Eur J Trauma Emerg Surg (2015) 41:539–543
DOI 10.1007/s00068-014-0444-1

ORIGINAL ARTICLE

Loop versus end colostomy reversal: has anything changed?

B. R. Bruns · J. DuBose · J. Pasley · T. Kheirbek · K. Chouliaras · A. Riggle · M. K. Frank · H. A. Phelan · D. Holena · K. Inaba · J. Diaz · T. M. Scalea

Received: 2 June 2014 / Accepted: 26 August 2014 / Published online: 4 September 2014

Abstract
Purpose Though primary repair of colon injuries is preferred, certain injury patterns require colostomy creation. Colostomy reversal is associated with significant morbidity and healthcare cost. Complication rates may be influenced by technique of diversion (loop vs. end colostomy), though this remains ill-defined. We hypothesized that reversal of loop colostomies is associated with fewer complications than end colostomies.
Methods This is a retrospective, multi-institutional study (four, level-1 trauma centers) of patients undergoing colostomy takedown for trauma during the time period 1/2006–12/2012. Data were collected from index trauma admission and subsequent admission for reversal and included demographics and complications of reversal. Student's *t* test was used to compare continuous variables against loop versus end colostomy. Discrete variables were compared against both groups using Chi-squared tests.
Results Over the 6-year study period, 218 patients underwent colostomy takedown after trauma with a mean age of 30; 190 (87 %) were male, 162 (74 %) had penetrating injury as their indication for colostomy, and 98 (45 %) experienced at least one complication. Patients in the end colostomy group ($n = 160$) were more likely to require midline laparotomy (145 vs. 18, $p < 0.001$), had

B. R. Bruns (✉) · J. Pasley · M. K. Frank · J. Diaz · T. M. Scalea
R Adams Cowley Shock Trauma Center, University of Maryland, 22 S Greene St S4D07, Baltimore, MD 21201, USA
e-mail: Bbruns@umm.edu

J. Pasley
e-mail: Jpasley@umm.edu

M. K. Frank
e-mail: Mfrank@stapa.umm.edu

J. Diaz
e-mail: Jdiaz@umm.edu

T. M. Scalea
e-mail: Tscalea@umm.edu

J. DuBose
The University of Texas Health Science Center, Houston, TX, USA
e-mail: Joseph.J.DuBose@uth.tmc.edu

T. Kheirbek · D. Holena
Division of Traumatology, Emergency Surgery and Surgical Critical Care, University of Pennsylvania, Philadelphia, PA, USA
e-mail: Tareq.Kheirbek@uphs.upenn.edu

D. Holena
e-mail: Daniel.Holena@uphs.upenn.edu

K. Chouliaras · K. Inaba
Department of Surgery, University of Southern California, Los Angeles, CA, USA
e-mail: Chouliar@usc.edu

K. Inaba
e-mail: Kenji.Inaba@med.usc.edu

A. Riggle · H. A. Phelan
Parkland Memorial Hospital, The University of Texas Southwestern, Dallas, TX, USA
e-mail: Andrew.Riggle@phhs.org

H. A. Phelan
e-mail: Herb.Phelan@UTSouthwestern.edu

greater intra-operative blood loss (260.7 vs. 99.4 mL, $p < 0.001$), had greater hospital length of stay (8.4 vs. 5.5 days, $p < 0.001$), and had more overall complications (81 vs. 17, $p = 0.005$) than patients managed with loop colostomy ($n = 58$).

Conclusions Local takedown of a loop colostomy is safe and leads to shorter hospital stays, less intra-operative blood loss, and fewer complications when compared to end colostomy.

Keywords Colonic trauma · Colon · Stoma · Stoma reversal · Loop colostomy · End colostomy

Purpose

In the setting of civilian trauma, the management of colon and rectal trauma has evolved from that of near mandatory colostomy creation to aggressive primary repair of lesions without fecal diversion. However, certain clinical scenarios still mandate the creation of a colostomy, either a loop or end. Often, the decision to proceed with one stoma type as opposed to another is the result of provider bias or institutional practice pattern. Though both operations achieve the primary purpose of fecal diversion [1, 2], the morbidity of the index operations as well as subsequent operations for reversal is often contested and data specifically examining loop versus end colostomy reversal for trauma remains limited.

In 1990, Pachter et al., reported a 10-year experience consisting of 87 patients who underwent colostomy closure at the Bellevue Hospital Trauma and Shock Unit. Seventy-nine of the patients had end colostomies, while only 8 (9 %) underwent loop colostomy. The mean hospital length of stay was 14.3 days and a 25 % complication rate was reported, with discharge delays in half of those with morbidity. Most complications were small bowel obstructions ($n = 10$), of which only one required operative intervention [3]. Investigators did not report loop and end colostomy complications individually.

Similarly, Bulger and colleagues examined 86 patients requiring colostomy for penetrating colon injury over a 10-year period at Harborview Medical Center. Sixty of those patients underwent subsequent stoma reversal, with an overall morbidity of 17 %. Subgroup analysis of loop versus end stoma reversal showed no difference in the rates of wound infection or anastomotic leak, but did illustrate a higher rate of anastomotic stricture with loop colostomy takedown [4].

In another series, Berne, et al, studied 40 patients undergoing colostomy reversal after trauma. Twelve patients experienced 16 complications (30 % overall morbidity). Fifteen patients (38.5 %) required laparotomy for takedown, and those patients experienced a 40 % complication rate. Half of patients in the end colostomy group had documented complications compared to 21.4 % in the loop colostomy group [5].

We hypothesized that loop colostomy takedown would be associated with a decreased need for exploratory laparotomy with its attendant complications. Given the potential for institutional and provider bias towards certain techniques of fecal diversion, we employed a multi-institutional study design to explore the association between index technique of fecal diversion and post-operative outcomes after colostomy reversal.

Methods

This is an Institutional Review Board (IRB) approved, retrospective analysis of patients undergoing restoration of intestinal continuity after end or loop colostomy for trauma at four level-1 trauma centers during the time period from January 1, 2006 to December 31, 2012. Participating centers included the University of Southern California, Parkland Memorial Hospital, The Hospital of the University of Pennsylvania, and the R Adams Cowley Shock Trauma Center at the University of Maryland. Patients undergoing stoma reversal were identified from each trauma center through review of registry and administrative databases. Only patients undergoing stoma reversal after colostomy creation for trauma were included. Patients with incomplete or missing data were excluded from the analysis ($n = 12$).

Data were collected from both the index trauma admission and the subsequent admission for operative restoration of intestinal continuity. Baseline demographics included age, gender, mechanism of injury, indication for colostomy creation, need for re-operative revision of the colostomy, and time from index admission to reversal. Operative notes for reversal were reviewed and intra-operative blood loss and intravenous fluid requirement were collected. Outcomes included hospital length of stay, intensive care unit length of stay, and complications (wound infection, ileus, partial small bowel obstruction, intra-abdominal abscess, anastomotic leak, dehiscence of fascia, and need for re-operative therapy). Patient follow-up was through discharge from the hospital.

Analysis was performed using SAS 9.2 software (Cary, NC). Student's t test was used to compare continuous variables (age in years, time to reversal, intra-operative estimated blood loss (EBL), intra-operative intravenous fluid (IVF) replaced, intra-operative transfusion requirements, and intensive care unit (ICU) and hospital length of stay) against loop versus end colostomy reversal. Categorical variables were compared using Chi-squared or

Fischer's exact test, as appropriate. Two-tailed statistical significance was set at $p < 0.05$.

Results

Over the 6-year study period, 218 patients (University of Pennsylvania, 90; University of Southern California, 67; Shock Trauma Center, 51; Parkland Hospital, 10) with complete data were identified that had undergone colostomy takedown after trauma. One hundred and ninety (87 %) were male with a mean age of 30 years. One hundred and sixty-two (74 %) had a penetrating mechanism of injury as the indication for colostomy (155 gunshot wounds and 7 stab wounds). Rectal injury was the indication for colostomy creation in 109 patients (50 %), with 94 patients (43 %) having colon injury as the indication. Fifteen patients (7 %) underwent colostomy for other traumatic injuries requiring fecal diversion; these injuries included extensive perineal and gluteal soft tissue destruction (Table 1).

Fifty-eight patients (27 %) underwent loop colostomy and 160 (73 %) underwent end colostomy creation. Patients in each group were similar with regards to age, gender, mechanism of injury, indication for colostomy creation, need for revision of stoma during initial hospitalization, and time to reversal of stoma. Patients with an end colostomy required laparotomy (defined as surgical entry into the peritoneal cavity via midline incision) significantly more than those with loop colostomy (Table 2). Of the 15 patients with end colostomy that did not require laparotomy for reversal, 9 underwent local takedown and 6 had laparoscopic approaches.

Table 1 Demographics, study population

Age (years), mean ± SD	30 ± 12
Gender, *n* (%)	
Male	190 (87)
Female	28 (13)
Mechanism, *n* (%)	
GSW	155 (71)
Blunt	48 (22)
Stab	7 (3)
Other	8 (4)
Colostomy indication, *n* (%)	
Rectal injury	109 (50)
Colon injury	94 (43)
Other	15 (7)
Need for revision, *n* (%)	5 (2)
Weeks to reversal, mean ± SD	49 ± 79
Any complication, *n* (%)	98 (45)

Table 2 Comparison of loop versus end colostomy groups

	Loop colostomy ($n = 58$)	End colostomy ($n = 160$)	*p* value
Age (years), mean ± SD	28 ± 11	31 ± 12	0.210
Gender, *n* (%)			
Male	52 (90)	138 (86)	0.649
Female	6 (10)	22 (14)	
Mechanism, *n* (%)			
GSW	40 (69)	115 (71)	0.769
Stab	1 (2)	6 (4)	
Blunt	15 (26)	33 (21)	
Other	2 (3)	6 (4)	
Colostomy indication, *n* (%)			
Colon injury	10 (17)	84 (53)	<0.001
Rectal injury	40 (69)	69 (43)	
Other	8 (14)	7 (4)	
Need for revision during initial hospitalization, *n* (%)	1 (2)	4 (3)	1.00
Time to reversal (weeks)	55.3	46.6	0.556
Laparotomy required, *n* (%)			
Yes	18 (31)	145 (91)	<0.001
No	40 (69)	15 (9)	

Table 3 Intra-operative and hospital outcomes

	Loop colostomy ($n = 58$)	End colostomy ($n = 160$)	*p* value
Intra-operative EBL (mL)	99.4	260.7	<0.001
Intra-operative IVF (mL)	2,009.5	3,823.1	0.002
Hospital LOS (days)	5.5	8.4	<0.001
ICU LOS (days)	0	0.3	0.057
Any post-op complication, *n* (%)	17 (30)	81 (51)	0.005

EBL estimated blood loss, *IVF* intravenous fluid, *LOS* length of stay)

Intra-operative blood loss and fluid requirement were both significantly greater in patients undergoing end colostomy reversal. Additionally, hospital length of stay was greater in patients undergoing takedown of end colostomy. ICU length of stay was similar in both groups, with no patients in the loop colostomy group requiring ICU admission. There were significantly more post-operative complications in the end colostomy reversal cohort (Table 3). There were no mortalities in either group.

Examining specific post-operative complications illustrated more wound infections and episodes of ileus and partial small bowel obstruction in patients undergoing end colostomy reversal ($p < 0.001$). Rates of intra-abdominal

abscess, anastomotic leak, dehiscence, and need for re-operative therapy were equivalent between the two groups (Table 4).

Discussion

In comparison to end colostomy takedown, loop colostomy reversal is associated with a decreased hospital length of stay, less intra-operative blood loss, a lower rate of wound infections, and a decreased incidence of paralytic ileus/partial small bowel obstruction. The management of colonic trauma has changed greatly over the past 40 years. In 1979, Drs. Stone and Fabian published the first randomized controlled trial of primary closure of perforating colon trauma versus colostomy creation. They were able to illustrate lower incisional infection rates, lower intra-abdominal infection rates, and a shorter hospital length of stay [6]. In 1994, investigators in Memphis reviewed 60 patients with destructive colon wounds and concluded that primary anastomosis was associated with a 3 % leak rate in healthy patients without excessive bleeding [7]. In light of these studies, an aggressive attitude towards primary colon repair has been adopted by many, but certain situations continue to mandate colostomy creation.

Classic management of extra-peritoneal rectal injuries involves fecal diversion by creation of either an end or loop colostomy [8], though some investigators have suggested diversion is not indicated with non-destructive lesions [9]. Given the technical challenge and relative inaccessible nature of operating on the extra-peritoneal rectum, primary repair is rarely recommended and occasionally dangerous to pursue. Thus, fecal diversion is commonly employed via either a loop or end colostomy creation, with the choice of colostomy frequently dictated by institutional dogma or provider preference. In light of the current data, in conjunction with previous studies showing loop colostomy to be completely diverting [1, 2], loop colostomy should be preferentially performed over end colostomy if technically feasible.

Table 4 Specific post-operative morbidity

	Loop colostomy ($n = 58$)	End colostomy ($n = 160$)	p value
Wound infection	6	32	<0.001
Ileus/PSBO	5	38	0.012
Intra-abdominal abscess	7	23	0.825
Anastomotic leak	7	9	0.140
Dehiscence	4	16	0.602
Need for re-operation	9	24	1.00

PSBO partial small bowel obstruction

Increasingly, resource utilization and cost containment are becoming overriding factors in healthcare delivery. Dr. Pachter's series of 87 patients undergoing colostomy reversal highlights the increased cost associated with post-operative morbidity. However, subgroup analysis was not performed and end colostomy was grouped with loop colostomy in the overall analysis. They conclude that given the significant financial impact of colostomy creation and takedown, colostomy should be avoided when possible [3]. The decreased length of stay and decreased complication rate in the current series leads one to conclude that resources are more judiciously utilized and cost containment is optimal when loop colostomy is performed in lieu of an end stoma creation.

In the present study, the incidence of ileus and partial small bowel obstruction was significantly higher in the end group when compared to loop stoma reversal. We were unable to directly address stricture rates in the current study. However, the clinical presentation of persistent ileus, partial small bowel obstruction, and stricture are similar and may represent a spectrum of the same morbidity. The rates of re-operation were low in both groups, suggesting that stricture and partial small bowel obstruction resolved without operative intervention in the vast majority of cases.

The current study has important limitations, which must be addressed. Given the retrospective nature of the study, the investigators were solely reliant on the adequacy of the medical record and database availability. Varying practices at each of the four institutions, along with different mechanisms of database entry and accessibility of medical records, further limit the granularity of the present study. However, the varying clinical practices and overall robust operative experiences at each of the four sites enables us to evaluate a large population of patients with both loop and end colostomies. As follow-up was limited to the stoma reversal admission only, late strictures and delayed complications were not captured, thus presenting another limitation in the current analysis. Further examination of the clinical question should proceed in prospective fashion.

The current study supports the creation of loop colostomy over that of end colostomy for traumatic injury when technically feasible and clinically indicated. Loop colostomy is associated with less need for laparotomy, less intra-operative resuscitation, a shorter hospital length of stay, and fewer post-operative complications when compared to reversal of end colostomy.

Conflict of interest Brandon R. Bruns has no conflicts of interest to report. Joseph DuBose has no conflicts of interest to report. Jason Pasley has no conflicts of interest to report. Tareq Kheirbek has no conflicts of interest to report. Konstantinos Chouliaras has no conflicts of interest to report. Andrew Riggle has no conflicts of interest to report. M. Kirsten Frank has no conflicts of interest to report. Herb

A. Phelan has no conflicts of interest to report. Daniel Holena has no conflicts of interest to report. Jose Diaz has no conflicts of interest to report. Thomas M. Scalea has no conflicts of interest to report.

Ethical standards The current study was approved by each Institutional Review Board (IRB) and has therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

References

1. Morris DM, Rayburn D. Loop colostomies are totally diverting in adults. Am J Surg. 1991;161(6):668–71.
2. Schofield PF, Cade D, Lambert M. Dependent proximal loop colostomy: does it defunction the distal colon? Br J Surg. 1980;67(3):201–2.
3. Pachter HL, Hoballah JJ, Corcoran TA, Hofstetter SR. The morbidity and financial impact of colostomy closure in trauma patients. J Trauma. 1990;30(12):1510–3.
4. Bulger EM, McMahon K, Jurkovich GJ. The morbidity of penetrating colon injury. Injury. 2003;34(1):41–6.
5. Berne JD, Velmahos GC, Chan LS, Asensio JA, Demetriades D. The high morbidity of colostomy closure after trauma: further support for the primary repair of colon injuries. Surgery. 1998;123(2):157–64.
6. Stone HH, Fabian TC. Management of perforating colon trauma: randomization between primary closure and exteriorization. Ann Surg. 1979;190(4):430–6.
7. Stewart RM, Fabian TC, Croce MA, Pritchard FE, Minard G, Kudsk KA. Is resection with primary anastomosis following destructive colon wounds always safe? Am J Surg. 1994;168(4):316–9.
8. Lavenson GS. Management of rectal injuries. Am J Surg. 1971;122(2):226–30.
9. Gonzalez RP, Phelan H, Hassan M, Ellis CN, Rodning CB. Is fecal diversion necessary for nondestructive penetrating extraperitoneal rectal injuries? J Trauma. 2006;61(4):815–9.