

COLON TRAUMA: PRIMARY REPAIR EVOLVING AS THE STANDARD OF CARE

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This study reviewed the management of colon injuries treated at the trauma surgical service, University of Nevada Medical Center between 1987 and 1992. Sixty-six patients sustained either blunt or penetrating colon injuries during the study period. The patients were divided into two groups: patients who underwent diverting colostomies and patients who underwent primary repair. Both groups were equally matched in terms of colon injury severity as well as trauma scores. The results indicated that primary colon repair was as safe if not safer than colostomy with less complications and at lower costs. The authors conclude that primary repair should be reevaluated in a critical manner as an evolving standard of care. (*J Natl Med Assoc.* 1996;88:574-578.)

Key words • trauma • colon trauma • colostomy

The philosophy regarding the operative management of colon trauma is continuously changing. The once "knee-jerk" response of creating a colostomy in the face of fecal contamination consistently is being challenged by increasing surgical data in support of primary repair.¹⁻⁸ However, reform does not go unchallenged. While the safety of primary repair in selected situations has been well documented,^{1,3,5,9-12} exact intraoperative criteria dictating the method of colon repair are still controversial. This article reviews the 5-year experience in colon trauma at a university medical center to more precisely define the risk factors for colon-related complications and to identify the circumstances in which

primary repair is not only safe, but also superior to fecal diversion.

MATERIALS AND METHODS

The charts of 66 patients who sustained either blunt or penetrating colon injury and were treated at University Medical Center, Las Vegas, Nevada, during the years 1987 to 1992 were reviewed. Patient management was conducted by a surgical attending and a senior surgical resident on arrival at the trauma center. All patients were managed via standard Advanced Trauma Life Support protocol and were aggressively resuscitated with lactated Ringer's solution and, if necessary, type zero negative or type-specific uncross-matched blood. All patients received preoperative antibiotics, either a second-generation cephalosporin (2 g of cefoxitin or 1 g of cefotetan) or a combination of cefotaxime (1 g) and metronidazole (500 mg). The decision to perform a laparotomy on a penetrating abdominal injury relied on peritoneal penetration, with local wound exploration being performed for those injuries in question. Blunt abdominal injury was evaluated clinically or with a diagnostic peritoneal lavage.

Various operative reports from six different surgeons were evaluated retrospectively over a 5-year period. Colon injuries were managed by either primary repair, resection and anastomosis, or fecal diversion (end colostomy/ileostomy or loop colostomy). Intraoperative decisions for the various forms of colon management were based on the extent of colon injury, degree of fecal contamination, and anatomical location of the injury.

Each case was reviewed for:

- patient age,
- location and mechanism of injury,
- Injury Severity Score,
- colon injury severity,
- length of hospital stay,
- hospital cost,

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TABLE 1. LOCATION OF COLON INJURY

Location of Injury	Type of Repair	
	Primary	Diversion
Right	15	3
Transverse	11	9
Left	12	13
Diversion	3	0

- presence of shock,
- number of blood transfusions,
- method of surgical repair, and
- colon-related complications (wound infection or seroma, intra-abdominal abscess, wound dehiscence, suture line failure, and death).

These variables were analyzed in relation to the development of wound infection and intra-abdominal abscess to identify potential risk factors that may contribute to colon-related postoperative morbidity. The Student's *t*-test and chi-squared test were used for statistical analysis.

RESULTS

The general characteristics of the 66 patients analyzed included an average age of 28 years (range: 11 to 70 years), with 73% being male. Forty-one patients underwent primary repair of the colon while 25 patients underwent fecal diversion. Sixty-seven percent of the patients sustained a gunshot wound to the abdomen, 15% were stab wounds, and 18% were blunt injury. Location of injury included 27% of the patients having right colon injuries, 30% transverse colon, 36% left colon, and 5% having multiple colon injuries (Table 1). Four patients presented in shock (defined as a systolic blood pressure <90 mm Hg on arrival at the hospital). Each patient was assigned an Injury Severity Score (the sum of the squares of the highest Abbreviated Injury Scale grade in each of the three most severely injured systems) and a Colon Injury Severity grade (defined as grades I-V, with I being serosal injury, II being single wall injury, III being <25% wall involvement, IV being >25% wall involvement, and V being colon wall and blood supply injury). The average Injury Severity Score was 21 and the average Colon Injury Severity grade was 3.2. Overall, three deaths occurred; two were multiorgan failure clinically unrelated to the colon wound, and one was a severe cardiac contusion secondary to blunt injury with an intraoperative myocardial infarction.

Forty-one patients underwent primary repair. Twenty-nine of these patients received a simple two-layer hand-sewn repair; 12 patients required resection

TABLE 2. ASSOCIATED ABDOMINAL INJURIES

Organs	% Primary Repair	% Diversion
Small bowel	54	66
Spleen	12	8
Liver	10	8
Kidney	7	0
Gallbladder	7	0
Stomach	5	20
Pancreas	6	8
Diaphragm	5	4
Major vascular	2	8
≥2 organs	41	32
<2 organs	59	68

and anastomosis (nine were ileocolo anastomosis and three were colocolostomies). In the fecal diversion group, there were 11 sigmoid end colostomies, 9 transverse colostomies, 3 ileostomies, 2 descending colon colostomies, and 1 transverse loop colostomy. Twenty-two patients in both the primary repair and fecal diversion group had sustained a gunshot wound to the abdomen.

In recording the frequency of involved associated abdominal injuries, the small bowel was the most commonly injured organ, occurring in 54% of the primary repair group and 66% in the diversion group (Table 2). Both groups were similar in having more than two injured abdominal organs—41% of the primary repair and 32% of the diversion group.

The differences in the average Injury Severity Score between the two groups were not statistically significant; primary repair patients averaged a score of 19.9 and the diversion group, 23.2 (Table 3). In analyzing the severity of colon injury, 15 patients who underwent primary colon repair had a Colon Injury Severity grade >III. Comparably, 21 patients who sustained a fecal diversion had a grade >III (Table 3). The average Colon Injury Severity score was statistically greater in the diversion group (3.9 ± 1) compared with those patients with primary repair (2.8 ± 0.2 ; $P < .001$).

A total of four patients were in shock on arrival at the trauma center. One out of the four underwent primary repair of the colon and received 4 units of packed red blood cells intraoperatively. The other three patients who presented in shock underwent colostomy and were given 9 units, 2 units, and 23 units of packed red blood cells, respectively. A total of four patients in the primary repair group and seven patients in the diversion group received >4 units packed red blood cells.

The morbidity and mortality associated with the colon injury were assessed in relation to the methods of repair (Table 4). Wound infection occurred in 2% of the

TABLE 3. METHODS OF REPAIR

Injury	Primary Repair	Diversion
Colon Injury Severity		
Grade I	10	0
Grade II	7	1
Grade III	8	2
Grade IV	13	19
Grade V	3	2
Mean±SEM	2.8±0.21	3.9±0.11
P value	<.001	
Injury Severity Score		
Mean Score	19.9	23.2
P value	NS	

Abbreviations: NS=not significant.

TABLE 4. COMPLICATIONS

Complications	% Primary Repair	% Diversion
Wound infection	2	12
Wound seroma	2	0
Wound dehiscence	1	0
Abdominal abscess	0	2
Suture line failure	0	0
Death	3	8
Overall	14.6	28

primary repair patients as opposed to 12% in the diversion group. There were no clinically presenting suture line failures in those patients with primary repair of the colon wound and consequently, no intra-abdominal abscesses, whereas 2% of the diversion patients formed an abscess.

The overall complication rate of fecal diversion was double that of primary repair (28% versus 14.6%). The potential risk factors (mechanism and location of injury, shock, number of transfusions, Colon Injury Severity grade, Injury Severity Score, and methods of repair) then were placed under chi-squared analysis to evaluate what affect each risk factor had on the development of either a wound infection or intra-abdominal abscess (Table 5). Mechanism of injury, shock, blood transfusion >4 units, severity of colon injury, and most importantly, method of repair did not have any statistical significance on the development of the above complications. The presence of a right-sided injury contributed to an 8% wound infection rate ($P<.001$), whereas having an Injury Severity Score >25 proved significant in the 12% formation of an intra-abdominal abscess ($P<.05$).

The overall length of hospital stay was greatest for those patients requiring a colostomy (Figure 1). It is

TABLE 5. POTENTIAL RISK FACTORS

Risk Factor	Wound Infection		Abscess	
	%	P Value	%	P Value
Mechanism of injury				
Gunshot wound	9		2	
Stab	0	NS	0	NS
Blunt	8		8	
Shock				
Systolic blood pressure <90 mm Hg	0	NS	0	NS
Transfusions				
≥4 units	18		18	
<4 units	0	NS	18	NS
Injury Severity Score				
<25	2		0	
≥25	26	NS	13	<05
Location				
Right colon	11		6	
Transverse	15	<.001	5	NS
Left colon	0		0	
Multiple	0		0	
Colon Injury Severity				
Grade I	0		0	
Grade II	0	NS	0	NS
Grade III	0		0	
Grade IV	9		3	
Grade V	23		17	
Repair method				
Simple	0		0	
Resection/anastomosis	17	NS	0	NS
Diversion	12		8	

Abbreviations: NS=not significant.

important to note that the 14±3.9 day hospital stay for the diversion group does not include readmission for colostomy take down. Figure 2 also reflects a significantly greater mean hospital cost for the colostomy group compared with the primary repair group (\$36,866 versus \$14,297; $P<.02$).

DISCUSSION

The evolution of primary repair in the setting of colon trauma slowly has gained acceptance over the last two decades. It was Woodhall and Oschner¹³ in 1951 who first pointed out the differences in blast injury between civilian and military gunshot, and subsequently questioned the long-standing dogma that colostomy is superior to primary closure in all traumatic colon wounds.¹⁴ Since Harlan Stone's prospective study in 1979, further support for primary closure of the colon in civilian trauma has been published, but often in select cases only. The continued reluctance to perform a primary repair of a colon injury in the face of gross fecal

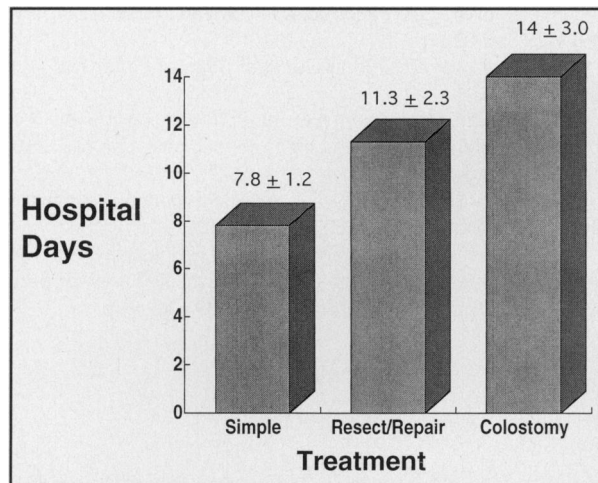


Figure 1. Length of hospitalization by type of treatment.

contamination stems from the belief that this method of repair may cause greater intra-abdominal catastrophe and postoperative morbidity. The belief that fecal diversion mandates a safer postoperative course has generated more convincing surgical literature in favor of primary repair.^{2,4,8}

Since 1980, many retrospective studies have supported primary anastomosis in the face of civilian colon trauma but each is dependent on select patient criteria. Shannon and Moore² advocate primary repair in patients who are hemodynamically stable with an Abdominal Trauma Index <25. Shultz et al¹⁵ identified a group of patients with few associated intra-abdominal injuries, low Penetrating Abdominal Trauma Index, and low Flint Colon Injury Score who were managed safely by primary repair. Criteria described by Adkins et al¹ include the time interval between injury and repair and the patient's general condition. It was not until the strength of two prospective trials by Chappuis et al⁸ and Salem et al⁴ that primary repair in colon injury was considered independent of the above-mentioned associated risk factors.

In our series, there were no suture line failures in any of the primary repair patients. This is consistent with a retrospective study conducted in Memphis.⁶ The wound infection and overall complication rate was significantly higher in the diversion group (Table 4), but this does not take into account the added morbidity and hospital stay for closure of the colostomy (such added morbidity may be as high as 28%¹⁶). The presence of shock, mechanism of injury, number of transfusions, location and severity of the colon injury, and most importantly, the method of repair had no statistical significance in

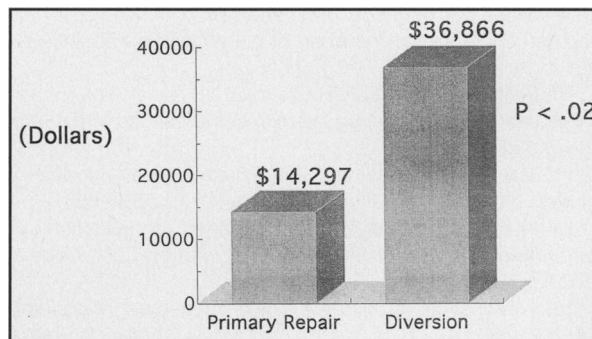


Figure 2. Hospital cost by type of surgical repair.

the formation of an intra-abdominal abscess. Our study is in agreement with Moore et al^{2,5} and several others^{3,17} in showing that high Injury Severity Scores prove to be most significant in abscess formation and overall patient morbidity/mortality.

CONCLUSION

This study suggests that almost all civilian colon trauma can be managed by primary repair. Primary repair is a safe and cost-effective method of managing traumatic colon injuries. In his article, "Penetrating Injuries to the Colon," Frame et al¹⁶ states that the value of retrospective studies lies not in the immediate institution of changes that may be indicated by the findings, but rather in using the findings as guidelines for prospective studies. This point is well stated and is used as a reminder that our institution is currently undergoing a prospective study to gather further data on conclusions drawn from the present study.

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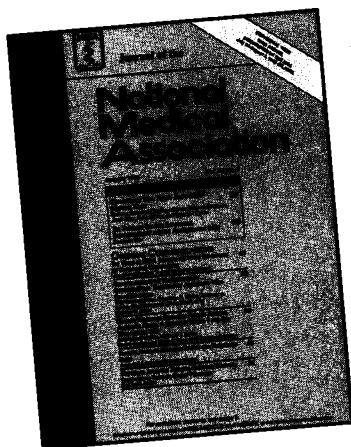
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