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Original Research Article

A COMPARATIVE STUDY ON MICROORGANISMS INVOLVED IN NECROTISING FASCIITIS AND OUTCOME OF NECROTISING FASCIITIS AMONG DIABETICS AND NON-DIABETICS

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ABSTRACT

Background: Necrotising fasciitis is a rapidly progressive soft tissue infection associated with high morbidity and mortality. Diabetes mellitus is a frequent comorbidity and may influence clinical presentation, microbiology, management, and outcomes. This study aimed to compare clinical features, microbiological patterns, management, and outcomes of necrotising fasciitis in diabetic and non-diabetic patients. **Materials and Methods:** This observational study was conducted at Government Rajaji Hospital, Madurai, a tertiary care teaching hospital in South India, over a period of six months from July 2021 to December 2021. Patients with surgically confirmed necrotising fasciitis were included and divided into diabetic and non-diabetic groups. Clinical, laboratory, microbiological, and outcome data were analysed. **Result:** Of 85 patients, 45 (52.94%) were diabetic and 40 (47.06%) were non-diabetics. Diabetics had a higher mean age (55.6 ± 7.51 vs 44.48 ± 6.28 years). Pain was the commonest symptom (95.56% diabetics; 85% non-diabetics). Diabetics presented later (2.84 ± 1.21 vs 2.20 ± 0.85 days). Idiopathic onset predominated in diabetics (46.67%), while trauma was common in non-diabetics (62.5%). Lower limb involvement was most frequent. Polymicrobial infections were more common in patients with diabetes (80%), whereas monomicrobial infections were more frequent in patients without diabetes (92.5%). Intensive care unit (ICU) and hospital stays were longer in patients with diabetes, with higher amputation and mortality rates; however, the outcome difference was not statistically significant. **Conclusion:** Necrotising fasciitis in patients with diabetes shows delayed presentation, distinct microbiology, and longer ICU and hospital stays with higher complication rates. Early diagnosis, timely surgery, and appropriate antimicrobial therapy are crucial to optimise outcomes.

INTRODUCTION

Necrotising fasciitis is a rapidly progressive and destructive soft tissue infection involving the skin, subcutaneous tissue and superficial fascia. It is a life-threatening condition associated with high mortality and long-term morbidity.[1] Reported mortality rates vary widely in the published literature, reflecting variations in early diagnosis, comorbidities, and time to surgical intervention. The disease spreads rapidly along the fascial planes and causes extensive tissue necrosis. Patient survival mainly depends on how early the disease is recognised and how quickly appropriate treatment is started.[2] Any delay in diagnosis or surgical intervention significantly increases the risk of mortality and limb loss.[3]

Necrotising soft tissue infections are commonly seen in immunocompromised patients and in individuals with diabetes mellitus or peripheral vascular disease.[4] Diabetes mellitus is considered as one of the most important predisposing factors for necrotising fasciitis. Poor glycaemic control leads to impaired immune response, microvascular disease and delayed wound healing. These factors together contribute to increased susceptibility to infection and more severe disease.[5] Diabetic patients also tend to present late due to reduced pain sensation and lack of awareness, which further worsens the outcome. Mortality in necrotising fasciitis can be reduced by early diagnosis, prompt surgical debridement and appropriate antibiotic therapy.[6]

Clinically, early diagnosis of necrotising fasciitis is difficult as initial features may resemble cellulitis.

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However, certain signs can help raise suspicion. The presence of blisters and bullae is an important clinical clue, as these features are uncommon in erysipelas or simple cellulitis.[7] Cellulitis associated with ecchymosis, bullae, dermal gangrene, extensive oedema or crepitus usually indicates an underlying necrotising infection. Such findings require urgent surgical exploration to confirm the diagnosis and to initiate definitive treatment. Delay in surgical intervention at this stage can lead to rapid disease progression and systemic toxicity.[8]

Broad spectrum antibiotics, aggressive surgical debridement and intensive care unit support are the mainstay of management in necrotising fasciitis. Repeated debridement is often required to control the infection. Even with advances in critical care, surgical techniques and antimicrobial therapy, necrotising fasciitis continues to be associated with significant morbidity, prolonged hospital stays and high mortality. This is particularly seen among diabetic patients, who often require longer Intensive care unit (ICU) stay and multiple surgical procedures.[9]

The microbiological pattern of necrotising fasciitis varies from patient to patient and may differ between diabetics and non-diabetics. Diabetic patients are more likely to have polymicrobial infections involving gram-negative organisms and anaerobes, whereas non-diabetic patients may present with monomicrobial infections. Identification of the causative organisms and their antibiotic sensitivity pattern play an important role in selecting appropriate empirical and definitive antibiotic therapy and in improving treatment outcome.[10]

There is limited regional data comparing the clinical profile, microbiological spectrum and outcome of necrotising fasciitis between diabetic and non-diabetic patients. Understanding these differences may help in early risk assessment, timely intervention and better management strategies. Such comparative evidence can support more appropriate empirical antibiotic selection and improve clinical decision-making in high-risk patients. Therefore, this study aimed to compare the microorganisms involved in necrotising fasciitis among diabetic and non-diabetic patients and also to compare the outcomes of necrotising fasciitis among diabetics and non-diabetics.

MATERIALS AND METHODS

This cross-sectional comparative study was conducted at Government Rajaji Hospital, Madurai, for six months from July 2021 to December 2021, involving 85 patients diagnosed with necrotising fasciitis. The approval for the study was obtained from the Institutional Ethics Committee of Madurai Medical College and Government Rajaji Hospital, and informed consent was obtained from all participants.

Inclusion and exclusion criteria

Patients above 18 years of age, both male and female, who presented with necrotising fasciitis were included, regardless of whether they had associated comorbid conditions. The diagnosis was confirmed clinically and intraoperatively during surgical debridement.

Patients with septic shock, those who did not consent to participate, those who had already undergone wound debridement elsewhere, and patients with behavioural problems or other medical illnesses requiring urgent priority care were excluded.

Methods: Data collection was done by recording baseline demographic and clinical details using a structured proforma. Details regarding age, sex, associated comorbidities, presenting symptoms, duration of illness and diabetic status were noted. Routine laboratory investigations such as haemoglobin, total and differential leukocyte count, ESR, CRP, blood glucose levels, renal function tests, serum electrolytes, lipid profile, urine analysis and radiograph of the affected limb were performed. Wound discharge was taken from the lesion and sent for culture and antibiotic sensitivity. Specimens were obtained prior to the antibiotic change whenever feasible. Additional investigations, such as biopsy of the affected area and arterial or venous Doppler studies, were done whenever required.

Data were collected through clinical examination, laboratory reports, imaging findings and microbiological analysis. Based on the laboratory values, the Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC) score was calculated, and patients were classified into low-risk, intermediate-risk and high-risk groups.

The procedure included initial medical management and early surgical debridement. All wounds were washed thoroughly with saline, and necrotic tissue was removed. Antibiotics were started empirically and later changed according to culture sensitivity reports. Patients received regular wound dressings, intravenous antibiotics and supportive care. Diabetic patients were managed with dietary control, oral hypoglycaemic drugs or insulin. Diabetes status was classified based on previous diagnosis/documented history or blood glucose evaluation at admission, and patients were grouped into diabetic and non-diabetic categories.

Patients with septicemia or organ dysfunction were treated in the intensive care unit. Once the wound became healthy, split skin grafting or secondary suturing was done. Amputation was performed in selected cases to control infection. Morbidity and mortality were assessed at the end of one month, and outcomes were compared between diabetic and non-diabetic patients. The primary outcome was the microbiological pattern (monomicrobial vs. polymicrobial isolates), and the secondary outcomes included ICU stay, hospital stay, need for amputation, and mortality at 1 month.

Statistical analysis: Data was analysed using SPSS software v29. Quantitative variables are analysed

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using mean and standard deviation with Student t-test, while qualitative variables are expressed as frequencies and percentages and analysed using Chi-square test, with significance set at $p \leq 0.05$. Missing data were excluded from the analysis.

RESULTS

Out of the total 85 cases, 45 patients (52.94%) were diabetics and 40 patients (47.06%) were non-diabetics. The mean age was higher in diabetics (55.6 ± 7.51 years) vs non-diabetics (44.48 ± 6.28 years). Males were more commonly affected in both groups, with 25 cases (55.56%) among diabetics vs 23 cases (57.50%) among non-diabetics [Table 1].

Among diabetic patients, necrotising fasciitis was most commonly idiopathic in origin in 21 cases (46.67%), vs minor trauma being the commonest predisposing factor among non-diabetic patients in 25 cases (62.5%). The lower limb was the most common site of involvement in both groups. Pain was the predominant symptom. The mean duration of symptoms before presentation was longer in diabetics (2.84 ± 1.21 days) vs non-diabetics (2.20 ± 0.85 days) [Table 2].

Table 1: Baseline demographic characteristics

Variable	Category	Diabetic (n = 45)	Non-Diabetic (n = 40)	P-value
Case distribution		45 (52.94)	40 (47.06)	-
Age (years)	< 40	2 (4.44)	15 (37.50)	< 0.001
	41 – 50	11 (24.44)	19 (47.50)	
	51 – 60	21 (46.67)	5 (12.50)	
	> 60	11 (24.44)	1 (2.50)	
Mean age		55.6 ± 7.51	44.48 ± 6.28	
Gender	Male	25 (55.56)	23 (57.50)	0.969
	Female	20 (44.44)	17 (42.50)	

Table 2: Comparison of clinical profile and symptom duration between patient groups

Variable	Category	Diabetic (n = 45)	Non-Diabetic (n = 40)	P-value
Predisposing factors	Idiopathic	21 (46.67)	13 (32.50)	0.147
	Insect bite	4 (8.89)	2 (5.00)	
	Minor trauma	17 (37.78)	25 (62.50)	
	Snake bite	1 (2.22)	0 (0.00)	
	Thorn prick	2 (4.44)	0 (0.00)	
Site of lesion	Back	1 (2.22)	0 (0.00)	-
	Gluteal region	3 (6.67)	0 (0.00)	
	Forearm (Left/Right)	2 (4.44)	8 (20.00)	
	Thigh (Left/Right)	6 (13.33)	5 (12.50)	
	Leg (Left/Right)	26 (57.78)	26 (65.00)	
	Perineum	8 (17.78)	0 (0.00)	
Symptoms at presentation	Pain	43 (95.56)	34 (85.00)	-
	Fever	31 (68.89)	27 (67.50)	
	Swelling	26 (57.78)	23 (57.50)	
	Discharge	23 (51.11)	21 (52.50)	
	Skin discoloration	18 (40.00)	13 (32.50)	
	Blisters	11 (24.44)	7 (17.50)	
Duration of symptoms	1 day	6 (13.33)	7 (17.50)	0.006
	2 days	13 (28.89)	19 (47.50)	
	3 days	13 (28.89)	10 (25.00)	
	4 days	8 (17.78)	2 (5.00)	
	5 days	5 (11.11)	2 (5.00)	
	Mean ± SD (days)	2.84 ± 1.21	2.20 ± 0.85	

Among patients with diabetes, uncontrolled diabetes was more common, observed in 25 cases (55.56%). Polymicrobial infection predominated in diabetics, occurring in 36 cases (80%) vs 3 cases (7.5%) in non-diabetics, while monomicrobial infection was more frequent in non-diabetics, seen in 37 cases (92.5%) vs 9 cases (20%) in diabetics. Streptococcus pyogenes was the most common organism isolated from non-diabetic patients. Patients with diabetes commonly showed mixed growth patterns involving gram-negative organisms and anaerobes [Table 3].

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Table 3: Comparison of diabetic control status and microbiological profile between diabetic and non-diabetic patients

Variable	Category	Diabetic (n = 45) n (%)	Non-Diabetic (n = 40) n (%)	P-value
Diabetic control status	Controlled	20 (44.44)	—	-
	Not controlled	25 (55.56)	—	
Microorganisms isolated	Klebsiella	2 (4.44)	1 (2.50)	< 0.001
	Klebsiella / E. coli / anaerobes	8 (17.78)	0 (0.00)	
	Pseudomonas	1 (2.22)	5 (12.50)	
	Streptococcus pyogenes	1 (2.22)	20 (50.00)	
	Streptococcus pyogenes / E. coli	10 (22.22)	2 (5.00)	
	E. coli	2 (4.44)	8 (20.00)	
	Gram-negative non-fermenters / E. coli / anaerobes	10 (22.22)	0 (0.00)	
	Staphylococcus aureus	3 (6.67)	3 (7.50)	
	Proteus/anaerobes	8 (17.78)	1 (2.50)	
Type of infection	Polymicrobial	36 (80.00)	3 (7.50)	< 0.001
	Monomicrobial	9 (20.00)	37 (92.50)	

Most gram-negative organisms and mixed infections were sensitive to piperacillin–tazobactam, amikacin, and imipenem, while resistance was commonly seen with amoxycillin–clavulanate. Streptococcus pyogenes and Staphylococcus aureus showed good sensitivity to ceftriaxone, cefoperazone–sulbactam, and linezolid [Table 4].

Table 4: Antibiotic sensitivity pattern of microorganisms isolated from necrotising fasciitis wounds

Microorganisms	Antibiotic sensitivity												
	CTR	CTX	CFS	AMOXY CLAV	CIPRO	PTZ	AK	GM	LZ	MRP	IMI	Tet	Metro
Klebsiella	S	S	S	R	S		S	S		S	S	R	
Klebsiella /E. coli / Anaerobes	S	S	S	R	R	S	S	S	R	S	S	R	S
Pseudomonas	R	R	R	R	IS	S	S	R		S	S	R	
Streptococcus pyogenes	R	R		S	R	S	R				S	S	
Streptococcus pyogenes / E. coli	S	S	S	R	R	S				S			
E. coli	S		S	R	S		S	S				R	
Gram-negative non- fermenters/ E. coli / anaerobes	S	IS	S	R	R	S	S			S		R	S
Staphylococcus aureus	S		S	S	S	S		S	S	S		S	
Proteus/anaerobes	S	IS	S	R	R		S			S		R	S

CTR: ceftriaxone; CTX: cefotaxime; CFS: cefoperazone–sulbactam; AMOXY CLAV: amoxicillin–clavulanate; CIPRO: ciprofloxacin; PTZ: piperacillin–tazobactam; AK: amikacin; GM: gentamicin; LZ: linezolid; MRP: meropenem; IMI: imipenem; Tet: tetracycline; Metro: metronidazole.

Diabetic patients had a longer mean ICU stay (4.08 ± 1.93 days) vs non-diabetic patients (2.14 ± 1.68 days) (p = 0.041). The mean hospital stay was also higher among diabetics (25.44 ± 10.18 days) than non-diabetics (20.13 ± 6.55 days) (p = 0.006). Amputation was more frequent in patients with diabetes (17.78%) than in those without diabetes (7.5%), and mortality was higher in patients with diabetes (13.33%) than in those without diabetes (2.5%), although the difference was not significant (p = 0.071) [Table 5].

Table 5: Comparison of ICU stay, hospital stay, and outcomes between diabetic and non-diabetic patients

Variable	Category	Diabetic (n = 45)	Non-Diabetic (n = 40)	P-value
ICU stay (days)	< 2	2 (4.44)	4 (10.00)	0.041
	2 – 4	3 (6.67)	2 (5.00)	
	5 – 7	5 (11.11)	1 (2.50)	
	> 7	2 (4.44)	0 (0.00)	
	Mean ± SD (days)	4.08 ± 1.93	2.14 ± 1.68	
Hospital stays (days)	< 10	6 (13.33)	5 (12.50)	0.006
	11 – 20	5 (11.11)	17 (42.50)	
	21 – 30	18 (40.00)	15 (37.50)	
	> 30	16 (35.56)	3 (7.50)	
	Mean ± SD (days)	25.44 ± 10.18	20.13 ± 6.55	
Outcome	Amputation	8 (17.78)	3 (7.50)	0.071
	Death	6 (13.33)	1 (2.50)	
	Healed by secondary intention	8 (17.78)	5 (12.50)	
	Split skin graft	18 (40.00)	20 (50.00)	
	Follow-up	5 (11.11)	11 (27.50)	

DISCUSSION

This study compared the microbiological profiles and outcomes of necrotising fasciitis in patients with and

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without diabetes. Necrotising fasciitis mainly affects older males, particularly those with diabetes. Patients with diabetes tended to present late, often without a clear trigger, had complex infections, longer hospitalisations, and more amputations. Non-diabetics usually followed trauma with simpler infections. Despite the more severe condition in patients with diabetes, the overall survival rates were similar in both groups. Comparable survival between groups may reflect early surgical debridement, ICU care, and culture-guided antibiotic modification in both groups.

In our study, necrotising fasciitis affected older patients with diabetes, with a consistent male predominance observed across both the diabetic and non-diabetic groups. Similarly, Tan et al. studied 127 surgically proven cases and reported a higher proportion of diabetics (61.4%) than non-diabetics (38.6%), with a male predominance. Patients with diabetes represented a higher-risk, clinically distinct group, consistent with the older age profile observed in our study.10 Nirala et al. reported 226 cases of necrotising fasciitis, with patients with diabetes showing a higher mean age (54.81 ± 15.33 years vs. 44.09 ± 15.77; $p < 0.001$) and male predominance.[11] These studies support our results by showing that necrotising fasciitis occurs more often in older men with diabetes, who consistently represent a higher-risk clinical group.

Our study showed that diabetic patients commonly had an idiopathic onset, non-diabetic patients often followed minor trauma, and lower limb involvement predominated in both groups. Similarly, Kaur et al. reported trauma as the most common etiological factor (48% diabetics, 44% non-diabetics), with lower limb involvement predominating in both groups (84% and 88%, respectively).[12] Magesh Kumar et al. found that trauma was the most common etiological factor (30%), while idiopathic causes accounted for 6.7%. The lower limb was the predominant site, involved in 53.3% of cases, supporting lower-limb predominance across patient groups.[13] These studies support our results by showing comparable causes and the same pattern of lower-limb predominance, suggesting similar disease behaviour in diabetic and non-diabetic patients.

In this study, pain predominated in both groups, whereas patients with diabetes typically presented later with a longer duration of symptoms than those without diabetes. Similarly, Magesh Kumar et al. found that pain was the predominant presenting symptom, reported in 57 patients (95%). Patients showed delayed presentation, with a mean symptom duration of 10.08 ± 10.09 days, supporting later presentation patterns, particularly seen in higher-risk groups such as diabetics.[13] Tan et al. showed that patients with diabetes presented atypically with less tenderness ($p = 0.042$) and had higher misdiagnosis rates ($p = 0.038$), resulting in a longer time to surgery ($p = 0.05$).10 These studies support our findings by confirming pain as the dominant symptom and demonstrating delayed or atypical presentation in patients with diabetes, leading to later diagnosis and intervention.

In our study, patients with diabetes commonly had uncontrolled disease with polymicrobial, gram-negative, anaerobic infections, whereas non-diabetics showed monomicrobial infections, often streptococcal. Similarly, Rao et al. found that diabetics had poor glycaemic control (mean HbA1c 9.62 ± 2.47%) with polymicrobial necrotising fasciitis (67.9%), whereas non-diabetics showed a higher proportion of monomicrobial infections.[14] Cheng et al. reported that non-diabetics showed higher monomicrobial infections with Group A Streptococcus (9/81, 11.1%), while diabetics had significantly more polymicrobial infections (26.2% vs 9.9%; $p = 0.007$), involving gram-negative and anaerobic organisms.[15] These studies support our findings by showing that poor glycaemic control in diabetics predisposes to polymicrobial, gram-negative infections, while non-diabetics develop monomicrobial, streptococcal necrotising fasciitis.

In this study, gram-negative infections showed broad-spectrum sensitivity, whereas diabetic patients experienced prolonged ICU and hospital stays compared with non-diabetic patients. Similarly, Halbhavi et al found that gram-negative isolates showed high sensitivity to amikacin (78–100%), piperacillin–tazobactam, and imipenem/meropenem (~100%), while amoxicillin–clavulanate showed poor sensitivity (25–44%).16 Rao et al. found that patients with T2DM had a longer mean ICU stay (4.4 ± 4.0 days) compared to non-diabetics (3.3 ± 2.4 days), and required prolonged hospitalisation, indicating greater disease severity and resource utilisation in diabetics.[14] Kaur et al. found that diabetic patients had significantly longer hospital stay (26.24 ± 11.79 days) compared with non-diabetics (18.68 ± 8 days, $p = 0.011$), indicating greater disease severity; ICU stay data were not reported.[12] These studies support our observations that gram-negative pathogens respond to broad-spectrum antibiotics and that diabetic patients experience longer ICU and hospital stays due to more severe disease.

Our study showed that amputation and mortality rates were higher among patients with diabetes. The difference in outcomes between the diabetes and non-diabetes groups was not significant. Similarly, Cheng et al. found that the rate of amputation was significantly higher in patients with diabetes (28.6%) than in those without diabetes (13.6%, $p<0.05$), while the mortality rate was similar (28.6% vs. 30.9%, $p=0.747$), indicating no significant difference in outcomes.[15] These studies support our results by showing that patients with diabetes required amputations more often, yet survival remained similar in both groups, indicating comparable outcomes rather than increased disease severity in patients with diabetes.

Strengths: The strength of this study is the direct comparison of patients with and without diabetes with comprehensive clinical, microbiological, and

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outcome-based evaluations. All cases were surgically confirmed, and microbiological cultures with antibiotic sensitivity testing were performed. Intergroup comparisons allowed for the evaluation of diabetes-related differences in clinical profiles and outcomes.

Limitations: This single-centre study may not reflect the broader population. The limited sample size affects the statistical strength. Potential confounders, such as age, comorbidity burden, and severity at presentation, were not adjusted for using multivariable analysis. Variations in disease severity at presentation and management practices may have influenced the outcomes. Long-term outcomes were not evaluated, and differences in management approaches could have influenced the results.

Clinical implications: Early identification of necrotising fasciitis in patients with diabetes is critical, as the presentations are often subtle. Timely surgical management and appropriate antibiotics can improve outcomes. Future studies should assess the independent predictors of mortality and limb loss and include long-term functional outcomes.

CONCLUSION

This study highlights important differences in the presentation, microbiology, and clinical course of necrotising fasciitis in patients with and without diabetes. Patients with diabetes tended to be older, presented later, and showed more complex infection patterns with longer ICU and hospital stays. Infections in patients with diabetes are often polymicrobial, requiring broader antimicrobial coverage. Although amputation and mortality rates were higher among patients with diabetes, the outcomes were comparable between the groups, and the difference was not statistically significant. Early recognition and prompt intervention are essential for improving patient outcomes.

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