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Original Article

Clinical study, surgical management of diabetic foot ulcers and its complications in patients of age 20-75 years

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Abstract:

Background: Diabetic people are more likely to develop soft tissue infections of the foot as a result of ischemia and neuropathy. These infections are polymicrobial in nature, in order to avoid amputations, they must be properly recognized and treated.

Objective: To study the surgical management and complications of diabetic foot

Methods: Hospital based prospective study was carried out among 50 known diabetic cases with diabetic foot ulcer. These cases were studied in detail clinically. Routine investigations along with specific investigations including fasting blood sugar, post prandial blood sugar, HbA1C were done in all cases. The cases were treated conservatively by Glycemic control and Dressings. Surgical interventions such as debridement and amputation were done as per the need. The cases were followed up for 3 months' period for every 2 weeks' interval.

Results: Majority were 51-60 years(36%). Males were more(58%) than females(42%). History of trauma was in 68%. Most common site of lesion was dorsum of foot(30%). Majority(40%) had diabetes since last five years. Neuropathy was in 36% and bone infection in 16%. Most common causative organism was staph aureus(26%). Eleven patients were managed with conservative management. 72% required debridement. Disarticulation of toes was in 26%. 10% required major amputation. Split thickness skin graft was required in 30%. Some patients required a combination of therapy. Majority (34%) had 21-40 days of hospital stay followed by 1-20 days in 28% of the cases. Size of ulcer and blood sugar level at the time of admission were significantly associated with duration of hospital stay.

Conclusion: Increased blood sugar level at time of admission and greater size of ulcer are important risk factors for prolonged hospital stay in patients with diabetic foot ulcer. Trauma was most common cause of diabetic foot ulcer.

Key words: diabetes, complications, diabetic foot ulcer, blood sugar

Introduction:

Diabetes foot ulceration is a common, yet largely preventable, ailment that affects one out of every twenty diabetic individuals. Risk factors include somatic neuropathy, high mechanical foot pressure, callus formation, deformities, and peripheral vascular disease. Chronic foot ulceration is a leading cause of morbidity in diabetes patients. [1]

Vascular syndrome includes both macrovascular and microvascular alterations, and abnormalities in the peripheral nerve caused by either metabolic changes in the nerve or subsequent to vascular reasons. In the United States, 2% to 3% of diabetics will get a foot ulcer each year, and around 15% will have a foot ulcer over their lifetime. [2]

Diabetic people are more likely to develop soft tissue infections of the foot as a result of ischemia and neuropathy. These infections are polymicrobial in nature, in order to avoid amputations, they must be properly recognized and treated. [3]

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According to one prospective cohort research, roughly 15% of diabetic individuals who develop foot ulcers also have underlying osteomyelitis. A total of 16% of ulcerated patients underwent lower extremity amputation at the same level, likely due to infection. [4]

The diabetic foot problem is one of the most common and preventable complications of diabetes mellitus. It can be avoided by performing daily foot inspections, wearing appropriate shoes, looking for redness and other signs of trauma, and avoiding deep nail trimming, smoking, and the use of chemicals or sharp instruments to trim calluses. As a result, this study has been undertaken to evaluate the understanding of the pathophysiology of diabetic foot lesions and to employ the full extent of particular protocols in their care. The objectives of the present study are to study clinically the surgical management of diabetic foot ulcers and its complications in patients of age 20-75 years, to study different treatment modalities in management of diabetic foot and to study the outcome of surgical intervention in diabetic foot patients

Materials & methods:

This was a hospital based prospective study carried out among 50 known diabetic cases with diabetic foot ulcer. Type-2 Diabetes Patients with foot ulcer admitted in General Surgery Department, Malla Reddy Institute of Medical Sciences, Suraram, Medchal between the period of January 2020 to June 2021 were studied in the present study.

Institutional Ethics Committee permission was obtained vide letter number: IEC/MRIMS/101/2019 dated 21/12/2019. Written informed consent was taken from all study participants.

Inclusion criteria:

1. All the patients with type 2 diabetes presenting with foot ulcers, infection and gangrene of foot from Wagner grading 1-5
2. Patients who have given consent.
3. Patients aged between 20-75 years of either gender

Exclusion criteria:

1. Patients with foot infections without diabetes
2. Patients with prevailing peripheral vascular diseases
3. Patients with type 1 diabetes
4. Patients above 75 years of age
5. Patients below 20 years of age

Analysis of 50 cases of diabetic foot ulcers in above said period was done. These cases were studied in detail clinically and were recorded as per the pro-forma after taking informed consent from the patients. Routine investigations like complete blood picture, complete urine analysis, random blood sugar along with specific investigations including fasting blood sugar, post prandial blood sugar, HbA1C were done in all cases. The cases were treated conservatively by Glycemic control and Dressings. Surgical interventions such as debridement and amputation were done as per the need. The cases were followed up for 3 months' period for every 2 weeks' interval. Gangrene of the foot was graded as per Wagner grading. The pus from the foot ulcer was sent for Microbiology examination to the Microbiology laboratory for culture in order to identify the organisms and report was collected and recorded.

Statistical analysis:

All the data was collected in approved pro forma and data is entered in MS Excel 2007 and is subjected to statistical analysis. Descriptive data was analyzed using proportions. Chi square Test was applied for the proportions and two per T test was applied for mean values

Results:

Table 1: Age and sex distribution of study subjects

Characteristics		Number	%
Age (years)	21-30	2	4
	31-40	8	16
	41-50	10	20
	51-60	18	36
	61-70	10	20

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	71-75	2	4
Sex	Male	29	58
	Female	21	42

Majority of the study subjects were in the age group of 51-60 years i.e. 36% followed by 20% of the cases each in the age group of 41-50 years and 61-70 years. Males were more (58%) affected than the females (42%). (Table 1)

Table 2: Distribution of study subjects as per other features

Features		Number	%
History of trauma	Yes	34	68
	No	16	32
Site of lesion	Dorsum	15	30
	Toes	12	24
	Sole	9	18
	2nd and 3rd web space	2	4
	Whole of the foot	1	2
	Dorsum with toes	6	12
	Lateral aspect of foot	5	10
Duration of DM (years)	Newly diagnosed	6	12
	<1	7	14
	1-5	20	40
	6-10	10	20
	11-15	6	12
	16-20	1	2
Neuropathy	Yes	18	36
	No	32	64
Bone infection	Yes	8	16
	No	42	84

History of trauma was seen in 68% of the cases. Most common site of lesion was the dorsum of the foot in 30% of the cases. Majority (40%) had diabetes since last five years. Neuropathy was seen in 36% of the cases and bone infection was seen in only 16% of the cases. (Table 2)

Table 3: Distribution as per the causative organism found

Causative organism	Number	%
Staph aureus	13	26
Pseudomonas aeruginosa	10	20
Sterile	8	16
Polymicrobial	8	16
E coli	5	10
Klebsiella	4	8
Proteus	2	4

Most common causative organism found was staph aureus in 26% of the cases followed by Pseudomonas aeruginosa in 20% of the cases. 16% of the cases were sterile. (Table 3)

Table 4: Distribution of study subjects as per the surgical procedure

Surgical procedure	Number	%
Conservative	11	22
Debridement	36	72
Disarticulation (toes)	13	26
Major Amputation	5	10
Split thickness skin graft	15	30

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Eleven patients were managed with conservative type of management. 72% of the cases required debridement. Disarticulation of toes was carried out in 26% of the cases. 10% of the cases required major amputation. Split thickness skin graft was required in 30% of the cases. Some patients required a combination of therapy. (Table 4)

Table 5: Distribution of study subjects as per duration of hospital stay (days)

Hospital stay (days)	Number	%
1-20	14	28
21-40	17	34
41-60	8	16
61-80	6	12
81-100	1	2
101-120	2	4
> 120	2	4

Majority (34%) had 21-40 days of hospital stay followed by 1-20 days in 28% of the cases. (Table 5)

Table 6: Association of various factors with duration of hospital stay

Characteristics		Hospital stay		Chi square	p
		1-20 days	> 20 days		
sex	female	4 (19%)	17 (81%)	0.91	0.34
	male	9 (31%)	20 (69%)		
Clinical presentation	ulcer	9 (34.6%)	17 (65.4%)	2.09	0.148
	ulcer plus other	4 (16.7%)	20 (83.3%)		
History of trauma	no	4 (25%)	12 (75%)	0.012	0.912
	yes	9 (26.5%)	25 (73.5%)		
Neuropathy	no	11 (34.4%)	21 (65.6%)	3.241	0.072
	yes	2 (11.1%)	16 (88.9%)		
Characteristics		N=13	N=37	t	p
Age	Mean±SD	52±12.69	54.32±11.94	0.594	0.555
Duration of symptom (days)	Mean±SD	13.15±7.66	14.14±17.09	0.199	0.843
Duration of DM (years)	Mean±SD	3.92±5.02	4.62±4.15	0.494	0.624
Size of ulcer (cm)	**Mean±SD**	**5.42±1.34**	**8.52±3.46**	**3.129**	**0.003**
Blood sugar at admission (mg/dl)	**Mean±SD**	**185.31±46.88**	**242.65±85.15**	**2.298**	**0.026**

Among the factors studied for association with the duration of the hospital stay, only size of ulcer and blood sugar level at the time of admission were significantly associated with the duration of hospital stay. The mean size of the ulcer was 5.42 cm among those with duration of hospital stay up to 20 days compared to 8.52 cm among those with duration of hospital stay more than 20 days. The mean blood sugar at admission was 185.31 mg/dl among those with duration of hospital stay up to 20 days compared to 242.65 mg/dl among those with duration of hospital stay more than 20 days. (Table 6)

DISCUSSION

In the current study, the age ranged from 51-60 years. The patients' mean age was 52.9 years, which is close to earlier researches. [1, 3&5] This comparable mean age may point to time-dependent risk factors in the genesis and progression of diabetic foot ulcer disease, which are universal to diabetes in any context. Diabetes onset age varies among continents as well. This study clearly brings out to a conclusion of increased incidence in elderly age group because of greater duration of diabetes, atherosclerosis and neuropathy. This might be explained by the fact that the incidence of atherosclerosis and peripheral vascular disease increases with age, as well as the fact that diabetes mellitus raises the risk and accelerates atherosclerosis. Thus, the resulting ischemia will aggravate the presentation of diabetic foot in the elderly, halting healing of the ulcer, increasing complications, and finally increasing the chance of amputation.

Males were more impacted than females in this research, with a male to female ratio of 1.2:1, which is consistent with earlier studies. [5] The smoking habits of men, which were reported in 35.3% of cases, may explain their

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preponderance (all of them were males). Smoking is a risk factor due to arterial wall thickening, decreased blood circulation, and ischemia alterations in the afflicted neurons. [6] As a result, there is also a loss of sensation and an increased susceptibility to injury. So, this study emphasizes of proper foot care and diabetic control of the working people of family as they are more prone for diabetic foot ulcers due to increased incidence of trauma, physical stress. It also recommends for cessation of smoking which can further complicate the problem.

In the current study, 68% had a history of trauma. Sensory neuropathy can result in the loss of a wide range of senses including touch, pressure, warmth, vibration, position, and pain. When the sense of pain is lost, an insensate foot develops, resulting in repeated unrecognized trauma and improper pressure distribution on the feet, and so emerges as the primary cause in producing foot ulcers. [7] This study emphasizes prevention of diabetic foot ulcers. So diabetic patients should keep in mind regarding the strong association of trauma and severity of diabetic foot ulcer in order to prevent unnecessary complications such as disarticulations/amputations.

The most prevalent site of diabetic foot lesion in the current study of 50 cases is the dorsum of the foot in 15 patients (30%). According to the Apelquist research series [8], the dorsum is affected in 14% of cases and 51% in the toes which is in accordance with this study.

In the current study, the duration of diabetes was found to have a significant relationship with diabetes-related complications such as neuropathy. According to Daniel Prasad E et al [9], duration of diabetes is directly proportional to the complications such as diabetic foot ulcers The median duration of diabetes in this study is consistent with other studies. [4, 10-11] This finding may imply the differences in the quality of diabetes care where German and Indian patients, on average have longer duration of diabetes exposure before they develop foot ulcers. It is possible that better diabetes care that they receive delays the onset of foot ulcer disease. The majority of patients in this research presented to the surgical department between 4 and 20 weeks after the beginning of an ulcer. Other researchers [1, 10, 12] have revealed similar findings. Low socioeconomic status, poverty, a lack of diabetes education (concerning the importance of general foot care, the significance of diabetes, and its complications), unrecognized foot trauma from walking barefoot, and a lack of access to medical care may all contribute to the patients' late presentation. Other variables that contribute to late presentation include loss of time at home surgery, faith healers, and undiagnosed diabetes.

In the current study, 36% had peripheral neuropathy. 57 Patients with pure neuropathic ulcers have sufficient blood flow but develop ulceration due to increased pressure. Neuropathy patients might walk on needles, glass, and other sharp items without realizing it. The incidence of risk factors for foot ulcers and infections, including neuropathy and vasculopathy, differs from that reported in the Western literature. In contrast to the West, where neuro-ischemia is the most important predisposing factor, studies from India show that 50-70% of ulcers are neuropathic. In patients being followed for DFIs, the prevalence of vasculopathy has been recorded to be 10-30% compared to the West, which suggests the existence of PVD in 46-60%. However, the diagnostic criteria for vasculopathy in the investigations were not consistent.

In the current study, osteomyelitis was discovered in 8 of 50 individuals. Many diabetic foot ulcers have osteomyelitis. The typical radiographic triad of osteomyelitis is demineralization, periosteal response, and bony destruction, which emerges only after 30–50% of bone damage, a process that might take weeks. After the contaminated bone has been removed, the patient simply takes medications to manage infection in the surrounding soft tissue. [13] Diagnosis of osteomyelitis (OM) in diabetic feet is usually difficult. Diabetic bone infection is often contiguous from underlying soft tissue, rather than systemic dissemination. The gold standard for diagnosis remains positive results on both microbiological and histopathological examinations of aseptically acquired bone specimens. However, bone collection and processing are not always possible in many Indian medical centre.

In the analysis, the proportion of individuals with bone involvement was 16%, compared to 30% in the Madan et al [14] study. Plain film sensitivity in the diagnosis of Osteomyelitis has yielded mixed results. It is connected to the infection's chronicity, and at least 30–50% bone loss is necessary to show obvious changes on X-ray. Demineralization, periosteal response, and bony destruction are the typical radiographic trio of osteomyelitis that emerge after 30-50% bone damage. It is the nidus for infection, and until it is managed, the wound will never heal. Plain radiographs are discussed. On radiographs, the most prevalent Osteomyelitic alterations include osteopenia, periosteal thickening, cortical erosions, and new bone formation. According to Daniel P et al [9] osteomyelitis can be seen in up to 25% of cases. In this study we had around 16% incidence of osteomyelitis, which is less when compared to above studies. This may be attributed to early diagnosis and intervention in diabetic foot patients.

In the current investigation, 49 individuals had pus or seropurulent discharge sent for culture and sensitivity testing (98%). It was polymicrobial in 16%, Staphylococcus aureus in 26% and Pseudomonas aeruginosa in 20%. According to Gadepalli et al [15], Gram-negative aerobes were most frequently isolated (51.4%), followed by gram-positive

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aerobes and anaerobes (33.3 and 15.3%, respectively). Although most previous researches have highlighted aerobes, namely Staphylococcus aureus, as the most significant organism, there is no strong evidence that anaerobes play an equal or greater role. [16] Bacteroid, proteus, and E coli are the most prevalent organisms seen. Infection is the third most important component in the etiology of diabetic foot lesions, and when combined with ischemia, it will predispose to amputation. [5] Except for Meropenem and imipenem, for which 100 percent organisms are susceptible, all the bacteria found in this investigation demonstrated great resistance to routinely used antibiotics. Unfortunately, these antibiotics are prohibitively costly given the degree of economic state in this portion of the underdeveloped world. The discovery of polymicrobial illness and multiple drug resistance demands for rapid surgical intervention. Antibiotic susceptibility testing is still crucial in the treatment of diabetic foot ulcers. Infection is the third most prevalent cause of diabetic foot lesion etiology. When combined with ischemia, it commonly results in amputation.

In the current study, 11 individuals had conservative therapy, whereas 36 underwent debridement. The first and most critical stage in the healing of diabetic ulcers is debridement. The removal of all nonviable, infected tissue from open wounds as well as surrounding callus is the cornerstone of comprehensive treatment for diabetic foot ulcers, until a new border of healthy bleeding soft tissue and uninfected bone is created. [13] According to DL Hunt et al [17],10-15% of cases underwent amputation. According to Chalya PL et al [18] amputation rates cane go up to 58%. In this study 10% of cases underwent amputation. The basic principal of the foot salvage technique is early conservative amputation and thorough debridement of diabetic foot infection. [7] Because the majority of diabetic foot lesions are neuropathic in nature, despite severe foot infection, early conservative amputation can save at least part of the foot. [7] Several risk factors for diabetes amputations have been identified in the literature. There are, however, differences across the investigations. Strict glycemic control, as well as participation in multidisciplinary diabetic clinics staffed by vascular, orthopedic, internists, podiatrists, rehabilitation physicians, orthopedic shoemakers, and diabetic specialist nurses, have been shown to significantly reduce complications and amputation rates. [3, 19]

The length of stay in the hospital was connected to the kind, extent, and severity of the condition, as well as other co-morbid medical illnesses. In the current study, the shortest hospital stay was 8 days and the longest was 166. The average length of hospital stay for the current study was 42 days. This can be due to late presentation to the hospital. The severity of the inflammatory reaction (ESR), the recent management of blood glucose level (HbA1c), BMI, and significant vascular disease (CVA or CAD) at the time of hospital admission all had an effect on the length of hospital stay. In diabetic patients with sepsis, HbA1c level is an independent predictor of length of hospital stay. BMI was linked to immune system malfunction as a result, individuals with a higher BMI stay in the hospital for a longer period of time. The length of stay testifies to the economic and health-care burden imposed by diabetic foot infections.

Moist wound environment helps a lot in diabetic wound healing in present study. Moist wound environment provided by super oxidized solutions and normal saline dressing. It provides good environment for epithelial migration. Eusol is used in regular dressing to remove dead and necrotic tissue. It acts as a chemical debridement as explained earlier. Betadine is used in infected cases because of its broad spectrum antimicrobial coverage. Once the wound is healthy then betadine use is stopped, because it is a hypertonic solution which leads to swelling of the cells due to osmosis. It may hamper the wound granulation. Keeping a wound moist facilitates more rapid migration of epidermal cells across the wound bed, which enhance epidermal migration. [13]

In the current study, ulcer size had no early consequence because ulcer healing is dependent on several variables such as infective load, ischemia, neuropathy, uncontrolled hyperglycemia, and immunocompromised status in Diabetes mellitus. Split thickness skin grafting was performed in the present if the ulcer size was large. So this study clearly states that size of ulcer is not a prognostic factor for healing. In patients with no specific risk factor, patient education in foot care, preventive skin and nail care, and footwear lowers the incidence of foot ulcers and lower limb amputation by 25%. Prescription given on footwear that accommodates deformity while reducing pressure and shear forces delivered to the skin overlying bone prominence keeps people ambulatory and prevents ulcer development.

Limitations of the study

Due to COVID pandemic the inflow of patients in general was minimal and hence the study had to be restricted to only 50 patients and has not been large enough to be of reasonable precision. All the facts and figures mentioned here may considerably vary from those of large series covering a longer period of time, but still as the cases of the study were collected from a tertiary level Hospital, the study assumes significance in reflecting the facts regarding Diabetic foot management.

Conclusion:

Increased blood sugar level at the time of admission and greater size of the ulcer are important risk factors for prolonged hospital stay in patients with diabetic foot ulcer. Trauma was most common cause of diabetic foot ulcer.

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Hence, in these patients, avoiding the trauma by wearing the appropriate foot wear can reduce the incidence of diabetic foot among diabetics. At the same time, if they can control the blood sugar levels adequately by regular check up and treatment, the duration of hospital stay can be reduced.

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