ORIGINAL ARTICLE

Investigation of the clinical efficacy of thiol–disulfide homeostasis, delta neutrophil index, and ischemia-modified albumin in cases of incarcerated and strangulated hernia

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ABSTRACT

BACKGROUND: The treatment of patients presenting with the diagnosis of incarcerated and/or strangulated inguinal hernia is mostly surgery. If strangulation and necrosis are present, the need for laparotomy arises, which may increase the risk of morbidity. Currently, it is not possible to clearly determine whether there is bowel ischemia and necrosis before surgery. In this study, we aimed to investigate the clinical efficacy of the thiol–disulfide homeostasis, delta neutrophil index (DNI), and ischemia-modified albumin (IMA) parameters in incarcerated and strangulated hernia cases.

METHODS: Patients that presented to the general surgery outpatient clinic due to inguinal hernia or to the emergency department of the hospital with a preliminary diagnosis of incarcerated and/or strangulated hernia in April 2021-November 2021 were included in the study. The patients were divided into the following four groups: patients that underwent elective repair for inguinal hernia (Group 1), those who were followed up without surgery due to incarcerated hernia (Group 2), those who underwent hernia repair without bowel resection due to incarceration (Group 3), and those who underwent bowel resection due to strangulation (Group 4). Group 1 was defined as the control group, while Groups 2, 3, and Group 4 were evaluated as the incarcerated/strangulated hernia group. The demographic data of the patients, length of hospital stay, body mass index, comorbidities, medical history and physical examination findings, radiological examinations, treatments applied, white blood cell (WBC) count, lactate, and DNI, thiol–disulfide and IMA parameters were evaluated.

RESULTS: The WBC count, disulfide/native thiol, disulfide/total thiol, and IMA values were significantly higher in the incarcerated/strangulated hernia group than in the control group, while the native thiol and total thiol values were higher in the latter than in the former (P<0.05). There was no statistically significant difference between the groups in terms of lactate (P>0.05), but the mean WBC count was higher in Group 4 compared to Group 1, and the mean DNI was significantly higher among the patients who underwent bowel resection and anastomosis than in those that were followed up and discharged (P<0.05).

CONCLUSION: We consider that the preoperative evaluation of the thiol–disulfide homeostasis, IMA, and DNI parameters in incarcerated/strangulated hernia cases can be an effective and easily applicable method in predicting difficulties that may be encountered intraoperatively and the surgical procedure to be applied to the patient.

Keywords: Delta neutrophil index; incarcerated hernia; ischemia-modified albumin; strangulated hernia; thiol–disulfide homeostasis.

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INTRODUCTION

Hernia repair is one of the most common surgical procedures performed in general surgery. Each type of hernia carries the risk of incarceration, a condition that requires urgent surgical intervention. An incarcerated hernia comprises a part of the abdominal organs and abdominal tissue that cannot be returned to the abdominal cavity using standard maneuvers and is trapped in a hernia sac. The tissue trapped in an incarcerated hernia often consists of the small intestine or omentum. Strangulation of a herniated small bowel segment means that the circulation of the compressed tissue is interrupted, which starts a process that can lead to necrosis and perforation. The occurrence of tissue necrosis may require a treatment process involving resection, which increases the length of hospital stay and has a higher complication rate. Among incarcerated hernias, more complicated treatment methods that require small bowel resection are most needed in those located in the femoral area.[1]

It is very difficult to preoperatively detect complications and difficulties that may occur during the intraoperative and postoperative periods. Incarcerated hernias are the second most common cause after intra-abdominal adhesions in patients presenting to the emergency department with mechanical bowel obstruction.[2] When all hernias are considered, the risk of incarceration is between 0.29% and 2.9%.[3] While the mortality rate is <1% in patients with hernias undergoing elective surgery, this rate rises to 5% in cases of incarcerated or strangulated hernias that require urgent surgery.[4,5] Thus, there is an increase in morbidity and mortality after surgery that requires resection in patients presenting to the emergency department with an incarcerated hernia.

If the presence of tissue ischemia and necrosis can be determined before surgery in patients who present to the emergency department with incarcerated hernia, as was also the objective of our study, they can be informed in more detail, and both the patient and surgeon can be better prepared for the operation. More importantly, considering the necessity of resection-ostomy or resection-anastomosis in patients with serious comorbidities, such a preoperative evaluation can ensure that the surgery of these patients is performed in technically more equipped centers with an intensive care unit where a multidisciplinary approach can also be adopted. As a result, the rates of complication, mortality, and morbidity rates can be reduced, and complications that do develop can be managed more effectively.

Dynamic thiol–disulfide homeostasis (TDH) has been proven to play an important role in the mechanisms of detoxification, enzymatic reactions, apoptosis, and cellular signal transduction. Kundi et al., evaluating patients with a pre-diagnosis of acute myocardial infarction presenting with chest pain, reported that their thiol, disulfide, thiol–disulfide/total thiol, and disulfide/native thiol values were significantly higher. According to the results obtained, the authors concluded that TDH was a valuable biochemical parameter in patients with acute myocardial infarction.[6]

Ischemia-modified albumin (IMA) defines albumin that interacts with free radicals released from ischemic tissues whose blood supply and oxygenation are interrupted, while the albumin cobalt binding test measures modified albumin released after ischemia exposure with the indirect calorimetry method. Studies have shown the importance of IMA as a marker in many cases where tissue blood supply and oxygenation are interrupted, such as myocardial ischemia, skeletal muscle ischemia, bowel and mesenteric ischemia, stroke, and cerebrovascular events.[7-9]

The delta neutrophil index (DNI) is defined as immature granulocytes that are not found in peripheral blood except in the neonatal period.[10] In a limited number of previous studies, DNI was evaluated as a marker in patient groups, such as sepsis, acute appendicitis, meningitis, decompensated heart failure, acute gout attack, and acute pancreatitis where ischemia and inflammatory processes are at the forefront, and it was shown to guide physicians in the determination of the severity of these conditions.[11]

In this study, we aimed to investigate the clinical efficacy of TDH, DNI, and IMA in patients with incarcerated and strangulated hernias, and the usability of these parameters as markers in the preoperative detection of the presence of ischemia and necrosis.

MATERIALS AND METHODS

The study included 73 patients who presented to the general surgery outpatient clinic due to inguinal hernia in April 2021-November 2021 and was planned to undergo elective hernia repair and those that were admitted to the emergency department of the hospital with the preliminary diagnosis of incarcerated and/or strangulated hernia. All the participants provided written informed consent. The patients were divided into the following four groups: Group 1, patients who underwent elective hernia repair with mesh due to inguinal hernia; Group 2, those who were referred to the outpatient clinic for an elective surgery plan after follow-up without surgery due to incarcerated hernia and discharged; Group 3, those who underwent hernia repair without bowel resection due to incarceration; and Group 4, those who underwent bowel resection due to strangulation. In addition, the patients in Group 1 were defined as the control group, and those in Groups 2, 3, and Group 4 were evaluated as the incarcerated/strangulated hernia group. Patients who had an active infection or a diagnosis of rheumatoid arthritis, those that had cancer in any organ or had received radiotherapy and/or chemotherapy due to cancer, and those with chronic diseases, such as uncontrolled diabetes mellitus (DM) and hypertension (HT) were excluded from the study. The patients' demographic data, length of hospital stay, body mass index, comorbidities, history and physical examination findings, radiological examinations (erect plain abdominal radiography [EPAR], abdominal ultrasonography, and abdominal tomography), treatments applied, white blood cell [WBC] count, lactate, DNI, native thiol, total thiol, disulfide, disulfide/native thiol, disulfide/total thiol, native/total thiol, and IMA values were evaluated. EPAR was used to identify patients with and without air-fluid levels (AFLs); ultrasound (US) to identify those with and without fluid in the hernia sac or abdomen and those with and without significant blood supply in the intestinal loops based on color Doppler US (CDUS); and computed tomography (CT) was used to identify patients with and without herniated small bowel loops and ileus findings. In addition, when taking the patients' history and performing a physical examination, complaints such as nausea, vomiting, and inability to pass gas and stool were recorded. All the patients participating in the study had abdominal pain at the time of presentation.

For the measurement of the thiol, disulfide, and IMA values, blood samples taken from the patients in biochemistry tubes before the operation were used (no additional blood sample was collected), and after centrifugation, 2 cc serum was placed in the Eppendorf tube and kept at –80°C until analysis. The thiol, disulfide, and IMA values in the serum collected at the end of the study were analyzed free of charge at the biochemistry department of Ankara Yıldırım Beyazıt University. Approval was obtained from the Clinical Research Ethics Committee of Health Sciences University Ankara City Hospital (approval number: E1-21-1667).

Statistical Analysis

The study was carried out with 73 patients, and the data were transferred to IBM SPSS Statistics v. 23 for analysis. While analyzing the study data, descriptive statistics (mean, standard deviation) were presented for numerical variables. The independent-sample t-test was used to determine whether there was a difference between the two groups, and one-way analysis of variance (ANOVA) was used to determine whether there was a difference between more than two groups. According to the results of one-way ANOVA, first the Levene test was conducted to test the homogeneity of variance, and then a multiple comparison test (Bonferroni or Tamhane's T2) was undertaken to determine the group or groups from which the significant difference originated. The Bonferroni test was used to analyze the differences between the groups if the compared variables met the homogeneity of variance condition, and Tamhane's T2 test was used otherwise. In addition, the Chi-square test was conducted to examine the relationship between categorical variables.

RESULTS

The mean age of the patients was 57.84±15.66 years, the mean length of hospital stay was 4.38±3.25 days, and the mean BMI was 34.13±9.01. Of the patients, 47.9% had HT and 24.7% had DM, 77.4% had complaints of nausea, vomiting, or inability to pass gas and stool, 56.6% had AFL (+) in EPAR, 83% had no significant blood supply in the intestinal loops located in the hernia sac according to CDUS and had fluid in the hernia sac on US, and 50.9% had herniated small bowel loops and ileus findings according to CT (Table 1). While there was no statistically significant difference between

Table 1. Descriptive statistics

	n	%
Age (Mean±SD)	57.84±15.66	
Length of hospital stay (days) (Mean±SD)	4.38±3.25	
Pre-diagnosis		
Incarcerated umbilical hernia	17	23.3
Incarcerated incisional hernia	14	19.2
Incarcerated right inguinal hernia	13	17.8
Incarcerated left inguinal hernia	7	9.6
Incarcerated left femoral hernia	1	1.4
Recurrent incisional hernia	1	1.4
Right inguinal hernia	10	13.7
Left inguinal hernia	10	13.7
BMI (Mean±SD)	34.13±9.01	
Comorbidity		
HT	35	47.9
DM	18	24.7
COPD	2	2.7
Asthma	1	1.4
Cerebral palsy	1	1.4
Benign prostatic hyperplasia	1	1.4
Cardiac bypass	1	1.4
History and physical examination findings		
Present	41	77.4
Absent	12	22.6
EPAR		
AFL (+)	30	56.6
AFL (-)	23	43.4
US		
-	11	17.0
+	44	83.0
CT		
-	26	49.1
+	27	50.9
Treatment group		
Group 1	20	27.4
Group 2	11	15.1
Group 3	28	38.4
Group 4	14	19.2

the incarcerated/strangulated hernia group and control group in terms of BMI (P=0.187), the former had a significantly higher age and length of hospital stay compared to the latter (P<0.05) (Table 2). In addition, the WBC, disulfide/native thiol, disulfide/total thiol, native thiol/total thiol, and IMA values were significantly higher in the incarcerated/strangulated hernia group than in the control group, while the native thiol and total thiol values were significantly higher in the latter than in the former (P<0.05) (Table 3). There was no statistically significant difference between these groups in terms of age, BMI, history-physical examination findings, and EPAR, US, and CT findings (P>0.05), but the length of stay was significantly higher in the incarcerated/strangulated hernia group compared to the control group (P<0.001) (Table 4).

While there was no statistically significant difference between the groups in terms of lactate, DNI, and disulfide (P>0.05), the mean WBC count was significantly higher among the patients that underwent bowel resection and anastomosis (Group 4) compared to the control group (Group 1), and the mean DNI of Group 4 was significantly higher compared to the followed up and discharged group (Group 2). The mean native thiol and total thiol values of the control group and Group 2 were significantly higher compared to the patients that underwent hernia repair without bowel resection (Group 3) and Group 4 (P<0.05). The mean disulfide/native thiol and disulfide/total thiol ratios were also significantly higher in Group 4 than in the control group. The mean native thiol/total thiol ratio of Group 4 was lower than that of the control group. Finally, the mean IMA value of Group 4 was significantly higher compared to all the remaining groups (Table 5).

DISCUSSION

In the United States, average of 700,000 primary and recurrent hernia repairs is performed each year. The most common and serious complication of inguinal hernias is strangulation, occurring in 1.3–3% of cases. Strangulation significantly increases mortality and morbidity. It is most commonly seen in indirect inguinal hernias, but femoral hernias are the most likely to develop strangulation (5–20%).[3] In addition, incarcerated hernias are the second most common cause of mechanical bowel obstruction among patients presenting to the emergency department.[2] This shows the importance of incarcerated hernia as a complication. It is a situation that should be taken seriously by surgeons due to both the increasing mortality rate and the burden on the health system caused by the requirement of urgent surgery. While the mortality rate is <1% in inguinal or ventral elective hernias, it reaches 5% in hernias cases accompanied by incarceration and/or strangulation.[4,12]

Table 2. Comparison of the demographic data between the control and incarcerated/strangulated hernia groups

	Control group	Incarcerated/strangulated hernia group	T	P-value
	Mean±SD	Mean±SD		
Age	51.6±12.68	60.19±16.13	−2.141	**0.036***
Length of hospital stay (days)	1.20±0.41	5.58±3.03	−10.273	**0.000***
BMI	36.41±7.28	33.27±9.51	1.333	0.187

t: Independent-samples t-test; *P<0.05.

Table 3. Comparison of the parameters between the control and incarcerated/strangulated hernia groups

	Control group	Incarcerated/strangulated hernia group	t	P-value
	Mean±SD	Mean±SD		
WBC (x10⁹/L)	7.90±1.02	11.19±3.70	−5.909	**0.000***
Native thiol (µmol/L)	469.34±41.10	320.94±84.89	9.996	**0.000***
Total thiol (µmol/L)	501.93±33.87	363.52±85.66	9.892	**0.000***
Disulfide (µmol/L)	16.29±12.64	21.29±12.60	−1.511	0.135
(Disulfide/native thiol)*100	3.66±3.49	7.23±4.94	−2.959	**0.004***
(Disulfide/total thiol)*100	3.25±2.59	6.03±3.41	−3.292	**0.002***
(Native thiol/total thiol)*100	93.50±5.19	87.95±6.83	3.292	**0.002***
IMA (ABSU)	0.69±0.05	0.87±0.20	−5.947	**0.000***

t: independent-samples t-test; *P<0.05.

Table 4. Comparison of the demographic data between the treatment groups

	Group 1		Group 2		Group 3		Group 4		test	P-value
	n	%	n	%	n	%	n	%		
Age	51.60±12.68		63.82±10.72		59.93±16.95		57.86±18.4		1.819[F]	0.152
Length of hospital stay (days)	1.20±0.41[b]		4.73±3.04[a]		5.21±2.78[a]		7.00±3.26[a]		16.604[F]	**0.000***
BMI	36.41±7.28		38.39±7.9		31.90±9.36		32.01±10.17		2.180[F]	0.098
History and physical examination finding										
Present	0	0	9	81.8	19	67.9	13	92.9	3.488[k]	0.175
Absent	0	0	2	18.2	9	32.1	1	7.1		
EPAR										
AFL (+)	0	0	7	63.6	15	53.6	8	57.1	0.328[k]	0.849
AFL (-)	0	0	4	36.4	13	46.4	6	42.9		
US										
-	0	0	4	36.4	5	17.9	0	0	5.810[k]	0.055
+	0	0	7	63.6	23	82.1	14	100		
CT										
-	0	0	4	36.4	14	50	8	57.1	1.085[k]	0.581
+	0	0	7	63.6	14	50	6	42.9		

[a,b]indicates the differences between the mean values of the groups (a = highest mean); [k]chi-square test; [F]one-way analysis of variance; *P<0.05.

Table 5. Comparison of the parameters between the treatment groups

	Group 1		Group 2		Group 3		Group 4		test	P-value
	n	%	n	%	n	%	n	%		
WBC (×10⁹/L)	7.90±1.02[b]		11.14±5.09		11.00±2.86		11.61±4.18[a]		5.085[F]	**0.003***
Lactate (mmol/L)	-		1.96±1.19		1.79±0.87		2.49±1.11		2.283[F]	0.113
DNI	-		5.65±7.70[b]		1.75±1.83		8.06±7.00[a]		3.649[F]	**0.046***
DNI										
Negative	0	0	4	36.4	13	46.4	5	35.7	0.593[k]	0,744
Positive	20	100	7	63.6	15	53.6	9	64.3		
Native thiol (μmol/L)	469.34±41.10[a]		431.30±55.48[a]		320.83±41.41[b]		234.42±67.29[c]		76.459[F]	**0.000***
Total thiol (μmol/L)	501.93±33.87[a]		474.93±38.87[a]		363.11±45.04[b]		276.81±73.30[c]		74.040[F]	**0.000***
Disulfide (μmol/L)	16.29±12.64		21.81±17.77		21.14±12.53		21.20±8.09		0.747[F]	0.528
(Disulfide/native thiol)*100	3.66±3.49[b]		5.61±5.97		6.79±4.74		9.37±3.97[a]		4.648[F]	**0.005***
(Disulfide/total thiol)*100	3.25±2.59[b]		4.65±4.08		5.72±3.22		7.72±2.71[a]		6.030[F]	**0.001***
(Native thiol/total thiol)*100	93.50±5.19[a]		90.70±8.16		88.56±6.44		84.56±5.42[b]		6.030[F]	**0.001***
IMA (ABSU)	0.69±0.05[c]		0.70±0.05[c]		0.79±0.09[b]		1.14±0.16[a]		72.652[F]	**0.000***

[a,b]indicates the differences between the mean values of the groups (a= highest mean); [k]chi-square test; [F]one-way analysis of variance; *P<0.05.

When a patient presenting with a hernia is considered to have no strangulation or if short-term strangulation is suspected, the hernia sac is reduced by a physical examination and the patient is followed up in terms of complications, which not only poses risks for the patient but also places a burden on the health system. These are only a few examples showing the importance of detecting the presence of strangulation and necrosis as soon as the patient presents to the hospital. However, it is very difficult to detect the presence of strangulation and answer the question of whether it is a simple mechanical obstruction or an incarcerated hernia accompanied by necrosis or perforation. In such cases, the currently accepted approach is early surgical intervention. Successful treatment is only possible when the current situation is resolved with the appropriate surgical technique at the appropriate time before the development of further complications.

The treatment of a patient presenting with an incarcerated and/or strangulated hernia is often surgery. The surgical approach almost always starts with an inguinal incision, especially in cases of inguinal or femoral hernia. When the herniated structures are evaluated peroperatively, if strangulation and necrosis are present, it is often not possible to perform adequate exploration and resection-anastomosis from the inguinal incision, and therefore laparotomy is undertaken through a second incision, which increases the morbidity risk for the patient. This new incision can also bring along the risk of another incisional hernia. Incisions performed without the knowledge of the presence of necrosis and the need for resection-anastomosis before surgery cause an unnecessary laparotomy burden and post a morbidity risk for the patient. Currently, it is not possible to clearly determine the presence of necrosis and the need for resection-anastomosis before surgery. Every surgical intervention to the abdomen and every incision carries the risk of incisional hernia in the following process. Incisional hernia after laparotomy has an incidence of 5–13.9% and usually occurs within the 1st year after surgery.[13] According to the data of the Toronto Shouldice Clinic, 5.6% of incisional hernias are seen in the first 2 weeks, 52% in the first 6 months, 67% in the 1st year, 78% in the first 2 years, and 88% in the first 4 years.[14] Studies have shown that the rate of wound complications and infection in the treatment of ventral and incisional hernias with mesh is 12–20%.[15] Recurrence is one of the most important problems in the treatment of ventral and incisional hernias. To date, no significant difference has been reported between the open and laparoscopic approaches in terms of recurrence. In a randomized controlled study involving ventral hernia repair with the open approach, the recurrence rate at the 3rd-year follow-up was reported as 24%, and the retromuscularly placed mesh was found to have protruded 2–3 cm from the defect. Recurrence rate of 4.4% at the end of 3-year follow-up of 270 patients who underwent laparoscopic mesh repair, this rate is observed to reach 9% in retrospective studies.[16-20] These studies and rates show that hernias, as well as incarcerated/strangulated hernias, will continue to be a major burden for the healthcare system and a serious problem for surgeons for a long time.

IMA, which started to gain popularity at the beginning of the 1990s, has attracted clinicians' attention, especially in cardiology outpatient clinics due to its elevation in minutes in cases where other markers are not sufficient. IMA can be detected in the early period after ischemia, and it has been suggested that it may be an early marker before necrosis.[21] In a study conducted in 2001, Bar-Or et al. showed that IMA concentrations increased in the blood of patients who had transient ischemia after percutaneous transluminal coronary angioplasty before there was a significant increase in Creatine Kinase-MB, myoglobin, and troponin I.[22] In addition to these studies suggesting that IMA reflects coronary ischemia in the early period, Refaai et al. found that post-operative IMA levels significantly increased in 23 patients who underwent arthroscopic knee surgery compared to the baseline. The authors cut off the leg blood flows of the patients using the tourniquet method during surgery and compared the IMA levels before and after surgery. They determined the preoperative and postoperative IMA levels as 90.2 U/mL and 96.7 U/mL, respectively ($P<0.05$).[23] In light of these findings, the elevation in IMA in the early period after ischemia does not appear to be specific to acute coronary syndrome, but it includes all conditions accompanied by ischemia. It has been shown that a high IMA value can be used as an important marker to reflect ischemia in conditions such as mesenteric ischemia, ovarian torsion, abdominal compartment syndrome, deep vein thrombosis, end-stage renal disease, peripheral vascular disease, and intrauterine disorders.[24,25]

A limited number of studies have evaluated DNI as a marker in patient groups in which ischemia and inflammatory processes are at the forefront, such as sepsis, acute appendicitis, meningitis, decompensated heart failure, acute gout attack, and acute pancreatitis and suggested that DNI can guide clinicians in the prediction of the severity of these conditions.[11] In a study undertaken in 2016, Cha et al. suggested that DNI, WBC, and C-reactive protein, which tend to increase inflammation and septic processes, could be used as markers to predict strangulation in advance. They included 160 patients who presented with mechanical bowel obstruction after strangulation and reported that among these three parameters, only the baseline DNI values were higher in the strangulated group compared to the non-strangulated group (0% vs. 3.2%, P=0.003). As a result of the study, the authors concluded that DNI could be an auxiliary parameter for CT in detecting strangulation.[26]

Another study conducted to detect the presence of necrosis at an early stage in patients presenting with incarcerated hernia belongs to Kadıoğlu et al., who tried to imitate incarcerated and strangulated small intestines by exposing rat intestines to ischemia for certain periods and monitored the blood IMA levels of the rats. As a result of the study, the authors argued that IMA was an effective marker in predicting necrosis in incarcerated hernia; however, they emphasized the need for further studies to generalize this hypothesis.[27] In our study, we observed that the IMA values were higher in the incarcerated/strangulated group compared to the control group and in the group that underwent bowel resection due to ischemia-related strangulation compared to the other treatment groups. In a retrospective study on the preoperative detection of necrosis in 163 patients with incarcerated hernia, Keeley et al. considered that hyponatremia could be a marker for the presence of necrosis and recommended that surgery should be urgently performed in patients presenting with incarcerated hernia accompanied by hyponatremia.[28] Similarly, in a retrospective study of 167 patients who underwent surgery for incarcerated hernia, Şahin et al. revealed that the blood lactate level could be a marker for the presence of necrosis. It was also noted that the need for resection might arise, especially in patients with a blood lactate level of ≥1.46 mg/dL.[29] In the current study, there was no difference between the groups in terms of lactate values.

Erel and Neşelioğlu reported that under oxidative stress conditions created by oxygen radicals formed due to ischemia, the reduced thiol concentration increased, the native (non-reduced) thiol concentration decreased, and the disulfide and disulfide/native thiol, disulfide/total thiol and native/total thiol values increased in a correlated manner.[30] Kundi et al. also showed that the thiol–disulfide, thiol–disulfide/total thiol, and disulfide/native thiol values were significantly higher in patients with acute myocardial infarction, and based on their results, they suggested that TDH could be used as a biochemical marker in patients with acute coronary syndrome.[6] Akkurt et al. investigated the efficacy of TDH and IMA in preoperatively predicting the degree of difficulty and probability of conversion to open surgery in 65 patients scheduled to undergo laparoscopic cholecystectomy. The authors reported that the mean native thiol and total thiol values were significantly higher in patients without a history of cholecystitis compared to those with a history of cholecystitis, while the disulfide, disulfide/native thiol, disulfide/total thiol, native thiol/total thiol, and IMA values were significantly higher in patients with a history of cholecystitis compared to those without this history. As a result, they concluded that the preoperative TDH and IMA parameters could be used as biochemical markers to predict intraoperative difficulties.[31] In the current study, we observed that the disulfide/native thiol and disulfide/total thiol ratios were higher in the patients who underwent hernia repair due to incarcerated hernia and those that were followed up and discharged compared to the control group, and the highest disulfide/total thiol ratio was observed in the group that underwent bowel anastomosis due to strangulation, where ischemia is the most intense.

In our study, consistent with the literature, the preoperative WBC count was higher in the incarcerated/strangulated group than in the control group, and the preoperative WBC and DNI parameters statistically significantly differed between the treatment groups, with the highest values being observed in the group that underwent bowel resection due to strangulation.

CONCLUSION

The preoperative evaluation of TDH, IMA, and DNI parameters, especially in incarcerated/strangulated hernia cases requiring operation is an effective and easily applicable method to predict difficulties that may be encountered intraoperatively. It can be used to detect intestinal ischemia, make timely interventions before necrosis develops, and prevent the need for resection. We also consider that it has positive contributions to the surgical process in terms of the preparation of operating room personnel and surgical team, preparation of postoperative intensive care unit if necessary, and prevention of complications.

Ethics Committee Approval: This study was approved by the Health Sciences University Ankara City Hospital Research Ethics Committee (Date: 14.04.2021, Decision No: E1-21-1667).

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REFERENCES

1. Kulah B, Kulacoglu IH, Oruc MT, Duzgun AP, Moran M, Ozmen MM, et al. Presentation and outcome of incarcerated external hernias in adults. Am J Surg 2001;18:101–4. [CrossRef]
2. Markogiannakis H, Messaris E, Dardamanis D, Pararas N, Tzertzemelis D, Giannopoulos P, et al. Acute mechanical bowel obstruction: Clinical presentation, etiology, management and outcome. World J Gastroenterol 2007;13:432–7. [CrossRef]
3. Gallegos NC, Dawson J, Jarvis M, Hobsley M. Risk of strangulation in groin hernias. Br J Surg 1991;78:1171–3. [CrossRef]
4. Nilson H, Stylianidis G, Haapamaki M, Nilsson E, Nordin P. Mortality after groin hernia surgery. Ann Surg 2007;245:656–60. [CrossRef]
5. Deeba S, Purkayastha S, Paraskevas P, Athanasiou T, Darzi A, Zacharakis E, et al. Laparoscopic approach to incarcerated and strangulated inguinal hernias. J Soc Laparoendoscopic Surg 2009;13:327–31.
6. Kundi H, Ates I, Kiziltunc E, Cetin M, Cicekcioglu H, Neselioglu S. A novel oxidative stress marker in acute myocardial infarction; thiol/disulphide homeostasis. Am J Emerg Med 2015;33:1567–71. [CrossRef]
7. Bhagavan NV, Lai EM, Rios PA, Yang J, Ortega-Lopez AM, Shinoda H, et al. Evaluation of human serum albumin cobalt binding assay for the assessment of myocardial ischemia and myocardial infarction. Clin Chem 2003;49:581–5. [CrossRef]

8. Sinha MK, Roy D, Gaze DC, Collinson PO, Kaski JC. Role of "Ischemia modified albumin", a new biochemical marker of myocardial ischaemia, in the early diagnosis of acute coronary syndromes. Emerg Med J 2004;21:29–34. [CrossRef]
9. Gunduz A, Turedi S, Mentese A, Karahan SC, Hos G, Tatli O, et al. Ischemia-modified albumin in the diagnosis of acute mesenteric ischemia: A preliminary study. Am J Emerg Med 2008;26:202–5. [CrossRef]
10. Seok Y, Choi JR, Kim J, Kim YK, Lee J, Song J. Delta neutrophil index: A promising diagnostic and prognostic marker for sepsis. Shock 2012;37:242–6. [CrossRef]
11. Kim H, Kim Y, Lee HK, Kim KH, Yeo CD. Comparison of the delta neutrophil index with procalcitonin and C-reactive protein in sepsis. Clin Lab 2014;60:2015–21. [CrossRef]
12. Primtesta P, Goldacre MJ. Inguinal hernia repair: Incidence of elective and emergency surgery, readmission and mortality. Int J Epidemiol 1996;25:835–9. [CrossRef]
13. Skandalakis LJ, Gadacz TR, Mansberger AR, Mitchell WE, Colborn GL, Skandalakis JE. Modern Hernia Repair. The Embryological and Anatomical Basis of Surgery. New York: Parthenon; 1996.
14. Ellis H, Coleridge-Smith PD, Joyce AD. Abdominal incisions--vertical or transverse? Postgrad Med J 1984;60:407–10. [CrossRef]
15. Stoppa RE. The treatment of complicated groin and incisional hernias. World J Surg 1989;13:545–4. [CrossRef]
16. Cassar K, Munro A. Sugical treatment of incisional hernia. Br J Surg 2002;89:534–45. [CrossRef]
17. Heniford BT, Park A, Ramshaw BJ, Voeller G. Laparoscopic ventral and incisional hernia repair in 407 patients. J Am Coll Surg 2000;190:645–50. [CrossRef]
18. LeBlanc KA, Booth WV. Laparoscopic repair of incisional abdominal hernias using expadedpolytetrafluoroethylene: Preliminary findings. Surg Laparosc Endosc 1993;3:39–41. [CrossRef]
19. Heniford BT, Park A, Ramshaw BJ, Voeller G. Laparoscopic repair of ventral hernias: Nine years" experience with 850 cosecutive hernias. Ann Surg 2003;238:391–400. [CrossRef]
20. Parker HH 3rd, Nottingham JM, Bynoe RP, Yost MJ. Laparoscopic repair of large incisional hernias. Am J Surg 2002;68:530–3, discussion 533–4. [CrossRef]
21. Bar-Or D, Lau E, Winkler JV, Harris L, Lau E, Hetzel FW. A novel assay for cobalt-albumin binding and its potential as a marker for myocardial ischemia-a preliminary report. J Emerg Med 2000;19:311–5. [CrossRef]
22. Bar-Or D, Winkler JV, Vanbenthuysen K, Harris L, Lau E, Hetzel FW, et al. Reduced albumin-cobalt binding with transient myocardial ischemia after elective percutaneous transluminal coronary angioplasty: A preliminary comparison to creatine kinase-MB, myoglobin, and troponin I. Am Heart J 2001;141:985–91. [CrossRef]
23. Refaai MA, Wright RW, Parvin CA, Gronowski AM, Scott MG, Eby CS. Ischemia-modified albumin increases after skeletal muscle ischemia during arthroscopic knee surgery. Clin Chim Acta 2006;366:264–8. [CrossRef]
24. Renda L, Tatar EI, Saylam G, Eminağaoğlu S, Özdek A, Korkmaz H, et al. Ani işitme kaybi hastalarinda iskemi modifiye albuminin tanida ve prognozdaki yeri. KBB-Forum 2009;8:84–9.
25. Sbarouni E, Georgiadou P, Voudris V. Ischemia modified albumin changes-review and clinical implications. Clin Chem Lab Med 2011;49:177–84. [CrossRef]
26. Cha YS, Lee KH, Lee JW, Choi EH, Kim HI, Kim OH, et al. The use of delta neutrophil index and myeloperoxidase index as diagnostic predictors of strangulated mechanical bowel obstruction in the emergency department. Medicine (Baltimore) 2016;95:e5481. [CrossRef]
27. Kadioğlu H, Ömür D, Bozkurt S, Ferlengez E, Memmi N, Ersoy YE, et al. Ischemia modified albumin can predict necrosis at incarcerated hernias. Dis Markers 2013;35:807–10. [CrossRef]
28. Keeley JA, Kaji A, Kim DY, Putnam B, Neville A. Predictors of ischemic bowel in patients with incarcerated hernias. Hernia 2019;23:277–80. [CrossRef]
29. Şahin M, Buluş H, Yavuz A, Turhan VB, Öztürk B, Kiliç NA, et al. The role of the lactate level in determining the risk rates of small bowel resection in incarcerated hernias. Ulus Travma Acil Cerrahi Derg 2020;26:593–9. [CrossRef]
30. Erel O, Neselioglu S. A novel and automated assay for thiol/disulphide homeostasis. Clin Biochem 2014;47:326–32. [CrossRef]
31. Akkurt G, Akkurt B, Alptekin E, Birben B, Keşkek M, Erel Ö. Efficacy of thiol disulfide homeostasis and ischemia modified albumin values in estimating the degree of difficulty for laparoscopic cholecystectomy. Comb Chem High Throughput Screen 2021;24:433–40. [CrossRef]

ORİJİNAL ÇALIŞMA - *ÖZ*

Thiol/disülfid hemostazı, delta nötrofil indeks ve iskemi modifiye albümin'in inkarsere ve strangüle herni olgularında klinik etkinliği

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AMAÇ: İnkarsere ve/veya strangüle inguinal herni tanısı ile başvuran hastaların tedavisi çoğu zaman cerrahidir. Strangülasyon ve nekroz mevcut ise laparotomi ihtiyacı doğar ve buna bağlı morbidite riskinde artış olabilir. Günümüzde ameliyat öncesinde bağırsakta iskemi ve nekroz olup olmadığını net olarak saptamak mümkün değildir. Bu çalışmada, thiol/disülfid hemostazı, delta nötrofil indeks (DNİ) ve iskemi modifiye albumin (İMA) parametrelerinin inkarsere ve strangüle herni olgularında klinik etkinliğini araştırmayı amaçladık.
GEREÇ VE YÖNTEM: Nisan 2021- Kasım 2021 yıllarında genel cerrahi polikliniğine inguinal herni nedeniyle ve acil servise inkarsere ve/veya strangüle herni ön tanısı ile başvuran hastalar çalışmaya dahil edildi. Hastalar dört gruba ayrıldı; inguinal herni nedeniyle elektif onarım yapılan hastalar (Grup 1), inkarsere herni nedeniyle operasyon yapılmadan gözlemlenen hastalar (Grup 2), inkarserasyon nedeni ile bağırsak rezeksiyonu yapılmadan fıtık onarımı yapılan hastalar (Grup 3) ve strangülasyon nedeni ile bağırsak rezeksiyonu uygulanan hastalar (Grup 4) şeklinde gruplandırıldı. Ek olarak Grup 1'de olan hastalar kontrol grubu, Grup 2, 3 ve Grup 4'de olan hastalar inkarsere/strangüle herni grubu olarak tanımlandı. Hastaların demografik verileri, yatış süresi, vücut kitle indeksi (VKİ), ek hastalıkları, öykü ve fizik muayene bulguları, radyolojik tetkikleri, uygulanan tedavi, WBC (White blood cells), laktat, DNİ, thiol-disülfid ve İMA parametreleri değerlendirildi.
BULGULAR: İnkarsere/strangüle grubundaki WBC, disülfid/native thiol, disülfid/total thiol ve İMA değerleri kontrol grubuna göre daha yüksek iken, kontrol grubundaki native thiol, total thiol değerleri inkarsere/strangüle grubuna göre daha yüksek olarak izlendi ($p<0,05$). Laktat bakımından gruplar arasında istatistiksel olarak anlamlı bir farklılık bulunmamakta iken ($p>0.05$), Grup 4 hastalarda WBC ortalaması Grup 1'e göre, bağırsak rezeksiyonu ve anastomoz yapılanlarda DNİ ortalaması ise takiple taburcu edilen gruba göre daha yüksek olarak izlendi ($p<0.05$).
SONUÇ: İnkarsere/strangüle herni olgularında, thiol disülfid hemostazı, İMA ve DNİ paremetrelerinin ameliyat öncesinde değerlendirilmesinin; intraoperatif olarak karşılaşılabilecek zorlukları ve hastaya uygulanacak olan cerrahi işlemi önceden tahmin etmede etkin ve kolay uygulanabilir bir yöntem olabileceği düşüncesindeyiz.
Anahtar sözcükler: İskemi modifiye albümin; inkarsere herni; strangüle herni; thiol disülfid homeostazı; delta nötrofil indeks.

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