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Neutrophil-to-Lymphocyte Ratio Predicts the Severity of Incarcerated Groin Hernia

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Background: The incarceration of a segment of bowel within a groin hernia can result in intestinal strangulation if hernia treatment is delayed. Once intestinal strangulation occurs, a bowel resection may be required, and there is an overall increased risk for postoperative complications. The aim of this study was to identify biomarkers to predict the severity of an incarcerated groin hernia.





Material/Methods: We retrospectively evaluated the records of 95 patients with incarcerated groin hernias who underwent emergency surgical correction of the hernias. The need for a bowel resection was regarded as an indicator of severity in incarcerated groin hernia patients. The patients were divided into 2 groups: patients with bowel resection surgery and patients without bowel resection surgery.

Results: We discovered that leukocyte count (leukocyte count $\geq 10 \times 10^3/\text{mm}^3$), neutrophil-to-lymphocyte ratio (NLR, $\text{NLR} \geq 11.5$), presentation of bowel obstruction, and duration of incarceration (duration of incarceration ≥ 26 h) were significantly associated with bowel resection in incarcerated groin hernia patients by using the chi-square test. Factors such as leukocyte count, NLR, presentation of bowel obstruction, and duration of incarceration were analyzed using multivariate logistic regression analysis. We found that NLR, presentation of bowel obstruction, and duration of incarceration were independently and significantly related to bowel resection in incarcerated groin hernia patients.

Conclusions: An elevated NLR can serve as a biomarker for the prediction of severity of incarcerated groin hernias. Additionally, incarcerated groin hernia patients who present with bowel obstruction or with duration of intestinal incarceration longer than 26 h have an increased risk for bowel resection.

MeSH Keywords: **General Surgery • Hernia • Lymphocytes • Neutrophils**

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Background

Groin hernia surgery is a common general surgery procedure. When hernia surgery is performed as an elective procedure, it is managed better and carries a lower morbidity and mortality risk than emergency hernia surgery. Once intestinal incarceration occurs, the incarceration may evolve into intestinal strangulation and the hernia content can quickly become ischemic, increasing the need for intestinal resection. As a result, when presented with an incarcerated groin hernia at our hospital, we initiate an emergency hernia surgery. Kurt et al. [1] reported that bowel resection was required in approximately 15% of all patients with an incarcerated groin hernia, and the rate of bowel resection was higher in incarcerated femoral hernias than in other types of incarcerated groin hernias. Alvarez et al. [2] reported that intestinal strangulation accounted for 57% of femoral hernia, and 41% of the patients with intestinal strangulation required a bowel resection, which carries a 33% morbidity rate and a 7% mortality rate. Dahlstrand et al. [3] also reported that bowel resections that resulted from strangulated femoral hernias had increased morbidity and mortality rates. Performing a bowel resection during surgery indicates that the incarcerated bowel was necrotic. Few studies have reported whether certain biomarkers can predict the severity of incarcerated groin hernias. The aim of this study was to identify biomarkers to predict the severity of incarcerated groin hernias.

Material and Methods

Patients and data collection

We collected data from 95 patients with incarcerated groin hernias who underwent emergency hernia surgery between January 2013 and February 2017 at the Department of Gastroenterology, First People's Hospital of Zun Yi, Guizhou Province, China. The permission to use the patients' clinical data was granted by the First People's Hospital of Zun Yi.

All the patients had blood analysis, plain abdominal radiographs, and abdominal ultrasonography, or a computer tomography scan performed immediately upon presentation. All the patients presented with a palpable lump in the groin area during their physical examination. Once the patient was diagnosed with an incarcerated groin hernia, the emergency hernia surgery was initiated.

Table 1 summarizes the patients' clinicopathologic data, which included sex, age, body mass index (BMI), leukocyte count, neutrophil count, NLR (calculated as the neutrophil count divided by the lymphocyte count), platelet count, type of hernia, bowel obstruction, and duration of incarceration.

The need for a bowel resection during surgery was regarded as an indicator of severity in the incarcerated groin hernia patients. The patients were divided into 2 groups: patients with bowel resection surgery and patients without bowel resection surgery.

The receiver operating characteristic (ROC) curve for determination best cutoff values of continuous variables

Age, BMI, leukocyte count, neutrophil count, NLR, platelet count, and duration of incarceration were calculated as the best cutoff values by the ROC curve. ROC curve analysis showed that the area under the ROC curve for NLR was 0.714. When the NLR value was 11.5, the Youden index was maximal. Therefore, the cutoff value of NLR was set at 11.5. The cutoff values for the other continuous variables were calculated in a similar fashion. The cutoff values of age, BMI, leukocyte count, neutrophil count, platelet count, and duration of incarceration were 70 years, 26 kg/m², 10×10³/mm³, 8.0×10³/mm³, 210×10⁴/mm³, and 26 h, respectively.

Statistical analysis

ROC curve analysis was used to determine cutoff values for age, BMI, leukocyte count, neutrophil count, NLR, platelet count, and duration of incarceration. The best cutoff values were selected according to the maximal Youden index. The mean values of the parametric continuous variables were compared using the independent two-sample *t* test. The clinicopathological characteristic differences of the 2 groups were compared using the chi-square test. The multivariate logistic regression analysis by enter method was used to identify the significant factors related to intestinal incarceration resulting in bowel resection surgery. All statistical analyses were performed with SPSS version 17.0 (Chicago, IL). Throughout our analysis, *p* values <0.05 were considered to be statistically significant.

Results

A total of 95 patients with incarcerated groin hernias were included in our study, of which 59 patients did not have bowel resection surgery and 36 patients had bowel resection surgery. Fifty patients were male, and 45 patients were female. The mean age, BMI, leukocyte count, neutrophil count, platelet count, NLR, and duration of incarceration of all patients were 67 years, 20.49 kg/m², 8.99×10³/mm³, 7.34×10³/mm³, 215.63×10⁴/mm³, 8.77, and 42.20 h, respectively. There were no statistically significant differences in the mean BMI (*p*=0.700), neutrophil count (*p*=0.064), or platelet count (*p*=0.599) between patients with bowel resection surgery and patients without bowel resection surgery. The patients who had bowel resection surgery had higher NLR values (12.71±11.62 vs. 6.37±3.85, *p*<0.001), ages (69.89±12.33 vs. 65.24±16.72, *p*<0.038), and

Table 1. Univariate analysis of clinical/laboratory parameters and incarcerated groin hernia patients with or without bowel resection.

Variable	No bowel resection n=59	Bowel resection n=36	P value
Sex			0.656
Male (%)	30 (51)	20 (56)	
Female (%)	29 (49)	16 (44)	
Age(years)			0.131
<70 (%)	29 (49)	12 (33)	
≥70 (%)	30 (51)	24 (67)	
BMI(kg/m ²)			0.295
<26 (%)	57 (97)	33 (92)	
≥26 (%)	2 (3)	3 (8)	
Leukocyte count(×10 ³ /mm ³)			0.007
<10 (%)	48 (81)	20 (56)	
≥10 (%)	11 (19)	16 (44)	
Neutrophil count(×10 ³ /mm ³)			0.057
<8.0 (%)	41 (69)	18 (50)	
≥8.0 (%)	18 (31)	18 (50)	
Platelet count(×10 ⁴ /mm ³)			0.250
<210 (%)	35 (59)	17 (47)	
≥210 (%)	24 (41)	19 (53)	
NLR			<0.001
<11.5 (%)	54 (92)	20 (56)	
≥11.5 (%)	5 (8)	16 (44)	
Type of hernia			0.361
Femoral (%)	28 (47)	20 (56)	
Indirect (%)	30 (51)	14 (39)	
Direct (%)	1 (2)	2 (5)	
Bowel obstruction			0.001
With (%)	30 (51)	31 (86)	
Without (%)	29 (49)	5 (14)	
Duration of incarceration (hours)			0.006
<26 (%)	40 (68)	14 (39)	
≥26 (%)	19 (32)	22 (61)	

BMI – body mass index; NLR – neutrophil-to-lymphocyte ratio.

Table 2. Relationship between clinical/laboratory parameters and incarcerated groin hernia patients with or without bowel resection.

Variable	Mean n=95	No bowel resection n=59	Bowel resection n=36	P value
Age (years)	67.00	65.24±16.72	69.89±12.33	0.038
BMI (kg/m ²)	20.49	20.72±2.95	20.12±3.26	0.700
Leukocyte count (×10 ³ /mm ³)	8.99	8.26±2.65	10.18±4.05	0.046
Neutrophil count (×10 ³ /mm ³)	7.34	6.55±2.58	8.69±3.92	0.064
Platelet count (×10 ⁴ /mm ³)	215.63	213.88±70.03	218.50±81.15	0.599
NLR	8.77	6.37±3.85	12.71±11.62	<0.001
Duration of incarceration (hours)	42.20	33.29±41.83	56.81±51.04	0.245

BMI – body mass index; NLR – neutrophil-to-lymphocyte ratio.

Table 3. Risk factor of bowel resection for incarcerated groin hernia patients.

Risk factor	Odds ratio	95% CI	P value
NLR (<11.5/≥11.5)	9.612	2.369–38.999	0.002
Bowel obstruction	4.982	1.494–16.612	0.009
Duration of incarceration (<26/≥26 hours)	5.128	1.708–15.396	0.004
Leukocyte count (<10/≥10)	1.738	0.545–5.547	0.351

NLR – neutrophil-to-lymphocyte ratio; CI – confidence interval; Odds ratio derived from multiple logistic regression analysis.

leukocyte counts (10.18±4.05 vs. 8.26±2.65, p=0.046) than the patients without bowel resection surgery (Table 2).

Using the ROC curve analysis, we determined the cut-off values of age (<70/≥70 years), BMI (<26/≥26 kg/m²), leukocyte count (<10×10³/≥10×10³/mm³), neutrophil count (<8.0×10³/≥8.0×10³/mm³), platelet count (<210×10⁴/≥210×10⁴/mm³), NLR (<11.5/≥11.5), and duration of incarceration (<26/≥26 h). We discovered that the leukocyte count (p=0.007), NLR (p<0.001), presentation of bowel obstruction (p=0.001) and duration of incarceration (p=0.006) were associated with bowel resection (Table 1). Additionally, multivariate logistic regression analysis was used to analyze the leukocyte count, NLR, presentation of bowel obstruction, and duration of incarceration. This analysis revealed that the NLR (odds ratio=9.612, p=0.002), presentation of bowel obstruction (odds ratio=4.982, p=0.009), and duration of incarceration (odds ratio=5.128, p=0.004) were independently and significantly related to bowel resection in incarcerated groin hernia patients (Table 3).

Discussion

Alvarez et al. [4] observed that 13% of incarcerated groin hernia patients had bowel resection surgery. Kurt et al. [1] reported

that bowel resection was required in approximately 15% of all patients with an incarcerated groin hernia. Ge et al. [5] found that incarcerated groin hernia patients who were without health insurance and patients with incarcerated femoral hernias had increased risks for requiring bowel resection surgery. Suppiah et al. [6] revealed that emergency femoral hernia surgery had a higher rate of bowel resection than did elective femoral hernia surgery. Kemler et al. [7] reported that small bowel resection was required in up to 60% of patients with strangulated femoral hernias. Therefore, the rate of bowel resection is higher in incarcerated groin hernia.

Discomfort levels are increased in patients who undergo bowel resections as a result of incarcerated groin hernias. The need for bowel resection surgery was regarded as an indicator of severity of incarcerated groin hernia in our study. We found that the average age, leukocyte count, and NLR in the bowel resection group were significantly higher than the average age, leukocyte count, and NLR in the no-bowel resection group. We calculated the cutoff values of the continuous variables by ROC curve analysis and discovered that leukocyte count, NLR, presentation of bowel obstruction, and duration of incarceration were significantly associated with bowel resection in incarcerated groin hernia patients using the chi-square test. The leukocyte count, NLR, bowel obstruction, and duration of incarceration

were analyzed through multivariate logistic regression analysis; bowel obstruction (odds ratio=4.982, $p=0.009$) and duration of incarceration (odds ratio=5.128, $p=0.004$) were identified to be significantly related to bowel resection in incarcerated groin hernia patients. Until now, there have been no biomarkers that could predict the need for necrotic bowel resection resulting from incarcerated groin hernias. This study identified NLR (odds ratio=9.612, $p=0.002$) as a biomarker for the prediction of the need for bowel resection caused by ischemia in incarcerated groin hernia patients.

Neutrophilia, which can suppress lymphocytes, is a form of inflammatory response [8]. NLR was first used to diagnose appendicitis in 1995 [9]. Ishizuka et al. [10] discovered that NLR ($\leq 8 / > 8$) was more closely associated with gangrenous appendicitis than with WBC count and C-reactive protein. Jung et al. [11] found that NLR ($\leq 5.6 / > 5.6$) was associated with perforated appendicitis in elderly patients. Shimizu et al. [12] reported that NLR ($\leq 5 / > 5$) may be more sensitive than the WBC count or C-reactive protein for diagnosis of catarrhal appendicitis. These findings indicate that NLR can be a good predictor of the severity of inflammatory response. Additionally, NLR can reflect the body's immune response to cancer cells. Therefore, some studies have reported that NLR can predict the prognosis of patients with certain types of cancer, such as gastric cancer [13], non-small cell lung cancer [14], and colon cancer [15,16]. NLR may be important in colon cancer as well as in groin hernia [17,18]. Overall, NLR seems to be important in the prediction of severity of certain diseases. Our research confirmed that incarcerated groin hernia patients with $NLR \geq 11.5$, independent of WBC count and neutrophil count, had much higher risk for bowel resection. NLR has also been used in the diagnosis of adult strangulated inguinal hernias. Zhou et al. [19] reported that $NLR > 6.5$ was significantly related to the presence of a strangulated inguinal hernia. These authors suggested that $NLR > 6.5$ may serve as the best predictor for diagnosing strangulated inguinal hernias. In their study, the NLR value was related to the presence of an ischemic bowel. As the intestine becomes necrotic, the systemic inflammatory response increases. Thus, a high NLR ($NLR \geq 11.5$) can serve as a biomarker to predict the need for bowel resection in patients with incarcerated groin hernias.

We found that the occurrence rate of bowel obstruction was 86.11% (31/36) in the bowel resection group and 50.85% (30/59) in the no-bowel resection group. The bowel obstruction occurrence rate difference had remarkable statistical significance ($p=0.001$) in univariate analysis. Using multiple

logistic regression analysis, we demonstrated that bowel obstruction was significantly associated with the need for bowel resection surgery in incarcerated groin hernia patients. We also discovered that the duration of incarceration ($< 26 / \geq 26$ hours) (odds ratio=5.128, $p=0.004$) was an independent risk factor for bowel resection. The reason for bowel obstruction was that the intestines can quickly develop ischemia and necrosis due to long duration of incarceration. Therefore, bowel resection surgery may be needed. In contrast, Ge et al. [5] reported that the duration of incarceration was 33.9 ± 52.0 h in the no-bowel resection group and 48.5 ± 57.0 h in the bowel resection group ($p=0.062$). These results indicate that the bowel resection group had longer durations of incarceration than the durations in the no-bowel resection group, although this was not statistically significant in their study. Further investigations are needed to determine what duration of incarceration will lead to intestine ischemia and necrosis for bowel resection. Overall, the presence of obstructed bowels and the duration of incarceration can be useful indicators for the need to perform bowel resection in patients with incarcerated groin hernias.

Once incarcerated groin hernias are diagnosed, hernia surgery should be initiated immediately because intestinal incarceration can rapidly evolve into intestinal strangulation, increasing the need for bowel resection. When patients are sent into the hospital, we cannot accurately distinguish incarceration or strangulation using clinical presentations. However, we can determine the state of the incarcerated groin hernia using NLR and help the families of patients understand the severity of the disease. If manual reduction of the hernia is successful, serial NLR values could be used to dynamically monitor the response and condition of the patient. If NLR continues to increase, it may suggest that the patient's condition is worsening and that they will need emergency hernia surgery.

Conclusions

Elevated NLR can serve as a biomarker for the prediction of severity of incarcerated groin hernias. Additionally, incarcerated groin hernia patients who present with bowel obstruction or with the duration of intestinal incarceration longer than 26 h are more likely to require bowel resection.

Conflict of interest

None.

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