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ORIGINAL SCIENTIFIC REPORT

Ostomy Usage for Colorectal Trauma in Combat Casualties

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Abstract

Introduction The role for diverting ostomy as a method to help reduce morbidity and mortality has been well established in the combat trauma population. However, factors that influence the type of ostomy used and which ostomies become permanent are poorly studied. We examine patterns of ostomy usage and reversal in a large series of combat trauma patients.

Methods We performed a retrospective review of combat casualties treated at our continental U.S. military treatment facility from 2003 to 2015. All patients who underwent ostomy formation were included. Clinical and demographic factors were collected for all patients including the type of ostomy and whether or not ostomy reversal took place. Patients were grouped and analyzed based on ostomy type and by ostomy reversal.

Results We identified 202 patients who had ostomies created. End colostomies were most common ($N = 149$) followed by loop colostomies ($N = 34$) and end ileostomies ($N = 19$). Casualties that underwent damage control laparotomy (DCL) were less likely to have a loop colostomy created ($p < 0.001$). Ostomy reversal occurred in 89.9% of patients. There was no difference in ostomy reversal rates by ostomy type ($p = 0.080$). Presence of a pelvic fracture was associated with permanent ostomy (OR = 3.28, $p = 0.019$), but no factor independently predicted a permanent ostomy on multivariate analysis.

Discussion DCL and a severe perineal injury most strongly influence ostomy type selection. Most patients undergo colostomy reversal, and no factor independently predicted an ostomy being permanent. These findings provide a framework for understanding the issue of fecal diversion in the combat trauma population and inform military surgeons about injury patterns and treatment options.

Introduction

Throughout the history of trauma care, there have been several translatable and interchangeable management practices between military and civilian casualties. However, care for combat-associated colorectal trauma maintains itself as a distinct field from civilian colorectal trauma. During World War II, the U.S. Surgeon General noted improved survival in patients with ostomies created for fecal diversion and subsequently mandated this practice for casualties suffering colorectal injuries [1, 2]. While

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research in civilian trauma has ultimately resulted in a consensus that primary repair or resection with primary anastomosis is superior for the vast majority of colorectal injuries [3–6], recent publications focused on combat-associated colorectal injuries have reaffirmed the role for fecal diversion in combat colorectal trauma in reducing morbidity and mortality [7–12].

Although the loop colostomy, compared to end colostomy, has been advocated for fecal diversion in most circumstances of combat colorectal injury, [9] previous reports have indicated that end colostomies are used far more commonly in combat trauma for fecal diversion [7, 9–12]. While large series have examined factors effecting which patients undergo fecal diversion [11], there has been little investigation into the factors that influence the type of ostomy utilized to manage colorectal and severe perineal injuries in the combat trauma population. Some indications may anatomically favor one ostomy type over others, such as a severe injury to the proximal right colon necessitating an end ileostomy, but many colorectal or perineal injuries could potentially be managed with any stoma type.

Furthermore, factors which predict the eventual closure of, or alternatively, the inability to close ostomies and restore intestinal continuity are also poorly understood. Previous publications have shown reversal rates ranging from 70% for patients with anal injuries, [12] to 86% for all combat trauma patients managed with an ostomy [9]. Of all these casualties, only an associated intra-abdominal injury (in addition to a colorectal injury) was found to be a factor predicting permanent colostomy [12].

In this study, we seek to address factors that may influence the type of ostomy created and factors that predict permanent stoma formation by examining demographic and clinical characteristics in a cohort of military casualties. We hypothesize that undergoing damage control laparotomy is associated with management with an end colostomy, and that a perineal injury is associated with permanent ostomy.

Methods

Study design and data collection

We performed a retrospective cohort study of U.S. military service members injured in Afghanistan and Iraq that underwent ostomy formation as part of their initial care and ultimately evacuated to a single Continental U.S. (CONUS) military treatment facility (MTF) between 2003 and 2015. Institutional review board (IRB) approval was received from the Walter Reed National Military Medical Center IRB prior to any data collection. The Department of Defense Trauma Registry (DoDTR) patient database was used to identify patients that underwent ostomy formation overseas and to collect data on the patients' initial injury. Patient treatment information from overseas to inpatient CONUS care was supplemented by the Theater Medical Data System (TMDS) and via our facility's, the Department of Defense's (DoD), and Veteran's Affairs' (VA) electronic medical records.

Chart review was conducted to gather clinical characteristics including the indication for the ostomy, whether damage control laparotomy (DCL) was performed, injury severity scores (ISS), associated injuries including presence of pelvic fracture, bladder injury or extremity amputation, blood products administered and the type of stoma created. Whether a patient underwent ostomy takedown was also determined where follow-up documentation was available within DoD and VA electronic medical records to the point that the patient had either undergone surgery or a final decision was made to forgo colostomy reversal. When a reversal did not occur, medical records were reviewed to determine the primary factor involved in the decision to not perform ostomy reversal.

Data analysis

Patients were grouped based on the type of ostomy they received (end ileostomy, loop colostomy, and end colostomy), and then variables were compared between these groups. Rates of ostomy reversal were calculated based on the availability of follow-up within the medical records. Student's *t* tests, Chi-squared tests, and ANOVA were used to compare continuous and categorical variables as appropriate. Those variables with a p value ≤ 0.15 were included in a multivariate analysis utilizing multiple logistical regression to identify independent predictors for selection of an ostomy type and for predictors of reversal. All statistics were performed in SPSS Version 24 (IBM, Armonk, NY).

Results

We identified 202 combat casualties with ostomies created during the study time period. End colostomies were the most commonly performed stoma procedure ($N = 149$, 73.7%), followed by loop colostomies ($N = 34$, 16.8%) and end ileostomies ($N = 19$, 9.4%), respectively. Indications for stoma were divided into four main reasons: colon injury ($N = 89$, 44.1%), rectal injury ($N = 70$, 34.7%), severe perineal wounds ($N = 37$, 18.3%), and anal sphincter injury ($N = 6$, 3.0%). Management with end colostomies predominated for all indications, though rectal injuries were more frequently than any other indication diverted via loop

Table 1 Type of ostomy used in the management for the various indications for fecal diversion

	Colon injury ($N = 89$)	Rectal injury ($N = 70$)	Perineal injury ($N = 37$)	Anal sphincter injury ($N = 6$)
End colostomy, *N* (%)	66 (74.1)	48 (68.6)	30 (81.1)	5 (83.3)
Loop colostomy, *N* (%)	5 (5.6)	22 (31.4)	7 (18.9)	1 (16.7)
End ileostomy, *N* (%)	18 (20.2)	0	0	0

colostomy (Table 1). Of the 18 patients managed with end ileostomy, all had injuries specifically to the right colon or terminal ileum.

Mean injury severity score (ISS) for entire cohort was 33.8 (range 4–66) and was similar between the three ostomy groups ($p = 0.9$) and between those patients who did and did not undergo ostomy reversal ($p = 0.06$). Mean number of total blood products (packed red blood cells, fresh whole blood, fresh frozen plasma, platelets, and cryoprecipitate) administered was 39.6 units (range 0–396). Again, there were no differences in blood product transfusions between ostomy types ($p = 0.7$) or between casualties who underwent ostomy takedown versus those patients that were left with a permanent stoma ($p = 0.2$). Patients who were managed with a DCL were less likely to have a loop colostomy matured compared to an end colostomy or ileostomy ($p < 0.001$). Table 2 displays demographic and clinical characteristics of patients that were managed with the three ostomy types identified within the study.

On multivariate analysis, undergoing DCL independently decreased the likelihood of management with a loop colostomy (RR = 0.225, 95% CI = 0.095–0.534, $p = 0.001$). Conversely, the presence of a rectal injury was identified as an independent predictor for the maturation of a loop colostomy (RR = 5.89, 95% CI = 1.98–17.54, $p = 0.001$).

Follow-up to the final decision regarding ostomy reversal versus permanent stoma was available for 179 (89%) patients. Within this group, the majority underwent ostomy reversal ($N = 161$, 89.9%). All loop colostomies were reversed, though there was no statistical difference in ostomy reversal rates by ostomy type ($p = 0.08$). On univariate analysis, the only variable associated with a permanent ostomy was the presence of a pelvic fracture (RR = 3.28, 95% CI = 1.17–9.19, $p = 0.019$), but no factors were found to independently predict this on multiple logistic regression. Table 3 displays a comparison of the demographic and clinical factors for patients that did and did not undergo ostomy reversal. For those 18 patients not reversed, seven (38.9%) did not undergo reversal due to neurologic injury that would compromise continence, eight (44.4%) remained diverted due to destructive perineal injuries, and three were lost to follow-up without a documented reason in available medical records as to why reversal did not occur.

Table 2 Comparison of demographic and clinical factors between patients managed with the three ostomy types

	End colostomy	Loop colostomy	End ileostomy	*p* value
Age, mean (SD)	25.4 (5.6)	25.4 (4.8)	25.7 (5.9)	0.168
ISS, mean (SD)	33.9 (14.0)	32.9 (12.3)	33.8 (13.8)	0.886
Total blood products, mean (SD)	44.7 (22.8)	22.8 (21.5)	27.6 (23.2)	0.710
Mechanism of injury				
Explosion, *N* (%)	88 (59.1)	26 (74.2)	8 (44.4)	0.240
GSW, *N* (%)	56 (37.6)	9 (25.7)	9 (50.0)	
Other, *N* (%)	5 (3.4)	0	1 (5.6)	
Open abdomen, *N* (%)	115 (77.2)	15 (42.9)	17 (94.4)	< 0.001
Amputated lower extremity, *N* (%)	49 (33.3)	13 (37.1)	2 (11.1)	0.125
Pelvic fracture, *N* (%)	65 (43.9)	12 (34.3)	3 (16.7)	0.064
Bladder injury, *N* (%)	29 (19.6)	7 (20.0)	2 (11.8)	0.728
Perineal injury, *N* (%)	84 (56.4)	27(77.1)	4 (22.2)	< 0.001
Reversed, *N* (%)	117 (88.6)	31 (100)	13 (81.3)	0.080

ISS injury severity score, *GSW* gunshot wound

p values are displayed for Chi-squared tests for categorical variable and ANOVA for continuous variables

Table 3 Comparison of demographic and clinical factors in patients who did and did not undergo ostomy reversal

	Reversed (N = 161)	Not reversed (N = 18)	p value
Age, mean (SD)	25.3 (5.5)	24.4 (3.9)	0.511
ISS, mean (SD)	32.4 (13.8)	40.3 (12.4)	0.063
Total blood products, mean (SD)	38.9 (49.0)	55.8 (58.2)	0.230
Mechanism of injury			
Explosion, N (%)	100 (62.1)	12 (66.7)	0.695
GSW, N (%)	55 (34.2)	6 (33.3)	
Other, N (%)	6 (3.7)	0	
Indication for diversion			
Colon injury, N (%)	65 (40.4)	9 (50.0)	0.321
Rectal injury, N (%)	58 (36.0)	7 (38.9)	
Perineal injury, N (%)	35 (21.7)	1 (5.5)	
Anal sphincter injury, N (%)	3 (1.9)	1 (5.5)	
Open abdomen, N (%)	114 (70.8)	16 (88.9)	0.161
Amputated lower extremity, N (%)	105 (65.2)	13 (72.2)	0.575
Pelvic fracture, N (%)	61 (37.9)	12 (66.7)	0.018
Bladder injury, N (%)	33 (20.5)	4 (22.2)	0.874

ISS injury severity score, *GSW* gunshot wound

p values are displayed for Chi-squared tests for categorical variable and ANOVA for continuous variables

Discussion

To our knowledge, this is the largest series to analyze combat-related ostomies and the factors that contribute to their use and ultimately reversal. End colostomy formation was the procedure of choice for all indications for diversion. However, among casualties with loop colostomies, we identified rectal injuries as the most common reason for this procedure. Likewise, while end colostomy was the predominant ostomy selected following DCL, the majority of patients with an end ileostomy were also managed with a DCL.

The reason for these findings likely has to do with the decision to perform DCL. When in the abdomen in a damage control setting to expedite control of gross spillage from hollow viscus injury, the bowel is frequently divided and left in discontinuity until the patient is stabilized and then brought back to the operating room at a later time for definitive surgery. Consequently, on return to the operating room surgeons are presumably making the decision to not perform an anastomosis and are simply bringing up the distal end of the remaining colon or ileum as an end colostomy or ileostomy. While we were unable to determine from our review the surgeon's decision for the type of ostomy, end ostomy in the setting of DCL with bowel discontinuity is a plausible explanation for their predominance in our cohort combat colorectal injuries.

In contrast, the majority of patients managed with a loop colostomy had a rectal injury as their indication for diversion and did not have a damage control laparotomy or open abdomen during their care. Many of these patients had extraperitoneal rectal injuries and presumably had their stoma matured as part of a less emergent surgery where there was less or no loss of colon or rectum requiring resection. Additionally, the presence of an associated perineal injury and a lower extremity amputation was higher in the patients managed with loop colostomy. This association could indicate that in patients where the surgeon documented rectal injury as their primary indication for fecal diversion, the decision to divert was aided by a foreseen potentially added benefit of protecting a comorbid severe perineal or very proximal lower extremity amputation wound from fecal contamination.

End ileostomies were used, as predicted, in cases where the ascending colon or ileocecal junction was injured and required resection. While civilian-based trauma literature would argue that diversion is likely unnecessary or harmful in this situation, [3, 4] we would highlight that among the 18 patients managed with end ileostomy all had complicating comorbid injuries common to the combat injured patient, that shift the balance to favor fecal diversion. Specifically, 17 underwent DCL with their abdomen remaining open, six had additional hollow viscous injuries requiring repair or resection, five required right nephrectomies, three required splenectomies, and three required

diaphragm repairs. Additionally, two of these patients who ultimately had an end ileostomy matured initially had undergone right hemicolectomies only to have their ileocolic anastomosis fail.

The vast majority of patients in our series were able to undergo ostomy reversal. Interestingly, only pelvic fracture was significantly associated with an ostomy being permanent. When controlling for other factors on multivariate analysis, no single factor predicted an ostomy being permanent. However, our review indicated that severe perineal injuries, presumably resulting in an anatomic destruction of the anus and rectum that would prevent adequate continence, were the most commonly cited reason leading to the decision to not reverse an ostomy and that neurologic injury resulting in decreased anal sphincter tone or control were a close second. Impressively, even the majority of patients (75%) with anal sphincter injury as the documented indication for fecal diversion were able to successfully have their ostomy reversed. These findings can hopefully be a source of encouragement for the wounded warriors recovering from a host of severe injuries who in our anecdotal experience are often times more aggrieved by the presence of an ostomy than their combat-inflicted injuries.

This study is limited by its retrospective design and those limitations that are inherent to this type of study. Also, the DoDTR, which was the source for identification of patients within this study, includes only patients who survived to evacuation to a role III or Combat Support Hospital. Consequently, there likely is a survival bias that may influence our results. Finally, the data collected here are primarily descriptive in nature and merely report on the practice of military surgeons over the more recent years of military conflict; thus, it is not possible to draw conclusions as to how practice should change in the future from this study.

Regardless of the study's limitations, these findings provide a framework for understanding the broad and complex issue of fecal diversion in the combat trauma population, and they inform military surgeons about injury patterns and treatment options that have defined practice over the past decade plus of military conflicts.

Future research is needed to answer this question and determine whether there is a true benefit to the patient with a loop colostomy over an end colostomy though admittedly this will be difficult to accomplish in the combat trauma setting. Evidence to support loop colostomy formation over end colostomy formation is limited to expert opinion in the combat trauma population. If a true benefit exists, research into shifting the balance of management from end to loop colostomies would be warranted and a prospective study of this question could prove beneficial, but we do not believe there is adequate evidence to support one type of ostomy over another at this time.

Conclusion

Lessons learned from our series of combat casualties managed with ostomies should improve our understanding the role for diverting ostomies in the severely wounded, both in the context of initial management of combat injuries as well as expectations for eventual ostomy reversal. Fecal diversion with an ostomy has been a central component of combat colorectal injuries since World War II. The severe injuries of the modern battlefield have continued to necessitate diversion, and a focus on damage control surgery may be the driving factor leading to the predominance of end colostomies in these patients. Thankfully, the vast majority of ostomies created for combat-associated injuries are temporary, and even patients with the highest injury severity ultimately have their stoma reversed.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

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