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LRINEC Scoring Accuracy and Its Association with Clinical Outcomes in Necrotizing Fasciitis Patients

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Abstract

Necrotizing Fasciitis (NF) is a soft tissue infection characterized by rapidly progressive necrosis of the fascia and is associated with high morbidity and mortality worldwide. It has atypical clinical symptoms during the early course of the disease, making timely diagnosis challenging. Early and adequate antibiotic therapy combined with timely surgical intervention is essential to reduce morbidity and mortality in NF. Consequently, realiable diagnostic tools are needed for early diagnosis of NF. The LRINEC score is one of the diagnostic tools that is simple and rapidly applicebe; however, its use in diagnosing NF is still under debate. This study aimed to determine the accuracy of LRINEC scoring in diagnosing NF compared to histopathological examination (the gold standard) and to assess its association with morbidity and mortality. This observational prospective cohort study included NF patients presenting to the surgical emergency department throughout 2024. A total of 29 patients were enrolled, with an average age of 53.9 years, dominated by men. Diabetes mellitus was the most common comorbidity, present in 18 patients (72.9%). Death occurred in 1 patient (3.4%). The mean LRINEC score among subjects was 6.3. The LRINEC score demonstrated an accuracy of 89.66% compared to histopathological findings, with a sensitivity of 95% and a specificity of 77.78% for scores >6. Thus, thee LRINEC score demonstrates good diagnostic accuracy for necrotizing fasciitis, despite the lack of statistically significant association between LRINEC score and morbidity or mortality in this study.

Keywords: Histopathology, morbidity, mortality, necrotizing fasciitis, LRINEC score, sensitivity and specificity

Introduction

Necrotizing fasciitis (NF) is a rapidly progressive soft tissue infection characterized by extensive fascial necrosis and associated with high morbidity and mortality. Early diagnosis remains challenging because initial clinical manifestations are often nonspecific and may complications, including septic shock, limb amputation, and death. Therefore, reliable adjunctive diagnostic tools are needed to facilitate early clinical suspicion and timely surgical intervention.

The Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC) score, first proposed by Wong et al., was developed to distinguish NF from other soft tissue infections using routine laboratory parameters. Although the LRINEC score is widely used in clincal practice, subsequent validation studies have reported variable sensitivity and specificity across different populations. In addition, the prognostic value of the LRINEC score in predicting morbidity and mortality remains controversial. Given these inconsistencies and limited local data, this study aimed to evaluate the diagnostic accuracy of the LRINEC score using histopathological examination as the reference standard and to explore its association with clinical outcomes in patients with necrotizing fasciitis treated at a tertiary referral hospital.

Methods

This prospective observational cohort study included patients presenting with soft tissue infection. The study population consisted of the patients with suspected soft tissue infections who presented to the Emergency Department and inpatients at Dr. Hasan Sadikin General

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Hospital betweenJuly to December 2023.

Participants were recruited using a consecutive sampling method, in which all eligible patients meeting the inclusion criteria were enrolled sequentially until the required sample size was achieved.

The sample size was determination based on the research objectives and the type of data in the study. The research design involved diagnostic accuracy analysis; therefore sample size estimation was based on the expected proportion. Because previous studies reported variable diagnostic performance, the estimated proportion was set at 0.5 to achieve maximum variability.. The sample size calculation for diagnostic tests with the output of Area Under the Curve (AUC) approach was applied. Based on a previous study by El Manyer et al, the AUC for the LRINEC score was reported as 65%.[3] A minimum clinically meaningful AUC difference of 0.3 was assumed. Based on this calculation, the minimum required sample size was 26 patients.

The inclusion criteria consisted of patientsaged ≥18 years with suspected of necrotizing fasciitisin the extremity who underwent surgical intervention and consented to tissue sampling for histopathological examination. Exclusion criteria included patients who refuse medical treatment, patients receiving immunosuppressant therapy, pregnant patients, and patients with a hospital length of stay of less 48 hours. Patients with incomplete clinical or laboratory data were excluded from the final analysis.

Patients clinically suspected of early necrotizing fasciitis or diagnosed with soft tissue necrotizing infections were evaluated. Data were collected to assess clinical characteristic, LNIREC scores, and clinical outcomes at Dr. Hasan Sadikin General Hospital. Patients presenting to the emergency department or referred from other departments were followed from admission until surgical intervention and histopathological confirmation when available. Clinical, laboratory, and outcome data were recorded for analysis.

The primary outcome variable was histopathological confirmation of necrotizing fasciitis, which was used as the reference standard for evaluating the diagnostic accuracy of the LRINEC score. Secondary outcome variables included major amputation (defined as below-knee or above-knee amputation) and in-hospital mortality. These outcomes were assessed to explore whether higher LRINEC scores were associated with worse clinical outcomes during hospitalization.

The LRINEC scoring is laboratory-based scoring system developed for early identification of necrotizing fasciitis and differentiation from other skin and soft tissue infections. The score is calculated using six laboratory parameters: C-reactive protein (CRP), leukocyte count, hemoglobin level, serum sodium, blood glucose, and serum creatinine. LRINEC scores were categorized as >6 (positive) or ≤6 (negative).

Necrotizing Fasciitis was defined as infection involving one or more soft tissue layers including the dermis, subcutaneous tissue, superficial fascia, deep fascia, or muscle, accompanied by necrotizing changes. Histopathological evidence of NF was defined as necrosis, polymorphonuclear infiltration, vasculitis, and capillary thrombosis in the tissue. Mortality was defined as deaths that occur in patients during the hospitalization period. Morbidity was defined by the need for major amputation defined as transtibial/below knee amputation (BKA), or transfemoral/above knee amputation (AKA). Although the diagnosis of necrotizing fasciitis is primarily clinical and based on surgical findings, histopathological confirmation is routinely performed in our institution following debridement. Therefore, histopathological examination was used as the reference standard to ensure diagnostic objectivity and uniformity across cases.

Data analysis was performed using SPSS version 26. Descriptive statistics were used for baseline characteristics. Categorical variables were analyzed using Chi-square test or Fisher's exact test when expected cell counts were less than five. Diagnostic performance metrics, including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), likelihood ratios, and overall accuracy were calculated. A p-value <0.05 was considered statistically significant. This study was approved by the Health Research Ethics Committee of Dr. Hasan Sadikin General Hospital (Ethical Approval Number: DP.04.03/D.XIV.6.5/441/2024)

Results

A total of 29 patients with necrotizing fasciitis who met the inclusion criteria were included in the study. The majority of the patients were male, comprising 21 individuals (72.4%). The most common comorbidity was diabetes mellitus, present in 18 patients. The mean LRINEC score was 6.3. Morbidity occurred in 14 patients, including 11 patients who underwent major amputation. One patient (3.4%) died during

Table 1 Characteristics of Patients (n=29)

Characteristic	Frequency (n)	%	Mean (SD)	Median (Min-Max)
Sex				
Male	21	72.4		
Female	8	27.6		
Comorbid				
Diabetes mellitus	18	62.1		
PAD	7	24.1		
AKI/CKD	4	13.8		
Hypertension	3	10.3		
Morbidity				
Above knee amputation	6	20.7		
Below knee amputation	5	17.2		
Minor amputation	3	10.3		
Mortality				
Yes	1	3.4		
No	28	96.6		
Continuous Variables				
Age (years old)			53.9 (13.1)	(21-84)
LRINEC score			6.3 (3.0)	(1-12)
Hb (gr/dL)			10.1 (2.1)	10.1 (6.3-14.3)
Leukocyte (cell/µL)			6.863 (12.694)	(5-48.410)
Random blood glucose (mg/dL)			151.3 (90.8)	(7-505)
Creatinine (mg/dL)			1.02 (0.8)	(0.3-4.6)
Sodium (mmol/L)			133.2 (6.7)	134 (112-146)
C-Reactive Protein (mg/L)			14.6 (7.1)	13.3 (2.1-28.1)

hospitalization.

Based on histopathological examination, necrotizing fasciitis was confirmed in 20 patients and excluded in 9 patients. A LRINEC score >6 was observed in 19 patients with histopathological findings consistent with necrotizing fasciitis and in 2 patients without histopathological evidence of necrotizing fasciitis. In contrast, a LRINEC score of <6 was observed in 1 patient with pathological findings consistent with necrotizing fasciitis, and in 7 patients whose pathological findings were not consistent with necrotizing fasciitis. Chi-square testing revealed a significant association between LRINEC score >6 and histopathological findings (p<0.001) (Table 3).

Furthermore, the study indicated that the sensitivity of a LRINEC score of >6 was 95%, specificity was 77.78%, positive predictive

Table 2 Comparison Between LRINEC Score and Histopathological Findings

LRINEC Score	Histopathology Positive, n	Histopathology Negative, n	Total, n	p-value
≥6 (High Risk)	19	2	21	<0.001
<6 (Low Risk)	1	7	8	
Total	20	9	29	

*Analysis using chi square test

Table 3 Diagnostic Performance of LRINEC Score ≥6

Diagnostic Index	Value
Sensitivity	95.0%
Specificity	77.8%
Positive Predictive Value (PPV)	90.5%
Negative Predictive Value (NPV)	87.5%
Positive Likelihood Ratio (PLR)	4.3
Negative Likelihood Ratio (NLR)	0.06
Accuracy	89.6%

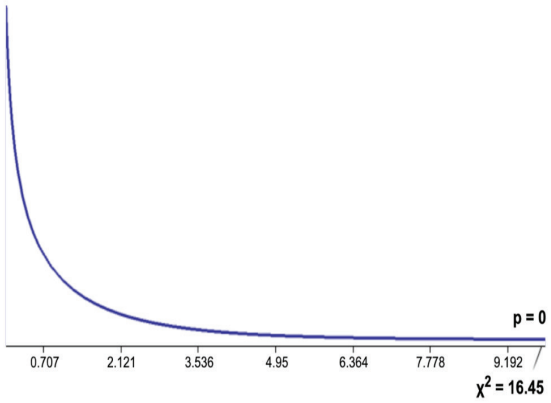

Figure 1 Comparison of LRINEC Score and Histopathological Findings Using Chi-square Analysis

value was 90.48%, and negative predictive value was 87.5%. The positive likelihood ratio was calculated to be 4.26, the negative likelihood ratio was 0.06, and the overall accuracy was 89.66% (Table 4).

LRINEC score of >6 was observed in 8 patients who underwent major amputations and in 13 patients who did not undergo major amputations. A LRINEC score of <6 was found in 3 patients with major amputations and in 5 patients without major amputations. Chi-square analysis did not demonstrate a significant association between a LRINEC score of >6 and major amputations (p=1.000) (Table 5).

Based on the results of the study, a LRINEC score of >6 was observed in 1 patient who died, while 20 patients were discharged. A LRINEC score of <6 was found in all 8 patients who were discharged. Chi-square testing did not reveal a significant association between a LRINEC score of >6 and mortality (p=1.000).

Diabetes mellitus (DM) was identified in 9 patients who underwent major amputations and in 9 patients who did not. Additionally, 5 patients without DM were found among those who underwent amputation, while 6 patients without DM were noted among those who were not amputated. Chi-square test did not reveal a significant association between DM and the occurrence of amputation (p=1.000).

Peripheral arterial disease (PAD) was identified in 7 patients who underwent amputation and in none of the patients without amputation. Chi-square analysis demonstrated a significant association between PAD and the occurrence of amputation (p=0.002).

Regarding acute kidney injury/chronic kidney disease (AKI/CKD), it was found in 2 patients who underwent amputation and in 2 patients who did not. Additionally, 12 patients without AKI/CKD were noted among those who underwent amputation, while 13 patients without AKI/CKD were observed in the non-amputation group. Chi-square did not reveal a significant association between AKI/CKD and

Table 4 Association Between LRINEC Score and Major Amputation and Mortality (n=29)

LRINEC score	Positive ≥6 (n)	Negative <6 (n)	Total	p-value
Major Amputation (AKA + BKA)				1.000*
Yes	8	3	11	
No	13	5	18	
Mortality				
Yes	1	0	1	1.000
No	20	8	28	
Total	21	8	29	

*chi square test

Table 5 Association Between Comorbidities and Amputation (n=29)

Comorbidity	Amputation Yes n	Amputation No n	Total	p-value*
Diabetes Mellitus (DM)				1.000
Yes	9	9	18	
No	5	6	11	
Peripheral Arterial Disease (PAD)				0.002
Yes	7	0	7	
No	7	15	22	
AKI/CKD				1.000
Yes	2	2	4	
No	12	13	25	
Hypertension (HT)				1.000
Yes	1	2	3	
No	13	13	26	

*Analysis using chi square test

the occurrence of amputation (p=1.000).

Hypertension (HT) was found in 1 patient who underwent amputation and in 2 patients who did not. Among those who underwent amputation, 13 patients did not have HT comorbidity, while 13 patients without HT comorbidity were also noted in the non-amputation group. Chi-square did not reveal a significant association between HT comorbidity and the occurrence of amputation (p=1.000).

Discussion

Necrotizing fasciitis (NF) remains one of the most aggressive and life-threatening soft tissue infections, with rapid progression and a high risk of morbidity and mortality. Despite advances in imaging and laboratory diagnostics, early clinical diagnosis is still challenging due to the disease's non-specific initial presentation. In this context, the Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC) score has gained attention as a potentially rapid, cost-effective tool to support early diagnosis. However, its diagnostic reliability and prognostic value remain debated. This study sought to evaluate the diagnostic performance of the LRINEC score in a cohort of patients at a tertiary referral hospital, using histopathology as the gold standard, and to explore its correlation with outcomes such as major amputation and mortality. [1,2,12]

The findings indicate that the LRINEC score demonstrated good diagnostic performance for identifying necrotizing fasciitis among patients presenting with soft tissue infections. A LRINEC score >6 was significantly associated with histopathologically confirmed NF, with a sensitivity of 95%, specificity of 77.78%, and overall diagnostic accuracy of 89.66%. These findings suggest that the LRINEC score may serve as a useful adjunctive tool for supporting early clinical suspicion of necrotizing fasciitis. Nevertheless, interpretation of LRINEC scores should always be integrated with clinical assessment, imaging findings when available, and intraoperative observations.

In this study=29 patients with necrotizing fasciitis who met the inclusion criteria were analyzed. The majority of the patients were male, comprising 21 individuals (72.4%). The most frequently encountered comorbidity in this study was diabetes mellitus, identified in 18 patients (62.1%). Major amputations occurred in 11 patients, and mortality was observed in one patient.

Several studies in the literature have reported similar diagnostic accuracy for the Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC) score. Thomas et al., in a prospective cohort study involving 100 patients, reported a sensitivity of 85.7% for LRINEC >6 when compared with surgical and histopathological confirmation. Likewise, Holland et al. found a sensitivity of 80% in a smaller cohort, reinforcing the utility of the LRINEC score as an early screening tool.

These findings are consistent with the current results and support the use of LRINEC as part of initial assessment protocols for suspected NF.[1,5]

Conversely, the lack of correlation between LRINEC and patient outcomes in this study differs from findings by Hameed et al. who observed that patients with LRINEC scores >7 were more likely to undergo major amputation. This discrepancy may be attributed to population differences; The study by Hameed focused specifically on diabetic limb infections, whereas the present study included all extremity NF cases regardless of underlying comorbidities. Furthermore, the present study excluded patients who did not undergo surgery, potentially omitting more severe or rapidly fatal cases that may have demonstrated stronger associations with high LRINEC scores. It is also possible that the relatively stable clinical condition of patients at the time of presentation in this cohort allowed for timely and repeated surgical debridement, resulting in improved local infection control and reduced progression to major amputation.[8,9]

Peripheral arterial disease (PAD) showed a statistically significant association with major amputation. However, PAD is an independent vascular disease that inherently predisposes patients to limb loss. Therefore, this finding should be interpreted cautiously, as PAD may act as a confounding factor rather than a direct consequence of necrotizing fasciitis severity. Although diabetes mellitus was the most prevalent comorbidity among the study population, PAD was the only comorbidity that demonstrated a statistically significant association with amputation in this cohort. This result is consistent with established pathophysiological mechanisms, as impaired peripheral circulation leads to reduced tissue perfusion and oxygenation, delayed wound healing, and heightened vulnerability to infection, thereby increasing the likelihood of amputation. These findings underscore the importance of thorough vascular evaluation in patients with necrotizing fasciitis, particularly in cases where limb preservation is a primary therapeutic objective.[1,2] However, due to the absence of multivariable analysis in this study, it cannot be determined whether PAD independently contributed to amputation risk in the context of necrotizing fasciitis. Furthermore, the LRINEC score did not demonstrate a correlation with mortality in this cohort. This may be attributed to the study's inclusion criteria, which were limited to patients who underwent surgical management; consequently, individuals with more severe disease who were either deemed inoperable or died prior to surgical intervention were not captured in the sample.

This study has several limitations. First, the relatively small sample size and the limited number of mortality events reduce statistical power, particularly in evaluating prognostic associations. Second, the single-center design may limit generalizability. Third, the absence of multivariable analysis prevents adjustment for potential confounding factors such as peripheral arterial disease. Finally, inclusion was limited to patients undergoing surgical intervention, potentially excluding rapidly fatal or conservatively managed cases. Therefore, findings regarding prognostic associations should be interpreted as exploratory rather than definitive.

In conclusion, the LRINEC score demonstrated good diagnostic accuracy in identifying necrotizing fasciitis in this cohort. However, a statistically significant association between LRINEC score and morbidity or mortality was not demonstrated. While these resuts support the use of LRINEC for initial screening, larger prospective studies with adequate sample size are required to further evaluate its potential prognostic role in clinical management.

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