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Can Systemic Inflammatory Markers Predict Small Bowel Resection in Incarcerated Inguinal Hernia?

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Abstract: ***Aim: The aim of the present study was to emphasize the importance of hemogram and CRP (C-reactive protein) levels in preoperative period in patients who would have small bowel resection due to circulatory disorder. Method: The study included 135 patients with ages varying from 25 to 91 who had emergency operation due to incarcerated inguinal hernia (IIH). Hemogram, leucocyte, neutrophil, lymphocyte, thrombocyte and CRP values of patients were determined during their first admission, and neutrophil / lymphocyteratio (NLR), thrombocyte/lymphocyte ratio (TLR) and lymphocyte/CRP (LCR) ratio were calculated from them. The patients were divided into two groups. The first group had the patients who were operated for incarcerated inguinal hernia but did not have circulatory disorder, while the second group consisted of the patients who had resection due to circulatory disorder in small bowel tissue. Findings: Of 135 cases who underwent surgery, 99 had hernia repair while 36 had resection plus hernia repair. WBC, CRP, NLR and PLR levels were higher in the group of patients who had hernia repair than in the group of patients who had SB resection due to circulatory disorder while LCR was higher in the resection group. Conclusion: In patients who will undergo surgery due to IIH, being aware of circulatory disorder which develops in SB during the preoperative period is critical for surgical team and anesthetist, which calls for a more careful surgery planning. Future prospective studies in this area would be useful for the treatment of patients and for surgery team.***

Keywords: Inguinal hernia; Emergency treatment; Lymphocyte; Neutrophyl

1. Introduction

IH constitutes 75% of abdominal front wall hernias, which is about 10-15% of all surgical procedures (1). In 5-35% of IHs which are not operated under elective conditions, incarceration develops and emergency surgical intervention is performed (1, 2). In 10-15% of these cases, IB resection is required due to necrosis secondary to strangulated inguinal hernia (SIH). Postoperative morbidity and mortality rates are high in IH cases who have resection due to strangulation (3, 4). Although the IHs first seem as a condition whose treatment would be simple, there has been no consensus method for it. The best method in hernia repair varies by the presence of circulatory disorder in tissue inside the herniasac (3). Recently; the most commonly practiced method involves reaching hernia sac using transinguinal anterior incision and repair of hernia sac pushing the organs back into abdomen. In cases for which SB resection and anastomosis are planned due to circulatory disorder, hernia sac is frequently enlarged or anastomosis is performed inside the abdomen which is accessed through a median incision (4). Enlargement of hernia sac represents a further intervention to anatomic integrity and leads to higher post-operative recurrence rates while median incision as a second incision may lead to incisional hernia and infection of wound area, impairing the life quality of the patient. Both situations result in higher post-operative morbidity.

When circulatory disorder is found inside SB during the preoperative examination, adopting a peritoneal (posterior) approach using laparoscopic TAPP (Trans-abdominal pre-peritoneal) or median incision allows a smooth and safe implementation of anastomosis while positively contributing to postoperative morbidity outcomes for the patient (5).

In the present study, adult IH cases who applied to emergency service due to incarceration and who underwent operation were analyzed. The cases who had SB resection due to circulatory disorder were compared to the ones who had hernia repair only in an effort to preoperatively identify the circulation disorder.

2. Material and Method

Files of the patients who applied to Emergency Surgery Department of Bağcılar Training and Research Hospital with strangulated SB and who were operated in January 2014-January 2019 period were identified and examined retrospectively online. The cases who had peritoneal irritation symptoms as the emergency surgery indication and whose hernia could not be reduced were included. The patients who were reduced themselves during operation or where hernia sac was empty, cases with omentum in hernia sac and cases with other systemic disorders affecting laboratory parameters such as COPD (chronic obstructive pulmonary disease), presence of infection source in another area of body and cases on antibiotic use were excluded. The cases were evaluated for age, gender, location of hernia and surgery findings. Irreducible external hernia, “incarceration” and presence of objective intraoperative ischemia and necrosis signs in addition to irreducible hernia were considered “strangulation”.

In addition, hemogram values of the patients during their first admission to hospital were found in electronic medium, and leucocyte, neutrophil, lymphocyte, thrombocyte and CRP values were recorded. Using these values, neutrophil/lymphocyte (NLR), thrombocyte/lymphocyte (TLR) and lymphocyte/CRP ratios (LCR) were calculated. Two study groups were established. The patients who underwent surgery due to incarcerated hernia but did not need SB resection constituted the Group I while the ones who had circulatory

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disorder and had SB resection constituted the Group II. The patients whose hernia were reduced themselves during the operation or whose herniasac was found to be empty, the patients whose herniasachad omentum and the patients with other systemic conditions that could affect the laboratory parameters (COPD, infection sources in other parts of body) and patients on antibiotic use were excluded.

Statistical Analyses:

SPSS software (version 19.0; SPSS Inc., Chicago, IL, USA) was used for statistical analyses. In univariate analysis, normally distributed variables were expressed as mean ± SD and compared using t-test. Nominal data were expressed as case numbers and percentages, and were compared using Fisher's exact test. Diagnostic accuracy was evaluated using receiver operating characteristic (ROC) curve analysis. Appropriate cut-off values were identified, and sensitivity and specificity were calculated for parameters with an area under the curve (AUC) value of > 0.600. All tests were two-sided. p <0.05 was considered statistically significant.

Findings:

Of 135 patients (24 women and 111 men) who underwent operation, 99 had hernia repair while 36 had resection plus hernia repair. In the patient group who had anastomosis, hernia sac was enlarged in 21 patients and resection with additional median incision was practiced in 15 patients. The mean age of the patients included in the study was 65.46±15.86 (range 25-91).

There are many studies in the literature dealing with complication rate and hospital stay of IIH patients who had resection and who did not in the post-operative period (4-7). Since our aim in the present study was to determine the circulatory disorder of the patients in preoperative period, evaluation of findings involving the laboratory parameters only in the preoperative period were planned.

Significant differences were found in univariate analysis between Groups I and II for WBC, CRP, NLR, PLR and LCR ($p < 0.05$). Besides, in multivariate logistic regression analysis, WBC, CRP, NLR, PLR and LCR were identified as independent variables in determining the SB segment where circulatory disorder developed ($p < 0.05$) (Table 1).

In the resection group, WBC, CRP, NLR and PLR were higher ($p < 0.05$) while LCR was lower ($p < 0.05$) (Table 1). In ROC curve analyses for these independent variables, AUC was above 0.600 for WBC, CRP, NLR, PLR and LCR (Figure 1-3). Proposed cut-off values and performance characteristics for these variables were given in Table 2.

Table 1: Comparison of the two groups (OR: odds ratio, WBC: white blood cell, CRP: C reactive protein, NLR: neutrophil / lymphocyteratio, PLR: platelet/lymphocyte ratio, LCR: lymphocyte/CRP ratio)

	Univariate analysis			**Multivariate analysis**		
	Group I	Group II	p	OR	95% CI (min-max)	p
Number (n)	99	36				
Age	61.93±16.37	75.16±9.33	0.012	1.119	0.966-1.297	0.135
WBC	9596±3301	14748±5905	0.013	1.182	1.036-1.348	0.013
CRP	32.45±27.42	135.53±91.17	0.002	1.030	1.006-1.054	0.015
NLR	5.13±3.15	13.73±4.59	0.002	1.944	0.991-3.813	0.043
PLR	166.76±83.59	313.45±152.14	0.006	1.851	1.130-3.032	0.014
LCR	492.96±159.62	129.44±45.84	0.006	0.566	0.350-0.916	0.021

Table 2: Proposed cut-off values for significant parameters in diagnosis of **incarcerated inguinal hernia (**WBC: white blood cell, CRP: C reactive protein, NLR: neutrophil/lymphocyte ratio, PLR: platelet/lymphocyte ratio, LCR: lymphocyte/CRP ratio, AUC: area under the curve, OR: odds ratio)

Variable	**Cut-off value**	**AUC**	**95%CI (min-max)**	**Sensitivity (%)**	**Specificity (%)**	**p**
WBC (/mm^3)	≥13565	0.73	0.52-0.93	60	90	0.029
CRP (mg/L)	≥77.5	0.89	0.76-1.00	80	93	0.001
LCR	≤14.75	0.89	0.73-1.00	94	75	0.001
NLR	≥**11.98**	0.71	0.51-0.91	50	97	0.044
PLR	≥213.25	0.70	0.50-0.90	70	78	0.047

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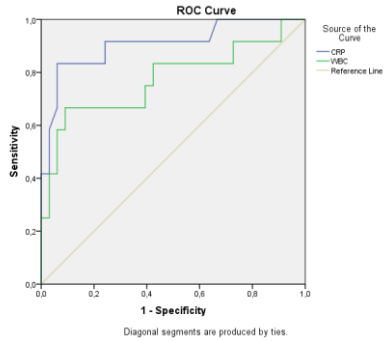

Figure 1: Receiver operating characteristic (ROC) curve analysis of significant parameters for the diagnosis of **incarcerated inguinal hernia** (WBC: White blood cell, CRP: C reactive protein).

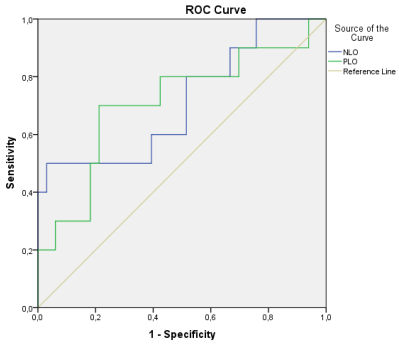

Figure 2: Receiver operating characteristic (ROC) curve analysis of significant parameters for the diagnosis of **incarcerated inguinal hernia** (NLR: neutrophil/lymphocyteratio, PLR: platelet/lymphocyteratio)

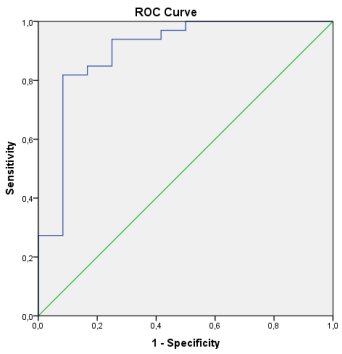

Figure 3: Receiver operating characteristic (ROC) curve analysis of significant parameters for the diagnosis of **incarcerated inguinal hernia- (lymphocyte/CRP ratio)**

3. Discussion

Groin hernias include the hernias in inguinal and femoral regions. The word *hernia* which means the protrusion of an organ from the structure surrounding it were derived from the Greek word *hernios* meaning *bud (5)*. IH is generally due to the developmental disorder in inguinal canal. It is characterized by extrusion of intra-abdominal visceral organs from inguinal canal. Weakness in abdominal muscles and increased intra-abdominal pressure play major role in the formation of IH. Emergency surgical intervention is practiced in 5-35% of all IH patients due to developing complications (2, 3). The most common complications were strangulation and incarceration. Kurt et al. (5) reported that in about 15% of the patients who had IIH diagnosis, bowel resection is performed. Especially in the case of strangulation, emergency surgery should be implemented as soon as possible. Early diagnosis is the most crucial factor in prognosis of these patients (8). Some strangulated hernia cases were reported which were not diagnosed in time and for which enterectomy was needed (9).

There has been no method yet which can clearly determine the bowel ischemia/necrosis in SIH. The most common examinations employed for the preoperational evaluation of IIH in the emergency department are ultrasonography (USG) and computed tomography (CT).Accurate diagnosis rate in USG, which is directly associated with the experience of radiologist, is 55-80% whereas CT has an accuracy of 64-88% (10). Besides, in centers lacking a radiologist, appropriate diagnostic data may not be always available for the differential preoperative diagnosis. In such conditions, easily obtained data which can help in early diagnosis and in surgical planning could be useful.

The present study included patients who were operated under emergency conditions due to IIH. Preoperative hematological parameters of the two groups who had and did not have bowel resection were compared to determine their predictive values. Univariate analysis showed that WBC, CRP, NLR and PLR were higher ($p < 0.05$) in the patient group who had resection while LCR was higher in the patient group who did not have resection ($p < 0.05$). In multivariate analysis, WBC, CRP, NLR, PLR and LCR were independent variables in identifying the circulatory disorder in small bowel of patients who were operated for IIH (Table 1). These findings are in line with the literature. In a similarly planned study, Xie et al. (9) reported significantly higher age, NLR and leucocyte levels in the patient group who had resection.

In the present study, CRP had the most sensitive predictive value indicating the resection need in strangulated hernia patients. Sensitivity and specificity of CRP were calculated to be 80 and 93%, respectively (Table 1 and 2, Figure 3). CRP and NLR together can help in determining the strangulated hernia which would need SB resection due to ischemia. A review of the recent literature showed that NLR is an important marker in the identification of conditions progressing with intra-abdominal infection such as acute appendicitis and acute cholecystitis (10, 11). The reason for this is increased systemic inflammatory response due to bowel ischemia. Ishizuka et al. (12) determined a cut-off value of 8 for NLR, and mentioned that its diagnostic value is higher than WBC and CRP in diagnosing the gangrenous appendicitis. This finding could be explained by the elevated number of neutrophilic granulocyte and decreased lymphocyte number in inflammatory events such as appendicitis (13). In addition, there are also studies reporting that NLR could determine the prognosis especially in stomach cancer and small-cell lung cancer (14, 15). Similarly, an association was found between NLR and SBHs requiring enterectomy ($p= 0.04$) (Table 1).

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In addition, based on ROC curve, NLR had a significant sensitivity and a very high specificity (50 and 97%, respectively) in the present study. Based on our results, the cases with high NLR values (a cut-off value of 11.98 for calculated for NLR) (Table 2) should be operated at once and it should be kept in mind that these patients very likely need bowel resection. On the other hand, in cases who have high risk for surgery, who have high ASA score and who have accompanying metabolic conditions, lower NLR could indicate that manual reduction could be safely performed.

NLR was 13.73±4.59 in the patient group who had resection and 5.13±3.15 in the group who did not have resection ($p<0.05$) (Table 1). In ROC curve analysis, sensitivity and specificity of NLR to predict ischemic event that would necessitate small bowel resection were 50 and 97%, respectively (Table 2 and Figure 1). According to another ROC curve analysis, sensitivity and specificity of LCR which had a cut-off value of 14.75 were 94 and 75%, respectively. These findings could be explained by elevated CRP value during the suppression of lymphocytes in parallel with inflammatory event due to ischemia (Table 2 and Figure 1).

Since bowel incarceration could turn into strangulation in IIH and then could necessitate a bowel resection due to ischemia, emergency surgery should be applied immediately. It may not be easily detected whether the hernia is incarcerated or strangulated at the first hospital admission. Some parameters that could guide the surgeon to determine the status of IIH could allow a better preparedness of the surgeon for the operation. In addition, patients and their relatives could be more consistently informed about the severity of the current status. WBC, NLR, PLR and LCR are practical markers that could be used rapidly for this purpose. Besides, these markers could be used for monitoring the status of bowel after a successful manual reduction. It would be appropriate for the surgeon to carefully evaluate the patient and consider surgical intervention in patients with elevated WBC, NLR and PLR values or decreased LCR value during the follow-ups.

Limitations of the present study were its retrospective and single-centered nature. In addition, conditions of the patients that could interfere in the bowel ischemia (metabolic disorders, cardiac and pulmonary sufficiency, antibiotic use, etc.) were excluded. In addition, results of imaging methods and physical examination findings were not evaluated. We believe that with the future prospective studies WBC, NLR, PLR or LCR could be standard markers used in preoperative diagnosis of SIH cases which require small bowel resection due to ischemia.

4. Conclusion

Similar to NLR which has been extensively studied and verified to be efficient, PLR and LCR are parameters that could be used to determine the need for SB resection due to ischemia in SIH patients. They can provide more valuable data than conventional WBC and CRP for surgeons working in centers with limited facilities in diagnosis during preoperative period. Future prospective studies with larger cohort in this area could contribute considerably to clinicians working in surgical practice.

Conflicts of interest:

"The authors declare that there is no conflict of interest regarding the publication of this paper." Data could be sent to ones who make a request.

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