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Damage Control in Severe Ballistic Trauma

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Abstract

Introduction: Severe ballistic lesions are the cause of hemodynamic disorders and early coagulopathy causing a high mortality rate, their management needs to be adapted to each situation.

Materials & amp; Methods: This retrospective study aims to evaluate the feasibility and outcomes of abbreviated laparotomy and early re-exploration. It includes patients suffering from severe ballistic injuries who had to undergo a Damage Control Surgery (DCS) due to a high severity trauma score. Moreover, morbidity and mortality rates were analysed.

Results: The sample included 73 male patients with an average age of 31years. Most patients suffered from haemorrhagic shock 74%, respiratory distress 40%, and peritoneal contamination 63%. The severity score was 72. After (DCS), the re-exploration was impossible in certain cases. The mortality rate was 28, 8%.

Conclusion: Abbreviated laparotomy and DCS are effective practices for stabilizing victims of gunshot and maintaining the function and integrity of the organism.

Keywords: Ballistic trauma; Severity score; DCS; Mortality

Introduction

The management of seriously injured patients by gunshots or in armed conflicts has witnessed a significant évolution in both its technical and logistical aspect, the medical transportation of patients, and specific care at specialized centres.

War Surgery is an iterative step-by-step surgery, depending on unfavourable particular practices. Complex wounds and aggressive factors, including burns and blasts, often cause severe damage to organs.

Surgical procedures can be reduced to so-called “rescue” interventions in order to preserve the vital prognosis. First aid administered to the injured is often critical to their survival, and the aim is to reduce the mortality caused by the lethal triad, which consists of haemorrhage, hypothermia and coagulopathy; these three factors are known to be predictive of mortality [1,2]. Damage Control (DC) is as a systematic approach used to save a seriously injured individual in critical conditions with a significant risk of post-traumatic coagulopathy and death throughout the stages of care [2,3]. We have adopted the Damage Control Surgery (DCS) concept in seriously injured patients, and we have often used systematic re-exploration of victims who received first aid in other hospitals. The aim of this retrospective study is to evaluate the results of “damage control” and abbreviated laparotomy in the management of severe ballistic trauma.

Methods and Materials

This retrospective study concerns two groups of patients suffering from a severe ballistic trauma having required

treatment by "damage control", or abbreviated laparotomy forum January 1997 to 2004. The first group of patients was initially treated at our department. In view of the complexity and gravity of the lesions, and above all, the unstable hemodynamic state of the patients, after temporary control of the haemorrhage and the digestive lesions, a resuscitation phase was necessary before carrying out a systematic surgical revision.

The patients of the second group, initially treated in another department for serious thoraco-abdominal lesions, were systematically reassessed on their arrival after an abbreviated laparotomy, thoracotomy and thoracic drainage. The indication of an early reoperation was considered in front of serious biological and radiological clinical elements and on the data of the operative reports provided by the teams having ensured the first assumption.

All patients received preoperative antibiotic therapy. Internal jugular catheters have been inserted for the treatment of fluid resuscitation with electrolyte replacement. Heated blankets were used to minimize temperature loss. Laparotomy was performed through a midline incision. The first step in the procedure included haemorrhagic control by abdominal packing in the four quadrants. Selective ligation or clamping of vascular lesions and Pringle manoeuvrewere used for hepatic lesions. We have reviewed the characteristics of the Trauma, the Severity Score (ISS), the type of surgery performed, ventilation, hospital stay, morbidity, re-explorations and mortality. We have compared the severity factors, and the variables were analysed using Fisher's exact test to test the independence of the factors, P value <0.05) was considered to indicate a significant statistical difference.

Results

Seventy-three patients were treated according to the concept of "damage control surgery", abbreviated laparotomy and/or thoracotomy for haemorrhage control, resuscitation, and re-exploration. All patients included in the study are male, with an average age of 27 years to 35 years, suffering from severe trauma, bleeding, respiratory distress, hypothermia and /or coagulopathy. Forty-five patients in the first group were directly evacuated from the accident site, and 28 patients in the second group received first aid at another hospital. In the first group, 38 patients had haemorrhagic shock, 15 patients were in respiratory distress, metabolic disorders were found in 25 patients, and nine patients had early coagulopathy. Extra-abdominal lesions were found in the majority of patients. The average severity score was 72.3 (Table 1 and Figure 1).

Table 1: Features of patients according to severity of initial state.

	1st group		**2ndgroup**		
Age (median) Years	27,6 (19-54)		26,87 (19-55)		
Initial status	N	%	N	%	P. Value
Haemorrhagic Shock	38	84,4	16	57,1	NS
Unstable	14	31,1	10	35,7	NS
Temporary stable with resuscitation	4	8,8	2	7,1	NS
Early coagulopathy	9	20	12	42,85	<0,013
Acute respiratory distress	15	33, 3	14	50	< 0,023
Peritonitis	12	26,6	14	50	<0,001
Blood transfusion >8	27	60	19	67,8	NS
Septic shock	3	6,6	19	67,8	<0,0001
Pelvic unstable fracture	7	15,5	5	17,8	NS

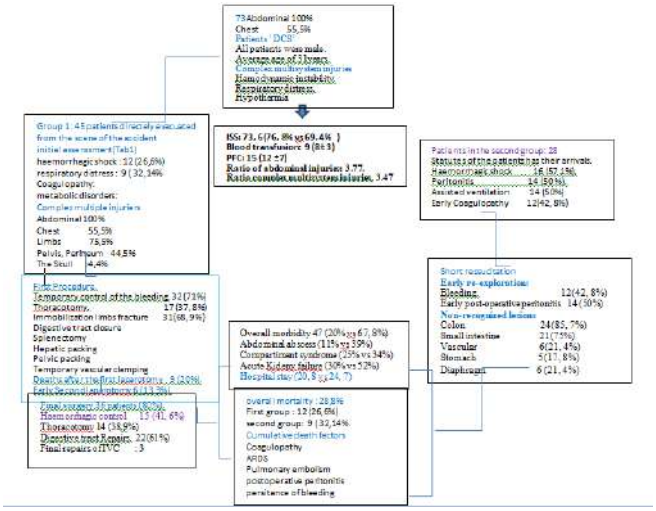

Figure 1: Management end outcome of patients with severe injuries.

Wounds were found as follows: wounds of the digestive tract in 20 patients, the liver in 21 patients, the pelvis and perineum in 13 patients. The majority of patients had extra-abdominal wounds, while thoracic wounds were found in 25 patients, limb fractures in 34 patients, vascular injuries in 9 patients, and vascular and brain injuries in 2 patients. Most patients had multiple lesions. The ratio of abdominal lesions was 3.77 and the extra-abdominal lesions ratio was 3.47. The initial procedure consisted of temporary control of haemorrhage in 27 patients, bypass of the digestive segments in 17 patients, thoracic drainage in 20 cases, thoracotomy in 17 cases and immobilization of fractures in 23 cases.

There were three deaths after the first laparotomy, and six patients required an early second laparotomy, final surgery was performed 36 to 48 hours after the temporary haemorrhagic control for the other 36 patients. Control of haemorrhage was possible in 15 patients, and thoracotomy was necessary in 14 patients. 20 patients required a repair of digestive tract lesions, 16 patients had a colostomy and two ileostomies, repair of multiple gastrointestinal lesions, iliac vessels lesions in 2 patients and final repair of the inferior vena cava.

Sixteen patients from the second group (57.1%) were in haemorrhagic shock when they arrived, 19 (65.85%) had an acute peritonitis and aseptic shock, 14 (50%) were in respiratory distress and required assisted ventilation, and 12 had early coagulopathy. After a short resuscitation, all these patients were re-operated. In addition to the lesions described in the report, non- recognized lesions of the colon, small intestine, stomach, and iliac vessels were revealed. Given the complexity and severity of the lesions and the condition of the injured we have often adopted a conservative attitude especially with regards to:digestive lesions, control of haemorrhage after removal of packing in 2 patients, definitive vascular repair in 6 patients, thoracic re-exploration to control bleeding in 5 patients, surgical treatment of limb lesions in 5 patients, and immobilization of lower limb fractures by external fixators in 7 patients. Seven patients (25%) required a second early surgical re-exploration for persistent bleeding in three patients and early postoperative peritonitis in four cases (Table 2 and Figure 1).

Table 2: Feature of patients according to injured organs.

Injured organs	G1	(%)	G2	(%)	P: value
Liver	21	46,6	12	42,9	NS
Spleen	10	22,2	5	17,9	NS
Diaphragm	4	8,8	3	10,7	NS
Colon	13	29	22	75,6	0,0001
Small intestine	23	51	19	67,9	0,022
Gallbladder	1	-	1	-	NS
Stomach	3	6,6	5	17,9	:0,017
Kidney	6	13,3	3	10,7	NS
Pelvic	10	22,2	9	32	NS
Bladder	3	-	5	17,9	<0,047
Major vascular	9	20	6	21,4	<0,031
Iliac bone	12	26,6	5	17,9	<0,018
Thoracic	25	55,6	8	28,6	<0,024
Orthopaedic (limbs)	34	75,5	19	67,9	NS
Intracranial	2	-	1	-	
ISS Score		72,3		69,4	
RIAI	3,77				
REAI	3,47				

The overall mortality was 28.8%, (26.6% in the first group and 32.14% in the second group), and was linked in the majority of cases to the consequences of coagulopathy, Acute Respiratory Distress (ARDS), pulmonary embolism

in 2 of the cases, and a fatty embolism in 2 cases. 47 patients developed complications (20% vs 67.85%), these complications included intra-abdominal abscesses (26.66% *vs.* 57.14%), acute renal failure (30.5 % *vs.* 52%) (Table 3). The average hospital stay was 20.8 *vs.* 24.7 days.

	1st group		2nd group		
Morbidity	N	%	N	%	P. Value
Postoperative peritonitis (POP)	3	6,6	19	67,8	< 0,0001
Peritoneal abscess(PA)	5	11,1	11	39,3	0,005
Gastric bleeding	1	2,2	3	10,7	NS
pulmonary embolism	1	2,2	1	3,6	NS
Fat embolism	0	0	2	7,1	0,069
Coagulopathy	9	20	12	42,8	< 0,036
Failure acute kidney	11	30,5	13	52	<0,04
Death	12(3+9)	26,6	9(2+7)	32,1	0,026

Discussion

Haemorrhage is a predominant cause of death during severe trauma responsible for early coagulopathy, which is made worse by the consumption of clotting factors. The effect of the bullets on the tissues is at the origin of significant tissue damage by cavitation and shaking, and the frequency of multiple lesions is responsible for a high mortality rate. In the majority of cases, high-speed gunshot wounds and improvised explosive devices cause multiple injuries, and the victims of such cases have a high severity score [2,3]. The working environment and the specific conditions require prior organization and preparation in terms of material and human resources by setting up an efficient and operational system.Urgent care must be prioritized [2-4].

The majority of patients in the second group had several associated lesions and a very high severity score. In addition to haemorrhagic lesions, there were other aggravating factors essentially peritonitis, acute respiratory distress, and some patients had a coagulopathy chart when they arrived. The management of such lesions can only be advised in a global framework and a conservative conduct based on adapted resuscitation and shortened surgery as defined by Stone [5] in 1983, for the fight against the lethal triad of hypothermia, acidosis and coagulopathy [2,6]. To deal with severe lesions, we have adopted the concept of DCS, which consists of urgent surgical procedures to stabilize the victims in order to save their life, and to preserve bodily and functional integrity [3]. Damage Control Surgery is most useful in 25% of trauma victims who have an early coagulopathy with a high risk of mortality [2].

Rotondo [7] describes three distinct phases of DCS. The first phaseof DCS consists in obtaining control of the haemorrhage and the risk of contamination, as well as a temporary abdominal closure. The digestive anastomosis are referred. The second phase of resuscitation (DCR) consists of warming up, correction of coagulopathy and normalization of hemodynamic parameters. During this phase, as was the case in our series, early responses to hemodynamic instability are often necessary, and a number of deaths are observed. The third phase consists of final haemorrhagic control and definitive repair of digestive injuries. This phase can only be conceived after having stabilized the patient and restored normal physiology [4]. In our series this step was not possible in some patients, due to hemodynamic instability and early death.

Early Coagulopathy has been observed in a number of our, especially in patients of the second group, this phenomenon is increased by the persistence of the haemorrhage and the occurrence of septic and respiratory complications.Acute post-traumatic coagulopathy is a multifactorial complex linked to an endogenous process occurring after serious injuries in about a third of patientsand is considered as an independent factor of mortality. [8] To combat complications in the intensive care phase, the majority of teams have adopted a new systematic approach (DCR) with

the aim of restoring physiological balance, minimizing haemorrhage, preventing coagulopathy and maximizing oxygenation of tissues [9,10]. During recent conflicts, another resuscitation strategy (1:1 ratio of red blood cell concentrate and fresh frozen plasma) has been developed. This method is associated with reduced mortality and improved limb recovery in victims of civilian and military trauma. [9]

In addition, liver damage remains frequent (83.3%) and is responsible for a mortality rate of 35% to 45.8%. [11] A significant number of surgeons prefer to leave a "laparotomy" with a temporary abdominal closure; the final closure is postponed for a few days until a revision or emergency laparotomy can be performed safely [5-11]. The application DCS in severe thorax trauma makes it possible to save a number of patients. However, control of the bleeding and permanent closure of lesions is only possible in certain patients, and the mortality rate remains high (40%). [12,13] Pelvic bleeding after gunshot trauma is traditionally difficult to control. In some cases, packing can ensure haemostasis [14]. Minimally invasive techniques, such as essentially embolization [15-17] and "intra-aortic balloon occlusion" [18], are being used more and more to achieve definitive haemorrhage control.

Conclusion

Haemorrhage is a predominant cause of death in severe trauma responsible for early coagulopathy aggravated by the consumption of coagulation factors.DCS is a systematic approach adopted to save patients suffering from severe trauma with a significant risk of post-traumatic coagulopathy and death.

We have noted the fact that in certain cases final surgery was impossible due to the seriousness of the lesions and the occurrence of death during the resuscitation phase in some cases and during the final surgery in others. Additionally, resumptions for early exploration remains frequent.

General and/or specific complications areresponsible for an additional number of deaths and an extension of the hospital stay. Although the death rate of our patients remains comparable to data from recent studies, it is essential to adopt a systematic approach based on multidisciplinary collaboration, the use of resuscitation adapted to each situation (DCR), and the systematic search for non-recognized lesions (abdominal) in patients operated by other teams in the emergency. The introduction of non-invasive techniques for haemorrhage control (embolization, obturation) will be of great help.

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