ORIGINAL ARTICLE

Lymphocyte-to-C-reactive protein ratio as a new biomarker for predicting mortality and morbidity in Fournier's gangrene

El cociente linfocito-proteína C reactiva como nuevo marcador predictivo de mortalidad y morbilidad en la gangrena de Fournier

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Abstract

Objective: *The purpose of this study was to research the neutrophil–lymphocyte ratio (NLR), lymphocyte-to-C-reactive protein ratio (LCR), and Fournier's Gangrene Severity Index (FGSI) for predicting prognosis and mortality in patients with Fournier's gangrene (FG).* **Material and Methods:** *Patients diagnosed with FG and treated in a tertiary referral hospital in the period from January 2013 to June 2020 were reviewed. LCR, FGSI, and NLR values were calculated.* **Results**: *Our series included a total of 41 patients. Of the patients, 78% survived and 21.9% (n = 9) died. Survivors were significantly younger than non-survivors (p = 0.009). Hospital costs were higher in non-survivors and close to statistical significance (p = 0.08). The ROC analysis revealed that the FGSI, LCR, and NLR parameters were significant in identifying survivors and non-survivors (AUC = 0.941 [0.870-1.000], p < 0.001; AUC = 0.747 [0.593-0.900], p = 0.025; and AUC = 0.724 [0.548-0.900], p = 0.042).* **Conclusion**: *A low LCR value can be used as a marker to assess mortality and disease severity in patients with Fournier's gangrene.*

Keywords: *Fournier's gangrene. Lymphocyte C-reactive protein ratio. Mortality. Cost effective.*

Resumen

Objetivo: *Investigar el cociente neutrófilos-linfocitos (CNL), el cociente linfocitos-proteína C reactiva (CLP) y el índice de gravedad de la gangrena de Fournier (IGGF) para predecir el pronóstico y la mortalidad en pacientes con gangrena de Fournier (GF).* **Método:** *Se revisaron los pacientes diagnosticados de GF y atendidos en un hospital de tercer nivel de referencia en el período de enero de 2013 a junio de 2020. Se calcularon los valores de CLP, IGGF y CNL.* **Resultados:** *Nuestra serie incluyó 41 pacientes, de los cuales el 78% sobrevivieron y el 21.9% (n = 9) fallecieron. Los supervivientes eran significativamente más jóvenes que los no supervivientes (p = 0.009). Los costes hospitalarios fueron mayores en los no supervivientes y cercanos a la significación estadística (p = 0.08). El análisis ROC reveló que los parámetros IGGF, CLP y CNL fueron significativos para identificar supervivientes y no supervivientes (AUC: 0.941 [0.870-1.000], p < 0.001; AUC: 0.747 [0.593-0.900], p = 0.025; AUC: 0.724 [0.548-0.900], p = 0.042).* **Conclusiones:** *Un valor bajo de CLP se puede utilizar como marcador para evaluar la mortalidad y la gravedad de la enfermedad en pacientes con GF.*

Palabras clave: *Gangrena de Fournier. Cociente linfocitos-proteína C reactiva. Mortalidad. Coste-efectividad.*

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Introduction

Fournier's gangrene (FG) is quickly progressing fasciitis of the perianal and genital regions. Because lag in diagnosis and treatment can be fatal, it is crucial not to overlook any symptoms, even if they are non-specific. Although initially described by Bauriene in 1764, the disease was named in 1883 after Jean Alfred Fournier, a dermatologist and venereologist from Paris[1]. The infection can progress rapidly, extending throughout the fascial planes toward the abdominal wall, legs, and the thorax[2]. Mortality rates for FG range from 3% to 45%[3]. Previous case series of FG reported a mortality rate of almost 80%, which later decreased to below 40% over the last 15 years[4]. Eke investigated 1726 cases and found a total mortality rate of 16% in the study[3]. Several studies have demonstrated prognostic factors that unfavorably act on survival including advanced age, disseminated disease, delayed treatment, a positive blood culture, diabetes, high urea levels, an anorectal origin of infection, presence of shock or sepsis at admission, and immunosuppressive states[5].

With regard to the prognosis of the disease, Laor et al.[6] have developed the Fournier's Gangrene Severity Index (FGSI) by adjusting the acute physiology and chronic health evaluation (APACHE II) scoring system. The authors showed that FGSI scores could be used to predict mortality and survival reliably at rates of 75% and 78%, respectively. However; there is an ongoing debate in the current literature about the prognostic value of FGSI. An increased neutrophil–lymphocyte ratio (NLR) has been shown to predict poor prognosis in FG patients[7]. Therefore, we aimed to evaluate whether different parameters could help predict the course of the disease.

Today, lymphocyte-to-C-reactive protein ratio (LCR) has been used to predict prognosis and mortality, especially in reflecting the state of inflammation in different cancer cases. In our prior study, we demonstrated that low pre-operative LCR values could be used to predict strangulation in incarcerated abdominal wall hernias[8]. Furthermore, it has been demonstrated that LCR can be used to predict prognosis in many cancer types[9,10]. One recent study has reported that high low LCR levels predicted a bad prognosis and higher in-hospital mortality in patients with coronavirus disease 2019 (COVID-19)[11].

The aim of this study is to determine the prognostic significance of LCR, a new inflammatory marker, to predict mortality in patients with FG.

Materials and methods

We case series analysis reviewed patients treated for FG in the School of Medicine Hospital of the Tokat Gaziosmanpasa University in the period from January 2013 to June 2020. The study was approved by the Ethics Committee of the School of Medicine of Tokat Gaziosmanpasa University (20- KAEK-293).

The diagnoses and International Classification of Diseases-10 (N49.3) code of the patients were retrieved from the hospital database and recorded. The recorded data included demographic information; clinical, laboratory, and radiological findings; and medical history, comorbidities, the length of hospital stay, the time elapsed from the time of admission until surgery, further debridements, intestinal diversion, and the need for orchiectomy. The diagnosis was made based on the clinical examination findings of foul odor, skin necrosis, and subcutaneous crepitations in the perianal region and/or based on the observation of perianal abscess and foci of air in radiological imaging tests. A definitive diagnosis was made based on the classical tissue appearance observed during surgery. Patients with less medical records, restricted perianal or scrotal abscesses, and no soft-tissue extension were excluded from this study. The patients were separated into two groups as survivors and non-survivors. The parameters that could be associated with mortality were evaluated.

Laboratory tests consisted of complete blood count and biochemical and microbiological tests at admission including the levels of serum glucose, serum creatinine, serum electrolytes, and C-reactive protein and blood gas analysis, lymphocyte count, neutrophil count, and wound cultures.

The LCR was obtained as the ratio of the lymphocyte count (count per microliter) to the CRP level (mg/l). NLR was obtained as the neutrophil count (count per microliter) to the lymphocyte count (count per microliter). Mean LCR, NLR, and FGSI values were compared between the groups of survivors and non-survivors to examine the association of these parameters with poor prognosis and mortality.

Treatment costs were calculated as the amount invoiced to the social security institution covering the period from the time of admission to the hospital discharge.

Statistical analysis

In our study, statistical analyses were performed with the SPSS package program (Version 22.0, SPSS

Inc., Chicago, IL, USA, License: Gaziosmanpasa University). Restrictive statistics were offered as mean ± standard deviation for normally distributed continuous data, median (min–max) for non-normally distributed continuous data, percentage (%), and number for categorical data. The normal distribution of the data was analyzed with the Shapiro–Wilk test. In comparing numerical variables between two free groups, the Student's t-test was used for normally distributed data, and the Mann- Whitney U test was used for non-normally distributed data. The Receiver Operating Characteristic (ROC) analysis method was used to evaluate whether NLR, LCR, and FGSI values can be used to predict survival and non-survival mortality status. The Youden Index (maximum specificity and sensitivity) was used to determine the most cutoff point in the ROC analysis. For the statistical significance level, $p < 0.05$ was accepted.

Results

A total of 41 patients participated in the study. Of the patients, 26.8% (n = 11) were women and 73.2% (n = 30) were men. The mean age of the patients was 58.17 ± 14.91 (24-95) years. Of the patients, 78% (n = 32) survived but 21.9% (n = 9) died. The mean age was statistically significantly higher in non-survivors ($p = 0.009$). There was a statistically significant difference between the groups in terms of the length of hospital stay, body temperature, and heart rate ($p = 0.027$, $p < 0.001$, and $p = 0.035$, respectively, Table 1). There were no significant differences in the other parameters between the groups ($p > 0.05$). Descriptive statistics and the comparisons of the other parameters between the groups are presented in table 1.

Of the comorbidities and predisposing factors, diabetes mellitus (DM) was the most common as it was found in 26 (63.4%) patients. DM was followed by congestive heart failure in four patients (9.8%), hypertension and paraplegia in five (12.2%), malignancy in three, and chronic renal failure in two patients. Immunosuppression was present in two patients due to chemotherapy and in one patient due to chronic corticosteroid use. Three patients had chronic alcohol use and 12 had a habit of smoking. Comorbidities were similar between survivors and non-survivors. As for the history of surgery, two patients underwent left hemicolectomy and low anterior resection due to colon/rectum tumors, two underwent surgery for inguinal hernia, one was operated on for a brain tumor, and two patients were operated for anal fistulas.

The most common complaint at admission was perianal pain and swelling (64.5%) followed by fever (50.1%-49.1%), purulent discharge in the perianal region (41.86%), and poor general condition (52.4%). The most common clinical presentation was necrosis in the perineal and scrotal regions.

Diverting colostomy was performed on nine survivors and six non-survivors. Orchiectomy was performed on two survivors and three non-survivors.

Etiological factors for mortality in non-survivors included severe sepsis (n = 3), acute renal failure (n = 1), multiple organ failure (n = 3), respiratory failure due to lung cancers (n = 1), and congestive heart failure (n = 1). All of the non-survivors and 40.6% of the survivors were treated in the intensive care unit. Patients hospitalized in the intensive care unit were compared between survivors and non-survivors, and it was found to be statistically significant in favor of survivors ($p = 0.02$) (Table 1). This showed us the importance of mechanical ventilator support and combating sepsis in the intensive care unit.

Hospital costs were higher in non-survivors compared to survivors and the difference was close to statistical significance ($p = 0.08$) (Table 1).

The comparison of the laboratory test results and the values of NLR, LCR, and FGSI between non-survivors and survivors are presented in Table 2. There were statistically significant differences in creatinine, hematocrit, CRP, and lactic acid levels in the neutrophil count, and in the values of NLR, LCR, and FGSI between the groups ($p = 0.003$, $p = 0.020$, $p = 0.004$, $p < 0.001$, $p < 0.001$, $p = 0.041$, $p = 0.024$, $p < 0.001$, respectively; Table 2). However, the levels of sodium (Na), potassium (K), glucose, white blood cell, serum bicarbonate, and lymphocyte counts were not statistically significantly different between the groups ($p = 0.343$, $p = 0.210$, $p = 0.060$, $p = 0.376$, $p = 0.889$, $p = 0.722$, respectively, Table 2). Non-survivors had significantly higher FGSI and NLR values and significantly lower LCR values compared to survivors (Table 2 and Fig. 1).

The results of the ROC analysis; the sensitivity, specificity, and positive and negative predictive values; and the likelihood ratios (+) of the FGSI, NLR, and LCR parameters are presented in table 3. Figure 2 shows the ROC curves. The ROC analysis revealed that the FGSI, LCR, and NLR parameters were significant in distinguishing between survivors and non-survivors (AUC = 0.941

Table 1. Comparison of baseline characteristics describing survivors and non-survivors

Variables	Total n (%) (n = 41)	Survivor n (%) (n = 32)	Non-survivor n (%) (n = 9)	p-values
Gender				
Female	11 (26.8)	10 (90.9)	1 (9.1)	0.401*
Male	30 (73.2)	22 (73.3)	8 (26.7)	
Comorbidity				
DM				
-	15 (36.6)	11 (73.3)	4 (26.7)	0.701*
+	26 (63.4)	21 (80.8)	5 (19.2)	
CHF				
-	37 (90.2)	28 (75.7)	9 (24.3)	0.559*
+	4 (9.8)	4 (100)	0 (0)	
HT				
-	36 (87.8)	28 (77.8)	8 (22.2)	1.000*
+	5 (12.2)	4 (80)	1 (20)	
Asthma				
-	38 (92.7)	29 (76.3)	9 (23.7)	1.000*
+	3 (7.3)	3 (100)	0 (20)	
CRF				
-	39 (95.1)	31 (79.5)	8 (20.5)	0.395*
+	2 (4.9)	1 (50)	1 (50)	
Paraplegia				
-	6 (87.8)	27 (75)	9 (25)	0.568*
+	5 (12.2)	5 (100)	0 (0)	
Colon/Rectum tumor				
-	36 (87.8)	30 (83.3)	6 (16.7)	0.395*
+	2 (4.9)	1 (50)	1 (50)	
CAH				
-	37 (90.2)	29 (78.4)	8 (21.6)	1.000*
+	4 (9.8)	3 (75)	1 (25)	
Brain tumor				
-	40 (97.6)	32 (80)	8 (20)	0.220*
+	1 (2.4)	0 (0)	1 (100)	
Lung tumor				
-	40 (97.6)	32 (80)	8 (20)	0.220*
+	1 (2.4)	0 (0)	1 (100)	
Colostomy				
-	26 (63.4)	23 (88.5)	3 (11.5)	0.053*
+	15 (36.6)	9 (60)	6 (40)	
Orchiectomy				
-	36 (87.8)	30 (83.3)	6 (16.7)	0.061*
+	5 (12.2)	2 (40)	3 (60)	
Debridement				
1	11 (26.8)	11 (100)	0 (0)	0.083*
>1	30 (73.2)	21 (70)	9 (30)	
Intensive care				
-	19 (46.3)	19 (100)	0 (0)	0.002*
+	22 (53.7)	13 (59.1)	9 (40.9)	
Bacterial Cultures				
Bacteria reproduction				
-	8 (19.5)	8 (100)	0 (0)	0.164*
+	33 (80.5)	24 (72.7)	9 (27.3)	
Escherichia coli				
-	17 (41.5)	15 (88.2)	2 (11.8)	0.262*
+	24 (58.5)	17 (70.8)	7 (29.2)	
Staphylococcus				
-	35 (85.4)	27 (77.1)	8(22.9)	1.000*
+	6 (14.6)	5 (83.3)	1 (16.7)	
Pseudomonas				
-	36 (87.8)	28 (77.8)	8 (22.2)	1.000*
+	5 (12.2)	4 (80)	1 (20)	
Others (*Streptococcus, Klebsiella, Acinetobacter*, Staph saprophyticus, *Enterococcus*)				
-	31 (75.6)	25 (80.6)	6 (19.4)	0.662*
+	10 (24.4)	7 (70)	3 (30)	
VAC				
-	21 (51.2)	16 (76.2)	5 (23.8)	1.000*
+	20 (48.8)	16 (80)	4 (20)	

(Continues)

Table 1. Comparison of baseline characteristics describing survivors and non-survivors *(continued)*

Variables	Total n (%) (n = 41)	Survivor n (%) (n = 32)	Non-survivor n (%) (n = 9)	p-values
	Median (min-max)	Median (min-max)	Median (min-max)	
Age	57 (24-95)	56.5 (24-95)	77 (48-81)	0.009†
Length of hospital stay, days	20 (3-75)	20.5 (7-75)	15 (3-45)	0.027†
Time between application date and surgery date (Hours)	3 (1-8)	3 (1-8)	3 (1-6)	0.466†
Cost, $	2316 (181-14492)	1823 (181-14448)	3432 (637-14492)	0.080†
Temperature, °C	37 (36-39)	37 (36-38)	39 (37-39)	<0.001†
Heart rate, bpm	100 (68-130)	96.5 (68-130)	115 (88-120)	0.035†
Respiration rate, rpm	20 (16-26)	20 (16-24)	20 (18-26)	0.653

*Fisher exact test. †Mann–Whitney U test with median (min–max).
DM: diabetes mellitus; CHF: congestive heart failure; HT: hypertension; CRF: chronic kidney diseases; CAH: coronary artery disease; bpm: beats per minute; rpm: breaths per minute; tm: tumor; VAC: vacuum-assisted closing.

Table 2. Comparison of laboratory values NLR and LCR values of patients according to mortality status

Variables	Survivor (n = 32)	Non-survivor (n = 9)	p-values
Na, mmol/L	134.5 (119-153)	135 (131-143)	0.343*
K, mmol/L	4.22 ± 0.79	4.59 ± 0.65	0.210†
Creatinine, mg/dL	1.03 (0.42-3.67)	3 (0.92-4)	0.003*
Hct, %	35.6 (25-43.2)	29.5 (20-37.3)	0.020*
WBC, ×1000/mm^3	12 (2.87-26.8)	14.6 (8.13-26.31)	0.060*
Lactic acid, mmol/L	2 (1-3)	3 (2-4)	< 0.001*
Glucose, mg/dL	151.1 (22-729)	214.5 (80.7-653.2)	0.376*
Venous bicarbonate, mmol/L	21 (16-29.2)	22 (18-28.1)	0.889*
Neutrophil count	10.71 ± 4.41	17.92 ± 4.06	< 0.001†
Lymphocyte count	1.08 (0.5-2.61)	1.20 (0.6-1.8)	0.722*
CRP, mg/dL	110.3 (8-435.6)	211 (140-400)	0.004*
NLR	9.43 (1.2-24)	14.09 (7.78-38.33)	0.041*
LCR	0.0116 (0.0024-0.1)	0.0057 (0.0028-0.0075)	0.024*
FGIS	5.16 ± 2.49	10.11 ± 1.76	< 0.001†

*Mann–Whitney U test with median (min–max). †Student's t-test with Mean±SD.
FGIS: Fournier's gangrene severity index; LCR: lymphocyte-to-C-reactive protein ratio; NLR: neutrophil-to-lymphocyte ratio; WBC: white blood cell; Htc: hematocrit; Na: sodium; K: potassium.

[0.870-1.000], p < 0.001; AUC = 0.747 [0.593-0.900], p = 0.025; AUC = 0.724 [0.548-0.900], p = 0.042, respectively, table 3). At the same time, the ROC areas under the curve (ROC AUC) were statistically compared. The AUC value for FGIS (0.941) was significantly higher (p = 0.038) than the AUC value of the LCR (0.747). AUC value for FGIS was significantly higher (0.724) than NLR's AUC value (p = 0.0499). There was no significant difference between the AUC values of LCR and NLR (p = 0.824).

ROC analysis was performed for CRP and neutrophil. ROC AUC for CRP 0.806 (0.671-0.940). The ROC AUC for neutrophil is 0.903 (0.806-0.999).

Table 3. ROC analysis results for FGIS, LCR, and NLR values with sensitivity, specificity, positive-negative predictive values, and likelihood ratio (+) values

Variables	FGIS	LCR	NLR
AUC (95% CI)	0.941 (0.870-1.000)	0.747 (0.593-0.900)	0.724 (0.548-0.900)
p-values	< 0.001	0.025	0.042
Cut-off	6.5	0.0088	9.19
Sensitivity (95% CI)	1 (0.628-1)	1 (0.628-1)	0.889 (0.506-0.994)
Specificity (95% CI)	0.812 (0.629-0.921)	0.563 (0.379-0.732)	0.5 (0.322-0.677)
PPV (95% CI)	0.6 (0.328-0.825)	0.391 (0.205-0.612)	0.333 (0.164-0.553)
NPV (95% CI)	1 (0.839-1)	1 (0.781-1)	0.941 (0.692-0.996)
LR + (95% CI)	5.33 (2.59-10.97)	2.29 (1.54-3.39)	1.78 (1.17-2.70)

FGIS: Fournier's gangrene severity index; LCR: lymphocyte-to-C-reactive protein ratio; NLR: neutrophil-to-lymphocyte ratio; AUC: area under the ROC curve; CI: confidence interval; PPV: positive predictive values; NPV: negative predictive values; LR: likelihood ratio; ROC: receiver operating characteristic.

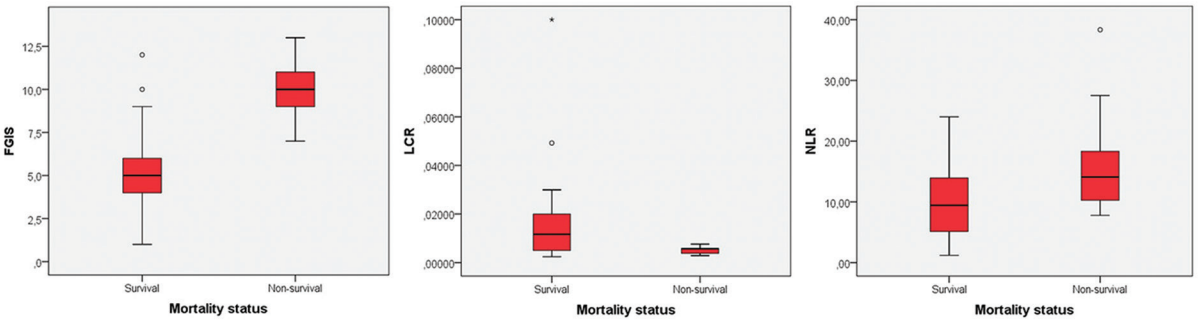

Figure 1. *Comparison of FGIS, LCR, and NLR values between mortality groups by box plot.*

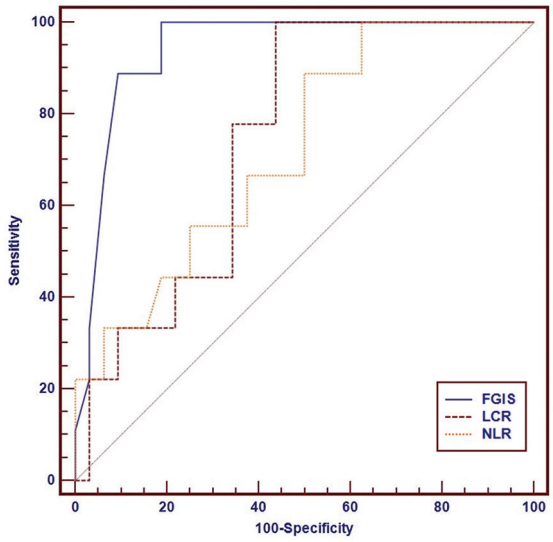

Figure 2. *Receiver operating characteristic curves.*

The cutoff point for FGSI was 6.5. For this cutoff point, classification success was determined as 100% sensitivity (62.8-100%) and 81.2% specificity (62.9-92.1%) (Table 3). The cutoff point for LCR was found to be 0.0088. For this cutoff point, classification success was determined as a sensitivity value of 100% (62.8-100%) and a specificity value of 56.3% (37.9-73.2%) (Table 3). The cutoff point for NLR was 9.19. For this cutoff point, classification success was determined through a sensitivity value of 88.9% (50.6-99.4%) and a specificity value of 50% (32.2-67.7%) (Table 3).

Discussion

FG is associated with high mortality rates when emergency intervention is not performed. Several

scoring systems and biomarkers have been used to predict prognosis and mortality in patients with FG. In our study, we investigated the usability of LCR, a new inflammatory marker, to predict mortality in FG. We found out in our study that a low LCR value is a free prognostic factor for mortality in patients with FG. Furthermore, NLR and FGSI values were significantly higher in non-survivors compared to survivors.

Despite the advanced diagnostic methods, treatment approaches, and intensive care facilities we have today, mortality rates for FG remain high. Stone and Martin (1972) reported the mortality rate as 88% in the study of 33 patients[12]. Mortality rates in FG range from 3% to 45% in recent case series in the literature. In our current series, the mortality rate was found as 21.9%, which falls within the range reported in the literature[3,13]. The key reasons for high mortality rates are the aggressive nature of the infection and the devastating effects of the accompanying predisposing factors.

In the past, FG was thought to occur only in young men. Recent studies have reported a gradual increase in the age of FG patients[14]. The effect of advanced age on mortality has been discussed in many studies; however, the results are conflicting. Sorensen et al.[13] in a large-scale population-based study on 1641 patients and Bozkurt et al.[15] reported that advanced age has been associated with mortality. In our study, the mean age of the patients was 57 years and survivors were significantly younger than non-survivors as reported by the previously mentioned studies. On the contrary, some authors have reported no significant differences in age between survivors and non-survivors[10,16].

Several scoring systems have been developed for determining the severity of the infection and predicting prognosis in patients with FG. The most commonly used scoring system is FGSI developed by Laor et al.[6] A threshold parameter is used in the FGSI system to predict outcomes. It is reported that an FGSI value of < 9 corresponds to a survival rate of 78% and an FGSI value of ≥ 9 corresponds to a probability of death at a rate of 75%. In our series, FGSI scores were significantly lower in non-surviving patients compared to survivors ($p = 0.001$). The mean FGSI score of survivors was about half of the mean FGSI score of non-survivors (5.11 ± 2.49 and 10.11 ± 1.76, respectively) and the cutoff value was 6.5. There are other studies, which demonstrated that the FGSI scoring system was not associated with mortality and did not predict prognosis.

Several studies about various diseases have demonstrated that NLR is associated with the severity of systemic inflammation and indicate the disease severity[17-19]. We found only a few studies about the prognostic significance of NLR and its association with mortality in FG patients in the scientific literature. In a 33-patient series study by Bozkurt et al., NLR, FGSI, and the Laboratory Risk Indicator for Necrotising Fasciitis scoring system were investigated. That study reported that all three parameters could be used to predict poor prognosis, including mortality and the need for mechanical ventilation[16]. In another study, the authors reported that FG patients, who needed multiple debridements, had higher mean NLR levels (> 8) compared to the patients, who needed only one debridement procedure[7]. In our study, NLR was significantly higher in non-survivors compared to survivors ($p = 0.04$). We associated increased NLR levels with poor prognosis and high mortality.

LCR has recently received attention and has been reported as a potential predictor of prognosis and inflammation. Recent studies have demonstrated that LCR predicted prognosis in specific types of cancer such as colon and stomach cancers. In patients with colorectal cancer, low pre-operative LCR levels were associated with the highest recurrence rate[20]. In a recent study of 2,424 stage IV cancer cases, 13 different inflammatory markers were studied. Researchers stated that LCR score can be used to predict prognosis in stage IV patients according to other evaluated inflammation indicators[21]. In another study about stomach cancer, low pre-operative LCR levels were associated with peritoneal metastasis, advanced stage, and distant organ metastasis. In long-term results, low pre-operative LCR levels have been reported as an independent prognostic factor for both disease-free survival and overall survival[10]. LCR has also been employed in global studies about the coronavirus disease 2019 (COVID-19) pandemic caused by the novel severe acute respiratory syndrome coronavirus-2. Those studies have reported that the use of LCR is feasible as an indicator of systemic inflammation caused by the cytokine storm[22]. In a meta-analysis, Lagunas-Rangel reviewed six studies and concluded that increased NLR and decreased LCR values might be associated with the severity of COVID-19[11]. In light of the abovementioned data, we investigated whether LCR could predict disease severity and mortality in patients with FG. In our series, LCR values were significantly lower in non-survivors compared to survivors ($p = 0.025$).

Our study had certain limitations. First, our study had a small sample size because of the retrospective design and the rarity of the disease. Second, the study was carried out in only one tertiary referral hospital, meaning that the patients may have been treated by different surgeons and through different methods. There is a need for a multi-center prospective study with a larger sample size to further confirm the prognostic value of LCR and its association with mortality in FG.

Conclusion

FG continues to be an important health problem with high mortality rates. Early diagnosis and treatment are extremely crucial in FG. Low LCR and high FGSI and NLR values can be used for predicting poor prognosis and mortality. This is the first study in the literature that investigated the possible association of LCR with the prognosis in FG. However, although FGSI has the best area under the curve and has been proven in many studies, we think that this area should be kept in mind in LCR. However, prospective multicenter studies are needed on this subject.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Ethical disclosures

Protection of human and animal subjects. The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics committee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. Right to privacy and informed consent. The authors have obtained approval from the Ethics Committee for analysis and publication of routinely acquired clinical data and informed consent was not required for this retrospective observational study.

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