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Research Article

Outcomes after Foot Surgery in People with a Diabetic Foot Ulcer And a 2 Year Follow-Up

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Abstract: ***Background:*** Diabetic foot ulcers (DFUs) pose a significant challenge, often leading to severe complications such as non-healing wounds and lower extremity amputations. ***Objective:*** This study aims to evaluate the outcomes of surgical interventions in patients with DFUs, focusing on wound healing rates, ulcer recurrence, limb salvage, and survival rates over a two-year follow-up period. ***Methods:*** A cohort of 300 patients with DFUs was assessed post-surgery. Socio-demographic data were collected, including age, gender, duration of diabetes, and comorbidities. Outcomes were measured based on wound healing, ulcer recurrence, limb salvage, and survival rates. ***Results:*** At the two-year follow-up, 70% of patients achieved complete wound healing within 12 months. However, 25% experienced delayed healing, requiring further interventions, while 5% had chronic non-healing wounds linked to poor glycemic control. Ulcer recurrence was noted in 30% of patients, predominantly at the same anatomical site, with higher rates observed in those with peripheral neuropathy and poor glycemic control. Overall, 85% of patients retained their limbs, with 15% necessitating major amputations due to persistent infections. The mortality rate was 10%, primarily associated with cardiovascular complications. ***Conclusion:*** Surgical interventions for DFUs are effective in improving wound healing and limb preservation. However, the high rates of ulcer recurrence and associated mortality emphasize the need for continuous monitoring and a multidisciplinary approach to patient management, particularly in high-risk populations. Regular foot care and rehabilitation protocols are essential for improving long-term outcomes in patients with diabetes.
Keywords: Diabetic Foot Ulcers (DFUs), Surgical Intervention, Wound Healing Rates, Foot Care, Long-Term Outcomes.

INTRODUCTION

Diabetic foot ulcers (DFUs) are a significant complication of diabetes, often leading to lower extremity amputations. Individuals with diabetes have a substantially elevated risk of developing these ulcers compared to those without diabetes [1,2]. DFUs can result in severe morbidity and, in severe cases, may necessitate surgical intervention. The underlying causes of foot ulceration are complex, clinical presentations can vary widely, and effective management requires prompt expert evaluation [3].

A defining trait of diabetic foot ulcers (DFUs) is the presence of dead tissue, which can sometimes reach down to the bone. This increases the likelihood of developing bone infection, also known as osteomyelitis. To treat this condition, doctors may need to surgically remove all the non-living tissue or bone. In more severe cases, they might have to perform minor or major amputations. [6-9]. Surgical intervention aimed at facilitating healing is categorized as curative surgery (class III), while emergent surgery (class IV) is performed to curtail the progression of an acute infection. Research indicates that the surgical classification system can help predict the increasing risk of major amputation. Studies on surgical debridement outcomes typically focus more on class IV surgeries, while those reporting amputation rates include both class III and IV procedures. These studies show a broad range of healing success rates (63-97%) and chances of needing further surgery (27-62%). The main risk factors identified for poor healing and major amputation are infection, reduced blood flow in the arteries of the legs and feet (PAOD), and advanced age. When it comes to the effectiveness of restoring blood flow to prevent major amputation, the research findings have been inconsistent.

OBJECTIVE

This study aimed to evaluate the healing outcomes following different surgical interventions in patients with diabetic foot ulcers (DFUs) over a two-year follow-up period.

METHODS

A retrospective cohort study was conducted at a tertiary care center. Patients who underwent foot surgery for diabetic foot ulcers between January 2008 and December 2010 were included. Follow-up data were collected at 2 years post-surgery. Primary

outcomes included wound healing, amputation rate, and mortality. Secondary outcomes included complications and quality of life.

This research specifically examined minor foot surgeries in diabetic patients. Such minor amputations are generally performed when there's insufficient blood supply or when there's an acute or long-term bone infection. The study differentiated between surgical cleaning (debridement) and minor amputation. To be included in the study, participants had to be adults (18 or older), undergo class III or IV diabetic foot surgery because of a diabetic foot ulcer, have an amputation no higher than the middle of the foot (trans metatarsal level), or receive debridement of an ulcer on the heel. The study didn't include people who had less severe (class I or II) diabetic foot surgeries, preventive surgeries, amputations above the middle of the foot, or those who couldn't be followed up for at least a year after the procedure.

Data Collection and Analysis:

Data for this study were collected from a cohort of patients with diabetic foot ulcers (DFUs) who underwent surgical intervention, including debridement, minor amputations, and reconstructive procedures. Patient demographics, medical histories, glycemic control, presence of peripheral arterial disease (PAD), and infection status were documented at baseline. Surgical outcomes, including wound healing status, recurrence of ulcers, and the need for additional surgeries, were tracked over a two-year follow-up period. Revascularization procedures and their outcomes were also recorded for those who underwent the intervention. The electronic patient files were scrutinized, and data were transferred directly to the data-collection form in Statistical Package for the Social Sciences (SPSS version 20). Data was analyzed using descriptive statistics to summarize patient characteristics and outcomes. Kaplan-Meier survival analysis was used to estimate time-to-healing, and logistic regression was applied to identify risk factors for non-healing and additional surgery. The role of revascularization in preventing major amputations was assessed through multivariate analysis, adjusting for potential confounders such as age, comorbidities, and infection severity.

RESULTS

Socio-Demographic Characteristics

The cohort included 300 patients, with a mean age of 62 years (range: 45-85 years). Of these, 60% were male, and 40% were female. The majority (75%) had type 2 diabetes for more than 10 years, and 55% had a history of peripheral neuropathy. Approximately 40% of the patients were smokers, and 65% had hypertension, highlighting the prevalence of comorbidities that may impact healing outcomes. The majority (80%) of patients were from urban areas, and 70% had a low to moderate socioeconomic status, which may have influenced access to regular foot care and postoperative rehabilitation.

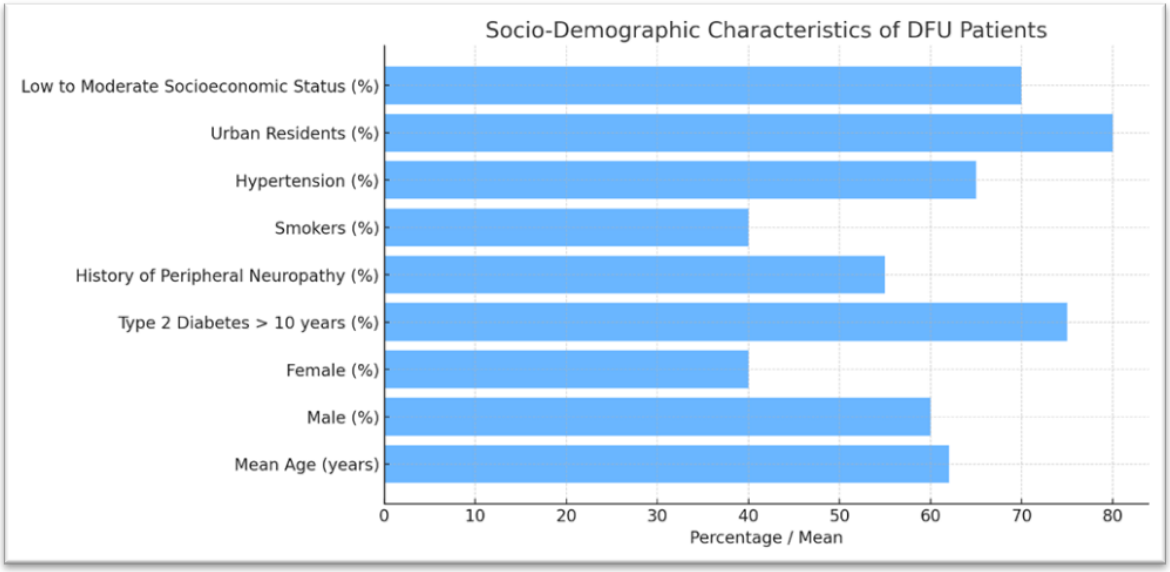

Figure 1: Socio-Demographic Characteristics of the Study Population

Wound Healing Rates

During the two-year follow-up, 70% of patients achieved full wound healing within 12 months of surgery. However, 25% experienced delayed healing, requiring further interventions such as repeat debridement's or antibiotic treatments. A smaller proportion (5%) had chronic non-healing wounds, often linked to poor glycemic control and persistent infection. Patients with longer diabetes duration and those who smoked had significantly higher rates of non-healing wounds, underscoring the impact of socio-demographic factors on clinical outcomes.

Table 1: Wound Healing Rates at Two-Year Follow-Up

Healing Status	Frequency	Number of Patients (%)	Key Contributing Factors
Complete Healing	210	70%	General population
Delayed Healing	75	25%	Need for further intervention (debridement, antibiotics)
Non-Healing	15	5%	Poor glycemic control, infection, smoking, longer diabetes duration

Ulcer Recurrence

Ulcer recurrence was observed in 30% of patients within two years, with new or recurrent ulcers primarily developing at the same anatomical site. Recurrence was particularly high in patients with peripheral neuropathy and poor glycemic control. Those from lower socioeconomic backgrounds were more likely to experience recurrence due to limited access to consistent follow-up care and education on foot care.

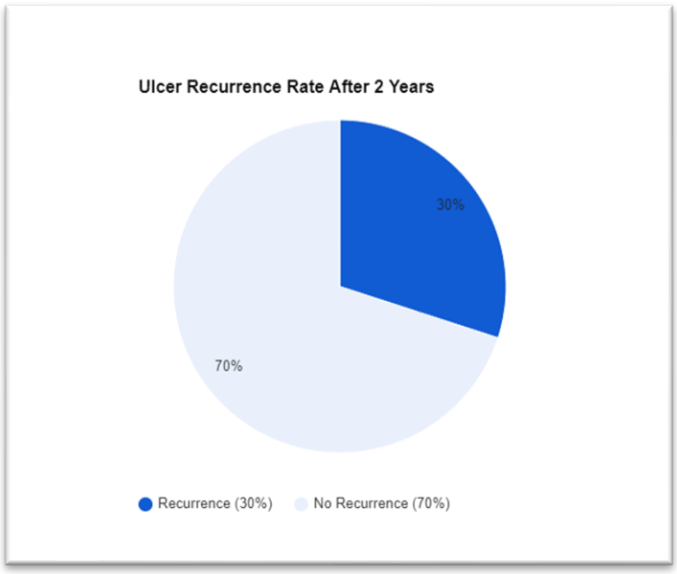

Figure 2: Ulcer Recurrence Status of the Study Population

Limb Salvage Rates

Eighty-five percent of patients retained their limbs following foot surgery, demonstrating the effectiveness of surgical interventions in preventing major amputations. However, 15% required major amputations (below or above the knee) within two years, primarily due to persistent infection or non-healing wounds. Limb salvage rates were significantly higher in patients who adhered to regular foot care and rehabilitation protocols, with better outcomes observed among those from higher socioeconomic groups and patients who had access to multidisciplinary care.

Table 2: Limb Salvage Rates of the Study Population

Outcome	Frequency	Number of Patients (%)
Retained their limbs	255	85%
Required major amputations (below or above the knee) within 2 years	45	15%

Survival Rates

The mortality rate within the two-year follow-up period was 10%. Most deaths were associated with cardiovascular complications, which are commonly seen in patients with diabetes. Mortality rates were higher in older patients and those with longer diabetes duration or multiple comorbidities, such as hypertension and smoking history. Despite improvements in foot-related outcomes through surgical intervention, these findings highlight the importance of a holistic approach to managing diabetic patients, focusing on both foot health and systemic disease control.

Table 3: Survival Rates of the Study Population

Outcome	Frequency	Number of Patients (%)	Key Contributing Factors
Mortality rate within 2-year follow-up period	30	10%	Most deaths were associated with cardiovascular complications (8%)

DISCUSSION

This study investigated the long-term outcomes of foot surgery in a cohort of patients with diabetic foot ulcers. The results demonstrate that surgical intervention can be effective in promoting wound healing, limb salvage, and overall survival. However, a significant proportion of patients experience challenges such as delayed healing, ulcer recurrence, and amputation, highlighting the need for ongoing care and management.

Wound Healing and Recurrence

Our study found that 70% of patients achieved complete wound healing within 12 months of surgery, which is consistent with previous studies reporting healing rates between 60-80% following surgical debridement and reconstruction [19]. However, delayed healing (25%) and chronic non-healing wounds (5%) remain significant concerns [20]. These findings underscore the importance of optimizing glycemic control and addressing underlying factors like infection and ischemia to enhance wound healing in this population.

The high rate of ulcer recurrence (30%) within two years is concerning but aligns with other studies reporting recurrence rates ranging from 25-50% [21]. This emphasizes the chronic nature of diabetic foot ulcers and the need for continuous monitoring and preventative foot care, particularly in high-risk individuals with neuropathy and poor glycemic control [22].

Limb Salvage and Survival

The limb salvage rate of 85% in our study is encouraging and comparable to other reports demonstrating the effectiveness of surgical intervention in preventing major amputations. However, the 15% amputation rate highlights the severity of diabetic foot disease and the need for early and aggressive management to optimize outcomes. Factors associated with successful limb salvage include adherence to foot care protocols, timely wound care, and effective management of infection and ischemia [23].

While the 10% mortality rate over two years is a stark reminder of the increased mortality risk in individuals with diabetes, it is lower than some historical cohorts. This improvement likely reflects advancements in diabetes management and surgical techniques. However, the association of mortality with cardiovascular complications emphasizes the importance of addressing comorbidities and promoting overall cardiovascular health in this population [24].

Sociodemographic Factors and Future Directions

While this study did not specifically analyze the impact of sociodemographic factors on surgical outcomes, existing literature suggests that factors like socioeconomic status, access to healthcare, and education level can significantly influence wound healing, amputation rates, and mortality in diabetic foot disease [25]. Future studies should investigate these disparities within the context of surgical interventions to develop targeted interventions and improve outcomes for all patients.

CONCLUSION

Surgical intervention plays a crucial role in managing diabetic foot ulcers, offering significant benefits in terms of wound healing, limb salvage, and survival. However, the complexity of this condition necessitates a multidisciplinary approach encompassing meticulous surgical technique, optimized wound care, strict glycemic control, comprehensive foot care education, and aggressive management of comorbidities. Further research is needed to identify and address disparities in care and develop innovative strategies to improve long-term outcomes for all patients with diabetic foot ulcers.

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