43
Trauma of the Colon, Rectum, and Anus

W. Brian Perry

Key Concepts

- Primary repair is the treatment of choice for all nondestructive colonic injuries.
- Resection and anastomosis is the treatment of choice for most destructive colonic injuries.
- Diversion should be considered in patients undergoing damage-control laparotomy or who have significant pre-injury comorbidities or significant hemodynamic derangement.
- Primary repair is appropriate for accessible rectal injuries.
- Diversion alone without direct repair is sufficient to treat isolated extraperitoneal rectal injuries.
- Presacral drainage and distal washout are no longer recommended for rectal injuries.
- Anal injuries are often amenable to delayed reconstruction.

Introduction

The management of the injured colon has evolved considerably over the past century and a half. Accumulated wartime experience demonstrates that mortality fell from >90% during the American Civil War to <10% in Iraq and Afghanistan (Figure 43-1). Many factors have led to this improvement, including better transport time (Figure 43-2), resuscitation, transfusion, antibiotics, and improved surgical techniques. Civilian experience paralleled this and further refined current treatment algorithms. Multiple well-done studies confirm the safety of primary repair for most injuries although care must still be used in damage-control situations. Extraperitoneal rectal trauma is typically managed by proximal diversion; the utility of routine distal washout and presacral drainage has recently been shown to be of no benefit. Anal trauma lends itself to delayed reconstruction in many cases.

Colonic Trauma

Epidemiology

Most colonic injuries are due to penetrating abdominal trauma. Gunshot wounds are the most common cause (Figure 43-3), followed by stabbing and impalement. The colon is the second most commonly injured organ in penetrating abdominal trauma, behind only the small bowel [1].

Blunt colonic injuries are rare, accounting for <10% of lesions found at laparotomy for blunt trauma, primarily from motor vehicle crashes. Lap belt use, especially without concomitant shoulder harness, increases the risk of visceral injury (Figure 43-4). Most blunt injuries are minor—small hematomas or serosal tears; more serious injuries typically involve devascularization due to avulsion from the adjacent mesentery (Figure 43-5). "Blowout" injuries due to a blast overpressure wave are occasionally seen in victims of explosions, sometimes without external signs of abdominal trauma [2].

The American Association for the Surgery of Trauma has published a grading scale for colonic injuries (Table 43-1) [3].

Diagnosis

Prompt abdominal exploration accurately finds the majority of colonic injuries in penetrating anterior abdominal trauma. It is important to remember that the diaphragm may rise as high as the nipple line or the bottom of the scapula at full exhalation. Wounds to the flank or back can cause colonic trauma in the absence of initial peritoneal irritation or hemodynamic instability; computed tomography (CT) with triple contrast is useful for delineating such injuries, with 90% sensitivity and 96% specificity [4].
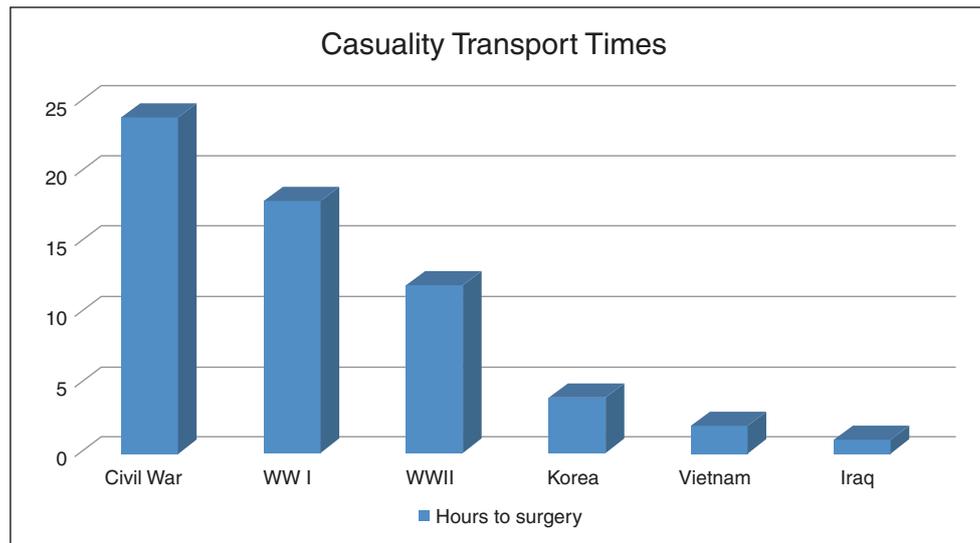
Casuality Transport Times

FIGURE 43-1. Time from injury to surgical management in American wars.

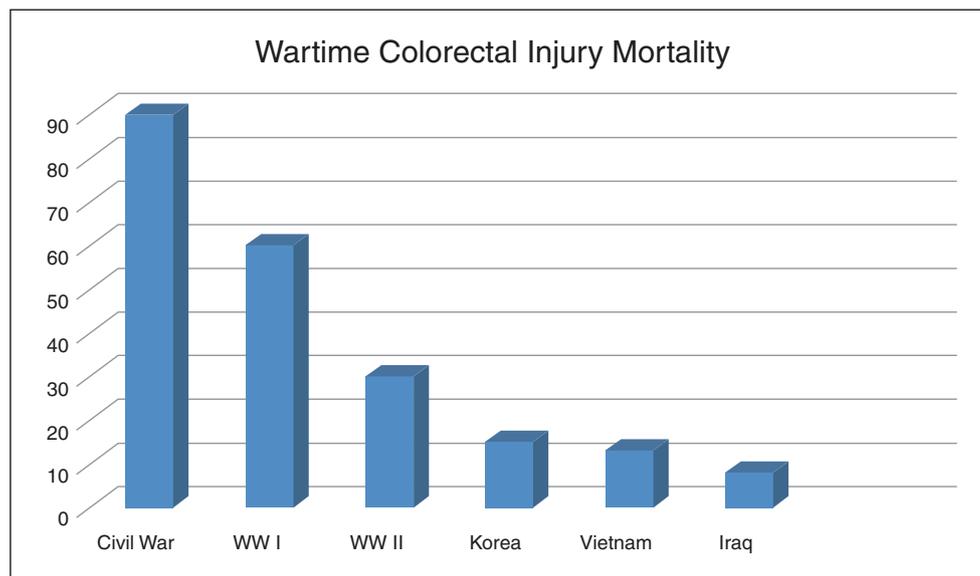**Wartime Colorectal Injury Mortality**

FIGURE 43-2. Mortality rate of penetrating colorectal trauma in American wars.
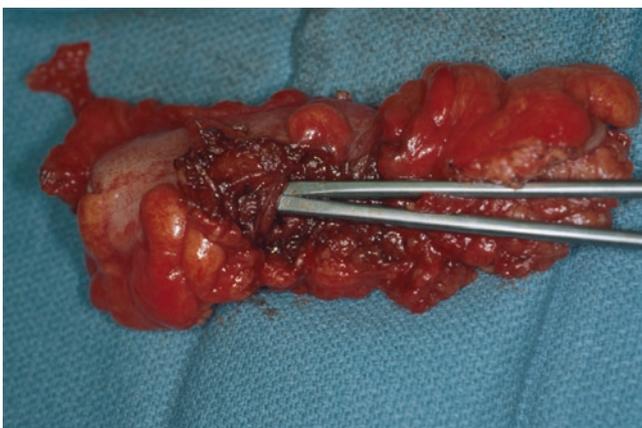

FIGURE 43-3. Destructive gunshot wound to the colon.

Accurate diagnosis of colonic injury is more difficult for a bluntly injured patient, whose examination is often compromised by concomitant brain or spinal cord trauma. Triple-contrast CT is the examination of choice in such instances. Organ-specific diagnosis is not always possible (or necessary). The presence of free intraperitoneal air mandates exploration for perforated hollow viscus. Free intraperitoneal fluid in the absence of solid organ injury should significantly raise the index of suspicion for bowel injury (Figure 43-6).

Diagnostic peritoneal lavage is rarely used in the contemporary evaluation of patients with suspected colonic injury. It may be useful in the austere environment where CT is unavailable or in the patient who cannot be safely transported due to profound instability or who is in the operating

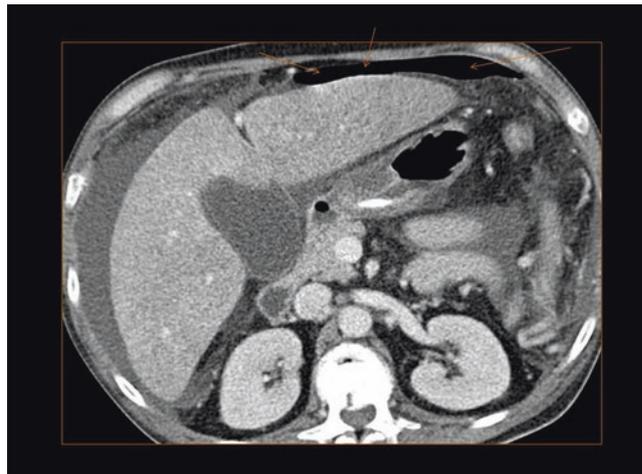FIGURE 43-4. "Seat belt sign" from improperly worn lap belt.

FIGURE 43-6. Computed tomography scan of a blunt trauma patient showing free air and free fluid in the absence of solid organ injury. Exploration revealed a cecal injury.
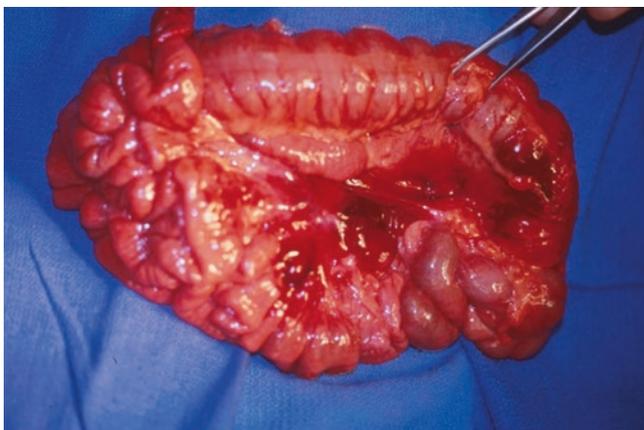

FIGURE 43-5. Blunt colonic mesenteric avulsion.

TABLE 43-1. American Association for the Surgery of Trauma Colonic Injury Scale

Grade	Injury description
I	(a) Contusion or hematoma without devascularization
	(b) Partial-thickness laceration
II	Laceration ≤50% of circumference
III	Laceration >50% of circumference
IV	Transection of the colon
V	Transection of the colon with segmental tissue loss

theater for a prolonged period for other injuries. The presence of gross blood or fecal matter on aspiration or >500 white cells/>100,000 red cells on lavage analysis is highly suggestive of significant intra-abdominal injury and should prompt exploration [5].

Laparoscopy has little role in evaluating the most penetrating anterior abdominal trauma, but may be useful in stable patients with back, flank, or pelvic wounds.

History of Military Colonic Injury Management

The accumulated experience of military surgeons has been critical to the evolution of current civilian colonic injury management [6].

With only a few exceptions, laparotomy was considered futile in the management of penetrating abdominal injury until the early stages of World War I. Wallace, in defiance of accepted doctrine, insisted that hemorrhage was killing soldiers and advocated for prompt laparotomy [7]. This approach was accepted by June 1915 and was augmented by more expeditious evacuation of the wounded (Figure 43-7); mortality decreased from 87 to 40% by Armistice Day [8].

Ogilvie reported his experience in the North African Campaign in World War II, recommending colostomy, although his data did not clearly support it. Mortality ranged from 44% for simple suture repair to 100% for resection and anastomosis [9]. Multiple authors have failed to find the "colostomy or court-martial" edict, but the US Army Surgeon General Circular clearly mandated colostomy for penetrating injuries [10]. Regardless of the true impact of this specifically, mortality declined further to around 30%.

Mortality continued to improve through the Korean War, but primary repair remained rare. During the Vietnam War, there were multiple series showing the feasibility of resection and anastomosis for right-sided injuries; left colon and rectal injuries were still treated with colostomy. Mortality fell to just over 13% [6]. Recent experiences in Iraq and Afghanistan with primary repair or resection and anastomosis showed some success in selected cases. However, intra-abdominal repair failure was >15% in one review, typically in patients with other injuries; such failure complicated subsequent continuity restoration in 75% of patients. This experience reinforces the concern for primary repair in patients who experience significant hemodynamic derangement pre- or intraoperatively. Despite the challenges of devastating injuries, mortality fell again to 8% [11, 12].

Current Operative Management

Civilian experience has paralleled the military experience. While surgeons returning from World War II adopted mandatory colostomy, this was questioned as early as the 1950s. Woodhall and Ochsner's case series showed success in highly selected cases of primary repair, with a mortality rate of 9% [13]. Stone and Fabian's landmark 1979 study randomized patients with penetrating colonic trauma to primary repair vs. mandatory colostomy, with significant exclusion criteria for devastating injuries, treatment delay, or extensive blood loss. With the selected cohort, repair proved to be superior to colostomy [14]. Subsequent studies have expanded on this seminal work.

Accumulated high-quality data have conclusively shown the safety and efficacy of primary repair in patients with grade II injuries, even in the presence of risk factors such as

FIGURE 43-7. British Army system of casualty evacuation in World War I [7].

hypotension, multiple transfusions, and gross spillage. Studies by Chappuis [15], Sasaki [16], and Gonzalez [17] together randomized more than 300 patients to primary repair or colostomy, finding fewer complications in the repair group (Table 43-2).

Grade III, IV, and V injuries require resection. Initially, primary anastomosis was reported to be successful in small retrospective series, with a leak rate of <3%. However, subsequent nonrandomized prospective single-institution reports called into question the universal applicability of this approach. Cornwell found two fatal anastomotic leaks in 25 patients [18]. Stewart et al. reported an overall leak rate of 14% but on subgroup analysis of patients needing >6 units of blood found the leak rate increased to 33% [19]. Murray found similar abdominal sepsis rates whether anastomosis or diversion was used, but also found higher leak rates in the more severely injured [20]. It is interesting that based upon this data, there is little advocacy for colonic repair/resection with protective diversion by loop ileostomy in select cases to minimize the impact of stoma reversal surgery.

To address these concerns, the American Association for the Surgery of Trauma (AAST) conducted a multicenter randomized prospective trial of diversion vs. resection and anastomosis for destructive colonic injuries. Colon-related mortality was 1.3%, all in the diversion group. Anastomotic leak rate was 6.6% with no deaths. Severe fecal contamination, transfusion of more than three units of blood, and inappropriate antibiotic selection were identified as risk factors for abdominal complications, up to 60% if all three were present. Shock on admission, delay of surgery, penetrating abdominal trauma index >25, and method of colon management (diversion vs. anastomosis) were not independent predictors of complications. The authors concluded that resection and anastomosis are the treatment of choice in all destructive colonic injuries regardless of severity of injury [21].

Sharpe et al. reported that adherence to a simplified management algorithm for penetrating colonic injuries reduces morbidity and mortality. In short, nondestructive injuries underwent primary repair without regard to underlying illness or patient condition. Destructive injuries had resection and anastomosis unless they had >6 unit transfusion requirement or significant pre-injury comorbidities. Protocol compliance was 90%; three-fourths of all the patients with destructive injuries avoided diversion. When compared to similar colonic injuries before the protocol was introduced,
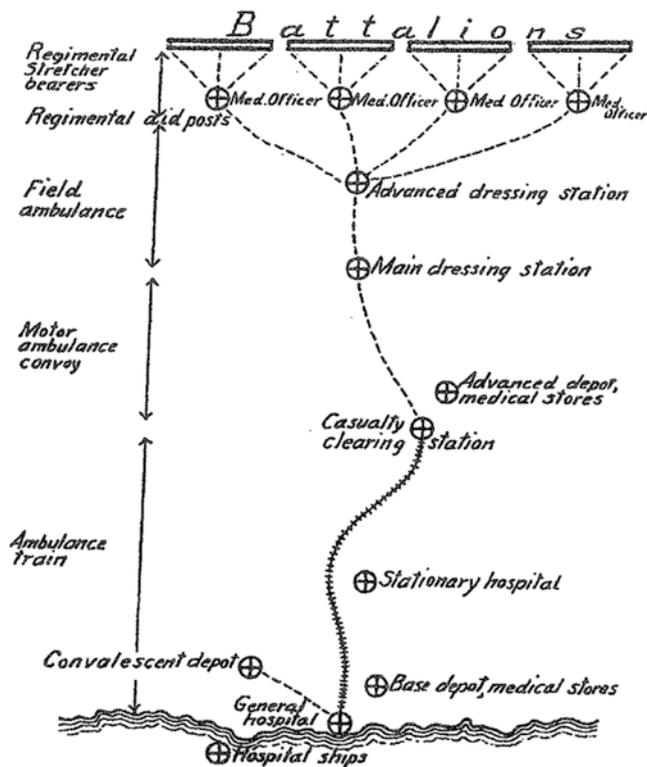
TABLE 43-2. Randomized prospective trials of primary repair vs. diversion without exclusion criteria

	Primary repair		Colonic diversion	
Study	Number of patients	Rate of abdominal septic complications (%)	Number of patients	Rate of abdominal septic complications (%)
Chappuis [15]	28	14.3	28	17.9
Sasaki [16]	43	2.3	28	28.6
Gonzalez [17]	89	18	87	21
Total	160	13.1	143	21.7

those patients thus managed had fewer abscesses (18% vs. 27%) and colon-related mortality (1% vs. 5%). Suture line failure rates remained low (5% vs. 7%). They concluded that, with reasonable exclusions, destructive colonic injuries can be safely managed with resection and anastomosis [22].

Over the past two decades, the damage-control laparotomy (DCL) approach to devastating abdominal trauma significantly reduced morbidity and mortality. Abbreviated laparotomy and intensive ongoing resuscitation aim to avoid the lethal triad of coagulopathy, acidosis, and hypothermia [23]. The management of colonic injuries in these situations is evolving. Early in the DCL era, colostomy was considered mandatory. This eliminated the morbidity of intra-abdominal leak, but created other issues, especially during the reconstructive phase of patient care, as the presence of a stoma can make abdominal wall reconstruction problematic. Several authors reported their initial positive experience with selected repair or resection and delayed anastomosis after DCL, citing the potential ability to inspect the suture or staple line at subsequent operations [24–26]. Other series voice more caution in this patient population, especially when resection and anastomosis are required [27] or there is a persistent need for vasopressors to maintain stability (Table 43-3) [28]. Interestingly, the leak rate in studies where the authors touted the safety of delayed anastomosis was nearly identical to those who urged caution.

Sharpe and colleagues again analyzed their results using the previously described management algorithm in patients undergoing delayed anastomosis following DCL. Protocol adherence was only 55%. Adherence to the algorithm resulted in significantly lower rates of suture line failure (4% vs. 32%) and colon-related morbidity (22% vs. 58%). They were unable to identify other risk factors that would predict suture line failure [29]. Clearly additional multicenter trials are needed in this critically injured patient population.

Ciesla and Burch have developed an algorithm for the management of colonic injuries, utilizing the metabolic status of the patient, the location of the injury, the need for segmental resection, and the condition of the bowel wall at the time of repair. Taking into consideration the data presented, such an approach should lead to safe initial restoration of colonic continuity in 70–90% of injured patients (Figure 43-8) [30].

Technical Considerations

During the initial exploration for penetrating trauma, control of gross spillage with quick suturing or stapling should occur rapidly, as soon as exsanguinating hemorrhage is stopped. This needs not be definitive resection or repair. The colon needs to be fully mobilized above and below suspected injuries, with particular care paid to the flexures and rectosigmoid junction. In penetrating trauma, paracolic hematomas must be fully explored; this is less important for blunt injuries unless there are other signs of perforation such as soiling or retroperitoneal emphysema. In nearly all cases of penetrating colonic injury, the skin is left open, with planned delayed primary closure or secondary closure with a vacuum-assisted closure device.

Primary repair can be safely accomplished in a number of methods. There is little difference between single- and double-layered suture techniques [31]. Isolated injuries to the more capacious right colon may be amenable to elevation and application of a linear stapler (Figure 43-9). Perforations that are within a few centimeters of each other are best treated by removing the intervening bridge of tissue and performing a single repair (Figure 43-10).

Similarly, there is little difference between stapled and sutured anastomoses [32]. Adherence to the standard principles of no tension, good tissue approximation, and adequate blood supply is critical (Figure 43-11). There is typically no need for colonic lavage, even when a left-sided anastomosis is constructed. Ileocolostomy is associated with fewer leaks

TABLE 43-3. Delayed colonic anastomosis following damage-control laparotomy

Study	Number of patients with DCL and colonic injury (early deaths prior to re-exploration excluded)	Number of patients receiving primary repair or delayed anastomosis without proximal diversion (%)	Number of colonic leaks (%)	Notes
Miller [24]	19	11 (58%)	0 (0%)	
Georgoff [25]	61	28 (46%)	4 (14%)	Two additional leaks in patients with proximal diversion
Kashuk [26]	29	21 (72%)	6 (28%)	Four leaks confirmed, two suspected
Weinberg [27]	56	49 (88%)	6 (12%)	
Fischer [28]	68	41 (60%)	7 (17%)	Leak rate 50% in patients with persistent vasopressor requirements
Sharpe [29]	149	74 (50%)	9 (12%)	Leak rate 32% when established protocol not followed

DCL damage-control laparotomy

FIGURE 43-8. Algorithm for
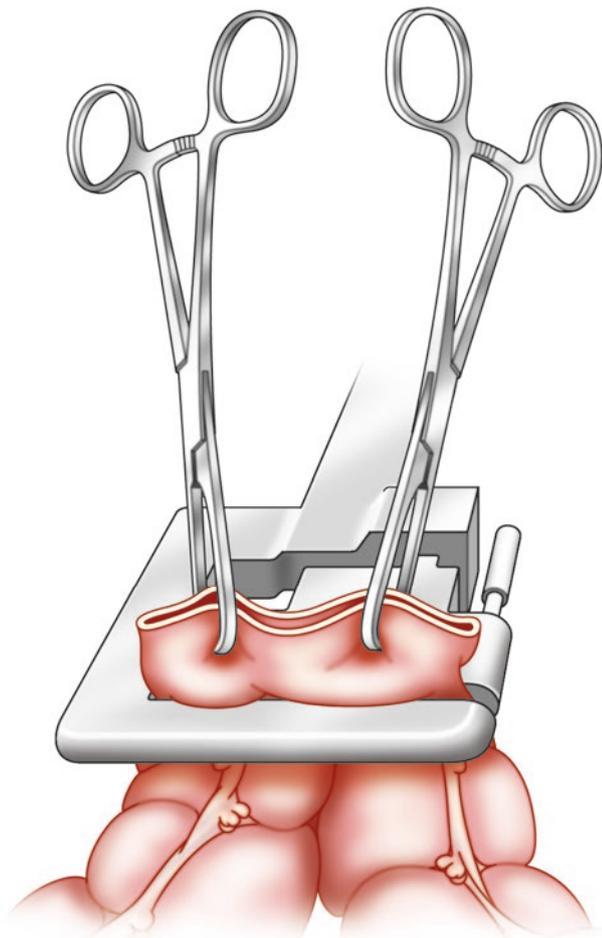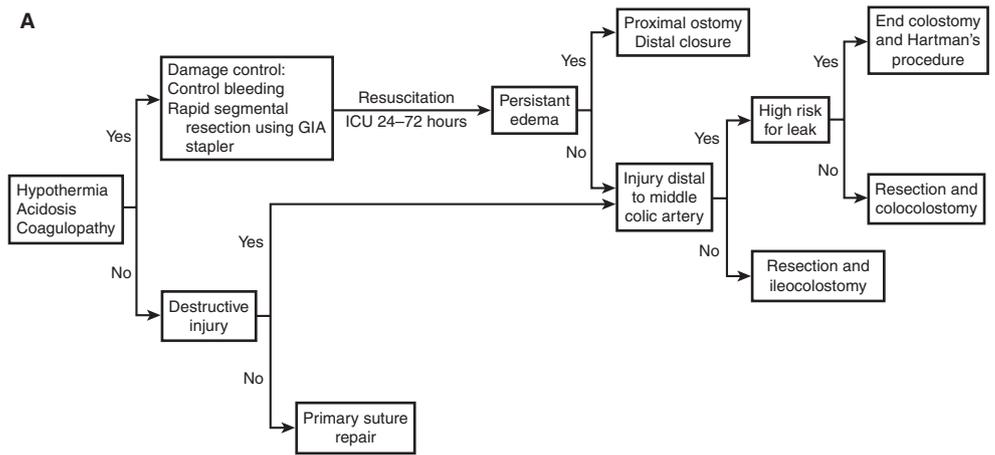colonic injury management [30].

FIGURE 43-9. Grade II colonic injuries can be elevated and closed
with a linear stapler, with care taken not to cause luminal
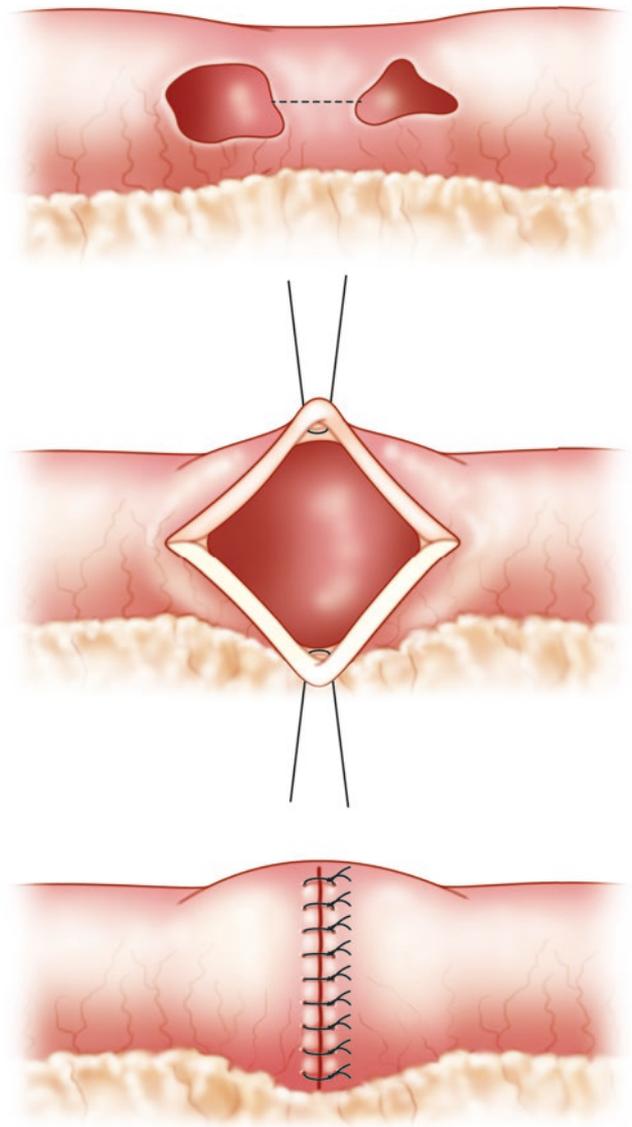narrowing.

FIGURE 43-10. The intervening bridge of tissue between two close
perforations can be removed and the resulting single defect can be
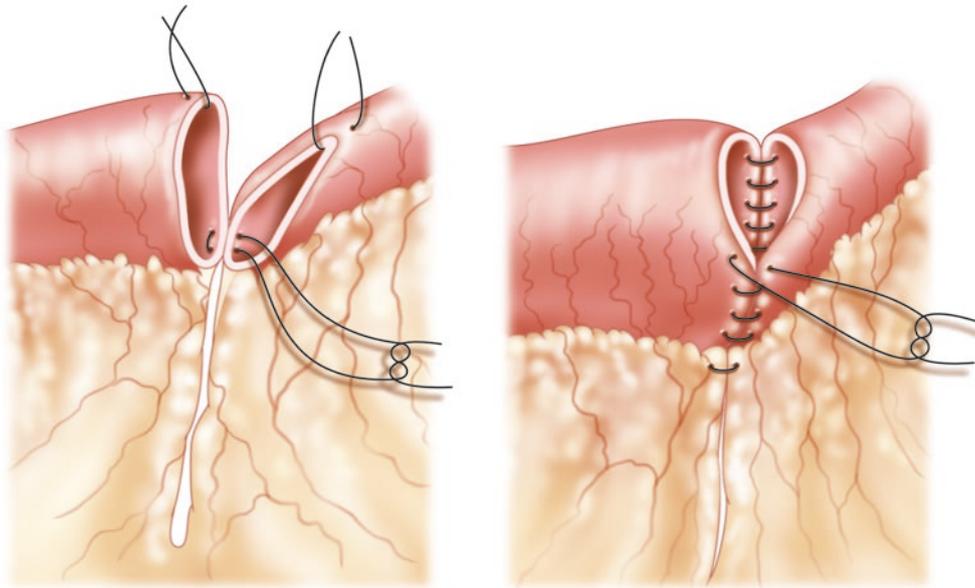closed transversely.

FIGURE 43-11. Single-layer hand-sewn colocolostomy.

FIGURE 43-12. Temporary abdominal closure can be accomplished with towels, a chest tube, and adhesive drapes if vacuum-assisted wound closure materials are not available.

than colocolostomy, making right hemicolectomy the procedure of choice for ascending colon and cecal injuries; there is little another difference between right- and left-sided colonic injuries.

Primary anastomosis with proximal fecal diversion with a loop colostomy or ileostomy has proven efficacious in elective resections for rectal cancer or in urgent resections for diverticulitis. The data are less clear in the setting of trauma. If chosen, loop ileostomy is easier to construct and take down. Loop transverse colostomies should be avoided when possible as they tend to be difficult to adequately pouch and tend to prolapse.

Should DCL be necessary, the colon can be left in discontinuity at the initial exploration; creation of a colostomy is not necessary. The abdomen is temporarily closed over nonstick plastic drapes, and a suction method of collecting fluid is fashioned (Figure 43-12). Once restoration of normothermia and correction of acidosis and coagulopathy are accomplished, the patient is returned to the operating room for further treatment based on the factors discussed above. When possible, the fascial edges should not be allowed to retract causing loss of domain (Figure 43-13). Temporary bridging mesh, either prosthetic or biologic, can be serially tightened at subsequent surgeries, facilitating eventual primary fascial closure (Figure 43-14).

FIGURE 43-13. Loss of domain with subsequent skin grafting becomes necessary if the fascial edges are allowed to retract.

FIGURE 43-15. Computed tomography showing rectal injury with contrast extravasation from a severe pelvic fracture.

FIGURE 43-14. Serial tightening of temporary bridging mesh allows for fascial closure after damage-control laparotomy.

TABLE 43-4. American Association for the Surgery of Trauma Rectal Injury Scale

Grade	Injury description
I	(a) Contusion or hematoma without devascularization
	(b) Partial-thickness laceration
II	Laceration ≤50% of circumference
III	Laceration >50% of circumference
IV	Full-thickness laceration with extension into the perineum
V	Devascularized segment

sharp bony edges from severe pelvic fractures (Figure 43-15); direct blunt rectal injury in the absence of pelvic fracture is very rare [33, 34]. The anus may be injured in a similar manner. This chapter does not cover obstetrical anal injury.

The American Association for the Surgery of Trauma has published a grading scale for rectal injuries (Table 43-4) [3].

Rectal and Anal Trauma

Epidemiology

The majority of rectal injuries are from penetrating pelvic trauma, more than 80% from gunshot wounds in most series. Accidental or intentional impalement, iatrogenic injuries, and rectal foreign bodies account for the rest. The rectum may be perforated in blunt force trauma, typically by the intrusion of
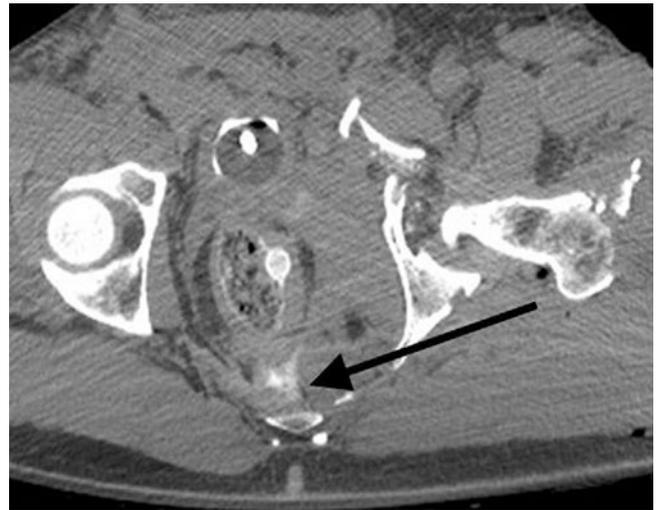
Diagnosis

The presence of gross blood on digital rectal examination is highly suggestive of rectal injury and mandates further evaluation. Sigmoidoscopy, either rigid or flexible, should be quickly performed, with an expected diagnostic accuracy of 80–95% [35]. Genitourinary injuries accompany up to one-third of rectal injuries; CT scan with bladder and rectal contrast is indicated for preoperative planning in stable patients [36]. Certain injury patterns, particularly transpelvic or buttock gunshot wounds, need thorough investigation even in the absence of rectal blood. Most anal injuries are obvious on external inspection, although occult sphincter disruption may occasionally occur.

History of Military Anorectal Injury Management

Mortality from penetrating battlefield rectal trauma was greater than 90% in World War I and still exceeded 60% early in World War II. With the edict mandating colostomy and the introduction of presacral drainage, mortality fell to <30% by the end of the war. The addition of distal rectal washout and improvements in casualty evacuation, resuscitation, and antibiotics were credited with mortality rates falling to <15% in Korea and Vietnam [6]. This leads to the classic "three Ds" of rectal injury management—diversion, drainage, and distal washout [37]. Recent reports from Iraq and Afghanistan showed overall mortality to be less than 8%. Soldiers with rectal injuries were more likely to have head, neck, or extremity injuries as compared to those with colonic injuries, largely due to the efficacy of modern body armor, which covers most of the abdomen and thorax [12].

Anal injuries in earlier conflicts were usually reported in series with rectal injuries, stressing prompt diagnosis, adequate debridement, and mandatory colostomy [38]. McCune noted in 11 of 41 patients that some function could be regained with a series of guided gluteal and sphincter exercises [39]. One of the signature injuries in the Iraq and Afghanistan conflicts is complex pelviperineal trauma caused by ground-level improvised explosive devices [40]. Glasgow analyzed 46 combatants with anal canal or sphincter injuries, the largest such series to date. Nearly 80% underwent fecal diversion; acute sphincter reconstruction was attempted in about 25%, but this did not influence eventual restoration of intestinal continuity. Of the patients available for long-term follow-up, 30% had a permanent colostomy, which was strongly predicted by the presence of concurrent intra-abdominal injury, hypogastric artery ligation, or pelvic fracture [41].

Current Management and Technical Considerations

While not specifically addressed in separate studies, there is consensus that intraperitoneal rectal injuries can be treated as colonic injuries.

Each of the "three Ds" has been challenged in the modern civilian management of rectal trauma. Several studies have shown that small perforations can be safely closed without proximal diversion, either transanally if low enough or from an abdominal approach if minimal rectal mobilization is required. Inaccessible injuries are still best managed by proximal diversion; extensive rectal mobilization is not recommended. If perforations cannot be safely closed, proximal diversion is still required [34, 42]. A recent study from South Africa demonstrated that laparoscopy is useful for evaluating stable patients without peritoneal signs who are suspected of having an isolated extraperitoneal rectal injury. If there is no evidence of intraperitoneal injury, then a loop sigmoid colostomy may be easily constructed [43]. Resection with stapling of the rectum distally and end colostomy is required for destructive injuries. Abdominoperineal resection is occasionally necessary in devastating open pelvic fracture [44]. These patients typically need damage-control surgery with pelvic packing; ligation or angioembolization of the hypogastric arteries may be necessary (Figure 43-16a, b).
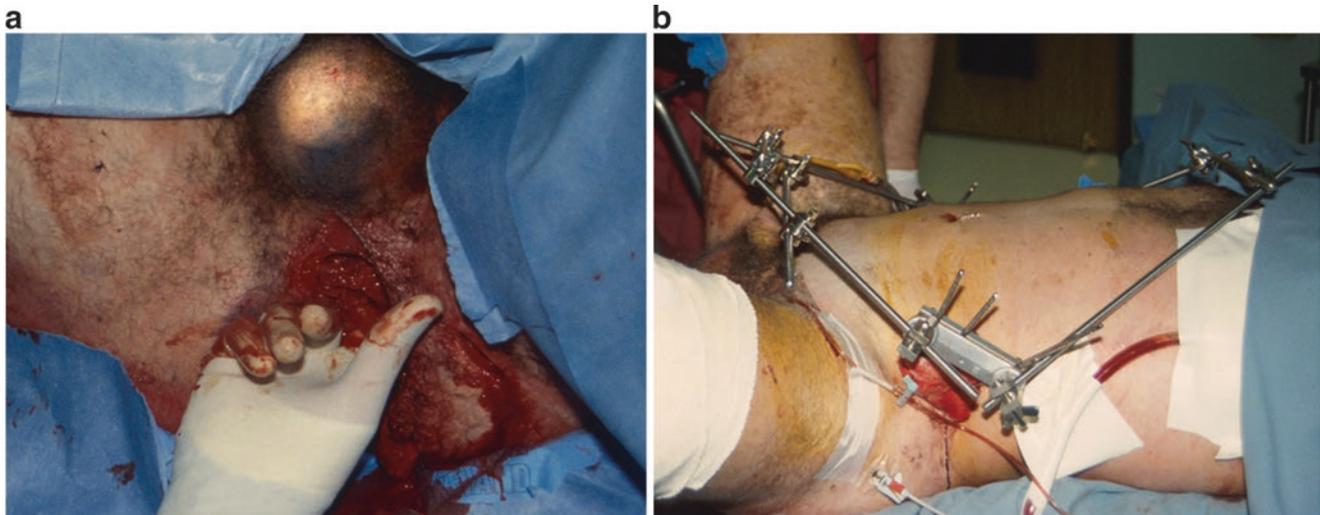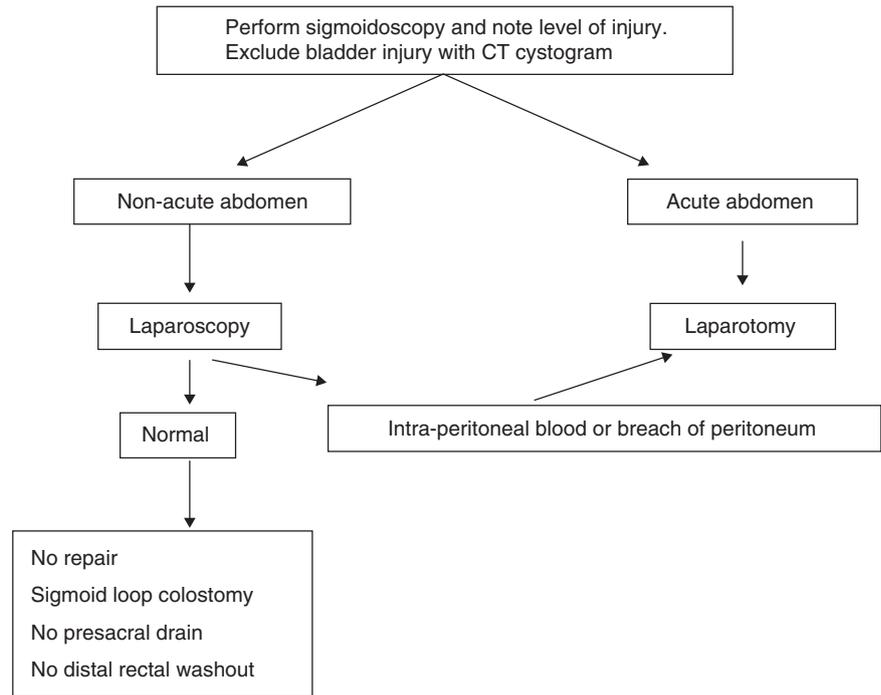
FIGURE 43-16. Severe open pelvic fracture with rectal injury. (a) Open perineal wound with exsanguinating hemorrhage which required expedient packing and angioembolization. (b) Note positioning of external pelvic fixation to allow laparotomy. Attention to colostomy siting is important to decrease the risk of pin tract infections.

FIGURE 43-17. Algorithm for
rectal injury management [43].

> **Perform sigmoidoscopy and note level of injury.**
> **Exclude bladder injury with CT cystogram**
>
> → **Non-acute abdomen**
> → **Acute abdomen**
>
> Non-acute abdomen → **Laparoscopy**
> Acute abdomen → **Laparotomy**
>
> Laparoscopy → **Normal**
> Laparoscopy → **Intra-peritoneal blood or breach of peritoneum** → Laparotomy
>
> Normal →
> No repair
> Sigmoid loop colostomy
> No presacral drain
> No distal rectal washout

Routine presacral drainage has been examined in several studies, including one randomized prospective trial. The extensive disruption of normal tissue planes required showed no benefit. Presacral drainage is no longer recommended [34, 43, 45]. Closed suction drains placed in the pelvis after mobilization and repair of mid-rectal injuries at laparotomy may still be useful, as clean tissue planes are not violated.

Similarly, distal washout of the rectum has not been shown to have any benefit in the routine management of penetrating civilian rectal trauma. Liquefaction of the stool column with subsequent spread into the pelvic spaces has been touted as a potential negative result of vigorous rectal irrigation in traumatic injuries [34].

Nichol and Navsaria have developed an algorithm for the management of penetrating civilian rectal injuries, taking into account recent accumulated experience (Figure 43-17). At laparotomy, small visualized wounds can be primarily repaired, while destructive injuries will require resection and end colostomy.

Anal injuries can be repaired primarily in relatively clean wounds in stable patients; routine proximal fecal diversion is not required. For destructive perineal wounds, appropriate debridement and proximal diversion are paramount. A vacuum-assisted wound closure device can be used on the perineum for short periods while serial debridement is ongoing. Marking of the ends of the sphincters with nonabsorbable suture can aid later reconstruction. It is imperative to investigate the genitourinary tract, as many patients will have combined injuries (Figure 43-18a–e).
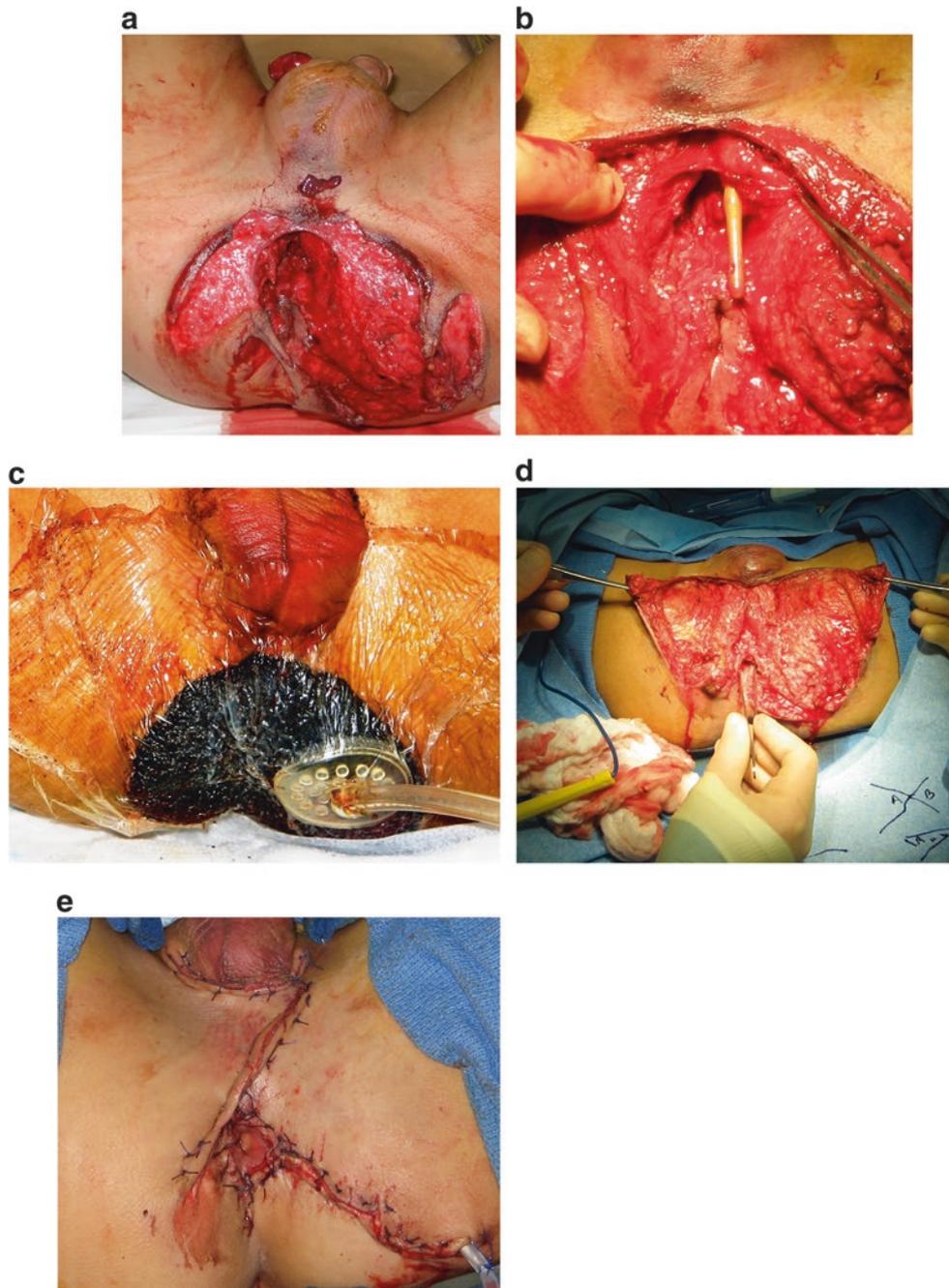
FIGURE 43-18. Destructive perineal and anal injury. (**a**) Mortar fragment entered the right hemiscrotum and exited the perineum, causing a massive injury. (**b**) Urethral transection was repaired through the perineum. (**c**) Serial debridements and vacuum-assisted wound closure changes created a healthy wound bed. (**d**) Flaps were constructed to facilitate closure. (**e**) After sphincteroplasty, the final wound closure. Colostomy was closed 6 weeks later and patient had excellent continence.

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