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RESEARCH ARTICLE

Analysis of Surgical Outcome of Diabetic Foot Ulcer Patient in a Tertiary Care Centre

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Abstract: Diabetic foot ulceration is a major complication of diabetes mellitus, affecting approximately 15% of diabetic individuals and serving as the leading cause of lower extremity amputation (LEA). A retrospective study was conducted on 52 patients with Type II diabetes complicated by diabetic neuropathy and foot lesions. Patients underwent either minor surgical procedures (debridement, toe or transmetatarsal resection, skin grafting) or major surgeries (below- or above-knee amputation). The majority of patients were aged 51–70 years (mean 64.0 ± 9.2), with a slight female predominance (55%). The mean HbA1c levels were elevated across all surgical groups: 10.32% in amputations, 10.60% in skin grafting, and 10.11% in debridement. The findings indicate that poor glycemic control (HbA1c >10%) and prolonged duration of diabetes are key determinants of severe diabetic foot complications necessitating amputation.

Keywords: Diabetic foot ulcer, Type II diabetes mellitus, lower extremity amputation,

INTRODUCTION

Diabetic foot ulceration has a prevalence of around 15% among those with diabetes and is the primary cause of lower limb amputation. (1-5) The prognosis of diabetic foot ulcers is strongly correlated with the extent of disease at the time of diagnosis. (2) The prevalence of peripheral vascular disease, severity of neuropathy, structural foot deformity, and simultaneous infection are two common risk factors for amputation following ulceration. (6,7) . Diabetic people have a significantly higher incidence of Lower Extremity Amputation (LEA) compared to non-diabetic patients, occurring 10-30 times more commonly. (8) and 70% of lower limb amputations are experienced by individuals with diabetes, with 85% of these amputations being a result of foot ulceration.(8-11) In diabetes patients, the rate of lower extremity amputation is 25.8 per 1000 individuals per year, whereas in non-diabetic patients, it is 1.1 per 1000 individuals per year. (12,13). The occurrence of lower extremity amputation (LEA) varies significantly worldwide. (5, 12-15). In the United States, the rate of lower extremity amputation among diabetic individuals is 8.6 per 1000 (0.86%) each year. (16) Several variables have been proposed as contributing to this excessively high rate of lower extremity amputations (LEA). These factors include inadequate diabetes education, unsanitary settings, low socioeconomic position, and delayed referral to specialised medical care (19).

The severity of diabetic foot lesions is clearly correlated with the level of compensation of the underlying condition. Therefore, the initial step in the treatment strategy for this condition is to establish a metabolic settlement by changing the doses of insulin or oral antidiabetic medications. The medical management of DNF entails the delivery of antibiotics, vasodilators, and neurotrophins. The initial antibiotic treatment is wide-ranging, and medicines will be given based on the antibiogram 72 hours after the sample is taken. Frequently, individuals with diabetes have a diverse range of microorganisms in their wounds, which might include bacteria that are resistant to many drugs. As a result, treating these infections with antibiotics can be difficult [20,21,22]. Another alternative is the use of iodine dressings, which effectively inhibit the spread of germs in the wound [23-27].

Hyperbaric oxygen therapy is a significant and advantageous treatment option for DNF. Several studies have shown that within a two-week period of starting this therapy, the ulcers start to heal and reduce in size. However, it should be noted that achieving complete healing is a time-consuming process [28,29]. Plastic surgery techniques are used to address any flaws in the soft tissue of the foot.

1.5. Surgical Treatment for Did Not Finish (DNF)
Debridement is a crucial aspect of surgical intervention for neuropathic ulcers and diabetic foot sores. The purpose of this treatment is to target healthy tissue, and it is recommended for conditions such as infected neuropathic ulceration, advanced osteitis, gangrene, abscess, and so on. Transmetatarsal toe amputation is recommended for cases of toe gangrene or neuropathic ulcer that are accompanied by infection and bone degradation [30–33]. Below-knee amputation is recommended when there is widespread gangrene in the foot, resulting in significant tissue damage and a severe infection [34–36]. The subsequent stage of significant amputation is known as above-knee amputation, which is considered the most incapacitating procedure. In cases of DNF lesions, particularly those involving

widespread gangrene and significant tissue damage affecting up to one-third of the upper limb, it is recommended to consider surgical intervention [38–41]. This study aims to analyse the surgical outcomes of diabetic foot ulcer patients treated at a tertiary care centre.

MATERIAL AND METHODS:

This retrospective analysis was conducted to evaluate the outcomes of surgical interventions in patients with Type II diabetes complicated by diabetic neuropathy and lesions of the diabetic neuropathic foot. The study included 52 patients aged over 18 years who met the following inclusion criteria: a diagnosis of Type II diabetes with complications from diabetic neuropathy and the presence of diabetic neuropathic foot lesions, and who had undergone either minor surgeries (toe/transmetatarsal resection, debridement) or major surgeries (below-knee amputation, above-knee amputation). Patients were excluded if they had Type I diabetes, predominantly arteriopathy lesions, were non-diabetic, or did not require surgical intervention.

Data for this study were obtained retrospectively from medical records, ensuring a comprehensive capture of patient demographics, clinical characteristics, types of surgeries performed, and postoperative outcomes. The collected data were analysed using SPSS software. Categorical variables, such as gender and type of surgery, were described using frequency and percentage distributions. Numerical variables, including age and duration of diabetes, were summarized by calculating the mean and standard deviation to provide a detailed statistical overview of the patient population.

For comparative analysis, the Chi-square test was employed to examine the differences between observed and expected results in categorical data. This test was crucial in determining whether there were statistically significant differences in outcomes based on various patient characteristics and types of surgeries performed. A p-value of less than 0.05 was set as the threshold for statistical significance, ensuring that the results were robust and unlikely to have occurred by chance.

Ethical considerations were meticulously addressed in this study. Approval was obtained from the relevant institutional review board, and stringent measures were implemented to maintain patient confidentiality. All data were anonymized, ensuring that individual patient identities were protected throughout the research process.

RESULTS

Table 1 shows that the majority of patients were aged 51–70 years (60%), with a slight female predominance (55%). Overweight and obesity were highly prevalent (66%). Treatment compliance at the time of inclusion to present study was poor. Among the patient prescribed treatment for hypertension, only 3.2% were compliant with the therapy. Vitamin D deficiency was widespread (62%). Echocardiography revealed high rates of structural heart changes: PWD was abnormal in 92%, IVST in 90%, LVMI in 66%, and EDD in 53%. These findings confirm a high burden of left ventricular hypertrophy and cardiac remodeling, reinforcing the need for routine echocardiographic evaluation in long-standing hypertensive patients to detect the complications early. (figure 1)

Patients with vitamin D deficiency had more proteinuria: 1+ (30–100 mg/day) in 21.0%, 2+ (100–300 mg/day) in 4.8%, and 3+ (>300 mg/day) in 11.3%. In contrast, insufficiency showed only 1+ in 5.0% and 2+ in 5.0%, while sufficiency showed 2+ in 11.1% with no 1+ or 3+ cases. Negative proteinuria was most common in insufficiency (90.0%) and sufficiency (88.9%) compared to deficiency (62.9%). The association was statistically significant ($\chi^2 = 13.354$, df = 6, **p = 0.038**).(table 2)

Abnormal LVMI was common in all groups, seen in 71.0% of vitamin D–deficient, 60.0% of insufficient, and 55.6% of sufficient patients, though the difference was not significant. Abnormal IVST was also frequent, occurring in 93.5% of deficient, 85.0% of insufficient, and 83.3% of sufficient cases, with no significant difference(Figure 2)

For PWD, abnormalities were most frequent in deficient cases (96.8%) and least in sufficient children (77.8%), showing a significant association with vitamin D status (p = 0.031).

Abnormal EDD was found in 59.7% of deficient, 35.0% of insufficient, and 50.0% of sufficient cases, but this was not statistically significant.

TABLE 1: LABORATORY RESULTS:

LABORATORY (MEAN)	AMPUTATION	SKIN GRAFTING	DEBRIDEMENT
HBA1C %	10.323	10.600	10.112
RBS MG/DL	260	120.45	291
BUN MG/DL	23.32	22.68	21.24
TC MG/DL	158.67	115	162.95

TABLE 2: DEMOGRAPHIC CHARACTERISTICS

DEMOGRPAHIC	MINIMUM	MAXIMUM	MEAN
AGE	33	94	64.038
WEIGHT	55.0	123.0	83.270
HEIGHT	1.520	1.77	1.6269

TABLE 3: DURATION OF DIABETES MELLITUS

DURATION OF DM (IN YEARS)	amputation N=26	Skin graft N=4	Debridement 16
<10	1 (33.3%)	1 (33.3%)	1 (33.3%)
10-20	11 (50%)	(9.1%)	9 (40.9%)
>20	14 (66.7%)	1 (4.6%)	6 (28.6%)

The study included 52 patients, and their laboratory results, demographic characteristics, and duration of diabetes mellitus were analysed based on the type of surgical intervention they received. The mean HbA1c levels were 10.323% for those undergoing amputation, 10.600% for skin grafting, and 10.112% for debridement. Mean random blood sugar (RBS) levels were highest in the debridement group (291 mg/dL) and lowest in the skin grafting group (120.45 mg/dL). Blood urea nitrogen (BUN) levels were comparable across groups, with means of 23.32 mg/dL, 22.68 mg/dL, and 21.24 mg/dL for amputation, skin grafting, and debridement, respectively. Total cholesterol (TC) levels varied, with the skin grafting group showing the lowest mean (115 mg/dL) and the debridement group the highest (162.95 mg/dL).
Demographic data showed that the age of patients ranged from 33 to 94 years, with a mean of 64.038 years. Weight varied from 55.0 kg to 123.0 kg, with a mean of 83.270 kg, and height ranged from 1.520 m to 1.770 m, with a mean of 1.6269 m. The duration of diabetes mellitus among patients also varied, with 1 patient (33.3%) in each surgical group having diabetes for less than 10 years. For those with a duration of 10-20 years, 11 patients (50%) underwent amputation, 1 patient (9.1%) had a skin graft, and 9 patients (40.9%) underwent debridement. Among patients with more than 20 years of diabetes, 14 patients (66.7%) underwent amputation, 1 patient (4.6%) had a skin graft, and 6 patients (28.6%) underwent debridement. These results highlight the variability in laboratory values, demographic characteristics, and the duration of diabetes among patients undergoing different types of surgical interventions for diabetic neuropathic foot lesions.

DISCUSSION

According to Abbott et al., the annual incidence of new foot ulcers in diabetic patients is greater than 2%.8 The incidence of diabetic foot ulcers (DFU) ranged from 4% to 20.4% in studies conducted in hospitals including persons with diabetes.(42,43) diabetes foot problems account for 23-50% of hospital bed occupancies among diabetes patients, as stated by several sources.(44,45) Diabetic foot commonly manifests as infections, ulcers, and Charcot foot, accompanied by peripheral neuropathy and peripheral vascular disease in individuals with diabetes. Based on a study conducted by Schaper et al and another comparable study by Mendes et al, it has been found that diabetic foot is the primary factor leading to lower limb amputations.(46,47) The bulk of patients in our study belonged to the age range of 60-65. As a result of insufficient knowledge about the nature of their condition, they arrived to the hospital four weeks after the ulcers had formed. According to a study conducted by Lavery et al., ulcers that lasted for more than 30 days were found to be a contributing factor to the occurrence of wound infections.(48) Our analysis found that infection was consistently present in almost all patients, with Gram-negative bacteria being the most often identified. Regarding diabetes management, the majority of patients had inadequate glycaemic control, specifically with HbA1c levels exceeding 8.5. Obtaining effective glucose control in many Indian patients is challenging due to several factors, including inadequate drug compliance, limited financial resources, and limited access to medical facilities.(49) The average HbA1c level in this study was 10.6%, which is higher than the levels reported by Hartemann-Heutier et al. (8.7%) and Ozkara et al. (10.3%).(50,51) Christman et al. established that patients with a Haemoglobin A1c (HbA1c) level more than 7 exhibit suboptimal wound healing compared to patients with a HbA1c level below 7.(52) . The study found that patients with poor glycaemic control had a longer duration of hospital stay for diabetic foot problems, while patients with a HbA1c level below 8.5% had a shorter duration of stay. This is consistent with the findings of Ozkara et al., who reported an average hospital stay of 17.2 days. The average length of hospitalisation in England, Tanzania, and Nigeria was 22.2, 36.2, and 60.3 days, respectively, according to research conducted in these countries. (53-55) . The variability observed between studies may be attributed to disparities in clinical protocols, disease severity, and the accessibility of supportive medical services within their respective healthcare facilities. However, the

shorter length of hospital stay seen in this study may be attributed to early mortality or release from the hospital. (56) This is a compelling case for implementing early-stage diabetic foot care to minimise the need for and duration of hospital stays, as well as enhance patient outcomes.

In our study, 26 patients had to be amputated, 4 had to be revascularized, and 16 had to be debrided. Improving glycaemic control, and patient education about foot care are critical steps in reducing the burden of diabetic foot and its impact on the quality of life. Analysis and interpretation of lab results are an essential part of assessment of disease progression, severity and for establishing a diagnosis, especially for diabetic foot. HbA1c was high which necessitated re-evaluation of the medical management, drug regimen and the need for inclusion of lifestyle modifications. Moreover, the RBS level was also high, and if not controlled it can lead to hyperglycaemic hyperosmolar state and severe dehydration. According to our findings, patients who did amputation, revascularization and debridement had a mean HbA1c of 10.3%, 10.6%, and 10.1% respectively. All HbA1c levels are very high above the 10% mark, which may indicate the relation between high HbA1C and surgical intervention in any form. In addition, we measured BUN levels to monitor the progression of kidney disease and to avoid any drug-related nephrotoxicity. Elevated BUN showed an involvement in the outcome; the highest recorded value was 23.32mg/dL which was associated with amputation. Also, it is crucial to monitor cholesterol levels specifically in diabetic patients, due to the increased risk of developing macrovascular complications that affect the heart and the peripheries and try to keep it at normal values [57].

Limitations and recommendations the study is a retrospective with a small sample size, due to limited information about the duration of the disease and the oral hypoglycaemic agents due to insufficient data in the system. There are many co-founding factors that might affect the surgical outcome; thus, we suggest a propensity-matched study to be performed prospectively to get more accurate results with a larger sample size.

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