ORIGINAL RESEARCH

Application of Damage Control Surgery Combined with Seamless Integrated Rescue Mode in Emergency Treatment of Severe Thoracic and Abdominal Trauma

Weiya Zhou, BM; Mingyu Xue, BM; Shiwei Zhang, BM; Min Wang, BM; Yifeng Wu, BM

ABSTRACT

Objective • To analyze the application effect of damage control surgery (DCS) combined with seamless integrated rescue mode in emergency treatment of severe thoracic and abdominal trauma.

Methods • The clinical data of 90 patients with severe thoracic and abdominal trauma admitted to the emergency room of our hospital from September 2020 to September 2021 were selected for the retrospective analysis. According to the different treatment methods, they were divided into the experimental group (EG) and the control group (CG), with 45 cases in each group. The CG was treated with seamless integrated rescue mode, and the EG received the DCS combined with seamless integrated rescue mode. The mortality, complication rate, mixed venous oxygen saturation (SvO_2), cardiac index (CI), central venous pressure (CVP), prothrombin time (PT), active partial thromboplastin time (APTT), the content of arterial blood lactate (ABL), C-reactive protein (CRP), interleukin-6 (IL-6) and interleukin-10 (IL-10) were compared between the two groups.

Results • Compared with the CG, after intervention, the levels of SvO_2, CI, CVP, APTT and IL-10 in the EG were signally higher (all $P < .05$), while the levels of PT, ABL, CRP and IL-6 in the EG were memorably lower (all $P < .05$), and the mortality and complication rate in the EG were notably lower (all $P < .05$).

Conclusion • The application of DCS combined with seamless integrated rescue mode in emergency treatment of patients with severe thoracic and abdominal trauma can effectively reduce the mortality of patients, improve their coagulation dysfunction, decrease the level of inflammatory factors and reduce the occurrence of complications, with a positive significance for improving disease prognosis. (*Altern Ther Health Med.* 2023;29(8):793-797).

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INTRODUCTION

Thoracic and abdominal trauma, as a common type of disease with the high mortality rate in the emergency department, often causes damage to thoracic and abdominal organs under external forces, such as high fall, traffic accident and heavy hits, so the condition is often more complex. Domestic survey results showed that about 5.8 million people die from trauma each year and the mortality as high as 19%.[1-3] The delayed rescue is the important factor that lead to the ineffective treatment of patients in the golden time window, so that it is necessary to develop an efficient rescue plan.

Seamless integrated nursing model for trauma emergency, as a new emergency mode in emergency department, can effectively improve the rescue success rate and shorten the rescue time, thus improving the treatment rate. In the treatment of patients with severe thoracic and abdominal trauma, medical staff are required to be highly responsible and have a high professional level, and the occurrence of any errors will seriously affect life safety of patients. Damage control surgery (DCS) has been applied in surgical emergency treatment with the progress of medical technology, and damage control requires simple surgery for patients to effectively control their primary injury, so as to restore the physiological function and effectively improve the rescue success rate of patients, with an important guiding significance for rescue work.[4-7] However, there is no in-depth

study on the combination application of DCS and seamless integrated rescue mode in clinical practice at present. Based on this, this study will analyze the application effect of DCS combined with seamless integrated rescue mode in emergency treatment of severe thoracic and abdominal trauma.

MATERIALS AND METHODS

Study design

This study was in line with the declaration of Helsinki (2013).[8] A retrospective analysis was conducted to explore the application of DCS combined with seamless integrated rescue mode in emergency treatment of severe thoracic and abdominal trauma.

General information

Inclusion criteria. (1) Patients had obvious abdominal trauma, accompanied by abdominal pain, pressure pain and other symptoms. (2) Patients had no major organ disease. (3) Patients had normal coagulation function.

Exclusion criteria. (1) Patients had mental and language disorders. (2) Patients were in lactation and pregnancy. (3) The clinical data of patients were missing. (4) Patients had severe infectious diseases. (5) Patients had malignant tumors. (6) Patients withdrew from this study in the midway.

METHODS

Control group

The seamless integrated rescue mode was adopted. (1) Establishment of medical team. The head nurse served as the leader of this group, and the members in the group were given access training and crisis awareness training on time, and they were assessed regularly to strengthen the crisis awareness of the members and improve their professional skills, while the responsibility was divided to ensure that everyone fulfills their corresponding responsibility. At the same time, the equipment in ambulance was checked to ensure the adequate preparation. (2) Pre-hospital emergency care. After receiving the emergency telephone in the emergency room, the emergency team should go out within 5 minutes, and the patient's injury should be evaluated immediately when receiving the patients. The corresponding emergency treatment was taken according to the actual condition of patients, and the patients' condition was fed back to the emergency department to complete the preparation for reception on the ambulance, so as to ensure the smooth connection of various departments. (3) In-hospital emergency care. After the patients arrived at the hospital, the emergency team was immediately informed in the hospital to open a green channel for patients with severe thoracic and abdominal trauma and detected their vital signs.

Experimental group

On the basis of the CG, the EG was treated with DCS for cooperative treatment. (1) Rapid and simplified treatment in the early stage. The fatal massive hemorrhage was controlled to improve respiratory embarrassment of patients, mainly including the treatment such as emergency surgery or hemostasis by embolization of active bleeding, decompression drainage for pericardial tamponade, pneumohemothorax and mediastinal emphysema, temporary fixation of thoracic wall in flail chest and paradoxical respiration, and temporary external fixation of unstable fracture. (2) The patients were transferred to ICU for resuscitation and guardianship to help patients stabilize circulation and restore tissue perfusion, taking the measures such as respiration support and the correction of hypoxia, coagulation dysfunction and acid intoxication. (3) After the patients' vital signs and internal environment were stable, definitive surgery was performed 1-2 days after the implementation of exploratory laparotomy to develop a detailed surgical plan, taking out the anterior tamping, then full exploration and anatomical reconstruction.

Observation indices

The general information such as gender, age, body mass index (BMI), education level, religious belief, situation of household income and place of residence were compared between the two groups.

Hemodynamics. The parameters of mixed venous oxygen saturation (SvO_2), cardiac index (CI) and central venous pressure (CVP) before and after intervention were detected using hemodynamic monitoring instrument (model: BioZ-2011; manufacturer: Shenzhen Mai Dean Medical Equipment Co., Ltd.)

Coagulation function test. The peripheral venous blood of patients was taken to measure the prothrombin time (PT) and active partial thromboplastin time (APTT) using an automatic coagulation analyzer (model:CX-9000; manufacturer: Nanjing Huijie Medical Technology Co., Ltd.) before and after emergency treatment.

Content of arterial blood lactate (ABL). The arterial blood samples were collected through the intubation of internal carotid artery to detect the content of ABL in patients.

Levels of inflammatory factors. The peripheral venous blood (5ml) of patients was taken before and after emergency to obtain the serum samples after centrifugation, then storing in an ultra-low temperature environment to wait for test. The C-reactive protein (CRP) was measured by immunoturbidimetry, and the enzyme-linked immunosorbent assay was used for measuring interleukin-6 (IL-6) and interleukin-10 (IL-10). The kits were purchased from Shanghai Woxing Biotechnology Co., Ltd.

Occurrence of mortality and complications. The mortality and the occurrence of complications in patients at treatment endpoints were recorded, including acute respiratory distress syndrome (ARDS), disseminated intravascular coagulation (DIC), acute renal failure (ARF), and multiple organ dysfunction syndrome (MODS).

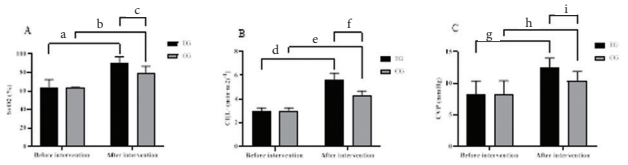
Statistical analysis

In this study, the data processing software was Statistical Product and Service Solutions (SPSS) 26.0 (Armonk, State of New York, USA), and GraphPad Prism 7 (GraphPad Software, San Diego, CA, USA) was used to draw the pictures of this data. The collected data included in this study were enumeration

Table 1. Comparison of baseline data between the two groups [n(%), $\bar{x} \pm s$]

Items	EG (n = 45)	CG (n = 45)	χ^2/t	*P* value
Gender			0.046	.830
Male	26 (57.78)	27 (60.00)		
Female	19 (42.22)	18 (40.00)		
Age ($\bar{x} \pm s$, years)	27.69±6.27	27.62±6.24	0.053	.958
BMI (kg/m²)	21.86±1.73	21.82±1.65	0.112	.911
Education level			0.415	.813
Primary and junior high schools	8 (17.78)	7 (15.56)		
Senior high school and junior college	20 (44.44)	18 (40.00)		
University and above	17 (37.78)	20 (44.44)		
Religious belief			0.179	.673
Yes	20 (44.44)	22 (48.89)		
No	25 (55.56)	23 (51.11)		
Situation of household income			0.403	.525
≥3000 yuan/(month·person)	19 (42.22)	22 (48.89)		
<3000 yuan/(month·person)	26 (57.78)	23 (51.11)		
Place of residence			1.607	.205
Urban area	24 (53.33)	18 (40.00)		
Rural area	21 (46.67)	27 (60.00)		

Figure 1. Comparison of hemodynamics indexes between the two groups ($\bar{x} \pm s$)



[a]indicated a distinct difference in the SvO_2 level of EG before and after intervention (63.15 ± 9.11 vs. 89.83 ± 7.26, t = 15.364, P < .001).
[b]indicated a distinct difference in the SvO_2 level of CG before and after intervention (63.26 ± 0.80 vs. 79.59 ± 7.34, t = 14.837, P < .001).
[c]indicated that compared with the CG, the SvO_2 level in the EG was obviously higher after intervention (89.83 ± 7.26 vs. 79.59 ± 7.34, t = 6.654, P < .001).
[d]indicated an evident difference in the CI level of EG before and after intervention (2.91 ± 0.35 vs. 5.59 ± 0.59, t = 26.207, P < .001).
[e]indicated an evident difference in the CI level of CG before and after intervention (2.97 ± 0.29 vs. 4.27 ± 0.41, t = 17.365, P < .001).
[f]indicated that compared with the CG, the CI level in the EG was obviously higher after intervention (5.59 ± 0.59 vs. 4.27 ± 0.41, t = 12.325, P < .001).
[g]showed a conspicuous difference in the CVP level of EG before and after intervention (8.23 ± 2.15 vs. 12.38 ± 1.61, t = 10.364, P < .001).
[h]showed a conspicuous difference in the CVP level of CG before and after intervention (8.29 ± 2.10 vs. 10.34 ± 1.52, t = 5.305, P < .001).
[i]indicated that compared with the CG, the CVP level in the EG was obviously higher after intervention (12.38 ± 1.61 vs. 10.34 ± 1.52, t = 6.181, P < .001).

Note: The horizontal axis represented before and after intervention in EG and CG, and the vertical axis of Figure 1A, Figure 1B and Figure 1C showed SvO_2 (%), CI [L·(min·m²)⁻¹] and CVP (mmHg), respectively.

data and measurement data, tested by χ^2 test and t test. When P < .05, the difference was statistically significant.

RESULTS

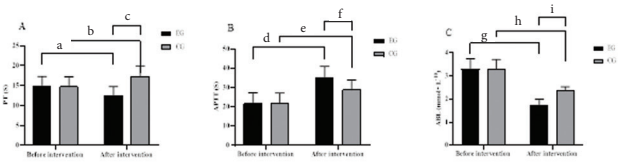
Comparison of baseline data between the two groups

There was no obvious difference in gender, age, BMI value, education level, religious belief, situation of household income and place of residence (P > .05), as shown in Table 1.

Comparison of hemodynamics between the two groups

There was no apparent difference in hemodynamics indexes between the two groups before treatment (P > .05),

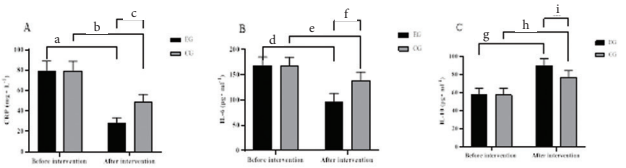
Figure 2. Comparison of coagulation function between the two groups ($\bar{x} \pm s$)



[a]indicated a distinct difference in the PT level of EG before and after intervention (14.78 ± 2.53 vs. 12.36 ± 2.35, t = 4.701, P < .001).
[b]indicated a distinct difference in the PT level of CG before and after intervention (14.72 ± 2.50 vs. 17.34 ± 2.63, t = 4.844, P < .001).
[c]indicated that compared with the CG, the PT level in the EG was obviously higher after intervention (12.36 ± 2.35 vs. 17.34 ± 2.63, t = 9.472, P < .001).
[d]indicated an evident difference in the APTT level of EG before and after intervention (21.67 ± 5.56 vs. 35.26 ± 5.74, t = 8.890, P < .001).
[e]indicated an evident difference in the APTT level of CG before and after intervention (21.61 ± 5.55 vs. 28.79 ± 5.13, t = 6.373, P < .001).
[f]indicated that compared with the CG, the APTT level in the EG was obviously higher after intervention (35.26 ± 5.74 vs. 28.79 ± 5.13, t = 5.638, P < .001).
[g]indicated a conspicuous difference in the ABL level of EG before and after intervention (3.29 ± 0.46 vs. 1.72 ± 0.28, t = 18.810, P < .001).
[h]indicated a conspicuous difference in the ABL level of CG before and after intervention (3.31 ± 0.40 vs. 2.39 ± 0.14, t = 14.563, P < .001).
[i]indicated that compared with the CG, the ABL level in the EG was obviously higher after intervention (1.72 ± 0.28 vs. 2.39 ± 0.14, t = 14.357, P < .001).

Note: The horizontal axis represented before and after intervention in EG and CG, and the vertical axis of Figure 2A, Figure 2B and Figure 2C showed PT (s), APTT (s) and ABL (mmol·L⁻¹), respectively.

Figure 3. Comparison of levels of inflammatory factors between the two groups ($\bar{x} \pm s$)



[a]indicated a distinct difference in the CRP level of EG before and after intervention (79.43 ± 9.42 vs. 28.34 ± 5.06, t = 32.051, P < .001).
[b]indicated a distinct difference in the CRP level of CG before and after intervention (79.39 ± 9.39 vs. 48.72 ± 7.42, t = 17.191, P < .001).
[c]indicated that compared with the CG, the CRP level in the EG was obviously higher after intervention (28.34 ± 5.06 vs. 48.72 ± 7.42, t = 15.222, P < .001).
[d]indicated an evident difference in the IL-6 level of EG before and after intervention (167.41 ± 17.82 vs. 96.83 ± 16.27, t = 19.621, P < .001).
[e]indicated an evident difference in the IL-6 level of CG before and after intervention (167.37 ± 17.74 vs. 138.46 ± 16.82, t = 7.933, P < .001).
[f]indicated that compared with the CG, the IL-6 level in the EG was obviously higher after intervention (96.83 ± 16.27 vs. 138.46 ± 16.82, t = 11.934, P < .001).
[g]indicated a conspicuous difference in the IL-10 level of EG before and after intervention (57.53 ± 7.46 vs. 89.45 ± 8.47, t = 18.971, P < .001).
[h]indicated a conspicuous difference in the IL-10 level of CG before and after intervention (57.43 ± 7.40 vs. 77.35 ± 7.22, t = 12.925, P < .001).
[i]indicated that compared with the CG, the IL-10 level in the EG was obviously higher after intervention (89.45 ± 8.47 vs. 77.35 ± 7.22, t = 7.293, P < .001).

Notes. The horizontal axis represented before and after intervention in EG and CG, and the vertical axis of Figure 3A, Figure 3B and Figure 3C showed CRP (mg·L⁻¹), IL-6 (pg·ml⁻¹) and IL-10 (pg·ml⁻¹), respectively.

Table 2. Comparison of mortality and complication rates between the two groups [n(%)]

Groups	Number of survivors	Number of deaths	Complications				
			ARDS	DIC	MODS	ARF	Overall incidence
EG	43 (95.56)	2 (4.44)	1 (2.22)	0 (0.00)	1 (2.22)	1 (2.22)	3 (6.67)
CG	36 (80.00)	9 (20.00)	4 (8.89)	1 (2.22)	3 (6.67)	2 (4.44)	10 (22.22)
χ^2		5.075					4.406
P value		<.05					<.05

and compared with the CG, the levels of SvO_2, CI and CVP in the EG were signally higher (all $P < .05$) after intervention, as shown in Figure 1.

Comparison of coagulation function between the two groups

There was no apparent difference in coagulation function between the two groups ($P > .05$). After intervention, compared with the CG, the levels of PT and ABL in the EG were prominently lower ($P < .05$), while the APTT level in the EG was memorably higher ($P < .05$), as shown in Figure 2.

Comparison of levels of inflammatory factors between the two groups

There was no apparent difference in the levels of inflammatory factors between the two groups ($P > .05$), after intervention,and compared with the CG, the levels of CRP and IL-6 in the EG were prominently lower (all $P < .05$), while the IL-10 level in the EG was memorably higher ($P < .05$), as shown in Figure 3.

Comparison of mortality and complication rates between the two groups

The mortality and complication rate in the EG was notably lower (all $P < .05$). See details in Table 2.

DISCUSSION

Trauma is the main cause of death in young adults under 45 years old, with the development of domestic transportation industry, construction industry and other industries, and the incidence of accidents like traffic accident, the smash of heavy weight and high fall has increased, so the incidence of thoracic and abdominal trauma is increasing year by year. Patients with severe thoracic and abdominal trauma usually have varying degrees of respiratory and circulatory dysfunction, and the main death reason is hemorrhagic shock, acute respiratory dysfunction and multiple organ dysfunction caused by trauma, so that it is necessary to give timely and effective treatment plans for patients with severe thoracic and abdominal trauma. The effective emergency treatment can stabilize the vital signs and internal environment of patients, effectively reduce the incidence of complications, and improve the survival rate of patients.[9-13] Medical staff, as execution personnel of medical behavior, need to quickly complete the nursing evaluation of trauma and communication with patients, while providing patients with airway management and oxygen treatment, electrocardiogram monitoring, specimen examination, establishment of venous channel, hemostasis, blood transfusion and infusion.

The seamless integrated rescue mode of trauma is commonly used in emergency nursing care, which could integrate on-site treatment, hospital first aid, information sharing and postoperative rehabilitation, to maximize the rescue effect through skilled rescue skills and management processes of medical staff.[14-18] The seamless integration of emergency mode can shorten the emergency process, so that patients can be treated in the shortest time, thereby improving the success rate of rescue. During the emergency period, professional teams are responsible for the emergency work, and they not only should effectively combine the pre-hospital and in-hospital treatment, but also seamlessly connect the treatment and nursing process at different stages to ensure the effectiveness and consistency of the emergency process. In addition, the members of the group performed their duties, which is helpful to the smooth development of emergency work.

For patients with multiple organs and system injury, the application of routine surgery and other complex surgical plans for treatment is easy to delay the best treatment time, which is not conducive to the clinical rescue. The traditional emergency medical rescue mode usually excessively pursues the perfection of surgery, resulting in long operation time of some patients, but it will affect the treatment effect due to coagulation function, acidosis and other postoperative complications although the operation is successful. Damage control does not pursue the perfection of surgical operation, as a short and effective control surgery for patients, which can quickly solve the problems of bleeding and infection, and control their hemodynamics, acid-base balance and internal environment. After the body functions of the patients are stable, the deterministic repair and reconstructive method of the surgery will be applied.[19-22] Damage control is divided into three steps. The first step is emergency surgery, aiming to control bleeding and stabilize the vital signs of patients. The second step is the application of drug therapy to help patients recover the physiological functions of important organs. Finally, after the physical functions of patients are stable, the second operation is carried out to repair the injury of various organs of patients in all directions and avoid the occurrence of infection.

Kobayashi et al.[23] have found that severe thoracic and abdominal trauma can cause hypothermia in patients, affect their coagulation function and increase the hemorrhage risk, and patients with body temperature below 30 °C will activate fibrinogen, thereby reducing platelets and aggravating coagulation dysfunction. At the same time, the results of Haymet et al.[24] have shown that patients with severe thoracic and abdominal trauma generally had abnormal oxygen metabolism dynamics. SvO_2 could reflect the complementary balance between oxygen transport and consumption, and the SvO_2 level in patients was lower than the normal range. The persistent bleeding of patients can cause hemodynamic disorder, imbalance of blood volume, and the reduce of CVP. CI can be used to evaluate tissue ischemia, while ABL as an important indicators can be used to evaluate sensitivity of

tissue perfusion status, which can be used to judge prognosis and improvement condition of tissue hypoxia. APTT and PT are vital indicators reflecting the coagulation function of patients, and the shortening of APTT and prolongation of PT represent the hypercoagulable state of blood in patients. According to the study, after the intervention of DCS combined with seamless integrated rescue mode, the PT value of the EG decreased, and the PT value of the CG increased, with a distinct difference ($P < .05$). Compared with the CG, the APTT in the EG was overtly higher ($P < .05$), while ABL in the EG was prominently lower ($P < .05$).

The results of Kobayashi et al.[25] have shown that most of the important organs in the human exist in the chest and abdomen. Once the fracture and bleeding occurred, it would adversely affect the physiological function of patients and seriously threaten their life safety. The uncontrolled inflammatory response would cause secondary damage of multiple organs, resulting in ARF, MODS, DIC and other complications, thus adversely affecting the prognosis of patients. According to the results of this study, compared with the CG, the levels of serum CRP and IL-6 in the EG were notably lower, the IL-10 level was prominently higher ($P < .05$), and the mortality and complication rate in the EG were signally lower (all $P < .05$), proving that DCS combined with seamless integrated rescue mode can effectively improve the levels of inflammatory factors in patients, thus effectively preventing complications and reducing the mortality of patients. Research contribution. Through clinical controlled trials, this study confirmed that the implementation of DCS combined with seamless integrated rescue mode for patients with severe thoracic and abdominal trauma improves the clinical prognosis, and provides a new direction for the formulation and selection of clinical intervention programs. Research limitations. Limited by the small sample size, single source and a lack of research on the clinical rehabilitation indicators of the patients, this study has some inadequacies. Therefore, more multi-center studies with an expanded sample size and more objective clinical indicators will be carried out to provide more evidence for the emergency treatment of patients with severe thoracic and abdominal trauma.

In conclusion, the application of DCS combined with seamless integrated rescue mode in emergency treatment of patients with severe thoracic and abdominal trauma can effectively improve the coagulation function and hemodynamics indexes, and reduce the levels of inflammatory factors, which has a positive significance for disease rehabilitation.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

AUTHORS' CONTRIBUTIONS

WZ and YW designed the study and performed the experiments, MX and SZ collected the data, MX, SZ and MW analyzed the data, WZ and YW prepared the manuscript. All authors read and approved the final manuscript.

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