

Evaluation and clinical significance of predictors for strangulation and intestinal resection in emergency anterior abdominal wall hernia surgery

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ABSTRACT

BACKGROUND: Emergency anterior abdominal wall hernia surgery plays a pivotal role in emergency general surgery practice. In this study, the predictive value of laboratory and imaging findings as well as demographic information and comorbidities of the patients for the recognition of strangulation and intestinal resection was investigated.

METHODS: Patients over the age of 18 who were operated consecutively with an indication for emergency anterior abdominal wall hernia surgery between January 2017 and December 2019 in a single tertiary hospital were included in this retrospective cohort study. The patient population was divided into two groups according to the pre-operative findings during the emergency anterior abdominal wall hernia surgery. Group 1 consisted of cases with incarceration but without strangulation, whereas Group 2 consisted of cases with strangulation in addition to incarceration. Moreover, in evaluation for the requirement for intestinal resection, patient Group 2 was divided further into two groups, namely, as Group (1 or 2) a and Group (1 or 2) b, defining the need for intestinal resection.

RESULTS: A total of 106 patients who had emergency anterior abdominal wall repair surgery due to incarcerated hernias were included in the study. The evaluation of the indices related to systemic inflammation revealed that lactate dehydrogenase to white blood cell ratio was significantly lower but neutrophil to platelet and neutrophil to albumin ratios were significantly higher in patients with strangulation, showing the significance of those systemic inflammation indices in detecting strangulation ($p=0.027$, $p=0.035$ and $p=0.030$, respectively). Moreover, the analysis of the patients in whom intestinal resection was required (Group 2a vs. 2b) exposed that neutrophil to albumin ratio was significantly higher in the patients with intestinal resection ($p=0.036$).

CONCLUSION: Indices of systemic inflammation such as lactate dehydrogenase to white blood cell ratio, neutrophil to platelet ratio, and particularly neutrophil to albumin ratio may be potentially beneficial to prevent complications and improve clinical outcomes in emergency hernia surgery.

Keywords: Emergency anterior abdominal wall hernia surgery; intestinal resection; neutrophil to albumin ratio; strangulation.

INTRODUCTION

Emergency anterior abdominal wall hernia surgery plays a pivotal role in emergency general surgery practice.^[1] A delay in surgical management might result in obstruction and/or strangulation, especially in the presence of an incarceration. The presence of strangulation in incarcerated emergency cases might lead to necrosis, perforation, or intestinal resection. Incarceration and strangulation might increase the

risk for pre-operative difficulties and post-operative complications. Complications associated with anesthesia as well as surgical complications such as hemorrhage, intra-abdominal abscess, or recurrence were suggested to increase in incarcerated or strangulated cases. Early recognition of those cases and appropriate preparation of both the patient and the surgical team as well as close follow-up of the patients might be helpful in reducing and improved managing of the complications associated with incarceration and strangulation.^[2,3]

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In emergency cases, laboratory findings such as white blood cell counts (leukocytes and WBC), C-reactive protein levels (CRP), lactate dehydrogenase (LDH) levels, and imaging findings such as ultrasonography (US) and computed tomography (CT) scans can be used to detect strangulation.^[3,4] In addition, clinical findings such as age, gender, comorbidities, and hernia type should be evaluated.^[5]

Herein, the predictive value of laboratory and imaging findings as well as demographic information and comorbidities of the patients for the recognition of strangulation was investigated. Moreover, the influence of those clinical, laboratory, and patient-related parameters on post-operative complications and surgical complications according to the Clavien-Dindo Classification System was assessed. Finally, pre-operative findings of the patients with emergency anterior abdominal wall hernia surgery were studied with respect to obtaining appropriate prognostic implications and potentially contributing to their use during and after the surgery.

MATERIALS AND METHODS

Patients over the age of 18 who were operated consecutively with an indication for emergency anterior abdominal wall hernia (incisional, umbilical, inguinal, femoral, etc.) surgery between January 2017 and December 2019 in a single tertiary hospital were included in this retrospective and cohort study after receiving ethical approval from the local committee. Elective cases, patients who were operated for other emergent reasons, patients with additional anterior abdominal wall hernia repairs, patients with missing hospital records, and post-operative follow-up as well as patients under the age of 18 were excluded from the study. As shown in Figure 1, 106 out of 825 patients were selected to be included in the study following the application of the inclusion and exclusion criteria.

Demographic and clinical data of the patients such as age, gender, smoking habits, comorbidities according to Charlson comorbidity index, hernia type, operation type, presence of strangulation, mesh use, drain use, length of hospital stay, presence of local complications such as seroma, hematoma, and surgical site infection/abscess, stage of the complications according to Clavien-Dindo classification system, recurrence, reoperation, and the requirement for intestinal resection were analyzed. Pre-operative laboratory such as WBC counts ($\times 10^3/\mu\text{l}$), CRP (mg/dL) levels, LDH (IU/L), total (TBil, mg/dL) and indirect bilirubin (IBil, mg/dL) levels, neutrophil counts ($\times 10^3/\mu\text{l}$), lymphocyte ($\times 10^3/\mu\text{l}$), and platelet counts ($\times 10^6/\mu\text{l}$) as well as albumin (g/dL) levels values were evaluated, followed-by the calculation of various indicators of systemic inflammation to evaluate their prognostic significance, such as LDH to albumin ratio, LDH to WBC ratio (LDH/WBC), indirect bilirubin to albumin ratio (IBil/Albumin), lymphocyte to CRP ratio (LCR), neutrophil to platelet ratio (NPR), neutrophil to lymphocyte ratio (NLR), CRP to albumin ratio

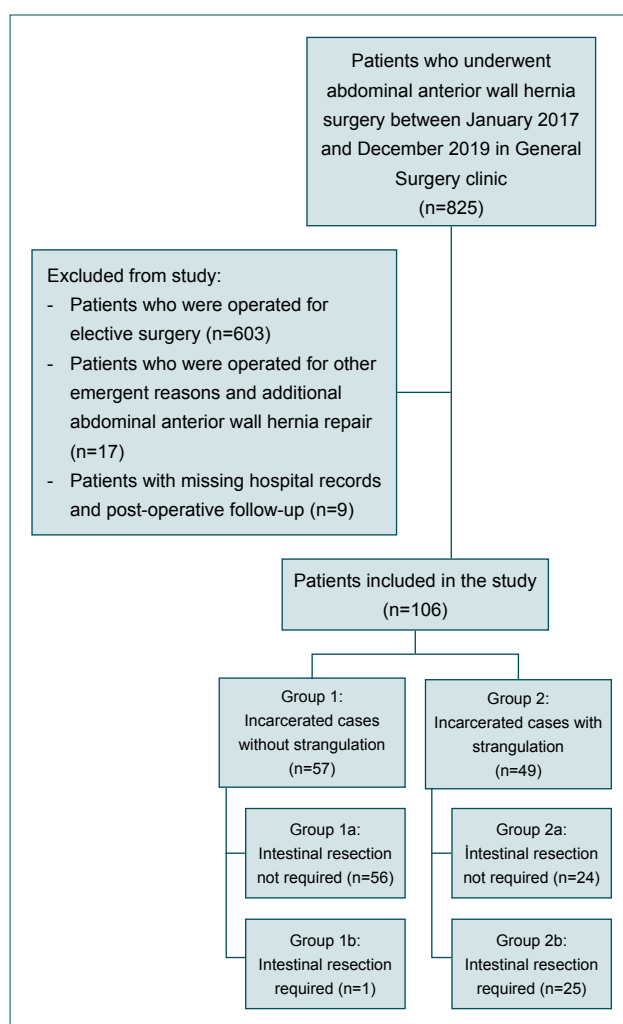


Figure 1. Study flow diagram.

(CAR), platelet to albumin ratio (PAR), platelet to lymphocyte ratio (PLR), and neutrophil to albumin ratio (NAR). Furthermore, the location of the hernia, the maximum defect size, and the presence of obstruction as well as strangulation on imaging were evaluated by examining the pre-operative abdominal and superficial ultrasonographies.

The patient population was divided into two groups according to the pre-operative findings during the emergency anterior abdominal wall hernia surgery. Group 1 consisted of cases with incarceration but without strangulation, whereas Group 2 consisted of cases with strangulation in addition to incarceration. Moreover, in evaluation for the requirement for intestinal resection, patient Group 2 was divided further into two groups, namely, as Group 2a and Group 2b, defining the need for intestinal resection.

This study was conducted in accordance with the fundamental ethical principles for medical research involving human subjects, as stated in the guidelines of World Medical Association Declaration of Helsinki and was approved by the Local Ethics Committee (March 11, 2021-2021/120).

Statistical Methods

This study was designed as a retrospective study. Continuous variables were defined by descriptive statistics (mean, median, minimum-maximum, and standard variation). Normal distribution of continuous variables was evaluated using the Kolmogorov–Simirnov and Shapiro–Wilks tests. Two groups of continuous variables that were normally distributed were compared with Student's t-test, whereas two groups that were not normally distributed were compared with Mann–Whitney U test. More than two groups of continuous variables that were not normally distributed were compared using the Kruskal–Wallis test. Dichotomous and categorical variables in two groups were compared with the Pearson Chi-square test. Fisher's exact test was used where appropriate. The evaluation of the correlation between nonparametric variables was performed using the Spearman's rank test and the strength of the correlation was determined and demonstrated according to the calculated Spearman's Rho values. The level of statistical significance was determined as 0.05. All analyses were performed using IBM SPSS Statistics® Statistical Software Program version 25 (IBM Corporation, 1 New Orchard Road, Armonk, New York, United States).

RESULTS

A total of 106 patients who had emergency anterior abdominal wall repair surgery due to incarcerated hernias were included in the study. The study population consisted of 45 (42.4%) males and 61 (57.6%) females with an overall median age of 63 (minimum-maximum: 20–94 years). Among all, inguinal hernias were the most common anterior abdominal wall defects observed ($n=41$, 38.6%). Group 1 study group, which consisted of cases with incarceration but without strangulation included 57 (53.7%) patients, whereas Group 2 study group that consisted of cases with strangulation in addition to incarceration included 49 (46.3%) patients.

The demographic and clinical characteristics of the patients are listed in Table 1. No significant differences could be found between the Group 1 and Group 2 patients in terms of age, gender, smoking habits, and the presence of comorbidities ($p=0.237$, $p=0.938$, $p=0.324$ and $p=0.560$, respectively, Table 2). Cardiac disease was the most common comorbidity in the study population, with 37 patients (34.9%) ($n=21$, 19.8% in Group 1 vs. $n=16$, 15.1% in Group 2). In contrast, 38 (35.8%) patients were found not to have any comorbidities. ($n=19$, 17.9% in group 1 vs. $n=19$, 17.9% in Group 2, Tables 1 and 2). Median Charlson comorbidity index point of the patients in Group 1 was 3 (0–6, Minimum-maximum), whereas the median Charlson comorbidity index point of the patients in Group 2 was 2 (0–6, Minimum-maximum). No statistically significant difference could be observed in terms of median Charlson comorbidity index points between the two patient groups ($p=0.166$, Table 2).

It was detected that the type of the surgical procedure (open or laparoscopic) and mesh usage did not differ significantly in both groups ($p=0.622$ and $p=0.163$, respectively), whereas the use of closed-suction drains was found to be more common in Group 2 ($p=0.002$). The distribution of inguinal and other hernias was also similar between the two groups ($p=0.080$, Table 3). Furthermore, there were not any significant differences between the two groups in terms of the presence of recurrence, reoperation, or local complications ($p=0.359$, $p=0.132$ and $p=0.545$, respectively), though it was determined that complications equal to or greater than Grade 2 according to Clavien-Dindo classification system were more common in group 2 ($p=0.001$). In addition, it was found out that Group 2 patients stayed significantly longer in the hospital ($p=0.009$, Table 3). Mortality was observed in only one patient in Group 1 over the whole course of the study.

The presence of pre-operative ultrasonographic findings concerning strangulation significantly determined the risk for finding signs of strangulation intraoperatively (Odds Ratio [OR] = 3.715, 95% confidence interval [CI]: 1.657–8.331, $p=0.001$). However, the presence of pre-operative sonographic findings of strangulation could not be able to dictate the risk for intestinal resection (OR=2.045, 95% CI: 0.834–5.018, $p=0.115$). Furthermore, patients with strangulation findings did not demonstrate significantly different defect sizes according to pre-operative imaging than those in patients without any strangulation findings ($p=0.720$, Table 2).

It was identified that pre-operative CRP levels, LDH levels, total and indirect bilirubin levels, lymphocyte counts, platelet counts, and albumin levels did not differ significantly between the patients without strangulation and those with strangulation ($p=0.255$, $p=0.314$, 0.756, $p=0.779$, $p=0.819$, $p=0.190$, and $p=0.736$, respectively). In contrast, pre-operative WBC and neutrophil counts were significantly higher in patients with strangulation (Group 2) ($p=0.004$ and $p=0.005$, respectively, Table 2).

The evaluation of the indices related to systemic inflammation revealed that LDH/WBC ratio was significantly lower but NPR and NAR ratios were significantly higher in patients with strangulation, showing the significance of those systemic inflammation indices in detecting strangulation ($p=0.027$, $p=0.035$ and $p=0.030$, respectively, Table 2). Moreover, the analysis of the patients in whom intestinal resection was required (Group 2a vs. 2b) exposed that NAR was significantly higher in the patients with intestinal resection ($p=0.036$, Table 4 and Fig. 2). The reason for intestinal resection in a patient without any strangulation was iatrogenic injury due to massive intra-abdominal adhesions.

DISCUSSION

The repair of anterior abdominal wall hernias is a vital part of both emergency and elective surgery. In addition, emergency

Table 1. Patient characteristics

	Group 1 n (%)		Group 2 n (%)		Total
	Male	Female	Male	Female	
Number of patients	24 (22.6)	33 (31.1)	21 (19.8)	28 (26.4)	106 (100)
Smoking habitus	8 (7.5)	3 (2.8)	5 (4.7)	1 (0.9)	17 (15.9)
Median age (years) (Min-Max)	61 (20–89)	69 (35–93)	62 (23–94)	57 (31–82)	
History of any comorbidities	13 (12.3)	25 (23.6)	12 (11.3)	18 (17.0)	68 (64.3)
Type of comorbidity					
Cardiac	8 (7.5)	13 (12.3)	7 (6.6)	9 (8.5)	37 (34.9)
Endocrine	2 (1.9)	4 (3.8)	2 (1.9)	7 (6.6)	15 (14.2)
Respiratory	3 (2.8)	1 (0.9)	1 (0.9)	1 (0.9)	6 (5.7)
Renal	0	1 (0.9)	2 (1.9)	0	3 (2.8)
Rheumatological	0	4 (3.8)	0	1 (0.9)	5 (4.7)
Malignancy	0	2 (1.9)	0	0	2 (1.9)
Charlson Comorbidity Index					
0	9 (8.5)	3 (2.8)	4 (3.8)	5 (4.7)	21 (19.8)
1	1 (0.9)	2 (1.9)	4 (3.8)	3 (2.8)	10 (9.4)
2	2 (1.9)	5 (4.7)	3 (2.8)	7 (6.6)	17 (16.0)
3	1 (0.9)	8 (7.5)	3 (2.8)	5 (4.7)	17 (16.0)
4	5 (4.7)	8 (7.5)	4 (3.8)	6 (5.7)	23 (21.7)
5	5 (4.7)	6 (5.7)	1 (0.9)	2 (1.9)	14 (13.2)
6	1 (0.9)	1 (0.9)	2 (1.9)	0	4 (3.8)
Mesh use	18 (17.0)	13 (12.3)	10 (9.4)	10 (9.4)	51 (48.1)
Drain use	7 (6.6)	12 (11.3)	12 (11.3)	19 (17.9)	50 (47.2)
Operation type					
Open	22 (20.8)	32 (30.2)	21 (19.8)	27 (25.5)	102 (96.2)
Laparoscopic	2 (1.9)	1 (0.9)	0	1 (0.9)	4 (3.8)
Hernia type					
Indirect inguinal	14 (13.2)	5 (4.7)	10 (9.4)	2 (1.9)	31 (29.2)
Direct inguinal	2 (1.9)	3 (2.8)	4 (3.8)	1 (0.9)	10 (9.4)
Pantaloon	1 (0.9)	0	0	0	1 (0.9)
Femoral	1 (0.9)	7 (6.6)	1 (0.9)	3 (2.8)	12 (11.3)
Umbilical	3 (2.8)	11 (10.4)	5 (4.7)	13 (12.3)	32 (30.2)
Epigastric	2 (1.9)	0	0	0	2 (1.9)
Spigelian	0	0	0	1 (0.9)	1 (0.9)
Obturator	0	0	0	1 (0.9)	1 (0.9)
Incisional	1 (0.9)	7 (6.6)	1 (0.9)	7 (6.6)	16 (15.1)
Hernia localization					
Inguinal	18 (17.0)	15 (14.2)	14 (13.2)	6 (5.7)	53 (50.0)
Non-inguinal	6 (5.7)	18 (17.0)	7 (6.6)	22 (20.8)	53 (50.0)
Recurrence	1 (0.9)	3 (2.8)	1 (0.9)	5 (4.7)	10 (9.4)
Reoperation	1 (0.9)	3 (2.8)	1 (0.9)	7 (6.6)	12 (11.3)
Side effects according to the Clavien-Dindo Classification System					
I	15 (14.2)	15 (14.2)	9 (8.5)	5 (4.7)	44 (41.5)
II	7 (6.6)	10 (9.4)	3 (2.8)	6 (5.7)	26 (24.5)
IIIa and IIIb	0	0	0	1 (0.9)	1 (0.9)
IVa and IVb	2 (1.9)	7 (6.6)	9 (8.5)	14 (13.2)	32 (30.2)
V	0	1 (0.9)	0	0	1 (0.9)
Presence of any local complications					
Seroma	1 (0.9)	2 (1.9)	0	0	3 (2.8)
Hematoma	0	0	0	1 (0.9)	1 (0.9)
Mesh reaction	0	0	0	0	0
Surgical site infection/abscess	2 (1.9)	3 (2.8)	2 (1.9)	6 (5.7)	13 (12.3)
Wound dehiscence	0	0	0	0	0
Pre-operative US finding of strangulation					
No strangulation	20 (18.9)	20 (18.9)	4 (3.8)	15 (14.2)	59 (55.7)
Strangulation	4 (3.8)	13 (12.3)	17 (16.0)	13 (12.3)	47 (44.3)
Intestinal resection requirement	0	1 (0.9)	11 (10.4)	14 (13.2)	26 (24.5)

Min: Minimum; Max: Maximum; US: Ultrasonography.

Table 2. Comparison of the pre-operative data between Group 1 and 2

	Group 1 (Median [Min-Max])	Group 2 (Median [Min-Max])	p-value
Median age (years) (Min-Max)	66 (20–93)	60 (23–94)	0.237
Gender			
Male	24	21	0.938
Female	33	28	
Smoking habitus			0.324
Present	11	6	
Absent	46	43	
Type of comorbidities			0.481
Cardiac	21	16	
Endocrine	6	9	
Respiratory	4	2	
Renal	1	2	
Rheumatological	4	1	
Malignancy	2	0	
History of comorbid diseases			0.560
Present	38	30	
Absent	19	19	
Charlson Comorbidity Index	3 (0–6)	2 (0–6)	0.166
Preoperative WBC count ($\times 10^3/\mu\text{l}$)	9000 (4500–20100)	11500 (4500–25660)	0.004
Pre-operative CRP levels (mg/dL)	16.64 (0.26–248.32)	15.97 (0.30–338.15)	0.255
Pre-operative LDH levels (IU/L)	222.5 (145.0–1241.0)	218.0 (116.0–518.0)	0.314
Pre-operative neutrophil count ($\times 10^3/\mu\text{l}$)	6500 (2900–17600)	8400 (3300–23710)	0.005
Pre-operative IBil levels (mg/dL)	0.56 (0.02–1.96)	0.53 (0.11–1.82)	0.779
Pre-operative lymphocyte count ($\times 10^3/\mu\text{l}$)	1700 (300–3400)	1700 (300–5000)	0.819
Pre-operative platelet count ($\times 10^6/\mu\text{l}$)	248 (127–487)	259 (100–489)	0.190
Pre-operative albumin levels (g/dL)	3.43 (1.99–4.84)	3.40 (2.06–4.94)	0.679
Pre-operative LAR	68.88 (36.93–256.41)	66.87 (34.96–189.45)	0.423
Pre-operative LDH/WBC	0.023 (0.000–0.124)	0.019 (0.006–0.053)	0.027
Pre-operative IBil/Albumin	0.154 (0.005–0.599)	0.172 (0.000–0.671)	0.684
Pre-operative LCR	88.63 (3.92–6538.46)	76.75 (2.66–4000.00)	0.451
Pre-operative NPR	0.027 (0.011–0.066)	0.033 (0.010–0.112)	0.035
Pre-operative NLR	3.64 (0.97–43.33)	4.82 (1.00–53.33)	0.096
Pre-operative CAR	4.58 (0.08–106.58)	5.72 (0.08–114.30)	0.308
Pre-operative PAR	71572.83 (28995.43–232663.32)	73756.51 (26595.75–204854.37)	0.273
Pre-operative PLR	150.00 (40.97–860.00)	147.92 (49.20–1055.00)	0.768
Pre-operative NAR	1828.50 (871.80–5577.89)	2466.54 (962.10–6504.07)	0.030
The maximum defect size according to pre-operative US (mm)	23 (6–60)	24 (9–100)	0.720
Pre-operative US finding of strangulation			0.001
No strangulation	40	19	
Strangulation	17	30	

Min: Minimum; Max: Maximum; US: Ultrasonography; mm: Millimeter; WBC: White blood cells; CRP: C-Reactive protein; LDH: Lactate dehydrogenase; IBil: Indirect bilirubin; LAR: LDH to Alb ratio; LDH/WBC: LDH to WBC ratio; IBil/Albumin: Indirect bilirubin to albumin ratio; LCR: Lymphocyte to CRP ratio; NPR: Neutrophil to platelet ratio; NLR: Neutrophil to lymphocyte ratio; CAR: CRP to albumin ratio; PAR: Platelet to albumin ratio; PLR: Platelet to lymphocyte ratio; NAR: Neutrophil to albumin ratio. Statistically significant results ($p < 0.05$) were written in bold format.

Table 3. Comparison of the intraoperative and post-operative data between Group 1 and 2

	Group I (Median [Min-Max])	Group I (Median [Min-Max])	p-value
Mesh use	31	20	0.163
Present	26	29	
Absent			0.002
Drain use	19	31	
Used	38	18	
None			
Requirement for intestinal resection			<0.001
Present	1	25	
Absent	56	24	
Operation type			0.622
Open	54	48	
Laparoscopic	3	1	
Localization of the hernia defect			0.080
Inguinal	33	20	
Non-inguinal	24	29	
Duration of hospitalization (days)	3 (1–18)	5 (1–31)	0.009
Recurrence	4/57	6/49	0.359
Re-operation	4/57	8/49	0.132
Side effects according to Clavien-Dindo Classification System			
No complication	0	2	
Class I	30	14	
Class II	17	9	
Class IIIa and IIIb	0	1	
Class IVa and IVb	9	23	
Class V	1	0	
Side effects according to Clavien-Dindo Classification System			0.001
Class 0-I-II	47	25	
Class >II	10	24	
Presence of local complications			
No local complications	49	40	
Seroma	3	0	
Hematoma	0	1	
Surgical site infection/abscess	5	8	
Presence of local complications			0.545
Absence	49	40	
Presence	8	9	

Min: Minimum; Max: Maximum. Statistically significant results ($p < 0.05$) were written in bold format.

inguinal hernia repairs are performed nearly as often as appendectomies.^[6] It was previously stated that similar to the situation in elective practice, the most common localization in emergency anterior abdominal wall hernias was the groin region.^[7,8] Accordingly, comparable results were obtained in

this study. Incarceration was suggested as the main indication in emergency hernia surgery, which could result in obstruction and strangulation. Therefore, patients might present with acute mechanical intestinal obstruction, necrosis, perforation, or intra-abdominal abscess, which might impose the resec-

Table 4. Comparison of the Group 2a (no need for intestinal resection) and Group 2b (intestinal resection performed) patients within the patients of Group 2 (strangulation) in terms of different ratios of pre-operative laboratory tests

	Group 2a	Group 2b	p-value
Pre-operative WBC count (x10 ³ /μl)	10950 (5200–25660)	12800 (4500–24480)	0.114
Pre-operative CRP levels (mg/dL)	12.20 (0.30–190.21)	69.30 (1.14–338.15)	0.201
Pre-operative LDH levels (IU/L)	211 (116–518)	219 (121–485)	0.828
Pre-operative neutrophil count (x10 ³ /μl)	7650 (3500–23710)	9700 (3300–21660)	0.089
Pre-operative IBil levels (mg/dL)	0.52 (0.22–1.13)	0.53 (0.11–1.82)	0.332
Pre-operative lymphocyte count (x10 ³ /μl)	1800 (500–4400)	1500 (300–5000)	0.347
Pre-operative platelet count (x10 ⁶ /μl)	257 (100–476)	273 (142–489)	0.562
Pre-operative albumin levels (g/dL)	3.51 (2.70–4.94)	3.31 (2.06–4.60)	0.283
Pre-operative LAR	62.39 (34.96–130.16)	67.37 (35.59–189.45)	0.570
Pre-operative LDH/WBC	0.02 (0.01–0.05)	0.02 (0.01–0.05)	0.444
Pre-operative IBil/Albumin	0.17 (0.00–0.41)	0.18 (0.03–0.67)	0.132
Pre-operative LCR	139.18 (7.41–4000.00)	28.04 (2.66–1975.61)	0.078
Pre-operative NPR	0.03 (0.02–0.11)	0.04 (0.01–0.10)	0.230
Pre-operative NLR	3.92 (1.91–20.88)	7.53 (1.00–53.33)	0.093
Pre-operative CAR	3.27 (0.08–51.41)	19.83 (0.33–114.30)	0.176
Preoperative PAR	72036.47 (26595.75–128648.65)	79301.75 (40000.00–204854.37)	0.403
Pre-operative PLR	137.16 (76.59–504.00)	196.15 (49.20–1055.00)	0.097
Pre-operative NAR	2255.44 (1282.05–6408.11)	2893.98 (962.10–6504.07)	0.036

Min: Minimum; Max: Maximum; US: Ultrasonography; mm: Millimeter; WBC: White blood cells; CRP: C-Reactive protein; LDH: Lactate dehydrogenase; IBil: Indirect bilirubin; LAR: LDH to albumin ratio; LDH/WBC: LDH to WBC ratio; IBil/Albumin: Indirect bilirubin to albumin ratio; LCR: Lymphocyte to CRP ratio; NPR: Neutrophil to platelet ratio; NLR: Neutrophil to lymphocyte ratio; CAR: CRP to albumin ratio; PAR: Platelet to albumin ratio; PLR: Platelet to lymphocyte ratio; NAR: Neutrophil to albumin ratio. Statistically significant results (p<0.05) were written in bold format.

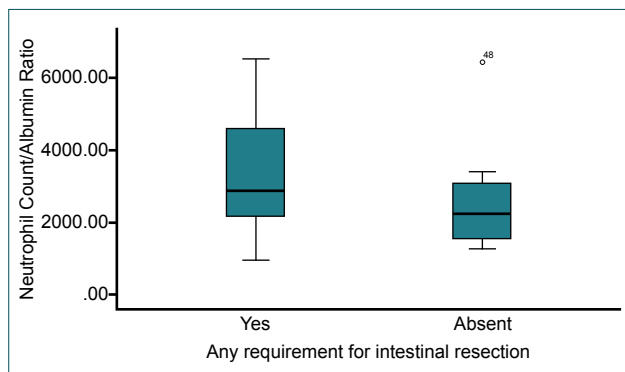


Figure 2. The distribution of NAR (Neutrophil to Albumin ratio) in patients with and without intestinal resection within patients in Group 2. The median levels are indicated as bold thick lines within each box-plot graph. The difference is statistically significant (p=0.036).

tion or excision of intra-abdominal structures.^[9] In this study, patients who underwent emergency anterior abdominal wall hernia repair surgery were operated with an indication of incarceration and they were grouped according to whether or not strangulation accompanied their pre-operative findings.

Sneiders et al.^[10] investigated the risk factors for incarceration in 4472 patients operated for primary anterior abdom-

inal wall and incisional hernias and indicated that age for primary hernias as well as age, female gender, and diabetes mellitus (endocrine disease) for incisional hernias were found to be associated with incarceration. Likewise, Simsek et al.^[11] questioned the factors affecting strangulation, necrosis, and mortality in incarcerated anterior abdominal wall hernia repair surgeries and argued that factors such as age, gender, comorbidity, hernia type, and lateralization did not influence strangulation, necrosis, or mortality. Correspondingly, the results of this study revealed that age, gender, or comorbidities were found not to associate with strangulation. The duration of pre-operative symptoms longer than 24 h was previously suggested to be a significant predictor of strangulation and necrosis.^[6] However, the duration of symptoms before surgery was neither registered nor analyzed in this manuscript, which could be regarded among the limitations of this study.

Yang^[12] proposed in a review article that laparoscopy was getting increasingly more common in emergency hernia repair, in accordance with the statement in this manuscript that the rate of laparoscopic surgery had increased especially in emergency inguinal hernia surgery. Furthermore, it was suggested that laparoscopy in emergency anterior abdominal wall surgery should only be performed in centers with immense

experience and without surgical equipment limitations. In this manuscript, however, it was denoted that there was no significant difference in laparoscopic technique between the two groups, though laparoscopic surgery was performed only in 4 (3.8%) patients in a series of 106 patients. That low number of laparoscopic surgeries reported in this manuscript might hinder any comparison between the open and laparoscopic techniques in emergency anterior abdominal wall hernia repair, which might be counted as another limitation of this study.

Abd Ellatif et al.^[13] previously claimed that mesh usage was safe in strangulated hernia repairs even in the event of an inevitable intestinal resection. However, the results of the present study did not reveal any statistically significant difference between the incarcerated cases without any intestinal resection and those with intestinal resection. Ergül et al.^[14] suggested in their study that closed-suction drains were used more often in emergency surgeries and that the use of those drains did not increase the risk of infections, though closed-suction drain use was associated with a longer hospital stay. However, Xourafas et al.^[15] stated that drain usage was not associated with increased morbidity or mortality. The results of the present study as well revealed that closed-suction drains were used more common in strangulated hernias.

It was repeatedly reported in a vast number of the previous studies that complications were more common in emergency hernia surgery. Similarly, it is widely accepted that local and systemic complications are more common in incarcerated cases accompanied by strangulation, which may result in longer hospital stays, recurrences, and reoperations.^[3,16] However, the rate of recurrences, reoperations, and local complications were found not to differ significantly between different patient groups in the present study, although post-operative surgical complications of Grade 2 or more according to Clavien-Dindo classification system were more common in patients with strangulation (Group 2).

Imaging findings such as the presence of free fluid, intestinal wall thickening, peristalsis, air echogenicity-density, and the size of the defect were suggested to aid in detecting strangulation. In addition, it was proposed in a number of the previous studies that US was more appropriate than CT for detecting strangulation in incarcerated cases.^[17,18] It was also suggested that although the size of the defect might play a role in the presence of an incarceration, it was not an independent risk factor for strangulation.^[18,19] The main imaging modality used in the present study was US, as well. Moreover, the results of the present study revealed that the rate of determining intraoperative sonographic findings of strangulation was higher in patients with pre-operative findings of strangulation, whereas pre-operative normal sonographic findings were associated with no intraoperative finding of strangulation ($p=0.001$) and the odds for a patient demonstrating pre-operative strangulation findings in US of being diagnosed intraoperatively for

strangulation is 3.715 (95% CI 1.657–8.331, $p=0.001$).

It was previously demonstrated in various studies that WBC and neutrophil counts were associated with ischemic bowel and increased bowel resection.^[20,21] Moreover, pre-operative platelet, lymphocyte, and neutrophil counts as well as albumin levels were shown to significantly differ in predicting surgical site infections in a study group with patients suffering from groin hernias repaired with meshes.^[22] Although neutrophil and WBC counts were demonstrated to significantly associate with strangulation in the present study, no other pre-operative blood tests differed significantly between the two patient groups (group 1 vs. group 2).

Zhou et al.^[23] reported that NLR was the most suitable index for detecting strangulation in a retrospective series of 263 patients. Similarly, Yildirim et al.^[24] indicated that LCR and NLR were significant in the prediction of both intestinal ischemia and resection in strangulated anterior abdominal wall hernias. While Zhuo et al.^[22] suggested NLR and PLR as predictive indices in emergency groin hernia surgery, their findings failed to demonstrate any significantly predictive value for the lymphocyte to monocyte ratio (LMR). Ikeguchi et al.^[25] indicated that both CAR and NLR were significantly associated with operative morbidity and mortality in emergency ileus cases with bowel strangulation. Although any analysis of LAR has not yet been reported in the current emergency hernia surgery literature, its value was previously demonstrated as a parameter that affected mortality in severe infections requiring intensive care.^[26] Other indices were also shown to associate with either disease diagnosis, clinical outcomes, morbidity, or mortality in various previous studies, such as the NPR in cardiac emergencies, IBil/Albumin in neurological and neonatal emergencies, LDH/WBC in systemic inflammation and the prognosis of Coronavirus disease-19, PAR in cancers of especially the hepatobiliary system, and NAR in sepsis and septic shock.^[27–32] The results of the present study revealed that among the indices commonly used as indicators of systemic inflammation in various diseases LDH/WBC, NPR and NAR were significantly associated with strangulation in emergency anterior abdominal wall hernias.

In addition to not specifying the duration of pre-operative symptoms, single imaging technique (US) used for the evaluation and the inability to access some patient data, the retrospective, single-center, and non-randomized design with limited number of patients in a limited study time frame may comprise other limitations of the present study. Growing but yet scarce number of studies in the present literature evaluating indices as systemic inflammatory indicators or the fact that their analyses were in fields other than surgical emergencies could also be counted among other limitations. Nevertheless, it should not be neglected that studies evaluating the potential use of indices of systemic inflammation are currently at their infancy and only a minute portion of current literature includes such studies.

Conclusion

Strangulation and ultimately intestinal resection are two serious conditions that may influence operative morbidity and mortality. In addition to US as a valuable diagnostic tool and WBC counts as well as neutrophil counts as significant pre-operative blood tests, indices of systemic inflammation such as LDH/WBC, NPR and particularly NAR may be potentially beneficial to prevent complications and improve clinical outcomes in emergency hernia surgery.

Ethics Committee Approval: This study was approved by the University of Health Sciences, Gülhane Scientific Research Ethics Committee (Date: 11.03.2021, Decision No: 2021/120).

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ORJİNAL ÇALIŞMA - ÖZ

Acil karın ön duvarı fitiği cerrahisinde strangüstasyon ve intestinal rezeksiyon prediktörlerinin değerlendirilmesi ve klinik önemi

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AMAÇ: Acil karın ön duvarı fitiği cerrahisi, acil genel cerrahi pratiğinde çok önemli bir rol oynamaktadır. Bu çalışmada, hastalarda strangüstasyon ve intestinal rezeksiyonun tanınmasında laboratuvar ve görüntüleme bulgularının yanı sıra demografik bilgilerinin ve komorbiditelerinin prediktif değeri araştırıldı.

GEREÇ VE YÖNTEM: Bu geriye dönük kohort çalışmasına, Ocak 2017 ve Aralık 2019 tarihleri arasında acil karın ön duvarı fitiği ameliyatı endikasyonu ile üçüncü basamak bir hastanede ameliyat edilen 18 yaş üstü hastalar alındı. Hasta popülasyonu acil karın ön duvarı fitiği operasyonunda peroperatif bulgulara göre iki gruba ayrıldı. Birinci grup, inkarsere ancak strangüle olmamış olgulardan, ikinci grup ise inkarsereyona ek olarak strangüle olgulardan oluşturuldu. Ayrıca intestinal rezeksiyon gereksiniminin varlığına göre grup (1 veya 2)a ve grup (1 veya 2)b olmak üzere iki grup daha oluşturuldu.

BULGULAR: İnkarsere fitik nedeniyle acil karın ön duvarı onarımı yapılan toplam 106 hasta çalışmaya dahil edildi. Sistemik inflamasyonla ilgili indekslerin değerlendirildiğinde strangüle hastalarda laktat dehidrojenaz/lökosit oranının anlamlı olarak daha düşük olduğu, ancak nötrofil/platelet oranı ve nötrofil/albumin oranlarının anlamlı olarak daha yüksek olduğu gözlemlendi ve bu sistemik inflamasyon indekslerinin strangüstasyonu tespit etmedeki önemini gösterdi (sırasıyla $p=0.027$, $p=0.035$ ve $p=0.030$). Ayrıca intestinal rezeksiyon gereken hastalar analiz edildiğinde intestinal rezeksiyon yapılan hastalarda Nötrofil/Albumin oranının anlamlı olarak daha yüksek olduğunu saptandı ($p=0.036$).

TARTIŞMA: Laktat dehidrojenaz/lökosit oranı, nötrofil/platelet oranı ve özellikle nötrofil/albumin oranı gibi sistemik inflamasyon indeksleri, acil fitik cerrahisinde komplikasyonları önlemek ve klinik sonuçları iyileştirmek için faydalı olma potansiyeli taşımaktadır.

Anahtar sözcükler: Acil karın ön duvarı herni cerrahisi; intestinal rezeksiyon; prediktörler; strangüstasyon.

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