Observational Study

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Changes to the myocardial enzyme spectrum in patients with different degrees of spleen injury and their clinical value

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Abstract

To investigate the changes to the myocardial enzyme profile and its clinical value in patients with different degrees of spleen injury.

Of all patients who underwent total splenectomy due to trauma-induced spleen injury from January 2019 to January 2022 were selected, 70 patients with grade III and IV spleen injuries were selected as the experimental group. In addition, 70 patients with grade I and II were selected as control group 1, and another 70 patients as control group 2. The levels of creatine kinase (CK), creatine kinase isoenzyme (CK-MB), lactate dehydrogenase (LDH) in the 3 groups were detected before (T0) and on the 1st day (T1) after surgery, on the 3rd day (T2) and on the 7th day (T3) after surgery, and on the 14th day (T4) after surgery, respectively, to analyze the relationship with the severity of spleen injury.

The spleen injury experimental group, control group 1, and control group 2 were all cured and discharged after corresponding treatment, and there was no myocardial infarction within 3 months of hospitalization and discharge follow-up. The experimental group had higher CK, CK-MB, and LDH than control group 1 and control group 2 at the same time point from T0 to T4 (P<.05); the CK and CK-MB of control group 1 were higher than those of control group 2 at the same time points from T0 to T4 (P < .05), the LDH at points T0 to T2 was higher than that of control group 2 (P < .05), and the LDH was lower at points T3 and T4. Compared with T0 in the same group, CK, CK-MB, and LDH at T1 to T4 in the 3 groups were all lower than those at T0 (P < .05).

The early peripheral blood myocardial enzyme spectrum of patients with different degrees of spleen injury is increased, and the increase of myocardial enzyme spectrum is positively correlated with the severity of spleen injury, suggesting that patients with traumatic spleen injury may have myocardial damage in the early stage, and should be treated as soon as possible.

Abbreviations: CK = creatine kinase, CK-MB = creatine kinase isoenzyme, LDH = lactate dehydrogenase.

Keywords: abdominal trauma, creatine kinase, creatine kinase isoenzyme, lactate dehydrogenase, myocardial enzymes, spleen injury

1. Introduction

The spleen is the abdominal organ most vulnerable to blunt injuries caused by external forces such as extrusion and collision, accounting for 40% to 50% of all blunt abdominal injuries.[1,2] With the rapid development of the national economy and the prosperity of industries such as transportation and construction, the incidence of traumatic spleen injury is increasing year by year.[3] Early studies on the spleen mostly focused on the immune function, surgical efficacy, and complications.[4] Recent studies have shown that traumatic spleen injury may damage the heart and induce acute myocardial infarction.[5] This paper mainly studies the changes of myocardial enzyme spectrum in patients with different degrees of spleen injury and its clinical value, by further comparing traumatic spleen injury severity and the myocardial enzyme spectrum of relationship, facilitating early damage in patients with spleen injury, and predicting late patient outcomes, in order to effectively prevent complications and increase the cure rate in patients.

2. Materials and Methods

2.1. Research objects

Patients who underwent total splenectomy due to trauma-induced spleen injuries from January 2020 to January 2022 were selected, with 70 patients with grade III and IV spleen injury being selected as the experimental group. This included 20 males and 15 females; aged 20 to 70 years old, with a mean of (49.94 ± 11.90) years old.

Thirty-five patients with grade I and II spleen injuries were in control group 1, including 18 males and 17 females; the age ranged from 20 to 70 years old, with an average of

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The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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(49.40 ± 16.96) years old. In addition, 70 patients with abdominal trauma surgery other than spleen injury were selected as the control group 2, including 19 males and 16 females, aged 20 to 70 years, with an average of (49.20 ± 9.78) years old. Among them, there were 8 cases of liver contusion, 11 cases of mesenteric vascular injury, 14 cases of intestinal rupture, and 2 cases of pancreatic injury. There was no significant difference in gender and age among the three groups ($P > .05$), as shown in Table 1. Informed consent was provided by the patients or their family members participating in the study and approved by the Medical Ethics Committee of the hospital.

2.2. Selection criteria

(1) The inclusion criteria for experimental group and control group 1: computed tomography (CT) showed massive hemoperitoneum, active hemorrhage, and unstable vital signs; Meet the diagnostic criteria for spleen rupture of grades I to II and grades III to IV in "Grading of Spleen Injury"; There is no serious injury to other parts or hollow organs; Age (18–70 years old); Male or female; Sign the informed consent form.
(2) The inclusion criteria for control groups 2: Mainly in patients with injuries to other abdominal organs (such as liver injury, intestinal injury, mesenteric injury, pancreatic injury); Age (18–70 years old); Male or female; Sign the informed consent form.
(3) Exclusion criteria: Patients with severe craniocerebral injury; Patients with a history of severe heart disease; Patients with severe trauma and fractures; Patients who died or were transferred; Pregnant or breastfeeding women.

2.3. Surgical treatment

After admission, patients with a spleen injury should receive rapid blood transfusion, supplement blood volume, complete various blood routines and biochemical examinations, and make preoperative preparations. Total splenectomy was performed for treatment, and general anesthesia was performed under endotracheal intubation.[6,7]

2.4. Determination of laboratory indicators

The experimental groups, control group 1, and control group 2 were collected before surgery (T0), on the 1st day after surgery (T1), on the 3rd day after surgery (T2), on the 7th day after surgery (T3), and on the 14th day after surgery (T4). Peripheral blood samples were measured for myocardial enzymes, and the results of myocardial enzymes were compared among the three groups.

Table 1

Baseline data of the patients.

Program	Experimental group	Control group 1	Control group 2	Static	*P*
Gender				0.230	.891
Male	40	36	38		
Female	30	35	32		
Age	49.94 ± 11.90	49.40 ± 16.96	49.20 ± 9.78	2.606	.272
Reason				4.412	.684
Traffic accident	50	46	48		
Falling fred	14	16	14		
Other	6	8	8		

2.5. Statistical analysis

SPSS26.0 (Chicago, IL) statistical software was used for data analysis. The measurement data met the normal distribution and was represented by $\bar{x} \pm s$. Repeated measurement analysis of variance was used to measure data at different time points. the comparison of multiple groups at the same time point was performed by one-way analysis of variance. SNK-Q test was performed for comparison between groups. Non-normal distribution data was tested by an nonparametric rank sum H test. Counting data, represented by example (%) and chi-square ($\chi 2$) test, $P < .05$ was considered statistically significant.

3. Results

3.1. Three groups of treatment results

The spleen injury experimental groups (control group 1, and control group 2) were all cured and discharged after corresponding surgical treatment, and there was no myocardial infarction within three months of hospitalization and discharge follow-up.

3.2. Comparison of myocardial enzymes in the spleen injury experimental group and control group 1 and control group 2 at different times

Compared with the control group 2, the creatine kinase (CK), creatine kinase isoenzyme (CK-MB), and lactate dehydrogenase (LDH) in the experimental group at the same time point from T0 to T4 were higher than those in the second control group ($P < .05$).). CK and CK-MB in control group 1 were higher than those in control group 2 at the same time point at T0T4 ($P < .05$), LDH at points T0 to T2 was higher than that in control group 2 ($P < .05$), and LDH at T3 and T4 was lower than that of the control group 2 ($P < .05$).

Compared with control group 1, CK, CK-MB, and LDH in the experimental group were higher than those in control group 1 at the same time point from T0 to T4 ($P < .05$); compared with T0 in the same group, CK, CK-MB, and LDH at T1 to T4 were lower than those at T0 ($P < .05$), as shown in Figure 1 and Table 2.

4. Discussion

The spleen is the largest lymphoid organ in the human body, which is responsible for the body's immune defense work, as well as hematopoiesis, blood storage, immune enhancement, endocrine regulation, and anti-tumor functions.[4] The spleen is fragile in texture and rich in blood supply. It is located between the stomach fundus and the diaphragm in the left quarter costal region, opposite to the 9th to 11th ribs. The location is superficial, and prone to massive bleeding after injury, which may endanger life and have a high fatality rate if not rescued in time.[8] According to the pathological classification, spleen injury can be divided into 3 types: central rupture, subcapsular rupture, and complete rupture. According to the discussion of spleen surgery symposium in Tianjin, patients with splenic rupture were divided into 4 levels according to the degree of splenic rupture injury.[9]

In patients with spleen injury, due to primary injury, secondary bleeding, edema and other reasons, the cells are ischemia and hypoxia, which in turn leads to insufficient blood supply to myocardial cells, causing myocardial ischemia, and hypoxia injury, resulting in the release of myocardial injury markers into the blood, leading to myocardial injury. The level of zymogram increased.[10] In addition, in the early stage of splenectomy patients, the platelet count and the blood viscosity was significantly increased.[11] On

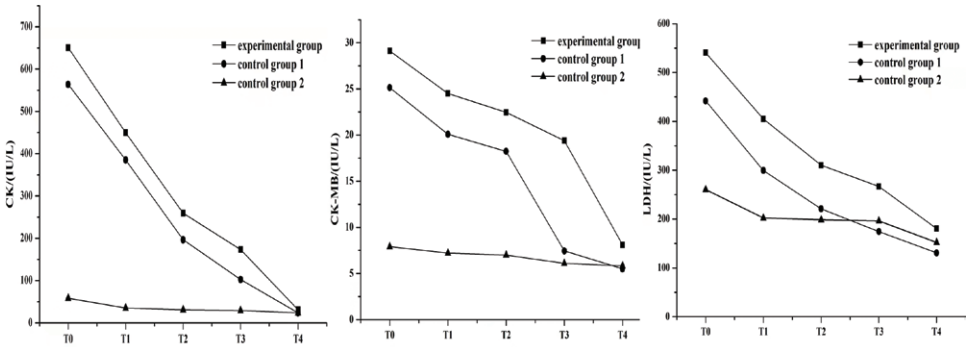

Figure 1. The trends of myocardial enzyme profiles in 3 groups.

Table 2

Comparison of myocardial enzyme indices among the 3 groups.

Group	Time	CK/(IU/L)	CK-MB(IU/L)	LDH(U/L)
Experimental group	T0	650.69 ± 76.63[ab]	29.11 ± 5.45[abc]	540.40 ± 74.20[abc]
	T1	449.60 ± 30.12[abc]	24.51 ± 4.82[abc]	404.80 ± 29.96[abc]
	T2	259.20 ± 51.28[abc]	22.47 ± 4.09[abc]	310.31 ± 47.17[abc]
	T3	173.26 ± 20.73[abc]	19.39 ± 3.70[abc]	266.77 ± 45.65[abc]
	T4	30.80 ± 4.70[abc]	8.12 ± 2.13[abc]	180.31 ± 37.89[abc]
Control group 1	T0	563.80 ± 66.95[a]	25.13 ± 3.29[a]	441.91 ± 63.96[a]
	T1	385.03 ± 27.30[ac]	20.08 ± 1.30[ac]	299.49 ± 51.85[ac]
	T2	196.43 ± 33.56[ac]	18.23 ± 2.37[ac]	221.03 ± 32.91[ac]
	T3	102.40 ± 13.98[ac]	7.45 ± 0.99[ac]	174.49 ± 19.74[ac]
	T4	23.83 ± 4.11[c]	5.51 ± 0.61[c]	130.86 ± 17.16[ac]
Control group 2	T0	58.23 ± 10.48	7.91 ± 1.54	260.34 ± 42.32
	T1	35.06 ± 3.73[c]	7.21 ± 0.38[c]	202.29 ± 25.55[c]
	T2	30.80 ± 5.92[c]	6.99 ± 0.76[c]	198.57 ± 23.60[c]
	T3	29.29 ± 5.26[c]	6.10 ± 0.94[c]	196.20 ± 25.24[c]
	T4	23.83 ± 4.82[c]	5.82 ± 0.89[c]	152.03 ± 25.99[c]

CK = creatine kinase, CK-MB = creatine kinase isoenzyme, LDH = lactate dehydrogenase.

the one hand, the blood supply decreased at the same time, resulting in insufficient blood supply to myocardial cells, resulting in myocardial damage, and a large amount of myocardial enzymes being released into the blood. it increases the risk of vascular embolism, leading to an increased possibility of vascular-related complications such as myocardial infarction. Meanwhile, studies studies have shown that hemodynamic changes can seriously affect cardiac function,[12] and severe trauma can also lead to impaired myocardial function in patients.[13]

The results of this investigation showed that compared with the abdominal trauma group without spleen injury, CK, and CK-MB in the spleen injury group were significantly increased at different time points. The number of patients with spleen injury is higher, and the possible reasons are that the more severe the spleen injury, the greater the blood loss, and the more obvious the myocardial ischemia and hypoxia in the same period of time, leading to the higher levels of myocardial enzyme profile. The LDH of patients with grade I and II spleen injury was higher than that of patients with abdominal trauma within 3 days, and the LDH was lower than that of patients with abdominal trauma after 3 days. The possible reason is that LDH is an enzyme present in almost all tissues and organs, which is used to mark damaged cells. Patients with grade I and II spleen injuries suffered fairly mild injuries and recovered fairly quickly, resulting in a faster decrease in LDH levels, which was lower than in patients with abdominal trauma. The myocardial zymogram of the patient increased significantly within 3 days of splenic injury, and decreased to the normal level after 1 week after active surgical treatment. The detection of myocardial enzyme level in the early stage of splenic injury patients has a certain sensitivity, which is conducive to early judgment and evaluation of the severity of splenic injury patients, and predict the prognosis of patients with late splenic injury, and improve the cure rate.

Common complications after splenectomy include fever, intra-abdominal infection, secondary hemorrhage, splenic vein thrombosis, pancreatic leakage, and post-splenectomy perilous infection (OPSI).[14,15] Fever: there are many causes for fever, such as the absorption of necrotic tissue, heat, the formation of blood seepage, and hematoma in the spleen fossa. infection in the abdominal cavity and the formation of subphrenic abscess, pancreatic fluid exudation caused by pancreatic tail injury. To find the cause of fever and give symptomatic treatment for the cause of fever is an effective way to control fever and handle fever; Intra-abdominal infection: the common causes are hematoma formation, gastrointestinal injury, pancreatic tail injury. Keeping the operation delicate and avoiding damage to the corresponding tissues, routine drainage and antibiotics after operation are effective solutions; Secondary massive hemorrhage: it is usually caused by technical problems in the cutting and ligation of splenic pedicle vessels. Strict compliance with operational norms and postoperative drainage can prevent massive hemorrhage; Splenic vein embolism: the injury to the splenic vein after surgery and the increase of postoperative platelets are the main causes of thrombophlebitis, and anticoagulation can effectively prevent the occurrence of this complication; Pancreatic leakage: the main cause is that the pancreatic tail is damaged by improper operation during the operation. Drugs such as octreotide are used to inhibit the secretion of the pancreas, and the drainage tube is flushed. Most of the pancreatic leakage can heal by itself. The age, reason and postoperative interval of

splenectomy patients were the main wechat factors. Madenci reported that Children who have undergone splenectomy may develop impaired immunologic function and heightened risk of overwhelming postsplenectomy infection.[16] An et al reported that in patients with adults who underwent splenectomy had longer hospital stay, bore higher costs, and faced greater risk of mortality than the overall US discharge population.[17]

OPSI is dangerous and has a high mortality rate. The key lies in prevention. Teenage spleen trauma should not be easily removed if it can protect the spleen. In patients with OPSI, do not wait for blood culture results and use broad-spectrum and highly effective antibiotics based on experience.

In conclusion, the myocardial enzyme profile of patients with spleen injury and other abdominal trauma increased significantly in the early stage, and the myocardial enzyme profile of patients with spleen injury increased more significantly than that of patients with other abdominal trauma, and the increased level of myocardial enzyme profile was positively correlated with the severity of spleen injury. Myocardial enzyme profile increased in patients with early splenic injury, suggesting that the myocardium may be damaged, and it is necessary to pay close attention to the changes of myocardial enzyme spectrum. In view of the complications after splenectomy, actively search for the cause, routine catheterization and drainage, application of broad-spectrum and efficient antibiotics, application of anticoagulation, myocardial protection, and other drugs to reduce the risk of coagulation, vascular embolism, and myocardial injury, which can prevent complications early happened. Our research has some limitations. First, since a retrospective design was used in this study, there may be confounders affecting the results. Second, the number of samples is small and there are certain limitations: all patients feature a spleen injury caused by trauma, not those who have underwent splenectomy due to other reasons such as liver cirrhosis and blood system diseases. Why there is no basic research on the molecular mechanisms leading to the elevation of myocardial enzyme spectrum, and the sample size needs to be addressed at a later stage.

5. Conclusion

The early peripheral blood myocardial enzyme spectrum of patients with different degrees of spleen injury is increased, and the increase of myocardial enzyme spectrum is positively correlated with the severity of spleen injury, suggesting that patients with traumatic spleen injury may have myocardial damage in the early stage, and should be treated as soon as possible.

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Author contributions

Peng Gu and Shouli Xia contributed equally to this work. Zhengwu Zho contributed to the study design and literature search. Peng Gu and Shouli Xia and Shengjin Han contributed to the literature search and the writing of the manuscript. Zhengwu Zhou and Jianzhong contributed to the review and revise of the manuscript.
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