

Investigation of Risk Factors Affecting Surgical Decision in Traumatic Colon Injuries

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Abstract

Background: Management of colon injuries in trauma surgery has not yet been standardized. Our aim is to present our findings in patients with colon injury retrospectively in order to contribute to the selection of a surgical algorithm.

Methods: Patients were evaluated with regard to age, sex, type of trauma, hemodynamic state, the time period between trauma and surgery, amount of transfusion; additional organ injury, localization and severity of colon injury, fecal contamination, surgical procedures, postoperative complications, and mortality, and then the factors affecting morbidity and mortality were investigated.

Results: Mean Abdominal Trauma Index (ATI) of 34 cases was 18.9; ATI was over 25 in 6 (18%) cases. The time period between trauma and surgery was over 8 hours in 2 (6%) cases. Mean Colonic Injury Severity Scale (CISS) was 3. Severe fecal contamination was detected in 4 (12%) cases. Primary repair and colostomy were performed in 26 (76.5%) and 8 (23.5%) cases, respectively. Mortality occurred in 2 cases who had received colostomy procedure.

Conclusions: Decision of performing either primary repair or resection anastomosis should depend particularly on CISS (which should be equal to or less than III) accompanied by low ATI, prompt admittance (i.e. within the first 8 hours), and little or no fecal contamination.

Keywords: Colon injuries; Abdominal trauma index; Trauma colon injury; Hemorrhagic shock

Introduction

Due to the experience gained during and after the World War I, and improvements in anastomosis techniques, at present, traumatic colon injuries are managed successfully. Mortality rate due to colon injuries declined gradually from 60% in World War I to 40% in World War II, 10% in Vietnam War and below 3-5% presently.¹ Despite the improvements and success in managing colon injuries, the rates of morbidity and mortality are still high and the approach to colon injuries in trauma surgery has not yet been standardized.

Primary repair was first applied in colon injuries by J. Frazer in 1915.² Although this method was ini-

tially objected to, it was later agreed on and applied by some other researchers. At present, although all colon injuries are reported to be managed primarily with identical mortality and morbidity rates with those of colostomy procedure, in practice it is not the method of preference due to surgeons' individual experiences and habits.

In this study, we investigated the factors affecting morbidity and mortality by evaluating patients who underwent surgery due to colon injury in a retrospective manner.

Materials and Methods

Patients who underwent surgery in 2nd Surgery Clinic in Izmir Bozyaka Research and Education Hospital between 2002 and 2008 due to blunt and penetrating colon injury were investigated retrospectively. The

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cases were evaluated with regard to age, sex, type of trauma, hemodynamic state, time period between trauma and surgery, amount of transfusion, additional organ injury, localization and severity of colon injury, fecal contamination, surgical procedures, postoperative complications, and mortality, and then factors affecting morbidity and mortality were investigated. Severity of colon injury was evaluated by Colonic Injury Severity Scale (CISS), fecal contamination by George classification, and severity of additional intraabdominal organ injury by Abdominal Trauma Index (ATI). A systolic blood pressure less than 80 mmHg on admission was referred to as shock.

Statistical analyses were performed using Fisher Exact tests on SPSS for Windows software (Version

15.0, Chicago, IL, USA) with 95% confidence interval. $p < 0.05$ was considered statistically significant. All the parameters were summarized in tables.

Results

Thirty four patients who underwent surgery due to colon injury were included in the study. The males constituted 85% of all the patients with a mean age of 38 (range: 17-72) years. Penetrating traumas, most commonly (41.2%) caused by sharp instrument injury, constituted 79.4% of all the injuries. Colostomy was performed in 8 patients with penetrating trauma, 6 (17.6%) of whom had shotgun injury (Table 1).

Table 1: Features of patients, injuries and surgeries

	Total No (%)	Primary No (%)	Colostomy No (%)
Gender			
Male	29 (85.3)	22 (84.6)	7 (87.5)
Female	5 (14.7)	4 (15.4)	1 (12.5)
Age (years)			
<65	33 (97.1)	26 (100.0)	7 (87.5)
≥65	1 (2.9)	0 (0.0)	1 (12.5)
Type of trauma			
Shotgun injury	13 (38.2)	7 (26.9)	6 (75.0)
Sharp instrument injury	14 (41.2)	12 (46.1)	2 (25.0)
Blunt trauma	7 (20.6)	7 (26.9)	-
Injury localization			
Right colon	9 (26.5)	8 (30.7)	1 (12.5)
Transverse colon	12 (35.3)	7 (26.9)	5 (62.5)
Left colon	13 (37.2)	11 (42.4)	2 (25.0)
Time between trauma and surgery (hours) *			
<8	32 (94.1)	26 (100.0)	6 (75.0)
≥8	2 (5.9)	-	2 (25.0)
Hemodynamic state			
Stable	29 (85.3)	23 (88.4)	6 (75.0)
Shock	5 (14.7)	3 (11.6)	2 (25.0)
ATI *			
<25	28 (82.3)	25 (96.2)	3 (37.5)
≥25	6 (17.7)	1 (3.8)	5 (62.5)
Fecal contamination *			
Minimal	20 (58.8)	20 (76.9)	-
Mild	10 (29.4)	6 (23.1)	4 (50.0)
Serious	4 (11.8)	-	4 (50.0)
CISS *			
I	-	-	-
II	22 (64.8)	22 (84.6)	-
III	7 (20.5)	4 (15.3)	3 (37.5)
IV	5 (14.7)	-	5 (63.5)
V	-	-	-

*= statistically significant

Colon injury was most commonly (37.2%) localized to the left colon. Surgical procedure performed depending on the localization of colon injury was listed alone or in association with ATI, CISS and George classification as displayed in Table 2.

Additional intraperitoneal organ injury was detected in 23 cases and the number of organs injured in these cases varied between 1 and 5 (Table 3). The preference of colostomy in patients with pancreas injury was significantly higher; mean ATI in such patients was 39.4 (range: 27-70).

The mean duration between trauma and surgery was 2,7 (range: 0,5-8) hours. One to 8 units of blood transfusion was performed in 15 (44.1%) cases. Shock was observed in 5 cases on admission (Table 1). The rate of preference of primary repair in cases with ATI less than 25 and that of colostomy procedure in those with ATI higher than 25 were significantly significant ($p<0.05$). Surgical procedures which were evaluated using CISS and George classification are listed in Table 1.

Fourteen different complications were observed in 11 cases. Local complications occurred in 7 (21%) patients, including surgical site infection in 6 patients, and evisceration in 1 patient. Of the 7 complications, those suffered via pulmonary, urinary and postoperative ileus were found in 5, 1 and 1 patients, respectively. Surgical site infection was found in 3 and 3 patients in primary suture and colostomy groups respectively. Pulmonary complications occurred in 1 and 4 patients included in primary suture and colostomy groups respectively. Ileus and evisceration was found only in colostomy patients. Mortality was observed in two cases due to hemorrhagic shock caused by solid organ injury in one patient and by extraabdominal injury in the other.

Discussion

Although many reports have been published on the procedure to be applied in colon injury, a solid

Table 2: Evaluation of surgery types by ATI, George and CISS classifications with regard to colon injury sites

		Primary			Colostomy		
		Right No (%)	Left No (%)	Transverse No (%)	Right No (%)	Left No (%)	Transverse No (%)
ATI	<25	7 (26.9)	7 (26.9)	11 (42.3)	1 (12.5)	1 (12.5)	1 (12.5)
	≥25	1 (3.8)	-	-	-	4 (50.0)	4 (50.0)
George	Minimal	4 (15.4)	6 (23.1)	10 (38.5)	-	-	-
	Moderate	4 (15.4)	1 (3.8)	1 (3.8)	-	2 (25.0)	2 (25.0)
	Major	-	-	-	1 (12.5)	3 (37.5)	-
CISS	1	-	-	-	-	-	-
	2	4 (15.4)	6 (23.1)	11 (42.3)	-	-	-
	3	2 (7.7)	1 (3.8)	-	-	2 (25.0)	2 (25.0)
	4	2 (7.7)	-	-	1 (12.5)	3 (37.5)	1 (12.5)
	5	-	-	-	-	-	-

Table 3: Distribution of additional organ injury according to surgical method preferred

Injury site	No	%	Primary suture No (%)	Colostomy No (%)
Small intestine	10	29.4	6 (17.6)	4 (11.8)
Liver	7	20.6	5 (14.7)	2 (5.9)
Pancreas	5	14.7	1 (2.9)	4 (11.8)
Stomach	5	14.7	3 (8.8)	2 (5.9)
Spleen	4	11.8	3 (8.8)	1 (2.9)
Duodenum	2	5.9	1 (2.9)	1 (2.9)
Extrahepatic biliary system	3	8.8	3 (8.8)	0 (0.0)
Kidney	2	5.9	1 (2.9)	1 (2.9)
Major vessel	1	2.9	0 (0.0)	1 (2.9)
Urinary bladder	1	2.9	1 (2.9)	0 (0.0)
Bone	1	2.9	1 (2.9)	0/0.0

algorithm has not yet been established. While colon injuries were managed conservatively before the World War I, with experience gained in consequent wars, efforts were made to apply and improve surgical strategies. American Surgeons Association established colostomy as the gold standard in management of all colon injuries in 1943; this approach decreased the mortality rate from colon injury to 30-35%.³ Mortality rate was then declined to 10-15% with advances in resuscitation, antibiotic use, patient transfer, and intensive care unit conditions; colostomy was accepted as the main surgical treatment protocol in colon injuries until late 1970s. Later, a landmark prospective study by Stone and Fabian published in 1979 suggested that several patient suffering from colon injuries who do not possess various risk factors could be managed successfully by primary repair.⁴ This study was followed by similar randomized prospective studies by Chappuis *et al.* in 1991, Falcone in 1992, Sasaki in 1995, and Kamwendo *et al.* in 2002 who all found that none of the factors that were accepted previously as risk factors for primary repair indeed affected the success of anastomosis and that all colon injuries could be managed by primary repair.⁵⁻⁸

Our series of colon injury was mainly formed by young and male population; however, age and sex were not found to affect significantly the surgical procedure to be selected (Table 1). Type and localization of colon injury were reported among factors affecting the selection of surgical procedure to be performed.^{9,10} We found in our study that colostomy procedure was significantly the method of preference in patients with shotgun injury. This might be caused by the facts that larger numbers of intraabdominal organs are subject to injury in cases with shotgun injury and that this type of injury causes greater tissue destruction.^{11,12} Therefore, we believe that the type of injury could affect the selection of surgical procedure, at least indirectly. However, when injury localization was evaluated alone and by using such tools as ATI, CISS and George classification, it was detected that localization of injury does not affect the selection of surgical procedure; this finding is in great accord with those reported in the literature.^{7,13}

That the most common intraabdominal organ injuries were observed in the small intestine and liver in our series of patients is in good accordance with the literature.^{5,11,14} Although the rates of morbidity and mortality are increased with increasing number of injured organs, how this fact affects the procedure to be selected in colon injuries is not clear. While some

studies suggested that colostomy procedure should be the method of preference in such cases due to the fact that additional organ injuries enhance the risk of complication,¹⁵ some others reported that neither the presence of additional intraabdominal organ injury nor the number of injured intraabdominal organs affects the selection of surgical procedure.^{14,16,17} The main goal in traumatic colon injury must be to avoid mortality and morbidity and save the patient in a short period of time. When we evaluated the preference of surgical method with respect to additional organ injury, we found that colostomy was significantly the method of preference in patients with pancreas injury. Pancreas injuries are known to be accompanied by enhanced risk of infection, and thus morbidity,¹⁸ and to cause sterile or infected pseudocyst or various other fluid collections.¹⁹ Moreover, since the presence of pancreas injury is indicative of a severe trauma and since the success of primary repair will be reduced in colon injuries accompanied by pancreas injury due to high risk of infection and fistula, we believe that colostomy should be the method of preference in such patients.

We found in our study that the rate of preference of primary repair in cases admitted within 8 hours and that of colostomy procedure in those admitted after 8 hours were statistically significant ($p<0,05$). The rates of complication and mortality are increased due to peritonitis and sepsis in delayed colon injuries, and anastomosis is risky in the abdomen with peritonitis.^{20,21} The delay in surgery could decrease the patient's chance of receiving a primary repair as well as survival, and could therefore lead to a false positive finding as high mortality in patients who received colostomy. We found that neither the amount of transfusion nor the presence of shock affected the selection of surgical procedure in our study. Chang JX *et al.* showed that the intestinal mucosa started regenerating within 3-6 hours in hemorrhagic shock and this regeneration was completed within 24 hours.²² Therefore, with current advances in patient transfer, resuscitation and intensive care unit conditions, we believe that the duration, but not the amount, of blood loss affects the selection of surgical method in colon injuries.

Several scoring systems are used in determining the severity of injury and deciding the surgical method to be performed. Prognosis in an abdominal trauma is determined by using Penetrating Abdominal Trauma Index (PATI) defined by Moore *et al.* which was later revised as ATI to be made available for blunt traumas as well.⁸ We found in our study that

ATI is one of the key factors in determining the preference of surgical method in colon injuries. An ATI higher than 25 was found to be associated with enhanced septic complications which enhances morbidity and mortality and affects the surgical method to be performed.^{23,24} Keeping in mind that a high ATI could also be accompanied by low severity of colon injury, we evaluated surgical procedure preference using CISS and found that primary repair was significantly the method of preference in patients with CISS score III and lower, while statistical analyses did not reveal colostomy as the method of preference in patients with CISS scores IV and V. Maxwell and Fabian divided colon injuries into two categories as destructive and non-destructive, and classified non-destructive injuries as Flint grade 1-2 and CISS I-II-III injuries and destructive ones as Flint grade 3 and CISS IV-V injuries.²⁵ Whereas many authors agreed on this classification and suggested primary repair in destructive type penetrating and blunt colon injuries, efforts were made to determine the risk factors in order to make decision on the type of surgery in non-destructive injuries. It has been reported in the literature that resection-anastomosis or primary repair could be performed after the patient's acidosis and bleeding were taken under control, and that the decision of colostomy should be made depending on the presence or absence of such conditions as destructive injury, comorbidity, accompanying organ injury, and hypotension.²⁶ We used George classification in our study in order to determine the degree of fecal contamination and found, similar to that with Flint classification,¹⁴ that primary repair or colostomy procedure was preferred significantly in

cases with minimal and moderate contamination or in those with major contamination, respectively. It has now been widely recognized that primary repair could be performed in all types of colon injuries if and when an algorithm is established by considering various risk factors and scoring systems.^{15,16,27}

The rate of mortality in colon injuries has been reported as approximately 5%, while that of complication varies between 15% and 50% depending on the surgical procedure applied and severity of injury.^{24,28} We found, in our study, a mortality rate of 5,9% and a morbidity rate of 32,3%. Although the rates of morbidity and mortality were significantly higher in patients receiving colostomy, we believe that this significance is not due to the surgical method performed but because of the fact that colostomy group contained high-risk patients and this result should not mislead us towards a conclusion that primary repair should be preferred over colostomy in all colon injuries.

In conclusion, although primary repair may not be performed safely in all colon injuries, it can be considered an alternative to resection anastomosis in patients with all of the followings: ATI less than 25, early admission (within the first 8 hours), CISS equal to or less than III, and George value minimal or mild.

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