The management of colonic trauma in the damage control era

B Shazi, JL Bruce, GL Laing, B Sartorius, DL Clarke

University of KwaZulu-Natal, South Africa

ABSTRACT

INTRODUCTION The purpose of this study was to audit our current management of colonic trauma, and to review our experience of colonic trauma in patients who underwent initial damage control (DC) surgery.

METHODS All patients treated for colonic trauma between January 2012 and December 2014 by the Pietermaritzburg Metropolitan Trauma Service were included in the study. Data reviewed included mechanism of injury, method of management (primary repair [PR], primary diversion [PD] or DC) and outcome (complications and mortality rate).

RESULTS A total of 128 patients sustained a colonic injury during the study period. Ninety-seven per cent of the injuries were due to penetrating trauma. Of these cases, 56% comprised stab wounds (SWs) and 44% were gunshot wounds (GSWs). Management was by PR in 99, PD in 20 and DC surgery in 9 cases. Among the 69 SW victims, 57 underwent PR, 9 had PD and 3 required a DC procedure. Of the 55 GSW cases, 40 were managed with PR, 9 with PD and 6 with DC surgery. In the PR group, there were 16 colonic complications (5 cases of breakdown and 11 of wound sepsis). Overall, nine patients (7%) died.

CONCLUSIONS PR of colonic trauma is safe and should be used for the majority of such injuries. Persistent acidosis, however, should be considered a contraindication. In unstable patients with complex injuries, the optimal approach is to perform DC surgery. In this situation, formal diversion is contraindicated, and the injury should be controlled and dropped back into the abdomen at the primary operation. At the repeat operation, if the physiological insult has been reversed, then formal repair of the colonic injury is acceptable.

KEYWORDS

Colonic trauma – Primary repair – Damage control surgery

Accepted 29 August 2015

CORRESPONDENCE TO

Damian Clarke, E: damianclar@gmail.com

Management algorithms for colonic trauma have evolved over the last few decades.^{1–12} Following the experience of military surgeons during the Second World War, mandatory diversion of all colonic injuries became the standard of care in civilian practice.^{1,2} This dogma has been challenged since the last quarter of the 20th century as authors began to publish their experience with either exteriorised repair or selective primary repair (PR) of civilian colonic injuries.^{3–10,12} The pendulum of surgical opinion swung increasingly away from mandatory diversion towards a policy of almost universal PR.^{13–15} The debate changed from which cases should be managed with PR of a colonic injury to which subgroups of patients still required a diversion.

The two situations where it was initially thought diversion would be required were civilians with a colonic gunshot wound (GSW) and patients with destructive colonic injuries.^{15–17} Several authors, however, have reported fairly large series of civilian colonic GSWs that were managed successfully by PR.^{5–10,12}

Management of destructive colonic injuries still appears to be highly individualised. The emergence of damage control (DC) surgery towards the end of the 20th century once

again changed the debate about primary colonic repair. The principle of DC is to avoid all definitive surgery in the unstable patient at the initial operation, and to control bleeding and soiling in an abbreviated procedure.^{18–24} The controversies in colonic trauma revolve currently around management of destructive colonic injuries, initial selection of cases for DC and (once a DC approach has been chosen) how to manage colonic injuries that have been temporised during the initial procedure. The purpose of this study was to audit our current management and outcomes of colonic trauma, to review our experience of colonic trauma in patients who underwent DC surgery and to produce a clinical algorithm for assisting with the management of these injuries.

Methods

The Pietermaritzburg Metropolitan Trauma Service (PMTS) maintains a digital trauma registry. All trauma patients cared for by the PMTS are entered into this registry. All patients treated for colonic trauma between January 2012 and December 2014 were included in the study, and data pertaining to the following criteria were collected and

reviewed: demographics, mechanism of injury, time of presentation, anatomical zone of injury, special investigations, anatomical injuries, method of management (PR, resection and anastomosis [RA], primary diversion [PD] or DC) and outcome (complications and mortality rate). Colon related morbidity was defined as anastomotic failure or the development of a colonic fistula and/or wound sepsis. Shock on presentation was defined as a systolic blood pressure of <100mmHg. Delay was defined as a period of >6 hours between injury and presentation. Systemic acidosis was defined as a base excess of $\leq -5\text{mEq/L}$.

Statistical methods

Given the small event numbers and expected cell counts of <5, differences in frequency of characteristics by anastomotic breakdown (leakage) and death were assessed using Fisher's exact test. Differences in mean base excess by outcome status was assessed using a standard t-test. A *p*-value of <0.05 was deemed statistically significant for all hypothesis tests. Data were analysed using Stata 13.0 (StataCorp, College Station, TX, US).

Results

A total of 128 patients (3 female) sustained a colonic injury during the two years under review. There were 2 patients younger than 13 years of age and 125 Africans in this cohort.

Ninety-seven per cent of injuries were due to penetrating trauma. Of those due to blunt trauma, the mechanisms were motor vehicle accident, assault, fall and kick from a horse. Of the penetrating injuries, 69 (56%) were due to stab wounds (SWs) and 55 (44%) were due to GSWs. Just over half (55%) of the patients presented within 12 hours of sustaining the injury, a third (31%) presented within 24 hours and 14% presented after 24 hours (2% within 48 hours, 7% within 72 hours, 5% experienced a delay of >72 hours). A total of 15 patients were hypotensive on presentation and 108 were normotensive (data missing for five patients).

Management

Management was by PR in 99 cases (77%), PD in 20 cases (16%) and DC surgery in 9 cases (7%). Among the PR patients, 77 (78%) underwent a simple repair and 22 (22%) required RA. Of the patients in the latter group, 16 (73%)

Figure 1 Summary of the colonic injuries

sustained a GSW, 4 (18%) a SW and 2 (10%) blunt trauma. Among the 69 SW victims, 57 (83%) underwent PR, 9 (13%) had PD and 3 (4%) needed a DC procedure. Of the 55 GSW patients, 40 (73%) underwent PR, 9 (16%) had PD and 6 (11%) required DC surgery. These data are illustrated in Figure 1.

The need for RA was much higher for GSWs than for SWs. Of the four blunt injury cases, two had PR and two had PD. Among the whole study cohort, the reasons for PD were concern about the mechanism and injury severity ($n=11$), delay ($n=3$), necrotising fasciitis ($n=2$), contamination ($n=2$) and haemodynamic instability ($n=2$).

Injury location

The locations of the injuries were caecum ($n=10$), ascending colon ($n=12$), hepatic flexure ($n=9$), transverse colon ($n=37$), splenic flexure ($n=15$), descending colon ($n=24$) and sigmoid colon ($n=21$). Small bowel injuries were the most commonly associated injuries ($n=29$), followed by the stomach ($n=17$), diaphragm ($n=14$), liver ($n=12$), kidney ($n=11$), gallbladder ($n=5$), pancreas, spleen and bladder ($n=4$ each).

Intensive care unit

Thirty-seven patients (29%) required intensive care unit (ICU) admission. The injury severity score was <10 in 15 of these cases. Thirty-five (95%) of the ICU patients needed a repeat laparotomy. Of the 20 who underwent PD, 1 (0.5%) died of multiple organ failure and 5 (25%) developed wound sepsis. Of the nine patients who required DC surgery, 3 (33%) had a delayed colonic anastomosis at the repeat operation and 4 (45%) underwent faecal diversion. The other two patients died in the ICU prior to a definitive operation.

Complications

Table 1 summarises the numbers of colonic anastomotic leaks and deaths in the study cohort, broken down by mechanism of injury, mode of repair and presence or absence of

hypotension. In the PR group, there were 16 cases with complications related to anastomotic failure. These consisted of five breakdowns and eleven patients with wound sepsis. There were four anastomotic leaks and a single low output colonic fistula (Table 2). Of the five anastomotic failures, four occurred secondary to a GSW and one secondary to a SW. This was not found to be significantly different. Only one of the leaks was secondary to a destructive colonic lesion, which required RA. The leak rate in the RA cohort was 4.5% (1/22) while for the entire PR group, it was 5.1% (5/99).

Individual case review identified a number of risk factors for anastomotic failure, which included technical error ($n=2$) and PR in the presence of clear indications for DC surgery ($n=2$). Of the five patients who experienced anastomotic breakdown, only two had sustained a right-sided colonic injury. In both of these cases, technical failure was considered to be a factor in the development of the complication. The other three cases of anastomotic failure occurred with left-sided colonic injuries.

Systemic hypotension was defined as a systolic blood pressure of <100 mmHg on presentation. Although there was a higher rate of anastomotic breakdown among shocked patients, this was not statistically significant given the small numbers ($p=0.112$). There was, however, a significant difference in mean base excess between patients who suffered a leak ($n=5$) and those who did not (-8.0 mEq/l vs -2.5 mEq/l respectively, $p=0.037$) (Table 1). Delay was defined as a period of >6 hours between injury and surgery. There was no significant difference in mean delay between cases with breakdown and those without ($p=0.231$). In the 11 patients who developed colon related wound sepsis, there was a higher rate of anastomotic failure but this was not statistically significant ($p=0.351$). There was no significant difference in mean base excess by wound complication status ($p=0.405$) and no significant difference in mean delay by wound complication ($p=0.428$).

Table 1 Anastomotic leaks and deaths in the study cohort, broken down by mechanism of injury, base excess, mode of repair and presence or absence of hypotension

	Anastomotic leak			Death		
	Yes	No	<i>p</i> -value	Yes	No	<i>p</i> -value
Blunt injury primary repair ($n=4$)	0 (0%)	4 (100%)	0.168	2 (50%)	2 (50%)	0.733
SW primary repair ($n=57$)	1 (2%)	56 (98%)		3 (5%)	54 (95%)	
GSW primary repair ($n=40$)	4 (10%)	36 (90%)		4 (10%)	36 (90%)	
Mean base excess in mEq/l	-8.0 (SD: 4.2)	-2.5 (SD: 5.7)	0.037	-10.2 (SD: 9.8)	-2.2 (SD: 4.9)	0.009
Primary repair ($n=99$)	5 (5%)	94 (95%)	0.715	4 (4%)	95 (96%)	0.012
Primary diversion ($n=20$)	–	–		2 (10%)	18 (90%)	
Damage control ($n=9$)	–	–		3 (33%)	6 (67%)	
Hypotension ($n=15$)	2 (13%)	13 (87%)	0.112	5 (33%)	10 (67%)	0.001
No hypotension ($n=108$)	3 (3%)	105 (97%)		4 (4%)	104 (96%)	
GSW = gunshot wound; SD = standard deviation; SW = stab wound						

Table 2 Analysis of patients experiencing an anastomotic complication

Complication	Age / sex	Time after injury	Zone of injury	Soiling or sepsis	Haemodynamic status during operation
Leak	21 M	5h 30m	Transverse	Faecal soiling	Unstable
Leak*	28 M	6h 15m	Caecum	Faecal soiling	Stable
Leak	63 M	10h	Sigmoid	Nil	Stable
Leak*	26 M	Not known	Caecum	Nil	Stable
Fistula	37 M	6h 15m	Splenic flexure	Nil	Unstable and acidotic

*Technical problems

Table 3 Details of the nine mortalities

Mechanism	Age	Damage control	Intensive care unit	Cause	Time after admission
MVA	60	No	Yes	Pulmonary embolus	32 days
SW	33	No	Yes	Multiple organ failure	1 day
SW	41	Yes	Yes	Multiple organ failure	2 days
SW	46	Yes	Yes	Acute kidney injury	2 days
GSW	55	No	Yes	Multiple organ failure	3 days
GSW	39*	No	Yes	Multiple organ failure	5 days
GSW	35	No	Yes	Acute kidney injury	7 days
GSW	70	No	Yes	Multiple organ failure	20 days
GSW	18	Yes	Yes	Multiple organ failure	22 days

GSW = gunshot wound; MVA = motor vehicle accident; SW = stab wound

*This patient developed a colonic leak.

Mortality

Nine patients (7%) died (Table 3). The cause of death was severe refractory septic shock ($n=5$), acute kidney injury ($n=2$), pulmonary embolus ($n=1$) and unexplained cardiac arrest ($n=1$). One patient, who had sustained a GSW, had a colonic leak. Five (9%) of the GSW victims, three (4%) of the SW victims and one (25%) of the blunt trauma victims died. There was a significant increase in mortality as management shifted from PR (4%) to PD (10%) to DC (33%). Those undergoing DC surgery were 8.3 times more likely to die than those in the PR group. PD patients were 2.5 times as likely to die as PR patients but this difference was not statistically significant. The presence of shock is ominous; 33% of shocked patients died (5/15) compared with 4% of non-shocked patients (4/108).

Discussion

The vast majority of injuries in this series were secondary to penetrating trauma and blunt injury cases remain uncommon. The literature over the last three decades suggests that PR of simple colonic injuries is a safe strategy and our experience supports this. Our anastomotic complication rate of 4% is in keeping with other reported rates. Of concern is the

association with technical failure and/or poor patient selection and anastomotic breakdown in our series.^{5,6,8} Inexperienced staff managing complex injuries will result in poor outcomes. This reflects systems failure and attention must be paid to ensuring that the appropriate levels of staff are involved in the management of these injuries. Septic wound complications remain common, occurring in 9% of our cases.

The management of destructive colonic injuries remains contentious. Despite evidence that PR is safe, many surgeons still opt to perform a PD for a number of indications.^{9,10,15,14} In our cohort, 16% of the cases were managed with a PD procedure. The reasons given for PD varied; some were fairly uncontroversial (such as delay and obvious established fasciitis) but for a large portion of patients, the reason for performing PD was given as 'mechanism of injury'. This is an imprecise term but these cases are likely to have been GSW injuries. However, the available literature suggests that PR for GSWs is safe, and our own figures show that GSW and destructive colonic injuries are not in themselves associated with a higher incidence of anastomotic failure than SW injuries and simple PR.

There is no doubt that surgeons are reluctant to perform PR, for a number of reasons that need to be clarified. Nevertheless, PD is not necessarily safer than PR or DC surgery as

evidenced by the high rate of septic complications and the fact that the mortality rate was twice that in the PR group.

GSWs remain more destructive than SWs. Almost a quarter of the patients undergoing PR in our setting required formal large bowel RA and the need for RA was much higher in those sustaining a GSW than among SW patients. However, the leak rate in the RA cohort was 4.5% and that of the entire PR group was similar at 5.1%. This suggests that the extent of the injury and the mechanism of injury do not necessarily exclude PR as an option. It would appear that PR of a destructive colonic injury is safe provided there is no persistent acidosis. We could not show a correlation between shock as defined by the presence of hypotension and anastomotic failure. Deteriorating base excess, on the other hand, is associated with colonic breakdown and we advocate considering it a contraindication to PR.

Almost certainly, a patient with ongoing instability should qualify for DC surgery.^{18–24} Those with hypovolaemic shock, metabolic acidosis, systemic hypothermia and complex intra-abdominal injuries should be subjected to an abbreviated laparotomy. Both PR and formal PD are inappropriate in this setting, and it is highly likely that a significant proportion of the PD patients in this series may have been better served by a DC approach. The higher mortality rate for those undergoing PD in our series suggests that this would have applied to several patients in this cohort.

Figure 2 depicts a suggested algorithm for the management of colonic trauma based on our data and on contemporary reviews.^{22,23} If there are no indications for DC surgery and the colonic injuries are non-destructive, then PR is

uncontroversial. If there are indications for DC surgery, this must be offered and PD should be avoided. If a destructive colonic lesion is present, clinical judgement is necessary. Our results imply that PD is associated with increased mortality and we would therefore suggest that the two acceptable options are PR or a DC operation.

The ongoing controversy in DC surgery is the appropriate management strategy in patients who have undergone an initial abbreviated procedure and are now returning to theatre for definitive management. Our data are insufficient to draw any definitive conclusions but our experience suggests that delayed PR is an acceptable option if the patient's physiology has normalised completely.^{18–24} Nevertheless, if there is persistent lactic acidosis and haemodynamic instability, then formal diversion remains the safest option. Continued collection of routine data as part of a trauma registry is needed to attempt to answer this question.²⁵

Conclusions

PR of colonic trauma is safe and should be used in the management of the majority of colonic injuries. Persistent acidosis, however, should be considered as a contraindication to PR. In unstable patients with complex injuries, the current optimal approach is to perform DC surgery. In this situation, formal diversion is contraindicated, and the injury should be controlled and dropped back into the abdomen at the primary operation. At the repeat operation, if the physiological insult has been reversed, then formal repair of the colonic injury is acceptable.

Acknowledgement

The material in this paper was presented at the Annual Meeting of the Surgical Research Society of Southern Africa held in Durban, South Africa, June 2014.

References

- Office of the Surgeon General. Circular Letter No. 178, 23 October 1943.
- Ogilvie WH. Abdominal wounds in the western desert. *Surg Gynecol Obstet* 1944; **78**: 225–238.
- Stone HH, Fabian TC. Management of perforating colon trauma. *Ann Surg* 1979; **190**: 430–436.
- Baker LW, Robbs JV. Selective management of penetrating injuries of the colon. *S Afr J Surg* 1982; **20**: 275–282.
- Baker LW, Thomson SR, Chadwick SJ. Colon wound management and prograde colonic lavage in large bowel trauma. *Br J Surg* 1990; **77**: 872–876.
- Baker LW, Thomson SR. The current status of the management of civilian injuries to the colon. *Surg Annu* 1991; **23 Pt 1**: 203–223.
- Thomson SR, Baker A, Baker LW. Prospective audit of multiple penetrating injuries to the colon: further support for primary closure. *J R Coll Surg Edinb* 1996; **41**: 20–24.
- Clarke DL, Thomson SR, Muckart DJ, Neijenhuis PA. Universal primary colonic repair in the firearm era. *Ann R Coll Surg Engl* 1999; **81**: 58–61.
- Demetriades D. Colon injuries: new perspectives. *Injury* 2004; **35**: 217–222.
- Herr MW, Gagliano RA. Historical perspective and current management of colonic and intraperitoneal rectal trauma. *Curr Surg* 2005; **62**: 187–192.
- Clarke DL, Thomson SR, Madiba TE, Muckart DJ. Selective conservatism in trauma management: a South African contribution. *World J Surg* 2005; **29**: 962–965.
- Govender M, Madiba TE. Current management of large bowel injuries and factors influencing outcome. *Injury* 2010; **41**: 58–63.
- Murray JA, Demetriades D, Colson M *et al.* Colonic resection in trauma: colostomy versus anastomosis. *J Trauma* 1999; **46**: 250–254.
- Demetriades D, Murray JA, Chan L *et al.* Penetrating colon injuries requiring resection: diversion or primary anastomosis? An AAST prospective multicenter study. *J Trauma* 2001; **50**: 765–775.
- Cho SD, Kiraly LN, Flaherty SF *et al.* Management of colonic injuries in the combat theater. *Dis Colon Rectum* 2010; **53**: 728–734.
- Cornwell EE, Velmahos GC, Berne TV *et al.* The fate of colonic suture lines in high-risk trauma patients: a prospective analysis. *J Am Coll Surg* 1998; **187**: 58–63.
- Dente CJ, Patel A, Feliciano DV *et al.* Suture line failure in intra-abdominal colonic trauma: is there an effect of segmental variations in blood supply on outcome? *J Trauma* 2005; **59**: 359–366.
- Miller PR, Chang MC, Hoth JJ *et al.* Colonic resection in the setting of damage control laparotomy: is delayed anastomosis safe? *Am Surg* 2007; **73**: 606–609.
- Vertrees A, Wakefield M, Pickett C *et al.* Outcomes of primary repair and primary anastomosis in war-related colon injuries. *J Trauma* 2009; **66**: 1,286–1,291.
- Weinberg JA, Griffin RL, Vandromme MJ *et al.* Management of colon wounds in the setting of damage control laparotomy: a cautionary tale. *J Trauma* 2009; **67**: 929–935.
- Ordoñez CA, Pino LF, Badiel M *et al.* Safety of performing a delayed anastomosis during damage control laparotomy in patients with destructive colon injuries. *J Trauma* 2011; **71**: 1,512–1,517.
- Steele SR, Maykel JA, Johnson EK. Traumatic injury of the colon and rectum: the evidence vs dogma. *Dis Colon Rectum* 2011; **54**: 1,184–1,201.
- Greer LT, Gillern SM, Vertrees AE. Evolving colon injury management: a review. *Am Surg* 2013; **79**: 119–127.
- Smith IM, Beech ZK, Lundy JB, Bowley DM. A prospective observational study of abdominal injury management in contemporary military operations: damage control laparotomy is associated with high survivability and low rates of fecal diversion. *Ann Surg* 2015; **261**: 765–773.
- Laing GL, Bruce JL, Skinner DL *et al.* Development, implementation, and evaluation of a hybrid electronic medical record system specifically designed for a developing world surgical service. *World J Surg* 2014; **38**: 1,388–1,397.