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Blunt Abdominal Trauma

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Pearls and Pitfalls

- Patients suffering a high-energy trauma have solid viscera rupture in the abdomen and/or aortic rupture in the thorax until proven otherwise.
- Initial abdominal examination is inaccurate for detecting visceral injury, and especially so if the patient is in an altered mental state (alcohol, drugs, closed head trauma), pregnant, or paralyzed.
- Significant blunt abdominal trauma alone represents an indication for abdominal imaging.
- Fracture of the lower ribs (“abdominal ribs”) should raise a very high suspicion of intraabdominal injury.
- Do not forget the possibility of hollow organ injury, especially with deceleration forces or a potential seat belt injury.
- An “elevated” left hemidiaphragm or a left “hydro/hemothorax” must raise the possibility of diaphragmatic rupture.
- The ultrasonographic focused abdominal sonography for trauma (FAST) exam has replaced virtually the diagnostic peritoneal lavage because of its ease, speed, sensitivity, and ability to be repeated easily.
- Computed tomography (CT) is a reliable imaging modality for solid organ and pelvic injury but requires a patient with stable vital signs.
• Diagnostic peritoneal lavage (DPL) has essentially been replaced by the FAST, but DPL has some use when other tests are equivocal or when hollow organ injury is suspected.

General Considerations

Blunt abdominal trauma can be produced not only by direct contusion to the abdomen but also by deceleration injury or falls. Serious, devastating intra-abdominal injuries may be present despite the absence of external signs of trauma. This understanding underscores the importance of a complete evaluation in patients suffering high-energy trauma (Table 2.1), including a thorough physical examination, the judicious use of diagnostic modalities, and careful follow-up. The physical examination is a crucial part of the initial evaluation; however, signs of clinically important blunt abdominal trauma are not reliable in severe trauma. Physical examination alone has a sensitivity of only ~35%, positive predictive value of 30–50%, and a negative predictive value of about 60%. If the Glasgow Coma Score is less than 7, the sensitivity of the physical examination is only 20%. Other circumstances in which the physical examination is unreliable include alcohol or drug intoxication, spinal cord injury, pregnancy, and multiple extra-abdominal injuries (Table 2.2). Therefore, further investigation of the patient subjected to forces sufficient to have caused injury are necessary beyond just the physical examination,

<table>
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<tr>
<th>Table 2.1. High-energy trauma.</th>
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<tr>
<td>Fall from higher than 10 ft</td>
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<tr>
<td>Ejection from a vehicle</td>
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<td>Motor vehicle crash at speeds exceeding 45 miles/h</td>
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<td>Motorbike accident</td>
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<td>Major fracture</td>
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<td>First rib fracture</td>
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<td>Lower costal rib fracture</td>
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<td>Seat belt restraint mark</td>
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Blunt Abdominal Trauma and the traumatologist must maintain a high index of suspicion of underlying intra-abdominal and intrathoracic injury. In patients with lower rib fractures, called the “abdominal ribs,” solid organ trauma should be suspected until proven otherwise. Splenic and/or hepatic injury is identified in 10–20%. As many as 40% of patients with hemoperitoneum show no findings on initial physical examination. For these reasons, the physical examination must be repeated serially by the same examiner, and consideration always given to diagnostic imaging (Fig. 2.1).

**Table 2.2. Unreliable physical examination.**

- Alcohol or drug intoxication
- Spinal cord injury
- Pregnancy
- Glasgow coma score <10
- Multiple extra-abdominal injuries

**Figure 2.1.** Mesenteric rupture due to a blunt abdominal trauma with subtle signs. The bowel was ischemic and had to be resected.

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The most frequently injured organ as a result of blunt abdominal trauma is the spleen (40–55%), followed by the liver (35–40%). Although the hollow organs are injured less frequently (15%), delay in diagnosis results in high rates of morbidity and mortality with these injuries. The added difficulty in diagnosis of hollow organ injury on physical examination alone adds further complexity to management (Fig. 2.2).

**Diagnostic Procedures**

Defining the extent of injury after blunt abdominal trauma can be difficult even for an experienced surgeon without the aid of diagnostic procedures. In most cases, significant blunt abdominal trauma alone is an indication for a more thorough evaluation, including at least some imaging modality.
Radiography

Chest x-ray must be a standard part of the initial evaluation of patients sustaining potential blunt abdominal trauma. Concomitant thoracic visceral injuries may occur and must be considered as well. Signs of abdominal visceral or diaphragm rupture are rarely seen on x-ray, but an elevated hemidiaphragm, an air/fluid level in the chest, or other findings suggesting the presence of intra-abdominal viscera in the chest require investigation or celiotomy. Although a rare finding, pneumoperitoneum may indicate hollow viscus injury warranting laparotomy. Just as with the physical examination, the abdominal x-ray can be unreliable in underlying intra-abdominal injury. Nevertheless, review of the abdominal part of a pelvic x-ray screening for pelvic fracture is of potential use, especially in the patient who is unreliable.

Ultrasonography

In 1992, Tso and colleagues evaluated the use of ultrasonography (US) in 63 patients with blunt abdominal trauma. This preliminary study demonstrated a sensitivity of 69%, specificity of 99%, and accuracy rate of 96%, similar to CT and diagnostic peritoneal lavage (DPL) at the same institution. Rozycki and colleagues reported their outcomes subsequently and coined the term focused abdominal sonography for trauma (FAST) in 1,540 patients (1,227 with blunt injuries and 313 with penetrating injuries). With an overall sensitivity of 84% and a specificity of 99%, US was most sensitive and specific for the evaluation of hypotensive patients with blunt abdominal trauma (sensitivity 100%, specificity 100%).

US has become the surgeon’s and traumatologist’s “stethoscope” for patients with abdominal trauma. The advantages of this technique are that it is relatively easy to learn, cost-effective, noninvasive, takes only a few minutes, has no radiation, can be repeated as many times as needed, and can be performed simultaneously with the resuscitation effort.
The goal of the FAST exam is to detect fluid in easily accessible areas: precordial (intrapericardial), Morrison’s pouch, left upper quadrant pouch of Douglas, and the pelvis. The estimated number of examinations that a non-radiologist must perform to acquire acceptable accuracy ranges from 100 to 400 US exams. FAST can detect a volume of fluid as low as 200 ml; however, injuries not resulting in hemoperitoneum or hollow visceral injury without extravasation of enough enteric content may be missed. There are notable limitations of the FAST exam which include: operator dependency, increased difficulty in the obese or distended patient, the patient with ascites or subcutaneous emphysema, and poor ability to recognize solid parenchymal or hollow visceral injuries without substantial extravasation of enteric content. One major advantage is that the FAST exam can be repeated serially and when clinical status changes. In the absence of clinical instability, a negative FAST can allow ongoing evaluation and treatment of extra-abdominal injuries (Fig. 2.3).

Figure 2.3. Algorithm for management according to the focused abdominal sonography for trauma (FAST) and computed tomography (CT) exam.
Computed Tomography

CT allows a complete and noninvasive assessment of the abdominal and pelvic cavities, retroperitoneal structures, soft tissues, and bones. CT is especially reliable for assessment of the liver and the spleen. In the kidney, CT allows assessment of not only the anatomy but the function as well. The accuracy in stable patients with blunt abdominal trauma is excellent, with a reported sensitivity and specificity approaching 98%. The negative predictive value is 99%, and thus a negative CT excludes very reliably the need for an immediate laparotomy in the vast majority of patients. For these reasons, CT has become the favored diagnostic procedure in blunt trauma, and should be obtained in most patients, provided they are hemodynamically stable.

CT is particularly useful when the physical examination is unreliable or equivocal or when nonoperative management is considered in the setting of stable patients with a positive DPL or FAST exam. Several additional advantages of CT are that it is noninvasive, can define the location and extent of solid organ or retroperitoneal injuries, can detect ongoing bleeding when intravenous (IV) contrast is used, and does not require hemoperitoneum, as do DPL and FAST exams. Unless contraindicated, IV contrast agent should be used when CT is obtained for evaluation of blunt abdominal trauma to examine renal function as to get a better definition of solid parenchymal injury, blood flow, and extravasation. Detection of hollow visceral injuries is less accurate and less reliable, even with quality contrast-enhanced CT. Nevertheless, certain findings on CT may suggest strongly the presence of an underlying injury to hollow viscera or to the mesentery; these CT findings include pneumoperitoneum, leak of the contrast agent into the peritoneal cavity, thickening of bowel wall or the mesentery, and free fluid without solid visceral injury. If any of these signs are found or there is other suspicion of hollow viscus injury, either DPL or an emergent laparotomy should be performed.
Diagnostic Peritoneal Lavage

Prior to the advent of the FAST exam, DPL had become the gold standard for blunt abdominal trauma. Only 30 ml of blood can produce a microscopically positive test. DPL is very sensitive (sometimes possibly too sensitive) and thus not specific. When negative, clinically important intra-abdominal bleeding is highly unlikely. In contrast, DPL is oversensitive in that not all patients with a positive DPL have a serious enough injury to warrant operative intervention. Additional limitations of DPL include the inability to detect retroperitoneal injury or solid organ injury in the absence of hemoperitoneum, and it is contraindicated in advanced pregnancy or with a history of multiple previous laparotomies; a pelvic fracture can produce a false-positive exam in the absence of solid or hollow visceral injury. The indications for DPL are similar to those for CT. Currently, with the FAST exam, DPL is used only rarely unless FAST is either unavailable or equivocal or when CT is contraindicated.

Prior to performing a DPL, a nasogastric (NG) tube and urinary catheter must be inserted. The technique may be performed open or with a needle and wire passed into the intraperitoneal cavity using the Seldinger technique. Under local anesthesia, an incision midline below the umbilicus incision is performed. When a pelvic trauma is suspected or confirmed, the incision should be made above the umbilicus in order to avoid entering a potential pelvic hematoma. Once the skin and the fascia are incised, the wire and catheter are inserted, removing this wire as the peritoneum is penetrated, and the catheter is advanced toward the pelvis. If the technique is open, the peritoneum should be incised under direct visualization. After the catheter is inserted, aspiration with a 20 ml syringe is performed. If more than 10 ml of gross blood is obtained, the test is considered positive and terminated. Otherwise, 1,000 ml of 0.9% normal saline is instilled into the peritoneal cavity, the patient is turned gently from side to side if possible, and the fluid is drained by gravity. The DPL is considered positive when the return fluid is grossly bloody or evidence of enteric content is seen. If the
fluid is pink or clear, a sample is sent to the laboratory for quantitative determination of red and white blood cells or signs; the criteria are outlined in Table 2.3.

**Initial Management**

For practical purposes, we classify trauma patients according to hemodynamic status as moribund (agonal), unstable, or stable.

*Moribund or Agonal Patients*

Moribund patients are those with no spontaneous ventilatory effort, no femoral pulse, and no response to painful stimuli. These patients require an emergent airway and strong consideration of immediate operative intervention for suspected hemorrhage. Accordingly, after assuring airway and breathing (the A and B of the ABCs of resuscitation), a laparotomy and/or a thoracotomy must be considered. Whether a resuscitative thoracotomy prior to laparotomy improves the survival rate of these patients is controversial. Some authors have recommended clamping of the thoracic aortic, even in the emergency room setting, prior to laparotomy (in the operating room) in patients with refractory hypotension and abdominal distension secondary to massive hemoperitoneum. The rationale for this approach is to increase upper torso and intracranial blood

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<td><strong>Positive</strong></td>
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<td><strong>Intermediate</strong></td>
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pressure immediately and to prevent cardiac arrest after release of abdominal wall tamponade during celiotomy. The mortality in this setting is exceedingly high, with very few survivors; many traumatologists do not believe in this approach. The patients are taken to an operating room immediately, placed supine, and the abdomen explored with other minimal maneuvers. During abdominal exploration, the finding of significant or ongoing intra-abdominal hemorrhage may require cross-clamping the aorta at the diaphragmatic hiatus if there had been no thoracotomy. The surgeon must pack and compress the bleeding area(s) and seek more stable conditions by infusing a large amount of IV fluid and blood. Most of these patients require a shortened procedure (so-called damage control) with transfer to a surgical critical care unit for stabilization and later definitive repair of the intraperitoneal injury if they survive.

**Unstable Patients**

Patients are considered unstable when any vital sign, such as pulse, ventilatory rate, or blood pressure, is significantly abnormal. The instability is produced by either respiratory compromise or hypovolemia, so the initial approach (the ABCs) must include the establishment of the airway, ventilation, and circulation with immediate control of any external bleeding and IV access. After the management of airway and breathing, the next step is fluid resuscitation with a warm, balanced salt solution. The authors start with a bolus of 1,500 ml in patients of 140 lb (70 kg) of weight. If a patient recovers skin color and the vital signs normalize, additional IV fluid is infused at a lower rate, according to the response in the pulse rate and amplitude and urine output. If stability is achieved, patients are managed according to the algorithm for stable patients. In contrast, if the vital signs do not recover or improve only temporarily with fluid resuscitation and blood transfusion, then ongoing hemorrhage should be suspected, and operative intervention may be indicated.
**Stable Patients**

Patients are judged to be stable when their vital signs are normal initially or when the vital signs return to normal after the initial IV bolus. A more detailed clinical history must then be obtained. Careful evaluation is necessary to define the extent of injury. The decision for continued observation or intervention is based on the mechanism of injury and findings on evaluation. The decision to treat by observation requires careful and repeated assessment. As the physical examination may not be reliable in a number of cases, serial examination will be crucial in decision making.

**Subsequent Management after Initial Evaluation**

The majority of patients with blunt abdominal trauma arrive with no clinical signs of abdominal trauma with the exception of pain and possibly abdominal wall ecchymosis. Management depends largely on the stability of the patient and findings of diagnostic procedures.

In the group of stable patients, several situations require special mention. Patients who appear stable but have risk factors for potential serious injury mandate particularly careful observation, because delayed clinical deterioration may occur (Table 2.1). Those who fell from more than 10 ft, were ejected from a vehicle, were involved in a motor vehicle crash of more than 45 miles/h, or were in a motorbike accident must be considered high-energy trauma. Subtle signs such as fracture of the first rib, abdominal wall ecchymosis from the seat belt ("seat belt sign"), or major fractures of long bones or pelvis also imply high-energy trauma and warrant close observation. Fractures of the lower "abdominal" ribs should suggest possible abdominal solid organ injury. In patients with a closed head injury, intoxication, drug abuse, or those who require neurosurgery or orthopedic surgery where the physical examination will be unreliable
for several hours because of the anesthetic, some objective evaluation of the abdomen is necessary, such as a FAST exam, CT, or DPL. As noted previously, the FAST exam has become one of the most important tests in diagnosis of severe blunt abdominal trauma. When the first view is negative, if there are any doubts, the FAST can be repeated on multiple occasions.

A major advance in the last two decades has been the use of primary nonoperative management for solid viscera injury, as guided by initial imaging and clinical response. Good evidence suggests that nonoperative management in both children and adults is safe, and the results are better than with a laparotomy in selected cases. Appropriate candidates for nonoperative management are those without active bleeding from solid viscera injury without evidence of hollow viscus or mesenteric injury. Observation requires hemodynamically stable patients in whom ongoing evaluation and observation can be performed. Quality CT imaging, a monitored environment, and access to emergent intervention are required (Table 2.4).

In selected patients with isolated solid viscera injury in whom contrast extravasation is seen either during the arterial or venous phase of the CT, a transcatheter arterial embolization may be considered. In contrast, nonoperative management should be abandoned in adults when hemodynamic status cannot be maintained after two units of packed red cells during the initial management or four units in the first 48 h, or if the embolization does not stop the extravasation at angiography.

<table>
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<th>Table 2.4. Requirements for non-operative management.</th>
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<tr>
<td>Hemodynamically stable</td>
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<td>Absence of peritonitis</td>
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<td>Contrast-enhanced CT without evidence of active bleeding</td>
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<td>Monitoring in an intensive care unit</td>
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<td>Staff available for repeated observation</td>
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<td>Operation room available 24 h</td>
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The success rate of nonoperative management is high for isolated hepatic injury, but is less in splenic and especially renal injury, and is dependent on the extent of parenchymal injury (e.g., grade of liver and splenic injury). Risk factors for failure of nonoperative management includes the need for transfusion and free fluid over 300 ml in the abdominal cavity.

**Selected Readings**


