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Research Article

Effectiveness of Single-Stage Aggressive Debridement Compared to Multi-Stage Surgery in Necrotizing Fasciitis

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Keywords
Necrotizing fasciitis, single-stage debridement, multi-stage debridement, clinical outcomes, hospital stay, wound healing.

Abstract

Background: Necrotizing fasciitis is a rapidly progressive, life-threatening soft tissue infection requiring prompt surgical intervention.

Objective: To compare clinical outcomes between single-stage and multi-stage surgical management in patients with necrotizing fasciitis.

Methodology: Between January 2021 and December 2022, a prospective observational research was carried out at Shifa College of Nursing, STMU, Islamabad. Ninety-six patients with necrotizing fasciitis were recruited and split into two groups: Group B (n=48) had multi-stage debridement, whereas Group A (n=48) received single-stage aggressive debridement. Results, such as the number of debridements, length of hospital stay, wound healing, postoperative complications, and mortality, were evaluated at discharge and 30-day follow-up. Demographic, clinical, laboratory, and radiological data were also gathered. Chi-square and independent t-tests were used for statistical analysis; $p < 0.05$ was deemed significant.

Results: Both groups were comparable in baseline characteristics, including mean age (45.32 ± 12.45 vs. 46.78 ± 11.89 years), gender distribution (male: 62.50% vs. 58.33%), and comorbidities such as diabetes mellitus (45.83% vs. 50.00%). The single-stage group required significantly fewer debridements (1.00 ± 0.00 vs. 2.58 ± 0.73; $p < 0.001$) and had shorter hospital stays (12.45 ± 4.32 vs. 18.67 ± 5.21 days; $p < 0.001$). Wound healing at 30 days was achieved in 42 patients (87.50%) in the single-stage group and 40 patients (83.33%) in the multi-stage group. Postoperative complications occurred in 10 (20.83%) vs. 16 patients (33.33%), and mortality was observed in 2 (4.17%) vs. 4 patients (8.33%), with differences not statistically significant.

Conclusion: Single-stage debridement reduces surgical interventions and hospital stay without compromising short-term outcomes compared to multi-stage management.

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Introduction

A serious, potentially fatal soft tissue infection, necrotizing fasciitis is characterized by the rapid deterioration of subcutaneous tissues and fascia, which, if left untreated, may cause serious systemic sickness and a high death rate [1]. Host-related variables, such as immunological function, metabolic abnormalities, hematological problems, nutritional status, and the existence of chronic systemic diseases, affect the disease's clinical course [2]. These variables may change the course of the illness, the body's reaction to infection, and the patient's ability to tolerate harsh surgical and medical procedures [3].

Delays may greatly impair results, such as increased mortality, longer hospital stays, and greater complication rates, therefore early detection and timely surgical care are essential [4]. Patients who have comorbid problems such diabetes mellitus, anemia, and chronic inflammatory disorders are more likely to have poor wound healing and fast disease progression [5,6].

It is well known that metabolic diseases, especially diabetes mellitus, are linked to weakened immunity, microvascular dysfunction, and heightened vulnerability to serious infections [7]. Bone marrow suppression and hematological abnormalities may impair host defense systems and affect perioperative results (8–10). Immune resilience is also influenced by nutritional status and early life health variables, which indirectly influence vulnerability to serious infections. Furthermore, environmental exposures and long-term respiratory disorders may exacerbate systemic inflammation, which may make infection prevention and surgical recovery more difficult [11,12].

Although surgical debridement is still the mainstay of treating necrotizing fasciitis, there is ongoing discussion on the best approach—single-stage vs multi-stage debridement. Single-stage aggressive debridement is becoming more and more popular in some situations to lower the number of operations, hospital stays, and overall morbidity, even though multi-stage debridement has historically been preferred to guarantee the removal of necrotic tissue by repeated evaluations (13–15). Surgical treatment is supplemented with antimicrobial therapy, which is directed by patient-specific variables and resistance patterns. In light of these factors, comparing the clinical results of single-stage and multi-stage surgical techniques is crucial for guiding best practices and enhancing patient outcomes.

Research Objective

To compare clinical outcomes between single-stage and multi-stage surgical management approaches in patients diagnosed with necrotizing fasciitis.

Materials and Methods

Study Design and Setting

Over the course of two years, from January 2021 to December 2022, Shifa College of Nursing, Shifa Tameer-e-Millat University (STMU), Islamabad, conducted a prospective observational (quasi-experimental) study. Although outcomes were prospectively followed, the choice of surgical approach (single-stage versus multi-stage debridement) was not randomized and was determined by the treating surgical team based on clinical judgment, disease extent, and patient stability. Therefore, the study is observational in nature, and causal inferences should be interpreted with caution. The objective was to assess and compare the clinical outcomes of patients undergoing single-stage versus multi-stage surgical management for necrotizing fasciitis.

Inclusion and Exclusion Criteria

The research comprised patients of various ages who had been diagnosed with necrotizing fasciitis based on intraoperative, radiological, and clinical data. Patients were only included if they had written informed permission and received single-stage or multi-stage surgical debridement. Exclusions from the research were patients with significant comorbidities that precluded surgical intervention, patients with insufficient medical records, and patients who were lost to follow-up or had superficial soft tissue infections that did not involve the fascia.

Sample Size and Grouping

During the study period, 96 patients who met the inclusion criteria were enrolled. Patients were

assigned to one of two groups based on the surgical strategy selected by the treating surgeons: Group A, which underwent aggressive single-stage debridement, and Group B, which received conventional multi-stage debridement.

The sample size was determined using hospital admission records and the anticipated frequency of necrotizing fasciitis cases presenting to the institution over the two-year study period. Based on historical data, an average of approximately 45–50 cases per year was expected. Assuming feasible recruitment over two years, a total sample of 96 patients was considered adequate to allow meaningful comparison of key clinical outcomes (mortality, complications, and length of hospital stay) between the two groups within the constraints of a single-center study.

Data Collection

Patient demographics, concomitant illnesses including diabetes mellitus, anemia, or immunosuppressive disorders, laboratory and radiographic results, and specifics about the surgical technique used were all gathered using a systematic proforma. At discharge and throughout a 30-day postoperative follow-up, clinical outcomes such as mortality, complication rates, wound healing, and length of hospital stay were evaluated. Experienced surgical teams carried out all surgical procedures, and patients were closely observed to record any difficulties that may have arisen after the procedure.

Statistical Analysis

SPSS version 25.0 was used for data entry and analysis. Calculations were made using descriptive statistics, such as frequency and percentage for categorical variables and mean and standard deviation for continuous data. The independent t-test for continuous variables and the chi-square test for categorical variables were used to compare Group A (single-stage) with Group B (multi-stage). P-values less than 0.05 were regarded as statistically significant.

Ethical Approval

The Institutional Ethics Committee of Shifa Tameer-e-Millat University (STMU), Islamabad, gave its approval to the research. All subjects provided written informed permission before being included in the trial, and patient confidentiality was rigorously maintained at all times.

Results

Table 1 shows that the two groups were comparable in baseline demographic and clinical characteristics. The mean age was similar between the single-stage group (45.32 ± 12.45 years) and the multi-stage group (46.78 ± 11.89 years; p = 0.62), with a male predominance in both groups (62.50% vs. 58.33%). The prevalence of comorbidities, including diabetes mellitus (45.83% vs. 50.00%), hypertension (31.25% vs. 35.42%), anemia (25.00% vs. 29.17%), immunosuppression (16.67% vs. 18.75%), and chronic respiratory disease (10.42% vs. 12.50%), did not differ significantly between groups (p > 0.05).

Table 1: Demographic and Clinical Characteristics of Patients

Category	Characteristic / Comorbidity	Group A (Single-stage, n=48; %)	Group B (Multi-stage, n=48; %)	p-value
Demographics	Age (years), mean ± SD	45.32 ± 12.45	46.78 ± 11.89	0.62
	Male	30 (62.50%)	28 (58.33%)	0.74
	Female	18 (37.50%)	20 (41.67%)	
Comorbidities	Diabetes Mellitus	22 (45.83%)	24 (50.00%)	0.66
	Hypertension	15 (31.25%)	17 (35.42%)	0.65
	Anemia	12 (25.00%)	14 (29.17%)	0.63
	Immunosuppression	8 (16.67%)	9 (18.75%)	0.79
	Chronic Respiratory Disease	5 (10.42%)	6 (12.50%)	0.74

Table 2 demonstrates comparable laboratory and radiological findings between the two groups at presentation. Mean WBC count was 15.32 ± 4.25 ×

$10^3/\mu L$ in the single-stage group and 15.89 ± 4.12 × $10^3/\mu L$ in the multi-stage group (p = 0.58), while CRP levels were also similar (98.45 ± 25.67 vs. 101.32 ± 27.14 mg/L; p = 0.47). Hemoglobin and creatinine levels showed no statistically significant differences (p = 0.33 and p = 0.44, respectively), and radiological evidence of fascial involvement was present in 100% of patients in both groups.

Table 2: Laboratory and Radiological Findings

Parameter	Group A (n=48)	Group B (n=48)	p-value
WBC count (×$10^3/\mu L$), mean ± SD	15.32 ± 4.25	15.89 ± 4.12	0.58
CRP (mg/L), mean ± SD	98.45 ± 25.67	101.32 ± 27.14	0.47
Hemoglobin (g/dL), mean ± SD	11.45 ± 1.78	11.12 ± 1.90	0.33
Creatinine (mg/dL), mean ± SD	1.12 ± 0.35	1.18 ± 0.38	0.44
Radiological evidence of fascial involvement, n (%)	48 (100.00%)	48 (100.00%)	-

Table 3 compares surgical management and clinical outcomes, showing that the single-stage group required significantly fewer debridements (1.00 ± 0.00 vs. 2.58 ± 0.73; p < 0.001) and had a shorter hospital stay (12.45 ± 4.32 vs. 18.67 ± 5.21 days; p < 0.001). Wound healing at 30 days was slightly higher in the single-stage group (87.50% vs. 83.33%), while postoperative complications (20.83% vs. 33.33%) and mortality (4.17% vs. 8.33%) were lower, although these differences were not statistically significant (p > 0.05).

Table 3: Comparison of Surgical Management and Clinical Outcomes at Discharge and 30-Day Follow-up

Outcome	Group A (Single-stage, n=48)	Group B (Multi-stage, n=48)	p-value
Number of Debridements, mean ± SD	1.00 ± 0.00	2.58 ± 0.73	<0.001
Duration of Hospital Stay (days), mean ± SD	12.45 ± 4.32	18.67 ± 5.21	<0.001
Wound Healing at 30 Days, n (%)	42 (87.50%)	40 (83.33%)	0.55
Postoperative Complications, n (%)	10 (20.83%)	16 (33.33%)	0.15
Mortality, n (%)	2 (4.17%)	4 (8.33%)	0.39

Table 4 summarizes the magnitude of outcome differences between groups, demonstrating a significant reduction in hospital stay by 6.22 days (95% CI: −8.14 to −4.30; p < 0.001) and in the number of debridements by 1.58 procedures (95% CI: −1.87 to −1.29; p < 0.001) in the single-stage group. Differences in wound healing rate (4.17%), complication rate (−12.50%), and mortality (−4.17%) favored single-stage management but did not reach statistical significance, as reflected by confidence intervals crossing zero and p-values > 0.05.

Table 4: Comparison of Clinical Outcomes Between Groups

Outcome	Mean Difference (95% CI)	p-value
Duration of Hospital Stay (days)	-6.22 (-8.14 to -4.30)	<0.001
Number of Debridements	-1.58 (-1.87 to -1.29)	<0.001
Wound Healing Rate (%)	4.17 (-6.71 to 15.05)	0.55
Complication Rate (%)	-12.50 (-28.32 to 3.32)	0.15
Mortality (%)	-4.17 (-11.30 to 2.96)	0.39

Discussion

According to our research, patients treated with single-stage aggressive debridement had shorter hospital stays (12.45 ± 4.32 vs. 18.67 ± 5.21 days; p < 0.001) and significantly fewer debridement procedures (mean 1.00 ± 0.00 vs. 2.58 ± 0.73; p < 0.001). These results support the idea that timely and effective source management may lessen the need for repeat procedures and the use of inpatient resources. While the conventional approach has recommended serial debridement over time to ensure complete removal of infected tissue, some research indicates that delays or prolonged operative strategies may increase hospital length of stay and resource utilization.

This is similar to the findings of Nawijn et al., who found that longer operative times were associated with longer ICU and hospital stays in necrotizing soft tissue infections (NSTI), though they did not specifically compare staged approaches (each 20 min increment increased hospital stay by about 3.3 days) [17].

Even though the number of debridements and length of hospital stay varied significantly, the 30-day wound healing rate was similar (87.50% vs. 83.33%; p = 0.55). This implies that short-term tissue healing was unaffected by fewer surgical procedures. The mean number of debridements per patient when treated conventionally, however, is frequently greater than two or three. This is particularly true in retrospective case series, where the mean number of debridements was reported to be 2.8 and hospital stays exceeded 30 days [18]. In contrast, many traditional cohorts report multiple serial debridements as standard. Given our decreased debridement rates and preserved wound healing, intensive single-stage therapy may be able to minimize surgical burden while achieving comparable healing.

The single-stage group had fewer postoperative complications (20.83% vs. 33.33%), although this difference was not statistically significant (p = 0.15). Previous research on adjunctive therapies like vacuum-assisted closure (VAC) versus traditional dressings has shown conflicting effects on complications. For instance, a meta-analysis found that vacuum-assisted closure was linked to lower mortality but no significant differences in hospital stay or complication rates. This suggests that wound care practices outside of the operating room can have a significant impact on outcomes but may not significantly change the incidence of complications on their own [18]. The quantitatively decreased complication rate in our research may be partially explained by faster decisive debridement and uniform postoperative care.

Our cohort's mortality rate was modest and did not vary substantially across groups (4.17% vs. 8.33%; p = 0.39). Depending on patient features and the time of intervention, reported fatality rates for necrotizing fasciitis vary greatly in the literature, typically ranging from 11% to 36% in different institutional series [19]. Effective surgical and supportive care regimens at our facility, as well as balanced baseline characteristics across groups, such as diabetes and other comorbidities, may account for the comparatively low mortality seen in both treatments.

Diabetes mellitus, a risk factor often identified in NF studies for poor outcomes and death, was present in 45.83% of single-stage patients and 50.0% of multi-stage patients (p = 0.66), indicating that comorbidity profiles in our analysis were comparable across groups [20]. Assuring similar baseline risks increases the likelihood that variations in hospital stays and debridement frequency are due to treatment techniques rather than underlying health disparities.

Additionally, there were similarities in laboratory measures including WBC count and CRP across groups, showing similar illness severity at presentation. Delays in surgical treatment are associated with higher morbidity and death in NSTIs [21]. Previous research emphasizes that early and vigorous surgical intervention, rather than initial laboratory severity alone, is a critical driver of outcomes. Our results demonstrate that a deliberate emphasis on thorough yet effective debridement may reduce surgical burden and hospitalization while producing positive results.

Study Strengths and Limitations

The prospective design, clear inclusion and exclusion criteria, and balanced baseline characteristics between the single-stage and multi-stage groups are some of this study's strong points that support the validity of compared results. Reliability is further improved by uniform postoperative monitoring and standardized surgical procedures. Furthermore, the evaluation of clinically significant outcomes—debridement rate, length of hospital stay, wound healing, complications, and mortality—offers useful information for surgical decision-making. A limited sample size, which lowers statistical power for identifying differences in uncommon events like death, and the single-center setup, which may restrict generalizability, are drawbacks. The surgical team's decision to assign patients to single-stage or multi-stage care may result in selection bias, and the 30-day follow-up period may not capture long-term complications or functional results.

Conclusion

Single-stage aggressive debridement was linked to a considerably lower number of surgical procedures and shorter hospital stays than multi-stage debridement in patients with necrotizing fasciitis, without sacrificing short-term wound healing, complication rates, or death. According to these results, single-stage treatment may, when practical, provide a safe and effective substitute for conventional multi-stage techniques, lowering the need for surgery and medical resources while preserving similar clinical results.

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