CHAPTER 29
Abdominal Trauma

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Introduction

Abdominal trauma is common in children, accounting for about 5% of admissions to major paediatric centres.[1–5] Most injuries are blunt in nature, but the incidence of penetrating trauma injuries is increasing. Although most blunt trauma injuries result from traffic injuries, falls (frequently off fruit-bearing trees) are particularly important in sub-Saharan Africa and other developing countries.[1,3,6] Firearms, bicycles, sports, and injuries inflicted as a result of child abuse are becoming increasingly noticeable in developing countries.[7–8]

A number of factors make children particularly vulnerable to abdominal injury. The relatively thin abdominal wall and lower rib cage in children means that the liver, kidney, and pancreas lie in close proximity to the anterior abdominal wall and are prone to injury even if the cause of trauma is trivial. Besides, the liver and kidneys, which are normally protected by the rib cage in adults, lie relatively lower in the abdomen of the child, making them vulnerable to injury. The liver also occupies a proportionately larger percentage of the child's abdomen, further exposing it to increased risk of injury.

Abdominal trauma is frequently associated with other extraabdominal injuries, which should not be overlooked. A distended stomach and full bladder may interfere with the evaluation of the injured child, and may need to be promptly emptied. The initial assessment and resuscitation of the injured child is detailed in Chapter 27.

Blunt Abdominal Trauma

Blunt injury accounts for up to 86% of abdominal trauma.[3] In children, blunt abdominal trauma produces a spectrum of injuries that may pose diagnostic and treatment challenges in the African setting, with its limited diagnostic facilities.[4] Special attention should be directed at handlebar injuries (which cause focused liver, pancreatic, duodenal, and jejunal injuries); lap-belt injuries (which produce a triad of abdominal abrasion, intestinal perforation, and intestinal laceration), and child abuse (in which the face and head may be involved). Bowel injuries may also cause significant morbidity due to a delay in diagnosis.[6]

Clinical Evaluation

After the initial evaluation, resuscitation, and stabilisation, the child with blunt abdominal trauma is carefully and thoroughly evaluated. An additional history is obtained, paying particular attention to vomiting, haematemesis, or rectal bleeding, which may indicate rectal or proximal intestinal injury. A history of loss of consciousness should be sought, as this may indicate head injury.

The presence of pallor, abdominal distention, and pain on physical examination may be a pointer to intraabdominal bleeding. The pulse rate should be carefully monitored, as it is a more sensitive indicator than blood pressure of haemodynamic status in children. Careful examination of the abdomen is performed, with particular attention to abrasions, bruises, distention, and tenderness. Note that peritoneal signs are particularly difficult to discern in a child with lower rib fractures, contusion or abrasions of the abdominal wall, pelvic fractures, and distended bladder. Abdominal examination may be unreliable in patients with head injury or depressed sensorium, so repeated examination or other diagnostic tests are often necessary in such patients.

Decompression of the stomach with a nasogastric tube and the passage of a urethral catheter (except if there is blood at the external meatus or a floating prostrate) may be helpful when examining children with blunt abdominal trauma. Rectal examination should be done to look for perianal soilage with blood, tenderness, floating prostate, or a palpable rent in the rectum. The examining finger should be inspected for blood stain.

The chest, central nervous system and musculoskeletal system should be examined to exclude injury in these systems.

Investigations

Relevant investigations of a child with abdominal trauma would include the techniques discussed in the following subsections.

Abdominal Ultrasonography

Focused abdominal sonography for trauma (FAST) is directed at identifying intraperitoneal or pericardial fluid, which may result due to solid organ injuries (spleen, liver, kidneys, heart). When available, it could be used as a screening tool in the immediate assessment of blunt abdominal trauma. The FAST examination evaluates four areas:

1. right upper quadrant including the hepatorenal fossa;
2. left upper quadrant including the perisplenic region;
3. right and left paracolic gutters and the pelvis; and
4. intercostal or subdiaphragmatic view of the heart.

Note that the FAST examination does not always identify injured solid organs, and its sensitivity depends on the skills of the operator.

Diagnostic Peritoneal Lavage

The aim of diagnostic peritoneal lavage (DPL) is to detect bleeding or leakage of intestinal contents or pancreatic juice into the free peritoneal cavity. This investigation is used for the evaluation of a traumatised child who is unstable. It may require urgent laparotomy for deteriorating neurologic status or when the source of blood loss or clinical findings are in doubt. DPL may be very helpful in resource-poor settings, where advanced imaging modalities are not available, to select patients who need operative intervention.

DPL is performed by placing a catheter under direct vision into the peritoneal cavity. In infants with no previous surgery, a plastic-sheathed needle is passed obliquely into the lower quadrant. In older children without previous surgery, the catheter may be passed by using the Seldinger technique. A positive result is obtained when blood, intestinal contents (bile-stained fluid), or free peritoneal air is encountered. If free fluid is obtained, 15 ml/kg body weight of Ringer's lactate or normal saline is introduced into the abdominal cavity and the effluent is analysed for red blood cells (RBC) (> 50,000/ml), white blood cells (WBC) (>500/ml), and the presence of intestinal contents and amylase. In children, the presence of blood alone at DPL is not necessarily an indication for operation because it could be due to solid organ injuries that can be managed nonoperatively.

Erect Plain Abdominal Radiograph

An erect plain abdominal radiograph should include the chest and pelvis. The findings should be correlated with clinical findings to avoid unnecessary laparotomy. Findings may include free peritoneal air (Figure 29.1) in intestinal rupture, medially displaced gastric or colonic gas shadow in splenic rupture, or generalised ground-glass appearance of massive intraperitoneal or retroperitoneal haemorrhage. Rib and pelvic fractures may be seen.

Computed Tomography

The contrast-enhanced (intravenous (IV) or enteral) computed tomography (CT) scan is probably the most useful imaging modality to identify and characterise solid and hollow visceral injury. It provides clear and accurate imaging of the intraabdominal organs, including intestinal perforation and injuries to retroperitoneal structures. The CT scan may show a contrast blush—a well-circumscribed area of contrast extravasation that is hyperdense with respect to the surrounding parenchyma (Figure 29.2). The contrast blush is a specific marker of active bleeding associated with a higher rate of operative intervention in children. Notwithstanding whether a contrast blush is present, however, the decision to operate should be made on the basis of clinical response to resuscitation; clinically stable patients with a contrast blush can be successfully treated nonoperatively.[9] Although a CT scan is widely accepted and gives accurate results with few false-positive and false-negative interpretations, it may not be readily available in some centres in Africa.

Exploratory Laparoscopy and Laparotomy

When available, laparoscopy can be valuable in the diagnostic evaluation of patients who are haemodynamically stable but there is a strong suspicion of intraabdominal organ injury.

Laparotomy may be needed for definitive diagnosis and treatment. It is indicated in the patient who responds poorly to adequate resuscitation efforts consisting of greater than 40 ml/kg of crystalloids or one-half the child's blood volume within the first 24 hours after injury. Blood should be grouped, cross-matched, and stored for a transfusion, when necessary.

To summarise, the surgeon in Africa, and indeed elsewhere, must be proficient in the clinical evaluation of the traumatised child with suspected intraabdominal injuries, even with the availability of advanced imaging techniques.[10] The value of clinical examination was demonstrated in a study by Chirdan et al. showing a drastic reduction in the rate of laparotomy without compromising outcome in resource-poor settings when a simple management algorithm is used. The algorithm includes clinical examination and simple radiology and laboratory tests.[4]

Treatment

Liver and Spleen

The liver and spleen are the solid organs most frequently injured in blunt trauma.

Nonoperative management

Most injuries stop bleeding spontaneously and can be managed nonoperatively, but the child must be haemodynamically stable.[11] Nonoperative management entails admission into the intensive care unit, where available. The child is placed on strict bed rest, and then carefully and repeatedly monitored. Vital signs are recorded every half hour until stability is achieved. The abdomen is examined every 4 hours for increasing distention and tenderness. Increasing distention may indicate intraperitoneal haemorrhage or gaseous distention, and further evaluation should be done immediately to ascertain whether operative intervention is necessary. Supportive laboratory investigations are done regularly. Any anaemia or fluids and electrolyte derangements are treated promptly.

If nonoperative management is successful, the activity of the child, such as sports or heavy work at school or home, must be limited for about 4 weeks. In Western countries, follow-up imaging is often not needed because patients have easy access to trauma centres in the event of rebleeding. This is not the case, however, in the African setting,

Figure 29.1: Free air in the peritoneal cavity due to intestinal perforation from blunt trauma.

Source: Courtesy of Manuel Meza, MD, Children's Hospital of Pittsburgh, Pittsburgh, Pennsylvania, USA.

Figure 29.2: Contrast blush seen on CT scan in a patient with grade 4 splenic laceration (arrow), indicating active bleeding. Note the haemoperitoneum over the liver.

where a follow-up CT or abdominal ultrasound (US) scan done before discharge from hospital helps the surgeon decide whether further hospital stay is necessary.

The nonoperative management approach is not without hazards, such as missed hollow viscus injuries and rebleeding. In the following situations after blunt trauma, nonoperative management may not be possible, and operative treatment then becomes necessary:

1. haemodynamic instability;
2. transfusion requirement is greater than half of estimated blood volume (estimated blood volume is 70–80 ml/kg body weight);
3. presence of associated injuries requiring surgery;

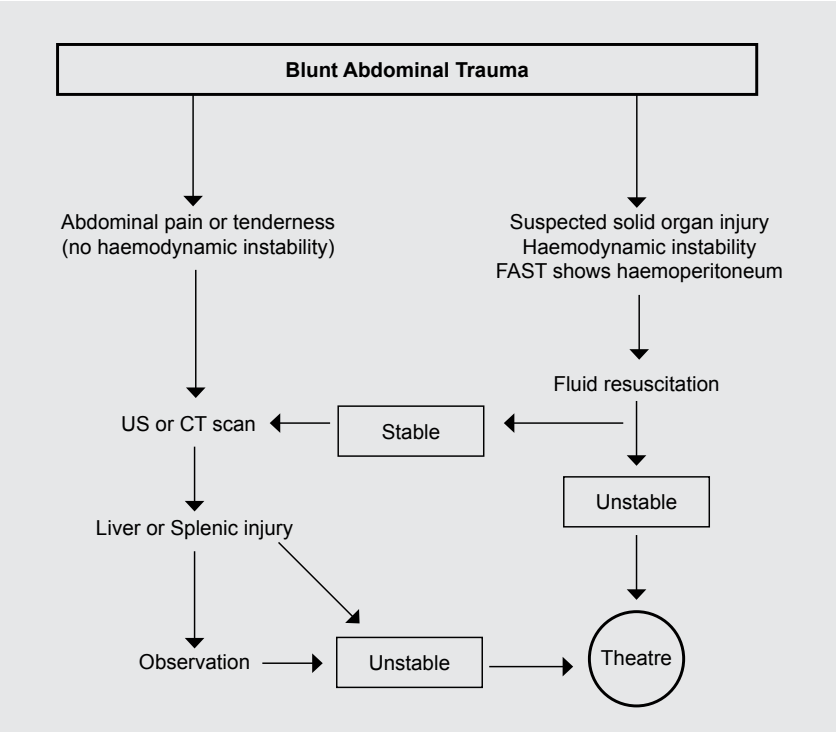

Figure 29.3: Algorithm for the management of blunt splenic or liver injury when CT or US is available. FAST is used for the rapid detection of haemoperitoneum in unstable patients, whereas detailed US may be used for the evaluation of stable patients.

4. unsure of the nature and extent of intraabdominal injury;

5. evidence of hollow viscera injury; or

6. lack of appropriate imaging facilities for adequate evaluation and monitoring of intraabdominal injury (e.g., CT scan, US).

Operative treatment entails full laparotomy using a midline incision, which may be extended. If US or CT is available, we recommend the algorithm for the management of solid organ injury illustrated in Figure 29.3.

Operative Management

Liver

Once the peritoneal cavity is entered, large packs are placed around the liver posteriorly, inferiorly, and superiorly to control initial haemorrhage. The packs are removed one by one to assess the extent of injury. If packing is unable to control haemorrhage, the Pringle manoeuvre (occlusion of the porta between the thumb and forefinger or using a vascular clamp) is done. Some lacerations may need to be extended to enable proper assessment of the extent of injury. The following interventions could be done, depending on the degree of injury to the liver:

- simple repair;
- exploration of expanding haematomas;
- resectional debridement where there is much devitalised liver tissue; or
- rarely, lobectomy if hepatic damage is extensive.

Spleen

The guiding principle in the operative management of splenic injury is to avoid splenectomy as much as possible to prevent the complication of overwhelming postsplenectomy infection (OPSI).

The spleen can be preserved by the following procedures: (1) splenorrhaphy, in which simple repair of lacerations is done, or (2) segmental resection if a segment of the spleen is devitalised or the spleen is wrapped up with the omentum. Haemostatic agents such as haemacele could be used to stop bleeding from the spleen. Splenectomy may be necessary in the following situations:

- multiple abdominal injuries;
- haemodynamic instability;
- uncontrollable bleeding; or
- lack of experience on the part of the surgeon.

If splenectomy is performed, place the child on long-term prophylactic antimalarials using proguanil or pyrimethamine. Give vaccination against pneumococcal infection (Pnuemovac(R), if available). Educate the parents on the susceptibility of the child to infections, and the need to report any infections early. Treat any infection promptly.

Injury to other solid organs

Injuries to other solid organs should be handled on their own merit. The management of injuries to the kidneys is discussed in Chapter 31.

Hollow viscera injury

Hollow viscera injuries are less common than solid organ injuries. The most commonly injured hollow viscera are those of the gastrointestinal tract, and only these are discussed here. The various types of gastrointestinal injuries include:

- contusion;
- serosal lacerations;
- perforation; and
- transverse mesenteric tear.

These features may not be obvious at initial assessment. A high index of suspicion and repeated examination are essential for the diagnosis.

DPL, plain abdominal radiographs, and a CT scan may need to be repeated after 24 hours to reach a diagnosis. Indicators of gastrointestinal injury are listed below:

- fever;
- haematemesis or drainage of blood-stained effluent from nasogastric tube;

- increasing pulse rate;
- increasing abdominal distention and tenderness;
- loss of bowel function;
- presence of intestinal contents at DPL; and
- free intraperitoneal air on erect plain abdominal x-ray or CT scan.

When diagnosis is made, operative treatment is necessary. The operative options include repair of laceration and closure of perforation and resection with primary anastomosis for extensive laceration, multiple perforations, and intestinal gangrene from transverse mesenteric tear.

Injuries to the left colon may be repaired primarily with or without the creation of a proximal colostomy, or the injured colon may be exteriorised as a colostomy and mucous fistula.

Penetrating Abdominal Trauma

Penetrating abdominal trauma is less common than blunt trauma and accounts for approximately 14% of abdominal trauma in children. It is frequently due to a fall onto sharp objects, a cow gore, gunshot wound, and, rarely, a stab injury. Treatment depends on the penetration of the peritoneum. After adequate resuscitation and stabilisation, the wound is explored under general anaesthesia to identify peritoneal breach.

If the peritoneum is breached, a formal laparotomy is required, through a separate incision, to identify and treat organ injuries. If a peritoneal breach is not detected (or a breach is only suspected), DPL is done and a laparotomy is performed if it is positive.

Where available, a triple-contrast CT scan (oral, IV, plus bladder contrast) should be done. If the CT scan is negative, the patient is observed for 24–48 hours; if it is positive, a laparotomy should be done.

In stab injuries to the flank or back, a CT scan is done. If a CT scan is not available, a laparotomy is done to exclude injuries to retroperitoneal organs. DPL is usually not useful.

If there is obvious organ evisceration, the organ is covered with clean moist gauze and polythene to decrease desiccation, loss of fluid, and hypothermia.

Whenever laparotomy is performed, it must be thorough to avoid missing any injuries. Injuries to solid organs or the gastrointestinal tract are treated as in blunt trauma.

Tetanus prophylaxis should be given if the child is unimmunised or if the immunisation status is unknown.

Anorectal Injuries

Anorectal injuries are not common in children, but they may be associated with significant morbidity if not identified and treated properly.[12–13]

Most anorectal injuries are due to penetrating trauma, and the penetrating objects often are potentially contaminated and capable of introducing infections, particularly tetanus.

Presentation

There may be a history of falling onto a sharp object or falling astride an object. Motor vehicle crashes may also produce anorectal injury. The common symptoms include:

- rectal bleeding;
- vaginal bleeding;
- vaginal discharge; and
- abdominal pain and tenderness.

Fever, if present, is an indication of intraperitoneal involvement or late presentation. Careful abdominal examination should be done to exclude intraperitoneal involvement. Examination of the perineum and anorectum after trauma is usually limited due to pain and tenderness. As such, adequate evaluation should be done under general anaesthetic and good lighting.

Evaluation

Under general anaesthetic, careful and meticulous examination of the perineum, anorectum, and vagina should be done. The aim of this evaluation is to ascertain the nature and extent of injury. The examination begins with inspection of the vagina, with particular attention to the posterior vaginal wall, which is frequently injured in girls. Any laceration in the perineum is noted, and the depth is ascertained. The anorectum is then examined; this may require proctosigmoidoscopy. Once the evaluation is complete, the injury should be graded (Figure 29.4).

Treatment

The treatment of anorectal injuries is summarised in Figure 29.5. The wound should be carefully explored. All dead or devitalised tissue should be completely excised. The wound should be repaired if accessible. Adequate drainage of the wound (perirectal) may be necessary. Laparotomy is required if intraperitoneal rectal injury is present. A protective (proximal) colostomy may be necessary in some situations. Tetanus prophylaxis and broad-spectrum antibiotics should be given. Sphincteric function should be evaluated after wound healing is complete.

Evidence-Based Research

Table 29.1 presents a retrospective review of management protocol using ultrasonography in laparotomy.

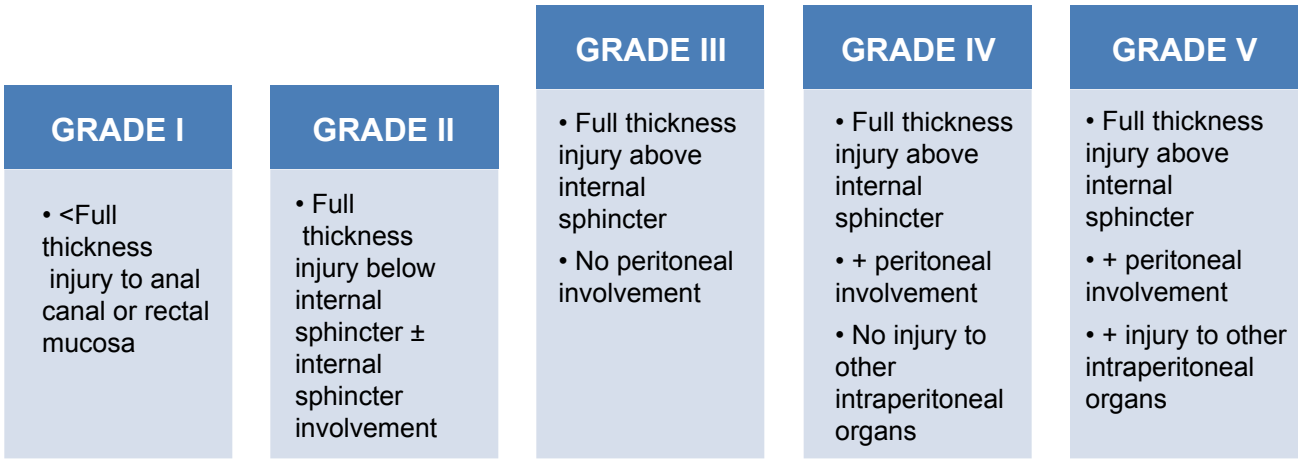

Figure 29.4: Grading of anorectal injuries.

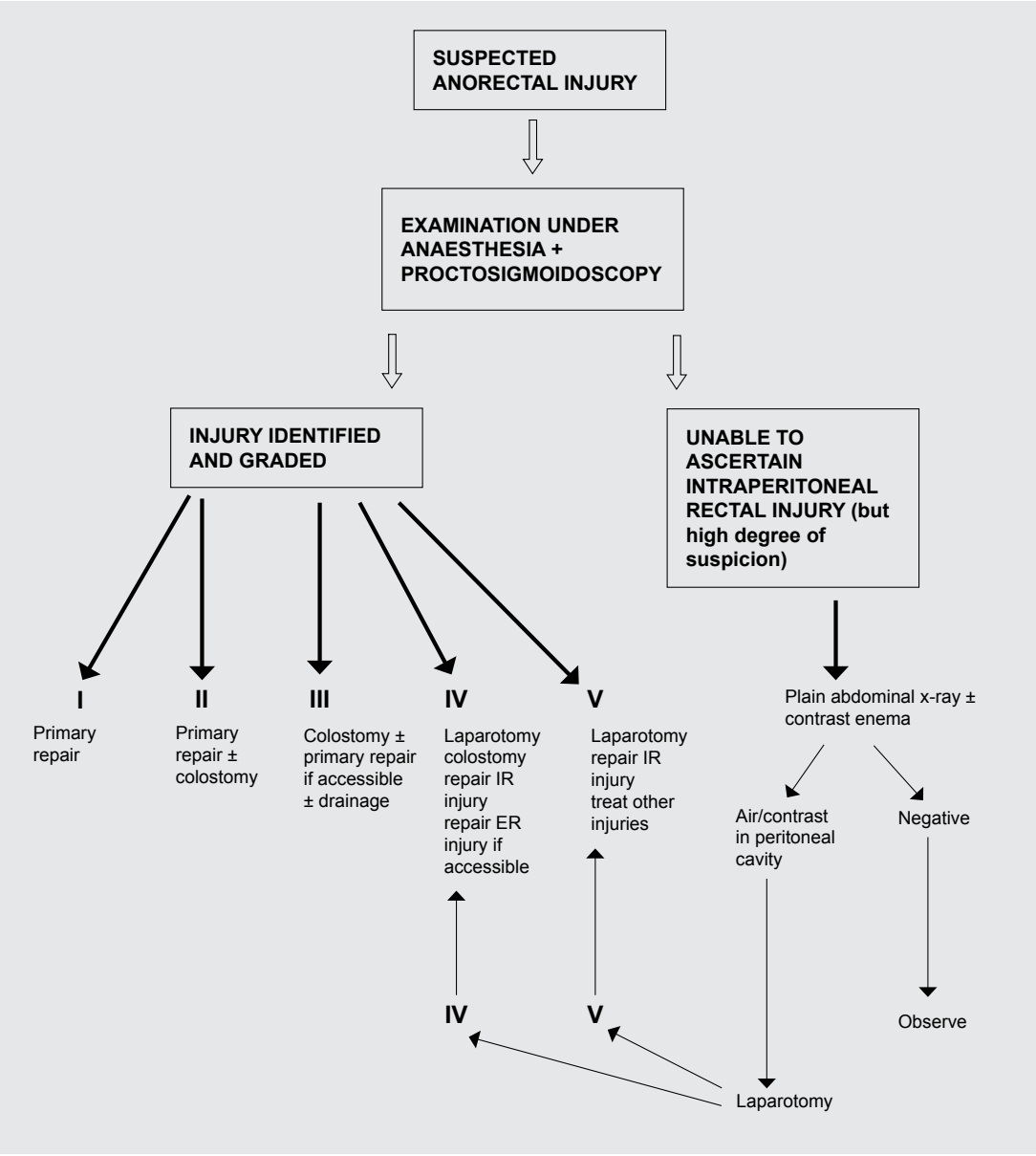

Figure 29.5: Treatment of anorectal injuries (IR: intraperitoneal rectum; ER: extraperitoneal rectum).

Table 29.1: Evidence-based research.

Title	Paediatric blunt abdominal trauma: challenges of management in a developing country
Authors	Chirdan LB, Uba AF, Yiltok SJ, Ramyil VM
Institution	Jos University Teaching Hospital, Jos, Nigeria
Reference	Eur J Pediatr Surg 2007; 17:90–95
Problem	To determine whether a simple protocol with ultrasonography significantly reduced the rate of laparotomy in countries with limited facilities.
Intervention	Retrospective review.
Comparison/ control (quality of evidence)	Laparotomy rates were compared between two groups, with and without a management protocol that included abdominal ultrasound (US) and plain abdominal films.
Outcome/ effect	Laparotomy rates were lower in the group in which the management protocol was followed.
Historical significance/ comments	Paediatric abdominal trauma in resource-poor settings can be successfully managed by using a simple protocol that depends on careful clinical assessment and simple radiologic tests.

Key Summary Points

1. Abdominal trauma in children is mostly due to blunt injuries.
2. Clinical evaluation is the most vital tool in diagnostic assessment.
3. When available, FAST, DPL, abdominal CT scan, or diagnostic laparoscopy are useful diagnostic adjuncts.
4. Laparotomy may be needed for definitive diagnosis and treatment.
5. Most solid abdominal organ injuries can be managed nonoperatively, but the child must be carefully monitored for signs of deterioration that will require laparotomy.
6. A high index of suspicion must be maintained to avoid missing hollow viscera injuries.
7. Patients undergoing splenectomy are at risk of overwhelming postsplenectomy infection (OPSI), and the child should be placed on long-term prophylactic antimalarials (proguanil or pyrimethamine) and receive vaccination against pneumococcal infection.
8. Anorectal injuries are associated with significant morbidity and should be promptly evaluated and treated.

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