

## Visceral Injuries in Children with Blunt Abdominal Trauma: Pattern, Presentation and Prognosis

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### Abstract

**Background:** Blunt abdominal injury following trauma is quite common in childhood. It may be responsible for major mortality and morbidity depending upon the pattern and presentation of the injury. The aim of our research was to study the pattern, presentation and prognosis of visceral injuries in children afflicted with blunt abdominal trauma. **Material and Methods:** It was a prospective study conducted over a period of two-and-half years during which a total of 28 children with some form of intra abdominal injury following blunt trauma were studied. Detailed demographic and clinical profiles of the patients were noted. The mechanism of injury, type and grade of visceral injuries and their management were studied. **Results:** There were 24 males and 4 females children (M:F ratio of 6:1) with some form of intra-abdominal injury. The mean age was 6.8 years. The most common form of injury was motor vehicle accident (53.5%). Around 7% of children suffered polytrauma. Ultrasound detected only 57% of the injuries. The liver was the most commonly injured solid visceral organ in children. Non-operative management was successful in all the patients with solid visceral injury. **Conclusions:** Solid organ injury is much more common than hollow visceral injury with liver being the most commonly injured intra-abdominal organ. Road traffic accident is the most common mechanism of injury. Ultrasound examination in blunt trauma is neither very specific nor sensitive. CT scan gives the accurate details of visceral injury but carries risk of radiation. Nonoperative management is the mainstay of treatment even in high grade solid organ injuries while operative intervention is required for most of the bowel injury.

**Keywords:** Blunt Trauma; Children; Visceral Injuries.

### Introduction

In this expeditiously moving world trauma has acquired epidemic proportions. Although orthopedic, cranial and cervical injuries predominate, around 20% admissions are due to abdominal trauma and 10% deaths in childhood are due to abdominal injuries [1,2]. Following trauma, abdomen may be injured by penetrating or blunt manner. Blunt injury to abdomen is more common form of injury especially in children. Besides motor vehicle collision (MVC),

children also sustain abdominal trauma while playing [3]. All the intra-abdominal organs are at risk following blunt injury. The mechanisms involved in intraabdominal visceral injury are three fold; the deceleration forces causing avulsion injury, compression force leading to compression of viscera between abdominal wall and vertebral column and direct external compression force causing sudden rise in intrabowel pressure leading to rupture or perforation. Moreover the children become especially vulnerable to visceral injury due to several unavoidable anatomical reasons; higher solid viscera-to-body ratio, underdeveloped muscles and abdominal wall, relatively elastic ribcage, and more anterior position of liver and spleen due to diaphragmatic position. However, children have good physiologic reserve and hardly any co-morbid conditions thereby allowing them to withstand hemodynamic instability better than adults [4]. This study was undertaken to assess the pattern of visceral involvement, presentation and management and the

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outcome of visceral injuries in children following blunt abdominal trauma.

### Material and Methods

This was a prospective study conducted from July 2015 to December 2017 in children less than 14 years of age presenting with history of blunt abdominal trauma to our hospital. At presentation all the children were subjected to an appropriate primary survey with simultaneous resuscitation. At the time of admission demographic data, mode of injury, time since injury and evidence of polytrauma were noted. A detailed clinical, abdominal examination and vital signs (blood pressure and heart rate) were recorded. The presence of other significant injuries involving other regions was also noted. The findings of pneumothorax, hemothorax, rib fracture, pulmonary contusion, and pneumoperitoneum on X-ray examination of chest, abdomen and pelvis were recorded. The abdominal ultrasound examination was done to look for the solid organs including pancreas, kidneys and bladder for any evidence of laceration, hematoma and intraperitoneal and retroperitoneal fluid. CT scan was done and grading of injuries was performed. The data was analyzed by descriptive and comparative statistics.

### Results

Out of the all the children who presented with history of abdominal trauma, twenty eight patients with visceral injury were included in the final analysis. The demographic profile of the children with intraabdominal injury is represented in Table 1. There were 24 males and four females (M:F ratio 6:1). The age range of the 28 children was 5-12 years with the mean age being 6.8 years. The most common cause

of injury was motor vehicle collision (pedestrian hit by speeding vehicle) which was present in 15 children (53.5%). The second most common cause of blunt intra-abdominal injury was fall from height (21.4%, n=6). This was followed by vehicle roll over (n=3), physical assault injuries (n=2), farm injuries (n=1), cattle horn (n=1) and in that order. Only 7.1 % (n=2) children were involved in a polytrauma while rest presented with history of isolated abdominal injury. Of these one had concussion head injury and the other had associated clavicle fracture. Pain abdomen was the most common presenting complaint seen in 25 children (89.2%). This was followed by abdominal distension and vomiting. In the final analysis, there were a total of 28 patients in whom there was a final diagnosis of some form of intra-abdominal injury. This final diagnosis was either based on CT scan and/or laparotomy. Out of these, 27 (96.4%) cases were diagnosed based on CT scan and 1 case on exploratory laparotomy. Among these 28 patients, solid organ injury was detected by sonography in 16 patients; 8 hepatic injuries, 6 splenic injuries, and 2 renal injuries. In three patients, ultrasound detected free fluid only while in 9 patients the ultrasound abdomen was normal. Out of these 28 children, 24 (85.7%) had single visceral injury while 4 (14.3%) had multiple visceral injuries, together making up to a total of 31 visceral injuries. The pattern of visceral involvement was; liver (39.2%, n=11), spleen (35.7%, n=10), kidney (14.2%, n=4), pancreas (7.1%, n=2), bowel (10.7%, n=3) and retroperitoneal hematoma (3.5%, n=1). One patient had both hepatic and splenic injury, one patient had both splenic and renal injury and one patient had both pancreatic and renal injury. The most common mode of injury in children with multiple intraabdominal injuries was vehicle rollover in which was present in 2 patients (out of four) while the most common mode of injury in children with single intraabdominal injury was pedestrian hit by speeding vehicle (50%, n=14). The grading of the intra-abdominal injuries is depicted in Table 2.

**Table 1:** Demographic profile of the patients

Parameter	Value
Mean Age	7.8 years
M:F	6:1
Mode of Injury	
Motor Vehicle Collision	53.5% (n=15)
Others	46.5% (n=13)
Isolated abdominal injury	92.9% (n=26)
Polytrauma	7.1% (n=2)
Single Visceral injury	85.7% (n=24)
Multiple Visceral injury	14.3% (n=4)
Main presenting complaint (Pain)	89.2% (n=25)

**Table 2:** Grading of visceral injuries

Organ	Grades				
	I	II	III	IV	V
Liver (n = 11)	2	4	3	2	0
Spleen (n = 10)	2	3	4	1	0
Kidney (n=4)	1	2	1	0	0
Pancreas (n = 2)	0	1	1	0	0

All the patients of solid visceral injury were managed non-operatively. The three patients of bowel perforation were managed by exploratory laparotomy with primary repair of the perforations (two ileal perforations while one jejunal perforation).

While the two cases of bowel injury were diagnosed immediately on preliminary X-ray abdomen showing pneumoperitoneum, one case of ileal injury, which was missed even on CT scan, underwent delayed operative intervention due to development of peritonitis. On laparotomy, there was a transverse tear in ileal mesentery and the resultant bowel gangrene requiring resection and end to end anastomosis. This patient was also having a nonexpanding hematoma in zone II of retroperitoneum.

Thus out of the 28 patients, 25 were managed non-operatively while three were managed operatively. Non-operative management was successful in all the patients of solid visceral injury. The child with splenic and associated bowel injury required operative intervention because of bowel perforation and on exploration the spleen was left without any procedure. There was no mortality in the studied children.

## Discussion

In children, blunt abdominal trauma is more common than penetrating trauma [1]. It is estimated that the incidence of solid visceral injuries in children with blunt abdominal trauma ranges from 4 to 8 percent. Injury to hollow viscus is seen less commonly than solid organ injury in these children [5,6]. The pattern of visceral injury following blunt abdominal trauma in children depends on mode of injury, governed by age and gender. The delayed presentation, missed or delayed diagnosis can affect the outcome. In convalescence, trauma may lead to temporary or permanent disability mandating long-lasting care which can cause considerable effect on their psychosocial health and may lead to significant financial liability [4].

The mean age of the children affected with intra-abdominal injury was 6.8 years and boys outnumbered girls in our study (M:F ratio=6:1). In various studies it has been shown that school-going boys are at are at maximum risk of road traffic accidents which include pedestrian injuries and self motor-vehicle injuries. The toddlers suffer the risk of fall injuries. The reason given for this association is that boys are relatively more outgoing and therefore shun restrictions making them potential targets of trauma related incidents.

Road traffic accidents have been identified as the single most common cause of abdominal trauma in children. In our study also 53.5% children suffered blunt injury while they were moving around the road and were hit by a speeding vehicle. Children become vulnerable to road traffic accidents while playing on road, going to market, going to school by road unsupervised. The next most common cause was fall from height. The most common mechanism is fall from unprotected roofs, stairs or parapet. The other causes of fall are fall from tree [7,8,9].

In our study abdominal pain was the presenting complaint in almost 90% of the patients. Abdominal tenderness was present in 67.8% (n=19) of the patients while distension was present in 10.7% (n=3) of the patients. We found that the liver was the most common (39.2%) visceral organ to be injured in our study group. This was followed by spleen (35.7%). Isolated hepatic injury was present in 35.7% (n=10) while isolated splenic injury was present in 28.5% (n=8) patients. Most of the hepatic injuries were of grade II while in spleen grade III were the most common grade. Various studies have reported spleen as the most common solid organ to be injured in children. The difference in our study is might be due to fewer numbers of cases. Both the organs are highly vascular with the liver having dual blood supply predisposing them to severe bleeding. Blunt Pancreatic injuries are rare in children. In our study there was a child each of grade II and grade III pancreatic injuries (7.1%, n=2). The most common mechanism is epigastric injury with the bicycle handlebar. Most of the patients have significant upper abdominal pain [10].

Blunt injury to bowel is less common and is reported to occur anywhere from 1 to 10 % of children with blunt abdominal trauma. In our study there were three cases of bowel injury (10.7%). Although plain X-ray may demonstrate free air under the diaphragm, the clinical as well as radiological diagnosis of bowel injury is often difficult as was demonstrated in one of the patient in our study group. The bowel injury was detected late following development of peritonitis.

The mode of injury, presentation and injury patterns may generally differ but the initial assessment and resuscitation is almost the same. Once the hemodynamic stability is ensured and the simultaneous primary survey is complete, a thorough physical examination performed. Any contusion, laceration, rib fracture or tell tale sign of injury must be recorded diligently. Any radiologic investigation is advised once the secondary survey is complete. In our study two cases of bowel injury were detected on preliminary plain x-ray showing pneumoperitoneum. CT scan has good sensitivity to detect solid organ injury but not in hollow viscus injury. Besides pneumoperitoneum, the other signs of bowel injury on CT scan are peritoneal fluid (without solid organ involvement), bowel wall enhancement and thickening, extraluminal gas, bowel wall discontinuity, and mesenteric stranding [12].

In absence of clear cut evidence of bowel injury, initiation of nonoperative management may lead to delayed surgical intervention with resultant morbidity as happened in one case in our study [17]. CT scan is the mainstay of diagnosis in hemodynamically stable children with hepatic and splenic injury. It can accurately grade the injury, detect the amount of hemoperitoneum as well as help detect other associated injuries.

For pancreatic injuries also the CT scan with IV contrast is the imaging modality of choice.

Even though CT scan offers the most accurate multiplanar imaging with good spatial resolution of the injuries of solid organs, it does have a disadvantage of unnecessary radiation exposure to the child. Therefore various studies have suggested that ultrasound can be combined with various scores and biochemical tests to select patients in whom judicious use of CT scan can be done [14,15].

Although ultrasound evaluation with FAST is a standard practice in children with abdominal trauma, a negative FAST does not rule out the intra-abdominal injury. Therefore a more detailed ultrasound examination or repeated FAST examination or ultrasound combined with clinical and biochemical

examination has been suggested as a better alternative [16,17].

Recently laparoscopy has come up as useful adjunct in assessment of blunt trauma patients. It is safe and can help decrease the unnecessary exploratory laparotomies [18].

Treatment of abdominal injuries in hemodynamically stable children is guided by the grade of injury on CT imaging. All the children with hepatic injury were managed conservatively in our study. It is reported that 85% and 90% of hepatic injuries can be managed nonoperatively [19].

The prerequisites for conservative treatment of hepatic injuries are hemodynamic stability and absence of peritoneal signs. Operative intervention in hepatic injuries is again guided by the extent and nature of injury. Patients with a major hepatic injury causing laceration, considerable exsanguinations require "damage control" surgery because of risk of development of triad of coagulopathy, hypothermia and acidosis. After resuscitation and control of blood parameters these patients are taken up for relook surgery and definitive repair [20].

In splenic injuries also, the standard care is non-operative and is successful in 90-95% of the children of splenic injury [19].

All the patients of splenic injury were managed conservatively in our study with good outcome. The one patient who had associated bowel injury was explored because of bowel perforation.

The indications for operative intervention include clinical suspicion of ongoing blood loss with hemodynamic instability and suspicion of an associated hollow visceral injury. As far as possible spleen should be preserved with spleen preserving operations like splenorrhaphy and partial splenectomy to avert the risk of postsplenectomy infections in children [21].

Low grade pancreatic injuries like contusions and laceration are also managed conservatively with good results. However, treatment of ductal injuries is an area of debate as some authors recommend conservative approach or partial resection while others advocate extensive surgical reconstruction.

The impediment of conservative management is that despite CT scan providing exact anatomical details of injury, the progress of the injury is not known. Whether it is solid organ or hollow visceral injury the most important and sensitive tool for successful completion of conservative management or timely detection of failure is frequent abdominal examination of the injured child.

## Conclusion

Blunt abdominal injuries in children are quite common occurrence. The solid viscera are more frequently involved the hollow viscus. However the latter poses more diagnostic challenge. The high incidence of road traffic accidents in children point toward the need of proper education program for parents vis-à-vis proper guardianship as well as road safety promotion among children. Although bowel injury frequently need surgical intervention, conservative management of singular solid organ injury with hemodynamic stability gives good results under cover of repeated abdominal examination.

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