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The predictive value of biochemical parameters in evaluating patients with abdominal trauma: The new scoring system

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ABSTRACT

Aim: The aim of this study was to investigate the contribution of non-invasively and rapidly obtained biochemical parameter results to the diagnosis and follow-up of intraabdominal injuries in multitrauma patients.

Material and Methods: A total of 2604 multitrauma patients who were treated following their referral to our emergency department between January 2009 and January 2012 were retrospectively reviewed. A logistic regression analysis was used in the risk assessment.

Results: Statistically significant associations between intraabdominal injury and certain biochemical variables measured at the time of the referral were determined. These variables were hemoglobin $\leq$9.99 g/dL [odds ratio (OR): 6.25, 95% CI: 2.86–13.52, $p < 0.0001$], serum alanine amino transferase (ALT) $\geq$ 100 IU/L (OR: 34.45, 95% CI: 21.76–54.54, $p < 0.0001$), and serum lipase $\geq$ 61 U/L (OR: 10.44, 95% CI: 6.56–16.49, $p < 0.0001$). The pretest probability score was determined for each patient by adding the scores that were obtained from each factor. ROC curve analysis was performed to determine the diagnostic value of the pretest probability score for detecting intra-abdominal injury (area = 0.88; $p < 0.0001$).

Conclusion: The results of our study demonstrated that biochemical parameters may contribute to the diagnosis and follow-up of intraabdominal injuries in multitrauma patients. In particular, ALT, AST, CK and myoglobin were found to have higher ORs than low hemoglobin. After these parameters are tested in larger scale studies in conjunction with the gold standard multislice abdominal CT, they may be used for establishing scores to evaluate the severity of abdominal injuries.

1. Introduction

Trauma is an important cause of morbidity and mortality worldwide and in Turkey.[1,2] According to the World Health Organization (WHO), in 2000, 5.8 million people died worldwide due to trauma caused by accidents.[2] Therefore, in multitrauma patients, diagnosing intraabdominal injuries accurately and in a timely manner is crucial. Undetected intraabdominal injuries can lead to late-stage mortality and morbidity due to trauma.[3] In multitrauma patients, certain algorithms, consisting of a synthesis of vital signs, physical examination and screening methods, are used to investigate intraabdominal injury to more easily diagnose intraabdominal trauma.[3–5] It has been reported that abdominal CT for detecting intraabdominal pathology in hemodynamically stable patients with blunt abdominal trauma has a sensitivity of 92–97.6% and a specificity of 98.7%.[5] However, it has also been reported that there must be a significant amount of bleeding for hemoperitoneal signs such as abdominal sensitivity and distention to occur, and in some cases, these signs may appear hours or days afterward.[6] A CT scan provides rapid and reliable data compared to biochemical tests for abdominal trauma patients. However, it has been reported that abdominal CT screening has some limitations, such as an increase in treatment costs, the absence of a radiologist on call for 24 h and

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limited use in selected patients due to the radiation load. Furthermore, under conditions in which abdominal CT screening is not currently possible, biochemical tests may be predictors for intra-abdominal injuries and may be associated with the injury level.[7–9] The priority and precedence of diagnostic methods in patients with abdominal trauma is determined on an individualized basis rather than the recommendations of guidelines. We aimed to investigate the contribution of non-invasively and rapidly obtained biochemical parameter results to the diagnosis and follow-up of intra-abdominal injuries in multitrauma patients. Second, we aimed to develop a scoring system and to investigate its clinical applicability as a pretest probability score to determine whether abdominal CT should be performed during the diagnosis and follow-up of intra-abdominal injury patients.

2. Methodology

2.1. Study design

This study, which included patients who were referred to a university hospital emergency department, had a cross-sectional, retrospective and analytical design. The study center has a 2000-bed capacity and receives 100,000 referrals to the emergency department annually. Following the approval of the local ethics committee (Ege University Clinical Trials Ethics Committee 12–2.1/6 30/05/2012), the study data were obtained by retrospectively screening abdominal trauma patients older than 18 years of age who were referred to the medical faculty emergency department between January 01, 2009 and December 31, 2011. Abdominal CT and clinical outcomes were accepted as gold standards in the evaluation of the intraabdominal injuries of the included patients.

2.2. Study population

In this study, 4299 multitrauma patients who were referred to the emergency department between the aforementioned dates were assessed. Among these patients, 82 were excluded due to insufficient patient records and 731 were excluded because these patients were younger than 18 years of age, and 882 patients were excluded because no abdominal trauma diagnosis was considered, and hence, no diagnostic tests were performed. Following the exclusion of these patients, 2604 patients were included in the study (Fig. 1).

2.3. Data collection

The data extracted from files of 4299 patients with multiple injuries was analyzed after a two-month archive scan. Demographic characteristics, vital signs at the time of referral, laboratory results [hemoglobin, creatinine kinase (CK), myoglobin, alanine amino transferase (ALT), aspartate amino transferase (AST), amylase, lipase], screening methods, identified pathologies, the ISS, which was calculated according to these pathologies, and data regarding how the patients were released from the emergency department were recorded. The cut-off values provided in Table 1 below are grouped according to the biochemical reference values and standard medical practices guided by the literature. Free intra-abdominal liquid and/or solid organ injury were considered positive for intra-abdominal injury in patients who underwent extended focused assessment by sonography in trauma (E-FAST).

2.4. Statistical analysis

Statistical analyses of the data were performed using IBM SPSS Statistics for Windows, Version 22.0 (released 2013, IBM Corp. Armonk, NY, USA). The chi-square test was used to compare variables between groups and logistic regression analysis was performed to identify independent predictors. The *t*-test was performed for numerical variables that were normally distributed, whereas the Mann-Whitney *U* Test was used for numerical variables that were not normally distributed. An ROC curve analysis was used in the determination of numerical data. The sensitivity, specificity, positive likelihood ratio (+LR) and negative likelihood ratio (−LR) were calculated.

3. Results

Seventy-four percent of the patients (n = 1927) were male, with a median age of 34 years (IQR 25 to 48). Among the patients included in the study, inside-the-vehicle accidents constituted 54.7% (n = 1424), outside-the-vehicle accidents constituted 20.1% (n = 524), motorcycle accidents constituted 16% (n = 416) and falls constituted 9.2% (n = 240) of the admissions to the emergency department. Summary of the analysis of the demographic characteristics and laboratory parameters of patients with intraabdominal injuries is given in Table 2.

The mean ISS of the included patients was 9.43 (median 0, IQR 0 to 16), and 1.15% of the patients (n = 30) died in the emergency

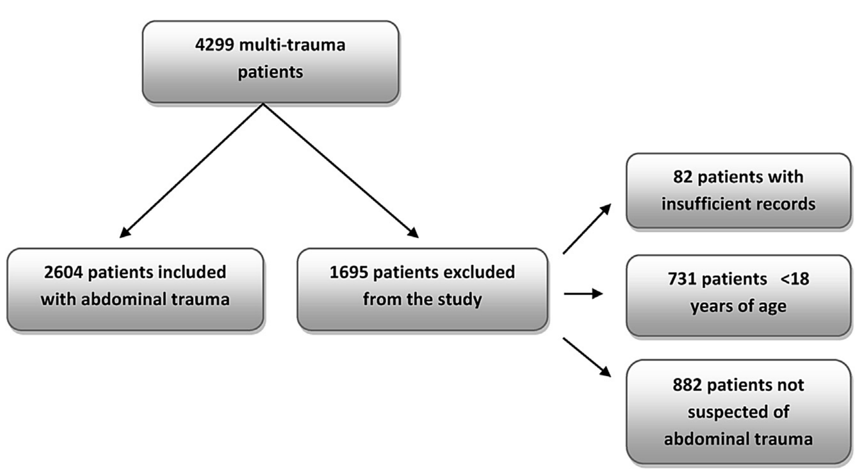

Fig. 1. Data collection process.

Table 1
Grouping of blood tests according to biochemical reference values and medical practice guided by the literature.

Blood test	Cut-off values
Hemoglobin	Less than or equal to 9.9 g/dL; greater than or equal to 10 g/dL
CK	Less than or equal to 175 U/L; 176–854 U/L; greater than or equal to 855 U/L
Myoglobin	Less than or equal to 72 ng/mL; greater than or equal to 73 ng/mL
ALT	Less than or equal to 100 IU/L; greater than or equal to 101 IU/L
AST	Less than or equal to 80 IU/L; greater than or equal to 81 IU/L
Amylase	Less than or equal to 100 IU/L; greater than or equal to 101 IU/L
Lipase	Less than or equal to 60 IU/L; greater than or equal to 61 IU/L

CK: creatinine kinase, ALT: alanine amino transferase, AST: aspartate amino transferase.

Table 2
Summary of the analysis of demographic characteristics and laboratory parameters of intra-abdominal injury patients.

	Without intra-abdominal injury (n = 2472)	With intra-abdominal injury (n = 132)	*p*
Sex			
Female	n = 649 (26.3%)	n = 26 (19.7%)	*p* = 0.093
Male	n = 1821 (73.7%)	n = 106 (80.3%)	
Mechanism			
Inside-the-vehicle accident	n = 1357 (54.9%)	n = 67 (50.8%)	*p* = 0.183
Outside-the-vehicle accident	n = 497 (20.1%)	n = 27 (20.5%)	
Motorcycle accident	n = 399 (16.1%)	n = 17 (12.9%)	
Fall	n = 219 (8.9%)	n = 21 (15.9%)	
Area of injury			
Head	n = 244 (9.9%)	n = 28 (21.2%)	*p < 0.001*
Thorax	n = 167 (6.8%)	n = 80 (60.8%)	
Vertebra	n = 128 (5.2%)	n = 14 (14.4%)	
Pelvis	n = 67 (2%)	n = 21 (15.9%)	
Extremity	n = 191 (7.7%)	n = 7 (5.3%)	
GCS (median)	15 (IQR 15 to 15) (n = 2472)	15 (IQR 15 to 15) (n = 132)	*p < 0.001*
ISS (median)	0 (IQR 0 to 9) (n = 2472)	50 (IQR 34 to 75) (n = 132)	*p < 0.001*
Referral SBP (median)	126 (IQR 110 to 140) mm Hg (n = 2419)	120 (IQR 101 to 135) mm Hg (n = 127)	*p = 0.024*
Referral Pulse Rate (median)	84 (IQR 76 to 93) beats/min (n = 2371)	94 (IQR 80 to 116) beats/min (n = 123)	*p < 0.001*
Referral Shock Index (median)	0.66 (IQR 0.58 to 0.76) (n = 2371)	0.77 (IQR 0.60 to 0.95) (n = 123)	*p < 0.001*
Hemoglobin (median)	14.20 (IQR 12.90 to 15.20)g/dL (n = 2320)	13.75 (IQR 12 to 14.95) g/dL (n = 130)	*p = 0.001*
CK (median)	152.50 (IQR 101 to 240)U/L (n = 866)	400 (IQR 290 to 618) U/L (n = 87)	*p < 0.001*
Myoglobin (median)	106 (IQR 49 to 313.50) ng/mL (n = 793)	929 (IQR 423.75 to 1000) ng/mL (n = 84)	*p < 0.001*
ALT (median)	22 (IQR 16 to 34) IU/L (n = 1864)	92.50 (IQR 26.50 to 217.75) IU/L (n = 120)	*p < 0.001*
AST (median)	24 (IQR 19 to 32) IU/L (n = 1730)	86 (IQR 32 to 234.25) IU/L (n = 98)	*p < 0.001*
Amylase (median)	65 (IQR 51 to 85) IU/L (n = 902)	85.50 (IQR 57 to 119) IU/L (n = 76)	*p = 0.005*
Lipase (median)	32 (IQR 24 to 42)IU/L (n = 1146)	58.50 (IQR 31 to 114.5) IU/L (n = 94)	*p = 0.001*

GCS: Glasgow coma scale, ISS: injury severity score, SBP: systolic blood pressure, CK: creatinine kinase, ALT: alanine amino transferase, AST: aspartate aminotransferase, IQR: Interquartile range.

room. Intraabdominal injury was detected in 5.1% (n = 132) of the study patients. Among the patients with abdominal injuries, 11.4% (n = 15) died, 9.8% were discharged, 1.5% (n = 2) refused treatment, and 1.5% were referred to another center. Of the 132 patients with intraabdominal injuries, 23.5% (n = 31) underwent abdominal surgery.

A statistically significant association was detected between a reference serum ALT level greater than or equal to 100 IU/L and the presence of intra-abdominal injury [odds ratio (OR): 31.22, 95% CI: 19.99–48.77; $p < 0.0001$]. We found a sensitivity of 49.17% and a specificity of 97.08% in the ROC curve analysis (area = 0.80; $p < 0.0001$). The +LR was 16.86, and the −LR was 0.52.

The detection of a serum AST level at referral equal to or greater than 80 IU/L was significantly associated with the presence of intra-abdominal injury (OR: 16.45, 95% CI: 10.56–25.63; $p < 0.0001$). A sensitivity of 51.02% and a specificity of 94.05% were found in the ROC analysis (area = 0.84; $p < 0.0001$). The +LR was 8.57, and the −LR was 0.52.

Statistically significant correlations were found between the SBP, pulse rate, shock index, GCS, abdominal examination, ultrasonography, hemoglobin, serum CK, serum myoglobin, amylase and lipase levels in the study population at referral and the presence of an intra-abdominal injury. The results of the analysis are presented in Table 3.

A scoring system that can be used as a pretest probability to determine the need for abdominal CT, which is used for the detection of abdominal injury in FAST negative patients, was developed in accordance with the OR obtained (Table 4). The new scoring system in Table 4 is adapted from OR values calculated by rounding the numbers. Total score has been estimated by the sum of points obtained from each parameter. Calculation of these values and rounding the numbers have been performed with respect to the publication by Ogura et al..[10]

ROC curve analysis performed to assess the diagnostic values of ALT, AST, lipase, amylase, CK and myoglobin are shown in Fig. 2, while Fig. 3 demonstrates the association of hemoglobin and systolic blood pressure for intraabdominal injury. The pretest probability score was determined for each patient by adding the scores that were obtained from each factor. ROC curve analysis was performed to determine the diagnostic value of the score that was calculated to detect intra-abdominal injury (area = 0.88; $p < 0.0001$, cut of value = 14 (Sensitivity = 83.78, Specificity = 86.36, −LR = 0.19, +LR = 6.14)) (Fig. 4). ROC curve analysis was repeated to determine the diagnostic value of the score that was calculated to detect intra-abdominal injury when excluding FAST positive patients (n = 2418 and 2418 FAST negative and FAST undetermined patients, n = 72 intra-abdominal injury, area = 0.87; $p < 0.0001$ cut of value = 14 (Sensitivity = 83.97,

Table 3
Summary of the analysis of vital signs and laboratory parameters in intra-abdominal injury.

	n	Lost Data	p	OR (95% CI)	Sensitivity	Specificity	ROC Area	+LR	−LR
Vital sign									
Reference SBP ≤ 89 mm Hg	2604	0	$p = 0.001$	7.04 (3.35–14.79)	7.87%	98.8%	0.58	6.57	0.93
Pulse rate≥110 beats/min	2494	110	$p < 0.0001$	6.96 (4.58–10.58)	30.89%	93.97%	0.67	5.12	0.74
Shock Index≥0.9	2494	110	$p < 0.0001$	5.91 (3.96–8.83)	34.15%	91.94%	0.65	4.24	0.72
Physical examination									
GCS≤ 14	2604	0	$p < 0.0001$	8.46 (5.39–13.28)	24.24%	96.36%		6.66	0.79
Traumatic abdominal examination or cannot be evaluated	2604	0	$p < 0.0001$	15.55 (10.69–22.63)	59.09%	91.50%		6.96	0.45
Laboratory									
ALT≥100 IU/L	1984	620	$p < 0.0001$	31.22 (19.99–48.77)	49.17%	97.%	0.80	16.37	0.52
AST≥80 IU/L	1828	776	$p < 0.0001$	16.45 (10.56–25.63)	51.02%	94.05%	0.84	8.57	0.52
Lipase≥60 IU/L	1240	1364	$p < 0.0001$	9.91 (6.31–15.57)	50%	90.84%	0.72	5.46	0.55
Amylase≥100 U/L	978	1626	$p < 0.0001$	4.01 (2.44–6.60)	39.47%	86.03%	0.65	2.83	0.70
Myoglobin ≥73	877	1727	$p < 0.0001$	4.53 (2.38–8.64)	96.43%	37.20%	0.84	1.54	0.10
CK≥855 U/L	952	1652	$p = 0.003$	15.99 (5–51.08)	17.24%	95.61%	0.80	3.93	0.87
Hemoglobin≤9.99 g/dL	2450	154	$p = 0.041$	6.93 (3.91–12.63)	12.31%	98.02%	0.58	6.21	0.89
Ultrasonography									
FAST Positive	2545	59	$p < 0.0001$	98.35 (51.32–188.47)	36.28%	99.42%		63.03	0.64

OR: odds ratio, +LR: positive likelihood ratio, −LR: negative likelihood ratio, SBP: systolic blood pressure, GCS: Glasgow coma scale, CK: creatinine kinase, ALT: alanine aminotransferase, AST: aspartate aminotransferase, FAST: focused assessment with sonography for trauma.

Table 4
Points for the scoring system calculated to detect intraabdominal injury.

Factor	Reference OR		Points
SBP	SBP≤ 89 mmHg for 7.04	≥110 mmHg	0
		100–109	7
		90–99	14
		≤89	21
Pulse rate	≥89 beats/min for 2.87	≤89 beats/min	0
		90–99	3
		100–109	6
		110–119	9
		120–129	12
		≥130	15
GCS	GCS≤ 14 for 8.46	15	0
		≤14	8
Abdominal Examination	Traumatic abdominal examination or cannot be evaluated for 15.55	Normal	0
		Traumatic abdominal examination or cannot be evaluated	16
ALT	≥45 IU/L for 13.05	≤44 IU/L	0
	≥100 IU/L for 31.22	45–99	13
		≥100	31
Hemoglobin	≤9.99 g/dL for 6.93	≥10 g/dL	0
		≤9.99	7

OR: odds ratio, SBP: systolic blood pressure, GCS: Glasgow coma scale, ALT: alanine aminotransferase.

Specificity = 85.71, −LR = 0.19, +LR = 5.88)) (Fig. 5).

4. Discussion

Multitrauma patients represent a challenging and exhausting population of patients who require rapid and accurate decision-making. The order of precedence of diagnostic methods to be used in these patients display a substantial variability and these methods possess advantages or disadvantages compared to each other. Although abdominal CT is considered as the best method for the recognition of intraabdominal injuries, this technique can be utilized only in selected patients due to increased treatment costs, it's the time-consuming nature of the process and the radiation load. However, in cases where abdominal CT scanning is not feasible, biochemical tests may have a predictive value.[7,8] Another issue is the difficulty in the risk classification of patients in the follow-up of solid-organ or viscous injuries that cannot be diagnosed in early stages. At this point, biochemical parameters may aid clinicians in determining those patients at risk. In this study, the predictive value of biochemical parameters in the diagnosis and follow-up of intra-abdominal injuries in multitrauma patients was examined.

The ISS is a tool used to describe the overall severity of an injury. It can be administered to people with sustained injury in more than 1 part of the body and it is determined by scoring every injury with the Abbreviated Injury Scale (AIS). The squares of the highest AIS rating for the 3 most severely injured body areas are added for calculation of ISS. The ISS is supposed to correlate between with mortality than the AIS rating.[11] The noteworthy difference between ISS of patients with and without abdominal trauma is one of the important factors that may affect the difference in terms of variables under investigation in this study. It may be expected that a more severe trauma is more likely to present with more obvious changes in biochemical and radiological measures.

A SBP <90 mm Hg prior to the hospital referral and within the emergency room or the existence of tachycardia were correlated with mortality and intraabdominal injuries in multitrauma patients.[10–14] Similarly, in our study, statistically significant correlations were found between the presence of intraabdominal injury and SBP values or pulse rates at referral. In addition to intra-abdominal injuries, hemorrhage-causing injuries, such as thoracic injuries or pelvic fractures, can lead to hypotension and tachycardia. In the literature, studies that examined the relationship

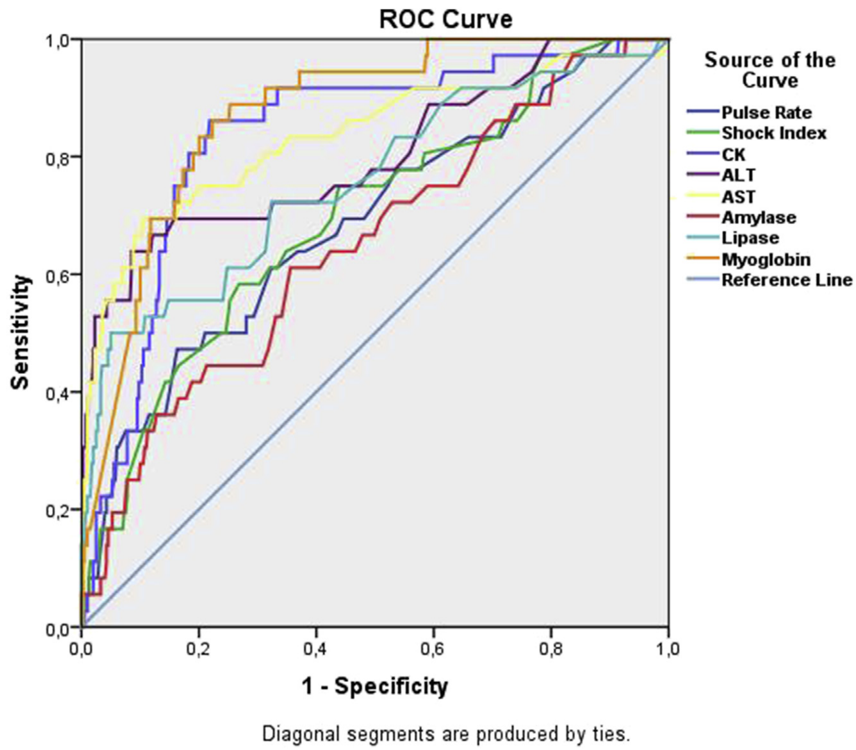

Fig. 2.

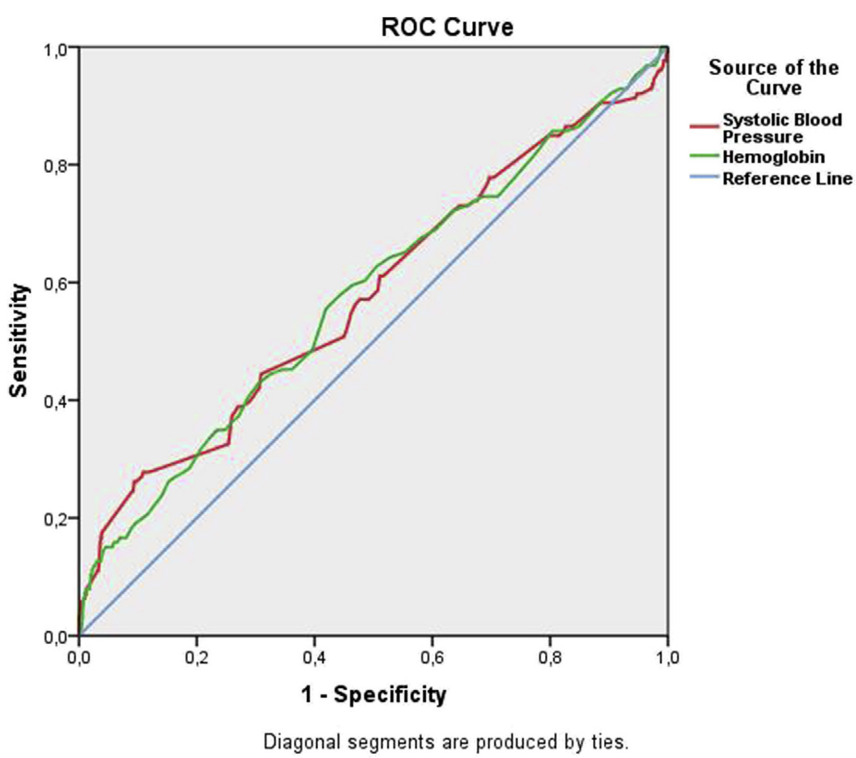

Fig. 3.

between hypotension or tachycardia and intraabdominal injuries did not indicate the presence of an additional injury; also, it was not precisely stated whether the effects of these factors were excluded or not in the analyses. Due to hemorrhage-causing extraabdominal pathologies, SBP measurements <90 mm Hg, a pulse rate >110 beats per minute and shock index values >0.9 are not sufficiently sensitive to predict intraabdominal injuries. Therefore, this finding indicates that these parameters do not possess good positive

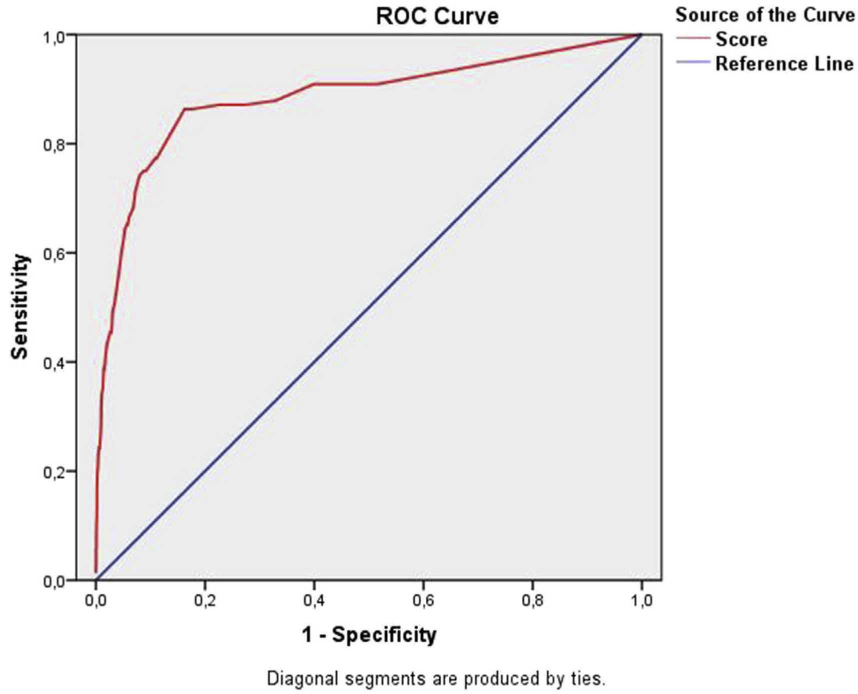

Fig. 4.

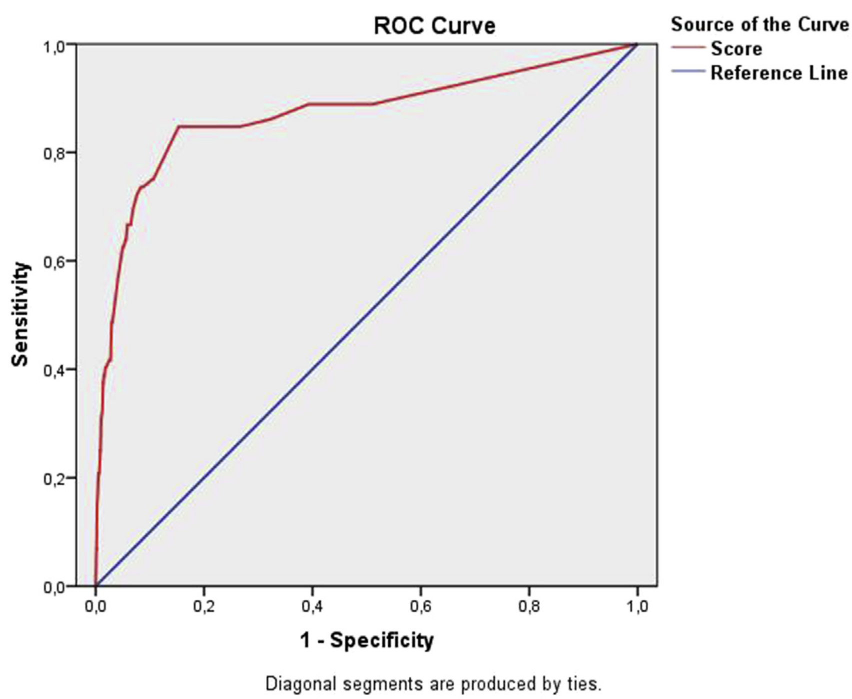

Fig. 5.

predictivity.

Deunk et al. found that a hematocrit level less than 36% was significantly correlated with the detection of an intraabdominal injury with abdominal CT (OR: 2.61, 95% CI: 1.98–3.49).[13] In our study, we obtained results similar to those of previous studies. The analysis of the correlations between the presence of an intra-abdominal injury and hemoglobin levels measured in hemorrhagic shock cases other than intraabdominal injuries yielded a poor accuracy rate and a low sensitivity. According to this finding, hemoglobin and hematocrit measurements alone are not sufficiently predictive in detecting intraabdominal injuries. Additionally, it must be kept in mind that low hemoglobin values should be recognized as a significant marker in assessing the need for further examination to detect intraabdominal injury.

In the literature review, we did not encounter any studies analyzing the relationship between serum CK level and abdominal injury. Therefore, we analyzed serum CK levels in our study by dividing the levels into three groups, $\leq$ 175 U/L, 176–854 U/L and $\geq$855 U/L, according to the laboratory reference limits and the lower limits used for rhabdomyolysis diagnosis. In this study, we found statistically significant relationships between serum CK and myoglobin levels and the detection of an intraabdominal injury. For patients with intraabdominal injuries, this finding more commonly suggests the co-occurrence of other injuries. Myoglobin levels were found to possess a substantially high NPV (99%) when the sensitivity and NPV obtained from the analysis of the correlation between myoglobin and intraabdominal injury were considered. Among the parameters examined in our study, myoglobin was found to have the largest ROC curve area (ROC area: 0.84, Fig. 2). In contrast, statistical significance was found when we examined the correlation between ISS and myoglobin ($t = 15.73$; $p < 0.0001$). This finding reminds that there may be a correlation between high serum myoglobin levels and intraabdominal injury. There is a need for larger scale prospective studies to investigate the relationship between myoglobin and intraabdominal injury that use abdominal CT for emergency room decisions.

Karaduman et al.[8] included 87 hemodynamically stable, pediatric multitrauma patients in their prospective study. The serum ALT and AST values of patients with and without intraabdominal trauma were compared by means of abdominal CT. They detected a significant elevation of serum ALT and AST values in the group of patients who had intraabdominal injury despite not having a liver injury. Karaduman et al.,[8] suggested that serum ALT and AST measurements, together with physical examination, must be used as screening methods in children with blunt abdominal trauma.[8] Ritchie and Williscroft[15] emphasized that liver enzymes could be helpful in the evaluation of patients with blunt abdominal trauma who are hemodynamically stable and unlikely to have liver injuries clinically. Srivastava et al.[16] indicated that liver injury and elevated ALT levels were positively correlated.[16] Tan et al.[7] stated that there was a significant relationship between elevated levels of serum ALT and AST and liver injury in their study that investigated patients with blunt abdominal trauma retrospectively over a three-year period. Also in that study, it was found that normal levels of serum ALT, AST and LDH excluded the possibility of serious liver injury.[7] Among 289 patients who underwent abdominal CT screening due to blunt abdominal trauma, Lee et al.[17] proposed that increased white blood cell counts together with elevated levels of serum ALT and AST were determined to be cogent rationales for the use of screening methods to investigate for liver injury.[17] The findings of our study with respect to the relationship between ALT and AST levels and intraabdominal injury are consistent with the literature. Transaminase levels may increase particularly in injuries of the heart, liver, skeletal muscle, kidneys, pancreas, spleen and lungs. Our study supports that an elevated serum transaminase level can be a significant indicator of intraabdominal injury. Although the association of serum transaminases with the presence of an intraabdominal injury showed a good degree of accuracy in distinguishing whether individuals are healthy or not according to the ROC analysis, the poor sensitivity would not allow the transaminase level to be used alone as a predictive test for intra-abdominal injury.

Moretz et al.[18] demonstrated that there was not a significant relationship between preoperative serum amylase levels and pancreatic injury in 51 patients with blunt abdominal traumas who underwent exploratory laparotomy. They stated that higher levels of posttraumatic serum amylase levels were not reliable for detecting or excluding any pancreatic injury.[18] Our findings are similar to the sensitivity and specificity rates of this study and we imply that the association of referral serum lipase levels with the presence of an intraabdominal injury would not be predictive for intraabdominal injury alone.

As a result, the vital signs, the physical examination findings, the biochemical tests and even the FAST result could not predict intra-abdominal injury alone. Abdominal CT is regarded as the gold standard for the detection of intra-abdominal injury in hemodynamically stable FAST negative patients. Biochemical parameters add only complementary information.[3–5] However, no definitive opinion exists in the literature regarding which patients should undergo intra-abdominal CT screening. A scoring system used to determine a pretest probability score may indicate abdominal CT screening for selected patients if it is used along with tests with a +LR for intra-abdominal injury.[19] In our study, the ROC curve analyses of our scoring system produced good results. Data were missing due to the retrospective design of our study. A substantial amount of the myoglobin and CK data were missing, which reduced the predictive power of the scoring system. The variability in terms of the mechanism of the injury is another restriction that limits the extrapolation of our results to larger populations. Despite these limitations, a scoring system developed by statistical analyses is promising for use as a pretest probability indicator. Use of a pretest probability score would prevent increased costs and unnecessary radiation exposure by making it possible to select patients who should undergo abdominal CT. Additionally, confirming its use in FAST negative patients would inform physicians of the probability of an intra-abdominal injury.

5. Limitation

This study has several limitations. This is a single-center study and results may not be reflecting generalized to other locations. In addition, since the study was retrospective, we had problems in data collection. If this was a prospective study we would have included the patient with a certain history of abdomen trauma and our control groups would be more accurate in this manner. We included the patients who had possible abdominal trauma in the study; however, we could not identify the patients who had undergone surgery regarding their abdominal injury so we could not test the efficiency of our scoring system in recognizing patients who need surgical intervention. Abdominal CT and clinical outcomes were accepted as gold standards in the evaluation of the intra-abdominal injuries of the patients but in a prospective study, ideal gold standard would be multislice abdominal CT for all patients.

6. Conclusion

Vital signs and biochemical parameters can make considerable contributions to the diagnosis of intraabdominal injuries; however, vital signs and blood tests alone are not sufficiently sensitive. Liver function tests and tests for CK and myoglobin levels are not performed in the routine follow-up of trauma patients. Significantly elevated AST, ALT, myoglobin and CK levels in ROC analyses indicate that these parameters could provide significant information, especially for non-operable follow-up patients and cases with occult injuries. Furthermore, due to their high specificity, these tests can be considered to be adjuncts for excluding the possibility of intra-abdominal injury. It has been suggested that it would be appropriate to develop a scoring system in accordance with the relationship of the dependent variables with intraabdominal injury. The clinical applicability of the scoring system that is presented in our study should be tested by further trials on larger prospective series.

Conflicts of interest

None declared.

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