

# LRINEC score diagnostic value for necrotizing infections of the upper extremity and correlation with morbidity and mortality in Orthopedics patients

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## ABSTRACT

**Objective:** To use the LRINEC scoring system for necrotizing infections of the upper extremity and study its correlation with morbidity and mortality in Orthopedics patients. **Materials and Methods:** We conducted a systematic review of the medical records of patients operated on by our team between March 1, 2015, and March 1, 2020. Data collection included the LRINEC scores of every patient who underwent surgery and had a clinical and postoperative diagnosis of necrotizing soft tissue infection, as well as their clinical history, causative organism, complications, Orthopedics-related morbidity and mortality data, and other significant clinical data (length of intensive care stay, need for mechanical respiratory assistance, need for dialysis, number of surgeries), which were then compared with their respective LRINEC score. **Results:** The review included 4126 medical records of patients who had undergone surgery by our team. There were three recorded cases of necrotizing infections in the upper extremity. Their LRINEC scores were retrospectively calculated and all of them showed a high risk of developing a necrotizing infection. The patients with the highest scores developed more Orthopedics and other clinical conditions. **Conclusions:** The LRINEC score is a reproducible method for the diagnosis of necrotizing soft tissue infections and is related to the number of complications and orthopedic conditions, although not necessarily with the number of surgeries.

**Key words:** Necrotizing infection; LRINEC score; morbidity; necrotizing fasciitis.

**Level of Evidence:** II

## Uso de la escala LRINEC en pacientes con infecciones necrosantes en el miembro superior y su correlación con la morbimortalidad ortopédica

### RESUMEN

**Objetivo:** Utilizar la escala LRINEC en pacientes con infecciones necrosantes de miembros superiores y evaluar su correlación con la morbimortalidad ortopédica. **Materiales y Métodos:** Se llevó a cabo una revisión sistemática de las historias clínicas de los pacientes operados por nuestro equipo, entre el 1 de marzo de 2015 y el 1 de marzo de 2020. Se registraron los puntajes de la escala LRINEC de cada paciente operado con diagnóstico clínico y posoperatorio de infección necrosante de partes blandas, así como sus antecedentes clínicos, el microorganismo, las complicaciones y la morbimortalidad ortopédica, y otros datos clínicos importantes (tiempo de internación en terapia intensiva, necesidad de asistencia respiratoria mecánica y de diálisis, cantidad de cirugías), y se los comparó con el puntaje. **Resultados:** Se analizaron 4126 historias clínicas de pacientes operados por nuestro equipo. Tres tuvieron infecciones necrosantes del miembro superior. El puntaje aplicado en forma retrospectiva determinó que todos tenían una alta probabilidad de sufrir una infección necrosante. Los pacientes con puntaje más alto desarrollaron más comorbilidades ortopédicas y clínicas. **Conclusiones:** La escala LRINEC es un instrumento reproducible para el diagnóstico de infecciones necrosantes de partes blandas y está relacionada con el número de complicaciones y la morbilidad ortopédica, aunque no necesariamente con la cantidad de cirugías realizadas.

**Palabras clave:** Infección necrosante; escala LRINEC; morbilidad; fascitis necrosante.

**Nivel de Evidencia:** II

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## INTRODUCTION

Necrotizing soft tissue infections have had many names and classifications over the years. Such variety is still present in the lack of consensus among specialists in naming these infections that, although rare, represent a multidisciplinary challenge for all involved medical care workers.

The condition was first described by Hippocrates.<sup>1,2</sup> The term “necrotizing fasciitis”, coined by Wilson and Schneur, is probably the most widely used by the different medical specialties. In recent years, the term “necrotizing soft tissue infections” has become the daily form to describe these necrotizing infections.<sup>3</sup>

Necrotizing soft tissue infections are caused by a variety of pathogens that may affect patients at any age, irrespective of their health status. This orthopedic emergency initially presents with nonspecific signs such as erythema and edema.<sup>4</sup>

A high level of suspicion is needed for timely identification and treatment of these infections. Early diagnosis, debridement, broad-spectrum antibiotics administration, a multidisciplinary care approach, and critical care management are vital to achieving a favorable outcome in these patients.<sup>5-7</sup>

Several authors have made efforts to procure a tool that would allow the differentiation between soft-tissue infections (cellulitis and abscess) and necrotizing infections. One of the most popular tools is the scoring system of LRINEC (Laboratory Risk Indicator for Necrotizing Fasciitis) developed by Wong *et al.* in 2004.<sup>8</sup> The LRINEC scoring system is based on six laboratory test results, which provide data for the final score. An LRINEC of six or greater is considered a high risk of necrotizing fasciitis. There is a limited number of studies on the correlation between the LRINEC score and patients' morbidity and mortality, with some authors questioning the LRINEC scoring system as a prognostic identification tool.<sup>9,10</sup>

The purpose of this study was to use the LRINEC scoring system for necrotizing infections of the upper extremity and to study its correlation with morbidity and mortality in Orthopedics patients.

## MATERIALS AND METHODS

We conducted a systematic review of the medical records of patients operated on by our team over a five-year period, between March 1, 2015, and March 1, 2020. The inclusion criteria were: both sex patients, of any age, who had undergone surgery for necrotizing soft tissue infections of the upper extremity. The exclusion criteria were: patients with soft-tissue necrosis caused by surgery, chemical causes or burn injuries.

We collected data from the blood tests, the medical records, and patients' pictures, and calculated the LRINEC score patients had before their first surgical treatment (Table 1). Data collection included clinical history, causative organism, complications, morbidity and mortality data as well as the length of intensive care stay, need for mechanical respiratory assistance, need for dialysis, the number of surgeries, which were then compared with the LRINEC score.

**Table 1.** LRINEC scoring system

Variable	Level	Score
C-reactive protein (mg/L)	>150	4
WBC (cells/mm <sup>3</sup> )	<15	0
	15-25	1
	>25	2
Hemoglobin (g/dL)	>13.5	0
	11-13.5	1
	<11	2
Sodium (mmol/L)	<135	2
Serum creatinine (mg/dL)	>1.6	2
Serum glucose (mg/dL)	>180	1

## RESULTS

The review included 4126 medical records of patients who had undergone surgery by our team. There were three recorded cases of patients treated for necrotizing fasciitis (aged 36, 61, and 71 years). Table 2 shows the retrospectively calculated LRINEC scores. The etiologic agent was *Streptococcus pyogenes* in all cases.

**Table 2.** Blood tests and LRINE scoring system

	C-reactive protein (mg/L)	WBC (cells/mm <sup>3</sup> )	Hemoglobin (g/dL)	Sodium (mmol/L)	Serum creatinine (mg/dL)	Serum glucose (mg/dL)	LRI-NEC
Patient 1	237.3	6.9	15	129	1.05	174	6
Patient 2	259	19.6	12.6	129	1.43	500	9
Patient 3	245	23.3	15.6	136	2.23	259	8

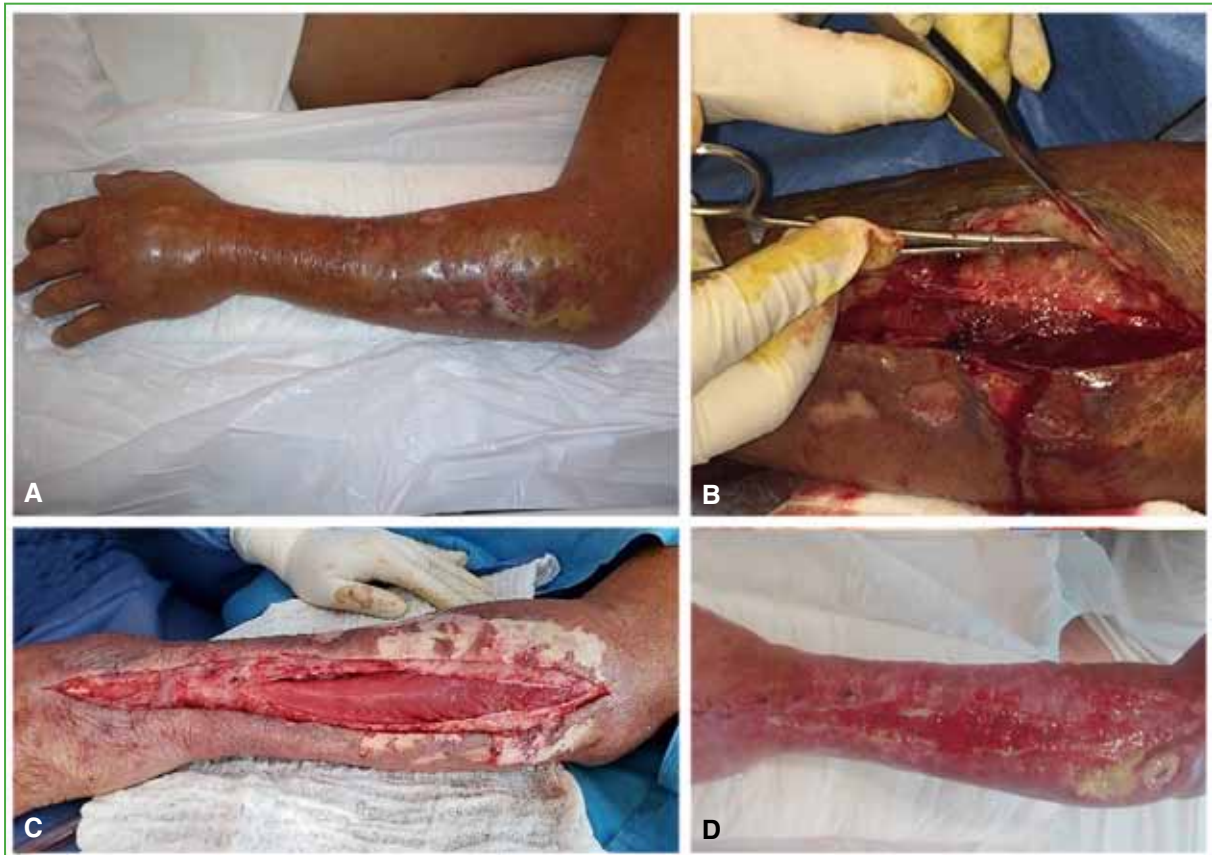
Orthopedics morbidity included upper-extremity disarticulation (patient 3), amputation of two phalanxes and need for flaps for coverage of soft-tissue defects (patient 2), need for skin graft (patient 1), need for dialysis (patients 2 and 3), and need for mechanical respiratory assistance (patient 3). The other collected data are shown in Table 3.

**Table 3.** Morbidity and mortality and LRINE scoring system

	LRI-NEC	Intensive care stay	Death	Dialysis	Mechanical respiratory assistance	Number of surgeries	Orthopedics condition
Patient 1	6	6	No	No	No	3	Skin graft
Patient 2	9	10	No	Yes	No	7	Phalanx amputation and flaps
Patient 3	8	84	No	Yes	Yes	3	Upper-extremity disarticulation

Figures 1-3 include the clinical photographs.

All patients obtained an LRINEC score that retrospectively established a high risk of developing a necrotizing infection. The patients with the highest scores developed more Orthopedics and other clinical conditions. All patients complained of disproportionate pain at the time of diagnosis.



**Figure 1.** Patient 1. A 69-year old male, with bladder cancer history, positive for HIV and hepatitis C virus, and an LRINEC score of 6. **A.** Image shows soft-tissue edema, which typically is greater than the erythema in these infections. **B.** Characteristic sign of necrotizing fasciitis. A thin layer of fluid is formed and dissects the subcutaneous cellular tissue from the fascial planes. **C and D.** Evolution until granulation before the posterior skin grafting.

## DISCUSSION

The LRINEC scoring system, which was developed based on data from 89 patients with necrotizing soft-tissue infections compared with 314 patients with severe cellulitis or abscess or both, is widely used; however, it has never been validated and the authors themselves noted that many other conditions might cause similar laboratory derangements.<sup>11</sup>

Holland's 28-patient study stated that 6 as the LRINEC score cutoff to establish the presence of necrotizing fasciitis is not sufficiently accurate and suggested decreasing the cutoff to 5 and using anatomical pathology studies to increase the system's specificity and sensitivity.<sup>10</sup>

Wilson y Schneur published a case of necrotizing fasciitis due to *Clostridium* and then polymicrobial flora with an LRINEC score of zero.<sup>9</sup>

Likewise, Tsai *et al.*<sup>12</sup> and Chao *et al.*<sup>13</sup> noticed that the score is inadequate to distinguish infections caused by bacteria from the *Vibrio* genus as these patients commonly present lower WBC counts and other inflammation markers.

Liao *et al.* cohort study included 233 patients with necrotizing fasciitis and 3155 with non-necrotizing cellulitis and showed that LRINEC score alone has limited use for the early differentiation between necrotizing cellulitis and non-necrotizing infections.<sup>14</sup>



**Figure 2.** Patient 2. A 36-year old male, with untreated type 1 diabetes mellitus, and an LRINEC score of 9. **A.** Image shows severe soft-tissue lesions and necrotic lesions. **B.** Surgical debridement was performed on the dorsal aspect of the hand and involved tissue from the middle and index fingers. The patient had a poor postoperative course, which required further debridement procedures and resulted in index amputation. **C.** Due to soft-tissue coverage deficit, a groin flap was used to cover the defects. Image also shows problems with the index stump. **D.** Final outcome.



**Figure 3.** Patient 3. A 71-year old male, with diabetes, renal failure, pacemaker and multiple vascular conditions; LRINEC score of 8. **A.** Image shows large hemorrhagic blisters, which are considered to be a sign of severe tissue lesions. **B.** Quick progression to soft-tissue necrosis after the first surgical debridement. An aggressive debridement was later performed. **C.** The patient had a poor early postoperative course (6h), with enlargement and progression of the edema and hemorrhagic blisters in the upper extremity. **D.** Upper-extremity disarticulation was performed due to the poor clinical course.

In line with the aforementioned authors, Borschitz *et al.* highlighted the need for the combined use of clinical and laboratory findings in an improved LRINEC score.<sup>15</sup> These authors suggested adding pain, fever, tachycardia, evidence of renal failure, fibrinogen levels, and erythrocyte counts and removing the serum sodium and glucose parameters from the scoring system.

In 2017, Bechar *et al.* conducted a systematic review of the literature on the use of the LRINEC score published between 2004 and 2014, which included 846 patients.<sup>16</sup> The authors concluded that the LRINEC score has a statistically positive correlation with the diagnosis of necrotizing fasciitis. They ruled out the findings of Tsai *et al.* and Chao *et al.* because they only considered atypical microorganisms and those of Holland due to procedural bias. Moreover, they considered that further studies need to be performed to validate the additional parameters and modifications suggested by Borschitz *et al.* and that modifying the LRINEC scoring system with the inclusion of clinical parameters (pain, fever, tachycardia) is required to increase the specificity and sensitivity of the early diagnosis of necrotizing infections.

All of our patients were correctly diagnosed by the LRINEC scoring system. Higher scores, over 6 points, had an impact on the number of complications and comorbidities, but not on the number of surgeries. Patient 3, who required upper-extremity disarticulation, mechanical respiratory assistance, and a longer intensive care stay, was not the patient with the highest score nor the most critically ill patient of this series. This fact leads us to conclude, in agreement with other authors, that modifying the scoring system to contemplate other clinical data would benefit its prognostic value for this case and its diagnostic value for the literature cases.

The limitations of this study include: the limited number of patients, its retrospective nature, and that all necrotizing infection cases were due to *Streptococcus pyogenes*, with no cases of polymicrobial or anaerobic infections.

## CONCLUSIONS

The LRINEC score is a reproducible method for the diagnosis of necrotizing soft tissue infections and is related to the number of complications and orthopedic conditions, although not necessarily with the number of surgeries. Clinical parameters should be considered in the score to improve the prognostic accuracy of the LRINEC score. Adding parameters such as pain, signs of kidney injury, length of intensive care stay to the scoring system could prove beneficial and warrant further studies on the association between the LRINEC score, and postoperative orthopedic conditions.

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