ORIGINAL ARTICLE

Prognostic value of lactate to hematocrit ratio score in patients with severe thoracoabdominal trauma

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ABSTRACT

BACKGROUND: Significant portion of trauma-related deaths occur in the 1st h; therefore, rapid diagnosis and adequate resuscitation in trauma patients are essential preventing mortality. In this study, we aimed to evaluate the role of lactate-to-hematocrite ratio (LHR) score for predicting mortality in patients with severe thoracoabdominal trauma.

METHODS: In this retrospective, cross-sectional study, we evaluated patients who applied to the emergency room between January 1, 2016, and December 31, 2019, due to multiple trauma. We measured the blood gas analysis values and LHR score of patients with severe thoracoabdominal trauma included in the study and investigated the effectiveness of the LHR score in predicting mortality.

RESULTS: 106 patients with severe thoracoabdominal trauma were included in the study. The 30-day mortality rate of the patients was 42.5% (n=45). Considering the 30-day mortality rates, the initial hematocrit, lactate, base deficit, and LHR score were statistically different between patients who died and survived. When the cutoff value for the LHR score was taken as 0.187 on the ROC curve to distinguish mortality, the sensitivity was found to be 77.8%, specificity to be 90.2%.

CONCLUSION: LHR score is an effective parameter with high sensitivity and specificity in predicting mortality in patients with severe thoracoabdominal trauma.

Keywords: Hematocrit; lactate; mortality; trauma.

INTRODUCTION

Thoracoabdominal injuries are the most frequent accompanying injuries and the second most common cause of death in multiple trauma patients.[1] Emergency departments are the most important step for the management of multiple trauma patients. Early diagnosis and treatment of life-threatening conditions in multiple trauma patients are an important issue for the clinician racing against time.[2]

Even the vital findings are very important to determine the hemodynamic stability; they remain incapable to detect the shock status especially in the early period of trauma. Therefore, the algorithms and physical examination findings, vital findings, and laboratory and imaging methods determined in the management of the trauma patients are evaluated as a whole.[2,3]

The blood loss is the most important cause of death in thoracoabdominal injuries. It is also one of the most important parameter in the shock staging. The mortality is directly related with the severity of blood loss, in other words with the low hematocrit value.[2,4] However, the cause of death in multiple trauma patients is not only due to the hemorrhagic shock. Obstructive shock conditions such as tension pneumothorax and cardiac tamponade, and respiratory failure such as flail chest and lung contusion may also be the cause of death. In this group of patients, hematocrit level can be determined as normal. Moreover, the hematocrit level can be normal in the early periods of hemorrhagic shock.[2] Once more, since the

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basal hematocrit level of the patients is mostly unknown. It can be difficult to determine the decrease of hematocrit level according to the basal value of the patients. Therefore, the hematocrit level is not decisive alone in the trauma management.

The lactate is a product of anaerobic metabolism as a result of the deterioration of tissue perfusion and oxygenation. Blood lactate levels have been shown to be a valuable parameter in predicting mortality in critical diseases such as sepsis and shock, as well as in the evaluation of resuscitation efficiency in cardiopulmonary resuscitation.[5–8] In addition, many studies have shown that lactate levels and lactate clearance are also a valuable marker in evaluating the severity and prognosis of patients with multiple trauma.[9–11]

In the light of these informations, it may be more meaningful to use lactate level and hematocrit level as a common parameter in multiple trauma patients. To the best of our knowledge, there is no previous study evaluating these two parameters together in the literature. Therefore, in our study, we aimed to evaluate the role of lactate-to-hematocrit ratio (LHR) score in the patients with severe thoracoabdominal trauma in predicting the mortality.

MATERIALS AND METHODS

Study Design

This study is a retrospective and cross-sectional study conducted in the emergency department of Medicine Faculty of Manisa Celal Bayar University. Patients with severe thoracoabdominal trauma admitted between January 1, 2016, and December 31, 2019, were evaluated. The ethical committee approval with a decision number 20.478.486 and dated October 23, 2019, was obtained from the Ethical Committee of Medicine Faculty of Manisa Celal Bayar University.

Study Population

733 multiple trauma patients applied to our emergency department between 2016 and 2019 were examined by scanning the hospital automation system and patient files. The multiple trauma patients who were 16 years and older, had thoracal, and/or abdominal trauma findings according to the physical examination and tomography findings, died in the emergency department or were admitted to intensive care unit (ICU) were included in the study. The criteria for thoracic trauma findings were determined as pneumothorax, hemothorax, more than 2 rib fractures, flail chest, extensive lung contusion, and cardiac contusion. Abdominal trauma findings criteria were determined as solid organ injury, intra-abdominal fluid detection, and penetrating abdominal injury. Patients who were under the age of 16, who had no signs of thoracic or abdominal trauma, who discharged from the emergency room or admitted to the clinic (not ICU) were excluded from the study. Furthermore, patients transferred from another facility to our hospital, or transferred to another hospital from our emergency room were not included in the study.

Data Collection

627 of 733 patients with multiple or penetrant thoracoabdominal trauma were excluded as they did not meet the study criteria (Fig. 1). 106 patients with thoracoabdominal trauma who met the study criteria were included in the study. Demographic data of the patients, trauma mechanisms, trauma regions, initial venous blood gas values (hemogram, hematocrit, lactate, base deficit, and pH), lactate-to-hematocrit ratio, surgical interventions, emergency outcomes, intensive care hospitalization times, and 30-day outcomes were recorded in the study form.

Statistical Analysis

The data were evaluated using Statistical Package for the Social Sciences 22, IBM, USA. The descriptive statistics for the continuous variables (characteristics) were presented as mean and standard deviation (SD) while counting and as percent for the categorical variables. The t-test was performed for the parametric variables when two independent groups were compared and the Mann–Whitney U Test was used while the parametric test assumptions were not met. The sensitivity and specificity were determined by calculating the area below the ROC curve to determine whether the lactate and LHR values were effective to distinguish the mortality. $P<0.05$ was considered statistically significant.

RESULTS

The mean age of 106 patients evaluated in the study was 41.03±18.8 and 78.3% of them (n=83) were male, 21.7% of them (n=23) were female. Evaluation of the patients according to trauma mechanism has shown; 32.1% (n=34) of 106 patients were inside-the-vehicle accidents, 22.6% (n=24) were falls, 17% (n=18) were outside-the-vehicle accidents, 11.3%

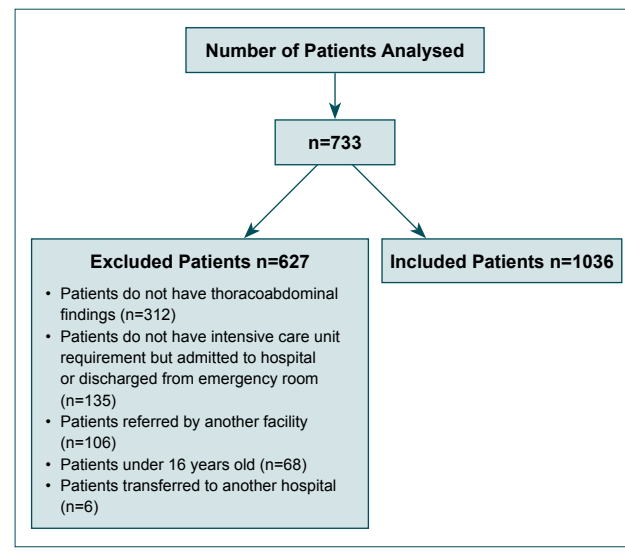

Figure 1. Patient flow chart.

Table 1. Demographic characteristics, trauma mechanisms, trauma regions and management summary of the patients

	n	%
Sex		
Male	83	78.3
Female	23	21.7
Trauma mechanism		
Car accidents	34	32.1
Falling	24	22.6
Pedestrian injury	18	17
Motorcycle accident	12	11.3
Gun shot injuries	10	9.4
Sharp object injuries	8	7.5
Trauma region		
Thorax	77	72.6
Abdomen	63	59.4
Head and neck	44	41.5
Pelvis	40	37.7
Extremity	37	34.9
Vertebra	20	18.9
Genitourinary	16	15.1
Surgery intervention		
Thorax	35	33.0
Abdomen	32	30.2
Pelvis	17	16.0
Genitourinary	8	7.5
Head and neck	6	5.7
Patients end-points		
Exitus in ED	31	29.2
ICU admission	75	70.8
Discharged from ICU	61	57.5
Death in the ICU	14	13.2
30-days mortality	45	42.5

ED: Emergency department; ICU: Intensive care unit.

(n=12) were motorcycle accidents, 9.4% (n=10) were firearm injury, and 7.5% (n=8) were sharp object injury. When trauma regions were evaluated, thoracic trauma findings were found 72.6% (n=77) of the patients and abdominal trauma findings were found 59.4% (n=63) of the patients. The most frequently accompanying traumas were head (n=44) and pelvic trauma (n=40). Thoracic intervention was applied to 35 (33%) patients (31 tube thoracostomy and four thoracotomy). Abdominal surgical intervention was applied to 32 (30.2%) patients (Table 1). About 55.7% (n=59) of the patients were intubated in the emergency department. 31 patients died in the emergency department, and 75 patients were hospitalized in the ICU. 14 of 75 patients died in the ICU, 61 of them were discharged from ICU. 30-day mortality ratio of the patients was 42.5% (n=45).

The mean laboratory values of the patients are given in Table 2. When the patients were evaluated according to 30-day mortality; the mean hematocrit value, lactate value, base deficit, and LHR score of died patients (n=45) were statistically different from discharged patients (n=61), (p=0.004, p<0.001, p<0.001, and p<0.001, respectively) (Table 2).

When the cutoff value for the LHR score was taken as 0.187 on the ROC curve to distinguish the mortality, while the sensitivity was found as 77.8%, the specificity was found as 90.2% (AUC:0.886, %95 CI: 0.816–0.956) (Fig. 2). When the cutoff value for the lactate levels was taken as 5.45 on the ROC

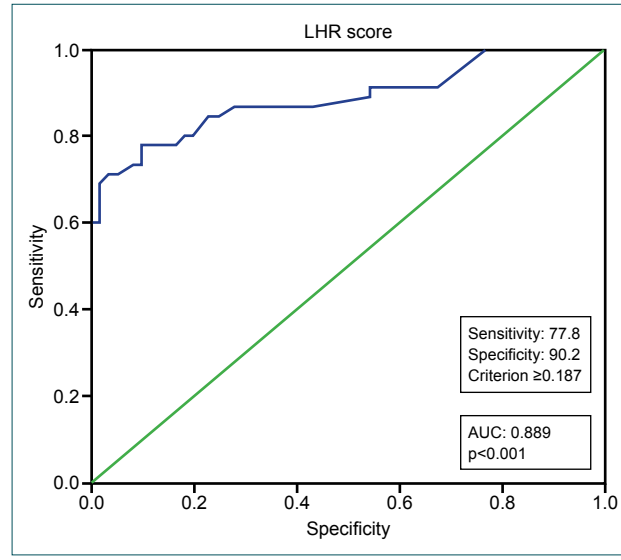

Figure 2. ROC curve of LHR score in order to distinguish the mortality.

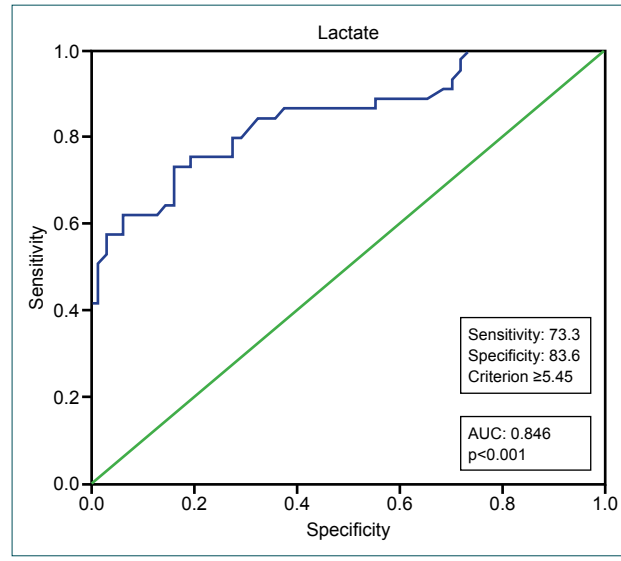

Figure 3. ROC curve of lactate in order to distinguish the mortality.

Table 2. Laboratory parameters of the patients and comparison with 30-day mortality

	Total (n=106)		30-day mortality Survivors (n=61)		30-day mortality Non-survivors (n=45)		p-value
	Mean	SD	Mean	SD	Mean	SD	
Age	41.03	18.80	36.14	17.64	47.64	18.46	0.45
Hemoglobin	11.45	3.02	12.55	2.16	9.96	3.39	0.016
Hematocrit	34.99	8.92	38.19	5.99	30.64	10.37	0.004
Lactat	6.31	4.60	3.93	2.07	9.53	5.11	<0.001
LHR ratio	0.222	0.260	0.106	0.058	0.380	0.336	<0.001
Base excess	-8.09	6.85	-4.66	3.76	-12.75	7.36	<0.001
pH	7.23	0.18	7.33	0.08	7.11	0.19	<0.001

LHR ratio: Lactate-to-hematocrit ratio; SD: Standard deviation. P-value was evaluated between the survivors and non-survivors group.

curve, while the sensitivity was found as 73.3%, the specificity was found as 83.6% (AUC: 0.846, %95 CI: 0.769–0.923) (Fig. 3), and when the cutoff value for the base excess levels was taken as -7.4 on the ROC curve, while the sensitivity was found as 85.2% and the specificity was found as 80% (AUC:0.845, %95 CI: 0.760–0.930) (Fig. 4).

DISCUSSION

In our study, we have detected that 0.187 cutoff value of LHR score had high sensitivity and specificity (77.8% and 90.2%, respectively) for predicting the mortality in patients with severe thoracoabdominal trauma.

The majority of patients were male and young adult patients as all the trauma patients in the world.[2] A significant part of the traumatic deaths occurs in the 1st few hours. Rapid diagnosis and sufficient resuscitation are the main steps for preventing mortality. The diagnostic tests such as laboratory and imaging methods are evaluated as a whole in trauma management. The most important one among the laboratory tests is the blood gas analysis as it is cheap and gives a rapid result. We can quickly obtain informations about the level of blood loss, volume condition, metabolic status, tissue perfusion, and oxygenation of the patient by blood gas analysis.[12]

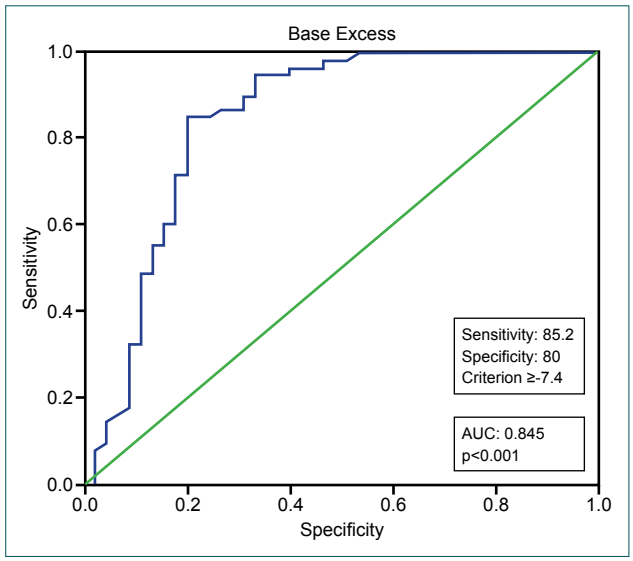

Figure 4. ROC curve of base excess in order to distinguish the mortality.

In a study conducted by Zehtabchi et al.,[13] they found that the decrease in hematocrit level in trauma patients was associated with major injury, but normal levels could not rule out serious injury. Therefore, they stated that hematocrit level alone is not sufficient to detect major injuries. Callaway et al.[9] investigated the effectiveness of lactate levels and base deficit for predicting mortality in normotensive blunt trauma patients and found that both lactate level and base deficit were associated with mortality. However, they noticed the initial normal values of lactate level and base deficit were not sufficient as a good prognosis marker. Congruently, Parsikia et al.[14] reported that initial lactate level in trauma patients may be an effective marker in predicting both mortality and surgical intervention. In contrast, Pal et al.[15] reported that initial serum lactate level was not effective in predicting mortality in trauma patients in a comprehensive study. However, they had specified that the lactate level could be connected with mortality in the group that was hospitalized in the ICU or was applied surgical intervention.

Similar to the above studies, we found in our study that both serum lactate level and base deficit were effective in predicting 30-day mortality in patients with severe thoracoabdominal trauma. In addition, we think that the LHR score has higher sensitivity and specificity in predicting 30-day mortality. Therefore, it can be a more valuable measurement.

In the management of critical patient, the lactate level decreases as the patient's volume and oxygenation level are corrected. Therefore, the lactate clearance is a more effective parameter than the lactate in evaluating the effectiveness of the treat-

ment and patient prognosis in the critical circumstances such as sepsis and shock. Lactate clearance has also been shown to be effective in predicting mortality in trauma patients.[16–18] In addition, low hematocrit levels is an indicator of blood loss. Blood replacement and volume resuscitation are vital in these patients. Evaluation of lactate and hematocrit levels together may more helpful for management of severe trauma patients. For this reason, the calculation of the baseline LHR score as well as control LHR scores with serial blood gas evaluations and aim to decrease this ratio may be important in terms of good prognosis, especially in severe trauma patients. We think that valuable information can be presented to the literature about this subject by the future studies.

Limitations

In our study, we evaluated patients with severe thoracoabdominal trauma who died in the emergency room or were hospitalized in intensive care. Therefore, we cannot generalize our results to all trauma patients, including mild or moderate trauma patients. Another limitation was the low number of patients. More comprehensive studies are needed.

Conclusion

Thoracoabdominal injuries are the most common injuries in multiple trauma patients. Management of trauma patient is a complex process in which clinical, laboratory, and imaging methods are interpreted together. Blood gas analysis provides rapid and important informations about the trauma patient's volume and metabolic status and helps the clinician to more accurate decisions. The LHR score calculated by blood gas analysis can be a guide in the management and predicting prognosis of the thoracoabdominal trauma patients. Hemorrhagic shock caused by blood loss is the most common cause of death in thoracoabdominal trauma patients. Furthermore, lactate level, which is an indicator of tissue perfusion and oxygenation impairment, is correlated with mortality. All that parameters obtained from blood gas analysis can be used to evaluate severity of injuries and prognosis of trauma patients separately. LHR seems to be a more valuable parameter in predicting mortality than hematocrit, lactate, or base deficit alone.

Ethics Committee Approval: This study was approved by the Manisa Celal Bayar University Faculty of Medicine Ethics Committee (Date: 30.10.2019, Decision No: 20.478.486).

Peer-review: Internally peer-reviewed.

Authorship Contributions: Concept: B.D.; Design: B.D.; Supervision: B.D.; Resource: B.D., E.S.G.; Materials: B.D., E.S.G.; Data: M.İ.Ş., A.B.; Analysis: M.İ.Ş., A.B.; Literature search: B.D., M.İ.Ş.; Writing: B.D., M.İ.Ş.; Critical revision: E.S.G., A.B.

Conflict of Interest: None declared.

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ORİJİNAL ÇALIŞMA - *ÖZ*

Ciddi torakoabdominal travma hastalarında laktat-hematokrit oranının prognostik değeri

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AMAÇ: Travmaya bağlı ölümlerin önemli bir kısmı ilk saatlerde olup, hızlı tanı ve yeterli resüsitasyon mortalitenin önlenmesinde büyük önem taşımaktadır. Bu çalışmada, ciddi torakoabdominal travmalı hastalarda lactate-to-hematocrite ratio (LHR) skorunun mortaliteyi öngörmedeki rolünü değerlendirmeyi amaçladık.

GEREÇ VE YÖNTEM: Bu geriye dönük, kesitsel çalışmamızda 1 Ocak 2016–31 Aralık 2019 tarihleri arasında acil servise çoklu travma nedeniyle başvuran hastaları değerlendirdik. Çalışmaya alınan ciddi torakoabdominal travmalı hastaların kan gazı analiz değerlerini ve LHR skorunu ölçtük ve LHR skorunun mortaliteyi öngörmedeki etkinliğini araştırdık.

BULGULAR: Ciddi torakoabdominal travmalı 106 hasta çalışmaya alındı. Hastaların 30 günlük mortalite oranı %42.5 (n=45) idi. Hastaların 30 günlük mortaliteye göre ölenlerle kurtulanlar arası başlangıç hematokrit, laktat, baz açığı ve LHR skoru istatistiksel olarak farklıydı. LHR skoru kestirim değeri, ROC eğrisi üzerinde 0.187 olarak alındığında %77.8 duyarlılık, %90.2 özgüllüğe sahipti.

TARTIŞMA: Ciddi torakoabdominal travmalı hastalarda LHR skoru mortaliteyi öngörmede yüksek duyarlılık ve özgülleğe sahip etkili bir parametredir.

Anahtar sözcükler: Hematokrit; laktat; mortalite; travma.

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