

## Ballistic Trauma of the Colon

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### Abstract

**Introduction:** Colon wounds during ballistic trauma are often associated with other severity factors responsible for significant morbidity and mortality. In seriously injured people, diversion in colostomy is preferable to one-time surgery. Our goal is to identify the prognostic factors that have determined the occurrence of septic complications and mortality after surgery.

**Methods:** In this retrospective study, the ballistic wounds of the colon (Flint grade 3) managed during the period (1999 - 2005) at the Regional University Military Hospital of Constantine, either by ideal surgery and immediate recovery or by initial externalization of the digestive segments, were reviewed. Indications, mortality, septic complications, and early surgical revisions were analysed.

**Results:** Eighty-one male patients operated on for colon wound (Flint grade 3) were included in this study. 93% of patients had hemorrhagic shock, 70% had peritonitis and 84% had extra-abdominal lesions. 58% of patients had colonic surgery in one time, and 42% had a colostomy. 41 patients were referred to our department after surgery in other hospitals, 70% had postoperative peritonitis. Surgical exploration has highlighted in addition to the release and disunions of digestive sutures other unknown lesions. The incidence of peritonitis by anastomotic release was 77% in the case of one-stage repair and 22% in the case of two-stage surgery ( $p < 0.0001$ ). Mortality is influenced by the existence of associated extra-abdominal lesions 22% and early recovery or mortality rate is around 44.5% ( $P < 0.001$ ).

**Conclusion:** The treatment of colon wounds during severe ballistic trauma must meet the requirements of emergency surgery. The ideal treatment should be reserved for favourable cases (recent and single lesions).

**Keywords:** Ballistic Colon Trauma; Primary Surgery; Colostomy; Mortality

### Introduction

The incidence of colonic wounds during abdominal ballistic trauma is estimated between 10 and 25% with a mortality rate of 9.5 to 33% [1]. The treatment of such wounds must be adapted to each case and local conditions. The management of colon wounds has gone through several phases. Since the First World War, when mortality was very high, the systematic externalization of colonic segments in colostomy has become the rule.

Retrospective studies have compared the results of first-time repairs and delayed repairs. For the majority, colostomy do not provide any benefit on the occurrence of septic complications and mortality rate. For some, the results of initial repairs are comparable and even better than those of colostomas. The data was confirmed in a prospective study [2], but it is important to note that these studies had many selection criteria and patients with severe lesions were excluded.

The management of a ballistic wound of the colon must be done in a global framework of care for the often seriously injured, such as victims of trauma by high-energy and/or explosive projectiles responsible for multiple injuries (chest, abdomen, extremities, skull...). The severity scores in these injured victims is very high [3,4], and the colonic lesions are often multiple, grade 3 of Flint [5], responsible for the contamination of the abdominal cavity, especially since the delay of surgery is longer than in civilian practice.

In these seriously injured patients, the priority is the vital prognosis by the control of various vital distresses (respiratory, hemodynamic), and to avoid the contamination responsible for septic shock, which is often fatal, by adopting the concept of "Damage Control" or shortened laparotomy. In this case, it makes sense to externalize digestive wounds. In patients who have improved their physiological state during the resuscitation phase, it is possible to restore digestive continuity during the second laparotomy.

Postoperative complications remain frequent, including peritonitis and postoperative abscesses related to the release of sutures and/or digestive anastomosis.

### Aim of the Study

The aim of this retrospective study is to analyze the results of different types of colonic wound repairs during abdominal ballistic trauma.

### Materials and Methods

All patients operated on for severe colon injuries discovered during the overall management of ballistic trauma victims were evaluated retrospectively. 81 patients with colorectal injury were included in the study.

This study involved two groups of patients with severe ballistic trauma. Those in the first group had an evaluation at the emergency unit level according to their condition on arrival and the severity of the lesions. In all cases, a systematic conditioning (placement of a central catheter, a gastric tube and a urinary catheter) was used. Triple antibiotic therapy was administered to all patients. Unstable patients were operated on urgently or we adopted the principle of shortened laparotomy; in some patients emergency chest drainage was necessary. Patients stabilized by resuscitation measures were explored in radiology (bodi-sascan) and a biological assessment before their visits to the operating room. Colic lesions were managed by suture, anastomosis resection, colostomy resection or discharge colostomy depending on the patient's condition.

Those in the second group were initially treated and operated on in local hospitals for serious trauma and then transferred to our hospital for complications or therapeutic supplement. The transfer documents of these patients, as well as the operating protocols, mention the different times of their medical care. All these patients were reassessed at their ICU admissions, and surgical revision was required after a short resuscitation in the majority of patients.

In addition to the characteristics of colonic lesions, knowing that in this study we retained only patients with serious wounds (grade 3 of Flint), all severity factors were studied in both groups of patients. We used trauma severity scores (IIS/TRISS...), to calculate the ISS, RTS and TRISS, the calculation tool available on the website [www.trauma.org](http://www.trauma.org) were used [3].

Several elements were analysed, mainly the factors that influenced morbidity and mortality, the rate of surgical revisions for septic complications and/or haemorrhage, the type of surgery, immediate repair or colostomy and the time of surgery.

The SPSS program for Windows 11.5 (SPSS Inc. Chicago, IL, USA) descriptive statistics were used for the evaluation of the data.

The Chi-square test was used to compare qualitative data between the two groups to determine factors affecting morbidity and mortality. A p-value of 0.05 was accepted as statistically significant.

## Results

We had 81 patients retained, 41 of which were initially treated at other hospitals. These are young male patients who have suffered severe ballistic trauma. The majority of patients had hemorrhagic shock 74 (93.3%), 57 (70.3%) patients had peritonitis; extra-abdominal signs of severity mainly respiratory distress in 83.9% of patients. It should be noted that in the majority of patients the colonic lesions were multiple involving several segments of the colon. Generally, these are shredded wounds with extensive necrosis, multiple lesions on the same segment. Other abdominal organs were affected in all patients, such as, small intestine in 26% of cases, stomach in 12.3% of cases, and liver in 20% of cases (Table 1). The majority of patients had an associated extra-abdominal lesion (97.5%), with a ratio of 2.87, mainly limbs 33.3% and chest 21% (Table 2).

Intraabdominal injuries	N	%
Small intestine	21	25,92
Unique	15	18,51
Multiple	06	07,40
Stomach	10	12,34
Liver	16	19,75
Spleen	08	09,87
Perineum	09	11,11
Epiploon	21	25,92
Bladder	08	09,87
Total	114	

**Table 1**

Extra-abdominal injuries	N	%
Thorax	17	20,98
Bone	27	33,33
Basin	07	08,64
Vascular	08	09,87
Skull	13	16,04
Backbone	07	08,64
Total	79 (97,53)	

**Table 2**

47 (58%) patients had colonic surgery in one time, 15 in the first group and 32 in the second group (37.5% vs. 78%). Thirty-four patients had two-stage surgery (62.5% vs. 41.9%) (Table 3).

Repair Type	1 <sup>st</sup> group		2 <sup>nd</sup> group		Total	
	N	%	N	%	N	%
First Repair	15	37,5	32	78	47	58
Resection-Anastomosis	05		04		09	
Suture	07		24		31	
HCD-Anastomosis	03		04		07	
2-step repair	25	62,5	09	22	34	42
Stoma	11		02		13	
Hartmann	14		07			21

Table 3

12 (30%) patients in the first group had at least one postoperative complication, four reinterventions were required for postoperative peritonitis, two patients died as a result of rework for anastomotic release and two related to the severity of the associated lesions (severe extra-abdominal lesions and a wound of the inferior vena cava). Both patients were managed under the concept of “Damage Control”.

32 (78%) patients in the second group had at least one serious complication, postoperative peritonitis in 70.7% of cases, 41% of patients had evisceration, 29% of patients had digestive fistula. Twenty-three (56%) patients were in respiratory distress requiring assisted intubation and ventilation. After a short resuscitation and conditioning, 35 (85%) patients had further surgery.

During systematic surgical revisions we found 35 cases of release of sutures and/or colonic anastomoses, small intestine in 12 cases and stomach in 2 cases, unknown colic lesions in stomach and diaphragm in 9 cases.

The incidence of peritonitis by anastomotic release was 10% in the first group vs. 44.4% in the second group ( $p < 0.0001$ ), it is 77.7% in the case of one-time repair and 22% in the case of two-stage surgery (Table 4). The combination of major liver wounds is responsible for a high mortality rate, the 16 deaths had a liver wound ( $p < 0.001$ ), mortality is also influenced by the existence of associated extra-abdominal lesions 22% ( $P < 0.001$ ), as well as for early reinterventions where the mortality rate reaches 44.5% (Table 5).

	1 <sup>st</sup> group			2 <sup>nd</sup> group			Total		P
	N	PPO	%	N	PPO	%	T	%	
Place	40	04	10	41	32	78,04	36	44,4	< 0,000
One-time repair	15	01	16,12	32	27	84,37	28	77,8	0,000
Two-step repair	25	03	11,53	09	05	55,55	08	22,2	0,774
OPP: postoperative peritonitis PPO/ wound suture $P < 0.001$ PPO/colectomy-anastomosis $P: 0.81$ NS PPO/Ostomy $P: 0.14$ NS PPO/Hartmman $P: 0.20$ NS									

Table 4

	N	%	p
Risk factors	16 (4 - 12)	19,7 (10 - 29,26)	0,030
Multiple colic lesions	12	29,26	< 0.001
Extra-abdominal injuries	09	21,95	< 0.001
Hail injuries	8/21	50	< 0.667
R. First	10	-	< 0.001
Stoma	06	-	< 0.0774
Liver damage	16	100	< 0.001
Epiploon	21	31,25	0,000
Re intervention	36	44,44	0,000
Multiple	14	34,14	0,001
Diaphragm/spleen			0,003
Hail / omentum			0,000
Bladder/perineum			0,000

Table 5

## Discussion

The management of traumatic colon injuries has changed significantly in recent decades. Since World War II, when colostomy diversion was the rule, there has been a significant shift toward primary repair [6,7].

The incidence of colon trauma in times of war is high 5 - 10%. Recently, during the Iraq war, the incidence of colorectal injury was 5.1%. In 71% of cases, these were injuries secondary to penetrating trauma, 23% were secondary to explosions and 5% occurred during blunt trauma. 72% of colon injuries are destructive injuries [8,9].

Mortality from colon wounds has decreased significantly in recent decades [10-12]. The mortality rate of primary repairs was 60 to 75% [1], in 1943 with systematic externalization, the mortality rate was 30%. Some authors have proposed an ideal treatment for right colon wounds and systematic externalization of left colon wounds. There are several comparative studies of treatment outcomes in one time and colostomy [13].

In our study, 58% of patients had a repair in one time. Comparing the two groups, in the majority of patients in the first group (65.5%) we performed colostomas. On the other hand, only 22% of patients in the second group had a colostomy during the first surgery ( $p < 0.001$ ). In addition to sutures, and/or resection-anastomosis, a left colectomy and colostomy type Hartmann was performed in 21 patients with multiple colic lesions.

For proponents of one-time treatment, there is no statistically significant difference between the types of operations and the complication rate and therefore neither is the bypass on the first repair. The value of one-time repairs is to reduce the risk of psychological trauma, colostomy complications, the number of hospitalizations and the economic cost [14]. These studies in the majority are retrospective, having been concerned with selected cases.

In 1979, Fabian, *et al.* [2] in a prospective randomized study, concluded that primary repair was superior to a colostomy, in reality this study involved a group of selected patients: important exclusion criteria, hypotension, hemorrhage more than one liter, when there are more than two injured organs, significant peritoneal contamination, a delay of more than eight hours, destructive wounds of the colon requiring resection, significant losses of the wall of the abdomen). Patients subsequently excluded had a mandatory colostomy [15].

Multicenter prospective studies found no significant difference in colon-related wound complications (22% and 27%,  $p = 0.373$ ) [4]. For Nurettin Ay [9] morbidity was significantly higher in the colostomy group than in the primary repair group (25%, vs. 50%,  $p = 0.001$ ) and in some studies mortality was significantly lower in the primary repair group (0% vs. 4%,  $p = 0.012$ ). These results are explained by the fact that 70.4% of patients treated with ostomy had serious lesions compared to the ratio of patients who had initial repair 37.9% ( $p = 0.001$ ) [9].

Our study involved a group of seriously injured people. The majority of patients were in haemorrhagic shock, generalised peritonitis and respiratory distress. Colic lesions were in all cases (Flint grade 3), often multiple and involving several segments of the colon, associated with small intestine and/or stomach wounds. All these lesions were at the origin of contamination of the peritoneal cavity, the coexistence of abdominal lesions (liver, diaphragm, spleen and large vessels) on the one hand and extra-abdominal lesions mainly the limbs and perineum, on the other hand increased the severity score of the injured. In addition, all patients in the first group were managed under the concept of “shortened laparotomy”, and the majority of patients in the second group had surgery for peritonitis and/or hemorrhage.

Several factors strongly influence the decision to opt for a first repair (suture and/or ana stomosis resection) or a colostomy [16]; the mechanism of the trauma, the patient’s condition, the extent of colonic lesions, the association of abdominal and/or extra-abdominal trauma and the degree of contamination.

Alexander, *et al.* [17], in a comparative study between immediate and delayed repair in injured patients where the abdomen is left open for revision and definitive surgery, found no significant difference between the two groups regarding the incidence of specific complications, but the authors themselves acknowledge the limitations of this study. Patients in the delayed repair group had a stay in intensive care and longer assisted living. This can be explained by the severity of the associated lesions.

A surgeon’s decision to repair a colonic wound immediately or deferred should be based on the patient’s overall physiological condition regardless of the repair technique chosen [17].

These wounds are often multiple and associated with damage to the abdominal organs and serious extra abdominal wounds involving the prognosis, characterized by high sepsis. Their treatment must be adapted to local conditions and the state of severity of the injured.

Driving in the face of gunshot trauma or combat must be careful and appropriate to each situation. The vital prognosis takes priority, the indications are an integral part of a global strategy especially in the face of a serious trauma or a shortened laparotomy where the concept of damage control is imposed.

The severity of the lesions remains related to the specific complications of abdominal surgery. Several scores have been proposed to assess the degree of severity of lesions and predict the risk of postoperative complications, a PATI score of 25, dramatic increase in post-operative septic complications.

Flint [5] in 1981 distinguishes three grades of colon wounds, grade three wounds are perforations associated with severe tissue loss, and devascularization causes high contamination and septic shock.

The American Association for Surgery of Trauma Colon Injury Scale (CIS), uses objective criteria to measure severity. In the presence of Flint's Grade 3 or CIS (Colon Injury Scale) grade IV and V destructive colon lesions, simultaneous shock, multiple abdominal lesions (PATI greater than 25), underlying morbidity and advanced peritonitis, it is recommended to perform a simple colostomy diversion [9,17,18].

In the military, other factors of gravity come into play. The velocity of high-energy projectiles and explosives are considered independent mortality factors. Hypotension, hemodynamic instability, advanced age, high trauma index, transfusion more than 4 units in the first hours, abdominal compartment syndrome, stay in intensive care, number of sutures are considered as factors of poor prognosis [18]. The primary repair rate of 75% in civilian traumatology and only 20 - 34% during recent armed conflicts [18], these are in the majority of cases of wounded where the evacuation time and triage is long, responsible for a potential delay in care in patients with multiple injuries with a high score (ISS) associated with significant soft tissue loss, burns and significant destructive colon lesions [5,18].

In some situations, most surgeons would agree that astomosis after resection is contraindicated, especially in the presence of hemorrhagic shock and/or significant contamination. Digestive anastomoses may be performed in some patients upon return to the operating room for definitive surgery after appropriate resuscitation [18-20].

In patients in the first group, four early reinterventions were required for septic complications, with a mortality rate of 10%. On the other hand, 32 patients (78%), in the second group required surgical revision for serious septic complications by release of anastomoses in 70.7%. In addition to the release of digestive anastomosis, other lesions were not treated during the first surgery.

Anastomosis and sutures were much more common in lesions of the rectum and sigmoid colon. The incidence of postoperative peritonitis was much more common for one-time repair than for two-stage repairs (77.7% vs. 22.2%)  $P < 0.001$ .

The incidence of postoperative peritonitis is influenced mainly by the number of colonic wounds 41.66% when it comes to multiple colonic wounds, the seat on the sigmoid colon (0.001), patients of the second group (78% vs. 10%), one-time repairs are much more providers of postoperative peritonitis by release of sutures and/or digestive anastomoses (77% vs. 22%). In the literature, civil series, the rate of digestive leakage after suturing or anastomosis remains low (2 to 7%) [21]. During the recent wars in Iraq and Afghanistan, 16 - 30% of patients who had a first repair or anastomosis had leaks that were controlled by colostomy [18].

The increase in the incidence of morbidity is ultimately dependent on the severity of the underlying trauma [22]; the time between trauma and surgery is a factor to be considered, and the rate of anastomotic release is influenced by this factor ( $p < 0.001$ ) [9].

In the presence of risk factors for anastomosis failure (severity score, significant fecal contamination, significant delay), our conduct is to postpone the anastomosis and perform a colostomy.

Several factors determine mortality represented mainly by injury severity score (NISS), scores (ASA), ballistic trauma, multiple intestinal lesions, association of multiple extra-abdominal lesions, time to surgery and shock. Several studies find no statistical relationship between colostomy making and mortality [22-24].

Mortality is highly correlated with injury severity, multiple colonic wounds, associated extra abdominal lesions, association of liver and diaphragm wounds. In a multivariate analysis the independent prognostic factors of postoperative morbidity are the factors significantly influencing mortality during colon trauma are NISS score, multiple intestinal lesions, ASA score, association of extra-abdominal lesions and time of surgery, generalized faecal contamination [20-23]. The combination of chest wounds, heart wounds, abdominal aorta, diaphragm [25].

In victims during combat, the association of perineal wounds is considered to be an aggravating factor responsible for a mortality rate of up to 33% in some series [26].

Although in civilian practice the majority is in favor of one-time reparation, is it possible to apply this conduct in the context of ballistic trauma during combat? [27]. Victims of battlefield trauma are often exposed to very serious injuries due to the energy of high-velocity bullets, explosion wounds and homemade bombs. Abdominal injuries are complex, multiple, and contaminated in the majority of cases. The surgeon is confronted with limited resources, and priority is given to vital care which falls within the overall framework of the “Damage Control” concept. The initial approach to colonic lesions was routine colostomy.

In the military, surgeons always take into consideration the location of lesions. One-time repairs are much more used for right colon wounds. On the other hand, when it comes to lesions of the left colon or rectum, the preference is for colostomy [28,29]. The experiences of the last decade in Iraq and Afghanistan have highlighted the importance of “damage control” adapted resuscitation and repeated laparotomies or “second look” are frequently used. There is considerable risk in performing an initial repair [30,31]. Mortality from anastomotic leakage is 31% [31].

### Conclusion

The management of destructive colon lesions is controversial, although the majority prefer anastomosis resection to external colostomy-type shunts.

In case of recourse to the strategy of “damage control”, the principle is to externalize the digestive wounds, and the priority is to save the injured by controlling the hemorrhage and the consequences of coagulopathy and avoiding the contamination of the peritoneal cavity. Permanent repair by anastomosis remains possible in some selected patients who have improved their haemodynamic states during the adapted resuscitation phase.

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