Blunt abdominal trauma: Solid organ injury non-operative management

See also:

Major paediatric trauma – The primary survey
Major paediatric trauma – The secondary survey
RCH Paediatric Trauma Manual (RCH intranet only)
RCH Massive Haemorrhage and Critical Bleeding Procedure (MHP) (RCH intranet only)

Key Points

1. Resuscitation should take priority over CT imaging, and where a child's haemodynamic status is refractory to resuscitation, surgery and/or angioembolisation should be considered as adjuncts to resuscitation
2. Blood should be the first choice in fluid resuscitation, avoiding crystalloids, with activation of the Massive Haemorrhage Procedure (MHP)
3. There is insufficient evidence for use of eFAST in paediatric abdominal trauma to consider this a routine step in paediatric trauma resuscitation
4. The primary determinants of management are the anatomy of the abdominal organ injury, the patient's physiological response to this injury, and their physiological response to resuscitation

Background

In Victoria, the vast majority (>90%) of children with abdominal major trauma sustain blunt trauma. Two thirds are injured by transport-related events, eg motor vehicle crashes, handle bar injury and pedestrian vs vehicle. The spleen (50%), liver (40%) and kidney (25%) are the most commonly injured solid organs, and 15% of children with blunt abdominal major trauma have >1 solid organ injury.

Several anatomical differences predispose pre-pubescent children to blunt abdominal injury, including:

- Compact torsos with smaller anterior-posterior diameters which provide a smaller area over which the force of injury can be dissipated
- The ribs are more pliable providing less protection
- The liver can protrude below costal margin making it more prone to injury
- The bladder sits above pubic symphysis and is prone to injury
- The abdominal musculature is generally weaker with less overlying fat
- Protection systems such as seat belts may be fitted or worn incorrectly

The majority of children with abdominal solid organ injury are best managed non-operatively. An uncommon, but important, group of these children do require an operative response, most typically in the setting of haemodynamic compromise refractory to resuscitation. This guideline sets out the current evidenced-based management of the paediatric trauma patient with abdominal solid organ injury.

Assessment of Abdominal Trauma

History

A detailed history of the mechanism may provide clues to suspected abdominal injuries. For example, in motor vehicle crashes, useful information includes the speed of vehicle(s) involved, position in the vehicle and side of impact, if airbags were deployed, type of restraint, intrusion into the passenger compartment, ejection from vehicle, rollover, and if others were injured or deceased due to the crash.

Examination

- Abdominal examination is part of the Circulation assessment in the primary survey, as bleeding from abdominal injuries can lead to haemodynamic compromise
- Caution should be applied to the interpretation of haemodynamic status and the likelihood of abdominal solid organ injury in children, because:
    - Physiological compensation allows a significant amount of bleeding from abdominal solid organ injury before evidence of hypotension
    - As such, 80% of children with abdominal solid organ injury have normal haemodynamic status at trauma reception
    - However, haemodyamic compromise in children is more likely if multiple abdominal solid organs are injured or higher grade injury
- Caution should be applied in younger children, those with distracting injuries or those who are neurologically impaired or ventilated, as the abdominal examination may be unreliable
- In compliant children, serial examinations can be useful to assess for deterioration, particularly in stable children where a decision is made not to perform a CT.
- A full assessment of the abdomen, flanks and back for signs of bruising, wounds and distension should be performed though many children with significant injury may have no overlying signs. Distension, tenderness or evidence of peritonitis can be signs of bleeding or perforation. Distension may also be caused by swallowing air. Irritation of the diaphragm from splenic or liver injury can cause referred pain to the ipsilateral shoulder when palpating the RUQ or LUQ.
- Digital rectal examination should not be routinely performed, but may be indicated in specific settings such as perineal trauma or pelvic trauma, and should only be undertaken with senior and/or specialist consultation.

Concerning features in history and examination include:

- High speed motor vehicle accident (>60km) with high impact and/or deceleration and/or ejection
- Fall from a height
- Seat belt sign (don't forget: bowel and pancreatic injury)
- Handlebar bruise (don't forget: duodenal and pancreatic injury)
- Other evidence or history of direct blow to the abdomen/flank
- Macroscopic haematuria

- Other severe injuries above and/or below the abdomen (suggest abdomen is unlikely to be spared), eg traumatic brain injury, femoral fracture
- Signs of shock (tachycardia, hypotension, poor perfusion)

Management

The management of the seriously injured child should follow the trauma primary and secondary survey with haemorrhage control, c-spine management, airway, breathing and circulation support as required.

Investigations

- Full blood count, liver function, lipase, renal function, venous blood gas, coagulation profile and crossmatch (or group and hold) should be performed in all children with a physical examination consistent with intra-abdominal injury. A normal haemoglobin does not rule out bleeding. Similarly, a normal LFT or lipase does not rule out intra-abdominal injury, but raised LFT and/or lipase should increase the suspicion for this. Recall also that lipase may be transiently raised by extra-abdominal injuries, e.g. traumatic brain injury.
- Urinalysis:
    - Macroscopic haematuria should prompt CT imaging to assess for renal tract and other solid organ injury, if not already performed. If CT shows evidence of renal injury, delayed CT imaging sequences should be performed to assess for urinary leak.
    - Microscopic haematuria is not informative in this setting as it lacks sufficient sensitivity and specificity for renal or other abdominal organ injury. Microscopic haematuria can be present without abdominal injury (e.g. viral illness, recent exercise). Clinical judgement is advised and microscopic haematuria is not an indication for CT imaging in the acute trauma setting.
- Plain x-rays
    - Chest X-ray and pelvic X-ray should be performed in accordance with primary survey guidelines.
- CT scans
    - Abdominopelvic CT with contrast has a high sensitivity and specificity for identification and grading of solid organ injury and should be performed if clinical concern for intra-abdominal injury. Unstable patients should be stabilised first or proceed directly to theatre.
- Radiation exposure risks still need to be considered in children and CT should be performed only on those who are truly indicated.

  Indications for CT include:
    - Abnormal findings on abdominal examination (e.g. significant bruising, tenderness, distension, peritonitis). A seat belt sign with no other findings could be observed with serial examination.

    - Haemodynamic compromise/hypotension for age (proceeding to CT only if stabilised)
    - Other significant injury/multisystem injury
    - Visible bleeding - macroscopic haematuria, rectal bleeding, haematemesis/blood from NG
    - Patient is unconscious/unable to co-operate with examination and high suspicion for abdominal injury
    - Significant mechanism of injury suggestive of abdominal injury.
    - Persistent vomiting
    - Abnormal bloodwork – raised ALT/AST/lipase or low haematocrit/decreasing haemoglobin
    - Senior clinical judgement

- Focused Assessment with Sonography for Trauma Evaluation (FAST) is a rapid and non-invasive bedside ultrasound examination evaluating for the presence or absence of free fluid in the abdomen. While the presence of fluid has a high specificity for intraabdominal injury (up to 96%), up to 37% of intraabdominal injury will have no peritoneal fluid. However, the presence of fluid (blood) is not an indication for surgery in a stable patient. Significant variability in sensitivity and specificity of the FAST scan is reported and FAST scans are not currently routinely recommended in the paediatric emergency department. They should not delay other interventions or investigations, they should be limited to credentialed providers and results should form only part of the evaluation rather than a diagnostic tool.

Treatment

The following principles should be considered for all children with blunt abdominal trauma:

- Vascular access should be obtained with large bore intravenous cannulae and trauma panel bloods sent. Intraosseous access should be used if unable to gain IV access.
- If fluid resuscitation is required, blood should be the first fluid of choice. The MHP should be activated early. Tranexamic acid should also be administered. Blood transfusion is also indicated if haemoglobin < 70.
- Warming IV solutions before administration may prevent or improve hypothermia and rapid infusers should be used for fast administration.
- Children should be adequately analgised, usually with IV analgesics.
- Decompression of the stomach with orogastric tube insertion (or nasogastric if no concerns for base of skull fracture or maxillofacial fracture) should be considered, especially in patients who are intubated.
- Bladder catheterisation to facilitate monitoring of urine output may be useful in certain cases. However, the procedure should not be performed if urethral injury is suspected (gross haematuria, blood at the urethral meatus, or a scrotal or perineal haematoma)

- Conservative management is the standard practice for haemodynamically stable children with solid organ injury, and should be achievable for over 95% of children.
- Children should be cared for a hospital with a paediatric trauma service (access to paediatric surgery, anaesthesia and intensive care)
- Emergency laparotomy may be required in blunt abdominal trauma if ongoing haemodynamic instability despite resuscitative efforts, radiographic evidence of pneumoperitoneum, grade V renovascular injury or signs of peritonitis.
- Angiography and embolization may be indicated for active bleeding – with a positive blush (or early aneurysm) visualised on CT and ongoing bleeding/ instability requiring blood transfusion.

The table below aims to guide teams in the inpatient management of isolated stable blunt renal, liver and splenic injury along with discharge instructions and follow-up care. The goal is conservative non-operative management, while aiming to return to normal activity in a safe timeframe without unnecessary prolonged hospital admissions. Exact guidance differs between institutions and guidance may change on an individual basis, particularly if multiple injuries are present which prolong their expected length of stay or expected progress to full diet or mobility. Additionally, those who were haemodynamically unstable and required blood transfusion should be managed as per the treating team and are likely to require longer periods of time before resuming enteral diet or mobilising.

Clinical Management of Blunt Abdominal Injury

Clinical Management:					
	Grade I	**Grade II**	**Grade III**	**Grade IV**	**Grade V**
Admit to	Surgical ward			PICU if haemodynamically unstable, otherwise surgical ward	
	Unstable patients may be transferred from ED directly to theatre or interventional radiology for angioembolisation.				
Anticipated LOS	1-2 days	1-3 days	2- 4 days	3-5 days	
Activity	Bed rest overnight Toilet privileges after 12 hours Full gentle ambulation at 24 hours (at least 12 hours pre-discharge)			Bed x 24 hours Toilet privileges after 24 hours Full gentle ambulation at 48 hours	
Vitals	4 hourly		2 hourly x 4hours then 4 hourly thereafter (If on the ward) or hourly in PICU		
Monitoring	Temperature, pulse respirations, blood pressure. Strict fluid balance. Serial abdominal examinations				
Labs	**Frequency**			**Frequency**	
FBE:	Repeat Hb 6-12 hours post admission			6, 12, 24 hours post admission or as clinically indicated	
Other labs:	Repeat if initially abnormal as clinically indicated				
Fluids	Blood should be used for resuscitation. Activate MHP if required				
	IV fluids if not tolerating PO		IV maintenance fluids while fasting if required.		
Nutrition	Clear fluids initially, progressing to full diet as tolerated.		Nil by mouth for 12-24 hours, progressing to clear fluids and full diet as tolerated. As per PICU and surgical team.		
Pain	Regular analgesia as per acute pain management guideline. Consider referral to Pain Management service for nurse controlled or patient controlled analgesia. Avoid NSAIDs with bleeding and avoid Paracetamol if abnormal liver function.				
Other procedures	Deep breathing exercises. No NGT. No urinary catheter			Urinary catheter in haemodynamically unstable	
Psychosocial	Social work, physiotherapy, occupational therapy, psychology, trauma service and other allied health input as required				
Discharge recommendations:					
Restricted Activity*	3 weeks	4 weeks	6 weeks		
Return to school	1 week			2 weeks	
Follow up	GP 1 week		GP in 1 week Paediatric surgery in 6 weeks/as directed		
Repeat imaging	Not required, unless clinically indicated.				

*Restricted activity includes full contact sport or physical activities or competitive sports or where there is the potential for contact e.g. gymnastics, dancing, cycling or motorised bikes, horse-riding, skating, snow sports, sea swimming, playgrounds, running, all ball sports, diving, boxing etc. Any rough play or any activities that could lead to a fall or hit to the abdomen must be avoided. Walking is allowed. Bathing or gentle solo swimming in private pools without playing is allowed. Alternative advice may be given at the discretion of the treating consultant.

Consider transfer when

- All children with major trauma should be transferred to a major trauma service for definitive management in conjunction with pre-hospital and inter-hospital transfer guidelines
- The child requires care beyond the comfort level of the hospital

For emergency advice and paediatric or neonatal ICU transfers, see Retrieval Services

Parent information

(Hyperlink to parent info leaflet)

References

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Appendix: Grading of injury

Splenic, renal and liver injuries are classified according to the American Association for the Surgery of Trauma (AAST) Organ Injury Scale (OIS). The majority will be classified by CT findings, as most abdominal injury will be managed non-operatively.

TABLE 1. Spleen Organ Injury Scale—2018 Revision

AAST Grade	AIS Severity	Imaging Criteria (CT findings)	Operative Criteria	Pathologic Criteria
I	2	– Subcapsular hematoma <10% surface area – Parenchymal laceration <1 cm depth – Capsular tear	– Subcapsular hematoma <10% surface area – Parenchymal laceration <1 cm depth – Capsular tear	– Subcapsular hematoma <10% surface area – Parenchymal laceration <1 cm depth – Capsular tear
II	2	– Subcapsular hematoma 10–50% surface area; intraparenchymal hematoma <5 cm – Parenchymal laceration 1–3 cm	– Subcapsular hematoma 10–50% surface area; intraparenchymal hematoma <5 cm – Parenchymal laceration 1–3 cm	– Subcapsular hematoma 10–50% surface area; intraparenchymal hematoma <5 cm – Parenchymal laceration 1–3 cm
III	3	– Subcapsular hematoma >50% surface area; ruptured subcapsular or intraparenchymal hematoma ≥5 cm – Parenchymal laceration >3 cm depth	– Subcapsular hematoma >50% surface area or expanding; ruptured subcapsular or intraparenchymal hematoma ≥5 cm – Parenchymal laceration >3 cm depth	– Subcapsular hematoma >50% surface area; ruptured subcapsular or intraparenchymal hematoma ≥5 cm – Parenchymal laceration >3 cm depth
IV	4	– Any injury in the presence of a splenic vascular injury or active bleeding confined within splenic capsule – Parenchymal laceration involving segmental or hilar vessels producing >25% devascularization	– Parenchymal laceration involving segmental or hilar vessels producing >25% devascularization –	– Parenchymal laceration involving segmental or hilar vessels producing >25% devascularization
V	5	– Any injury in the presence of splenic vascular injury with active bleeding extending beyond the spleen into the peritoneum – Shattered spleen	– Hilar vascular injury which devascularizes the spleen – Shattered spleen	– Hilar vascular injury which devascularizes the spleen – Shattered spleen

Vascular injury is defined as a pseudoaneurysm or arteriovenous fistula and appears as a focal collection of vascular contrast that decreases in attenuation with delayed imaging. Active bleeding from a vascular injury presents as vascular contrast, focal or diffuse, that increases in size or attenuation in delayed phase. Vascular thrombosis can lead to organ infarction.

Grade based on highest grade assessment made on imaging, at operation or on pathologic specimen.

More than one grade of splenic injury may be present and should be classified by the higher grade of injury.

Advance one grade for multiple injuries up to a grade III.

TABLE 2. Liver Injury Scale—2018 Revision

AAST Grade	AIS Severity	Imaging Criteria (CT Findings)	Operative Criteria	Pathologic Criteria
I	2	– Subcapsular hematoma <10% surface area – Parenchymal laceration <1 cm in depth	– Subcapsular hematoma <10% surface area – Parenchymal laceration <1 cm in depth Capsular tear	– Subcapsular hematoma <10% surface area – Parenchymal laceration <1 cm Capsular tear
II	2	– Subcapsular hematoma 10–50% surface area; intraparenchymal hematoma <10 cm in diameter – Laceration 1–3 cm in depth and ≤ 10 cm length	– Subcapsular hematoma 10–50% surface area; intraparenchymal hematoma <10 cm in diameter – Laceration 1–3 cm in depth and ≤ 10 cm length	– Subcapsular hematoma 10–50% surface area; intraparenchymal hematoma <10 cm in diameter – Laceration 1–3 cm depth and ≤ 10 cm length
III	3	– Subcapsular hematoma >50% surface area; ruptured subcapsular or parenchymal hematoma – Intraparenchymal hematoma >10 cm – Laceration >3 cm depth – Any injury in the presence of a liver vascular injury or active bleeding contained within liver parenchyma	– Subcapsular hematoma >50% surface area or expanding; ruptured subcapsular or parenchymal hematoma – Intraparenchymal hematoma >10 cm – Laceration >3 cm in depth	– Subcapsular hematoma >50%-surface area; ruptured subcapsular or intraparenchymal hematoma – Intraparenchymal hematoma >10 cm – Laceration >3 cm in depth
IV	4	– Parenchymal disruption involving 25–75% of a hepatic lobe – Active bleeding extending beyond the liver parenchyma into the peritoneum	– Parenchymal disruption involving 25–75% of a hepatic lobe	– Parenchymal disruption involving 25–75% of a hepatic lobe
V	5	– Parenchymal disruption >75% of hepatic lobe – Juxtahepatic venous injury to include retrohepatic vena cava and central major hepatic veins	– Parenchymal disruption >75% of hepatic lobe – Juxtahepatic venous injury to include retrohepatic vena cava and central major hepatic veins	– Parenchymal disruption >75% of hepatic lobe – Juxtahepatic venous injury to include retrohepatic vena cava and central major hepatic veins

Vascular injury is defined as a pseudoaneurysm or arteriovenous fistula and appears as a focal collection of vascular contrast that decreases in attenuation with delayed imaging, Active bleeding from a vascular injury presents as vascular contrast, focal or diffuse, that increases in size or attenuation in delayed phase. Vascular thrombosis can lead to organ infarction.

Grade based on highest grade assessment made on imaging, at operation or on pathologic specimen.

More than one grade of liver injury may be present and should be classified by the higher grade of injury.

Advance one grade for multiple injuries up to a grade III.

TABLE 3. Kidney Injury Scale—2018 Revision

AAST Grade	AIS Severity	Imaging Criteria (CT Findings)	Operative Goals	Pathologic Criteria
I	2	– Subcapsular hematoma and/or parenchymal contusion without laceration	– Nonexpanding subcapsular hematoma – Parenchymal contusion without laceration	– Subcapsular hematoma or parenchymal contusion without parenchymal laceration
II	2	– Perirenal hematoma confined to Gerota fascia	– Nonexpanding perirenal hematoma confined to Gerota fascia	– Perirenal hematoma confined to Gerota fascia
		– Renal parenchymal laceration ≤1 cm depth without urinary extravasation	– Renal parenchymal laceration ≤1 cm depth without urinary extravasation	– Renal parenchymal laceration ≤1 cm depth without urinary extravasation
III	3	Renal parenchymal laceration >1 cm depth without collecting system rupture or urinary extravasation	Renal parenchymal laceration >1 cm depth without collecting system rupture or urinary extravasation	Renal parenchymal laceration >1 cm depth without collecting system rupture or urinary extravasation
		– Any injury in the presence of a kidney vascular injury or active bleeding contained within Gerota fascia	–	
IV	4	– Parenchymal laceration extending into urinary collecting system with urinary extravasation	– Parenchymal laceration extending into urinary collecting system with urinary extravasation	– Parenchymal laceration extending into urinary collecting system
		– Renal pelvis laceration and/or complete ureteropelvic disruption	– Renal pelvis laceration and/or complete ureteropelvic disruption	– Renal pelvis laceration and/or complete ureteropelvic disruption
		– Segmental renal vein or artery injury	– Segmental renal vein or artery injury	– Segmental renal vein or artery injury
		– Active bleeding beyond Gerota fascia into the retroperitoneum or peritoneum	– Segmental or complete kidney infarction(s) due to vessel thrombosis without active bleeding	– Segmental or complete kidney infarction(s) due to vessel thrombosis without active bleeding
		– Segmental or complete kidney infarction(s) due to vessel thrombosis without active bleeding		
V	5	– Main renal artery or vein laceration or avulsion of hilum	– Main renal artery or vein laceration or avulsion of hilum	– Main renal artery or vein laceration or avulsion of hilum
		– Devascularized kidney with active bleeding	– Devascularized kidney with active bleeding	– Devascularized kidney
		– Shattered kidney with loss of identifiable parenchymal renal anatomy	– Shattered kidney with loss of identifiable parenchymal renal anatomy	– Shattered kidney with loss of identifiable parenchymal renal anatomy

Vascular injury is defined as a pseudoaneurysm or arteriovenous fistula and appears as a focal collection of vascular contrast that decreases in attenuation with delayed imaging. Active bleeding from a vascular injury presents as vascular contrast, focal or diffuse, that increases in size or attenuation in delayed phase. Vascular thrombosis can lead to organ infarction.

Grade based on highest grade assessment made on imaging, at operation or on pathologic specimen.

More than one grade of kidney injury may be present and should be classified by the higher grade of injury.

Advance one grade for bilateral injuries up to Grade III.