Blunt Abdominal Trauma

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Blunt trauma leads to injury when the elastic limit or breaking point of an organ is exceeded by the impact force applied. Impact force is defined by the amount of energy involved (e.g., the speed of a vehicle, the height of a fall), the location and surface of the blow to the body, and the duration of the impact. Understanding the mechanism of injury is imperative for assessing the initial risk and subsequent evaluation.

The risk for injury may vary slightly according to predisposing factors such as age and gender. Because men are more commonly engaged in dangerous activities, they are more frequently injured than women. A gravid uterus in a pregnant woman may offer some degree of protection to the intraperitoneal structures but adds the unique threat of placental abruption or uterine rupture.

A child’s abdomen is less well protected than an adult’s because of the thinner musculature, and it is far easier to injure abdominal organs such as the duodenum via compression against the posterior vertebrae. The elastic pediatric rib cage also provides less protection to the spleen and liver.

The risk for specific organ injury is linked to its structure and size. In particular, injuries to the spleen are far more common than injuries to other abdominal organs because of its poor elasticity. This is particularly true of abnormal spleens (e.g., patients with mononucleosis); such spleens are injured with far less force because of their larger size, which favors a greater mass effect, and because of their thinner capsule, which lacerates more easily. A spleen can be injured by a minor mechanism such as falling over a chair.

Blunt trauma can lead to injury to any abdominal structure. Direct, focused blows to the epigastrium may result in contusions and even perforation of the duodenum, as well as pancreatic injuries. Deceleration injuries may cause vascular sheering and subsequent thrombosis or tears of the renal artery (grade IV renal injury).
BOX 79.1 Management of Intraperitoneal Injuries

Intraperitoneal bleeding is an immediately life-threatening injury after blunt trauma, and management of intraperitoneal bleeding takes priority over injuries to other systems. Physical examination is unreliable in predicting the presence or absence of injury except for certain high-risk findings such as the seat belt and Kehr signs. Bedside ultrasonography is an excellent initial screening tool that facilitates early triage of patients to either laparotomy or the radiology suite for computed tomography (CT). CT is highly sensitive for detecting solid organ injuries but has lower sensitivity for detecting pancreatic, small bowel, and diaphragmatic injuries. Detailed CT allows grading of organ injuries and nonoperative management of solid organ trauma in stable patients and the use of angiographic embolization in patients with liver, spleen, and renal injuries.

ANATOMY

The abdominal compartment is bounded by the diaphragm, pelvis, and abdominal wall. The boundaries include the vertebral column and the muscles of the abdomen, the most important being the external oblique and rectus. The rib cage below the fourth intercostal space is considered part of the abdominal wall, and thus the abdominal compartment extends up into the chest.

The abdominal compartment is subdivided by the peritoneum into an anterior intraperitoneal cavity and the retroperitoneum. The lack of skeletal protection of the muscular anterior abdominal wall leads to a greater risk for injury to the intraperitoneal organs, notably the spleen, liver, and small bowel. Injured organs in the intraperitoneal cavity may bleed freely because of the substantial fluid capacity of this cavity, whereas brisk bleeding will be contained more by the limited space in the retroperitoneum.

PRESENTING SIGNS AND SYMPTOMS

Certain signs and symptoms suggest the presence of intraperitoneal injury. Blood pressure and heart rate are the most important vital signs when assessing for significant intraabdominal injury. Isolated prehospital hypotension has been shown to be a predictor of mortality and of chest or abdominal injury requiring operative intervention. Prehospital abnormal vital signs should not be discounted even if the patient arrives with “stable” vital signs. Normal vital signs do not rule out intraperitoneal injury.

Patients in shock usually demonstrate tachycardia. However, up to 44% of trauma patients in shock may have relative bradycardia, defined as a heart rate of less than 90 beats per minute and a systolic blood pressure lower than 90 mm Hg. Relative bradycardia has been identified as an independent risk factor for mortality. 5,6

Significant complaints and findings include abdominal pain or tenderness, ecchymoses and abrasions on the abdominal wall, and hematemesis. Increasing abdominal distention may be a marker of ongoing intraperitoneal bleeding. Peritonitis, even in the absence of hypotension, is a strong predictor of intraabdominal injury, although it does not necessarily predict the need for laparotomy in a stable patient.

Physical examination is limited in its ability to identify the presence or absence of intraabdominal injury. Therefore, further diagnostic testing should be performed, despite minimal clinical findings, if the abdomen sustained significant direct trauma such as a baseball bat or handlebar injury or if the patient is difficult to evaluate because of concomitant injuries or altered mental status for any reason. Other significant mechanisms, such as a rollover motor vehicle collision, a motor vehicle collision with ejection or significant intrusion, or a substantial fall, should be evaluated in light of the patient’s clinical picture. A motor vehicle collision with steering wheel deformity is associated with serious abdominal injury in front seat passengers but not in drivers; direct impact from a bicycle handlebar suggests an increased likelihood of abdominal injury requiring laparotomy. Intraperitoneal injury can also result from minor mechanisms, such as a fall from the standing position onto the abdomen.

Several insensitive clinical signs suggest specific injuries in a blunt trauma patient. The Kehr sign, which is left shoulder pain, suggests splenic rupture. The Cullen sign is ecchymosis around the umbilicus, and the Turner sign is ecchymosis in the flank area. These signs suggest retroperitoneal hemorrhage but are very rarely found in acute trauma patients. They occur only hours after injury and thus are of little use in the initial assessment of patients who have sustained blunt abdominal trauma.

The presence of the seat belt sign (erythema, ecchymosis, or abrasions in the pattern of a seat belt) is associated with intraperitoneal injuries—specifically, pancreatic, hollow viscus, and mesenteric injuries. Multiple studies have shown a significantly higher incidence of intraabdominal operative pathology in patients with the seat belt sign than in those lacking this sign after motor vehicle trauma. The seat belt sign usually results from incorrect use or improper placement of a seat belt restraint. It should be used as a predictor of intraperitoneal injury and therefore as an indication to perform diagnostic imaging in patients with blunt abdominal trauma. Negative findings on computed tomography (CT) in a patient with abdominal tenderness and the seat belt sign should be followed by observation, diagnostic peritoneal lavage (DPL), or laparotomy, depending on the findings and clinical suspicion. Although evisceration and clear-cut peritonitis are diagnostic of intraabdominal pathology, neither is a common finding.

Abdominal tenderness is often absent in patients with intraperitoneal injury. Drugs, alcohol, hypotension, and the presence of head injury reduce the patient’s ability to sense pain or tenderness. Additionally, other significant injuries such as fractures or large lacerations may distract the patient from feeling the pain associated with abdominal injury. In a large prospective study, 19% of patients with positive findings on CT for intraabdominal injury did not have abdominal tenderness. 7 Other studies have reported abdominal tenderness in only 42% to 75% of patients with small bowel or mesenteric injury. 8,9 The sensitivity, specificity, and negative and positive predictive values of abdominal pain or tenderness in predicting intraabdominal injury are reported to be 82%, 45%, 93%,
and 21%, respectively. Furthermore, patients with chest wall injuries and pneumothorax are at risk for injury and may not exhibit abdominal pain or tenderness. Thus, it is important to avoid relying solely on the physical examination, especially in a multitrauma patient or one with altered mental status, when deciding whether to perform diagnostic testing on a patient after blunt abdominal trauma.

**EVALUATION**

Physical examination of the abdomen following trauma consists of observation and palpation. The abdomen should be observed for signs of disruption, evisceration, ecchymoses, abrasions, and distention. Although it is important to perform a rectal examination to assess rectal tone and the prostate for possible urethral injury, a positive stool guaiac test is not predictive of injury. If gross blood is present on rectal examination, large bowel or rectal injury should be suspected.

**RED FLAGS**

- Prehospital hypotension indicates the need for diagnostic imaging of the abdomen.
- Abdominal ecchymosis is predictive of intraperitoneal injury.
- The presence of a Chance fracture is predictive of intraperitoneal injury.
- Left shoulder pain suggests splenic injury.
- Low rib fractures are associated with liver and spleen injuries.

The initial physical examination includes assessment of the pelvis for stability and the urethral meatus for blood as an indicator of associated urethral injury. These aspects of the examination will help the emergency physician (EP) plan the subsequent evaluation. Patients with pelvic instability may need stabilization of a pelvic fracture and embolization, whereas those with a urethral injury may need retrograde urethrography and suprapubic placement of a Foley catheter.

**DIFFERENTIAL DIAGNOSIS**

The specific injuries to be concerned with after blunt abdominal trauma can be broken down into several categories: solid organ (liver and spleen), hollow viscus, mesenteric, vascular (inferior vena cava and aorta), diaphragmatic, and retroperitoneal (renal, bladder, pelvic fractures, and vascular). Other less common injuries are gallbladder, pancreas, and rectus sheath hematomas.

**CHANCE FRACTURES**

A single lap belt restraint can result in Chance fractures of the lumbar spine. In a recent report, 33% of patients with Chance fractures had associated intraabdominal injury, and of these patients, 22% had hollow viscus injuries. In other studies, up to 89% of patients with Chance fractures had small bowel injuries. Some centers consider the presence of Chance fractures and the seat belt sign to be an indication for exploratory laparotomy.

**UPPER ABDOMINAL INJURIES**

Low rib injuries may be associated with spleen or liver trauma, as well as kidney injuries. The incidence of splenic injury in patients with “isolated” low rib pain or tenderness (no abdominal tenderness) was 3% in a recent report. Although the only prospective study on the subject is not definitive, it suggests that patients with pleuritic pain and isolated low left rib pain or tenderness, regardless of whether abdominal tenderness is present, should undergo imaging. In addition, patients with abdominal tenderness following low chest trauma should undergo diagnostic imaging (e.g., CT).

**LOWER ABDOMINAL INJURIES**

Blunt abdominal trauma may result in retroperitoneal injury to the kidneys or ureters. Intraperitoneal or extraperitoneal bladder rupture may also occur. Major pelvic fractures are associated with abdominal injuries in 30% of patients. Injury to the abdominal aorta is rare after blunt abdominal trauma. Other less serious injuries are abdominal wall hematomas, which do not usually require operative intervention but can result in significant blood loss.

**INJURIES WITH DELAYED PRESENTATION**

Several injuries are notoriously seen in delayed fashion or have subtle clinical findings. Pancreatic injuries may be manifested as abdominal pain and tenderness several hours after the trauma. Duodenal hematomas typically become evident 5 to 7 days after the trauma as vague abdominal pain and vomiting. This is in contrast to patients with duodenal perforations, who usually have acute pain and tenderness immediately after the trauma.

Traumatic diaphragmatic hernia can also occur in delayed fashion. These injuries are frequently missed because the sensitivity of CT for diaphragmatic injuries is low and the majority of patients have associated injuries. Most of these injuries result from a vehicular collision. Because the right hemidiaphragm is protected by the liver, the left hemidiaphragm is more commonly involved.

Diaphragmatic injuries occur in three phases. In the acute phase, immediately after injury, patients may have decreased or absent breath signs on one side of the chest or bowel sounds in the chest. If the injury is not detected, patients may go through a latent phase consisting of intermittent visceral herniation into the chest through the diaphragmatic rupture. These patients may have vague postprandial abdominal pain (which improves with standing because the herniated bowel is reduced), nausea, vomiting, and belching. During this phase the injury can go undetected for months to years. With time, patients will eventually enter the obstructive phase, which is associated with herniation and incarceration of bowel, intestinal obstruction, and ischemia. These patients exhibit abdominal pain, distention, and vomiting.

In the acute setting, patients with a diaphragmatic injury can also have tension viscerothorax—herniation of bowel into the chest, which results in increased intrathoracic pressure and mediastinal shift with compression of the superior vena cava. These patients have hypotension and decreased breath sounds on the affected side of the chest.
SOLID ORGAN INJURIES

The most common type of injury is solid organ injury. More than 90% of the injuries sustained in blunt trauma are isolated to the liver and spleen. Patients with hypotension as a result of blunt trauma usually have free rupture of a solid organ. Delayed onset of symptoms or pain without hypotension should raise concern about encapsulated hepatic or splenic trauma or hollow viscus injury. Although most intraperitoneal injuries today are managed nonoperatively, delayed diagnosis in some cases can lead to severe morbidity or mortality. Free intraperitoneal bleeding is the most urgent diagnosis in patients with blunt abdominal trauma. This immediately life-threatening condition may require interventions, including transfusion, exploratory laparotomy, and angiography with embolization.

PRIORITIES ACTIONS

1. Follow the advanced trauma life support protocols for initial resuscitation.
2. Determine the stability of the patient.
3. Perform chest and pelvic radiography on all unstable trauma patients.
4. Perform ultrasound examination on all major trauma patients.
5. Arrange transfer immediately for all patients with multisystem trauma or with the potential for intraperitoneal injury if a trauma surgeon is not available.
6. Triage the patient to either computed tomography scanning, laparotomy, the angiography suite (pelvic fractures or for embolization of abdominal injuries), intensive care unit, admission for observation, or discharge.

THE UNSTABLE PATIENT

INITIAL MANAGEMENT

The initial therapeutic intervention in patients with presumed intraperitoneal injury is to address the ABCs of trauma (airway, breathing, and circulation). Initially, all patients should receive high-flow oxygen. Intubation should be performed on unstable or severely injured multitrauma patients or those with the potential for rapid decline. After breathing is attended to, circulatory status is addressed. Antecubital venous or central line access should be obtained.

IMMEDIATE OPERATIVE INTERVENTION

There are several indications to proceed immediately to the operating room without further diagnostic testing, including evisceration, gross blood per rectum, blood per nasogastric tube or hematemesis, evidence of diaphragmatic injury, and hemodynamic instability with evidence of intraperitoneal injury (e.g., positive ultrasound findings).

Focused Abdominal Sonography for Trauma

Bedside ultrasonography has many advantages as an initial triage tool in an unstable trauma patient. It is readily accessible at most level I trauma centers and, in the hands of trained EPs, is accurate in detecting hemoperitoneum. Focused abdominal sonography for trauma (FAST) can be performed in less than 2 minutes and can triage patients to the operating room or further diagnostic testing, depending on the patient’s stability. In trauma patients, the incidence of an indeterminate sonographic result is low (less than 7%), and the reported sensitivity and negative predictive value in unstable patients approach 100%. The presence of hemoperitoneum in an unstable patient is an indication for operative intervention. The only caveat is that in patients with major pelvic trauma who may have bladder rupture with uroperitoneum, diagnostic peritoneal aspiration may be indicated to distinguish blood from urine. If the sonographic findings are negative, other sources of bleeding should be addressed, such as pelvic fractures and retroperitoneal bleeding.

Diagnostic Peritoneal Lavage

Some authors take a conservative approach and recommend confirming the results of negative ultrasonography with DPL in hypotensive patients. If ultrasonography is unavailable or if the results are indeterminate, DPL is required to determine the presence of intraperitoneal bleeding as an indication for immediate laparotomy. Before performing DPL, the EP should place a nasogastric tube and Foley catheter to decompress the stomach and drain the bladder.

DPL involves placement of a catheter into the peritoneal space and aspiration with a 10-mL syringe to see whether blood is present. In an unstable patient, an initial aspirate of 10 mL of blood is an indication for laparotomy. The presence of bile, food particles, or other gastrointestinal contents is also considered an indication for laparotomy. If the aspirate is negative, other sources of bleeding should be addressed (e.g., pelvic fractures). One liter of normal saline should be instilled into the abdomen if the initial aspirate is negative and then drained from the abdomen and sent to the laboratory for analysis.

THE STABLE PATIENT

LABORATORY TESTING

Laboratory tests are rarely helpful in the initial resuscitation of patients after blunt abdominal trauma. The utility of ordering individual laboratory tests when a specific clinical need is present versus routinely ordering a standard “trauma panel” has been studied. A significant cost savings, without adverse events, occurs if this practice is followed.

Several laboratory tests are useful in the initial evaluation of blunt trauma patients. The hematocrit should be measured for use as a baseline value and may be helpful as an indicator of bleeding if it is very low. Patients with a high likelihood of requiring an operation should have their blood typed and cross-matched in the event that a transfusion is required. A bedside glucose test should be performed on patients involved in a single-car accident and in patients with altered mental status after trauma.

All women of childbearing age should undergo a pregnancy test and be questioned about whether they are pregnant. Serial ultrasonography can be used as the initial and often definitive modality, and CT should be used sparingly in the first 20 weeks of gestation to avoid unnecessary exposure to radiation.
Coagulation profiles should be performed in patients with a significant mechanism of trauma and in those who will probably require an operation. In addition, any patient receiving warfarin (Coumadin) therapy should have a coagulation profile performed.

Lactate levels and base excess are two laboratory tests that have been shown to predict bleeding.\(^{20}\) In one recent study of stable trauma patients, an increased lactate level (>2.5 mmol/L in ethanol-negative patients and >3 mmol/L in ethanol-positive patients) and an increased base deficit (>0.0 in ethanol-negative patients and >3.0 in ethanol-positive patients) were associated with a significant risk for torso injury, whereas patients with a normal base deficit were unlikely to have injury.\(^{21}\) Other authors consider a base deficit cutoff value of 6 or less to be predictive of intraabdominal injury and an indication for diagnostic imaging or DPL.\(^{22}\)

Ultrasonography has become part of the advanced trauma life support algorithm for abdominal trauma regardless of patient stability. Ultrasonography is now listed as a cause of hypotension after blunt trauma and can help guide imaging. Some evidence also suggests that microscopic hematuria consisting of 25 or more red blood cells per high-power field may be one of the predictors of intraperitoneal injury.\(^{21}\)

Amylase and lipase levels do not predict pancreatic injury in the acute setting. However, they may be helpful for detecting traumatic pancreatitis in patients initially evaluated hours after trauma.

**PLAIN RADIOGRAPHS**

Plain radiographs cannot rule out intraperitoneal injury after blunt trauma. Chest radiography may be used to diagnose a diaphragmatic rupture (Fig. 79.1). However, plain radiographs of the chest are diagnostic of diaphragmatic rupture in only 50% of patients with left-sided rupture and in only 17% of those with right-sided rupture.\(^{24,25}\) Free air is a rare finding on an upright chest radiograph that indicates hollow viscus rupture (stomach or colon), but upright chest radiography is not usually feasible after blunt trauma. Thus, plain radiographs should not be used to rule out intraperitoneal injury.

Radiography is also useful for detecting pelvic fractures as a cause of hypotension after blunt trauma and can help guide evaluation for the management of associated genitourinary injuries. Although pelvic radiography is not necessary in patients with normal mental status and no pain or tenderness, it should be performed in unstable or seriously injured patients with an appropriate mechanism of injury.

**ULTRASONOGRAPHY**

FAST is recommended for all blunt trauma patients with any significant mechanism of injury as an initial screening test regardless of patient stability. Ultrasonography is now listed in the advanced trauma life support algorithm for abdominal trauma and is used in the majority of level I trauma centers.\(^{26}\) In the blunt trauma setting, ultrasonography has become part of the secondary survey to detect hemoperitoneum as an indicator of intraperitoneal injury.

If the sonogram shows free fluid and the patient is hemodynamically unstable, exploratory laparotomy is indicated. A stable patient with free fluid should undergo CT immediately to identify the type of injury and determine the need for laparotomy. A clinical algorithm that incorporates FAST is presented in Figure 79.2.

FAST is also used for the rapid detection of pericardial fluid, hemothorax, and pneumothorax. It does not replace chest radiography for hemothorax and pneumothorax but may be obtained faster and can be used to expedite thoracostomy tube placement.

The major limitation of ultrasonography is its inability to identify or grade solid organ injury. Its sensitivity for detecting hemoperitoneum as an indicator of intraperitoneal injury ranges from 76% to 90%, and its specificity ranges from 95% to 100%.\(^{15}\) However, its sensitivity is as low as 33% with splenic injuries and 12% with hepatic injuries for identifying encapsulated solid organ bleeding.\(^{13,27}\) Ultrasonography is also limited in assessing injuries that are not associated with a large amount of hemoperitoneum, such as retroperitoneal bleeding and injuries to the small bowel or diaphragm. Up to one third of patients with intraperitoneal injury will have negative findings on FAST, including as many as 10% of patients who require surgery.\(^{28}\) Thus, FAST does not replace more definitive tests such as CT, but it can be a triage tool to expedite the evaluation and management of patients with blunt abdominal trauma. The amount of intraperitoneal fluid that must be present to have abnormal FAST findings is at least 150 mL and may be as much as 1 L.\(^{29,30}\)

The technique of bedside ultrasonography in trauma patients consists of four standard views (Fig. 79.3): right upper quadrant (Morison pouch), subxiphoid, left upper quadrant, and suprapubic (pouch of Douglas). Although this examination has no standard sequence, the suprapubic view takes advantage of the full bladder as a sonographic window and should therefore be obtained before placement of a Foley catheter. Most operators start with the Morison pouch view because it is technically the easiest.

Obtaining all the views rather than one single view increases the sensitivity of the test.\(^{31}\) Performing serial examinations every 30 minutes into the resuscitation—or if a change in clinical status occurs—increases the sensitivity further. Trendelenburg positioning may improve the sensitivity by causing the hemoperitoneum to pool in dependent spaces. The differential diagnosis for fluid seen on ultrasonography includes...
ascites, as well as urine from intraperitoneal bladder rupture. All fluid will result in the same black stripe seen on the sonogram.

The finding suggestive of injury is hemoperitoneum, which appears as a black (anechoic) stripe between the kidney and the liver (Fig. 79.4), between the kidney and the spleen, or posterior to the bladder. Because ultrasonography is insensitive in detecting actual parenchymal injury, the operator should not waste time evaluating the spleen and liver for evidence of injury.

**DIAGNOSTIC PERITONEAL LAVAGE**

DPL was formerly the primary method for evaluating unstable patients after blunt abdominal trauma, but its use has markedly decreased with the widespread application of bedside ultrasonography. Currently, DPL is indicated when ultrasonography is unavailable or if the results are indeterminate in an unstable patient. Some authors recommend DPL to confirm the absence of hemoperitoneum in unstable patients with negative results on ultrasonography.\(^{32}\)

DPL is very sensitive in detecting intraperitoneal bleeding, can be performed rapidly, and is inexpensive. It can detect small amounts of intraperitoneal blood (as little as 20 mL).\(^ {33}\) The accuracy of DPL for predicting or ruling out intraperitoneal bleeding is close to 98%.\(^ {34,35}\) DPL has, however, been shown to be less accurate in patients with major pelvic fractures. The false-positive rate may be higher in this group of patients because of the presence of uroperitoneum as a result of bladder injury. Consequently, in the presence of a pelvic fracture, diagnostic peritoneal aspiration may be indicated to determine whether a positive FAST result is due to blood or urine.\(^ {36}\)
The disadvantages of DPL are that it is invasive, does not identify the specific organ that is injured, and does not sample the retroperitoneal space. It will also detect small amounts of bleeding associated with injuries that do not require operative intervention. The nontherapeutic laparotomy rate for patients with a positive DPL finding is reported to be as high as 35%. Thus, in stable patients, a positive DPL result is not an indication for laparotomy.

The only absolute contraindication to DPL is a clear need for emergency laparotomy. Relative contraindications include morbid obesity, previous abdominal surgery (because of the presence of adhesions), and late-term pregnancy.

DPL findings that predict the presence of intraabdominal injury after blunt trauma are a red blood cell count greater than 100,000/mm³, a white blood cell count greater than 500/mm³, amylase level greater than 10 IU/L, and alkaline phosphatase level of 3 IU/L or greater. The complication rate for DPL is less than 1%. The most serious complication is bowel perforation; other complications include wound infection and bleeding.

COMPUTED TOMOGRAPHY
Abdominal and pelvic CT is the standard diagnostic imaging modality for a stable patient with possible intraabdominal injury. CT provides excellent detail of solid organ and retroperitoneal injuries. Its performance in diagnosing hollow viscous injuries continues to improve. Because of the accuracy and detail of CT images, nonoperative management of solid organ injury can now be performed safely. With the use of three-dimensional reconstruction, radiologists can also image the lumbar spine and pelvis to evaluate for fractures.

The disadvantages of CT are the difficulty in monitoring and resuscitating a patient in the radiology suite and the risk for contrast allergy and renal failure from administration of the dye. The complication rate is 3%, which includes aspiration of oral contrast material.

CT is indicated in stable patients when intraabdominal injury is clinically of concern because of abdominal wall findings, traumatic distracting injuries, and a significant mechanism of injury. The presence of distracting injury and the need for operative intervention for other injuries (e.g., orthopedic injuries) are also indications for performing CT. In awake patients who have a reliable abdominal examination and no abdominal tenderness, the yield of performing abdominal CT scanning because they are undergoing extraabdominal surgery is very low. Less than 2% of patients undergoing abdominal CT scanning only because of the need for general anesthesia for urgent extraabdominal surgery actually had an abdominal injury, and less than 0.5% required laparotomy.

Recent studies have looked at determining clinical predictors for identifying patients at low risk for intraperitoneal injury after blunt trauma who may not need CT. One such clinical prediction rule consists of a Glasgow Coma Scale score of less than 14, costal margin tenderness, abdominal tenderness, femoral fracture, hematuria consisting of greater than 25 red blood cells per high-power field, hematocrit of less than 30%, and abnormal chest radiograph findings (pneumothorax or rib fracture). In the absence of any of these clinical variables, patients are at very low risk of having intraperitoneal injury (96% sensitivity and 99% negative predictive value).

Many trauma centers in the United States and Europe are using a newer technique, the “pan scan,” for obtaining a rapid CT scan of the head, neck, and torso in patients with a high mechanism of trauma who are at higher risk for traumatic injuries. The advantage of this technique is that it is faster than performing segmental, sequential CT scans and may detect injuries that would otherwise be missed or diagnosed in delayed fashion, such as spine and chest injuries. The biggest risk, however, is that this technique will be overused and expose patients to unnecessary radiation and cancer risk. The exact indications for performing a pan scan are controversial. However, a conservative approach would be to obtain a pan scan in patients with a major traumatic mechanism who are also not evaluable because of head injury, intubation, or depressed mental status from alcohol. A pan scan is also recommended for elderly trauma patients who may sustain significant injuries with lesser mechanisms and for patients with prehospital hypotension who are stable in the emergency department because they are also at risk for torso trauma.

Determining when a patient is stable enough to undergo CT remains a point of controversy. An unstable patient should not be sent to the radiography suite, where it is difficult to monitor and resuscitate a sick patient. Most centers use the response to fluid resuscitation and transfusion as an indicator of whether the patient is stable enough to be transported to the radiography suite for CT. This decision may also be influenced by the proximity and type of CT scanner.

CT is very accurate in diagnosing intraperitoneal injury, especially for detecting solid organ injury, as stated previously. Another advantage of CT is its higher accuracy and sensitivity than plain radiographs for detecting fractures of the thoracolumbar spine (TLS). In one prospective study, the accuracy of CT of the torso for detecting TLS fractures was 99% versus 87% for plain radiographs, with the “gold standard” for fracture being the discharge diagnosis of acute fractures confirmed by thin-cut CT or clinical examination of the patient when alert (or both). It is also much faster to obtain a torso CT scan than it is to obtain multiple plain radiographic spine images.

The limitations of CT lie in its low sensitivity for diaphragm, mesenteric, hollow viscus, and pancreatic injuries. Although the newer-generation multidetector CT scanners appear to have better resolution and sensitivity for these rare injuries, they are still not highly accurate. The sensitivity for diaphragmatic injury is between 67% and 84%, with specificities reported to be between 77% and 100%. The sensitivity of CT for detecting hollow visceral injury is reported to range from 83% to 94%. Multidetector CT without oral contrast enhancement was 82% sensitive and 99% specific for detecting bowel and mesenteric injuries. The reported sensitivity of CT for detecting pancreatic injuries after blunt trauma ranges from 50% to 68%, even with spiral CT technology. The use of oral contrast is not associated with an increase in sensitivity for detecting pancreatic injury. In a recent multicenter study, the sensitivity of CT was 76% for pancreatic injuries and 70% for duodenal injuries.

Oral Contrast or No Oral Contrast?
An ongoing controversy on the use of CT scanning for blunt abdominal trauma is the utility of oral contrast versus
intravenous contrast alone. Oral contrast is associated with increased time and the potential for vomiting, aspiration, and other complications, as well as discomfort if a nasogastric tube is placed. Several studies have documented that oral contrast enhancement is not essential for identifying solid organ, mesenteric, or bowel injuries. Because use remains controversial and local customs often prevail, oral contrast agents are still commonly used in many trauma centers.

**Findings in Patients with Blunt Abdominal Trauma**

CT findings suggesting solid organ injury are disruption of the perichyma, extravasation of contrast material, and hematoma. Patients with blunt intestinal or mesenteric injuries may have more subtle findings such as free fluid without obvious organ injury, mesenteric stranding or edema, and bowel wall hematoma. Other indicators of bowel and mesenteric injury are pneumoperitoneum, tears in the bowel wall, and wall thickening.

Isolated intraperitoneal fluid in patients without solid organ injury is associated with a high incidence of bowel or mesenteric injury. In patients without solid organ injury and with more than trace amounts of free fluid, the therapeutic laparotomy rate is 54% to 94%. At surgery, small bowel, mesenteric, and diaphragm injuries are usually found.

**ANGIOGRAPHY**

When combined with embolization, angiography is both a diagnostic and therapeutic modality. Though traditionally used in blunt trauma for the treatment of pelvic fractures, it has been found to be especially helpful in the nonoperative treatment of active bleeding from solid organ injuries. High-grade spleen and liver injuries, as well as renal lacerations, are amenable to this technique. Patients selected for this procedure must be stable and have solid organ injuries with active extravasation (contrast blush) on abdominopelvic CT.

**TIPS AND TRICKS**

Do not underestimate the mechanism of injury. A significant mechanism of injury requires evaluation for intraperitoneal injury even if the patient is stable and the findings on physical examination are normal.

The presence or absence of abdominal tenderness does not predict intraperitoneal injury.

Alcohol and distracting injuries can make the findings on physical examination unreliable.

All blunt abdominal trauma patients should undergo FAST. Before performing DPL, place a nasogastric tube and Foley catheter and obtain a pelvic radiograph.

Positive FAST findings or DPL aspirate in an unstable patient is an indication for laparotomy.

Unstable patients should not be transferred to the radiology suite for CT.

Significant intraperitoneal fluid without solid organ injury on a CT scan suggests the presence of small bowel injury. CT can fail to identify injuries of the pancreas, diaphragm, small bowel, and mesentery.

**TREATMENT**

The initial treatment of patients with blunt abdominal trauma includes fluid resuscitation, transfusion, and simultaneous consultation with the trauma surgery facility for operative intervention, angiography, or admission for observation.

Intravenous fluid resuscitation with normal saline or lactated Ringer solution is indicated for patients who are hemodynamically unstable (tachycardia or hypotension). The optimal amount and goal of resuscitation are controversial. Although the standard has been to immediately infuse 2 L of crystalloid followed by blood transfusion in patients with continued instability, many institutions move rapidly to blood transfusion and limit resuscitation so that patients are kept “underresuscitated” with a systolic blood pressure of approximately 90 mm Hg. This can usually be accomplished with type O-negative blood in women of childbearing age and type O-positive in all others. Once the bleeding lesion is identified and definitively controlled, full resuscitation is instituted. However, this practice is not typically recommended for patients with possible traumatic brain injury.

The presence of an unstable pelvis on physical examination or on the initial pelvic radiograph is another indication for early blood transfusion because patients with this condition will bleed profusely. EPs should place a pelvic stabilization binder or simply wrap a sheet tightly around the pelvis to stabilize the fractures as an early intervention.

For patients requiring large amounts of blood products, new evidence suggests that early administration of plasma and a higher ratio of plasma to packed red blood cells (PRBCs) transfused will result in lower mortality rates. In patients who require massive transfusion (defined as 10 or more units of PRBCs in 24 hours), it is recommended that they receive plasma, platelets, and PRBCs in a ratio close to 1:1:1.

Indications for operative intervention include hemodynamic instability, diaphragmatic injury, and hollow viscus injury. Although high-grade spleen and liver injuries once routinely underwent surgery, the use of angiography with embolization has become more common. Other CT findings that trauma surgeons may consider indications for operative intervention include the presence of intraperitoneal fluid without obvious organ injury and evidence of active extravasation. Because of the high incidence of associated small bowel injury, many institutions consider the presence of a Chance fracture in conjunction with abdominal wall ecchymosis an indication for laparotomy.

**PRIORITIZING MANAGEMENT OF INJURIES**

Emergency department management of unstable patients with blunt abdominal trauma becomes challenging when associated injuries are present. In general, intraperitoneal bleeding trumps other injuries in terms of the immediate need for operative management. An unstable patient with known intraperitoneal hemorrhage and associated pelvic trauma should undergo laparotomy first, followed by management of pelvic injuries (e.g., angiographic embolization of pelvic vessels).
unstable patients with evidence of associated traumatic brain injury, neurosurgical consultation should be obtained for intracranial bolt placement in the operating room while the intraperitoneal injuries are being addressed. Suspicion of aortic injury presents an added challenge in management. The aortic injury is not usually the cause of hemodynamic instability, and intraperitoneal bleeding should be the presumed source of the hypotension. Thus, in patients with concomitant aortic and abdominal injuries, laparotomy should be performed first. Abdominal bleeding takes priority over orthopedic injuries; frequently, however, the trauma surgeon can perform laparotomy at the same time that the orthopedic surgeon is repairing an open fracture.

NONOPERATIVE TREATMENT

Many reports in the surgical literature document success with nonoperative management of patients with spleen and liver lacerations. Most centers, however, consider the presence of hemodynamic instability or transfusion requirements as indications to operate on patients with solid organ injuries. Age may also be used as an indicator for surgery; children do well with nonoperative management, whereas elderly patients may have lower success rates with nonoperative care. Nonoperative salvage rates in patients with lacerations of the spleen are 94%, and up to 80% of grade 4 and 5 splenic injuries can be managed successfully without operative intervention.

In one prospective study, the failure rate of nonoperative treatment of kidney, liver, and splenic lacerations was 22%; the failure rate was higher for splenic injury than for liver or kidney injuries. Independent predictors of failure of nonoperative management were fluid identified on screening ultrasonography, significant blood on CT (>300 mL), and the need for blood transfusion.

INTERVENTIONAL RADIOLOGY

In major trauma centers, interventional radiologists in conjunction with trauma surgeons are performing angiography with embolization instead of operative management. The nonoperative salvage rate in patients with splenic lacerations who undergo embolization is 90%. Angiography with embolization may be performed in patients who are hemodynamically stable and do not have associated hollow viscus or other injuries requiring operative intervention.

For splenic injuries, arterial embolization may be indicated for patients with active extravasation of contrast material, pseudoaneurysm or arteriovenous fistula, large hemoperitoneum, and a higher grade of injury (III to V), assuming that no indications for operative intervention are present. The combination of contrast blush and significant hemoperitoneum may also predict a high failure rate for nonoperative management and may be an indication for arterial embolization or laparotomy with splenectomy.

If the patient is initially transported to a hospital that is not a designated trauma center, the EP must decide when to transfer the patient to the trauma center and what tests to perform before transfer. If the trauma is isolated to the abdomen and a general surgeon is available to admit the patient or perform therapeutic laparotomy, transfer may not be necessary. Patients with multisystem trauma or hemodynamic instability require transfer to a trauma center.

SUGGESTED READINGS


REFERENCES

References can be found on Expert Consult @ www.expertconsult.com.
REFERENCES


