Original Research Article

The Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC) Scoring: Diagnostic and Potential Prognostic Role

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Received: 03-08-2021 / Revised: 23-12-2020 / Accepted: 28-10-2021

Abstract

Introduction: Necrotizing fasciitis (NF) is an progressive and deadly soft tissue infection with necrosis, usually affecting the subcutaneous tissue and fascia. It has severe morbidity and mortality[1]. About thirteen per million population are thought to be hospitalized every year for Necrotizing Fasciitis, out of which around twenty to thirty percent die from the disease.**Materials and Methods:** This is a hospital-based observational study conducted on 101 patients presenting with symptoms suggestive of soft tissue infections in the department of General Surgery, Justice K.S. Hegde Charitable Hospital is attached to K S Hegde Medical Academy, a unit of Nitte (Deemed to be University), Mangalore. The study was conducted from January 2019 to June 2020. Information regarding the demographics & covariates of soft tissue infections was collected using a pretested semi-structured proforma cum observational checklist. LRINEC scoring system was applied to each of the study subjects**Results:** The objective of our study is to use the LRINEC scoring system in early detection and evaluate the prognostic value of patients with necrotizing fasciitis. With a Laboratory Risk Indicator for Necrotizing Fasciitis cut-off score >6, the sensitivity was 46% (95% confidence interval 31% to 61.61%), specificity was 98.33% (95% confidence interval 95% to 101%), positive predictive value was 95% (95% confidence interval 85% to 104%),and negative predictive value was 72.84% (95% confidence interval 63% to 82%).The area under the receiver operating characteristic curve for accuracy of the Laboratory Risk Indicator for Necrotizing Fasciitis score was 0.696 (95% CI 0.640 to 0.751).**Conclusion:** The LRINEC score is an outstanding diagnostic tool for distinguishing necrotizing fasciitis from other serious infections of soft tissue. Patients with an LRINEC score of≥6 have a higher rate of both morbidity and surgical debridement.

Keywords: Necrotizing fasciitis, LRINEC scoring system, morbidity, surgical debridement.

Introduction

Necrotizing fasciitis (NF) is an progressive and deadly soft tissue infection with necrosis, usually affecting the subcutaneous tissue and fascia. It has severe morbidity and mortality[1].Aboutthirteen per million population are thought to be hospitalized every year for Necrotizing Fasciitis, out of which around twenty to thirty percent die from the disease. There could be hundred percent mortality, when timely diagnosis and treatment could not be started [2].Some of the common risk factors to cause Necrotizing Fasciitis are Type 2 Diabetes Mellitus (DM). Immunocompromising disorders, drug abuse and malnutrition[2].These infections may progress from just a minor wound, usually without any provocation[3].Some approaches to attain favorable outcomes are early diagnosis, broad spectrum antibiotic therapy, continuous surgical debridement and multidisci-plinary care[1-3].LRINEC scoring system is derived from 6 commonly done hematological and biochemical test. It is used at the beginning to distinguish Necrotizing Fasciitis from other soft tissue infections. Various studies have analyzed the usefulness of LRINEC in diagnosing NF early. They found that it can help to identify and classify patients with Necrotizing Fasciitis into different categories of risk, which in turn helps in the appropriate utilization of hospital resources[1].Only a few studies have assessed the association between LRINEC score and NF outcomes. There is a growing need to find a simple, inexpensive and readily available tool which helps in stratification of NF patients. Our current study is done to evaluate the role of LRINEC score as a tool for prognosticating NF patients[4,5].

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Aims and Objectives

Aim

To prove the Laboratory Risk Indicator for Necrotizing Fasciitis Scoring can be used for early detection and to evaluate the prognostic value of necrotizing fasciitis patient

Objectives

To utilize the LRINEC (Laboratory Risk Indicator for Necrotizing Fasciitis) scoring system to predict Necrotizing Fasciitis in patients with cellulitis and other soft tissue infections

1. To evaluate whether risk categorization using LRINEC score is appropriate.
2. To evaluate the role of LRINEC score to predict clinical outcomes in patients with cellulitis and other soft tissue infection.
3. To interpret the accuracy of the score in the presence of a co-morbid condition.

Materials and Methods

Study Design: Hospital-based observational study

Study Setting: Justice K.S. Hegde Charitable Hospital is attached to K S Hegde Medical Academy, a unit of NITTE University, Mangalore–575018.

Study Duration: Study will be conducted from January 2019 to June 2020.

Study Population: Patients coming to K.S. Hegde Charitable Hospital and diagnosed with soft tissue infection

Sample Size: 101 Patients presenting with soft tissue infections.
The sensitivity of the LRINEC score is 59.2
Specificity-83.5
Prevalence-0.40 per 1lakh population
Based on these values the two sample size calculations are

Table 1:Formula used

Based on Specificity	
formula used	
$N = \frac{Z^2 Sp(1-Sp)}{d^2 \times (1-Prev)}$	
α: alpha error	5%
Z	1.959963985
Sp	0.835
1-sp	0.165
D	0.2
Prevalence	0.4
1-prevalence	0.6
SAMPLE AS PER SPECIFICITY	22.05237454
SAMPLE AS PER SPECIFICITY	23

FORMULA USED	
$N = \frac{Z^2 Se(1-Se)}{d^2 \times Prev}$	
α: alpha error	1%
z: z score for the said alpha	2.575829304
se: sensitivity	0.592
1-se	0.408
d: clinically significant difference	0.2
Prevalence	0.4
calculated values	100.1603991
sample size required	101

Inclusion Criterion:

- Patients presenting to Justice K.S. Hegde Charitable Hospital with symptoms suggestive of soft tissue infections during the study period.

Exclusion Criterion:

- Patients below 15 years or above 75 years of age.
- For the patient who needs multiple admissions due to soft tissue infection, only the first admission be considered.
- Patients with features of necrotizing fasciitis on presentation
- The patient has undergone surgical debridement for the present episode of soft tissue Infection.
- Patients with boils or furuncles with no evidence of cellulitis.
- Patient with surgical site infections.

Results

A total of 101 patients with cellulitis were included. Patients who needed multiple admissions due to soft tissue infection were excluded and only the first admission was considered. Patients with features of necrotizing fasciitis on presentation were also excluded from the study. The objective of our study was to use the LRINEC scoring system in early detection and evaluate the prognostic value of patients with necrotizing fasciitis. With a Laboratory Risk Indicator for NF scoring system Cut-off score > 6, sensitivity was 46% (95 percent confidence interval 31 percent to 61.61 percent), specificity was 98.33 percent (95 percent confidence interval 95 percent to 101 percent), positive predictive value was 95% (95 percent confidence interval 85 percent to 104 percent) and the negative predictive value was 72.84 percent (95 percent confidence interval 63 percent).

The following are the results of our study, taking into account the various factors that may affect the outcome and morbidity of necrotizing fasciitis.

Table 2: Age Distribution

Age group	Frequency	Percent
40 and below	10	9.9
41 – 50	22	21.8
51 – 60	32	30.7
61 – 70	26	25.7
Above 70	12	11.9
Total	101	100.0

Most of the cellulitis patients were in the 5th to 6th decades n=32

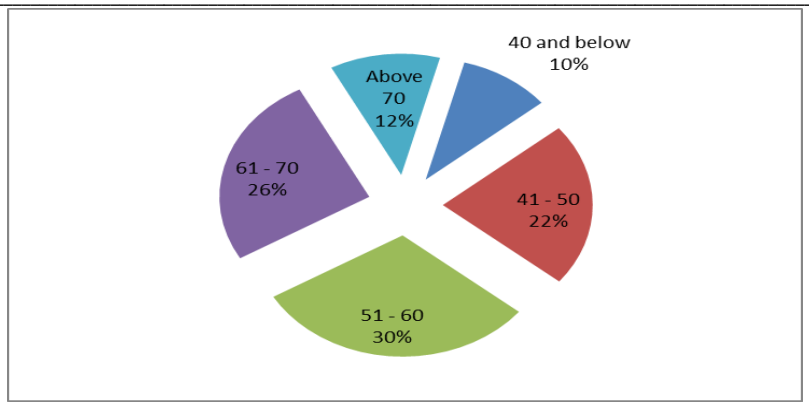

Fig 1: Age distribution chart

The age group was divided as

- Below 40 years: 10% (n= 10)
- 41-50 years: 21.8% (n= 22)
- 51-60 years: 30% (n= 32)
- 61-70 years:25.7% (n=26)
- Above 70 years: 12% (n= 11)

Table 3: Gender demographics

Sex			
		Frequency	**Percent**
	F	16	15.8
	M	85	84.2
	Total	101	100.0

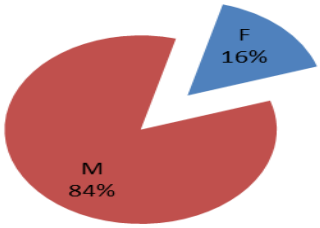

Fig 2: Gender distribution chart study population

Our study included patients of both genders with males constituting 84% of the study population while females had a much smaller representation of 16% in the study population.

Table 4: Wound debridement and conservative management

Debridement	Frequency	Percentage
Debridement	41	40.6
Conservative Management	60	59.4
Total	101	100.0

Fig 3: Wound debridement distribution chart

The above representation shows that 59% of the patients underwent wound debridement as a mode of management while 41% of the patients were conservatively managed.

Table 4: Distribution of LRINEC scoring system in patients with cellulitis

	N	Mean	Std. Deviation	Minimum	Maximum	Percentiles		
						25th	50th (Median)	75th
Hb	101	11.928	2.2056	6.0	17.3	10.500	12.050	13.400
TC	101	12067.33	5885.340	4400	33100	7900.00	10800.00	15350.00
Na	101	133.62	5.303	117	152	130.00	134.00	137.00
Creatinine	101	1.6104	1.74584	.29	11.00	.8600	1.0900	1.5350
RBS	101	176.07	91.831	71	521	119.50	140.00	208.00
CRP	101	71.2462	56.37730	.50	261.90	25.1850	63.1000	108.3000
Score	101	3.82	2.762	0	10	2.00	3.00	6.00

Table 4: Shows the mean, SD, and range of laboratory findings for patients with cellulitis and abscesses. The parameters used to calculate the LRINEC Scoring System included hematological parameters like the hemoglobin and total counts of the patient. Renal parameters like the creatinine value of the patient also contributed to the calculation of the final score. As cellulitis is shown to alter the values of glucose, acute phase reactants, and electrolytes in the blood, the score also included parameters like sodium, CRP, and random blood sugar levels. The mean hemoglobin of all the patients included in the study was 11.928 with the values ranging from 6 to 17.3. The total counts were found to be elevated in most patients with the mean value being 12067.33. The creatinine, CRP, and random blood sugar values were also increased in most patients with mean values being 1.61, 71.24, and 176.07 respectively. Sodium levels also varied from hypo to hypernatremia with each patient, with the final mean of all 101 patients being 133.62.

Table 5: Comparison between the patient who underwent debridement and non-debridement

Debridement		N	Mean	Std. Deviation	Mann-Whitney test p-value		Median(IQR)
Hb	Present	41	11.55	2.24	0.101	NS	11.6(10.2--12.75)
	Absent	59	12.19	2.16			12.5(10.6-13.6)
TC	Present	41	15634.15	6759.65	0.000	HS	15400(10150-18400)
	Absent	60	9630.00	3584.25			9350(7225-12400)
Na	Present	41	132.37	5.96	0.006	HS	132(129-135.5)
	Absent	60	134.48	4.66			136(132-138)
Creatinine	Present	41	2.09	2.10	0.000	HS	1.34(0.925-2.095)
	Absent	60	1.29	1.38			1.02(0.7775-1.1975)
RBS	Present	41	202.90	114.83	0.035	sig	160(132.5-221)
	Absent	60	157.73	67.17			135(114-182)
CRP	Present	41	98.34	53.72	0.000	HS	101(64.32-131.985)
	Absent	60	52.73	50.71			40(18.1075--73.9)

Debridement		N	Mean	Std. Deviation	Mann-Whitney test p-value		Median (IQR)
Score	Present	41	5.80	2.48	0.000	HS	6(3--7.5)
	Absent	60	2.47	2.04			2(1--4)

We observed statistically significant variations between WBC (p<0,000), serum sodium (p<0.006), creatinine (p<0,000) and CRP (p=0,000) levels when comparing laboratory values between debridement and non-debridement. The glucose levels between the two groups also showed significant differences with a p-value <0.035. However, no remarkable differences were detected in hemoglobin levels between those groups (p=0.101). It is also worthwhile to note that the mean score of patients who eventually underwent wound debridement due to the developing signs of necrotizing fasciitis was significantly higher than those patients who required only conservative management (p-value- 0.000)

Table 6: Comparing the two groups with a patient who underwent wound debridement and without debridement

			Debridement		Total
			Present	Absent	
Score	>6		19	1	20
			95.0%	5.0%	100.0%
			46.3%	1.7%	19.8%
	<6		22	59	81
			27.2%	72.8%	100.0%
			53.7%	98.3%	80.2%
Total			41	60	101
			40.6%	59.4%	100.0%
			100.0%	100.0%	100.0%

Score		Confidence Interval	
		Lower	Upper
Sensitivity	46.34	31.08	61.61
Specificity	98.33	95.09	101.57
PPV	95.00	85.45	104.55

NPV	72.84	63.15	82.53
Overall accuracy**	77.23	69.05	85.41
		p=0.000	HS

Table 6: Out of 101 patients, 41(40.6%) patients underwent surgery while 60 (59.4%) were conservatively managed. It is interesting to note that the majority of patients (95%) with a score of >6 eventually underwent wound debridement due to them developing necrotizing fasciitis while only 5 % of them needed non-surgical management. Similarly, the majority of the patients with a score < 6 (72.8%) recovered with only conservative management while only 27.2% of them required surgery.

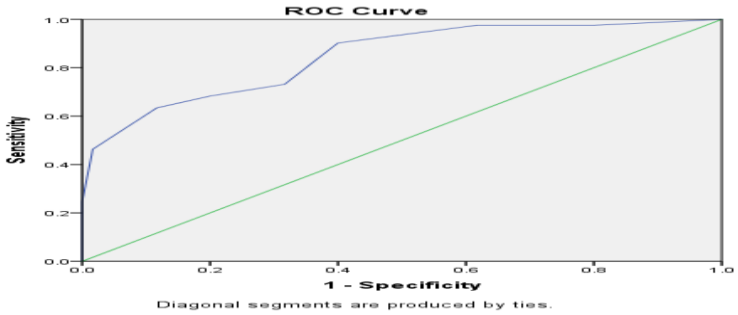

Fig 4: Risk factors for necrotizing fasciitis (LRINEC) for predicting the existence of necrotizing fasciitis

The area under the developmental cohort curve is 0.846 (95 % confidence interval, 0.769–0.923). (Solid line). The AUROC for the precision of the score of the LRINEC. With the LRINEC cut-off score > 6, the AUROC was 0.84646 for the accuracy of the LRINEC score

Table 7: Comparing age and gender demographics

		Debridement					
		Present			Absent		
		Count	Row N %	Column N %	Count	Row N %	Column N %
Age	40 and below	2	20.0%	4.9%	8	80.0%	13.3%
	41 – 50	9	40.9%	22.0%	13	59.1%	21.7%
	51 – 60	13	41.9%	31.7%	18	58.1%	30.0%
	61 – 70	10	38.5%	24.4%	16	61.5%	26.7%
	Above 70	7	58.3%	17.1%	5	41.7%	8.3%
Sex	F	8	50.0%	19.5%	8	50.0%	13.3%
	M	33	38.8%	80.5%	52	61.2%	86.7%

Debridement with the Following parameters	chi-square/Fishers exact test p	
Age	0.494	NS
Sex	0.404	NS

Table 7: The baseline demographics like age and gender were compared between the two groups. It is essential to highlight that there were no considerable variations found in either age or gender parameters between the two groups (p=0.494 and p= 0.404 respectively), thereby effectively eliminating these factors as confounding variables.

Table 8: Descriptive statistics

Debridement		**Mean**
Hb	Present	11.55
	Absent	12.19
TC	Present	15634.15
	Absent	9630.00
Na	Present	132.37
	Absent	134.48
Creat	Present	2.09
	Absent	1.29
RBS	Present	202.90
	Absent	157.73
CRP	Present	98.34
	Absent	52.73
Score	Present	5.80
	Absent	2.47

Table 8: Shows the mean LRINEC score value that is required for the debridement group is 5.80 and the median LRINEC score is 2.47.

Table 9: Hemoglobin

		Hb
Present	Hb	11.55
Absent		12.19

Table 9: Shows mean hemoglobin value of 11.55 gm/dl in patients who underwent debridement and 12.9 gm/dl in those who were managed conservatively.

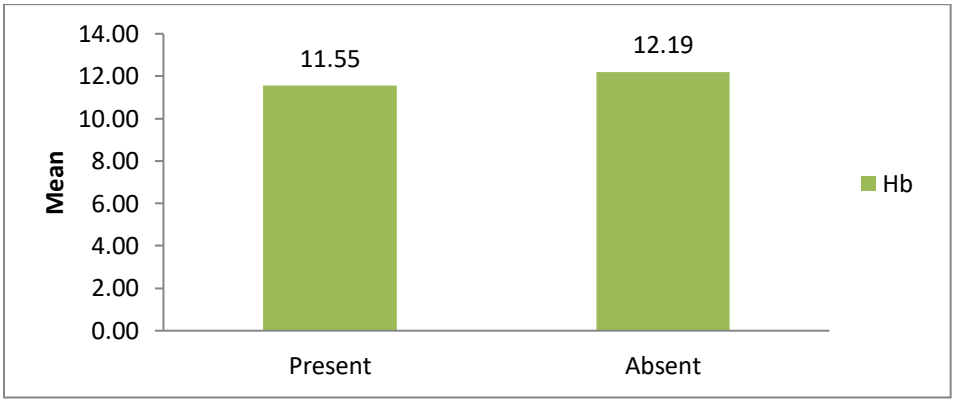

Fig 5: Histogram shows- The mean hemoglobin for the debridement group was 11.5 gm/dl, and the median hemoglobin for those who were conservatively managed was 12.19 gm/dl.

Table 10:Sodium

Na	Present	132.37
	Absent	134.48

Table 10: Shows mean sodium value of 132.5 in patients who underwent debridement and 134.48 gm/dl in those who were managed conservatively

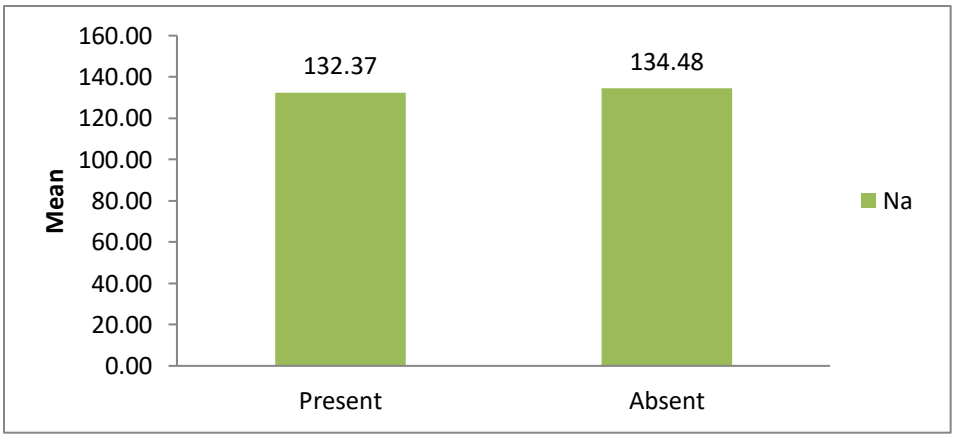

Fig 6: Histogram shows- The mean Sodium value that is required for the debridement group is 132.37 gm/dl, and the median Sodium is 134.48 gm/dl

Table 11:Total Leucocyte Count

TC	Present	15634.15
	Absent	9630.00

Table 11: Shows the mean value of 15634.15in patients who underwent debridement and 9630.00 in those who were managed conservatively

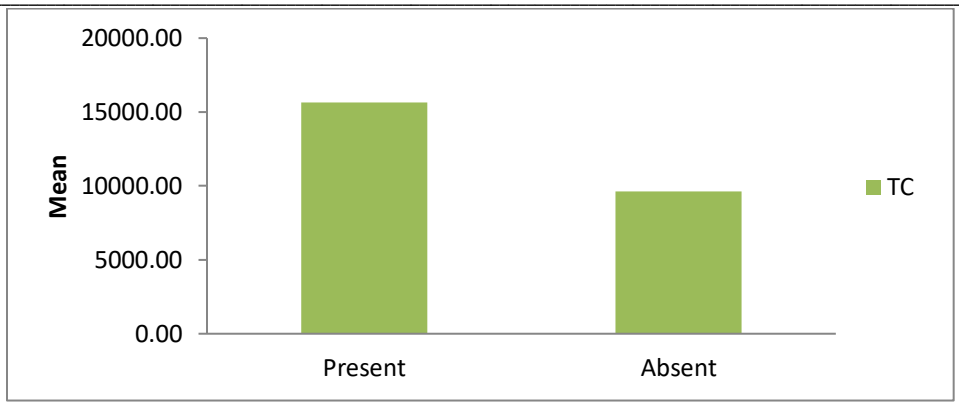

Fig 7: Histogram shows- The mean TLC value for the debridement group was 15634 and the mean TLC for the conservatively managed group was 9630.

Table 12: Shows mean creatinine value of 2.09 underwent debridement and 1.29 managed conservatively

Creatinine		
Creatinine	Present	2.09
	Absent	1.29

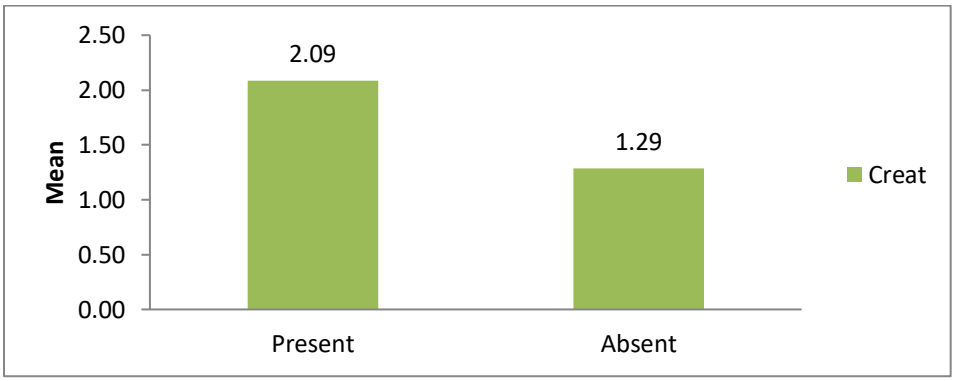

Fig 8: Histogram Shows- The mean creatinine value that is required for the debridement group is 2.09 and the median creatinine is 1.29.

Table 13:Random Blood Sugar

RBS	Present	202.90
	Absent	157.73

Table 13: Shows mean RBS value of 202.90 underwent debridement and 157.73 managed conservatively

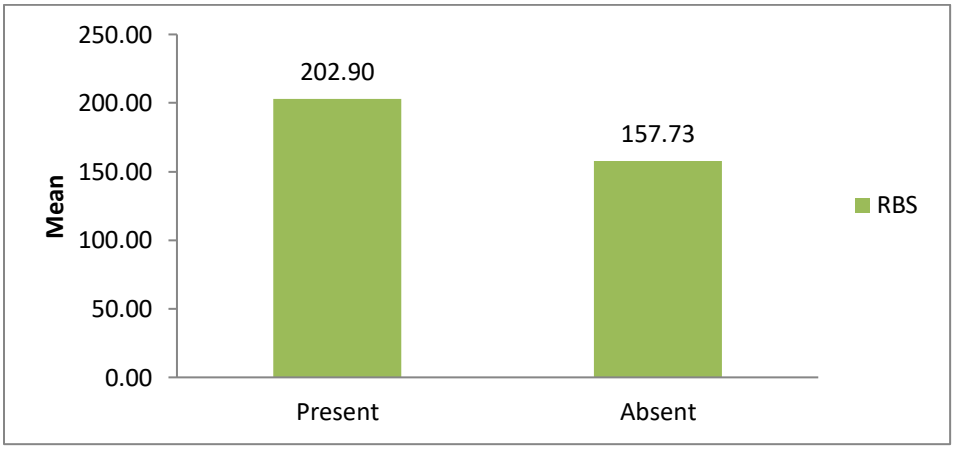

Fig 9: Histogram shows -The mean RBS value that is required for the debridement group is 202.9 and the median RBS is 157.73

Table 14:C-Reactive Protein

CRP	Present	98.34
	Absent	52.73

Table 14: Shows mean CRP value of 98.34 underwent debridement and 52.73 managed conservatively

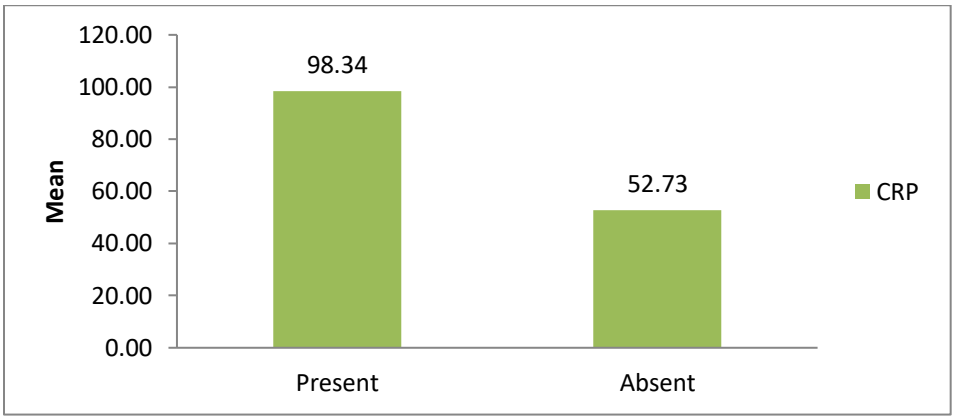

Fig 10: Histogram shows- The mean CRP value that is required for the debridement group is 98.34 and the median CRP is 52.73

Table 15:Total Score

		Score
Score	Present	5.80
	Absent	2.47

Table 15: Shows mean LRINEC value of 5.80 underwent debridement and 2.47 managed conservatively

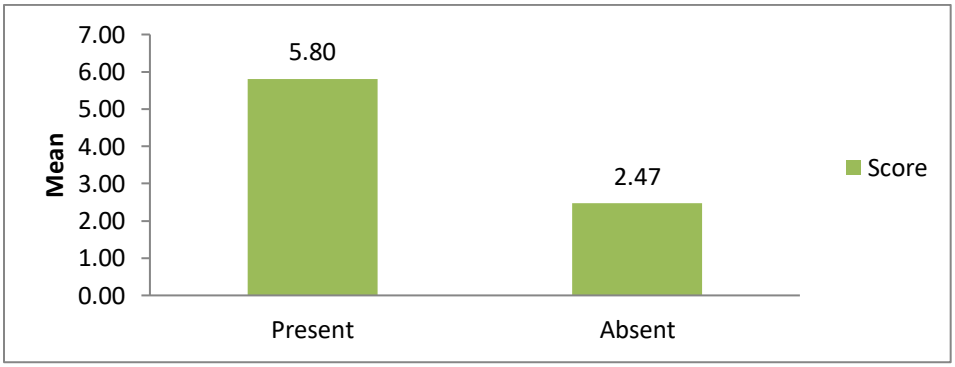

Fig 11: Histogram shows- The mean LRINEC score value that is required for the debridement group is 5.80 and the median LRINEC score is 2.47.

Discussion

Necrotizing fasciitis is a rapidly progressive infection involving the fascia and subcutaneous tissue.The prognostic indicators include early identification and extensive debridement of both devitalised fascia and subcutaneous tissues. Delay in this process has shown an increase in mortality. LRINEC scoring system helps to differentiate between necrotizing fasciitis and soft tissue infections of other etiologies[6].However, early detection of NF is tough as the disease is difficult to differentiate from cellulitis or abscess. My analysis using the LRINEC score is a robust score capable of detecting even early clinical cases of necrotizing fasciitis and predicting prognosis.We performed a prospective observational study to evaluate the accuracy of LRINEC scoring system in the diagnosis of NF with patients having soft tissue infection. Wong R, et al. performed a review on the LRINEC scoring system and concluded a score of > 6 had a sensitivity of 89.9 percent and a specificity of 96.9 percent, a positive predictive value of 92 percent, and a negative predictive value of 96.0 percent. These results indicate that this scoring system could be helpful in determining which patients with soft tissue infections should undergo a frozen section biopsy. This study was conceived to determine if the LRINEC scoring system would be a useful and practical tool in the diagnosis of necrotizing skin infections in the local patient population[7].

It is important to understand the diagnostic accuracy of LRINEC scoring system to appropriately measure the risk and benefits of using this score in patients with cellulitis.

An evidence-based approach to Necrotizing fasciitis diagnosis leads to early diagnosis, surgical intervention, and enhanced quality of life. 28 patients with the risk of necrotizing fasciitis diagnosed on admission were retrospectively assessed in the study conducted by

Holland MJ, et al. Of those, 17 with a low LRINEC score of 3.8 were found to have significant soft tissue infection. This suggests poor sensitivity[8].Retrospectively, Swain RA, et al. researched necrotizing fasciitis patients over 5 years between 2006 and 2011, consisting of 15 patients. The mean LRINEC score among those patients were differed between patients who survived and those who died. The LRINEC score was relatively high for patients who expired (LRINEC 9) compared to those who survived (LRINEC 6.5) with necrotizing fasciitis.A retrospective review has been performed by El-Menyar A, et al. (2017) to assess the function of the LRINEC score as an in-hospital prognostic tool for patients with NF. This was based on data from 294 patients who were admitted to surgical ICUs with a Thirteen-year conditional diagnosis of NF in a single tertiary care facility. A distinction has been made between candidates with LRINEC <6 (Group 1, n = 133) and candidates with LRINEC > 6 (Group 2, n = 161). Patients in Category 2 were 5 years old. And a high risk of developing diabetes, Mellitus, Pseudomonas infection, higher Sequential Organ Score of Failure Assessment (SOFA), prolonged ICU therapy, and hospital stay. Hospital and septic shock (37 vs. 15 percent, p = 0.001) Mortality was marginally higher (28.8 percent vs. 15 percent, p = 0.005) in Part 2. Using ROC, the LRINEC mortality cut-off was 8.5 with 0.64 AUC. The Pearson correlation analysis showed a large association between LRINEC and SOFA scores (r = 0.51; p < 0.002). The authors concluded that the score for LRINEC was NF, in addition to its diagnostic feature, which may identify high-risk NF for patients who are likely to encounter a worse or worse condition[9].Wall DB, et al. noted that NF has been associated with some clinical signs such as low Blood pressure, crepitation, necrosis of skin, bullae, and x-ray gas. Using the findings of the previous research, a basic model was created that serves as an adjunctive method for the diagnosis of NF (admission leucocyte count>15.4 x 10(9)/L or Na<135 mmol / L)and determining its ability to differentiate between patients with NF and no necrotizing soft tissue infection (non-NF) and concluding the study by stating that Admission leucocyte count greater than 15.4 x 10(9)/L and Na less than 135 mmol / L are useful parameters that may help to distinguish NF from non-NF infection, especially when classical "strong" signs of NF are absent[10].We performed a prospective and retrospective cohort analysis in the Department of General Operations. Patients with serious soft tissue infections in the extremities between January 2019 and June 2020. The LRINEC score was determined for all registered patient. The sensitivity, accuracy, positive predictive value, and negative predictive value of the cut-off scores <6 and >6 were evaluated. The reliability of the Laboratory Risk Predictor for Necrotizing Fasciitis score was expressed as the area under the receiver's operating characteristic curve.The score of the laboratory risk predictor for NF (LRINEC).It has been produced with the scope of providing diagnostic evidence for early in its evolution of NF. This score consists of Raised CRP > 150 mg / L (4 points), WBC > 25,000 / mm3, < 11 g / dL blood hemoglobin, Na < 135 mmol / L, > 141 µmol / L serum creatinine (2 points each) and > 10 mmol / L blood sugar level (one point each). The total possible score is 13, and our study found that a score of >6 was highly representative of Necrotizing Fasciitis with a positive predictive value of 95% percent positive.When comparing laboratory values between the debridement and non-debridement groups, statistically significant variations were observed between the WBC (p<0.000), the highly significant serum sodium level (p<0.006), the serum creatinine level (p<0.000), the blood glucose level (p<0.035) and the CRP level (p=0.000). However, there was no difference in hemoglobin levels between the groups p=0.101.When differentiating based on diabetes status, WBC, sodium, creatinine, glucose, and CRP were significantly different between debridement and non-debridement classes, while hemoglobin shows no significant difference.

Conclusion

The LRINEC score is an impressive diagnostic method to differentiate NF from serious soft tissue infections. In our study, LRINEC score had an outstanding 95 percent positive predictive value and 72.84 percent negative predictive value. It has been found that the LRINEC SCORING SYSTEM is a reliable scoring system for early detection of necrotizing fasciitis and the prediction of disease prognosis. In our study, a score of more than 6 is almost conclusive for necrotizing fasciitis and requires active and aggressive debridement. Hence, patients with a provisional diagnosis of NF should be diagnosed early and treated aggressively with wound debridement as early as possible, if necessary, with major amputations and broad-spectrum antibiotics in order to bring down morbidity and mortality.

Acknowledgement

The completion of this study could not have been possible without the constant support and guidance given by Late Dr B.K Shetty. His contribution to the study is sincerely appreciated and gratefully acknowledged. The guidance and advice given by him always will be remembered with a debt of gratitude.

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Conflict of Interest: Nil Source of support:Nil