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A study of predictors of lower extermity amputations in diabetic foot ulcer

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ABSTRACT

Background: Diabetic foot ulcers (DFUs) are severe complications in diabetes, leading to significant morbidity and mortality. A simplified classification system including precise prediction indicators for lower extremity amputations (LEA) would aid decision-making.
Methods: This prospective observational study included 100 patients with diabetic foot ulcers admitted to Government Villupuram Medical College & Hospital over one year.
Results: Approximately 38% of the patients were above 60 years, 31% were aged 51-60 years, and 12% were under 40 years. The mean age was 56.67 with a standard deviation of 12.97. Around 78% of the patients were males. 32% had SHTN, 22% CAD, 11% CVA, and 22% CKD. The diabetes duration was ≤5 years for 45% and >5 years for 55%. 62% were on oral hypoglycaemics agents, and 38% on insulin. About 56% were on regular treatment. Surgical treatments included above-knee amputation (5%), below-knee amputation (20%), Chopart's amputation (11%), wound debridement (41%), intertarsal amputation (1%), Lisfranc amputation (11%), and Ray's amputation (9%). Ulcers were found on the foot (68%), leg (28%), and sole (4%). Ulcer grading showed 12% grade I, 40% grade II, and 48% grade III. *Staphylococcus* was the most common organism cultured (55%).
Conclusions: Diabetic foot ulcers are preventable yet lead to significant morbidity and mortality. Future studies should focus on early diagnosis and treatment to improve patient outcomes.

Keywords: Amputation, Diabetic foot ulcer, Diabetes mellitus

INTRODUCTION

Diabetes mellitus, one of the most prevalent metabolic disorders, affects an increasing number of people worldwide, with a prevalence of 6.4%.[1] Diabetes-related foot ulcers are a common and growing issue in patients with diabetes. Diabetic foot ulcers (DFUs) are directly associated with peripheral vascular diseases and diabetic neuropathy.[2] Amputations and lower-extremity ulcers are chronic issues in people with diabetes. DFUs are a potentially preventable consequence of diabetes and are linked to significant morbidity and mortality.[3] According to estimates, a person with diabetes has a probability of acquiring a DFU of up to 25% over their lifetime.[4] DFUs are linked to prolonged hospital stays, significant financial burden, and high mortality.[5] Lower extremity amputation (LEA) is a severe potential outcome of DFU, often followed by death.[6] DFU is the main cause of non-trauma-related LEA globally, accounting for more than three-quarters of all LEAs in individuals with diabetes.[7] The medical and emotional impacts of LEA in diabetic patients are severe. Nearly 10% of patients who experienced serious LEAs died during admission. Additionally, post-LEA survivors have a much lower

quality of life and an increased likelihood of depression due to deficits in psychosocial functioning.[8] Studies indicate that the long-term prognosis following significant LEAs in people with diabetes is comparable to that of prostate and breast cancer.[9] In many Western countries, diabetes-related LEA rates have decreased significantly.[10] The Wagner classification system categorizes foot lesions as diabetic neuropathic or dysvascular and is highly linked to the chance of amputation.[11] Identifying risk factors is crucial to prevent this outcome, but little research has been conducted in India. This study aims to address this critical knowledge gap.

METHODS

To determine predictors for lower extremity amputation in diabetic foot. Which helps to intervene early for the actions that are needed to prevent the progression of the disease. All patients who fulfilled the inclusion criteria were enrolled in this study. Written informed consent was obtained from all the patients. The present study was carried out at Govt. Villupuram Medical College Hospital, where 100 patients with diabetic foot ulcers participated. A pretested and predesigned prototype is used in this study. All patients underwent detailed examinations according to the Proforma approved by the institutional ethics committee.

Sample size

Sample size was calculated based on the study conducted by Hingorani et al. Considering that the proportion of amputation followed by diabetic foot ulcer in patients with type diabetes was 80% with a 95% confidence interval and a margin of error of 7.84%, the estimated sample size was 100.

Study design

This was prospective observational study.

Study location

The location of the study was Government Villupuram Medical College in Mundiyampakkam, Tamil Nadu, India.

Study population

The study population included all patients with diabetic foot underwent amputation at the Department of General Surgery.

Study duration

The duration of the study was of one year from February 2022 to March 2023.

Inclusion criteria

Inclusion criteria were all cases of diabetic foot undergoing amputations at the Department of General Surgery; Government Villupuram Medical College Mundiyampakkam during the study.

Exclusion criteria

Exclusion criteria were patients with diabetes mellitus undergoing amputation following trauma; patients not willing to participate; lost to follow up.

Statistical analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 24. Qualitative variables were expressed as percentages. Quantitative variables are expressed as mean and standard deviation. The chi-square test was used to test the significance of the differences in proportions. An independent t-test was used to test the significance of differences in means.

RESULTS

Table 1: Age and sex wise distribution of study participants.

	Frequency	Percentage
Age in years		
≤40	12	12
41-50	19	19
51-60	31	31
>60	38	38
Sex wise distribution		
Male	78	78
Female	22	22

38% were more than 60 years of age, 31% were 51 to 60 years of age, and only 12% were less than 40 years of age About 78% were males and 22% were females.

Table 2: Distribution of all comorbidities among study participants.

Comorbidities	Frequency	Percentage
S.HTN	32	32
CAD	22	22
CVA	11	11
SHTN	2	2
CKD	21	21
Seizure	1	1
Total	100	100

32% of the patients had systemic hypertension, 22% had coronary heart disease, 11% had Cerebral vascular accident, 2 p% had secondary hypertension, 21% had chronic kidney disease and 1 % patients had seizure disorder.

Table 3: Duration of diabetes mellitus among study participants.

Duration of DM in years	Frequency	Percentage
≤5	45	45
>5	55	55
Total	100	100

45% patients had DM for 5 years or less than 5 years and 55% patients had DM more than 5 years.

Table 4: Mode and regularity of treatment among study participants.

	Frequency	Percentage
Mode of treatment		
Insulin	38	38
OHA	62	62
Total	100	100
Regularity of treatment		
Regular	56	56
Irregular	44	44
Total	100	100

About 62% are on oral hypoglycemic agents. About 56% were on regular treatment.

Table 5: Palpability of pulse among study participants.

Pulse	Frequency	Percentage
Femoral and popliteal	18	18
Femoral and popliteal, PTA	53	53
Femoral and popliteal, PTA and DPA	29	29
Total	100	100

29 patients had all the lower limb peripheral pulses palpable, 53 patients had peripheral pulse palpable upto PTA and 18 patients had peripheral pulses palpable upto Popliteal pulse.

Table 6: X ray changes among study participants.

X ray	Frequency	Percentage
Present	34	34
Absent	66	66
Total	100	100

X ray changes were present in 34% of study participants.

5 patients underwent above knee amputation, 20 patients underwent below knee amputation, 11 patients underwent Choparts amputation while 41 patients underwent wound debridement, 1 patient had Intertarsal amputation, 11 patients had Lisfranc amputation, 2 patients had single toe Rays amputation and 9 patients had multiple toes amputations.

Table 7: Surgical treatment among study participants.

Procedure	Frequency	Percentage
AK	5	5.0
BK	20	20.0
Choparts	11	11.0
Debridement	41	41.0
Intertarsal	1	1.0
Lisfranc	11	11.0
Ray's one toe	2	2.0
Rays multiple toes	9	9.0
Total	100	100.0

Table 8: Site of ulcer among study participants.

Site	Frequency	Percentage
Foot	68	68
Leg	28	28
Sole	4	4
Total	100	100

68 patients had ulcer over foot, 28 patients had ulcer over leg and 4 patients had sole ulcers.

Table 9: Grade of ulcer among study participants.

Grade	Frequency	Percentage
I	12	12
II	40	40
III	48	48
Total	100	100

12 patients had Grade I ulcer, 40 patients had Grade II ulcer and 48 patients had Grade III ulcer.

Table 10: Organism cultured from pus among study participants.

Organism	Frequency	Percentage
Klebseilla	6	6
Proteus	7	7
Pseudomonas	11	11
Staphylococcus	55	55
Sterile	21	21
Total	100	100

55 patients had *Staphyloccus* in pus culture, 6 patients had *Klebseilla*, 7 patients had *Proteus*, 11 patients had *Pseudomonas* and 21 patients had *Sterile* pus in culture.

DISCUSSION

The World Health Organization (WHO) defines diabetic foot as an infection, ulceration, or destruction of deep tissues associated with neurological abnormalities and

various degrees of peripheral vascular disease in the lower limbs. In the Dutch consensus, diabetic foot is defined as a diversity of foot abnormalities caused by neuropathy, micro-angiopathy, limited joint mobility, and other consequences of metabolic disturbances, mostly occurring in combination in patients with diabetes mellitus.

Proper assessment, early diagnosis, and intervention are required to reduce the incidence of lower limb amputation. Improper disease management leads to major amputation. Other studies on the specific properties of fibroblasts from patients with chronic diabetic ulcers showed that these cells were different from those obtained from patients without chronic ulcers in that the high-molecular-weight hyaluronic acid in the pericellular matrix was much more concentrated. The unique properties of fibroblasts may predispose these patients to chronic ulcer formation.

Akinci et al conducted a study on acute-phase reactants to predict the risk of amputation in diabetic foot infections. The aim of this study was to determine how well patients with diabetic foot infections will respond to treatment based on the levels of acute-phase reactants at baseline and after treatment. The study concluded that the amputation risk in diabetic foot infections was correlated with the circulating levels of acute-phase reactants.[12]

Walicka et al conducted a study on lower limb amputations in subjects with diabetes mellitus: Reasons and 30-Day Mortality. This study aimed to evaluate trends in the incidence of amputations, diagnoses at discharge, and mortality associated with diagnoses following LEA surgery. The study concluded that the main causes of LEA were vascular diseases, infections, and ulcerations. Depending on the diagnosis at discharge, the 30-day mortality rate following amputation is often high.[13]

In 1980, a different investigation revealed that 51.7 percent of cases had an aerobic infection, followed by 43.1 percent by anaerobic bacteria, and 5.1% fungal pathogens.[14] Another study conducted in California, USA, in 1996 found that Staphylococcus species were the most often isolated single organisms. In a study conducted in Ohio in 1996, Corynebacterium isolates were found to be one of several different species 15. According to a 1997 study conducted in Washington, USA, 67 percent of the infections were gram-positive cocci, and 92% of the pathogens were aerobic organisms.[16] In a study conducted by Letho et al amputations occurred 5.6 percent of the time in men and 5.3 percent of the time in men and women, respectively. An increased risk of amputation was linked to both long-term diabetes and high fasting plasma glucose levels during baseline assessment. Similarly, a key predictor of amputation was baseline HbA1C measurements of glycemic control. Plasma glucose or HbA1C had a dose-response association with the risk of amputation. Even after accounting for additional cardiovascular risk factors, the impact of hyperglycemia on the probability of amputation is still clearly visible. Peripheral neuropathy symptoms, bilateral lack of Achilles tendon reflexes, and vibration sensitivity were significant predictors of amputation. Amputation was additionally predicted by the absence of peripheral artery pulses and femoral artery bruits on auscultation. In a study conducted by Sadriwal et al it was concluded that Significant risk factors.[16]

Limitations

The follow-up period was limited to the duration of the hospital stay, which does not allow for the assessment of long-term outcomes and recurrence rates of diabetic foot ulcers.

CONCLUSION

Amputation and lower-extremity ulcers are chronic issues in people with diabetes. Diabetic foot ulcers are a potentially preventable consequence of diabetes and are linked to significant morbidity and mortality (DFU). More studies should be conducted in the future to predict risk factors for diabetic ulcers, and early diagnosis and treatment will be helpful for patients' recovery at the earliest.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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