Changes of the Blood Lymphocytes On Severe Trauma Patients in Early Time

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Abstract

Purpose: To evaluate the relationship between the change of blood lymphocyte counts in early stages of trauma patients and the secondary tissue injury after trauma.

Method: A retrospective study was conduct to include trauma patients with Injury Severity Score(ISS) ≥16 between January 1st, 2018 and December 31st, 2019. Lymphocyte counts of each trauma patient were collected and recorded in first 3 hours, 6-12 hours, 24-48 hours, and 49-72 hours after trauma, separately. The degree of secondary on the trauma patients were evaluated according to the results of laboratory tests, the time stay in ICU and received mechanical ventilation, and 28-day outcome. Correlation analysis was performed between lymphocytes change and the score of the secondary tissue injury in severe trauma patients.

Results: The lymphocyte count within first 3 hours after trauma was significantly high,the median was 4.03×10^9/L, then dropped significantly in 6-72 hours after trauma (median: 0.85~0.99×10^9/L), there was a significant statistical difference between the lymphocyte count within first 3 hours after trauma and that in 6-72 hours（P=0.000). The ratios of the lymphocytes counts in 6-72 hours to that within first 3 hours after trauma were very low, the median value was 0.22-0.27. The results of regression statistical analysis showed that the change of lymphocyte counts significantly associated with the severe degree of secondary injury (P=0.000). The lymphocyte ratio change can be used to predict the possibility of trauma patients secondary severe tissue injury occurred [Area Under the Curve(AUC) on the ratios of the lymphocytes counts in 6-72 hours to that within first 3 hours after trauma was 0.789, 0.840, 0.861, respectively]. The predictive thresholds of lymphocyte ratio of the trauma patients in the study were 0.31 to 0.35, the prediction sensitivity were 78% to

89% and specificity 74% to 84%. The lymphocyte counts there was significant difference between the patients with assessed as serious secondary tissue injury(87cases) and patients without(25 cases), the median value was 0.21-0.24 , 0.38-0.62, respectively , P=0.000.

Conclusion: Lymphocytes counts was significantly increased in the trauma patients with ISS score ≥16 within the first 3 hours after trauma, then decreased significantly in 6-72 hours after trauma. The change of lymphocyte count was significant relationship with the degree of secondary tissue injury, that can be used to predict the degree of secondary severe tissue injury occurred by inflammatory reaction in trauma patients.

Keywords： lymphocytes, severe trauma, secondary tissue injury

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Introduction

Trauma associated tissue injury initiates a release of a large number of cytokines, that lead immune activation and induce major immune dysregulation. Patients may present severe systemic inflammatory response (SIRS) or compensated anti-inflammatory immune response syndrome(CARS), that cause trauma patients second hit, and the direct or indirect interactions between SIRS and CARS more aggravate the tissue injury [1, 2, 3]. The degree of secondary tissue injury in trauma patients associated with the inflammatory levels， severe inflammatory reaction eventually lead more tissue injury, multiple organ dysfunction syndrome (MODS), and severe shock [4,5]. Lymphocytes often plays an important role in the immune response, changes of lymphocyte counts and expression in trauma patients must be associated with post-traumatic inflammatory response [6, 7]. This study was intended through analysis the relationship between the lymphocyte count change and the degree of secondary tissue injury in trauma patients, and the feasibility through assessing the change of lymphocyte count in trauma patients to predict the degree of secondary tissue injury in trauma patients.

Material and Methods

1. Study setting

This was a retrospective study of trauma patients with ISS score was equal or more than 16 points admitted in the ICU of a tertiary hospital of Shenzhen City, Guangdong, China, between January 2018 and January 2020. To evaluate the characteristics of lymphocyte count changes in trauma patients, a certain number of non-surgical and

non- traumatic patients in ICU were randomly selected as control group in same period. The study setting and data collection were approved by the Medical Ethics Committee of the hospital. This retrospective study will not interfere with the treatment of patients, will not cause damage to the rights of patients and the clinical data collection of the patients were agreed with the written consent of the patients and their families, and all the study protocols were approved by the patients or their families, the paper of approval content form was preserved in patient medical history records.

2. Patients

2.1.demography： The patients' age, sex, injury mechanism and site, time from the scene to the emergency department(ED); the kind (crystals, blood products, etc.) and quantity of fluid infusion on the trauma patients within first three days were recorded, ISS score was calculated and recorded according to scoring Criteria published by China Trauma Treatment Alliance (*http://www.ctrta.org.cn*).

2.2.Exclusion criteria：Burn patients; the patient died within 24hours after trauma or death caused by trauma directly, the patients with infused crystal fluid more than 4000ml or transfusion of packed red blood cells exceeding 10 units in first 8 hours after trauma; the patients with chronic important organs disease history, or with had been taken of any immune inhibitor or a history of autoimmune disorders Recently; the patients with a history of hospitalization or operation within the last month; or the age was older than 70 years or younger than 14 years; the patients transferred from other hospitals, or the time from scene to ED was over 3 hours, or stayed in the hospital less than 24 hours;

3. Data collection and evaluation

3.1. Lymphocyte count: The blood sample was drawn though femoral vein of the patients by trained qualified medical staff in the ED and the ICU of the hospital. All of blood sample tested using automatic blood analyzer （XT-1800i， Sysmex corporation, Tokyo, Japan）. The results of the lymphocyte count of the trauma patients were collected and recorded according to within the first 3 hours (trauma group A, TrA), 6-12 hours (trauma group B, TrB), 24-48 hours (trauma group C, TrC),

and 49-72 hours (trauma group D, TrD) after trauma. The results of the lymphocyte count of control groups were obtained at the same time interval when admission in ICU, also divided four groups.

3.2. Evaluation the degree on secondary tissue injury in the trauma patient:

3.2.1. Collection of the results of laboratory test: The trauma patients results of lactic dehydrogenase (LDH), creatine kinase (CK), C reactive protein (CRP) within 24-72hours after trauma were provided by the clinical laboratory of the hospital.

3.2.2. Clinical evaluation: Shock index evaluated at emergency department. SIRS score [8] and sepsis-related organ failure assessment (SOFA) score [9] were evaluated began at the third day after trauma.

3.2.3. Clinical outcome: The length time of stay in ICU, time of received mechanical ventilation, the length time of stay in hospital, mortality in hospital and the incidence of local or system infection were collected.

3.2.4. The score of degree on secondary tissue injury with trauma patients: In order to evaluate the degree of secondary tissue injury in trauma patients more comprehensively, this study designed an evaluation scale on secondary tissue injury cumulative scores using the above data (Table 1). Patients with a cumulative score ≥ 4 were considered to have serious secondary tissue injury, and the comprehensive score was 1, on the other hand, if the patient's cumulative score was <4 scores, was considered no serious secondary tissue injury, the comprehensive score was 0.

Table 1. Assessment of secondary tissue injury degrees in trauma patients

Subject	Item	assessment criteria	cumulative score
Lab result	LDH（U/L）	≥1000, or twice (Interval 12 hours) ≥700, 1 point	≥2 points, 1 score
	CK（U/L）	≥1000, or twice (Interval 12 hours) ≥700, 1 point	
	CRP（mg/L）	>50mg/L , 1point	
Clinical evaluation	SIRS(scores)	≥2 , 1point	≥2 points 1 score
	SOFA(scores)	≥5 at the third day after trauma, 1point	
	System or local infection	developed infection 48 hours later, 1point	
Clinical Outcome	Patient outcome	hospitalized more than 28 days or died	Yes: 1score
	stay time in ICU	≥ 7day	Yes: 1score
	mechanical ventilation	≥24hours	Yes: 1score

Note: 1. The assessment time of stay in ICU and mechanical ventilation were determined according to the median of all trauma patients observed in this study; 2. Patients with cumulative scores of ≥ 4, be considered to have serious secondary tissue injury, and the comprehensive score was 1 (serious), the patient with cumulative scores

were <4, be considered non secondary tissue injury, the comprehensive score was 0 (not serious). All examinations were recorded on a personal computer for subsequent blind analysis.

4. Statistical Analysis

Statistical software package SPSS statistics 22(Chicago, Illinois, USA) was used for statistics. Paired T test was used to compare the lymphocyte values between each trauma group and between the trauma group to the corresponding control group. Binary logic analysis was used to analyze the correlation between peripheral blood lymphocyte count changes and the secondary tissue injury score in all trauma patients. Receiver operating characteristic curve (ROC curve) and Youden index were used in the trauma patients to evaluate the feasibility of lymphocyte change in predicting secondary tissue injury, and the determination of cutoff values and sensitivity and specificity.

Result

1. **Patients:** 112 severe trauma patients were conformed to the inclusion criteria in this study period,there were 23 patients dead. 60 patients were selected as control groups in same period. The demographic characteristics of the trauma patients and control patients were shown in table 2, table 3.

Table 2. Demographic, injury, and outcome Characteristics (n=112)

Variable		Total
Age,	median (IQR), y	42.5 (34-52）
Male	n (%)	92(82%)
Mechanism of injury		
Traffic accident	n (%)	46 (41%)
High fall accident	n (%)	28 (25%)
Blunt wounded	n (%)	18 (16%)
Sharp instrument injury	n (%)	13 (11%)
Fall	n (%)	7 (6%)
Multiple injury	n (%)	52（46.4%）
Mortality in hospital	n (%)	22(19.6%)
time from scene to ED (h)	median (IQR)	1.5 (1-2)
ISS	median (IQR)	31 (25-41)
SOFA	median (IQR)	7 (5-9)
Shock index (SBP / heart)	median (IQR)	0.75 (0.50-0.98)
Mechanical ventilation time (h)	median (IQR)	22 (10-63)
stay time in ICU (day)	median (IQR)	7.0 (2.5-16.4)

Note: IQR，inter quartile range; ISS, injury severity score; SOFA, sepsis-related organ failure assessment

Table 3. Demographic, clinical Characteristics of control group (n=60)

Variable		Total
Age	median (IQR), y	52(43-57)
Male	n（%）	37 (61.7%)
Clinical diagnosis		
Location or system infection	n（%）	30 (50%)
Diabetic ketoacidosis	n（%）	7 (11.7%)
Drug poisoning	n（%）	4 (6.7%)
Severe heatstroke	n（%）	3 (5%)
Upper gastrointestinal hemorrhage	n（%）	2 (3.3%)

Note: IQR，inter quartile range;

2. **Lymphocyte count:** The lymphocyte counts of the trauma groups and the control groups are shown in table 4. The lymphocyte count of TrA was significantly higher than that of other trauma groups and all of control groups, with significant statistical difference（P=0.000). The lowest value presented in TrB, while the lymphocyte count in TrC and TrD showed a small rise, however there were not statistical significant differences between these trauma groups, also there was no statistical difference with the corresponding control groups.

Table 4. Peripheral blood lymphocyte count in trauma groups and control groups

Group	No	Sampling time(h)	Lymphocyte ($n\times10^9$ / L)		Students Test	
		Median	M±SD	(Median，IQR)	Trauma ： Control	between Trauma groups
Tr A	113	1.5	4.07±1.77	（4.03, 2.68—5.19）	P=0.000	
Con A	60	2.5	1.11±0.70	（0.93, 0.54—1.51）		
Tr B	110	7.6	0.98±0.51	（0.85, 0.57—1.30）	P=0.666	A：B P=0.000
Con B	60	8.0	0.97±0.49	（0.90, 0.52—1.24）		
Tr C	111	17.5	1.12±0.67	（0.96, 0.65—1.39）	P=0.334	A：C P=0.000
Con C	60	21.0	1.11±0.50	（1.03, 0.64—1.36）		B：C P=0.064
TrD	106	55.5	1.17±0.66	（0.99, 0.71—1.48）	P=0.359	A：D P=0.000
Con D	60	60.4	1.20±0.58	（1.09, 0.69—1.54）		B：D P=0.046
						C：D P=0.822

Note: TrA, TrB, TrC, TrD, means trauma group A , B, C and D, respectively; ConA, ConB, ConC, ConD, means control group A, B, C and D, respectively; IQR，inter quartile range; A:B means statistical compare between trauma group A and trauma group B, and so on.

3.Lymphocyte count hierarchical evaluation: The normal reference range of lymphocyte count accepted in the hospital is 1.1 ~ 3.2 10^9 / L. According to the result of lymphocyte count, all of patients in each trauma group or control group divided into three subgroups: greater than Upper limit of normal range; normal; less than low limit of normal range. The results lymphocyte count hierarchical of patients showed in table 5 and the bar chart of lymphocyte count hierarchical level in trauma groups showed in Figure 1. Within the first 3 hours after trauma, the lymphocyte counts in 66% of the trauma patients increased higher than the upper limit of normal range, only 1.6% patients were lower than the low limit of the normal range. On the contrary, within 6-72hours after trauma, there were more than 57% patients which the lymphocyte counts were less than the low limit of normal range. During the same period, more than 52% the control patients that the lymphocyte count lower than the low limit of normal range.

Table 5. The subgroup numbers of hierarchical level according to lymphocyte normal range

Group	Lymph. count（×10^9/L）		
	⩾3.2 (Ⅰ)	1.1-3.2 (Ⅱ)	<1.1 (Ⅲ)
TrA (n.112)	74（66.1%）	35（31.3%）	1（0.9%）
ConA（n.60）	1（1.6%）	25（42%）	34（57%）
TrB (n.110)	0	39（34.5%）	69（62.7%）
ConB (n.60)	0	29（48%）	41（68%）
TrC (n.111)	1（0.9%）	41（36.9%）	68（61.3%）
ConC（n.60）	0	26（40%）	34（60%）
TrD (n.104)	1（0.9%）	52（50.0%）	59（56.7%）
ConD（n.60）	0	29（48%）	31（52%）

Note: TrA, TrB, TrC, TrD, means trauma group A , B, C and D, respectively; ConA, ConB, ConC, ConD, means control group A, B, C and D, respectively;

4. **Assessment the influence of fluid infusion quantity to lymphocyte count:**

4.1.Calculated the fluid balance: The liquid equilibrium quantity was calculated by the infusion volume minus the loss volume. The lost volumes of every trauma patient was obtained accordance with the internal hematoma volume and hemorrhage volume, urine volume, drainage volume in the patients operating records and ICU care records in this study. The fluid balance results of infusion quantity of trauma groups in first 3days after trauma were showed in Table 6.

4.2. To assess influence of fluid infusion quantity to lymphocyte count: Calculated

the inter quartile range of fluid balance quantity in the every trauma group, the patients in every trauma group with more than the high quartile range (>75%) or less than low quartile range (25%) were selected and divided into two subgroups, compared the lymphocyte count difference between the two subgroups, the result was no statistical difference (Table 7).

Table 6. Status of fluid balance on the four trauma groups within 72hours after trauma

Group (No)	Interval(hour)	Median (ml)	IQR
Tr A(110)	0-3	3190.0	1892.5 — 4787.5
Tr B (109)	6-12	381	-261.0 — 1226.0
Tr C (100)	13-24	-21.0	-857 — 763.0
Tr D (85)	48-72	122.0	-523.0 — 582.0

Note: 1. TrA, trauma group A, TrB, TrC, TrD, as the same meaning; IQR，inter quartile range;

Table 7. Comparison of the lymphocyte count between the low quartile and the high quartile of fluid balance in the trauma group

Limit fluid value of dividing subgroup (ml)	No	Lymph counts（$\times 10^9$/L）		student test
Trauma A		Mean ± x	median	P
low quartile （1890）	25	3.81±1.69	3.92	0.678
high quartile（4780）	28	3.66±1.39	3.71	
Trauma B				
low quartile （-260）	32	0.88±0.42	0.83	0.377
high quartile （1230）	27	1.03±0.54	0.93	
Trauma C				
low quartile （-860）	25	1.10±0.77	0.92	0.600
high quartile （760）	23	1.26±0.77	0.99	
Trauma D				
low quartile （-520）	19	1.27±0.58	1.25	0.566
high quartile （580）	16	1.15±0.66	0.90	

Note: the subgroups were divide according to the value of the low quartile (<25%) and high quartile (>75%) of the fluid value of the inter quartile interval.

5. Lymphocyte count ratio： To analysis the lymphocyte count difference in the trauma patients between the four time periods in the study, calculated the lymphocyte count of TrA to the lymphocyte count of TrB, TrC, TrD ratio, respectively, the results showed the median values of lymphocyte in TrB, TrC and TrD were only 0.22 to 0.27 times of the trauma group A, respectively (table 8) .

Table 8. The ratio of lymphocyte count in trauma group B, C and D to trauma group A

Group	n	Mean ± x	Median	S	L
B/A	110	0.28±0.24	0.22	0.05	2.00
C/A	111	0.33±0.25	0.24	0.03	1.69

D/A	107	0.33±0.22	0.27	0.05	1.44

Note: B/A means lymphocyte counts of trauma group B to that of group A ratio, C/A, D/A as the same meaning

6.The score of secondary tissue injury degrees： 87 (77.7%) trauma patients were assessed as serious secondary tissue injury (secondary tissue injury cumulative scores was 1point), 25 (22.3%) trauma patients no serious secondary tissue injury (0 point). The result of bivariate logistic regression analysis showed a good correlation between the lymphocyte ratio and the secondary tissue injury cumulative scores. ROC curve and Youden index analysis showed that the lymphocyte count ratio in early time after trauma could been used to predict secondary severe tissue injury on the trauma patients in this study. The predictive cutoff value of lymphocyte count ratio were 0.31 to 0.37 within 6-72 hours after trauma, and the prediction sensitivity were 77% to 89% and specificity were 68 to 81% (Table 9, figure 2-4).

Table 9. The results of bivariate logistic regression analysis, ROC curve and Youden index of lymphocyte ratio in the trauma group

group	B	S.E.	Wald	*p*	Exp (B)	Cut off value	sensibility	specificity	AUC	Yueden index
B/A	4.033	0.719	31.450	0.000	56.451	0.315	0.89	0.75	0.789	0.63
C/A	3.841	0.653	34.564	0.000	46.565	0.305	0.78	0.84	0.840	0.62
D/A	3.389	0.558	33.211	0.000	29.648	0.345	0.85	0.74	0.861	0.58

Note: B/A means lymphocyte counts of trauma group B to that of group A ratio, C/A, D/A as the same meaning

In order to further confirm the reliability of prediction secondary tissue injury in trauma patients by using lymphocyte count ratio, the values of the lymphocyte ratio, SOFA scores, time stay in ICU, time stay in hospital and mortality were compared between severe secondary tissue injury group and non-severe secondary tissue injury group , the results showed there was a significant statistical difference between the two groups of patients（table 10）.

Table 10. Comparison the results between the two trauma groups that divided according to the secondary injury assessment score

Group	severe （87）		non-severe（25）		P
	Mean±SD	median	Mean±SD	median	
Ratio of lymph. counts in B/A	0.26±0.17	0.23	0.49±0.39	0.38	0.000
Ratio of lymph. counts in C/A	0.22±0.11	0.21	0.56±0.35	0.49	0.000
Ratio of lymph. counts in D/A	0.27±0.17	0.24	0.56±0.30	0.52	0.000
SOFA	7.46±3.18	7.0	3.26±1.86	3.0	0.000
Stay time of ICU（day）	12.4±11.1	10	5.0±7.9	2.5	0.009
Stay time of hospital（day）	55.2±59.6	29	22.7±12.3	21.5	0.041
Death （No）	21(24.1%)		2(8.0%)		

Note: B/A, lymphocyte counts of trauma group B to that of group A ratio, C/A, D/A as the same meaning； SOFA, Sequential Organ Failure Assessment

Discussion

Improvements in early resuscitation and promotion of damage control surgery, many trauma bleeding patients to survive, but in the trauma later period, there are still two-thirds of patients death with traumatic immune dysregulation, which most presented as anti-inflammatory response and pro-inflammatory response [10,11,12]. Tissue destruction and cell death by trauma lead to a large number of cytokines released into the blood, and the immune system was activated. Patients may present severe systemic inflammatory reactions, and the degree of local and systemic reactions is related to the severity of tissue injury caused with trauma [13, 14, 15]. Lymphocytes play an important role in the immune system, and changes of lymphocyte count in trauma patients is associated with post-traumatic inflammatory response [16].

Cabrera *et al.* [17] reported in trauma patients with ISS greater than 25 scores, there was a sharp increase of lymphocyte within 2 hours after injury, and they also observed that most of increase lymphocyte was NK cells (up to 150%), which turned to decrease after 24 hours and close to zero at 73 hours. T cells decreased by 40% within 24 h after trauma. The authors believed if lymphocyte was decreased less than 0.5×10^9/L, after 48hs of trauma, the mortality of trauma patients can be reached to 45%. Manson [18] reported lymphocytosis presented in severely injured patients within 2 hours after the trauma, and could be sustained to 24 hours after the trauma, and even to the occurrence of MODS. They also observed the peripheral blood

lymphocyte count decreased significantly within 6 hours in the animal hemorrhagic shock model, while the lymphocyte in the spleen remained unchanged until 24 hours later. In the bone marrow, it is elevated after 6 hours and remains elevated after 24 hours [6]. In fact, post-traumatic lymphocyte number and function changes are complex and still not fully understood [19].

However, the changes of lymphocytes in trauma patients should be related to the post trauma inflammatory response. One of factors associate with post-traumatic lymphopenia is related to cortisol released after trauma, it can lead to the excretion of neutrophils, and inducing lymphocyte apoptosis [10]. In addition, an increased extravasation of regulatory T cells into both lymphoid and non-lymphoid organs may explain the decrease of lymphocyte number in peripheral blood [20]. The decrease in the number of effector T cells after trauma and major surgery can induce the decrease of interferon in the body, both T lymphocytes and B lymphocytes are affected, antibody production is impaired and accelerated apoptosis [21]. In the inflammatory status, the inflammatory levels in the environment greatly influence the differentiation and activity of T lymphocyte populations [22].

The biochemical and physiological changes caused by trauma are related to the nature and extent of the inflammatory response [5]. In human, LDH distribute in liver, heart, kidney, muscle tissue and gastrointestinal tract. When these organ cells damaged, lactic acid accumulated in the body, LDH synthesizing secretion to increase, and the cell membrane permeability increased caused with inflammation at the same time, the LDH release into the blood, lead to blood levels of LDH elevated. So the blood LDH concentration is closely related to cell injury severity, serum LDH level can reflect the status of systemic inflammation and oxygen necrosis and hemolysis of local tissue [23]. CRP can also be used as an indicator of the degree of inflammatory damage, and CK is response indicator of muscle tissue injury. SIRS score is still valuable for judging systemic inflammatory response and tissue reperfusion injury [24], and SOFA is a better indicator of tissue and organ dysfunction [25]. In this study, the above indicators were used as comprehensive scoring indicators of secondary tissue injury.

The function of lymphocytes in human body can be inhibited or be activated by trauma, the factor of relationship between secondary tissue injury after trauma and change of lymphocyte counts and function remains unclear need to be further studied [7, 26]. Some patients with pure severe cranial injury and sharp injury in this study did not showed lymphocyte counts significant decrease, the reasons need further study, and the change of subgroups of lymphocyte in severe trauma patients also need further evaluated.

Conclusion

Through a retrospective study on 112 patients with severe trauma（ISS score ≥16 ）, we fund that Lymphocytes counts was significantly increased within the first 3 hours after trauma(median: 4.03×10^9/L), then decreased significantly in 6-72 hours after trauma (median: $0.85\text{-}0.99\times10^9$/L). The decrease degree of lymphocyte counts was significant relationship with the degree of secondary tissue injury, the degree of the change can be used to predict the severe degree of secondary tissue injury occurred by inflammatory reaction in trauma patients. The reason of lymphocyte count increased in the early stage and then decreased in trauma patient and the relationship between the change of lymphocyte count and degree of secondary tissue injury in trauma patient is still unclear and need further study.

DECLARATIONS

Ethics approval and consent to participate

The study setting and data collection were approved by the Medical Ethics Committee of Longgang Central Hospital of Shenzhen. This study will not interfere with the treatment of patients, will not cause damage to the rights of patients, just collected clinical treatment data of the patients, and all the study protocols were approved by the patients or their families, the paper of approval content form was preserved in patient medical history records.

Consent for publication

The authors promise no any individual patient privacy information in any form (including any individual details, images or videos) contain in this manuscript. The manuscript was reviewed and agreed for publication by the Medical Ethics Committee of Longgang Central Hospital of Shenzhen.

Data Availability Statement

The original datasets were analyzed during this study are not publicly available due to protect privacy of the patients reasons, but are available from the corresponding author on reasonable request (2009.caofeng@163.com).

Competing of interest

The authors declare that they have no conflicts of interest.

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Authors' contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by CF, YH and ZL. Interpretation of data was discussed by CF, RH. The first draft of the manuscript was written by CF substantively revised the manuscript. All authors read and approved the final manuscript.

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List of abbreviations

ISS: Injury Severity Score;

AUC: Area Under the Curve;

SIRS: severe systemic inflammatory response;

CARS: compensated anti-inflammatory immune response syndrome;

MODS: multiple organ dysfunction syndrome;

ED: emergency department;

TrA: trauma group A; TrB: trauma group B;

TrC: trauma group C; TrD: trauma group D;

LDH: lactic dehydrogenase;

CK: creatine kinase ;

CRP: C reactive protein;

SOFA: sepsis-related organ failure assessment;

ROC curve: Receiver operating characteristic curve;

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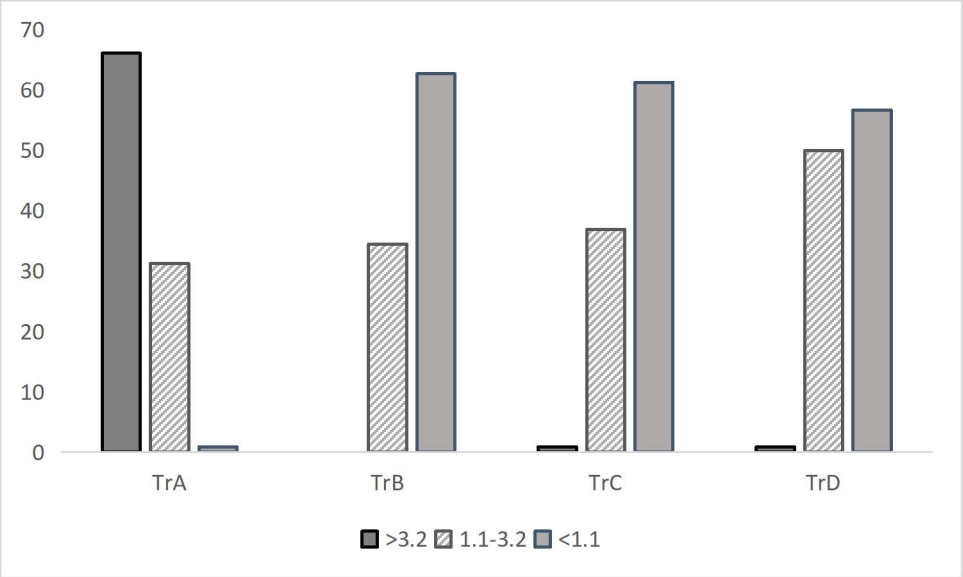
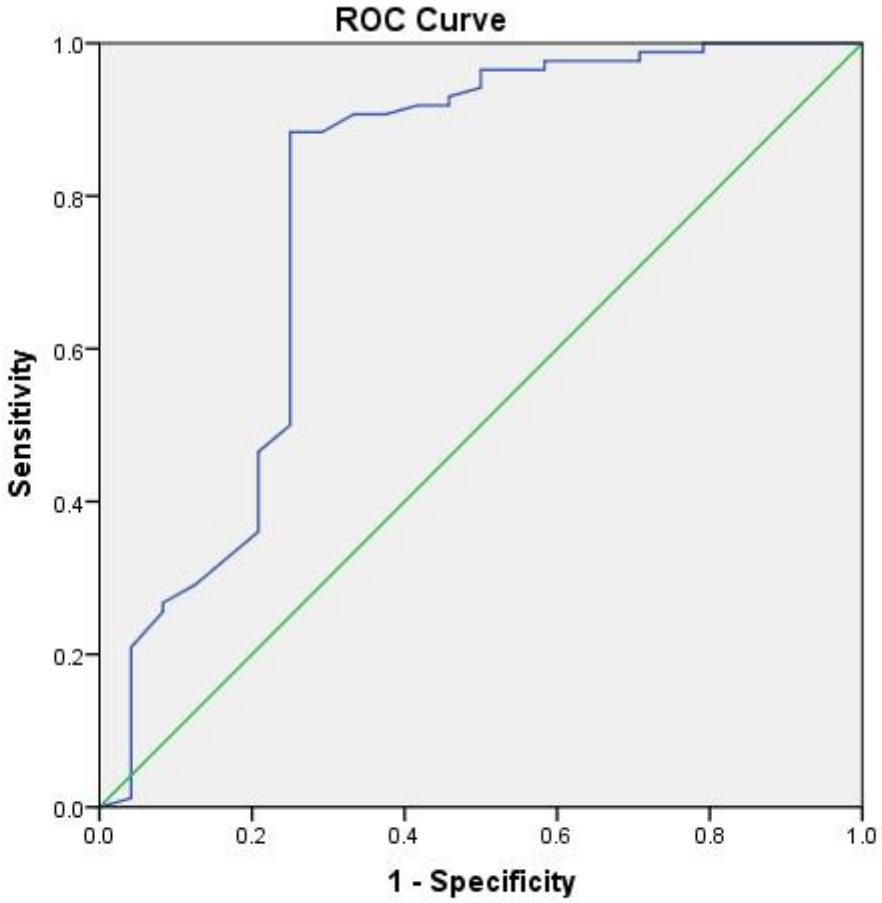
Figure 1. The lymphocyte numerical hierarchy of the four groups of trauma patients



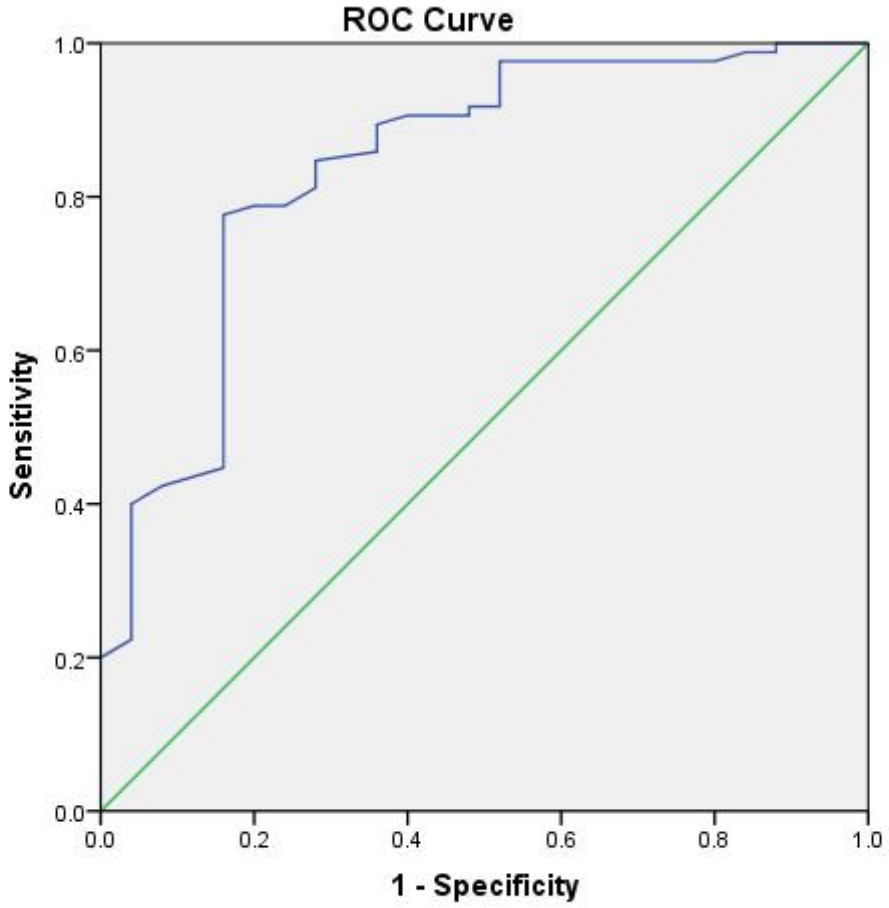
Note: 1. TrA, trauma group A; TrB, trauma group B; TrC, trauma group C; TrD, trauma group D. 2.≥3.2, lymphocyte count more than 3.2×10^9/L; norm, lymphocyte count is 1.1-3.2 $\times10^9$/L; <1.1，<1.1$\times10^9$/L.

Figure 2. ROC curve of lymphocyte ratio in group B /group A and secondary injury score



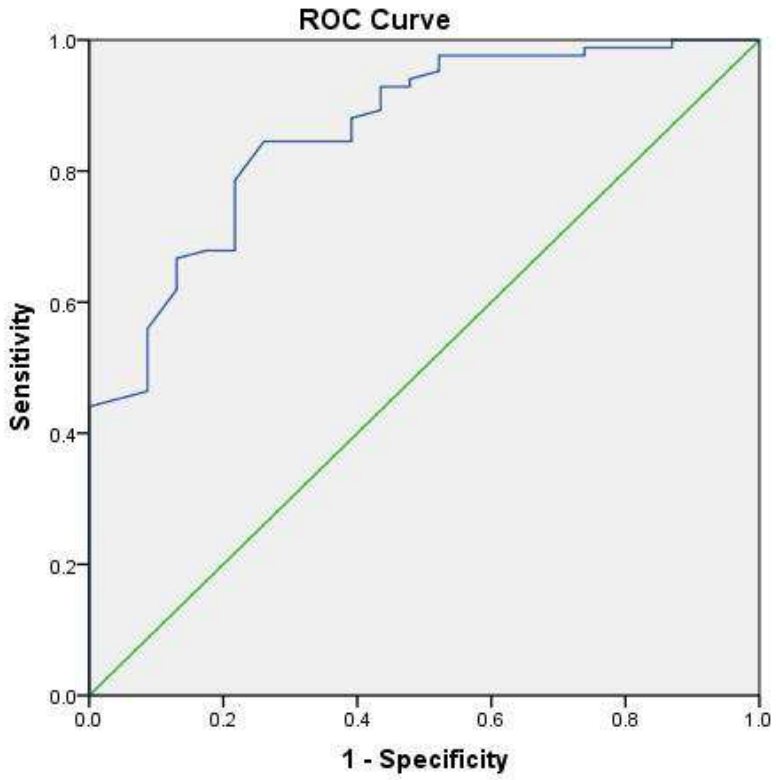
AUC	σ [a]	*P* [b]	95% CI	
			Low	High
.789	.065	.000	.662	.916

Figure 3. ROC curve of lymphocyte ratio in group C /group A and secondary injury score



AUC	σ [a]	*P* [b]	95% CI	
			Low	High
.840	.048	.000	.746	.934

Figure 4. ROC curve of lymphocyte ratio in group D /group A and secondary injury score



AUC	σ [a]	*P* [b]	95% CI	
			Low	High
.861	.041	.000	.780	.942

Attached file

Figure and Table Legend

Table 1. Assessment of secondary tissue injury degrees in trauma patients

Note: 1. The assessment time of stay in ICU and mechanical ventilation were determined according to the median of all trauma patients observed in this study; 2. Patients with cumulative scores of ≥ 4, be considered to have serious secondary tissue injury, and the comprehensive score was 1 (serious), the patient with cumulative scores were <4, be considered non secondary tissue injury, the comprehensive score was 0 (not serious). All examinations were recorded on a personal computer for subsequent blind analysis.

Table 2. Demographic, injury, and outcome Characteristics (n=112)

Note: IQR，inter quartile range; ISS, injury severity score; SOFA, sepsis-related organ failure assessment

Table 3. Demographic, clinical Characteristics of control group (n=60)

Note: IQR，inter quartile range;

Table 4. Peripheral blood lymphocyte count in trauma groups and control groups

Note: TrA, TrB, TrC, TrD, means trauma group A , B, C and D, respectively; ConA, ConB, ConC, ConD, means control group A, B, C and D, respectively; A:B means statistical compare between trauma group A and trauma group B, and so on.

Table 5. The subgroup numbers of hierarchical level according to lymphocyte normal range

Note: TrA, TrB, TrC, TrD, means trauma group A , B, C and D, respectively; ConA, ConB, ConC, ConD, means control group A, B, C and D, respectively;

Table 6. Status of fluid balance on the four trauma groups within 72hours after trauma

Note: 1. TrA, trauma group A, TrB, TrC, TrD, as the same meaning; IQR，inter quartile range;

Table 7. Comparison of the lymphocyte count between the low quartile and the high quartile of fluid balance in the trauma group

Note: the subgroups were divide according to the value of the low quartile (<25%) and high quartile (>75%) of the fluid value of the inter quartile interval.

Table 8. The ratio of lymphocyte count in trauma group B, C and D to trauma group A

Note: B/A means lymphocyte counts of trauma group B to that of group A ratio, C/A, D/A as the same meaning

Table 9. The results of bivariate logistic regression analysis, ROC curve and Youden index of lymphocyte ratio in the trauma group

Note: B/A means lymphocyte counts of trauma group B to that of group A ratio, C/A, D/A as the same meaning

Table 10. Comparison the results between the two trauma groups that divided according to the secondary injury assessment score

Note: B/A, lymphocyte counts of trauma group B to that of group A ratio, C/A, D/A as the same meaning；SOFA, Sequential Organ Failure Assessment

Figure 1. The lymphocyte numerical hierarchy of the four groups of trauma patients

Note: 1. TrA, trauma group A; TrB, trauma group B; TrC, trauma group C; TrD, trauma group D; 2. ≥3.2, lymphocyte counts more than 3.2×10^9/L; norm, lymphocyte counts were 1.1-3.2 $\times10^9$/L; <1.1， lymphocyte counts $<1.1\times10^9$/L.

Figure 2. ROC curve of lymphocyte ratio in group B /group A and secondary injury score

Figure 3. ROC curve of lymphocyte ratio in group C /group A and secondary injury score

Figure 4. ROC curve of lymphocyte ratio in group D /group A and secondary injury score

Figures

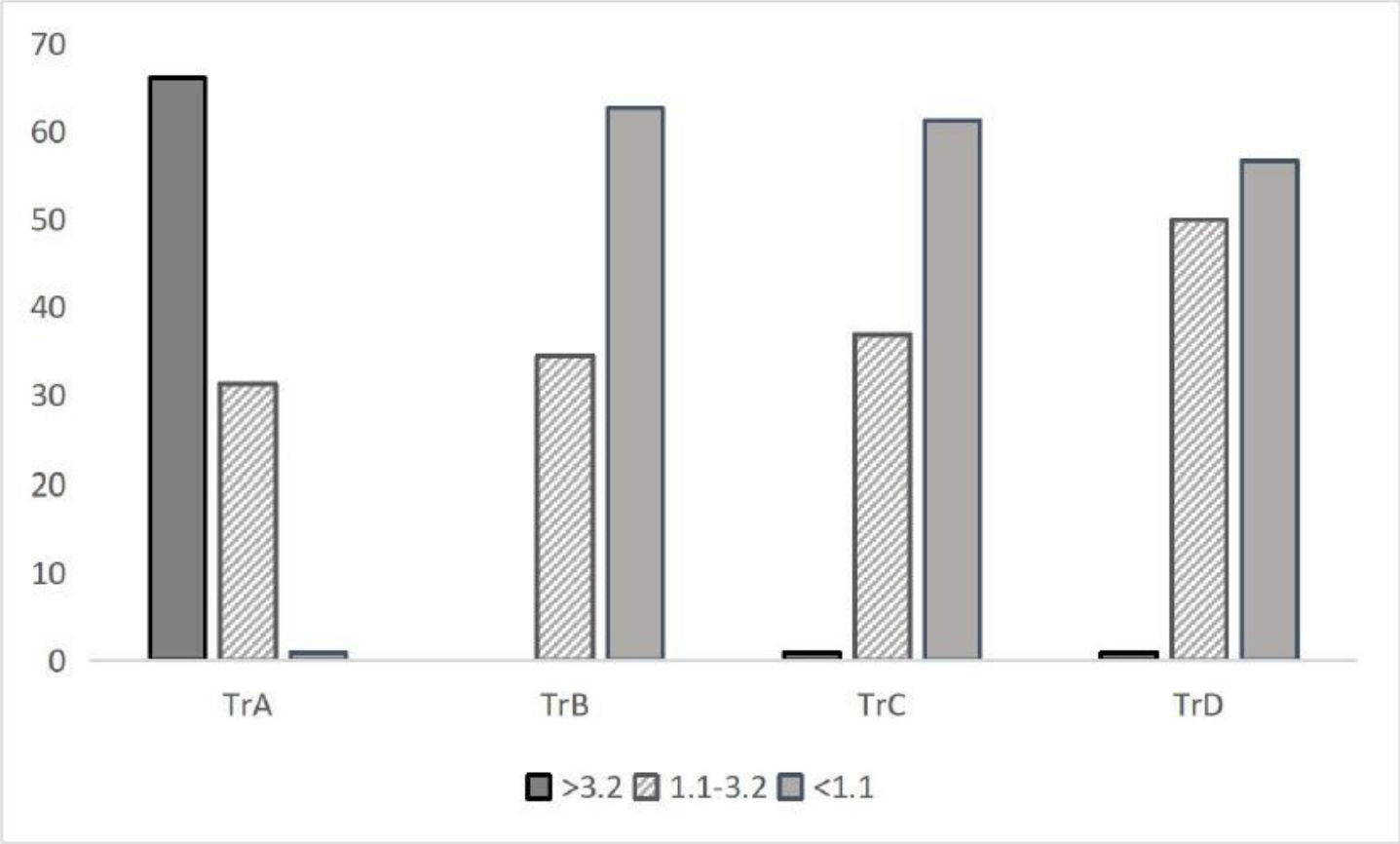
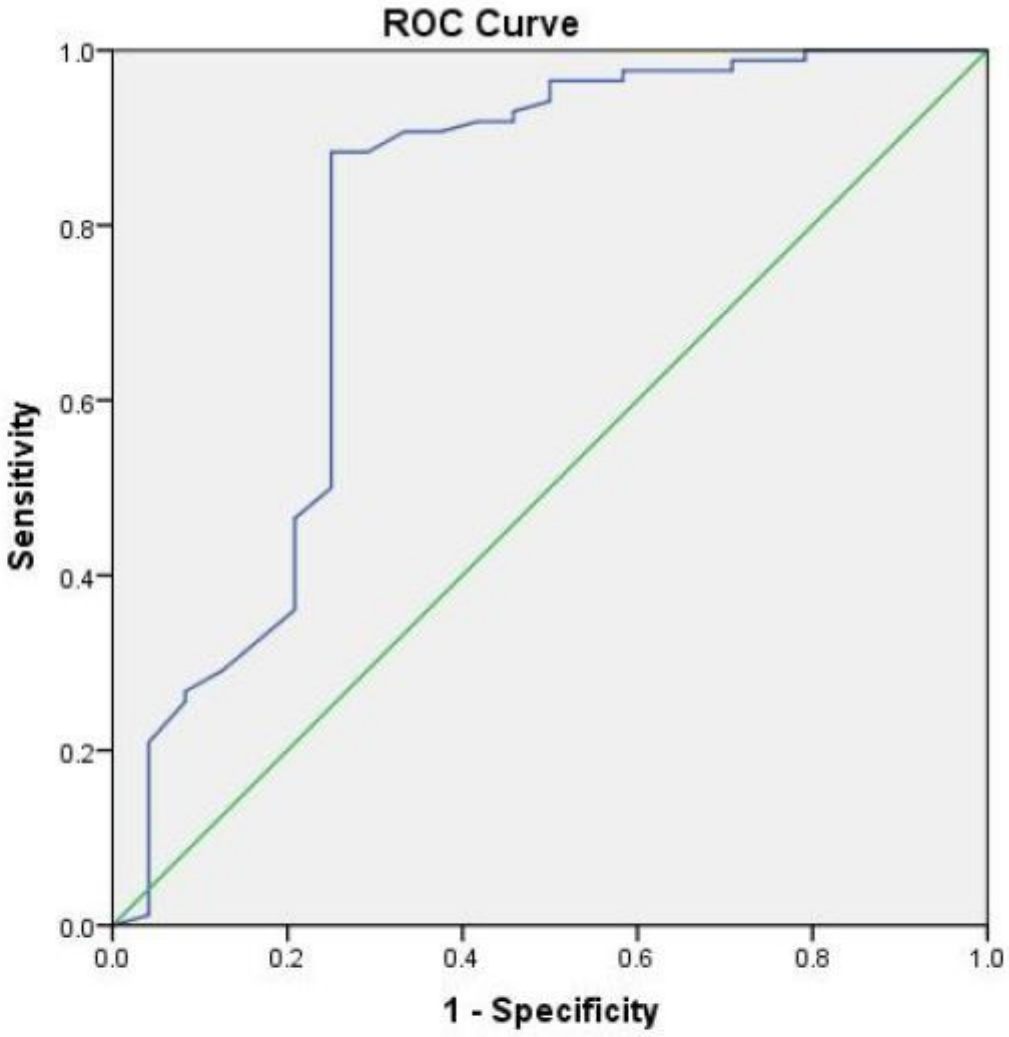


Figure 1

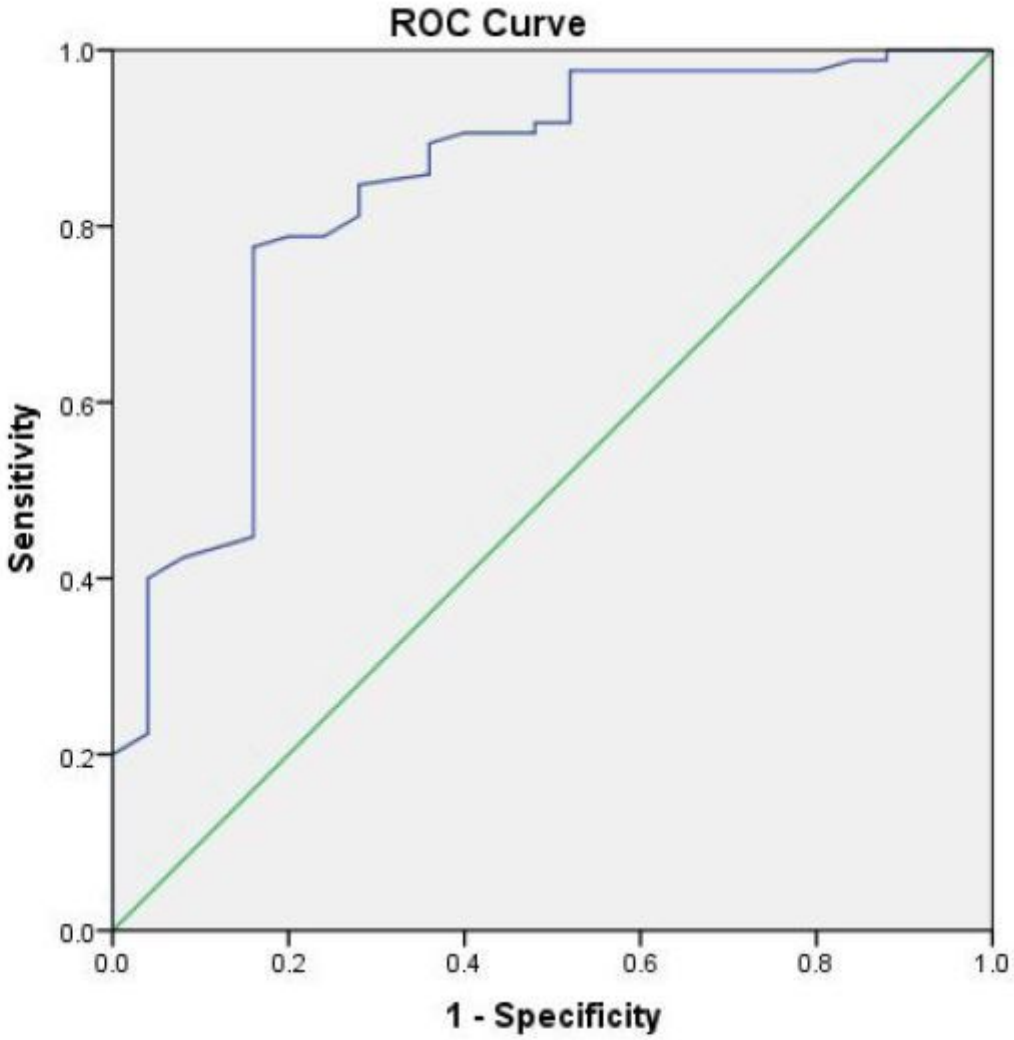
The lymphocyte numerical hierarchy of the four groups of trauma patients Note: 1. TrA, trauma group A; TrB, trauma group B; TrC, trauma group C; TrD, trauma group D. 2.≥3.2, lymphocyte count more than 3.2×109/L; norm, lymphocyte count is 1.1-3.2 ×109/L; <1.1<1.1×109/L.



AUC	σ [a]	P [b]	95% CI	
			Low	High
.789	.065	.000	.662	.916

Figure 2

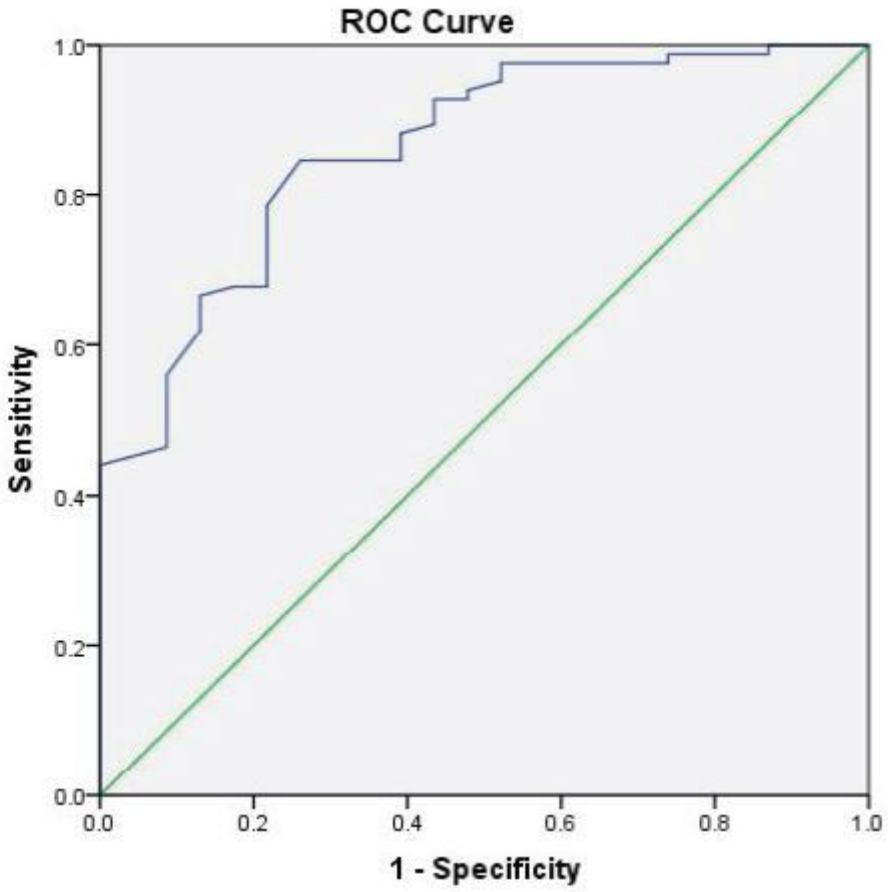
ROC curve of lymphocyte ratio in group B /group A and secondary injury score



AUC	σ [a]	P [b]	95% CI	
			Low	High
.840	.048	.000	.746	.934

Figure 3

ROC curve of lymphocyte ratio in group C /group A and secondary injury score



AUC	σ [a]	P [b]	95% CI	
			Low	High
.861	.041	.000	.780	.942

Figure 4

ROC curve of lymphocyte ratio in group D /group A and secondary injury score