risk diabetic patient. Infection in a diabetic foot is potentially limb-threatening and always requires urgent diagnostic and therapeutic attention.

Keywords: Diabetes, Foot ulcers, Neuropathy, Ischemia, Foot amputation

INTRODUCTION

Diabetes mellitus (DM) is an iceberg disease. It is a worldwide problem. The incidence of DM is increasing globally. Patient with diabetes has a 12% to 25% lifetime risk of developing a foot ulcer. In the diabetic patient, the foot is the crossroad for many pathological processes, in which almost all components of the lower extremity involved from the skin, subcutaneous tissue, muscles, bones and joints, to blood vessels and nerves.

Foot disorders are a major source of morbidity and a leading cause of hospitalization for persons with diabetes.³ Eighty-five percent of diabetic major amputations begin with a foot ulcer and the common pathway to amputation involves infection entering the foot and leading to gangrene. Four categories of diabetes are recognized. Type 1, formerly insulin-dependent diabetes mellitus (IDDM) is an autoimmune disease affecting the pancreas. Individuals with type 1 diabetes are prone to ketosis and unable to produce endogenous insulin. Type 2, formerly non-insulin-dependent diabetes

mellitus (NIDDM), accounts for 90% to 95% of cases diagnosed. Type 2 diabetes is characterized by hyperglycemia in the presence of hyperinsulinemia due to peripheral insulin resistance.4 Gestational as well as genetic defects and endocrinopathies are recognized as other types of diabetes. Diabetes is associated with numerous complications related to microvascular, macrovascular and metabolic etiologies. These include cerebrovascular, cardiovascular and peripheral arterial disease, retinopathy, neuropathy and nephropathy.5 Currently, cardiovascular complications are the most common cause of premature death. Diabetes continues to de one of the most common underlying causes of nontraumatic lower extremity amputations (LEAs). The other fifteen percent of major amputations will be due to rest pain, ischemia that has destroyed the foot or an unstable Charcot joint.⁶ Every 30 seconds, a lower limb or a part of a lower limb is lost somewhere in the world as a consequence of diabetes. Up to 70% of all lower-limb amputations are performed on people with diabetes. Every year, approximately 4 million people develop a new diabetic foot ulcer. The DM is the fourth to the fifth leading cause of death in developed countries.⁷

METHODS

This study was conducted comprising 100 patients with diabetic foot in the department of general surgery at Rajiv Gandhi government general hospital, MMC from January 2019 to June 2020, over 12 months. Data were collected by detailed history, clinical examination, wound or ulcer and were recorded in the pre-designed proforma. Wagner's classification, examination findings, blood investigations, renal function test, a swab of the wound, X-ray and treatment provided were collected. All patients are studied and clinical findings are recorded as per proforma case sheet data analyzed and necessary investigations done as per required and treatment given. Predisposing factors, complications, treatment and sequel are studied, analyzed stand discussed.

Inclusion criteria

All patients with DM suffering from foot ulcers and infections were included in the study. All age groups were included in the study. Patients with a known history of diabetes were also included. Patients with a gangrenous foot, complicated by diabetes were included in the study.

Exclusion criteria

Patients with foot infections without DM were excluded. Patients with gangrene foot of etiology other than infection of foot complicated by diabetes were excluded. Patients whose treatment could not be completed due to noncompliance were also excluded. Patients with

incidental diagnosis of diabetes on admission were also excluded.

Statistical analysis

Statistical testing was conducted with the statistical package for the social sciences system version SPSS 17 (SPSS Inc., Chicago, USA). For all statistical tests, a p<0.05 will be taken to indicate a significant difference. The above statistical procedures were performed by the statistical package IBM SPSS statistics. The p values less than 0.05 (p<0.05) were treated as significant in two tail condition.

RESULTS

Of 100 cases studied, most of the diabetic patients with foot lesions were in the age group of 61-70 (32%) followed by 51-60 (24%) (Table 1). The youngest was 31 years, came with complaints of abscess over the (R) forefoot and the oldest was 80 years admitted for cellulitis of (R) the whole forefoot. 78 (78%) were male patients and 22 cases females patients. The ratio of male:female is 3.54:1. Most of the patients had diabetes duration for about 6-10 years (28%). One patient had a history of diabetes for only 4 months and an 80 year old male patient came with a history of diabetes with a duration of 24 years.

Out of 100 SG cases, 22 (44%) cases presented with ulcers, 10 (20%) cases with cellulitis 16 (16%) of cases abscess, 24 (24%) of cases gangrene and (4%) of cases neuropathic ulcer (Table 2).

The most common site of lesion in the diabetic foot was the dorsum of the foot which was in about 32 patients (32%) (Table 3). Then the whole forefoot comprised about 14 cases (28%). The least was heel which was about 4 (4%) patients. Out of the 100 cases studied 60 patients (60%) not had a history of trauma and 40 patients (40%) not had a history of trauma.

In the present study 52 (52%) patients presented with neuropathy (Table 4). Ischemia was seen in 60 patients and there was an infection in 82 patients. Table 4 shows multiple complications can be presented in a single patient with a diabetic foot.

The most common microorganism grown on the culture of pus was *Staphylococcus aureus* in 30 (30%) patients followed by *Pseudomonas* 18 (18%), *Streptococcus* 14 (14%), *E. coli* 10 (10%), *Klebsiella* 8 (8%) and *Proteus* 6 (6%) (Table 5). In 14 (14%) patients there was no growth seen on culture some cultures yielded more than one type of bacteria.

Table 1: Age distribution.

Age (in years)	Number of patients	Percentage
11-20	0	0
21-30	0	0
31-40	12	12
41-50	12	12
51-60	24	24
61-70	32	32
71-80	20	20
Total	100	100

Table 2: Clinical presentations.

Clinical presentations	Number of patients	Percentage
Ulcer	44	44
Cellulitis	20	20
Abscess	8	8
Gangrene	24	24
Neuropathic ulcer	4	4

Table 3: Site of lesions.

Site of lesions	Number of patients	Percentage
Toes	22	22
Heel	4	4
Dorsum of foot	32	32
Plantar foot	18	18
Whole forefoot	28	28

Table 4: Complications.

Duration of DM in years	Number of patients	Percentage
Neuropathy	52	52
Ischemia	60	60
Infection	82	82

Table 5: Culture and sensitivity.

Organisms	Number of patients	Percentage
Staphlococcus aureus	30	30
Streptococcus	14	14
Pseudomonas	18	18
E. coli	10	10
Klebsiella	8	8
Proteus	6	6
No growth	14	14

Table 6: Treatment.

Operative procedure	Number of patients	Percentage	
Slough excision and regular dressing	12	12	
Wound debridement	28	28	
SSG	10	10	
I and D	6	6	
Fasciotomy	10	10	
RAYS amputation	16	16	

Continued.

Operative procedure	Number of patients	Percentage
Bellow knee amputation	4	4
Above-knee amputation	14	14

Table 7: Duration of hospital stay.

Hospital stay (in days)	Number of patients	Percentage
1-20	20	20
21-40	36	36
41-60	22	22
61-80	10	10
81-100	12	12

Out of 100 patients treated 12 (12%) patients were managed conservatively by/slough excision and regular dressing with antibiotics with diabetic control (Table 6). 28 (28%) patients were treated with wound debridement, (10%) patients treated with SSG, (6%) patients underwent I and D for abscess and 5 (10%) patients underwent J fasciotomy and 6 (16%) patients presented with gangrene of toes and phalanges were M treated with disarticulation. 4 (4%) patients underwent below-knee amputation and 14 (14%) patients were above-knee amputation. In most cases, the limb was salvaged by conservative treatment and minor computations.

In this study minimum stay in the hospital was 10 days and the maximum was 100 days (Table 7). The most common duration of hospital stay was between 21-40 days (36%). This long duration of hospitalization can be explained by the refractory to the treatment of the lesions owing to the diminished resistance of the body, hyperglycemia, prepared hormonal defense mechanisms and resistance of the organisms to antibiotic therapy.

DISCUSSION

The incidence of DM is increasing globally. India is emerging as the epicenter of diabetes today with a current prevalence rate of 14% in the population. Patients with diabetes have a 12-25% lifetime risk of developing a foot ulcer.⁸ Foot ulcers have become a major and increasing public health problem, the morbidities, impairment of the quality of life of patients and the implied costs for management have attracted the attention of health policy providers.⁹ Despite their rising importance, the management provided for foot ulcers is often inadequate, resulting in delayed healing and eventually the possibility of amputation. It is projected that developing countries will experience the greatest rise in the prevalence of type 2 diabetes in the next twenty years. 10 The people living in these countries, therefore, could expect greater risks of foot ulceration.¹¹ In our present study, the most common cause of diabetic foot was trauma in 70% and the remaining as complications of their diabetic status. 12 It is also observed in our study that 60% of diabetic foot occurred among those who walked barefoot and 35% in those wearing only slippers or chappals while only 5%

prevalence was observed in those wearing shoes. This observation revealed that proneness to injuries increased the risk of developing diabetic foot lesions (p<0.001).¹³ In Wagner's grade 2 through 5, the overall chance of local or major amputation is estimated to be around 60%. In the present study, the patients with diabetic foot presented with abscess (2%), cellulitis (23%), ulcer (55%) and gangrene (20%). The ulcer pattern ranged from 94% in grade 2, 20% in grade 3, 36% in grade 4 and 3% in grade 5 category. 14 Similarly, Porter et al from Mexico hospital have also reported 23% of their diabetic cases with grade 2 ulcers and 21% with grade 3.15 Appropriate tissue and bone cultures are useful to guide the use of antibiotic therapy. Gram-positive organisms account for the majority of infections, while the prevalence of Methicillin-resistant S. aureus has become prevalent in recent years. 16 Reed et al have stated that although gram-positive organisms are overwhelming in chronic diabetic ulcers, the polymicrobial nature of bacterial growth should not be ignored in the management planning, especially in developing countries.¹⁷ The pattern of infection as observed in the present study reveals that while 73% of cases were infected with a single infection of the gram-positive organism, 18% of cases had polymicrobial infections. Among these E. coli and Proteus were the predominant microorganisms involved.¹⁸ Chronic ulcers are frequently co-existing with fungal infections of the foot and it has been said that bacterial infection could be predisposed by a fungal infection.¹⁹ Schadewaldt et al in 2003 from Korea in a study of 13,271 patients with diabetes have shown that 78.4% have a fungal infection of the feet. Among these infections, 70.8% are *Tinea pedis* type. The investigators, therefore, consider fungal infection a risk factor for foot ulcers. Thus it emerges that limb salvage program in diabetic ulcers with early debridement might significantly reduce the need for amputations to some extent.20

CONCLUSION

The commonest presenting lesion was ulcers, followed by gangrene and cellulitis. The commonest site of lesion was the dorsum of the foot followed by forefoot and toes. The most common microorganisms grown from culture taken

from the lesion was *S. aureus* followed by *Pseudomonas*. Glargine insulin along with appropriate oral or iv antibiotics was effective in most of the cases. Ulceration, infection, gangrene and lower extremity amputation are complications often encountered in patients with DM. These complications frequently result in extensive morbidity, repeated hospitalizations and mortality.

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Ethical approval: The study was approved by the

Institutional Ethics Committee

REFERENCES

- 1. Amos A, McCarty D, Zimmet P. The rising global burden of diabetes and its complications: estimates and projections to the year 2010. Diabet Med. 1997;14(5):1-85.
- 2. Arieff AI, Carroll HJ. Nonketotic hyperosmolar coma with hyperglycemia: clinical features, pathophysiology, renal function, acid-base balance, plasma- cerebrospinal fluid equilibria, and the effects of therapy in 37 cases. Medicine (Baltimore). 1972;51(2):73-94.
- 3. Armstrong DG, Stacpoole-Shea S, Nguyen H, Harkless LB. Lengthening of the Achilles tendon in diabetic patients who are at high risk for ulceration of the foot. J Bone Joint Surg Am. 1999;81(4):535-8.
- 4. Banting FG, Best CH. The internal secretion of the pancreas. Indian J Med Res. 2007;125(3):251-66.
- Buse JB, Polonsky KS. Diabetic ketoacidosis, hyperglycemic hyperosmolar nonketotic coma and hypoglycemia. In: Hall JBM, Schmidt GA, Woods LDH, eds. Principles of Critical Care Medicine. 2nd ed. New York: McGraw-Hill; 1998: 1183-93.
- 6. Castano L, Eisenbarth GS. Type-I diabetes. A chronic autoimmune disease of humans, mice, and rats. Annu Rev Immunol. 1990;8:647-79.
- 7. Diabetes Control and Complications Trial Research Group. The effect of intensive diabetes therapy on the development and progression of neuropathy. Ann Intern Med. 1995;122:561-8.
- 8. Eisenbarth GS. Lilly Lecture 1986. Genes, generator of diversity, glycoconjugates, and autoimmune betacell insufficiency in type I diabetes. Diabetes. 1987;36(3):355-64.

- 9. Fagerberg SE. Diabetic neuropathy: a clinical and histological study on the significance of vascular affections. Acta Med Scand Suppl. 1959;345:1-97.
- 10. Flynn MD, Tooke JE. Etiology of diabetic foot ulceration: a role for the microcirculation. Diabet Med. 1992;9(4):320-9.
- 11. King H, Aubert RE, Herman WH. Global burden of diabetes, 1995-2025: prevalence, numerical estimates, and projections. Diabetes Care. 1998;21(9):1414-31.
- 12. Laguesse E. Structure et development du pancreas d'apres les travaux recents. J Anat (Paris). 1894;30:591-608.
- 13. Laing P. The development and complications of diabetic foot ulcers. Am J Surg. 1998;176:11-9.
- 14. McNeely MJ, Boyko EJ, Ahroni JH, Stensel VL, Reiber GE, Smith DG, et al. The independent contributions of diabetic neuropathy and vasculopathy in foot ulceration. How great are risks? Diabetes Care. 1995;18(2):216-9.
- 15. Porter R. The greatest benefit to mankind, a medical history of humanity. 1st ed. New York: WW Norton; 2010: 71.
- Ramsey SD, Newton K, Blough D, McCulloch DK, Sandhy N, Reiber GE, et al. Incidence, outcomes and cost of foot ulcers in patients with diabetes. Diabetes Care. 1999;22(3):382-7.
- 17. Reed JF. An audit of lower extremity complications in octogenarian patients with diabetes mellitus. Int J Low Extrem Wounds. 2004;3(3):161-4.
- 18. Reiber GE. Epidemiology of foot ulcers and amputation in the diabetic foot. In: Bowker JH, Pfeifer MA, eds. The diabetic foot. 6th ed. St. Louis, Mo: Mosby Inc; 2001: 13-32.
- 19. Reiber GE, Vileikyte L, Boyko EJ, Aguila MD, Smith DG, Lavery LA, et al. Causal pathways for incident lower-extremity ulcers in patients with diabetes from two settings. Diabetes Care. 1999;22(1):157-62.
- Schadewaldt H. The history of diabetes mellitus. In: Englehardt DV, eds. Diabetes, its medical and cultural history. Berlin: Springer Verlag; 1987: 43-100.

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