

Colon and Rectal Injuries During Operation Iraqi Freedom: Are There Any Changing Trends in Management or Outcome?

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PURPOSE: Despite the evolution in the management of traumatic colorectal injuries in both civilian and military settings during the previous few decades, they continue to be a source of significant morbidity and mortality. The purpose of this study was to analyze management and clinical outcomes from a cohort of patients suffering colorectal injuries. **METHODS:** This was a retrospective analysis of prospectively collected data from all patients injured and treated at the 31st Combat Support Hospital during Operation Iraqi Freedom from September 2003 to December 2004. **RESULTS:** From the 3,442 patients treated, 175 (5.1 percent) had colorectal injuries. Patients were predominately male (95 percent), suffered penetrating injuries (96 percent), and had a mean age of 29 (range, 4–70) years. Ninety-one percent of patients had associated injuries. Initial management included primary repair (34 percent), stoma (33 percent), resection with anastomosis (19 percent), and damage control only (14 percent). By injury location, stomas were placed more frequently with rectal or sphincter injuries 65 percent (25/40) *vs.* other sites (right, 19 percent (8/42); transverse, 25 percent (8/32); left, 36 percent (20/55); $P < 0.01$). Thirteen percent of patients eventually received stomas for failure of initial incontinuity management. Patients with colorectal injuries

had a significantly increased mortality rate than those without (18 percent (31/175) *vs.* 8 percent (269/3267); $P < 0.001$) but not the subset without colorectal injuries undergoing celiotomy (18 *vs.* 14.4 percent; $P = 0.41$). Rectal (odds ratio, 22; $P = 0.03$) and transverse colon (odds ratio, 17; $P = 0.04$) injuries were independently associated with increased mortality in multivariate regression analysis. Initial placement of stoma had an independent association with lower leak rates (odds ratio, 0.06; $P = 0.04$). **CONCLUSIONS:** Injury to the rectum or transverse colon is an independent predictor of mortality. The use of a diverting stoma varied by injury site and was associated with a decreased leak rate but demonstrated no impact on the incidence of sepsis or mortality. [Key words: Colon and rectal trauma; Operation Iraqi Freedom; Penetrating injuries; Stoma]

Management of traumatic injuries to the colon and rectum has undergone a dramatic shift over time. This has evolved from expectant management during the Civil War to selective primary suture repair during the World War I era, in which mortality rates ranged from 60 to 75 percent.¹ During World War II, after Olgive's experience with British forces, the United States Surgeon General mandated exteriorization or proximal stoma with an elective closure at a later date.² This change in surgical technique coincided with other advances, including decreased evacuation time, aggressive fluid resuscitation, improved antibiotics, and the use of banked blood, which all led to a significant decrease in mortality rates to 22 to 35 percent.^{3,4} In fact, failure to use

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either technique was justification for a court martial.⁵ Diversion then remained the standard practice for the next 40 to 50 years before finally the reemergence of primary repair, when feasible, as the treatment of choice.⁶⁻¹⁰ Wartime series were slower to mimic the civilian trauma experience, but similarly demonstrated that not all colorectal injuries required a colostomy, with equivalent morbidity and mortality rates.¹¹⁻¹³ Despite the abundance of evidence, colorectal injuries continue to be a source of not only significant morbidity and mortality but also ongoing debate about the correct management strategy. Although many civilian and military surgeons are more apt to avoid fecal diversion in a controlled setting, when faced with a large amount of destruction, multiple injuries, or wartime environment, management practices may change. The purpose of this study was to analyze the incidence, management, and clinical outcomes from a cohort of patients suffering colorectal injuries on the modern battlefield.

METHODS

After approval by the Joint Theatre Trauma Registry Institutional Review Board, we queried the prospectively collected data from all patients injured and treated at the 31st Combat Support Hospital during Operation Iraqi Freedom from September 2003 to December 2004 and identified all patients sustaining colon, rectal, or anal injuries. We collected data about patient demographics, injury characteristics, management, and subsequent outcome. Surgical treatment of the colorectal injuries was up to the discretion of the attending surgeon at the time of the operation. Injury Severity Scores (ISS) were calculated for each patient and colorectal injuries were graded according to the Abdominal Abbreviated Injury Score (AIS, range 0-6).¹⁴ Patients with multiple sites of colon or rectal injuries were included and analyzed as a separate group. Patients in the stoma group included: 1) primary repair or resection with anastomosis with any proximal diversion, 2) proximal stoma with stapled distal segment or mucus fistula, or 3) proximal diversion without repair (i.e., rectal injuries). Primary repair was defined as: 1) debridement with primary closure, or 2) resection with primary anastomosis (stapled or sutured) without diverting stoma. All patients undergoing temporary procedures to include closure of colon or rectal injury as a part of a damage control procedure were analyzed separately. A leak was defined after confir-

mation radiographically or surgically. Data were then entered into a computerized spreadsheet and analyzed by using SPSS® 12.0 for Windows (SPSS Inc., Chicago, IL). Statistical analysis was performed by using the unpaired Student's *t*-test or Mann-Whitney rank-sum test for continuous variables and chi-squared or Fisher's exact for categorical variables where appropriate. Odds ratios with 95 percent confidence intervals were calculated from contingency tables. Logistic regression analysis was performed on only those patients with colorectal injuries to identify factors independently associated with sepsis, anastomotic leak, and mortality. Statistical significance was set at $P < 0.05$.

RESULTS

From the 3,442 patients treated, 175 (5.1 percent) had colorectal injuries (Table 1). Patients were predominately male ($n = 167$; 95 percent), suffered penetrating injuries ($n = 168$; 96 percent), and had a mean age of 29 (range, 4-70) years. These patients presented with significant physiologic insults as

Table 1.
Patient Demographics

Variable (n = 175)	N	%
Total patients	3,442	N/A
Colorectal injured patients	175	5
Mean age (yr)	29	N/A
Male/female ratio	167/8	95/5
Nationality		
United States/coalition forces	85	37
Local National	110	63
Mechanism of Injury	14.2	N/A
Penetrating	168	96
Blunt	7	4
Associated Injuries	159	91
Abdominal	124	71
Orthopedic	83	47
Major vascular	26	15
Head	10	6
Injury Severity Score (mean)	23	N/A
AISS (0-6)	3	N/A
Initial Base Deficit	6.3	N/A
Site of Injury		
Left colon	61	35
Right colon	47	27
Transverse colon	34	19
Extraperitoneal rectum	26	15
Intraperitoneal rectum	21	12
Sphincter	14	9
Multiple	9	5

AISS = Abdominal Injury Severity Score.

evidenced by the mean injury severity score of 24 and base deficit of 6.3. More than 90 percent ($n=159$) of patients had associated injuries (abdominal, $n=124$; 71 percent), orthopedic, $n=83$; 47 percent), major vascular, $n=26$; 15 percent), head, $n=10$; 6 percent). The vast majority of the associated abdominal injuries were to the small intestine. Local nationals encompassed 63 percent ($n=110$) of patients and the remaining consisted of the United States' or coalition forces. There were significantly fewer colorectal injuries in patients with than without body armor (1.9 vs. 9.8 percent; $P<0.001$).

Injuries by location were right colon (27 percent, $n=47$), transverse colon (19 percent, $n=34$), left colon (35 percent, $n=61$), intraperitoneal rectal (12 percent, $n=21$), extraperitoneal rectal (15 percent, $n=26$), and sphincter (8 percent, $n=14$). In addition 15 patients (9 percent) had more than one site of colonic or rectal involvement. Median ISS was not significantly different between those patients with rectal (20), transverse colon (18), or other colonic sites (16; $P=0.14$). Similarly the median abdominal AIS was not significantly different between the groups with rectal (3), transverse colon (4), and other colonic sites (3; $P=0.36$). Initial management and outcome data were complete in 160 patients. This included primary repair (34 percent, $n=55$), stoma (33 percent, $n=53$), resection with anastomosis (19 percent, $n=31$), and damage control (14 percent, $n=24$). Thus, more than one-half (53 percent, $n=86$) of colorectal injuries were managed without diversion. By injury location, stomas were placed more frequently with rectal or sphincter injuries 65 percent (25/40) vs. other sites (right, 19 percent (8/42); transverse, 25 percent (8/32); left, 36 percent (20/55); $P<0.01$). When comparing left with right-sided injuries, there was a trend toward increased stoma placement in patients with left-sided injuries (36 vs. 19 percent; $P=0.07$). Of the patients who had initial primary repair or resection with anastomosis, 13 percent (11/86) developed a leak and eventually had stomas for failure of initial incontinuity management. Four additional patients who had damage-control procedures with stapled-off bowel and one patient with a proximal stoma placed along with repair of the injury site developed a leak, for an overall leak rate of 10 percent (16/160). By location, leaks occurred in patients with right colon (5/47), left colon (5/61), transverse colon (4/34), and rectum (2/47). Mortality rate in patients with a leak was 31 percent (5/16). Patients with colorectal injuries had a significantly increased mortality rate than those

without (18 percent (31/175) vs. 8 percent (269/3267); $P<0.001$) but not compared with the subset of patients without colorectal injuries undergoing celiotomy for other injuries (18 vs. 14.4 percent; $P=0.41$).

We performed univariate and multivariate logistic regression analysis to identify independent predictors of leak, sepsis, and mortality in the group of patients with colon or rectal injuries (Tables 2, 3, and 4). Initial placement of stoma had an independent association with lower leak rates (odds ratio (OR), 0.06; 95 percent confidence interval (CI), 0.004–0.91; $P=0.04$). Twenty-seven patients (16 percent) developed sepsis. Only injury severity score (OR, 1.1; 95 percent CI, 1.04–1.2; $P<0.01$) had a significant association with the development of sepsis. Finally, the overall mortality in this cohort was 17.7 percent (31/175). Adjusting for patient demographics, injury location, stomal placement, and overall physiologic impact of injuries, rectal (OR, 22; 95 percent CI, 1.3–37; $P=0.03$) and transverse colon (OR, 17; 95 percent CI, 1.1–25; $P=0.04$) injuries were independently associated with higher mortality in multivariate regression analysis (Table 5). Of note, although associated with a decreased leak rate, proximal stoma placement was not associated with a decrease in sepsis or mortality.

DISCUSSION

The management of both civilian and military penetrating colon injuries has been characterized by a history of dogmatic teaching in surgical residencies, as well as by poor outcomes with primary repair reported in past conflicts.^{13,15} Penetrating rectal injuries also have been particularly subject to a dogmatic management approach based mainly on anecdotal and historic data. The age-old dictums of the "3Ds"¹⁶ of rectal injury treatment—drain, divert, distal washout—along with the previous mandate of stomas for all colorectal injuries has been questioned not only in the civilian literature^{17,18} but in recent military conflicts as well.^{19–21} On the other hand, in Stone and Fabian's sentinel study advocating primary repair, 48 percent of their prospective patients were excluded, providing doubt as to widespread applicability of their findings.⁶ The goal of the present series was not meant to be a randomized trial of primary repair vs. fecal diversion, because many other studies (civilian) have shown equivalent or improved outcomes.^{22–29} Rather, this was meant to be an evaluation of the current management and outcome of patients with colon and rectal injuries on

Table 2.
Factors Associated with Leak by Univariate Analysis

Variable	Leak Rate with Variable Present (%)	Leak Rate with Variable Absent (%)	P Value
Initial stoma placement ^a	7	19	0.03
Primary repair	2	15	<0.01
United States/coalition forces	5	15	0.05
Sepsis present	46	4	<0.01

^a Statistically significant by multivariate analysis.

the modern-day battlefield in light of the increasing willingness to perform primary repair.

In identifying and attempting to compare our incidence of colorectal injuries with previous series, we found that most authors do not specify an incidence secondary to lack of entire population data. Rather the literature is scattered with prospective trials or retrospective case series of only colorectal injured patients. A few wartime series have estimated that the incidence of colonic injuries is 5 to 10 percent.^{30,31} Our incidence of 5.1 percent, although in-line with the military data, is higher than previously reported civilian series. In a study of 2,632 patients with hollow-viscus injury, colorectal injuries occurred in only 0.3 percent. Yet, this series included only blunt mechanisms, highlighting the differences between blunt force injury and penetrating trauma where the colon or rectum is at greater risk.¹⁸ Finally, as advances in personal protection from items such as body armor evolve, we may see future colorectal injury rates lower than previously reported.

Although the civilian trauma literature demonstrates successful primary repair in as many as 73 to 81 percent of these injuries,^{5,32-34} our rate of 53 percent is more comparable with recent military series that quote primary repair as 11 to 72 percent.^{30,31,35} Differences

between civilian and military trauma must always be considered and may account for diverse management strategies seen in the present series.³⁶⁻³⁸ Examples include the higher velocity weapons used in combat, which result in more destructive injury patterns, and the need to transport patients without continuous physician attention, making a "conservative" option, such as diversion, more attractive. In addition, the combat surgeon must consider not only the anatomic injuries and patient physiology but also the number and severity of other incoming casualties, the available resources, such as blood products, the amount of postoperative observation before evacuation to the next level of care, and the amount of monitoring and observation that will be available during that evacuation process. Thus, despite the preponderance of evidence supporting primary repair, colon and rectal injuries during wartime still present a difficult decision-making process, with potentially debilitating injury complexes and complications of repair. Our leak rate of 10 percent after primary repair is slightly higher than other civilian series, which range from 3 to 7 percent.^{16,18,24} Yet, as antibiotics continue to improve, the availability of blood products and modern critical care on the battlefield is increased, and the ability to evacuate quickly to higher levels of

Table 3.
Factors Associated with Sepsis by Univariate Analysis

Variable	Sepsis Rate with Variable Present (%)	Sepsis Rate with Variable Absent (%)	P Value
ISS > 15 ^a	39	21	<0.01
Primary repair	7	20	0.04
United States/coalition forces	5	27	<0.01
Associated vascular injury	31	14	0.04
Transfusion required	9	5	0.04

ISS = Injury Severity Score.

^a Statistically significant by multivariate analysis;

Table 4.
Factors Associated with Mortality by Univariate Analysis

Variable	Mortality Rate with Variable Present (%)	Mortality Rate with Variable Absent (%)	P Value
Rectal injury ^a	29	15	0.01
Transverse colon injury ^a	26	14	0.02
Damage control procedure	39	12	<0.01
Hypotension on Presentation	35	12	0.04
Associated vascular injury	42	13	<0.01
Sepsis present	46	12	<0.01

^a Statistically significant by multivariate analysis.

care, the distinction between the two environments becomes less and allows for future primary repair rates to continue to increase with minimal morbidity.^{39,40}

Our data also suggest that there may be a continued perceptual difference between left-sided and right-sided injuries, especially when faced with rectal injuries. There was a definite trend, albeit not statistically significant, in rates of diversion when limiting the evaluation to left colon *vs.* right colon injuries (36 *vs.* 19 percent; $P=0.07$). Rectal injuries, however, were much more likely to be treated with stoma placement. Unfortunately, the mere nature of this study makes it difficult to determine the exact reasons. Possible explanations outside of dogma include increased severity of injury to the bowel (*i.e.*, destructive *vs.* small tangential wounds), higher peritoneal soilage with left-sided injuries, significant resuscitation requirements, or more severe associated injuries that could not be identified by regression analysis. Interestingly, in a recent survey of 449 trauma surgeons regarding their preferred management for different types of colon injuries, 98 percent chose primary repair for at least one type of injury, and 30 percent stated that they would never use a colostomy, regardless of the location of the injury.⁴¹ Yet, when evaluating the nonrandomized and retrospective series to identify how surgeons are actually practicing, this difference in management among injury locations

persists in the civilian sector as well. Adesanya and Ekanem⁴² managed right colon wounds by primary repair in 69 percent *vs.* only 12 percent of left colon wounds, despite no eventual difference in morbidity or mortality. The authors did not speculate on the underlying reasons for the differences in management. Thus, outside of a randomized trial, and often in disconnect with survey results, there may be a commonly held misconception that left colon injuries are associated with worse outcome and more often treated with diversion. Our finding that stomal diversion for colon injuries did not impact the overall rates of septic complications or mortality remains consistent with the general lack of benefit demonstrated for stomas in civilian penetrating injuries.^{22,33}

In terms of the approach to rectal injuries, especially below the peritoneal reflection, similar to our results, patients more often are treated with fecal diversion. In a study of 100 consecutive patients with injuries to the extraperitoneal rectum, 100 percent were treated with colostomy, with a resultant pelvic sepsis rate of 11 percent and overall mortality rate of 4 percent.⁴³ The authors concluded that all patients with this injury should be diverted. In another study of 28 patients with extraperitoneal rectal injuries, all patients underwent diversion with no deaths. The authors again concluded that these injuries should all be managed with stomas and presacral drainage

Table 5.
Associated Injuries and Mortality by Location of Injury

Location of Injury	Associated Injuries Abdominal/Vascular/Chest	Mortality
Rectal (n=47)	21 / 12 / 5	14 (29) ^a
Transverse colon (n=34)	26 / 4 / 3	9 (26) ^a
Right or left colon (n=108)	77 / 10 / 11	8 (7)

Data are numbers with percentages in parentheses.

^a $P<0.05$.

without concern for primary repair of the injury itself.⁴⁴ Thus, the management of pelvic and low rectal injuries tends to be more consistent across both the military and civilian sectors.

We found rectal and transverse colon injuries to be associated with a higher mortality rate. The transverse colon in its central location in the upper abdomen and proximity to pancreas, major vascular structures, and liver can be associated with profound injury patterns. Similarly, rectal injuries are commonly associated with a combined major vascular or pelvic injury, significant blood loss requiring large volume resuscitation, coagulopathy, and acidosis. Emphasizing this point, in the present series, when we limited the associated injuries to only other abdominal, major vascular or chest injuries, 39 of 47 (83 percent) of rectal injuries, 33 of 34 (97 percent) of transverse colon injuries, and 98 of 108 (98 percent) of left or right colon injuries had one or more of these associated injuries present (P = not significant). However, further limiting associated injuries to only major vascular, rectal injuries had a statistically significant increase in this associated injury (32 vs. 12 percent of transverse colon and 9 percent of right and left colon injuries; $P < 0.01$). Limitations in the database do not allow for analysis of the degree of injury. Similarly, in a series of 28 patients with penetrating pelvic injuries, 43 percent sustained extraperitoneal rectal injuries, one-half of which had associated major vascular injuries and 43 percent with associated urologic injuries.⁴⁵ More than one-third of patients with rectal and vascular injuries died within one week, highlighting the devastation and increased mortality associated with this injury complex. As advances, such as damage-control procedures, become more commonplace, these rates may decrease; however, this data underscores the high morbidity associated with these injuries.

Our overall mortality rate of 18 percent in this study is slightly higher than other recent series, in which rates range from 6 to 12 percent.^{16,18,26,46} Reasons for this may include the inclusion of rectal injuries, which as discussed are associated with a higher mortality and often are excluded from other similar series. Even in the most recent Cochrane review in which mortality rates for primary repair and fecal diversion did not significantly differ, patients with rectal injuries were excluded.²² One must also consider that the current study is a strictly wartime series in which mortality has been consistently higher (8–30 percent) than civilian series.^{40,47–50}

In addition, the most prevalent wounding mechanism has become the improvised explosive device (IED), which may result in more severe and widespread injury than other mechanisms, such as gunshot wounds. When the present data are evaluated in light of these more recent wartime series, our mortality rate is comparable, thus emphasizing the differences between civilian and military traumatic injuries.

Limitations to this study include the inherent difficulties with a retrospective review. We had occasional missing data, such as lack of information about rectal drain placement and distal washout, which may have provided more insight into management and outcome. In addition, there remains limited long-term, follow-up data. Yet, the study represents one of the largest military or civilian series of colorectal injuries, especially in light of the changes on the modern-day battlefield, such as the lack of formal fronts, increasing use of improvised explosion devices, and modern critical care available closer to the site of injury.

CONCLUSIONS

In our cohort of patients, the incidence of colon and rectal injuries was comparable to post-Vietnam wartime series and higher than most civilian series. We found a slight decline in the rate of initial stoma placement compared with other wartime series, with no associated increase in mortality. We also identified rectal, along with transverse colon, injuries were associated with a higher mortality. Stomas were associated with lower leak rates and were placed more commonly for rectal injuries than other sites, although they had no significant impact on sepsis or mortality. Penetrating colorectal injuries remain a challenging clinical entity associated with significant morbidity and mortality. Further prospective study is required to identify the optimal management techniques in the battlefield setting.

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