

DELAYED PRESENTATION AS THE PRINCIPAL DETERMINANT OF POOR OUTCOMES IN DIABETIC NECROTIZING FASCIITIS: A PROSPECTIVE COMPARATIVE STUDY

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ABSTRACT

Necrotizing fasciitis (NF) is a rapidly progressive and potentially fatal soft tissue infection involving the superficial fascia and subcutaneous tissue.¹ It is considered a true surgical emergency because delayed diagnosis and treatment can rapidly lead to septic shock, multiple organ failure, limb loss, and death.² Early recognition, prompt surgical debridement, broad-spectrum antibiotic therapy, and intensive supportive care remain the cornerstones of successful management.³ Early diagnosis is often challenging because the disease progresses rapidly along the fascial planes, while the initial skin changes may be minimal.⁴ Several studies have shown that timely surgical intervention significantly reduces morbidity and mortality.^{5, 6}

INTRODUCTION

Although necrotizing fasciitis is relatively uncommon, it is associated with high morbidity and mortality worldwide.^{1, 2} The infection progresses rapidly, and delayed surgical treatment is associated with poor clinical outcomes.^{7, 8} Therefore, early diagnosis, prompt surgical debridement, and appropriate antimicrobial therapy are essential to improve patient survival.⁹

Diabetes mellitus is the most common underlying comorbidity in patients with necrotizing fasciitis.¹⁰ Chronic hyperglycaemia impairs neutrophil function, alters the immune response, reduces tissue perfusion, and delays wound healing, thereby increasing susceptibility to severe soft tissue infections.¹¹ These pathological changes may also contribute to rapid progression of infection and poorer clinical outcomes in diabetic patients.

Previous studies have consistently reported that diabetic patients have higher rates of multiple surgical debridements, amputations, prolonged hospital stay, intensive care unit admission, and mortality than non-diabetic patients.^{10, 11} However, most of these studies have mainly described diabetes as a risk factor, while the reasons responsible for these adverse outcomes have not been adequately explored.

One possible explanation is delayed presentation to the hospital. Peripheral neuropathy may reduce pain perception, causing diabetic patients to seek medical attention only after the infection has become advanced. As a result, these patients may present with greater tissue destruction, a higher inflammatory response, increased surgical burden, and poorer clinical outcomes. This clinically important and potentially modifiable factor has received relatively little attention in prospective comparative studies.

India has one of the largest populations of individuals with diabetes mellitus, and necrotizing fasciitis continues to be a common surgical emergency in tertiary care hospitals. Identifying the factors responsible for poor outcomes in diabetic patients may help improve early diagnosis, timely referral, and prompt surgical intervention, thereby reducing limb loss and mortality.

Therefore, the present prospective comparative study was undertaken to compare the clinical presentation, laboratory parameters, microbiological profile, surgical management, and clinical outcomes of necrotizing fasciitis in diabetic and non-diabetic patients. We hypothesized that delayed presentation is an important contributor to the increased disease severity and poorer clinical outcomes observed among diabetic patients with necrotizing fasciitis.

MATERIALS AND METHODS

Study Design

This prospective comparative observational study was conducted to compare the clinical presentation, laboratory findings, microbiological profile, surgical management, and clinical outcomes of necrotizing fasciitis in diabetic and non-diabetic patients.

Study Setting and Duration

The study was carried out in the Department of General Surgery, Sree Balaji Medical College and Hospital, Chennai, a tertiary care teaching hospital, over a period of 18 months from January 2023 to June 2024.

Study Population

All consecutive adult patients admitted with a clinical diagnosis of necrotizing fasciitis during the study period were screened for eligibility. Patients were divided into two groups based on the presence or absence of diabetes mellitus.

- **Group A:** Diabetic patients with necrotizing fasciitis (n = 85)
- **Group B:** Non-diabetic patients with necrotizing fasciitis (n = 85)

A total of 170 patients were included in the final analysis.

Inclusion Criteria

- Patients aged 18 years and above.
- Patients with a clinical diagnosis of necrotizing fasciitis confirmed by operative findings.
- Patients who provided written informed consent to participate in the study.

Exclusion Criteria

- Patients younger than 18 years.
- Pregnant women.
- Patients with chronic immunosuppressive conditions other than diabetes mellitus, including HIV infection, malignancy receiving chemotherapy, long-term corticosteroid therapy, or organ transplantation.
- Patients who declined to participate in the study.

Data Collection

After obtaining informed consent, demographic details, clinical history, duration of symptoms before hospital presentation, associated comorbidities, and physical examination findings were recorded using a predesigned data collection proforma.

Baseline laboratory investigations included complete blood count, random blood glucose, glycated haemoglobin (HbA1c), serum creatinine, C-reactive protein (CRP), serum electrolytes, and other routine biochemical investigations. Pus or tissue samples obtained during surgical debridement were sent for microbiological culture and antibiotic sensitivity testing.

All patients underwent emergency surgical exploration and debridement based on the clinical judgement of the treating surgical team. Repeat debridement was performed whenever clinically indicated until all necrotic tissue had been adequately removed. Definitive wound closure procedures, including split-thickness skin grafting or flap coverage, were performed after satisfactory control of infection.

Outcome Measures

The primary outcome was the comparison of clinical outcomes between diabetic and non-diabetic patients with necrotizing fasciitis.

Secondary outcome measures included:

- Duration of symptoms before hospital presentation.
- Laboratory parameters at admission.
- Microbiological profile.
- Number of surgical debridements.
- Requirement for major limb amputation.
- Intensive Care Unit (ICU) admission.
- Length of hospital stay.
- In-hospital mortality.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using the Statistical Package for the Social Sciences (SPSS) software version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean $\pm$ standard deviation (SD), while categorical variables were presented as frequencies and percentages.

Comparisons between the two groups were performed using the independent Student's *t*-test for continuous variables and the Chi-square test or Fisher's exact test for categorical variables, as appropriate. A *p*-value of <0.05 was considered statistically significant.

Ethical Considerations

The study was approved by the Institutional Ethics Committee of Sree Balaji Medical College and Hospital before commencement. Written informed consent was obtained from all participants prior to enrolment, and patient confidentiality was maintained throughout the study in accordance with the ethical principles of the Declaration of Helsinki.

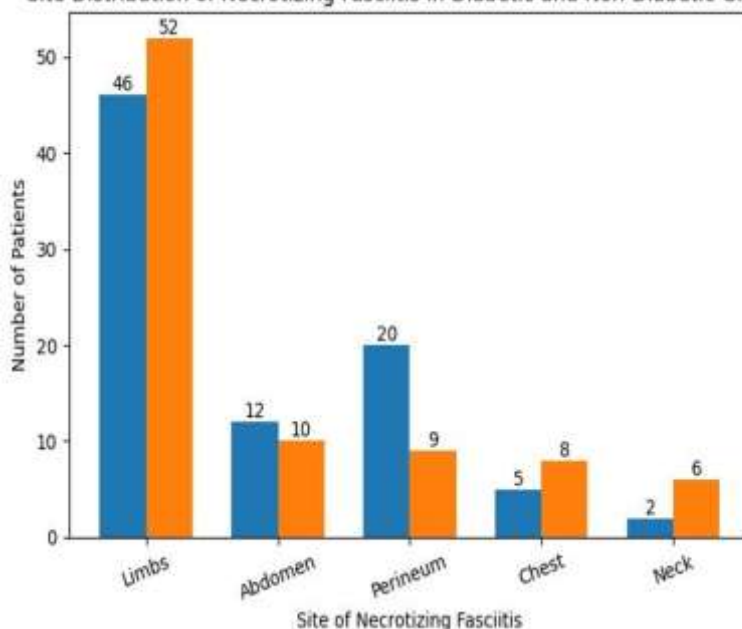
RESULTS

A total of 170 patients with necrotizing fasciitis were included in the study, comprising 85 diabetic and 85 non-diabetic patients. Comparative analysis demonstrated significant differences in demographic characteristics, laboratory findings, surgical management, and clinical outcomes between the two groups.

Table 1. Baseline Demographic Characteristics

Characteristic	Diabetic (n=85)	Non-diabetic (n=85)	p-value
Age (years)			
18–30	6 (7.1%)	18 (21.2%)	
31–40	12 (14.1%)	20 (23.5%)	
41–50	22 (25.9%)	24 (28.2%)	
51–60	28 (32.9%)	15 (17.6%)	
>60	17 (20.0%)	8 (9.4%)	<0.05
Gender			
Male	58 (68.2%)	60 (70.6%)	
Female	27 (31.8%)	25 (29.4%)	0.80

The baseline demographic characteristics are shown in Table 1. Diabetic patients were significantly older than non-diabetic patients ($p < 0.05$), with the highest proportion belonging to the 51–60-year age group (32.9%). Male predominance was observed in both groups without a statistically significant difference ($p = 0.80$).

Site Distribution of Necrotizing Fasciitis in Diabetic and Non-Diabetic Groups**Figure 1. Anatomical Distribution of Necrotizing Fasciitis**

The lower limbs were the most commonly affected anatomical site in both groups. Perineal involvement was relatively more frequent among diabetic patients; however, the overall distribution of disease sites was not statistically significant.

Table 2. Clinical and Laboratory Characteristics

Parameter	Diabetic	Non-diabetic	p-value
Duration of symptoms (days)	4.8 ± 1.9	3.6 ± 1.4	0.001
WBC ($\times 10^3/\mu\text{L}$)	18.4 ± 4.2	15.8 ± 3.9	0.01
CRP (mg/L)	142 ± 35	118 ± 29	0.02
Serum Creatinine (mg/dL)	1.8 ± 0.6	1.2 ± 0.4	0.01
Random Blood Sugar (mg/dL)	268 ± 52	122 ± 28	<0.001
HbA1c (%)	9.1 ± 1.4	—	—

Diabetic patients presented significantly later and exhibited significantly higher inflammatory markers, serum creatinine, and blood glucose levels than non-diabetic patients.

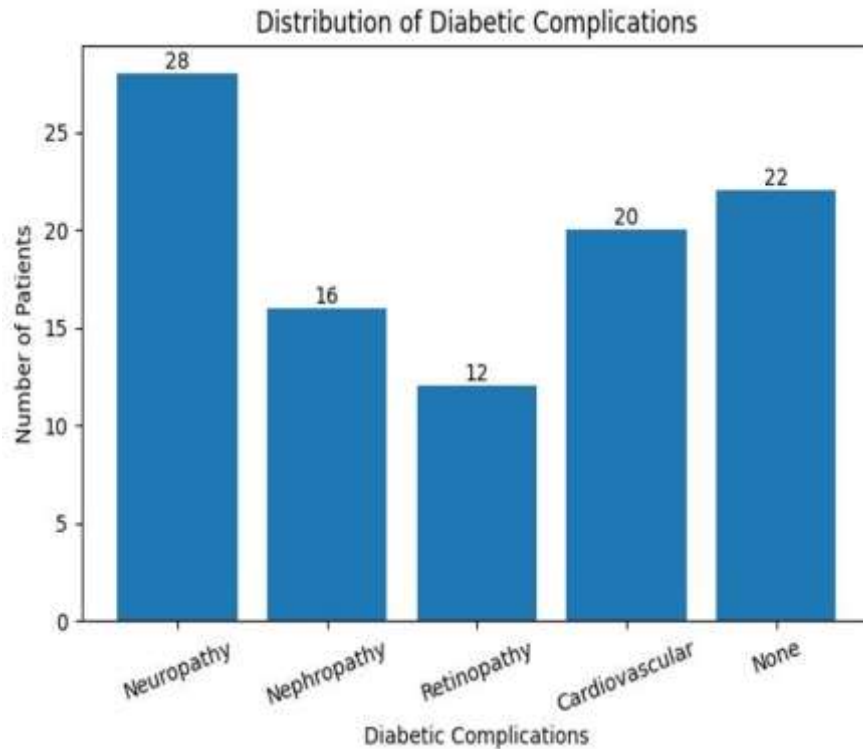


Figure 2. Diabetes-Related Complications

Among diabetic patients, neuropathy was the most common chronic complication, followed by cardiovascular disease and nephropathy.

Table 3. Surgical Management

Procedure	Diabetic	Non-diabetic	p-value
Debridement only	42 (49.4%)	58 (68.2%)	
Amputation	24 (28.2%)	10 (11.8%)	
Fasciotomy	12 (14.1%)	9 (10.6%)	
Skin grafting	7 (8.2%)	8 (9.4%)	0.032
Number of debridements	2.6 ±1.1	1.8 ±0.9	0.001

Debridement alone was the most common procedure in both groups. However, diabetic patients underwent significantly more amputations and required a greater number of surgical debridements.

**Figure 3. Postoperative Complications and ICU Admission
(Clustered bar chart)**

Outcome	Diabetic	Non-diabetic
Sepsis	35.3%	21.2%
Organ failure	18.8%	8.2%
Respiratory distress	16.5%	10.6%
ICU admission	44.7%	23.5%

ICU admission: $p = 0.01$

Postoperative complications were more frequent among diabetic patients. ICU admission was significantly higher in the diabetic group.

Table 4. Length of Hospital Stay

Parameter	Diabetic	Non-diabetic	p-value
Hospital stay (days)	18.4 ±5.2	12.6 ±4.3	0.001

Diabetic patients experienced significantly longer hospital stays than non-diabetic patients.

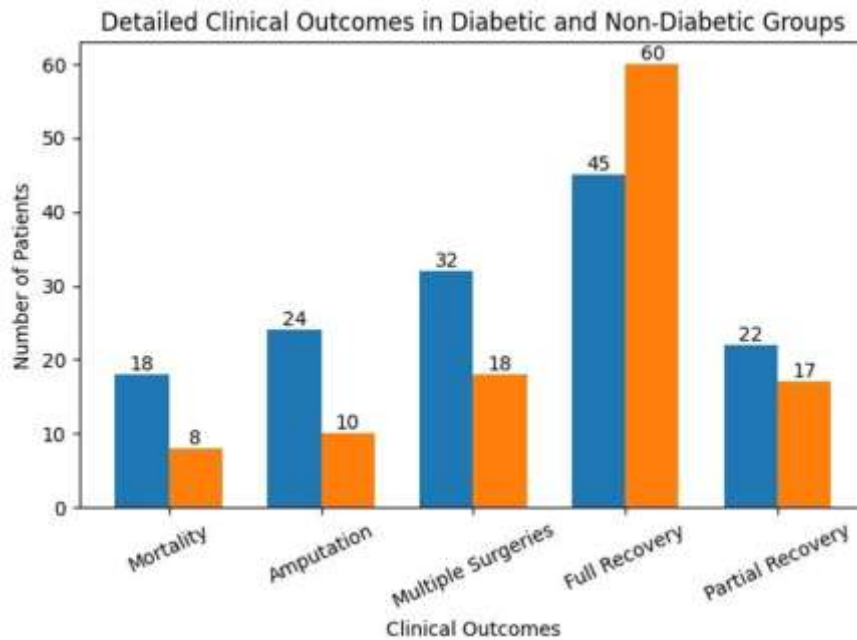


Figure 4. Clinical Outcomes

Overall $p < 0.001$

Diabetic patients experienced significantly higher mortality, amputation rates, and multiple surgical interventions, whereas complete recovery was significantly more common in non-diabetic patients.

Table 5. Microbiological Culture Isolates

Culture isolate	Diabetic	Non-diabetic	p-value
Polymicrobial	28 (32.9%)	15 (17.6%)	
Escherichia coli	12 (14.1%)	6 (7.1%)	
Streptococcus spp.	10 (11.8%)	18 (21.2%)	
Staphylococcus aureus	9 (10.6%)	14 (16.5%)	
Klebsiella spp.	6 (7.1%)	5 (5.9%)	
Pseudomonas spp.	4 (4.7%)	6 (7.1%)	
No growth	16 (18.8%)	21 (24.7%)	0.04*

Polymicrobial infection was the predominant microbiological pattern among diabetic patients, whereas *Streptococcus* species were the most common isolates among non-diabetic patients. Diabetic patients showed a greater prevalence of polymicrobial and Gram-negative infections.

Overall Findings

Diabetic patients with necrotizing fasciitis presented later, had significantly greater inflammatory responses and poorer metabolic control, required more aggressive surgical intervention, experienced increased ICU admission and prolonged hospitalization, and had significantly higher mortality and amputation rates compared with non-diabetic patients. The microbiological profile of diabetic patients was characterized by a higher frequency of polymicrobial and Gram-negative infections, reflecting greater disease severity and complexity

DISCUSSION

The present study demonstrated that diabetic patients with necrotizing fasciitis had more severe disease and poorer outcomes than non-diabetic patients. *Stevens and Bryant* emphasized that diabetes is one of the strongest risk factors for severe necrotizing soft tissue infections because of impaired immunity and delayed tissue healing [2]. Most diabetic patients in the present study were older than 50 years. *Wang et al.* similarly reported that necrotizing fasciitis is more common among middle-aged and elderly diabetic individuals [10].

Male predominance was observed in both study groups. *Wong et al.* also found that necrotizing fasciitis occurs more frequently in males than females [8].

The lower limb was the most commonly affected site in both groups. *Cheng et al.* likewise identified the lower extremity as the predominant site of infection because of trauma, diabetic foot ulcers, and peripheral vascular disease [20].

Diabetic patients had a longer duration of symptoms before presentation. *Goh et al.* reported that delayed diagnosis and referral significantly increase tissue destruction and mortality in necrotizing fasciitis [4].

Inflammatory markers, serum creatinine, and blood glucose levels were significantly higher among diabetic patients. *Anaya and Dellinger* noted that severe laboratory abnormalities usually reflect extensive infection and systemic inflammatory response [9].

Poor glycaemic control, reflected by elevated HbA1c levels, was common among diabetic patients. *Brownlee* explained that chronic hyperglycaemia impairs immune function and delays wound healing through persistent vascular and cellular damage [15].

Neuropathy was the most frequent diabetic complication in the present study. *Boulton et al.* described diabetic neuropathy as a major factor responsible for delayed recognition of foot injuries and infection [19].

Diabetic patients required more amputations and repeated surgical debridements than non-diabetic patients. *Bilton et al.* demonstrated that aggressive and repeated surgical debridement is essential for improving survival in necrotizing fasciitis [5].

Hospital stay and ICU admission were higher among diabetic patients. *McHenry et al.* also reported that severe infection and associated comorbidities contribute to prolonged hospitalization and increased intensive care requirements [21].

Mortality and limb loss were significantly higher in diabetic patients. *Anaya et al.* identified diabetes mellitus as an independent predictor of mortality and amputation in patients with necrotizing soft tissue infections [22].

Polymicrobial and Gram-negative infections were more frequent among diabetic patients. *Wang et al.* reported a similar microbiological pattern and recommended broad-spectrum empirical antibiotics until culture results become available [10].

Overall, the findings of the present study support previous evidence that diabetes adversely influences the presentation, management, and prognosis of necrotizing fasciitis. *Hasham et al.* concluded that early diagnosis, prompt surgical debridement, appropriate antimicrobial therapy, and optimal metabolic control are the key factors for improving patient outcomes [1].

LIMITATIONS

The present study has certain limitations. First, it was conducted at a single tertiary care center, which may limit the generalizability of the findings to other populations. *Anaya and Dellinger* emphasized that multicenter studies provide more representative data for necrotizing soft tissue infections [9]. Second, the sample size was relatively small, and studies with larger populations may provide stronger statistical evidence. *Hua et al.* highlighted the need for high-quality prospective studies to improve the evidence base for managing necrotizing soft tissue infections [7]. Third, long-term functional outcomes and quality of life were not evaluated. Finally, variations in antibiotic resistance patterns and long-term follow-up after discharge were beyond the scope of the present study.

CONCLUSION

The present study demonstrated that diabetes mellitus significantly influences the clinical presentation, management, and outcomes of necrotizing fasciitis. Diabetic patients presented later, had more severe laboratory abnormalities, required more extensive surgical procedures, and experienced longer hospital stays than non-diabetic patients. *Stevens and Bryant* reported that impaired immunity and poor tissue perfusion contribute to the increased severity of necrotizing soft tissue infections in diabetic patients [2]. Mortality, amputation, and ICU admission were also higher among diabetic patients in the present study. *Anaya et al.* similarly identified diabetes as an important predictor of mortality and limb loss [22]. Polymicrobial infections were more common among diabetic patients, supporting the need for broad-spectrum empirical antibiotic therapy. *Wang et al.* reported similar microbiological findings in diabetic patients with necrotizing fasciitis [10]. Early diagnosis, prompt aggressive surgical debridement, appropriate antimicrobial therapy, and strict glycaemic control remain the key factors for improving clinical outcomes. *Hasham et al.* concluded that timely multidisciplinary management is essential for reducing mortality and morbidity in necrotizing fasciitis [1].

CLINICAL IMPLICATIONS

The findings of this study emphasize the importance of maintaining a high index of suspicion for necrotizing fasciitis in diabetic patients presenting with rapidly progressive soft tissue infections. *Goh et al.* stressed that early recognition and prompt intervention are crucial for improving survival [4]. Strict glycaemic control, immediate surgical consultation, and timely debridement should be prioritized in diabetic patients. *Bilton et al.* demonstrated that aggressive surgical management significantly reduces mortality [5]. Early administration of broad-spectrum antibiotics followed by culture-guided therapy should remain the standard of care. *Stevens et al.* recommended prompt empirical antimicrobial therapy together with surgical intervention for optimal outcomes [6].

FUTURE RECOMMENDATIONS

Further multicenter prospective studies with larger sample sizes are recommended to validate the findings of the present study. *Hua et al.* highlighted the need for better-quality clinical evidence in the management of necrotizing soft tissue infections [7]. Future research should evaluate long-term functional outcomes, quality of life, recurrence rates, and antimicrobial resistance patterns. *Morgan* suggested that continued research is necessary to improve diagnostic strategies and treatment protocols for necrotizing fasciitis [25]. The role of prognostic scoring systems such as the LRINEC score should also be evaluated in larger diabetic populations. *Wong et al.* demonstrated the usefulness of the LRINEC score for early diagnosis of necrotizing fasciitis [23].

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DECLARATION OF CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest related to this study.

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ETHICAL APPROVAL

The study was conducted after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants before enrolment, and confidentiality of patient information was maintained throughout the study in accordance with the principles of the Declaration of Helsinki.

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