Original Article

Artificial liver support system in treatment of liver failure after acute poisoning

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BACKGROUND: Acute poisoning (AP) may cause failure of the liver and kidney, and even death. This study aimed to investigate the efficacy of artificial liver support system (ALSS) on the treatment of liver failure after acute poisoning.

METHODS: A total of 31 patients with liver failure caused by AP were admitted to emergency ICU, central ICU, and Department of Gastroenterology from 2005 to 2009 in Zhongshan Hospital Affiliated to Xiamen University, China. Among them, 13 patients served as a treatment group, and used ALSS in addition to detoxification treatment and protective treatment of liver function, and the other 18 patients served as a control group receiving detoxification treatment and protective treatment of liver function.

RESULTS: In the treatment group, 10 patients (76.9%) were cured or improved, 2 died, and 1 was discharged against advice. In the 18 patients in the control group, 7 (38.9%) were cured or improved, 3 died, and 8 were discharged against advice. There was a significant difference in the rates of improvement between the two groups ($P < 0.05$).

CONCLUSION: ALSS is a safe and effective clinical method for the treatment of acute toxic liver failure.

KEY WORDS: Toxicity; Liver failure; Artificial liver support system

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INTRODUCTION

With the availability of a vast number of chemicals and drugs, acute poisoning (AP) is a common medical emergency in any country. AP may cause failure of such organs as the liver and kidney, and even death.^[1-4] For effective management of an acutely poisoned victim, five complementary steps are required: resuscitation and initial stabilization; diagnosis of poison type; nonspecific therapy; specific therapy; and supportive care. This study aimed to determine whether artificial liver support system (ALSS) can be used to increase the survival rate of patients with liver failure caused by AP.

METHODS

Patients

A series of 31 patients with liver failure caused by

AP were admitted to emergency ICU, central ICU, and Department of Gastroenterology from 2005 to 2009 in Zhongshan Hospital Affiliated to Xiamen University, China. Among them, 13 patients (treatment group) were treated with ALSS for 84 times, including plasma exchange (PE) 49 times, plasma perfusion (PP) 12 times, and direct hemoperfusion (DHP) 23 times. The diagnosis of liver failure was made according to the *Diagnostic Criteria and Guidelines of Infectious Diseases of Liver Failure* set by the Severe Liver Disease and Liver Treatment Group, the Hepatology Society of the Chinese Medical Association in 2006. In the 31 AP patients (28 were male and 3 female), 21 suffered from drug poisoning, 5 food poisoning, 2 industrial poisoning, 2 fish bile poisoning, and 1 snake venom poisoning.

Another 18 patients served as a control group

receiving detoxification treatment and protective treatment of liver function.

In the treatment group, the age of the patients ranged from 17 to 64 years, with an average age of 38.4 years; in the control group, the age of the patients ranged from 15 to 62 years, with an average age of 37.6 years. Before the treatment, there were no significant differences in age, ALT, ALB, PTA and TBIL between the two groups ($P>0.05$).

Methods

Laboratory tests including routine test of blood, liver and kidney function, electrolytes in blood, coagulation, ECG and blood gas analysis after admission were done in the two groups. Patients in both groups received detoxification treatment and protective treatment of liver function, but patients in the treatment group were added with ALSS for an average of 2.7 times every 4-5 days. Before the initial treatment in the treatment group, we established the channel using a catheter with double lumen in the femoral vein of the lower extremities and an automatic plasma exchanger (KURARAY KM 8800 type, Japan) in each patient. Before treatment, 5 mg dexamethasone was routinely given. After administration of the initial dose of 20 mg, 2500 U heparin per hour was used to maintain the level. If the prothrombin time was more than 30 seconds, the heparin was used *in vitro*. Plasma 2000-3000 mL was exchanged every time, and albumin 20-30 g was used during 3-5 hours in each treatment. Heart rate, blood pressure, and blood oxygen pressure were monitored during the treatment, and the dose of heparin was adjusted according to the prothrombin time, which was tested every 1-2 hours. Heparin administration was ceased

after each treatment, and antibiotics were selectively used to prevent infection.

Parameters before and after treatment

Temperature, pulse, respiration and other vital signs before and after each treatment were monitored. Mental state, loss of appetite, abdominal distension, jaundice, 24-hour urine volume, presence or absence of symptoms of skin, mucous and gastrointestinal bleedings were observed in addition to routine tests of blood, liver and kidney function, electrolytes in blood and coagulation.

Evaluation of efficacy

Cure of AP indicates the improvement of clinical symptoms and liver function of the patients and their discharge from hospital. Invalid treatment means that the clinical symptoms and liver function of AP patients were not significantly improved or the patients died.

Statistical analysis

Parameters before and after treatment were analyzed using Student's *t* test, and the efficacy of the treatment was compared using the Ridit analysis between the treatment and control groups.

RESULTS

Changes in laboratory parameters

TBIL, ALT, AST, BUN and Cr index were decreased after treatment with ALSS. PT was significantly shortened before the treatment and no significant changes were found by tests of ALB, electrolytes and blood before and after the treatment (Table 1).

Table 1. Changes of laboratory parameters

Groups	AST (U/L)	ALT (U/L)	PT (s)	ALB (g/L)	TBIL (μmol/L)	NH ₃ (μmol/L)
Control group						
Before treatment	843.7±263.4	1032.5±389.7	18.7±3.9	30.4±5.0	332.7±110.8	284.9±92.7
After treatment	273.4±97.3	337.4±108.1*	15.4±1.1*	31.4±6.1	296.7±104.3	276.2±84.5
Treated group						
Before treatment	875.8±259.4	1024.7±397.2	18.5±4.2	29.7±4.7	328.4±113.1	274.6±87.4
After treatment	145.2±45.6**Δ	133.8±34.9**Δ	15.6±1.4*	31.2±5.4	175.6±87.5*Δ	115.3±37.8*ΔΔ
Groups	WBC (*10 ⁹ /L)	PLT (*10 ⁹ /L)	K ⁺ (mmol/L)	Na ⁺ (mmol/L)	BUN (mmol/L)	Cr (μmol/L)
Control group						
Before treatment	12.3±2.2	173.0±24.6	4.18±0.81	134.9±7.6	11.8±2.01	173.0±24.6
After treatment	10.5±1.6	154.8±19.8	4.02±0.58	135.7±6.4	9.56±1.12	154.8±19.8
Treated group						
Before treatment	12.1±2.3	163.4±21.3	4.23±0.85	137.5±8.8	12.4±1.96	163.4±21.3
After treatment	10.8±1.5	78.5±8.4*ΔΔ	4.12±0.79	136.5±6.3	6.6±0.71**ΔΔ	78.5±8.4*ΔΔ

Compared with the group before treatment, * $P<0.05$, ** $P<0.01$; compared with the group after treatment, Δ $P<0.05$, ΔΔ $P<0.01$.

Clinical symptoms and signs

Mental status, appetite, and abdominal distension were improved in the treatment group using ALSS. After ALSS for 3-4 times, 7 of the 9 patients with hepatic encephalopathy returned to normal consciousness, but the remaining 2 died after the treatment.

Prognosis

Of the 13 patients of the treatment group, 10 (76.9%) were cured or improved, 2 died, and 1 was discharged against advice. In the 18 patients of the control group, 7 (38.9%) were cured or improved, 3 died, and 8 were discharged against advice (Table 2).

Table 2. Comparison of efficacy between the control and treatment groups

Variables	Control group	Treatment group
Improvement in the cure rate	7 (38.9%)	10 (76.9%)
Against advice discharge	8	10
Mortality	3	11
Total	18	13

Between the treatment and control groups, $P < 0.05$

DISCUSSION

Liver failure after acute poisoning is a disease frequently encountered in emergency department. The disease is characterized by a sudden, severe, life-threatening deterioration of liver function, and complications include the development of renal dysfunction and multi-organ failure, often associated with a poor prognosis and high mortality. Necrosis of liver cells can cause the severe disorder of liver metabolism and detoxification function, which increases the levels of blood ammonia, endotoxin and bilirubin. In turn, these toxicities from metabolites deteriorate the liver damage through various pathways.

Artificial liver support system is an important method for the treatment of liver failure. The system processes the blood and plasma of severe hepatopathy by the blood cleansing technology. Through treatment, it is able to remove poisonous substances like endotoxin and bilirubin while supplying blood coagulation factors and immunoglobulin in plasma to alleviate symptoms and improve blood coagulation. ALSS can temporarily replace some liver functions including detoxication and synthesis, thus providing extrinsic supports for the severely injured liver to help the patient to pull through the critical stage and gain precious time for further treatment such as liver transplantation.^[5-12]

In this study we performed PE, PP and DHP in patients with liver failure after acute poisoning via ALSS. In most patients, symptoms were improved, and TBIL, ALT, AST, BUN and Cr index were significantly decreased after treatment with ALSS. Seven of the 9 patients with hepatic encephalopathy recovered with consciousness. Other studies^[13,14] also showed the improved survival rate of patients with liver failure in the artificial liver treatment group compared with the control group, thus helping patients to get the chance of liver transplantation.

In conclusion, ALSS is a safe and effective method for the treatment of liver failure after acute poisoning.

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Ethical approval: This study was approved by the Medical Ethics Committee of Zhongshan Hospital Affiliated to Xiamen University.

Conflicts of interest: No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

Contributors: Chen LG proposed the study and wrote the first draft. All authors contributed to design and interpretation of the study and to further drafts. Bayasi Guleng is the guarantor.

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