Surgical Considerations in the Management of Civilian Colon Injuries

ARTHUR C. BEALL, JR., M.D., DONALD L. BRICKER, M.D., FRANCIS J. ALESSI, M.D., HARTWELL H. WHISENNAND, M.D., MICHAEL E. DEBAKEY,* M.D.

From the Cora and Webb Mading Department of Surgery, Baylor College of Medicine, and the Jefferson Davis and Ben Taub General Hospitals, Houston, Texas

ALTHOUGH the surgical treatment of colonic injuries in wartime has become relatively standardized, operative procedures of choice for the management of colonic injuries in civilian practice remain controversial. Civilian injuries of the colon, however, often differ significantly from those occurring on the battlefield in regard to the wounding agent, period of delay between injury and definitive repair, total extent of injury to the patient, and various logistic considerations. For these reasons, a continuing evaluation of the selective use of primary repair of colonic injuries has been carried out in the charity hospitals of Houston and Harris County, Texas. As a part of such continuing evaluation, this report constitutes a re-appraisal of this approach to civilian colonic injuries.

Clinical Material

During the 15-year period from January, 1949, through December, 1964, 328 patients with traumatic injuries of the colon and rectum were admitted to the Jefferson Davis and Ben Taub General Hospitals, Houston, Texas. Methods of surgical management and results in these 328 patients have been the subject of previous reports from these institutions.[2, 4] In only 5½ years from January, 1965, through June, 1970, an additional 424 patients with traumatic injuries of the colon and rectum have been admitted to these hospitals. The total number of these patients admitted from January, 1949, through June, 1970, therefore, was 752, and this entire series has been analyzed with a comparison of the two groups.

Among the 752 patients, 643 were males and 109 were females. Minimal difference in sex distribution occurred between the two time periods (270 males to 52 females in 1949–1964; 373 males to 51 females in 1965–1970). There was, however, a most significant difference in wounding agents between the two time periods. From 1949 through 1964 gunshot wounds outnumbered stab wounds 207 to 105, a ratio of approximately 2:1. From 1965 through 1970 gunshot wounds outnumbered stab wounds 343 to 60, a ratio of approximately 6:1. Additionally, during the latter period of study, a progressively increasing number of gunshot wounds were produced by weapons with high muzzle velocities, such as the .357 Magnum. Miscellaneous colonic injuries, such as those associated with blunt trauma changed little between the two periods, numbering 16 and 18, respectively.

Presented at the Eighty-second Annual Meeting of the Southern Surgical Association, Boca Raton, Florida, December 9, 1970.

* Cora and Webb Mading Department of Surgery, Baylor College of Medicine, and the Jefferson Davis and Ben Taub General Hospitals.

Supported in part by the U. S. Public Health Service (HE-05387) and (HE-05435).

TABLE 1. *Associated Injuries*

	1949–1964 (241 Patients)	1965–1970 (370 Patients)	Total (611 Patients)
Small intestine	145	211	356
Liver	61	87	148
Stomach	44	76	120
Major vascular structures	44	69	113
Kidney or ureter	43	68	111
Chest (hemo-or pneumothorax)	22	77	99
Spleen	27	53	80
Diaphragm	27	46	73
Extremities	20	49	69
Duodenum	28	36	64
Pancreas	14	29	43
Lower urinary tract	9	34	43
Extrahepatic biliary tract	16	18	34
Central nervous system	6	17	23
Head and neck	0	9	9
Uterus	3	3	6
Trachea and esophagus	0	4	4
Clavicle	0	2	2
	509	888	1,397

Associated Injuries

Table 1 summarizes 1,397 major associated injuries occurring among 611 of the 752 patients. Of significance is the fact that while only 74 per cent of the patients in the earlier group (1949–1964) had major associated injuries, 87 per cent of the patients in the latter group (1965–1970) had such major associated injuries. Injury to the small intestine, liver, stomach, and major vascular structures was frequent in both groups. However, less than 10 per cent of all patients in the earlier group had involvement of the chest, while more than 20 per cent of all patients in the latter group had significant chest injuries in association with the colonic injury. Injury to the central nervous system also was far more frequent in the latter group (17 cases) as compared to the earlier group (six cases). Influence of such associated injuries on causes of deaths and types of complications occurring in the two groups will be noted subsequently.

Plan of Management

All patients admitted to the city-county charity hospitals of Houston and Harris County, Texas, following major trauma are seen first in the emergency room, where resuscitative measures are instituted. Of particular importance in the management of patients with penetrating abdominal trauma is use of an upper extremity vein for fluid and blood replacement, due to possibility of an inferior vena caval injury.[12] Adequate examination requires removal of all clothing to determine every possible major associated injury. Anteroposterior and lateral roentgenograms of the chest and abdomen usually are employed as an aid in locating missiles, and prior to obtaining these films radiopaque contrast material is injected via the intravenous tubing. Such excretory urograms not only may detect an unsuspected injury to the urinary tract, but also demonstrate function of the contralateral kidney should it become necessary to consider nephrectomy for management of injury to the kidney. If a rectal or rectosigmoid injury is suspected, sigmoidoscopy is performed. A nasogastric tube and a self-retaining urinary bladder catheter are inserted, tetanus prophylaxis is given, and wide spectrum antibiotic therapy is begun. If a thoracic injury is known or suspected in a patient who is to receive general anesthesia for abdominal exploration, intercostal tube thoracotomy is employed prophylactically. These resuscitative measures have been described in detail previously.[1, 3, 4]

Abdominal exploration is begun with a generous midline incision, and primary attention is directed toward arrest of significant hemorrhage. With massive injuries, such as those produced by shotgun blasts at close range, temporary occlusion of the aorta just below the diaphragm may be utilized while control of individual bleed-

TABLE 2. *Operative Procedures and Results*

Operation	Type Injury	Number			Number of Deaths			Mortality Rate (Per Cent)		
		1949–1964	1965–1970	Total	1949–1964	1965–1970	Total	1949–1964	1965–1970	Total
Primary repair	Gunshot wounds	141	162	303	11	17	28	8	10	9
	Stab wounds	100	54	154	2	0	2	2	0	1
	Other	15	8	23	1	2	3	7	25	13
	Total	256	224	480	14	19	33	5	8	7
Exteriorization as colostomy	Gunshot wounds	29	79	108	10	14	24	34	18	22
	Stab wounds	3	1	4	0	1	1	0	100	25
	Other	0	1	1	0	0	0	0	0	0
	Total	32	81	113	10	15	25	31	19	32
Primary repair and colostomy	Gunshot wounds	27	90	117	8	20	28	30	22	24
	Stab wounds	2	2	4	0	0	0	0	0	0
	Other	1	9	10	0	4	4	0	44	40
	Total	30	101	131	8	24	32	27	24	24
Exteriorized Primary repair without colostomy	Gunshot wounds	0	14	14	0	1	1	0	7	7
	Stab wounds	0	3	3	0	0	0	0	0	0
	Other	0	0	0	0	0	0	0	0	0
	Total	0	17	17	0	1	1	0	6	6
Total receiving definitive therapy		318	423	741	32	59	91	10	14	12
Total receiving no definitive therapy		10	1	11	10	1	11	100	100	100
	Total	328	424	752	42	60	102	13	14	14

ing areas is accomplished. Gastrointestinal injuries, particularly those involving the colon, are treated in such a way as to minimize peritoneal contamination until definitive management is possible. Associated injuries are cared for as conditions dictate.

If the patient's general condition is good and fecal contamination is minimal, individual colonic injuries usually are managed by primary repair using two-layer, transverse suture technic. Generous quantities of colonic wall are turned in, particularly in patients with gunshot wounds of the colon. When a high velocity missile has been employed or if inversion of adequate colonic wall for secure repair might compromise the bowel lumen, the involved segment is resected with end-to-end anastomosis. However, should the patient's general condition be tenuous, should extensive fecal contamination be present, or should extensive segments of colonic wall be involved, expeditious exteriorization is employed. Primary repair of the injury with proximal colostomy is used for lesions of the rectum and rectosigmoid below the peritoneal reflexion, while proximal colostomy is employed in association with resection and anastomosis in some cases of massive destruction of long segments of bowel. Occasionally, isolated injuries of the cecum are converted into a cecostomy. Injuries of the right side of the colon in which primary repair is not applicable, usually are managed by resection with ileo-transverse colostomy, rather than resorting to exteriorization with ileostomy. Upon completion of colonic repair drains are placed near the area and brought out through the flank, rectal injuries usually are drained via the perineum. Prior to wound closure the abdominal cavity is thoroughly irrigated with saline and with antibiotic solution, and wide spectrum antibiotics are continued systemically for 5 to 7 days, or longer.[10]

Results

Operative procedures employed and results are summarized in Table 2. Whereas 10 patients died prior to definitive therapy

TABLE 3. *Causes of Deaths*

	1949–1964	1965–1970	Total
Hemorrhage and shock	22	32	54
Pneumonia	1	11	12
Peritonitis	7	3	10
Pulmonary embolism	1	6	7
Renal failure	5	2	7
Myocardial infarction	2	2	4
Central nervous system injury	0	3	3
Aspiration	1	1	2
Duodenal fistula	1	0	1
Urinary tract and fecal fistula	1	0	1
Cardiac failure	1	0	1
Total	42	60	102

for colonic injury in the earlier period, only one patient died without definitive treatment during the latter period. This difference appears related to both improved methods of resuscitation and a more aggressive approach by the resident staff during the latter period, causing some of the more seriously injured patients who would have died without surgical intervention during the earlier period to die after definitive management in the latter period.

Among the 752 total patients there were 102 deaths, an overall mortality rate of 13.6 per cent. During the first 15 years (1949–1964) there were 42 deaths among 328 patients, a mortality rate of 12.8 per cent, whereas during the last 5½ years there were 60 deaths among 424 patients, a mortality rate of 14.2 per cent. This difference in mortality rates between the two periods is of no statistical significance, although the case material encountered in the two periods was decidedly different. As noted previously, the ratio of gunshot wounds to stab wounds rose from approximately 2:1 in the earlier period to approximately 6:1 during the latter period. Considering that the operative mortality rate for gunshot wounds of the colon was 15 per cent (81 deaths among 542 patients) as compared to an operative mortality rate for stab wounds of the colon of only 1.8 per cent (3 deaths among 165 patients), it is apparent that the case material encountered during the latter period necessitated considerable improvement in management to prevent a most significant increase in mortality rate.

A comparison of mortality rates between methods of managing the colonic injuries would not be meaningful, as by the plan of management employed, patients with the more serious extent of overall injury and those in the poorest general condition automatically fell into one of the two-stage repair groups. Of interest is comparison of mortality rates between the two periods of study for various types of procedures. Although there was a slight increase in mortality rate for patients undergoing primary repair during the latter period (8 per cent as compared to 5 per cent) this would appear related primarily to the increased ratio of gunshot wounds to stab wounds during the latter period. In fact, there were no deaths in the latter period among 54 patients undergoing primary repair of stab wounds of the colon. Despite an increased ratio of gunshot wounds to stab wounds during the latter period, mortality rate decreased in patients treated either by exteriorization with colostomy and those treated by primary repair and proximal colostomy.

A somewhat different method of two-stage repair has been undergoing evaluation in our hospitals in recent years. This has consisted of exteriorizing the area of primary repair in selected cases where otherwise a proximal colostomy would have been done, followed by return of the exteriorized segment to the abdominal cavity in 10–14 days if healing appears satisfactory. Such a procedure prevents formation of a fecal fistula and/or sepsis should the repair disrupt, and yet does not require a routine colostomy. Return of the exteriorized segment to the abdominal cavity can be done under local anesthesia without entering the bowel and significantly re-

duces the period of morbidity. However, only 17 such cases are included in the present series with one death caused by massive overall trauma in that particular patient. Although these early results appear somewhat encouraging, considerable additional evaluation of this procedure will be necessary prior to any conclusions and these data will be published subsequently.[5] This group is mentioned at this time only to explain that particular section of Table 2.

Deaths

Causes of deaths in the two periods of study are summarized in Table 3. As might be expected, hemorrhage and shock were the primary causes of deaths during both periods. The increased numbers of deaths during the latter period due to pulmonary complications probably related to the increased incidence of associated chest injuries during that period (Table 1). Deaths due to associated central nervous system injury also were more prominent during the latter period, probably related in part to the increased ratio of gunshot wounds to stab wounds. Of significance are the facts that only one death was caused primarily by a fecal fistula which developed in conjunction with a urinary tract fistula, and this death occurred during the earlier period of study.

Complications

Three hundred and three complications occurring among the 650 survivors are summarized in Table 4. During both periods of study infectious complications predominated as might be expected with an injury producing fecal contamination of the abdominal cavity. The increased number of infections encountered during the latter period again may relate to the increased ratio of gunshot wounds to stab wounds occurring during that period. This same reason may account for the significant increase in number of pancreatic fistulae occurring during the latter period. The increased number of patients experiencing intestinal obstruction during the latter period relates, at least in part, to the increased incidence of intra-abdominal infections, as these two complications often occurred concomitantly in the same patient. Incidence of pulmonary complications, similar to incidence of pulmonary deaths, also increased during the latter period, probably

TABLE 4. *Complications Among 650 Survivors*

	1949–1964 (286 Survivors)	1965–1970 (364 Survivors)	Total
Infections	26	104	130
Wound	18	56	74
Intra-abdominal and pelvic	4	28	32
Subphrenic	3	19	22
Intraheptic	0	1	1
Empyema	1	0	1
Fistulae	14	30	44
Fecal	8	12	20
Pancreatic	1	10	11
Small bowel	2	4	6
Gastroduodenal	1	4	5
Urinary tract	1	0	1
Biliary tract	1	0	1
Intestinal obstruction	8	24	32
Pneumonia	1	15	16
Psychosis	1	14	15
Wound dehiscence	7	1	8
Urinary tract infection	0	7	7
Pulmonary embolism	2	3	5
Pancreatitis	0	5	5
Jaundice	2	3	5
Upper gastrointestinal hemorrhage	0	4	4
Thrombophlebitis	0	3	3
Osteomyelitis of sacrum	3	0	3
Atelectasis	0	3	3
Hemo-or pneumothorax	0	3	3
Bleeding coagulopathy	0	3	3
Intra-abdominal hemorrhage	0	2	2
Acute renal failure	2	0	2
Seizures	0	2	2
Congestive heart failure	0	2	2
Miscellaneous	0	9	9
Total	66	237	303

related to the larger number of associated chest injuries. One cannot even speculate regarding the increased incidence of psychoses during the latter period, as the majority of these episodes were associated with delirium tremens. The nine complications listed as miscellaneous in Table 4 include the occurrence once each of false aneurysm, inferior vena caval thrombosis, common bile duct stricture, pericarditis, endometriosis, spontaneous abortion, hyperpyrexia, dehiscence through colostomy site, and necrosis of the colon.

Discussion

With each major military conflict significant improvements have been made in the care of the injured.[13] Such improvements relate to more rapid evacuation of the wounded to an area where definitive care is feasible, better overall management of the severely wounded patient, and improved surgical treatment of specific lesions. Early in World War II a policy of managing colonic lesions by exteriorization was established and must be credited with saving many lives during those hostilities.[3, 11] With the Korean conflict came a review of World War II statistics and a reemphasis on the use of exteriorization for colonic wounds.[17] Recent evaluation of experience in Vietnam lends little or no support to change in such policies, except in regard to some injuries to the right side of the colon where resection and ileotransverse colostomy is preferable to ileostomy.[7]

Nevertheless, civilian injuries often differ significantly from war wounds in regard to the wounding agent, the period of delay between injury and definitive care, total extent of injury to the patient, and various logistic considerations. For these reasons, Imes,[9] as early as 1945, suggested advantages of repairing some civilian colonic injuries primarily. Feasibility of this approach to civilian trauma further was supported by Woodhall and Ochsner,[16] Tucker and Fey,[14] and Vannix and associates.[15] In January, 1949, evaluation of the selective use of primary repair for injuries of the colon was instituted at the Jefferson Davis Hospital, the city-county charity hospital for Houston and Harris County, Texas. This evaluation has been continued through June, 1970, including experience at the Jefferson Davis Hospital and more recently at the Ben Taub General Hospital, both now managed by the Harris County Hospital District for the indigent of this county.

Policy for managing colonic injuries in these hospitals always has been one of individualization, primary repair being employed only in selected cases. Furthermore, almost 100 per cent of these patients have been operated upon by the resident staff under the supervision of the members of the Cora and Webb Mading Department of Surgery. Previous reports from these institutions have demonstrated that over the years a progressively increasing number of patients have been managed by primary repair, rather than a two-stage procedure, with a continuing decrease in overall mortality rate.[2, 4] Review of the last 5½ year's experience, however, demonstrates a decided change in these trends.

Whereas during the earlier period (1949–1964) approximately 80 per cent of patients with colonic injuries were managed by primary repair with an overall mortality rate for the entire group of 12.8 per cent, during the latter period (1965–1970) approximately 53 per cent of patients with colonic injuries were managed by primary repair with an overall mortality rate for the entire group of 14.2 per cent. Reasons for such changes in trends without change in policy become readily apparent when one analyzes such factors as wounding agents and associated injuries. As noted previously, the ratio of gunshot wounds to stab wounds has increased from approximately 2:1 to approximately 6:1 between the two periods. Furthermore, a significant increase

in the use of high velocity missiles has occurred during the latter period. At the same time total extent of injury to the patient also has increased, as noted by the difference in associated injuries, particularly chest injuries (Table 1). No longer is there the great difference in wound agents and total extent of injury that once existed between colonic injuries occurring in wartime and those occurring on the civilian battleground of Harris County, Texas.

Furthermore, as one compares the period of delay from injury to definitive therapy between war wounds and civilian wounds previous differences again cease to exist. Direct helicopter evacuation of the wounded to the point of definitive care, as now is practiced in Vietnam, often may result in an even shorter period of delay for the war wounded.[6] Logistical differences probably will continue to exist between management of war injuries and civilian injuries, however, particularly in regard to case loads, consistent levels of training and experience, and constant availability of senior staff.

Results of the continuing evaluation of the selected use of primary repair of civilian colonic injuries reported herein would appear to demonstrate that such an approach still is applicable in more than half of the patients seen with such injuries, thereby significantly reducing morbidity and period of hospitalization for this group of patients. As noted in Table 2, mortality rate for primary repair in gunshot wounds of the colon during the last 5½ years was only 10 per cent among 162 patients, and there were no deaths among 54 patients in whom stab wounds of the colon were repaired primarily. Deaths in the entire series of 752 patients with civilian colonic injuries usually related to the total extent of injury rather than to the colonic injury itself, as among 151 patients with colonic injuries of all types but without associated injury there were only two deaths, a mortality rate of only 1.3 per cent. Nevertheless, if one is to employ primary repair for selected cases of civilian colonic injuries, importance of individualization with mature and conservative judgment cannot be overstressed.

Summary

Methods of surgically managing colonic injuries were developed and defined during wartime, and these technics subsequently were applied to civilian injuries with equal success. However, shortly after World War II, numerous investigators pointed out significant differences between battlefield injuries of the colon and those occurring among a civilian population and suggested that primary repair was applicable to selected civilian wounds. Evaluation of the employment of such a policy was begun in our hospitals in January, 1949, since which time 752 patients with colonic injuries have been admitted to these hospitals.

During the 15-year period 1949–1964 primary repair of colonic injury was employed in approximately 80 per cent of 328 patients with an overall mortality rate of 12.8 per cent for the entire group. In the most recent 5½ years (1965–1970) frequency of primary repair has fallen to approximately 53 per cent of 424 patients with a similar overall mortality rate for the entire group (14.2 per cent). Analysis of the two groups demonstrates significant changes in clinical material with the ratio of gunshot wounds (mortality rate 15 per cent) to stab wounds (mortality rate 1.8 per cent) increasing from approximately 2:1 to approximately 6:1. This has resulted in significant differences in associated injuries encountered and has influenced causes of deaths and types of complications. Nevertheless, results of this review would appear to indicate that primary repair for selected patients with colonic injury still is applicable and advantageous, but that individualization with mature and conservative judgment is mandatory.

References

1. Beall, A. C., Jr., Bricker, D. L., Crawford, H. W., Noon, G. P. and DeBakey, M. E.: Considerations in the Management of Penetrating Thoracic Trauma. J. Trauma, **8**:408, 1968.
2. Beall, A. C., Jr., Crosthwait, R. W. and DeBakey, M. E.: Injuries of the Colon Including Those Incident to Surgery upon the Aorta. Surg. Clinics N. Amer., **45**:1273, 1965.
3. Beall, A. C., Jr., Diethrich, E. B., Cooley, D. A. and DeBakey, M. E.: Surgical Management of Penetrating Cardiovascular Trauma. So. Med. J., **60**:698, 1967.
4. Biggs, T. M., Beall, A. C., Jr., Gordon, W. B., Morris, G. C., Jr. and DeBakey, M. E.: Surgical Management of Civilian Colon Injuries. J. Trauma, **3**:484, 1963.
5. Bricker, D. L., Okies, J. E., Jordan, G. L., Jr., Beall, A. C., Jr. and DeBakey, M. E.: Exteriorized Primary Repair of Colon Injuries without Colostomy. Preliminary report. To be published.
6. Eiseman, B.: Combat Casualty Management in Vietnam. J. Trauma, **7**:53, 1967.
7. Ganchrow, M. I., Lavenson, G. S., Jr. and McNamara, J. J.: Surgical Management of Traumatic Injuries of the Colon and Rectum. Arch. Surg., **100**:515, 1970.
8. Horsley, G. W. and Michaux, R. A.: Surgery of the Colon in Overseas Hospital. Surgery, **19**:845, 1946.
9. Imes, P. R.: War Surgery of the Abdomen. Surg. Gynec. Obstet., **81**:608, 1945.
10. Noon, G. P., Beall, A. C., Jr., Jordan, G. L., Jr., Riggs, S. and DeBakey, M. E.: Clinical Evaluation of Peritoneal Irrigation with Antibiotic Solution. Surgery, **62**:73, 1967.
11. Ogilvie, W. H.: Abdominal Wounds in the Western Desert. Surg. Gynec. Obstet., **78**: 225, 1944.
12. Quast, D. C., Shirkey, A. L., Fitzgerald, J. B., Beall, A. C., Jr. and DeBakey, M. E.: Surgical Correction of Injuries of the Vena Cava. An Analysis of 61 Cases. J. Trauma, **5**:1, 1965.
13. Pridgen, J. E., Herff, A. F., Jr., Watkins, H. O., Halbert, D. S., D'Avila, R., Conch, D. M. and Prud'Homme, J. L.: Penetrating Wounds of the Abdomen: Analysis of 776 Operative Cases. Ann. Surg., **165**:901, 1967.
14. Tucker, J. W. and Fey, W. P.: Management of Perforating Injuries of the Colon and Rectum in Civilian Practice. Surgery, **35**:213, 1954.
15. Vannix, R. S., Carter, R., Hinshaw, D. B. and Joergenson, E. J.: Surgical Management of Colon Trauma in Civilian Practice. Amer. J. Surg., **106**:364, 1963.
16. Woodhall, J. P. and Ochsner, A.: Management of Perforating Injuries of the Colon and Rectum in Civilian Practice. Surgery, **29**:305, 1951.
17. Ziperman, H. H.: Management of Large Bowel Injuries in the Korean Campaign. U. S. Armed Forces Med. J., 7:85, 1956.