PATIENT MANAGEMENT GUIDELINES

FOR PENETRATING INTRAPERITONEAL COLON INJURIES

EAST Practice Parameter Workgroup for Penetrating Colon Injury Management

C. Gene Cayten, M.D.

Timothy C. Fabian, M.D.

Victor F. Garcia, M.D.

Rao R. Ivatury, M.D.

John A. Morris, Jr., M.D.

Patient Management Guidelines for Penetrating Intraperitoneal Colon Injuries

I. Statement of the Problem

Management of penetrating colon wounds has been evolving over the last three decades. Prior to that time, the most colon wounds in the civilian population were managed by exteriorization of the wound or proximal colostomy because of a fear of a high rate of breakdown. In the past 20 years, there has been an increasing trend toward primary repair. Advantages of primary repair are the avoidance of colostomy, with the subsequent reduction in the morbidity of the colostomy itself and the cost associated with colostomy care and the subsequent hospitalization for closure. Potential drawbacks of primary repair are the morbidity and mortality associated with failure of repair. If there is no difference in morbidity between the approaches, primary repair would be preferred. In recent years, there have been several prospective studies that support primary repair over colostomy, however, there is continued confusion as to when primary repair is appropriate.

II. Process

A computerized search of the National Library of Medicine was undertaken using "Knowledge Server" software. English language citations during the period of 1979 through 1996 using the words "colon injury" and "colon trauma" were identified from the data base of journal articles. Of the 113 articles identified, those dealing with either prospective or retrospective series of injuries were selected. The following groups of articles were eliminated from analysis: 1) literature review articles, 2) wartime experiences, 3) articles from institutions which were duplicative. This left 42 articles that were institutional studies of groups of patients sustaining penetrating abdominal trauma with intraperitoneal colon injury and in which the article evaluated the method of surgical management. Another group of articles reported on colostomy closure following penetrating injury. The articles were reviewed by a group of five trauma surgeons who collaborated to produce this management guideline.

III. Recommendations

A. Level I

There is sufficient class I and class II data to support a standard of primary repair for *nondestructive* (involvement of < 50% of the bowel wall without devascularization) colon wounds in the absence of peritonitis.

B. Level II

1. Patients with penetrating intraperitoneal colon wounds which are *destructive* (involvement of > 50% of the bowel wall or devascularization of a bowel segment) can undergo resection and primary anastomosis if they are:
   - Hemodynamically stable without evidence of shock (sustained pre- or intraoperative hypotension as defined by SBP < 90 mm Hg),
   - Have no significant underlying disease,
   - Have minimal associated injuries (PATI < 25, ISS < 25, Flint grade < 11),
   - Have no peritonitis.

2. Patients with shock, underlying disease, significant associated injuries, or peritonitis should have destructive colon wounds managed by resection and colostomy.

3. Colostomies performed following colon and rectal trauma can be closed within two weeks if contrast enema is performed to confirm distal colon healing. This recommendation pertains to patients who do not have non-healing bowel injury, unresolved wound sepsis, or are unstable.

4. A barium enema should not be performed to rule out colon cancer or polyps prior to colostomy closure for trauma in patients who otherwise have no indications for being at risk for colon cancer and or polyps.

IV. Scientific Foundation

A. Historical Background

Repair of colon wounds was historically a failure from the first description in the Book of Judges until World War I, when occasional success was noted. Due to the high failure rate with primary repair during World War I, colostomy was mandated by Major General W. H. Ogilvie, the consultant surgeon of the Middle East Forces in the East African Command in 1943. The reasons for the high failure rate were delays in therapy as well as high velocity wounds, delay in effective resuscitation with an absence of blood banks, and minimal antibiotic development at that time. Improvements in trauma care resulted in decreased mortality from these wounds by the time of the Korean and Vietnam conflicts. In the 1950s, there were some surgeons who began to challenge the concept that colostomy was mandatory for management of all civilian colon injuries. The first prospective study done in 1979 laid the foundation for the modern treatment of colon injuries by confirming the safety and efficacy of primary repair in selected patients.[1] During the 1980s, this concept has been advanced by other investigators. Exteriorization of colon repair with early drop back (5 - 7 days) into the peritoneal cavity was occasionally done during the period of time between 1960 and 1970, but has been abandoned in recent years. It is now recognized that almost all of those patients can be more appropriately treated by primary repair. The past decade witnessed an increasing interest in primary repair of colon wounds, and some have taken this concept one step further to colocolostomy after resection of destructive wounds of the colon.

B. Risk Factors for Complications in Colon Injury Management

Besides the severity of injury to the colon, a host of other factors have influenced the choice and results of operative treatment. Several risk factors have been identified by different investigators to identify those patients suited for definitive methods of repair and to differentiate them from patients at high risk for postoperative complications, especially anastomotic leak and intra-abdominal abscesses. The majority of these studies are either class II or class III studies. The five class I studies found either lower or similar septic complications and septic morbidity after primary repair as compared to colostomy.[1-5]

Shock: Several series documented that transient hypotension pre- or intraoperatively did not seem to affect the incidence of postoperative complications. There is evidentiary support, however, that mortality is significantly increased in the presence of sustained hypotension pre-and intraoperatively.[6-8,11,12,19]

Duration from injury to operative control: Traditionally, delayed treatment of colon injuries is considered a significant predictor of postoperative morbidity. Some investigators have suggested that morbidity is not increased when treatment is delayed up to 12 hours.[7,19,27]

Fecal contamination: Of all the variables that may potentially affect colon injury management, fecal contamination has been the most difficult to quantify. Several class II and III studies noted an increase in the rate of abscesses and septic deaths in patients with major fecal contamination although others did not consider gross fecal spillage a contraindication to repair or anastomosis. Major contamination, defined as contamination on more than one quadrant of the abdomen, was a significant contributor on multiple regression analysis in one class II study [6] and one class III study.[12] Some attempt should be made to establish an objective method of evaluating the degree of contamination.

Associated injuries and injury severity assessment: Some retrospective series emphasized multiple organ injuries as contraindications to repair of the colon injury. More recent class I series, though conceding that mortality and septic morbidity is higher in patients with a greater number of associated organ injuries, do not consider them a contraindication to primary repair of nondestructive wounds. Several class I studies and a large number of class II and class III studies suggest that associated injuries greater than two are associated with increased septic complications. PATI of more than 25, and ISS greater than 25, Flint grade greater than 11 are found to be significant for postoperative complications.
Blood transfusions: The number of units of transfused blood has been shown to be an independent risk factor for postoperative morbidity by several series, some class I and most class II and III. Four units were mentioned as a critical level, beyond which the risk for postoperative morbidity is increased.[6,12,20] The conclusions were based on logistic regression of a large number of patients.

Anatomic location of the injury: Several class I, II, and III articles did not find any significant difference in complications between right and left colon for primary repair.

C. Evaluation of the Evidence Supporting Primary Repair

There have been five class I studies reported. In those studies, 206 patients were randomized to either primary repair for nondestructive colon wounds or resection and anastomosis for destructive wounds (166 primary repair, 40 resection and anastomosis) and these were compared to 193 patients randomized to colostomy. One of these studies selected patients with less severe injuries for randomization as this was the first study of

primary repair for colon injuries.[1] In that study, there were 67 patients randomized to primary repair and 72 to colostomy; the 139 patients that were randomized represented 50% of colon injuries at the institution over the time of the study. In the remaining four class I studies, there were 99 nondestructive colon wounds primarily repaired and these studies included all patients with colon injuries regardless of severity. Additionally, one of the class II studies included all patients with nondestructive colon wounds to have primary repair because of degree of injury.[6] There were 83 patients in that study. Combining the four class I and one class II studies resulted in 182 nonselected patients who underwent primary repair. Of these 182, there were two suture line leaks, and one of these closed spontaneously without operative intervention. There were no deaths associated with primary repair.

There were three additional class II studies comprising 407 patients with primary repair. Those series were selected in that they included approximately 50% of patients with colon wounds with the remaining 50% being more severely patients who underwent colostomy or exteriorization. There were three suture line failures in those 408 patients having primary repair and one of these three patients with leak died.

There were 18 class III studies which provided sufficient data to evaluate suture line leaks in those patients undergoing primary repair for nondestructive wounds. Those class III studies in general performed primary repair on approximately 42% of the patients included in their reports. From those studies, there were 1,272 instances of primary repair. There were 15 suture line failures (1.1%) and two deaths associated with these failures; one death was documented to be in a patient with "advanced gastric carcinoma".[31]

Evaluation of the class I, II, and III studies would indicate that there has been approximately a 1% failure rate for all primary repairs. This failure rate is less than that for elective colorectal surgery. Mortality associated with a suture-line failure was uncommon. The decreased morbidity associated with avoidance of colostomy, the disability associated with the interval from creation to closure of the colostomy, and the charges associated with colostomy and the closure of the colostomy all support a standard for primary repair of nondestructive penetrating colonic wounds.

D. Evaluation of the Evidence Supporting Resection and Anastomosis for Destructive Wounds

In the four class I studies which included destructive wounds in the randomization process, there were 40 cases that underwent resection and anastomosis.[2-5] Of these 40 cases, there was one anastomotic leak (2.5%) without mortality. In class II studies, there were 12 patients reported who had destructive wounds undergoing resection.[6] From these 12, there was one anastomotic leak (8.3%) without mortality.

There were 14 class III reports which included patients with resection and anastomosis. In those reports, there were 303 cases in which resection and anastomosis for destructive colon wounds were performed. There were 16 failures (5.2%). Of those 16 failures, there were three deaths (19%).

Although the results with resection and anastomosis were good in class I and class II studies, there was a paucity of cases. Though 331 cases reported in the class III data is a substantial number, the results are marginal, especially considering the mortality associated with suture line failure. Most failures with resection and anastomosis have been in patients who have significant associated injuries and/or associated disease processes. The data would support resection and anastomosis for stable patients without significant associated injuries. Patients with serious injuries or significant underlying disease have better results with resection and colostomy.

E. Evaluation of Evidence for Colostomy Closure

The mortality for colostomy closure has been consistently 0% in many series.[33-42] The morbidity rates have ranged from 4.9% to 26.3% with some of the variation attributable to somewhat different definitions of complications. Recent series have reported lengths of stay for colostomy closures ranging from 4 to 151 days.[36-39,42]

There is one randomized, prospective trial performed by Velmahos et al. on 49 patients with colostomies.[33] All patients had undergone a contrast enema in the second postoperative week to assess distal colon function healing. Patients were excluded from early closure for non-healing of the bowel injury, resolving wound sepsis, or an unstable condition. The remaining 38 patients were allocated to either early or late colostomy closure. The mean day of colostomy closure for patients with early closure was 11.8 days, with a range of 9 to 14 days. The mean day of colostomy closure for the late closure patients was 104.8 days, with a range of 92 to 118 days. There was no significant difference in morbidity between the two groups. Technically, the early colostomy closure was far easier than the late colostomy closure and required significantly less operating time ($p=0.036$) and less intraoperative blood loss ($p=0.02$).

A study by Machiedo et al. performed at the New Jersey College Medical School affiliated hospitals between 1974 and 1978 was not randomized but patients were divided into three groups.[34] Group 1 consisted of patients in whom colostomy was closed within 6 weeks, and Group 2 consisted of those who were undergoing colostomy closure after 3 months. Lower infection rate than in Group 3. Patients in Group 2 exhibited a lower postoperative infection rate and a shorter postoperative length of stay than patients in Group 1.

Colostomies performed following colon and rectal trauma can be closed within 2 weeks if contrast enema is performed to confirm distal colon healing. This recommendation pertains to patients who do not have non-healing bowel injury, unresolved wound sepsis, or are unstable.

A study by Atweh et al. revealed that none of 84 patients had unsuspected colon lesions on barium enema at the time of colostomy closure.[40] They recommended contrast studies or endoscopy only for injuries below the peritoneal reflection. Crass et al. used contrast of the distal segment only if that segment contained the injury.[38]

Thus, a barium enema should not be performed to rule out colon cancer or polyps prior to colostomy closure for trauma in patients who otherwise have no indications for being at risk for colon cancer and/or polyps.

V. Summary

The decreased morbidity associated with avoidance of colostomy, the disability associated with the interval from creation to closure of the colostomy, and the charges associated with colostomy and the closure of the colostomy all support a standard for primary repair of non-destructive penetrating colon wounds.

For destructive penetrating colon wounds, the data would support resection and anastomosis for stable patients without significant associated injuries. Patients with serious associated injuries or significant underlying disease have better results with resection and colostomy.

VI. Future Investigations

Future studies should be conducted in a prospective randomized fashion concentrating on the role of colostomy and timing of closure for destructive colon injuries.

VII. References

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2. Chappuis CW, Frey DJ, Dietzen CD, et al: Management of penetrating colon injuries. A prospective randomized trial. Ann Surg 213:492-7, 1991

3. Falcone RE, Wanamaker SR, Santanello SA, et al: Colorectal trauma: Primary repair or anastomosis with intracolonic bypass vs ostomy. Dis Colon Rectum 35:957-63, 1992

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GUIDELINES FOR PENETRATING INTRAPERITONEAL COLON INJURIES

First Author	Year	Reference Title	Class	Conclusions
Stone HH	1979	Management of perforating colon trauma: Randomization between primary closure and exteriorization. *Ann Surg 190:430-6*	I	67 primary repairs, 0 resection and anastomosis, 1 primary repair leak, and 72 colostomies/exteriorizations.
Chappuis CW	1991	Management of penetrating colon injuries. A prospective randomized trial. *Ann Surg 213:492-7*	I	17 primary repairs, 11 resections and anastomoses, 0 primary repair leak, 0 resections and anastomosis leaks, and 28 colostomies/exteriorizations.
Falcone RE	1992	Colorectal trauma: primary repair or anastomosis with intracolonic bypass vs ostomy. *Dis Colon Rectum 35:957-63*	I	0 primary repairs, 12 resections and anastomoses, 0 resections and anastomosis leaks, and 12 colostomies/exteriorizations.
Sasaki LS	1995	Primary repair of colon injuries: A prospective randomized study. *J Trauma 39:895-901*	I	31 primary repairs, 12 resections and anastomoses, 0 primary repair leak, 0 resections and anastomosis leaks, and 28 colostomies/exteriorizations.
Gonzalez RP	1996	Colostomy in penetrating colon injury: Is it necessary? *J Trauma 41:271-5*	I	51 primary repairs, 5 resections and anastomoses, 1 primary repair leak, 1 resections and anastomosis leaks, and 53 colostomies/exteriorizations.
George SM Jr	1989	Primary repair of colon wounds. A prospective trial in nonselected patients. *Ann Surg 209:728-34*	II	83 primary repairs, 12 resections and anastomoses, 0 primary repair leak, 1 resections and anastomosis leaks, and 7 colostomies/exteriorizations.
Baker LW	1990	Colon wound management and prograde colonic lavage in large bowel trauma. *Br J Surg 77:872-6*	II	172 primary repairs, 0 resections and anastomoses, 1 primary repair leak, and 217 colostomies/exteriorizations.
Demetriades D	1992	Gunshot wounds of the colon: Role of primary repair. *Ann R Coll Surg Engl 74:381-4*	II	76 primary repairs, 0 resections and anastomoses, 2 primary repair leak, and 24 colostomies/exteriorizations.
Ivatury RR	1993	Definitive treatment of colon injuries: A prospective study. *Am Surg 59:43-9*	II	159 primary repairs, 26 resections and anastomoses, 0 primary repair leak, 2 resections and anastomosis leaks, and 67 colostomies/exteriorizations.

First Author	Year	Reference Title	Class	Conclusions
Thigpen JB Jr	1980	Current management of trauma to the colon. *Am Surg 46:108-10*	III	35 primary repairs, 0 resections and anastomoses, # primary repair leaks were not mentioned, and 37 colostomies/exteriorizations.
Wiener I	1981	Traumatic colonic perforation: Review of 16 years' experience. *Am J Surg 142:717-20*	III	85 primary repairs, 0 resections and anastomoses, # primary repair leaks not stated in paper, and 57 colostomies/exteriorizations.
Dang CV	1982	Trauma of the colon: Early drop-back of exteriorized repair. *Arch Surg 117:652-6*	III	24 primary repairs, 0 resections and anastomoses, 0 primary repair leak, and 58 colostomies/exteriorizations.
Karanfilian RG	1982	Penetrating injuries to the colon. *Am Surg 48:103-8*	III	17 primary repairs, 9 resections and anastomoses, 0 primary repair leak, 3 resections and anastomosis leaks, and 106 colostomies/exteriorizations.
Adkins RB Jr	1984	Penetrating colon trauma. *J Trauma 24:491-9*	III	36 primary repairs, 0 resections and anastomoses, 0 primary repair leak, and 20 colostomies/exteriorizations.
Cook A	1984	Traditional treatment of colon injuries. An effective method. *Arch Surg 119:591-4*	III	27 primary repairs, 0 resections and anastomoses, # primary repair leaks and # of resections and anastomotic leaks were not stated in the article, and 180 colostomies/exteriorizations.
Nallathambi MN	1984	Aggressive definitive management of penetrating colon injuries: 136 cases with 3.7 per cent mortality. *J Trauma 24:500-5*	III	43 primary repairs, 16 resections and anastomoses, 0 primary repair leak, 0 resections and anastomosis leaks, and 77 colostomies/exteriorizations.
Shannon FL	1985	Primary repair of the colon: When is it a safe alternative? *Surgery 98:851-60*	III	80 primary repairs, 30 resections and anastomoses, 1 primary repair leak, 0 resections and anastomosis leaks, and 118 colostomies/exteriorizations.
Dawes LG	1986	The risk of infection after colon injury. *Surgery 100:796-803*	III	21 primary repairs, 13 resections and anastomoses, 0 primary repair leak, 1 resections and anastomosis leaks, and 103 colostomies/exteriorizations.
Miller FB	1987	Emergency right colon resection. *Arch Surg 122:339-43*	III	0 primary repairs, 16 resections and anastomoses, 0 resections and anastomosis leaks, and 12 colostomies/exteriorizations.
George SM Jr	1988	Colon trauma: Further support for primary repair. *Am J Surg 156:16-20*	III	73 primary repairs, 0 resections and anastomoses, 0 primary repair leak, and 41 colostomies/exteriorizations.

First Author	Year	Reference Title	Class	Conclusions
Frame SB	1989	Penetrating injuries to the colon: Analysis by anatomic region of injury. *South Med J 82:1099-102*	III	30 primary repairs, 0 resections and anastomoses, # primary repair leaks not stated in article, and 35 colostomies/exteriorizations.
Nelken N	1989	The influence of injury severity on complication rates after primary closure or colostomy for penetrating colon trauma. *Ann Surg 209:439-47*	III	34 primary repairs, 3 resections and anastomoses, 1 primary repair leak, 0 resections and anastomosis leaks, and 39 colostomies/exteriorizations.
Ridgeway CA	1989	Primary repair vs. colostomy for the treatment of penetrating colon injuries. *Dis Colon Rectum 32:1046-9*		30 primary repairs, # resections and anastomoses not stated in article, 0 primary repair leak, and 35 colostomies/exteriorizations.
Orsay CP	1989	Colorectal trauma. *Dis Colon Rectum 32:188-90*	III	1 primary repairs, 2 resections and anastomoses, # primary repair leaks and # resections and anastomotic leaks not stated in article, and 230 colostomies/exteriorizations.
Levison MA	1990	Management of the injured colon: Evolving practice at an urban trauma center. *J Trauma 30:247-53*	III	98 primary repairs, 8 resections and anastomoses, 1 primary repair leak, 0 resections and anastomosis leaks, and 133 colostomies/exteriorizations.
Burch JM	1991	Evolution of the treatment of the injured colon in the 1980s. *Arch Surg 126:979-84*	III	564 primary repairs, 50 resections and anastomoses, 9 primary repair leaks, 4 resections and anastomosis leaks, and 344 colostomies/exteriorizations.
Morgado PJ	1992	Colon trauma -- clinical staging for surgical decision making. Analysis of 119 cases. *Dis Colon Rectum 35:986-90*	III	60 primary repairs, 32 resections and anastomoses, 1 primary repair leak, 2 resections and anastomosis leaks, and 9 colostomies/exteriorizations
Schultz SC	1993	Identifying the low-risk patient with penetrating colonic injury for selective use of primary repair. *Surg Gynecol Obstet 177:237-42*	III	40 primary repairs, 17 resections and anastomoses, 0 primary repair leak, 0 resections and anastomosis leaks, and 43 colostomies/exteriorizations.
Taheri PA	1993	A convincing case for primary repair of penetrating colon injuries. *Am J Surg 166:39-44*	III	43 primary repairs, 12 resections and anastomoses, 0 primary repair leak, 0 resections and anastomosis leaks, and 91 colostomies/exteriorizations.

First Author	Year	Reference Title	Class	Conclusions
Sasaki LS	1994	Primary repair of colon injuries: A retrospective analysis. *Am Surg 60:522-7*	III	50 primary repairs, 52 resections and anastomoses, 0 primary repair leak, 0 resections and anastomosis leaks, and 52 colostomies/exteriorizations.
Bostick PJ	1994	Management of penetrating colon injuries. *J Natl Med Assoc 86:378-82*	III	59 primary repairs, # resections and anastomoses not stated in article, 2 primary repair leak, # resections and anastomotic leaks, and 155 colostomies/exteriorizations.
Stewart RM	1994	Is resection with primary anastomosis following destructive colon wounds always safe? *Am J Surg 168:316-9*	III	0 primary repairs, 43 resections and anastomoses, 6 resections and anastomosis leaks, and 7 colostomies/exteriorizations.
Velmahos GC	1995	Early closure of colostomies in trauma patients -- a prospective randomized trial. *Surgery 118:815-20*	I	38 cases of colostomy closures.
Machiedo GW	1980	Colostomy closure following trauma. *Surg Gynecol Obstet 151:58-60*	III	30 cases of colostomy closures.
Thal ER	1980	Morbidity of colostomy closure following colon trauma. *J Trauma 20:287-91*	III	137 cases of colostomy closures.
Rehm CG	1993	Colostomy in trauma surgery: Friend or foe? *Injury 24:595-6*	III	25 cases of colostomy closures.
Williams RA	1987	Analysis of morbidity, mortality, and cost of colostomy closure in traumatic compared with nontraumatic colorectal diseases. *Dis Colon Rectum 30:164-7*	III	57 cases of colostomy closures.
Crass RA	1987	Colostomy closure after colon injury: A low-morbidity procedure. *J Trauma 27:1237-9*	III	75 cases of colostomy closures.
Sola JE	1993	Morbidity and timing of colostomy closure in trauma patients. *Injury 24:438-40*	III	86 cases of colostomy closures.

First Author	Year	Reference Title	Class	Conclusions
Atweh NA	1989	Indications for barium enema preceding colostomy closure in trauma patients. *J Trauma 29:1641-2*	III	84 cases of colostomy closures.
Livingston DH	1989	Are the risks after colostomy closure exaggerated? *Am J Surg 158:17-20*	III	121 cases of colostomy closures.
Pachter HL	1990	The morbidity and financial impact of colostomy closure in trauma patients. *J Trauma 30:1510-3*	III	87 cases of colostomy closures.