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Risk factors for bowel resection and postoperative complications in incarcerated abdominal wall hernia

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ABSTRACT

Objective: Timely identification of the risk of bowel resection is crucial for improving surgical outcomes in incarcerated hernias. Preoperative recognition of risk factors can improve postoperative recovery and patient safety. This study aims to investigate the predictors of bowel resection and postoperative complications in patients undergoing surgery for incarcerated abdominal wall hernias.

Material and Methods: A single-center retrospective analysis was performed on patients who underwent surgery for incarcerated abdominal wall hernia between January 2017 and January 2022. Multivariate logistic regression was performed to determine risk factors for bowel resection, postoperative complications, and mortality. A p-value of <0.05 was considered statistically significant.

Results: A total of ninety-two patients were detected. Mean age was 66.1±14.5 years and the 76 (82.6%) of the patients were male. Bowel resection was associated with symptom duration, higher platelet count, higher neutrophil to lymphocyte and platelet to lymphocyte ratio (p=0.014, p=0.040, p=0.042, p=0.015). Postoperative hospital stay was longer and postoperative mortality was higher in patients who underwent bowel resection (p<0.001, p=0.013). No risk factors for bowel resection or mortality were identified. Symptom duration and bowel resection were found to be risk factors for postoperative complications [odds ratio (OR): 1.713, 95% confidence interval (CI): 1.093-2.686; p=0.019] (OR: 4.655, 95% CI: 1.230-17.613; p=0.023).

Conclusion: Although no specific risk factors for bowel resection or mortality have been identified, symptom duration and bowel resection may be considered risk factors for postoperative complications in these patients. Furthermore, hernia sac fluid is not a risk factor for bowel resection.

Keywords: Abominal wall hernia, incarceration, bowel resection, fluid in hernia sac

INTRODUCTION

Abdominal wall hernia (AWH) repairs are among the most frequently performed elective and emergency surgical procedures worldwide. Incarceration occurs in 5-15% of cases, and 15% require bowel resection due to strangulation (1). Emergency surgical interventions for incarceration can reveal incarceration or perforation, necessitating bowel resection and increasing the risks of morbidity and mortality. Early intervention and risk stratification are critical for improving outcomes. Some of the reported risk factors include female gender, advanced age, serious comorbidities, delayed hospitalization and femoral hernia (2,3). Identifying risk factors before surgery can help predict postoperative complications and facilitate safer recovery. In light of these circumstances, we designed a study to identify preoperative predictors of bowel resection and postoperative complications of incarcerated AWH to guide clinical decision-making.

MATERIAL and METHODS

This single-center retrospective cohort study analyzed patients who underwent surgery for incarcerated AWH between January 2017 and January 2022. After ethical approvals were obtained, patients presenting to the emergency department were identified from the hospital electronic database. This study was conducted retrospectively and approved by the Local Ethics Committee of University of Health Sciences Türkiye, İzmir Tepecik Education and Research Hospital (approval number: 2022/06-35, date: 15.06.2022). Inclusion criteria included adults (>18 years of age) with complete medical records, while exclusion criteria were incomplete data, ascites-related comorbidities (e.g., cirrhosis, congestive heart failure), and pediatric cases. Data collection included descriptive parameters (age, gender), laboratory findings [complete blood count (CBC), C-reactive protein, albumin, lactate levels],

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preoperative findings of the hernia [hernia type, size, hernia sac fluid (HSF), symptom duration], perioperative findings (bowel resection, mesh application), and postoperative findings (hospital stay, complications and mortality). During the preoperative evaluation, the time from the onset of the patient's pain to the operation was recorded as symptom duration. Other vital signs could not be obtained retrospectively. On physical examination, all patients had pain in the area of the incarcerated hernia. Only polypropylene mesh, which had to be shaped and fixed by the surgeon, was used. The use of mesh was left to the surgeon's experience and discretion during the operation. Postoperative complications were categorized as surgery-related complications (e.g., wound infection, hematoma, seroma, ileus, anastomotic leak) and systemic complications (e.g., pneumonia, urinary tract infection, thromboembolic events). Mortality was defined as death between surgery and hospital discharge. HSF was defined as any measurable fluid detected on computed tomography (CT) scans. After descriptive statistics, patients were divided into groups according to the presence of HSF and bowel resection. The associations of parameters with these two findings were examined. Additionally, multivariate analysis was performed to investigate risk factors for bowel resection, postoperative complications, and mortality.

Statistical Analysis

SPSS version 25.0 software was used for statistical analysis. Kolmogorov-Smirnov/Shapiro-Wilk tests were used for the conformity of the variables to the normal distribution. While mean ± standard deviation was given for normally distributed variables, median (Q1-Q3) was stated for non-normally distributed variables. For comparing the continuous data in binary group, t-test was used for independent and normally distributed, and the Mann-Whitney U for not normally distributed values. Categorical data analysis were done with using Pearson's chi-square or Fisher's exact chi-square test. Independent factors were detected by using multivariate logistic regression analysis. In determination of parameters for multivariate analysis, modeling was performed considering clinical relevance and relationships of univariate parameters. To reduce concerns about overfitting, auxiliary variables were reduced using backward elimination. Model calibration was tested with the Hosmer-Lemeshow goodness-of-fit test. Furthermore, model performance was evaluated using ROC curves, and the area under the curve (AUC) was calculated based on predicted probabilities obtained from the logistic regression model. Odds ratio (OR) and 95% confidence intervals (CIs) were also given for each variable in multivariate analysis. $p<0.05$ was considered statistically significant.

RESULTS

A total of ninety-two patients were detected. The mean age was 66.1±14.5 years and the 76 (82.6%) of the patients were male. Among the incarcerated AWH, inguinal hernia was detected in 77 (83.7%) patients, incisional hernia in 7 (7.6%) patients, femoral hernia in 7 (7.6%) patients and umbilical hernia in 1 (1.1%) patient. The median duration of symptom onset until hospitalization was 1.5 (1-2.8) days. All surgeries were performed using the open surgical approach. Preoperative imaging revealed HSF in 32 (34.8%) patients. Intestinal resection was performed in 18 (19.6%) patients, and omentectomy was performed in 12 (13%) patients. A polypropylene mesh of the required size was applied to 69 (75%) patients. The median postoperative hospital stay was 3 (2-5) days. Postoperative complications were detected in 18 (19.6%) patients, and postoperative mortality was observed in 9 (9.8%) patients. Postoperative surgery-related complications included surgical site infection in 5 patients, hematuria in 2 patients, evisceration in 2 patients and ileus in 1 patient. Systemic complications included pneumonia in 2 patients, acute renal failure in 3 patients, sepsis in 1 patient and myocardial infarction in 2 patients. Other CBC results are detailed in Table 1.

Although the age was higher in patients with HSF and those who underwent bowel resection, the difference was not statistically significant. HSF was associated only with preoperative platelet count ($p=0.037$) (Table 1). The presence of bowel resection was associated with longer symptom duration, higher platelet count, higher neutrophil/lymphocyte ratio (NLR) and higher platelet/lymphocyte ratio (PLR) ($p=0.014$, $p=0.040$, $p=0.042$, $p=0.015$). Additionally, mesh placement was not preferred and the postoperative complication rate was higher in patients who underwent bowel resection ($p<0.001$, $p=0.001$). Patients who underwent bowel resection had a longer postoperative hospital stay and a higher postoperative mortality rate ($p<0.001$, $p=0.013$) (Table 2).

After crosstabs, multivariate analysis was performed to observe risk factors for bowel resection, postoperative complications and mortality. The performance of the models was evaluated using both ROC analysis and the Hosmer-Lemeshow test. None of the parameters were detected as a risk factor for bowel resection and postoperative mortality (Tables 3, 4). For the bowel resection model, ROC analysis showed an AUC of 0.736 (95% CI: 0.611-0.862) ($p=0.002$), the Hosmer-Lemeshow test showed $\chi^2=11.07$, $df=8$, $p=0.198$. For the mortality model, ROC analysis showed an AUC of 0.854 (95% CI: 0.712-0.997) ($p=0.001$), the Hosmer-Lemeshow test showed $\chi^2=8.99$, $df=8$, $p=0.343$. Among the parameters related to postoperative complications, duration of symptoms and bowel resection were found to be risk factors (OR 1.713, 95% CI 1.093-2.686; $p=0.019$) (OR 4.655, 95% CI 1.230-17.613; $p=0.023$) (Table 5). For postoperative complications model, the ROC analysis showed an AUC of 0.793 (95% CI: 0.659-0.926) ($p<0.001$), the Hosmer-Lemeshow test showed $\chi^2=3.14$, $df=8$, $p=0.926$.

Table 1. Factors associated with hernia sac fluid in incarcerated abdominal wall hernia

	All patients n=92	Without fluid in hernia sac n=60	With fluid in hernia sac n=32	p-value
Age, mean ± SD	66.1±14.5	65.1±15.2	68.2±13.1	0.332
Sex, n (%)				0.802
Male	76 (82.6)	50 (83.3)	26 (81.3)	
Female	16 (17.4)	10 (16.7)	6 (18.8)	
Type of hernia, n (%)				0.549
Inguinal	77 (83.7)	49 (81.7)	28 (87.5)	
Incisional	7 (7.6)	6 (10)	1 (3.1)	
Umbilical	1 (1.1)	1 (1.7)	0	
Femoral	7 (7.6)	4 (6.7)	3 (9.4)	
Duration of symptom, day, median (Q1-Q3)	1.5 (1-2.8)	1.5 (1-3)	1.5 (1-2)	0.797
WBC, median (Q1-Q3)	11000 (7400-14600)	10500 (7475-14225)	12050 (6525-17125)	0.354
Neutrophil, median (Q1-Q3)	8300 (5525-11500)	8300 (5650-10900)	8600 (4525-12900)	0.752
Lymphocyte, median (Q1-Q3)	1400 (900-2100)	1200 (825-2100)	1500 (950-2150)	0.319
Platelet, median (Q1-Q3)	251500 (205750-328500)	270000 (208750-362000)	237000 (190750-275250)	**0.037**
NLR, median (Q1-Q3)	6.83 (3.01-10.84)	6.83 (3.69-10.73)	6.83 (2.39-12.28)	0.544
PLR, median (Q1-Q3)	177.8 (116.1-363.1)	224.7 (125.6-397.4)	161.1 (103.3-269.3)	0.060
Fluid in hernia sac, n (%)	32 (34.8)			
Bowel resection, n (%)	18 (19.6)	10 (16.7)	8 (25)	0.337
Omentectomy, n (%)	12 (13)	8 (13.3)	4 (12.5)	1.000*
Mesh use, n (%)				0.312
Yes	69 (75)	47 (78.3)	22 (68.8)	
No	23 (25)	13 (21.7)	10 (31.3)	
Postoperative hospital stay, day, median (Q1-Q3)	3 (2-5)	3 (2-5)	3.5 (2-5.8)	0.463
Surgery-related complications, n (%)	10 (10.9)	7 (11.7)	3 (9.4)	1.000*
Systemic complications, n (%)	8 (8.7)	4 (6.7)	4 (12.5)	0.442*
Postoperative mortality, n (%)	9 (9.8)	4 (6.7)	5 (15.6)	0.268*

*: Fisher's exact test was used, SD: Standard deviation, WBC: White blood cell, NLR: Meutrophil/lymphocyte ratio, PLR: Platelet/lymphocyte ratio.

DISCUSSION

Incarcerated AWH remains a critical surgical emergency with high morbidity and mortality rates. Obstruction or strangulation may occur as a result of incarceration and these patients may require bowel resection. It is important to identify patients who can undergo bowel resection due to longer hospital stays and higher postoperative complications (4,5). A meta-analysis by Chen et al. (6) reported that female gender, older age, bowel obstruction, duration of incarceration, white blood cell count and neutrophilic leukocyte count were risk factors for bowel resection. Another study by Ge et al. (3) identified femoral hernia, peritonitis and lack of health insurance as risk factors in patients undergoing bowel resection for incarcerated inguinal hernia. Furthermore, some studies have reported a relationship between NLR and PLR values and bowel resection in incarcerated hernias (7). In our study, 18 patients (19.6%) underwent bowel resection due to strangulation or perforation. Although we found symptom duration, platelet count, NLR and PLR to be associated with bowel resection in patients undergoing surgery for incarcerated AWH, none of these parameters were found to be a risk factor for bowel resection in multivariate analysis. However, similar to the literature, bowel resection was associated with longer hospital stay, postoperative complications and mortality. Furthermore, consistent with the literature, femoral hernias were the hernia subgroup requiring the highest rate of bowel resection. Although femoral hernias represent a smaller proportion of cases, their clinical significance is considerable because of the higher risk of strangulation. Many studies have shown that femoral hernia is associated with bowel resection in patients. Although Ge et al. (3) identified femoral hernia as a

Table 2. Factors associated with bowel resection in incarcerated abdominal wall hernia

	All patients n=92	Without bowel resection n=74	With bowel resection n=18	p-value
Age, mean ± SD	66.1±14.5	66.1±13.6	73.3±13.4	0.051
Sex, n (%)				0.077*
Male	76 (82.6)	64 (86.5)	12 (66.7)	
Female	16 (17.4)	10 (13.5)	6 (33.3)	
Type of hernia, n (%)				0.072
Inguinal	77 (83.7)	64 (86.5)	13 (72.2)	
Incisional	7 (7.6)	6 (8.1)	1 (5.6)	
Umbilical	1 (1.1)	1 (1.4)	0	
Femoral	7 (7.6)	3 (4.1)	4 (22.2)	
Duration of symptom, day, median (Q1-Q3)	1.5 (1-2.8)	1 (1-2)	2 (1-3.3)	**0.014**
WBC, median (Q1-Q3)	11000 (7400-14600)	10550 (7175-14400)	11500 (9275-16100)	0.376
Neutrophil, median (Q1-Q3)	8300 (5525-11500)	7850 (5200-11100)	9500 (6950-12675)	0.202
Lymphocyte, median (Q1-Q3)	1400 (900-2100)	1400 (900-2225)	1400 (475-1800)	0.207
Platelet, median (Q1-Q3)	251500 (205750-328500)	247500 (201750-321750)	286000 (241500-480750)	**0.040**
NLR, median (Q1-Q3)	6.83 (3.01-10.84)	6.19 (2.66-10.66)	8.63 (5.64-20.17)	**0.042**
PLR, median (Q1-Q3)	177.8 (116.1-363.1)	171 (108.6-325)	291.3 (139.9-706.7)	**0.015**
Fluid in hernia sac, n (%)	32 (34.8)	24 (32.4)	8 (44.4)	0.337
Mesh use, n (%)				**<0.001***
Yes	69 (75)	63 (85.1)	6 (33.3)	
No	23 (25)	11 (14.9)	12 (66.7)	
Postoperative hospital stay, day, median (Q1-Q3)	3 (2-5)	3 (2-4)	7 (5-11.3)	**<0.001**
Surgery-related complications, n (%)	10 (10.9)	4 (5.4)	6 (33.3)	**0.003***
Systemic complications, n (%)	8 (8.7)	5 (6.8)	3 (16.7)	0.186
Postoperative mortality, n (%)	9 (9.8)	4 (5.4)	5 (27.8)	**0.013***

*: Fisher's exact test was used, SD: Standard deviation, WBC: White blood cell, NLR: Meutrophil/lymphocyte ratio, PLR: Platelet/lymphocyte ratio.

Table 3. Risk factors for bowel resection

	Univariate analysis		Multivariate analysis	
Variables for resection	**Odds ratio (95% CI)**	**p-value**	**Odds ratio (95% CI)**	**p-value**
Age	**1.051 (1.007-1.096)**	**0.023**	1.030 (0.983-1.080)	0.207
Female sex	3.200 (0.978-10.468)	0.054	-	-
Inguinal hernia	0.406 (0.119-1.387)	0.151	-	-
Duration of symptom	**1.380 (1.011-1.884)**	**0.043**	1.149 (0.816-1.616)	0.427
NLR	1.038 (0.997-1.081)	0.067	-	-
PLR	**1.003 (1.001-1.005)**	**0.008**	1.002 (1.000-1.004)	0.094
Fluid in hernia sac	1.667 (0.584-4.760)	0.340	-	-

NLR: Meutrophil/lymphocyte ratio, PLR: Platelet/lymphocyte ratio, CI: Confidence interval.

Table 4. Risk factors for postoperative mortality

	Univariate analysis		Multivariate analysis	
Variables for mortality	**Odds ratio (95% CI)**	**p-value**	**Odds ratio (95% CI)**	**p-value**
Age	1.061 (0.999-1.127)	0.053	-	-
Female sex	**4.733 (1.110-20.181)**	**0.036**	2.847 (0.371-21.857)	0.314
Inguinal hernia	0.650 (0.121-3.485)	0.615	-	-
Duration of symptom	**1.467 (1.040-2.070)**	**0.029**	1.201 (0.743-1.943)	0.454
NLR	**1.071 (1.016-1.129)**	**0.010**	1.035 (0.985-1.089)	0.175
PLR	**1.004 (1.001-1.006)**	**0.004**	1.002 (0.999-1.005)	0.225
Fluid in hernia sac	2.593 (0.644-10.437)	0.180	-	-
Bowel resection	**6.731 (1.592-28.462)**	**0.010**	1.194 (0.123-11.598)	0.879
Omentectomy	0.000 (0.000-.)	0.999	-	-
Mesh use	**0.222 (0.054-0.912)**	**0.037**	0.395 (0.052-3.008)	0.370

NLR: Meutrophil/lymphocyte ratio, PLR: Platelet/lymphocyte ratio, CI: Confidence interval.

Table 5. Risk factors for postoperative complications

	Univariate analysis		Multivariate analysis	
Variables for complication	**Odds ratio (95% CI)**	**p-value**	**Odds ratio (95% CI)**	**p-value**
Age	1.019 (0.982-1.058)	0.323	-	-
Female sex	3.200 (0.978-10.468)	0.054	-	-
Inguinal hernia	0.406 (0.119-1.387)	0.151	-	-
Duration of symptom	**2.000 (1.305-3.065)**	**0.001**	**1.713 (1.093-2.686)**	**0.019**
NLR	1.027 (0.990-1.066)	0.157	-	-
PLR	**1.003 (1.001-1.005)**	**0.013**	1.001 (0.999-1.003)	0.403
Fluid in hernia sac	1.247 (0.431-3.611)	0.684	-	-
Bowel resection	**7.222 (2.270-22.979)**	**0.001**	**4.655 (1.230-17.613)**	**0.023**
Omentectomy	0.337 (0.041-2.796)	0.314	-	-
Mesh use	0.433 (0.145-1.299)	0.135	-	-

NLR: Meutrophil/lymphocyte ratio, PLR: Platelet/lymphocyte ratio, CI: Confidence interval.

risk factor, many of the remaining studies have found only an association (1,2,6). Femoral hernias are generally considered less common and, therefore, it is difficult to detect a statistical difference. However, considering the anatomy of femoral hernia, it may be associated with bowel resection. Our findings are consistent with previous reports emphasizing early surgical intervention in this subgroup. However, the small number of femoral hernias in our series precludes definitive conclusions, and we consider this a limitation. Patients who underwent bowel resection were older, but this was not statistically significant. HSF, previously associated with surgical site infections (8), did not predict resection in our study.

Mortality and morbidity rates in incarcerated AWH have been reported to be approximately 5% and 20-30%, respectively. In our study, postoperative complication and mortality rates were 19.6% and 9.8%, respectively. Symptom duration and bowel resection were found to be risk factors for postoperative complications, but no risk factor was found for mortality. The logistic regression model demonstrated acceptable calibration and good discriminative ability. These findings support the robustness of our multivariate analysis despite the limited number of events.

Another issue in these patients is the use of mesh during hernia repair. While some advocate avoiding the use of mesh in contaminated cases (9), others support its safety in emergency situations (10,11). Furthermore, Loftus et al. (8) reported HSF as a predictive factor for surgical site infection in patients undergoing mesh repair for acutely incarcerated ventral and inguinal hernias. In our study, surgeons appeared to prefer mesh use more in patients undergoing bowel resection and HSF, but no statistical difference was found. Furthermore, mesh use was not identified as a risk factor for postoperative mortality or postoperative complications.

Study Limitations

This study has several limitations. First, the retrospective and single-center nature of the study limits its generalizability to other populations and may have affected the power to detect statistically significant risk factors. Second, our study lacked more specific parameters such as the amount or density of HSF. However, the presence or absence of fluid on CT findings was consistently reported by all patients.

CONCLUSION

Our study did not identify any risk factors for bowel resection. However, symptom duration, platelet count, NLR, and PLR may be associated with bowel resection. HSF was not identified as a risk factor. Furthermore, bowel resection prolongs the length of hospital stay and increases postoperative complications and mortality in patients undergoing surgery for incarcerated AWH. Duration of symptoms and bowel resection should be considered risk factors for postoperative complications. Randomized controlled trials in larger populations are needed to identify risk factors for bowel resection.

Ethics

Ethics Committee Approval: This study was conducted retrospectively and approved by the Local Ethics Committee of University of Health Sciences Türkiye, İzmir Tepecik Education and Research Hospital (approval number: 2022/06-35, date: 15.06.2022).

Informed Consent: Informed consent was not provided by the patients as this was a retrospective study.

Footnotes

Author Contributions

Concept - G.K.T., K.T., B.S., M.Ü.; Design - G.K.T., K.T., B.S., M.Ü.; Data Collection or Processing - G.K.T.,, B.S.; Analysis or Interpretation - K.T., M.Ü.; Literature Search - G.K.T., B.S.; Writing - G.K.T., K.T., M.Ü.

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