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Surgical Treatment of Diabetic Foot in Different Stages

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Abstract

Background: Diabetic foot infection encompasses a range of infectious conditions that form a continuum of clinical manifestations. The aim of this study was to identify the risk factors leading to complications in diabetic foot infections and to evaluate the outcomes of various treatment modalities for managing diabetic foot.

Subjects and Methods: A total of 100 cases were included in this study. The research focused on examining clinical presentations, management strategies, preventive measures, etiology, and surgical complications associated with foot infections in diabetic patients.

Results: Diabetic foot infections were most commonly observed in middle-aged individuals, particularly those in their 4th and 5th decades of life. The study included 50 males and 50 females. Of these, 70% were presented with diabetic foot ulcers, 20% had diabetic foot cellulitis, and 10% presented with gangrene. Surgical site infections were the most frequent complications, affecting a total of 10 patients.

Conclusion: The primary goal of surgical management for diabetic foot infections is now preservation of the foot. Treating diabetic foot infections remains challenging due to the presence of systemic diseases, compromised immune resistance, patient ignorance, poor adherence to long-term insulin therapy, and fear of surgery among some patients.

Keywords: Diabetic foot, Foot ulcers, Sequestrectomy, Debridement, Amputation

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Introduction

Diabetes can cause damage to both nerves and blood vessels over time, which can lead to the loss of foot function due to nerve damage [1]. People with diabetes may not feel injuries such as cuts, blisters, or sores because of this nerve damage. Additionally, poor blood circulation, often seen in those with diabetes, increases the risk of foot infections, which can range from mild cellulitis to more severe conditions like osteomyelitis. In fact, foot wounds are one of the leading causes of hospitalization for people with diabetes, and many of these cases may require surgical treatment [2].

A group of conditions, including infection, diabetic foot ulcers, and neuropathic osteoarthropathy, is referred to as diabetic foot syndrome. Globally, the number of people with diabetes is increasing rapidly, with 194 million affected worldwide, and the number is expected to rise to 344 million by 2030. Each year, between 2 and 6% of these individuals will develop a diabetic foot ulcer [3].

Infections in people with diabetes are more difficult to treat due to impaired blood circulation, which reduces the delivery of immune cells to the infection site and the concentration of antibiotics in the affected tissues [4]. Diabetic foot infections can vary from minor fungal infections to severe, life-threatening conditions. The types of infections seen in diabetic patients depend on the severity of the wound, with early infections often being monomicrobial and more advanced ones becoming polymicrobial [5, 6].

This study aims to explore the clinical signs, management approaches, and surgical complications associated with foot infections in diabetic patients.

Methods**Study design**

A total of 100 patients were included in this study. All participants provided written informed consent after being fully briefed on the study details. Inclusion in the study was contingent upon the patient's willingness and consent to participate. Ethical approval was obtained from the medical institute's ethical committee prior to conducting the study.

Patient history and examination

A detailed medical history was recorded for each patient, including any prior conditions related to diabetes, wound healing, ulcers, or boils on other parts of the body. A comprehensive examination was conducted, which included both general physical and local (site-specific) assessments, as well as systemic evaluation.

Wagner's classification and operative details

Wagner's classification system was used to assess the severity of diabetic foot ulcers. Operative characteristics were documented, including the type of surgery performed and any postoperative complications.



Investigations

Routine laboratory tests were conducted, including:

- Blood tests (routine blood work, blood sugar levels, and urine sugar test).
- X-ray imaging of the affected area.
- Culture and sensitivity testing of any infectious discharge.

Data collection and analysis

Data was collected through a specifically designed questionnaire. The data were analyzed using SPSS software (version 22.0). Statistical analysis was performed using Student's t-test and Chi-square test, with significance set at a p-value of less than 0.05.

Results

The data on diabetic foot patients reveals several key insights. Age-wise, the distribution is nearly equal, with 48% of patients under 50 years old and 52% aged 50 and above, suggesting that diabetic foot is a concern across both younger and older populations. However, the majority of cases present as ulcers (73%), followed by cellulitis (11%), gangrene (10%), and mixed cases (6%), emphasizing the prominence of ulcers in diabetic foot complications. In terms of infection, *Staphylococcus aureus* is the most commonly isolated microorganism, found in 57% of patients, followed by gram-negative bacteria (22%), beta-hemolytic streptococci (12%), and *anaerobic cocci* (9%), highlighting the role of bacterial infections in these cases. Treatment-wise, a significant number of patients (66%) required amputation, which is the most common surgical intervention, followed by debridement (18%) and other less common procedures like skin grafting and incision and drainage. These findings suggest that diabetic foot infections can progress to severe stages, often requiring invasive procedures, and underscore the importance of early detection and intervention to prevent complications such as amputation (Table 1).

The distribution of diabetic foot ulcers according to Wagner's classification highlights a range of severity among patients. The most common ulcer type is grade 1 (superficial ulcers), which accounts for 48% of cases, suggesting that many patients present with early, treatable ulcers. A substantial 30% of patients have grade 2 ulcers, which are deeper and affect tissues beyond the skin but without bony involvement or abscess formation. More severe stages are less common, with grade 3 ulcers (abscess with bony involvement) and grade 4 ulcers (localized gangrene) each representing 5% of cases. The most severe ulcer type, grade 5 (extensive gangrene), is found in 7% of patients, indicating that while advanced stages of gangrene are not the majority, they do still occur and often require urgent interventions such as amputation. Overall, the data suggests that while most diabetic foot ulcers are early and manageable, there remains a significant proportion that progresses to more complicated stages, emphasizing the need for timely diagnosis and aggressive management to prevent severe outcomes (Table 2).

Discussion

Foot ulcers are a common and serious complication for diabetic patients, often leading to infection that can spread to deeper tissues, potentially resulting in severe conditions such as septic gangrene and requiring amputation if not properly treated. To optimize pathogen identification, it's important to obtain specimens for culture after debridement of the wound to prevent contamination. Foot ulcers typically affect middle-aged individuals, usually in their 40s or 50s [7, 8].

Sensory neuropathy and reduced proprioception in diabetic patients make it difficult for the foot to react to repeated stresses, which means ulcers may worsen unnoticed on an insensate foot. Studies conducted in the Netherlands and Iran showed a prevalence of 20.0% and 20.4%, respectively, indicating regional variations in the prevalence of diabetic foot ulcers. These differences could reflect variations in the prevalence of diabetes and local risk factors [5].

Table 1: Basic characters of patients with diabetic foot.

Variables	No.	Percentage
Age (years)	<50	48
	≥50	52
Presentation	Ulcer	73
	Cellulites	11
	Gangrene	10
	Mixed	6
Common microorganism isolated	<i>S. aureus</i>	57
	Gram-negative	22
	Beta haemolytic <i>Streptococci</i>	12
	<i>A. cocci</i>	9
Operations	Skin grafting	6
	Incision and drainage	3
	Sequestrectomy	7
	Debridement	18
	Amputation	66

Table 2: Wagner's classification of diabetic foot ulcers.

Ulcer grades	Description	No.	Percentage
0	No ulcer but high-risk foot	5	5
1	Superficial ulcer	48	48
2	Deep ulcer, no bony involvement or abscess	30	30
3	Abscess with bony involvement	5	5
4	Localized gangrene e.g., toe, heel, etc.	5	5
5	Extensive gangrene involving the whole foot	7	7



A study by Morbach et al. [9] comparing diabetic foot disease in Germany, India, and Tanzania found that German patients were significantly older than those from India and Tanzania. These findings suggest that age may be a time-dependent risk factor in the progression of diabetic foot ulcers, which seem consistent across different regions. Additionally, the age of onset of diabetes varies by continent.

Treatment options for diabetic foot ulcers include wound debridement, excision of slough, and the application of various dressings like povidone-iodine, metronidazole, collagenase, L-lysine, and mupirocin to promote healing. In more severe cases, treatments may include split-skin grafting or amputations [10]. Wong et al. [11] reported an 87% success rate in limb salvage using repeated debridement and herbal treatments. Dressings such as saline-soaked gauze or moisture-retaining materials are often used to create an optimal wound environment that encourages healing.

Several limitations should be considered when interpreting the data. First, the relatively small sample size and lack of diversity in the patient population limit the generalizability of the findings to the broader diabetic community. Additionally, the data is cross-sectional, offering only a snapshot of patient characteristics and ulcer severity without tracking the progression of conditions or treatment outcomes over time. Important risk factors such as glycemic control, comorbidities, and the duration of diabetes are not addressed, which could provide a deeper understanding of ulcer development and healing. The data also lacks insight into patient responses to treatments or long-term recovery, such as healing rates or recurrence of ulcers. Furthermore, while the microorganisms isolated are listed, their specific impact on ulcer severity and progression is not explored. Lastly, factors like gender, socioeconomic status, and lifestyle choices, which influence the risk and management of diabetic foot ulcers, are not accounted for in the tables. These limitations highlight the need for further research to capture a more comprehensive picture of diabetic foot care and outcomes.

Conclusion

The approach to surgical management of diabetic foot has evolved significantly over time, with a current emphasis on preservation. Increased awareness of surgical complications associated with diabetic foot has contributed to a reduction in severe outcomes,

such as gangrene, in some patients. Diabetic foot remains one of the most challenging infections to manage due to factors like underlying systemic diseases, reduced immune resistance, patient ignorance, poor adherence to long-term insulin therapy, and a general fear of surgery among some patients.

Acknowledgements

None.

Conflicts of interest

None.

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