Historical Perspectives on Colorectal Trauma Management

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Abstract

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The authors discuss the history and evolution of management of traumatic wounds to the colon and rectum, summarizing early management parallel with the history of armed conflict followed by the increase in research and management interest by civilian centers in the post-Vietnam era. They explore the strong opinions of the early thought-leaders such as DeBakey and Ogilvie, detailing factors that may have impacted their views. The current literature on optimal management of both colon and rectal trauma is reviewed, including the contentious debate over which patients may benefit from diversion. Current organ injury staging and clinical practice guidelines are also reviewed, as well as lessons learned by the U.S. military in recent conflicts in Iraq and Afghanistan. Understanding of the evolution of colon and rectal trauma management, as well as the current literature, will help surgeons in their decision-making and management of these challenging injuries.

Colorectal trauma has challenged surgeons throughout the recorded history of the management of traumatic injuries. Until the post-World War II (WWII) era, the management of colon and rectal trauma evolved in parallel to the history of armed conflict. As early as armed conflict in the era of the Roman Empire, accounts describe surgeons eviscerating the injured viscus, repairing with suture, and returning it to the abdominal cavity.¹ Similarly, even Biblical accounts of suspected colonic injury exist in the Old Testament, likely around 1300 BC.² Much as the nature of warfare evolved, from conflict with swords, spears, and arrows to modern-day high velocity weaponry and explosive devices, so too has the management of colon and rectal trauma. Mortality from colon and rectal injury has fallen from greater than 90% in the American Civil War to currently less than 5% in recent conflicts and data from trauma centers. Along with the evolution in philosophy and surgical technique in the management of these injuries, there has also been consistent development of new perioperative techniques in sterility,

antibiosis, critical care, and technology. This article will describe the transformation in the management of colon and rectal trauma, both over the history of armed conflict and in the civilian trauma setting in the era following WWII.

Pre-World War I through World War II

In the American Civil War, penetrating intestinal injury was associated with a greater than 90% mortality rate.³ Management of these wounds was challenging, and laparotomy was rarely performed. While high-velocity rounds were not utilized until the combat associated with WWI, there began to emerge some convincing data from the British during the Boer War that mandatory laparotomy was necessary in cases of suspected intestinal injury.³ This marked a major paradigm shift in the management of patients with penetrating intestinal trauma, transitioning from expectant management with high mortality rates to a more aggressive surgical approach. Of note during this time period and change in

medical management, many revolutions were taking place, both in terms of increasing surgeon comfort with laparotomy technique via surgical pioneers such as Billroth and antibiotics, anesthetic techniques, and aseptic principles. In spite of this, operative intervention remained a contentious issue among surgeons caring for combat wounded, with MacCormac stating, "In this war a man wounded in the abdomen dies if he is operated upon and remains alive if he is left in peace."⁴

With the onset of hostilities in WWI, high velocity weaponry made its debut on the battlefield, resulting in increasingly devastating injuries. Although the war started with most surgeons opting for nonoperative management of penetrating abdominal trauma, some began to advocate for laparotomy in such cases. One such surgeon, Cuthbert Wallace, was instrumental in leading the British army to adopt laparotomy in cases of penetrating abdominal injury.⁵ Perry et al credited this young surgeon as well as improved casualty evacuation techniques with decreasing the mortality from such a wound from 87 to 40% by the end of the war.^{3,6}

World War II

Not much was published on abdominal trauma during the inter-war period, but with the return of hostilities and the large scale of the war, the incidence of penetrating abdominal trauma increased dramatically. As a result, the surgical community once again focused their attention on optimizing treatment of this challenging injury. Two surgeons from this period, Ogilvie and DeBakey, were outspoken about their experience and opinions on appropriate management, this time with a particular focus on intestinal injury.

Sir W.H. Ogilvie, a British surgeon who served in both World Wars, famously stated in his book "Forward Surgery in Modern War" that "The treatment of colon injuries is based on the known insecurity of suture and the dangers of leakage. Simple closure of a wound of the colon, however small, is unwarranted; men have survived such an operation, but others have died who would still be alive had they fallen into the hands of a surgeon with less optimism and more sense. Injured segments must either be exteriorized, or functionally excluded by a proximal colostomy."⁷ Ogilvie published incidence and outcomes data in his article entitled "Abdominal Wounds in the Western Desert."⁸ He described 107 patients with colonic injury, managed by suture repair, resection and anastomosis, and exteriorization. The reported mortality for each group was 44%, 100%, and in the largest group (that of exteriorization) 64%, respectively. He concluded in this report, in spite of quite variable data, that all wounds should be managed by exteriorization. A subsequent evaluation of his data, however, noted that the mortality rates were similar between the primary repair and diversion groups (53 vs. 59%).⁹ Ogilvie spoke and wrote often on this topic and many other lessons learned from his combat surgery experience throughout his career.

Michael DeBakey, who also served in WWII, authored another article similarly advocating for diversion and stoma creation.¹⁰ In it, contrary to the published work of Ogilvie, he

discusses the differences between combat and civilian practice, especially as applied to the scale of the conflict when he notes "All the circumstances of war surgery thus do violence to civilian concepts of trauma surgery." He notes the necessity of strict guidelines given the sheer scope of the war and the conditions where the surgery was being performed: "Undoubtedly the transgression of any of these directives would have been practical and safe in numerous selected cases, but not much reflection is needed to make clear the folly of permitting the privilege of selection under combat to thousands of surgeons who had been trained under varying schools of surgical thought and who were of varying degrees of ability and experience." Given the strong opinions of leading surgeons such as DeBakey and Ogilvie, it is widely reported that standard procedure as established by the federal government was that military surgeons perform diversion with stoma creation or face potential court martial. As noted by Perry et al, and in another article by Welling and Duncan, there is little evidence that shows any surgeons actually underwent such punitive proceedings.^{3,11}

Post-World War II

Following WWII, given the sheer scope of the conflict, and publications of the works of surgeons such as Ogilvie and DeBakey, renewed interest in research on the optimal treatment of colonic injury occurred in civilian trauma surgery. Given the strong opinions of surgeons who had served and risen to prominence in the war, the prevailing dogma of the time adopted by civilian surgeons mirrored the concept of diversion and exteriorization at the conclusion of the war. Many of the surgeons who gained early career experience in the war then transitioned back to civilian practice, likely keeping their experiences deeply ingrained in their practice. In the coming years, however, this dogma began to be challenged, both by the civilian surgical community and the ensuing Korean and Vietnam Wars.

The first randomized prospective trial to compare primary repair and diversion was a groundbreaking study by Stone and Fabian in 1979, and this marked a watershed moment in the evolution of management of colonic injury.¹² In their study, 139 patients were randomized to primary repair or diversion. Of particular importance is their strict inclusion criteria, which specified eligible patients not be in "profound" preoperative shock, estimated blood loss be less than 20% of blood volume, no more than two intra-abdominal organ systems injured, minimal fecal contamination, operative intervention within 8 hours of injury, and wounds of the colon or abdominal wall not being so severe as to require resection. Patients in the group meeting exclusion criteria received what the authors termed "obligatory colostomy." If meeting the strict inclusion and exclusion criteria, patients were randomized to primary closure or ostomy groups. Of the 139 patients who were randomized, 67 underwent primary closure, while the remainder underwent colostomy creation. They found that patients who underwent primary closure had lower incidence of both superficial and organ space surgical site infection, as well

as shorter hospital stay and lower costs of care. Given their exclusion criteria, they concluded that primary repair was preferable in appropriately selected patients. It is important to note they did not describe the location of the injury in each group (right-sided vs. left-sided colon), nor did they discuss primary anastomosis (only primary repair) with diverting proximal ileostomy.

Following the study by Stone and Fabian, numerous retrospective reports were published mirroring their results. The evidence continued to grow when, in 1991, Chappuis et al published another randomized prospective study removing the exclusion criteria from the study of Stone and Fabian, and went a step further by incorporating resection and anastomosis into their management.¹³ Twenty-eight patients were treated with either primary repair or resection with anastomosis, while another 28 were treated with diversion. Infectious complications were similar between groups, and no leaks from the primary repair/anastomosis group were observed.

Though the data were growing up to this time, a Cochrane review meta-analysis done in 2003 found only five studies to include in their analysis, demonstrating the heterogeneity in much of the published literature to this point. The included studies were all prospective randomized trials comparing primary repair to diversion, and the results suggested that total overall, infectious, and wound complications favored primary repair.¹⁴ The mounting evidence favoring primary repair caused many to opine that the use of diversion in traumatic colonic injury was a dated practice, including Nance and Nance in their provocatively titled editorial response "A Stake Through the Heart of Colostomy," where they stated that in their view "a surgeon using colostomy in the management of penetrating colon injury should be required to justify the continuation if this obsolete and discredited practice."¹⁵

In spite of this bold enthusiasm, many surgeons continued to publish studies demonstrating the utility of diversion and stoma creation in appropriate cases. As early as 1994, Stewart et al asked the critical question whether primary repair was appropriate for all patients.¹⁶ Their retrospective study assessed 60 patients with destructive wounds of the colon who underwent primary anastomosis with an overall leak rate of 14%. However, in patients who had either underlying chronic illness or required massive transfusion, that rate climbed to 42%, and nearly one of three patients with anastomotic leak died. Anastomotic leak rates were similar between right- and left-sided anastomoses. The authors urged caution with primary anastomosis in the setting of these risk factors, but noted that primary repair in healthy patients without massive transfusion requirements was safe with a leak rate of 3%.

Similar caution was urged by Demetriades et al in a large nonrandomized multicenter prospective study published in 2001, including 297 patients at 19 trauma centers.¹⁷ The study included patients with a devastating colon injury requiring resection, and the determination of surgical management was left to the attending surgeon. Two-thirds were managed with primary anastomosis, which had significantly

lower colon-related mortality and complications. After multivariate analysis, independent risk factors for complications included severe fecal contamination, transfusion of greater than 4 units of packed red blood cells within 24 hours, and single agent antimicrobial prophylaxis. Chosen surgical management of the injury was not found to be a risk factor for morbidity, with no difference between groups. In spite of mounting evidence supporting primary anastomosis, this study noted that expert trauma surgeons at 19 institutions still chose diversion in one-third of cases, illustrating the critical question manifested in the literature: which patients may still benefit from diversion? These studies showed several patient, surgeon, and institutional factors related to risk in the setting of primary repair or anastomosis, specifically regarding the severity of injury and polytrauma, transfusion and resuscitation requirements, and the amount of tissue destruction. Of note with the study of Demetriades et al, when faced with more severely injured patients, diversion remained the treatment option of choice.

Rectal Trauma

The preponderance of literature on "colorectal" trauma focuses primarily on colon and intraperitoneal upper rectal injury. Some studies have small groups of rectal injury included within their cohort, while others (and particularly those prospective randomized studies) exclude rectal injury so as to make their data more homogenous. As a result, the evolution of rectal trauma management must be considered separately from the aforementioned discussion, and most notably must differentiate between the intraperitoneal and the extraperitoneal rectum. Also important to note, given the location of the rectum in the pelvis, patients with rectal injury often have concomitant injury to other pelvic structures including fractures, bladder, and zone 3 retroperitoneal vascular injury.

Similar to colonic injury, many of the earliest data on rectal injury began in WWII, with a small cohort in Ogilvie's article "Abdominal Wounds in the Western Desert," as well as other authors with a small cohort of rectal injury in the setting of penetrating abdominal trauma.⁸ Additional and more robust series were published on the injury management strategies employed in Vietnam, and management recommendations at that time were nearly uniform. Lung et al describe 24 patients with combat-related rectal injury from 1968 to 1969, and all were managed with diversion (either loop or end colostomy), debridement of perineal injury if present, and transperineal drainage of the retrorectal space with or without coccygectomy.¹⁸ Lavenson and Cohen described a 29-patient cohort that was managed similarly, and also detailed the addition of a distal rectal washout in their management strategy.¹⁹ Most other series from the time, both civilian and military, employed similar techniques, and few differentiated between injury to the intraperitoneal and injury to the extraperitoneal rectum.

As the data began to grow supporting primary repair of penetrating colonic injury, many surgeons began to attempt this technique with intraperitoneal rectal injury in the

absence of massive tissue loss, while at the same time differentiating between intraperitoneal and extraperitoneal rectal injury as it applied to management strategy. This was initially described by McGrath et al, who examined 58 rectal injuries, 16 of which were intraperitoneal and the remainder had some extraperitoneal component.²⁰ They noted that 10 patients underwent primary repair without diversion, and there were no leaks in this group. Thirty-eight of the 42 patients with extraperitoneal injury were managed with diversion, with or without repair of the injury, and with or without drainage of the presacral space. They concluded that with extraperitoneal rectal injury and proximal diversion, if the wound was repaired then no presacral drainage was necessary, but if repair was not technically feasible, a drain should be employed to avoid pelvic infectious complications. A follow-on study by the same group echoed these results, and for the first time questioned the role of routine presacral drainage if the rectal injury was able to be repaired.²¹ This has largely remained the treatment paradigm until now, with primary repair of the intraperitoneal rectum without diversion in appropriate cases, and repair of accessible wounds of the extraperitoneal rectum without presacral drainage and with selective diversion. Distal third extraperitoneal rectal injury remains a challenge, as this anatomic region remains difficult to access from an abdominal approach. This difficulty has prompted recent descriptions of management of these wounds using a transanal endoscopic microsurgical (TEM) approach, though no large studies on this topic exist currently.²¹

Current Guidelines

Numerous surgical trauma associations have helped standardize the approach to the patient with colonic injury, both in terms of creating uniform definitions of injury, as well as publishing clinical guidelines on the topic of traumatic colon and rectal injury. The American Association for the Surgery of Trauma (AAST), via Moore et al, in 1990 has an established organ injury grading system for both colon and rectal injuries. Both range from grade I to grade V. For colon, grade I involves isolated hematoma, as well as partial-thickness laceration. Grade II is laceration <50% of the circumference, while III is >50% of the circumference without complete transection. Grade IV is transection of the colon, while grade V is either transection of the colon with segmental tissue loss or colonic vascular injury. Grading for the rectum is somewhat similar, except grade IV is a full-thickness laceration with extension into the perineum, and grade V is a devascularized segment.²² While the AAST definitions are helpful in categorizing and describing what can be a heterogeneous set of injuries, especially in standardizing injuries for research purposes, they are not always helpful in clinical decision making, particularly given that the grading system for rectal injury does not differentiate between intra- and extraperitoneal injury. This distinction is of particular clinical importance as detailed earlier.

The Eastern Association for the Surgery of Trauma (EAST) published guidelines for the management of both colon and

rectal injury, and there are two distinct guidelines by injury. The guideline for management of penetrating colon injury was published in the *Journal of Trauma* in 1998, and is likely due for a more contemporary update in the near future.²³ The guidelines were developed using meta-analysis methodology, and found level I evidence to support primary repair of nondestructive wounds with <50% of the bowel wall involved and in the absence of peritonitis. Their level II recommendations noted that patients with intraperitoneal colon wounds with >50% of the bowel wall involved or segmental devascularization may safely undergo resection and primary anastomosis provided that they are hemodynamically stable (systolic blood pressure >90 mm Hg), are without significant underlying medical comorbidity, have minimal associated injury, and do not have peritonitis. They go on to state that patients with those criteria should undergo resection and ostomy creation. These results echo the findings from the study of Demetriades et al discussed earlier.¹⁷

EAST recently published guidelines on the management of extraperitoneal rectal injury.²⁴ In their published guidelines, they make three evidence-based recommendations. With regard to the question of diversion for extraperitoneal rectal injury, the guidelines conditionally recommend proximal diversion, yet found the quality of evidence to be low. They note that the members of the committee made this conditional recommendation given a desire to avoid mortality and infectious complications, as well as a desire to encourage adherence to their recommendation. This is not unlike the aforementioned quote from DeBakey detailing the emphasis on diversion during WWII. The other two recommendations proscribe the avoidance of presacral drains and distal rectal washout, and the data are more convincing on these topics as detailed earlier. In a stable patient with an isolated extraperitoneal rectal injury, an attempt at transanal or TEM repair is a feasible option in the appropriate clinical setting. Additionally, the degree of anal canal and perineal involvement remains a critical factor in clinical decision making (particularly with regard to the fecal continence mechanism), yet is absent in many organ injury grading scales.

Contemporary Management of Combat Colorectal Trauma

The recent wars in Afghanistan and Iraq have produced a large number of colon and rectal injuries, which were carefully studied and categorized in our military trauma network. Several studies have appeared which have been written by military surgeons, using the military database, providing us with contemporary information about the care of these injuries. A major review article was published in 2012 by Glasgow et al, in the *Journal of Trauma and Critical Care Surgery*, which studied 977 coalition casualties with colorectal trauma.²⁵ Fecal diversion was significantly higher in Iraq than in Afghanistan, due to increased diversion for colon injuries. Wounds of the rectum were treated with the highest rate of diversion. The most significant fact which came from this study was that those with colorectal

trauma who were diverted had a significantly lower mortality rate (3.7%) versus those who were not diverted (8.2%, $p < 0.0001$). This finding should be interpreted with caution, given the widespread use of damage control surgery; despite the fact that the patients who were diverted had a slightly higher Injury Severity Score than those who were not diverted, many in the nondiverted group did not survive long enough for colostomy creation and expired from other injuries. A second review article listed 867 colorectal injuries. In this series, rectal injuries had the highest diversion rate (56%), followed by left-sided colon injuries (41%) and right-sided colon injuries (20%). In all, 320 colostomies were created in this series.²⁶ Not surprisingly, colostomies were significantly more common in patients with gunshot wounds, higher injury severity scores, more distal injuries, and those requiring damage control surgery. Finally, an article appearing in *Military Medicine* in 2014 related specifically to rectal injuries of 67 male patients. Of the 67, only 4% did not have some form of diversion. Colostomy closure occurred in 79% of patients at an average of 237 days after injury. The authors concluded that diversion is the preferred method of treatment of war-related rectal injuries, and that routine use of presacral irrigation and drainage was not supported.²⁷

The treatment of military colorectal injuries involves high-energy, devastating wounds. The civilian practice of routinely using primary repair of these injuries was found to be unsuitable in many of these cases of the recent wars. There have been some disastrous results of anastomoses which failed and leaked, which possibly could have been prevented by diversion. An important lesson of these recent combats is that diversion is still an important method of saving lives, even in 2016.

Conclusion

Considerable advancement in the management of colon and rectal trauma has occurred since WWI, with progression from what was once considered a uniformly fatal injury to excellent management strategies, often with primary repair and acceptable morbidity rates. Advancements have been made through examining lessons learned through combat, where the incidence of these injuries is much higher than in civilian trauma, as well as through the critical research accomplishments of the academic trauma surgery community. In concert with the evolution of surgical management, equally important advances have been made in resuscitative techniques, antibiotic use, critical care, and trauma systems. Current data yield information showing that primary repair or resection and anastomosis are acceptable in many cases, while in an unstable patient with a massive resuscitation, polytrauma, and extensive tissue loss at the site of injury, diversion is still the optimal management option. Also, initial antibiotic administration to include intestinal flora is essential upon presentation to care. In spite of increasing data and research on this topic, there is need for better data, particularly on defining the ever-contentious question of which patients still benefit from diversion. Additional research is

needed in the arena of rectal injury, with a focus on anatomic descriptions differentiating intra- and extraperitoneal rectum, as well as randomized prospective data on the use of transanal approaches to repair extraperitoneal rectal injury and potentially avoid diversion. With continued focus on innovation and quality research, the surgical community can continue to adapt management techniques to avoid the considerable morbidity and mortality associated with these challenging wounds.

Disclaimer

The opinions expressed in this article are those of the authors, and do not necessarily reflect the opinions of the Department of Defense, the United States Air Force, or the Uniformed Services University of the Health Sciences.

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