Hollow viscus injury is most commonly the result of penetrating abdominal trauma. It is relatively infrequent in the setting of blunt trauma: in one multi-institutional analysis, only 1.2% of blunt trauma admissions were associated with a hollow viscus injury. Initial resuscitation of the patient with abdominal trauma is described in detail elsewhere [see 7:1 Initial Management of Life-Threatening Trauma]. The diagnosis of hollow viscus injury remains a challenge in abdominal trauma patients, and subsequent evaluation is determined by the mechanism of injury. Regardless of the specific injury mechanism, however, the principles of operative management are the same.

**Determination of Need for Operation**

**BLUNT TRAUMA**

Hollow viscus injury after blunt trauma, though uncommon, can have serious consequences if the diagnosis is missed or delayed. In a multi-institutional study of 198 patients with blunt small bowel injury, delay of as little as 8 hours in making the diagnosis resulted in increased morbidity and mortality.\(^2\) Mortality increased in parallel with time to operative intervention (< 8 hours to operation, 2% mortality; 8 to 16 hours, 9%; 16 to 25 hours, 17%; > 24 hours, 31%), as did the complication rate.

Particular consideration should be given to lap- and shoulder-restraint injuries, which may be associated with an increased risk of hollow viscus injury. The so-called seat-belt sign (i.e., ecchymosis of the abdominal wall secondary to the compressive force of the lap belt) is associated with a more than doubled relative risk of association with hollow viscus injury.\(^3\) Flexion-distraction fractures of the spine (Chance fractures) are also associated with lap-belt use, and the presence of such fractures should raise the index of suspicion for associated hollow viscus injury.

Clinical examination often indicates the need for exploratory laparotomy. Abdominal tenderness after blunt torso trauma is frequently associated with significant intra-abdominal pathology, but the reliability of the examination may be compromised by distracting chest or long bone injury, closed head injury, spinal cord injury, or intoxication. In such scenarios, additional diagnostic tests are necessary.

Ultrasonography is routinely performed early in the evaluation of blunt abdominal trauma. It is highly specific and moderately sensitive in identifying intra-abdominal fluid, the presence of which in a hemodynamically unstable patient is an indication for laparotomy (in that it strongly suggests the presence of significant intra-abdominal hemorrhage).\(^4\) Ultrasonography does not, however, reliably distinguish solid-organ injury from hollow viscus injury—a distinction that is critical for determining subsequent management (i.e., operative versus nonoperative) in a hemodynamically stable patient. Diagnostic peritoneal lavage (DPL) may help differentiate one type of injury from the other (see below).

Helical (spiral) computed tomography is currently the imaging modality of choice in stable patients who have undergone blunt abdominal trauma. Our experience indicates that it is useful for identifying blunt hollow viscus injury. In a review of over 8,000 CT scans performed to evaluate cases of blunt abdominal trauma, we found that the number of abnormal radiologic findings suggesting blunt injury to the bowel, the mesentery, or both [see Table 1] was correlated with the true presence of injury.\(^5\) A CT scan demonstrating a solitary abnormality was associated with a true positive rate of 36%, whereas a scan demonstrating more than one abnormality was associated with a true positive rate of 83%. Unexplained intraperitoneal fluid (i.e., fluid appearing in the absence of solid-organ injury) was the most common radiographic finding associated with blunt bowel or mesenteric injury, but it often proved to be a false positive finding [see Table 1].

On the basis of this experience, we developed an algorithm for the evaluation of blunt hollow viscus injury in patients with unreliable clinical examination results [see Figure 1]. If CT scanning demonstrates no suspicious findings, the patient is observed. No further diagnostic workup of hollow viscus injury is performed, and the duration of the observation period depends on the reliability of the clinical examination. It is worth noting that the 2003 multi-institutional review of 2,457 cases carried out by the Eastern Association for the Surgery of Trauma (EAST) reported a 13% incidence of blunt small bowel injury in patients with an initial negative CT scan. These results indicate that caution should be exercised in dismissing the presence of hollow viscus injury on the basis of a negative scan.\(^5\) This concern is echoed by our own insti-

<table>
<thead>
<tr>
<th>Finding</th>
<th>True Positive CT Scans (%)</th>
<th>False Positive CT Scans (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unexplained intraperitoneal fluid</td>
<td>74</td>
<td>79</td>
</tr>
<tr>
<td>Pneumoperitoneum</td>
<td>28</td>
<td>2</td>
</tr>
<tr>
<td>Bowel wall thickening</td>
<td>30</td>
<td>8</td>
</tr>
<tr>
<td>Mesenteric fat stranding</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Mesenteric hematoma</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>Extravasation of luminal content</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Extravasation of vascular content</td>
<td>9</td>
<td>0</td>
</tr>
</tbody>
</table>
Figure 1  Algorithm outlines the evaluation of blunt injury to a hollow viscus.

PENETRATING TRAUMA

Gunshot Wounds

Gunshot wounds to the abdomen generally necessitate exploratory laparotomy, given the high incidence of intra-abdominal injury. The exception to this rule is the case of a tangential wound that is believed to be traversing the soft tissues of the abdominal wall without entering the peritoneal cavity. In this scenario, we usually perform laparoscopy to look for peritoneal penetration. If the peritoneum has been violated, a laparotomy is done to permit systematic evaluation of the peritoneal cavity. If the peritoneum has not been violated, the operation may be terminated and the patient discharged after recovery from anesthesia, provided that there are no other extra-abdominal injuries necessitating hospital admission.

Stab Wounds

Stab wounds to the abdomen are associated with a lower incidence of intra-abdominal injury than gunshot wounds are. Accordingly, there has been a shift toward selective management algorithms that rely on diagnostic tests, serial abdominal examination, or some combination of the two. When the peritoneum has obviously been penetrated (as with omental or bowel evisceration), we perform a laparotomy to evaluate the entire peritoneal cavity for organ injury. When it is unclear whether the peritoneum has been penetrated, we proceed with a definitive evaluation to rule out peritoneal violation. Anterior wounds (i.e., those anterior to the midaxillary line) are evaluated for fascial penetration by means of local wound exploration. In the emergency department (ED), with sterile technique and local anesthesia, the wound is sharply extended to allow retraction of the subcutaneous tissue and visualization of the anterior fascia. If fascial penetration is evident, laparoscopy is performed in the operating room to look for peritoneal penetration; if peritoneal penetration is confirmed, a laparotomy is then done. In cooperative patients who have no history of abdominal surgery, it is often possible to perform diagnostic laparoscopy with local anesthesia in the ED by establishing pneumoperitoneum through a 5 mm trocar (e.g., Optiview; Ethicon Endo-Surgery, Cincinnati, Ohio) and maintaining a relatively low (7 mm Hg) intra-abdominal pressure to allow visualization of the peritoneum while maintaining patient comfort.

Several centers have reported favorable experiences with expectant management of anterior stab wounds. Patients without evidence of peritonitis are admitted and monitored with serial physical examinations. As noted (see above), we prefer to determine the presence of peritoneal penetration at the time of presentation. The rationale for this approach is to avoid any delay in diagnosis of hollow viscus injury and to allow early discharge of patients without peritoneal violation. Various centers have described both DPL and CT criteria for excluding peritoneal penetration. Wounds to the lower back or the flank (posterior to the midaxillary line), which carry a lower risk of intra-abdominal injury, are evaluated with CT, augmented by intravenous, oral, and rectal contrast studies. CT scanning has proved to be a reliable means not only of identifying posterior intraperitoneal violation but also of evaluating injury to retroperitoneal structures.

Operative Management of Injuries at Specific Sites

When hollow viscus injury is suspected, antibiotics with broad-spectrum aerobic and anaerobic coverage should be administered before the skin incision. If injury is confirmed, the antibiotics should be continued for a 24-hour period. The EAST Practice Management Guidelines Workgroup has reviewed the available evidence regarding perioperative antibiotic use in the trauma setting. Data from prospective studies clearly indicate that prolonging antibiotic administration beyond 24 hours provides no additional protection against surgical site infection (SSI).

Abdominal exploration is generally performed through a midline incision that is sufficiently extensive to permit evaluation of the entire peritoneal cavity. Once initial control of any significant bleeding has been obtained, the next step is to control any contamination from spilled GI contents. Babcock clamps are useful for temporarily controlling contamination from bowel perforations without causing injury to the bowel wall. Inspection commences in a systematic fashion, with any holes in the bowel controlled as they are found. In the setting of penetrating injury, when an odd number of hollow viscus perforations are encountered, a diligent search for an additional perforation is essential. An odd number of perforations implies that one of the wounds is tangential (or that the projectile is intraluminal); this is a diagnosis of exclusion.
INJURIES TO THE STOMACH

Intraoperative evaluation of the stomach begins with full visualization of the anterior gastric surface from the pylorus to the esophagogastric junction. Proximal exposure is facilitated by incising the triangular ligament and retracting the left lateral section of the liver to the patient’s right. The posterior aspect of the stomach is assessed by opening the gastrocolic ligament, which provides access to the lesser sac. Care must be taken to avoid injuring the vascular arcade of the greater curvature. While the stomach is elevated superiorly, the transverse colon is retracted inferiorly to expose the posterior gastric wall. Frequently, light adhesions between the posterior gastric wall and the retroperitoneum overlying the pancreas must be freed to provide full exposure. Alternatively, the greater omentum may be detached from its avascular attachment to the transverse colon to afford access to the lesser sac. Care must be taken to avoid placing excess tension on the greater curvature of the stomach and the short gastric vessels so as not to cause iatrogenic injury to the spleen. The greater and lesser curvatures should be closely inspected because the omental attachments may obscure an underlying gastric wound. Such inspection is particularly important in the setting of a small-caliber missile wound: the perforation can be remarkably small, and the serosal tissue damage in such cases is often subtle.

Treatment of a gastric injury is dictated by its severity [see Figure 2], which is classified according to the grading system developed by the American Association for the Surgery of Trauma (AAST) [see Table 2]. Intramural hematomas (grade I) are managed by means of unroofing and evacuation, followed by seromuscular closure with interrupted sutures. The great majority of gastric perforations are amenable to primary repair (grades II and III). In view of the propensity of the richly vascularized gastric wall to bleed at the site of injury, a two-layer technique is recommended to achieve adequate hemostasis. When the wound involves the pylorus, conversion to pyloroplasty to prevent stenosis is often beneficial. Suture repair of wounds at the cardioesophageal junction is reinforced by gastric fundoplication.

Some extensive wounds are not amenable to primary repair (grades IV and V). Such injuries include significant tissue loss or gastric devascularization and often are associated with major vascular injury as a consequence of the proximity of the major vessels and the force necessary to cause such a significant injury. Patients with grade IV or V injuries often do not survive long enough to undergo laparotomy, and consequently, these extensive gastric wounds are rarely encountered. Grade IV injuries can usually be managed by means of a partial gastrectomy. Restoration of gastric outflow is accomplished with either a gastroduodenostomy or a gastrojejunostomy; the choice is dictated by the extent of the resection and the presence or absence of an associated duodenal or pancreatic injury. In the exceedingly rare event of complete gastric devascularization or destruction, a total gastrectomy is required; we have yet to encounter such a situation. Occasionally, reconstruction of intestinal continuity after resection should not be performed at the initial operation. Such a damage-control approach is indicated in the presence of the triad of acidosis, hypothermia, and coagulopathy.

In fasting patients, the stomach harbors low numbers of bacteria because of its low pH. In trauma victims, however, who, it seems, often arrive with full stomachs, a more neutral pH and a higher bacterial count can be expected. If a gastric perforation with significant contamination is encountered, secondary or delayed primary skin closure should be performed in view of the increased risk of SSI; this is particularly true when significant hemorrhage or associated injury is present, in which case the rate of intra-abdominal abscess formation may be as high as 24%.13

INJURIES TO THE SMALL INTESTINE

Injury to the small intestine is evaluated intraoperatively by “running the bowel”: the small bowel and its mesentery are inspected in a systematic and comprehensive fashion from the ligament of Treitz caudad to the ileocecal valve. As active mesenteric bleeding is encountered, it is controlled by isolation and individual ligation of the bleeding vessels rather than by mass ligation of the mesentery, which may produce ischemia. Likewise, as bowel perforations are found, temporary control measures are rapidly initiated in an effort to prevent excessive or ongoing soilage. Once all bowel injuries are accounted for, the decision must be made...
whether to perform primary repair, resection of the injured segment, or some combination of the two. Primary repair of multiple injuries preserves bowel length and is generally preferred. At the discretion of the operating surgeon, resection of a segment containing multiple injuries may be performed to expedite the operation, provided that the amount of bowel to be resected is small enough that its loss would have only a negligible effect on digestive function.

Management of each individual wound is determined by its severity according to the AAST grading system [see Figure 3 and Table 2]. Small partial-thickness injuries (grade I) are managed by reapproximating the seromuscular layers with interrupted sutures. Small full-thickness wounds (grade II) are repaired with limited debridement and closure. Closure is performed in either one or two layers (we prefer a single-layer closure), and transverse closure is preferred to avoid luminal narrowing. Larger full-thickness wounds (grade III) may be repaired primarily if luminal narrowing can be avoided; otherwise, resection and anastomosis should be performed. Extensive wounds and wounds associated with devascularization (grades IV and V) are treated with resection and anastomosis. When mesenteric injury is encountered in the absence of bowel injury, the associated bowel must be closely assessed for evidence of vascular compromise. If the bowel appears viable, the rent in the mesentery should be reapproximated after bleeding is controlled to prevent an internal hernia. If there is evidence of vascular compromise, bowel resection and anastomosis are indicated.

Determination of intestinal viability begins with assessment of the bowel’s appearance. Adjunctive measures, such as the use of a handheld Doppler device or fluorescein infusion with Wood lamp illumination, may facilitate assessment of perfusion in segments where viability is questionable. We generally prefer to use a handheld Doppler device because it is easy to use and is available at short notice in the OR. A probe applied directly to the antimesenteric side of the bowel wall effectively detects the presence of arterial flow, which reliably demonstrates viability.

Small bowel anastomoses are usually handsewn in one or two layers, though stapling devices may also be employed [see 5:29 Intestinal Anastomosis]. The choice of technique depends largely on surgeon preference. One multicenter retrospective study suggested that in the setting of trauma, stapled anastomoses had a higher complication rate than sutured anastomoses did14: overall, 13% of stapled anastomoses were associated with an intra-abdominal postoperative complication, compared with 5% of sutured anastomoses. Because this study did not separate small intestinal anastomoses from colonic anastomoses, it is unclear to what extent the results apply specifically to small bowel anastomoses. It is likely, however, that bowel edema contributes to staple line failure. If bowel edema is evident or anticipated, it may be prudent to perform a sutured anastomosis.

### Table 2: AAST Organ Injury Scales for Stomach, Small Intestine, Colon, and Rectum

<table>
<thead>
<tr>
<th>Injured Structure</th>
<th>AAST Grade*</th>
<th>Characteristics of Injury</th>
<th>AIS-90 Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stomach</td>
<td>I</td>
<td>Intramural hematoma &lt; 3 cm; partial-thickness laceration</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>Intramural hematoma ≥ 3 cm; small (&lt; 3 cm) laceration</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>Large (&gt; 3 cm) laceration</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>Large laceration involving vessels on greater or lesser curvature</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>Extensive (&gt; 50%) rupture; stomach devascularized</td>
<td>4</td>
</tr>
<tr>
<td>Small bowel</td>
<td>I</td>
<td>Contusion or hematoma without devascularization; partial-thickness laceration</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>Small (&lt; 50% of circumference) laceration</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>Large (≥ 50% of circumference) laceration without transection</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>Transsection</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>Transsection with segmental tissue loss; devascularized segment</td>
<td>4</td>
</tr>
<tr>
<td>Colon</td>
<td>I</td>
<td>Contusion or hematoma; partial-thickness laceration</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>Small (&lt; 50% of circumference) laceration</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>Large (≥ 50% of circumference) laceration</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>Transsection</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>Transsection with tissue loss; devascularized segment</td>
<td>4</td>
</tr>
<tr>
<td>Rectosigmoid and rectum</td>
<td>I</td>
<td>Contusion or hematoma; partial-thickness laceration</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>Small (&lt; 50% of circumference) laceration</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>Large (≥ 50% of circumference) laceration</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>Full-thickness laceration with perineal extension</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>Devascularized segment</td>
<td>5</td>
</tr>
</tbody>
</table>

*Advance one grade for multiple injuries, up to grade III.

AIS-90—Abbreviated Injury Score, 1990 version
AAST—American Association for the Surgery of Trauma
TRAUMA AND THERMAL INJURY

INJURIES TO THE COLON

In World War II, colostomy was mandatory for penetrating colon trauma because of the significant morbidity associated with anastomotic suture line dehiscence. In the ensuing years, experience with primary repair of penetrating colonic injuries in civilian settings suggested that primary repair could be performed safely and perhaps, in select cases, with less morbidity than colostomy. This suggestion was confirmed in the late 1970s by a randomized, prospective study that demonstrated significantly lower rates of intra-abdominal infection in patients treated with primary repair than in those treated with colostomy. In that early trial, high-risk patients (i.e., those with shock, hemorrhage, associated injuries, delayed presentation, significant peritoneal soilage, destructive wounds of the colon, or loss of abdominal wall integrity) were excluded from randomization and treated with colostomy. Currently, there is less concern for such risk factors, and primary repair is gaining wider acceptance.

To direct management decisions, it is helpful to categorize penetrating colonic injuries as either nondestructive or destructive [see Figure 4]. Although blunt colonic injuries are considerably less common, we manage them in a similar fashion.

Nondestructive colonic injuries are defined as wounds that involve less than 50% of the bowel wall without devascularization. Such wounds account for approximately 80% of colon wounds and are amenable to primary suture repair with limited amounts of debridement. Sufficient data have been accumulated over the past 30 years to support primary repair as standard treatment for nondestructive colon wounds in the absence of peritonitis, regardless of associated injuries or comorbid conditions. Evaluation of the available prospective and retrospective data indicates that the suture line failure rate for primary repair is approximately 1%, which is less than the rate generally reported for elective colon and rectal surgery. Mortality associated with suture line failure in this setting is uncommon. The favorable morbidity and mortality profiles, along with the inherent benefits of avoiding colostomy, support primary repair as standard therapy for nondestructive wounds. Partial-thickness lacerations (grade I) are repaired with inverting seromuscular sutures. Full-thickness lacerations (grade II) may be closed in one or two layers.

Destructive colonic injuries are defined as wounds that completely transect the colon (grade IV) or involve tissue loss and devascularized segments (grade V). Optimal management of such wounds is less certain than optimal management of nondestructive wounds. Data from randomized and prospective trials demonstrate that resection and primary anastomosis can be performed safely. It should be kept in mind, however, that these results are derived from a relatively small number of reported cases. The retrospective data indicate a higher incidence of suture line failure and a significant incidence of associated mortality, suggesting that resection and primary anastomosis may not be the optimal treatment for all colonic wounds.

A 1994 report from our institution (University of Tennessee) concluded that patients with destructive colonic injuries who had comorbid medical conditions or transfusion requirements greater...
Osteomyelitis. Delayed primary or secondary skin closure is of these retained missiles result in soft tissue infection or removed when it is technically feasible to do so. Approximately 10% or rectum may act as nidi for abscess formation and should be removed when it is technically feasible to do so.

Retained bullets or other projectiles that have penetrated the colon injury should be considered at the time of initial laparotomy. Between 50% and 75% of destructive wounds do not have risk factors that prompt diversion. Thus, the overall diversion rate ranges from 5% to 10%. In our experience over the past several years, 90% to 95% of all colon wounds have been managed using results in a large deserosalization injury to the cecum and ascending colon or to the sigmoid colon. In such cases, the serosa may be reapproximated with interrupted silk sutures in anaccord-type fashion, provided that the lumen is not significantly compromised by the imbrication of the submucosa. It is likely that subclinical luminal narrowing occurs frequently after such repairs, of which we rarely see sequelae. If significant luminal narrowing is anticipated or the serosal disruption is extensive enough to preclude reapproximation, resection of the injured segment with primary anastomosis is indicated.

Figure 5 Algorithm outlines the treatment of rectosigmoid or rectal injury.

than 6 units of blood were at significantly higher risk for suture line breakdown when the wounds were managed with resection and primary anastomosis. Other reported risk factors that may direct the surgeon toward fecal diversion include a Penetrating Abdominal Trauma Index (PATI) score greater than 25, shock, and a delayed operation. It is our practice to manage these patients as high-risk patients and perform fecal diversion. Diversion may be accomplished by means of either loop colostomy (with an open or closed distal stoma) or end colostomy (with a mucous fistula or closure of the rectal stump) [see Figure 6]. The diversion technique is dictated both by surgeon preference and by the nature of the colonic injury. In most civilian clinical practices, destructive wounds account for approximately 20% of all colon wounds encountered. Between 50% and 75% of destructive wounds do not have risk factors that prompt diversion. Thus, the overall diversion rate ranges from 5% to 10%. In our experience over the past several years, 90% to 95% of all colon wounds have been managed with primary repair or resection and anastomosis.

The potential risk of postoperative SSI associated with colonic injury should be considered at the time of initial laparotomy. Retained bullets or other projectiles that have penetrated the colon or rectum may act as nidi for abscess formation and should be removed when it is technically feasible to do so. Approximately 10% of these retained missiles result in soft tissue infection or osteomyelitis. Delayed primary or secondary skin closure is recommended.

If colostomy is performed, it will eventually have to be closed in most cases. The mortality associated with colostomy closure is low, but the reported morbidity has varied considerably, ranging from 5% to 25% in single-institution studies. We typically perform closure 2 to 3 months after hospital discharge to allow time for the resolution of the dense inflammatory adhesions that may form after laparotomy. Before closure, a contrast enema is obtained to confirm that no distal strictures or fistulas are present. Some surgeons maintain that early closure (within 2 weeks) is as safe as the traditional late closure (3 months), with a shorter operating time and less intraoperative blood loss, and suggest that it may also allow colostomy closure during the patient’s initial hospitalization. To date, however, this practice has not garnered wide enthusiasm.

Occasionally, blunt abdominal trauma associated with lap-belt use results in a large deserosalization injury to the cecum and ascending colon or to the sigmoid colon. In such cases, the serosa may be reapproximated with interrupted silk sutures in an accord-type fashion, provided that the lumen is not significantly compromised by the imbrication of the submucosa. It is likely that subclinical luminal narrowing occurs frequently after such repairs, of which we rarely see sequelae. If significant luminal narrowing is anticipated or the serosal disruption is extensive enough to preclude reapproximation, resection of the injured segment with primary anastomosis is indicated.

Injuries to the Rectum

Recognition of rectal injuries requires diagnostic vigilance. All patients with a penetrating wound to the pelvis, perineum, buttock, or upper thigh should be evaluated for rectal injury. Digital examination for the presence of rectal blood is mandatory, but the absence of blood does not definitively rule out injury. Rigid proctoscopy should be performed whenever there is any suspicion of rectal injury.

It is our practice to classify rectal injuries according to anatomic criteria, which then dictate management [see Figure 5]. The anterior and lateral sidewalls of the upper two thirds of the rectum are serosalized; injuries in this region are classified as intraperitoneal and are managed in the same manner as colonic injuries [see Figure 4]. The upper two thirds of the rectum posteriorly and the lower one third of the rectum circumferentially are not serosalized; injuries in these regions are classified as extraperitoneal.

Extraperitoneal wounds in the upper two thirds are usually amenable to exploration and suture repair. Fecal diversion is also performed as an adjunctive measure and may be accomplished with either loop or end colostomy [see 5:30 Intestinal Stomas]. In select cases in which the wound is primarily intraperitoneal with minimal extraperitoneal involvement, diversion may be omitted.

Extraperitoneal wounds to the lower third of the rectum are usually explored and repaired, provided that the wound is easily accessible without risk to the associated neurovascular and genitourinary structures. Fecal diversion is recommended. Wounds that are difficult to reach are not explored and instead are managed with proximal fecal diversion and presacral drainage. Presacral drainage is performed with the patient in the lithotomy position.
A curvilinear incision is made in the skin between the coccyx and the anus, and blunt dissection is employed to gain entry into the presacral space. Generally, we place one or two Penrose drains into this space and gradually withdraw them between postoperative days 5 and 7.

Whether presacral drainage is necessary is controversial. There is published prospective evidence to suggest that presacral drainage does not lessen morbidity; however, this study did not make a distinction between accessible and inaccessible extraperitoneal wounds. Our view is that for inaccessible extraperitoneal wounds, presacral drainage is required to prevent retroperitoneal abscess formation, which results from fecal contamination of a relatively closed space and can produce significant morbidity in the form of retroperitoneal infection that may also track downward into the thighs. Accessible extraperitoneal wounds that are explored and repaired become effectively intraperitonealized; thus, presacral drainage is not required for these injuries.

As emphasized (see above), a tangential gunshot wound is a diagnosis of exclusion. This point is of particular importance when the wound involves the rectum, because mobilization and visualization may be limited by a narrow pelvis, a fat-laden mesorectum, and, in many cases, a patient who is unstable as a result of associated injuries. Although a solitary proximal rectal gunshot wound may truly be tangential (or the projectile may be intraluminal), an associated distal extraperitoneal wound is often present. After primary repair of the proximal wound, fecal diversion and presacral drainage should be performed, as with inaccessible extraperitoneal rectal injuries.

Distal rectal washout was initially advocated on the basis of experience gained during the Vietnam War. In the majority of civilian studies since then, however, distal rectal washout has had no significant effect on morbidity. It may be useful in cases of severe wound contamination or fecal impaction, but in general, it does not seem to be an important adjunct to the management of rectal injuries. Typically, distal rectal washout involves lavage of the rectum distal to the injury with 3 to 6 L of irrigant via an irrigation tube placed into the distal limb of a loop colostomy. The irrigant may be normal saline, a genitourinary irrigant, or an antiseptic solution. Digital rectal dilatation is performed to facilitate drainage of the irrigant. Care should be taken to protect the midline wound with a polyethylene or similar barrier to reduce the risk of wound contamination during the washout.

Figure 6  Presacral drainage is provided through a curved incision midway between the anus and the tip of the coccyx. With blunt dissection, two fingers are inserted between the rectum and the hollow of the sacrum. Penrose drains are inserted and sutured to the skin.
References


Acknowledgment

Figure 6 Susan Brust, C.M.I.