A Case of Hepatic Injury Following Shrapnel Injury to the Abdomen in a Paediatric Patient

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DOI: 10.48107/CMJ.2021.10.002

DOAJ: a900814f902a478493008abc4bbac825

ABSTRACT

In children, trauma is the leading cause of morbidity and mortality worldwide. Trauma can be a catalyst resulting in intra-abdominal solid organ injury in this population. The case report highlights a prepubescent male who presented with a penetrating abdominal wound resulting in hepatic injury. The mechanism of injury in this case is unusual and differs from previously reported causes of penetrating abdominal trauma in children. The case demonstrates that penetrating abdominal injuries may be more likely to require surgical intervention secondary to their association with a high percentage of multiple organ injuries. Penetrating injuries in children require a high degree of vigilance to rule out visceral injury.

INTRODUCTION

Accidental or unintentional injuries are responsible for the death of more than 2,000 children daily worldwide.[1] Trauma serves as the leading cause of morbidity and mortality in children.[2] Though relatively uncommon, intra-abdominal solid organ injury is a potential source of significant morbidity in the paediatric population.[3] The spleen and the liver are the most commonly injured intra-abdominal organs.[3,4,5] Blunt abdominal trauma is more than twice as likely to occur than penetrating abdominal trauma in childhood.[6] The following case report is that of a prepubescent male who presented with a penetrating abdominal wound resulting in a grade II liver laceration. In this case, the unusual mechanism of injury is of interest.

CASE REPORT

A 12-year-old male, with nil known medical conditions, initially presented to a District Health Facility (DHF) with a penetrating abdominal wound. The patient gave a history of carrying a hydraulic arm, as seen in Figure 1, following removal from the trunk of the family sports utility vehicle. He reported accidentally releasing the hydraulic arm to the ground, subsequent to which, it exploded. The patient noted that, after explosion, a piece of metallic shrapnel was protruding from his abdomen. He removed the shrapnel to reveal a penetrating abdominal wound, as seen in Figure 2.

On presentation to the DHF, the patient was noted to

have a wound to the abdomen, approximately three centimetres in diameter, superior to umbilicus. It was approximately four centimetres tunnelling into the abdomen. He had generalized abdominal tenderness but no active bleeding. Laboratory investigations at this time showed a white blood cell count of 9.5 x 10^3/µL, haemoglobin of 12.9 g/dL and platelet count of 433 x 10^3/µL. Initial Focused Assessment with Sonography for Trauma (FAST) scan was unremarkable, however, repeated FAST scan prior to transfer to a tertiary-level hospital revealed a small collection of fluid in Morrison's Pouch.

On transfer to a tertiary-level hospital a few hours later, the patient was reassessed by the emergency department personnel. His abdomen was soft but still had generalized tenderness with voluntary guarding. There was no active bleeding at the puncture wound and his haemoglobin and platelet laboratory values were unchanged. However, he was noted to have an elevation in his white blood cell count to 20.8 x 10^3/µL. Repeated FAST at this time again showed a small collection of fluid in Morrison's pouch. He was referred to the surgical team and had a computerized tomography (CT) scan of the abdomen and pelvis with intravenous contrast. CT scan revealed the presence of a liver laceration with haematoma. The liver laceration measured approximately 6.7cm x 3.9cm x 6.3cm and extended from the subcapsular surface to the intraparenchymal region. These radiological findings were consistent with a grade II liver injury.

The patient was admitted by the surgical unit to the ward for conservative management. However, he had clinical deterioration with multiple episodes of vomiting and an ill -looking appearance. He was then scheduled for an emergency exploratory laparotomy later that day.

Intraoperatively, normal healthy bowel with bleeding at the rectus muscle and breech of peritoneum and abdomen wall was noted. There was no active bleeding at the liver laceration or injury to the gallbladder. The external wound was debrided and closed. Patient had clinical improvement postoperatively. He was allowed home five days post-surgical intervention with surgical outpatient clinic follow up.

DISCUSSION

In the paediatric population, though relatively uncommon, intra-abdominal solid organ injury is a potential source of significant morbidity.[3] The most commonly injured intra-abdominal organs are the spleen and the liver, which are located in the upper abdomen.[3,4,5] The anatomical construct of the human body offers the ribs as a partial source of protection to the liver. However, in children they are less effective than in adults as the ribs are very pliable in early childhood.

Figure 1: Picture of hydraulic arm similar to the one implicated in the mechanism of injury

Figure 2: Photograph of abdominal wound resulting from shrapnel injury with hydraulic arm

Additionally, in the younger paediatric population, the liver and spleen may extend caudally beyond the ribs. In children, larger viscera, less overlying fat, weaker abdominal musculature and the presence of less fibrous stroma tissue in the liver, also increases the potential of abdominal injuries and susceptibility to liver lacerations and bleeding if involved in trauma.[7] The liver is highly vascular as it has a dual blood supply from both the hepatic arteries and portal veins. Hence, injuries to the liver can result in rapid exsanguination resulting in increased risk of morbidity.

Blunt abdominal trauma is more than twice as likely to occur than penetrating abdominal trauma in childhood.[6] The most common mechanism of blunt abdominal trauma in children results from high-energy mechanism injuries, namely road traffic accidents, falls from elevated heights, bicycle accidents and child abuse.[6] Penetrating abdominal injuries, though found to be less common in the paediatric population, are associated with a high percentage of multiple organ injuries that require surgical intervention.[8] This finding is opposite to that found in adults where the hepatic mass appears protective because of its larger size. In children, the internal organs and their close proximity to each other, appears to make surgical intervention necessary for the majority of children with penetrating injury to the hepatic bed, and indicates that this approach should remain the standard of care for paediatric patients.[8] The majority of penetrating abdominal injuries in children have been found to be attributed to gunshot wounds and stab wounds.[8]

The patient's intra-abdominal injury did not result from the previously highly identified causes of penetrating injury. Instead, his was as a result of the shrapnel associated with the accidental explosion of a discarded hydraulic arm used in the opening and closing of the family sports utility vehicle trunk. The effects of penetrating trauma on the human body vary depending on the type of weapon and velocity in which they penetrated. Penetrating injuries from stab-type trauma usually results in local tissue effects along the tract of penetration. Meanwhile, high-velocity projectile injuries tend to result in wider tissue injury due to the effects of cavitation and more than one tract involvement. The projectile itself causes tissue damage along the tract while energy transfer from deceleration leads to cavitation and rapid collapse of tissue bordering the path of the projectile. Thus, while tissues or structures may not be directly transected as the projectile passes, significant injury can result from transferred ballistic forces.[9] With the possibility of more tracts and transferred ballistic forces, there is an increase likelihood of visceral injuries from shrapnel injury. Hence, surgical intervention rather than conservative management may be more necessary with penetrating injuries from shrapnel.

In cases of trauma, one of the most utilised radiological assessments is that of the FAST exam. It is a bedside assessment utilizing ultrasound technology and though it can identify the presence of blood in the abdominal cavity or pericardial sac, it cannot identify the severity of organ injury. FAST assessment is dependent on operator skills. Its sensitivity and specificity range from 63% to 100% and 95% to 100%.[10] In hemodynamically-stable patients, CT scans of the abdomen and pelvis with intravenous contrast often follows the FAST scanning in patients with abdominal trauma. It is the best modality for identifying hepatic injuries and allows for grading of the severity of hepatic injury. The administration of intravenous contrast allows for the identification of patients with active extravasation of blood. This is noted by a blush-appearance on the CT scan images of the liver. Of note, in the acute setting, magnetic resonance cholangiopancreatography does not have a role as a radiological assessment due to its time-consuming nature. However, it may be used in patients where there is a high suspicion of bile duct injury or leakage.

The American Association for the Surgery of Trauma (AAST) has created a classification to grade hepatic injury. This classification is inclusive of grade I to VI. As seen in Table 1, grade I hepatic injuries are of lesser severity while grade VI hepatic injuries are the most severe liver injuries. The majority of patients who present with grades I, II or III hepatic injuries can be successfully treated with nonoperative management. By comparison, almost two-thirds of grade IV, V or VI hepatic injuries require operative management utilising a laparotomy.[11, 12]

The World Society of Emergency Surgery (WSES) liver trauma management guidelines classifies hepatic injury as seen in Table 2. For WSES grades I to III, in the

Table 1: American Association for the Surgery of Trauma (AAST) Classification for Hepatic Injury

Grade	Description of Hepatic Injury
I	Haematoma: subcapsular, <10% surface area Laceration: capsular tear, <1cm parenchymal depth
II	Haematoma: subcapsular, 10-50% surface area Haematoma: intraparenchymal <10cm diameter Laceration: capsular tear 1-3cm parenchymal depth, <10cm length
III	Haematoma: subcapsular, >50% surface area of ruptured subcapsular or parenchymal haematoma Haematoma: intraparenchymal >10cm Laceration: capsular tear >3cm parenchymal depth Vascular injury with active bleeding contained within liver parenchyma
IV	Laceration: parenchymal disruption involving 25-75% hepatic lobe or involves 1-3 Couinaud segments Vascular injury with active bleeding breaching the liver parenchyma into the peritoneum
V	Laceration: parenchymal disruption involving >75% of hepatic lobe Vascular: juxtahepatic venous injuries (retrohepatic vena cava/central major hepatic veins)
VI	Vascular: hepatic avulsion

Table 2: World Society of Emergency Surgery (WSES) Liver Trauma Classification

	WSES Grade	AAST Grade	Hemodynamic Status
Minor	WSES grade I	I-II	Stable
Moderate	WSES grade II	III	Stable
Severe	WSES grade III	IV-V	Stable
Severe	WSES grade IV	I-VI	Unstable

absence of a positive blush sign on contrast enhanced CT scan or signs of early aneurysm, non-operative management is suggested. Conservative management is inclusive of serial clinical, laboratory and radiological evaluation. In the event of suspected abdominal lesions or patient becoming hemodynamically or clinically unstable, management proceeds to operative management. Operative management is also indicated in hemodynamically unstable patients and in non-responsive patients with WSES grade IV.[13]

The patient in this case had a grade II liver laceration which can be classified as a WSES grade I injury and is generally conservatively managed. The initial management plan by the surgical team involved conservative management of the liver laceration and healing by secondary intention to the open abdominal wound. However, with the patient's clinical deterioration, the decision was made to progress to intraoperative intervention to rule out the possibility of any previously undetected intra-abdominal injury and close the open abdominal wound. This modification to the management plan was more in keeping with the findings that surgical intervention is necessary for the majority of children with penetrating injury to the hepatic bed, and indicates that clinicians should always have a high degree of suspicion for visceral injuries in patients with penetrating abdominal injuries.[8]

CONCLUSION

In paediatrics, penetrating abdominal injuries are associated with a high percentage of multiple organ injuries and may be more likely to require surgical intervention. Hence, a high degree of vigilance to rule out

visceral injuries should be present in paediatric cases of penetrating injuries.

Funding Statement: None
Ethical Approval Statement: Not Applicable
Conflict of Interest Statement: None
Informed Consent Statement: Informed consent was obtained from the parent of the patient.
Author Contributions: The co-authors equally contributed to construct of the manuscript and final approval of the version to be published.

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