Original Article

Spectrum of Paediatric Blunt Abdominal Trauma in a Tertiary Care Hospital in India

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Abstract

Aim: To study the profile of paediatric blunt abdominal trauma and to assess the correlation of grade of injury with the outcome. **Materials and Methods:** It is a prospective observational study from January 2015 to December 2020. Children below 12 years with blunt abdominal trauma were included. Patient demographic data, treatment given and the final outcome were recorded. All patients were followed up for a minimum of 6 months to maximum 5 years. **Results:** A total of 68 patients were included in the study. Fall from height was the most common mode of injury (62%) followed by road traffic accidents (35%) and the other causes included in the miscellaneous group (hit by animal and fall of heavy object on the abdomen; 3%). Most commonly injured organ was liver (n = 28, 41%) followed by spleen (n = 18, 26%) and kidney (n = 15, 22%). Other injuries were bowel perforations (jejunal [n = 4], ileal [n = 1] and large bowel [n = 1]; 9%), pancreaticoduodenal (n = 5, 7%), urinary bladder (n = 3, 4%), abdominal vascular injury (iliac vein-1, inferior vena cava-1;3%), adrenal haematoma (n = 2,3%) and common bile duct (CBD) injury (n = 1, 1%). More than one organ injury was seen in 13 cases (19%). Non-operative management was successful in 84% (n = 27) and laparotomy was done in 16% (n = 11). Most of the patients sustained Grade IV injury (n = 36, 53%) and majority of the patients (n = 60, 88%) had good outcome without any long-term complications. **Conclusion:** Profile of paediatric blunt abdominal trauma include solid organ injuries such as liver, spleen, kidney, pancreas, adrenal gland and others like bowel injury, CBD, urinary bladder and abdominal vascular injury. The grade of injury does not correlate with the outcome in a higher grade of injury and these children had good outcome.

Keywords: Blunt abdominal trauma, conservative management, grade of injury, laparotomy, Outcome

Introduction

Trauma is the leading cause of mortality and disability in children over 1-year of age in both developed and developing countries and accounts for 60% of all childhood deaths. In recent decades, the child mortality has decreased due to substantial initiatives taken to reduce communicable diseases, but at the same time, these saved children are becoming victims to trauma.[1]

Abdominal trauma accounts for 10% of overall trauma and is the third most common cause of death in children after head and thoracic injuries. Because of their small size, multisystem involvement is common in children and the impact will be severe. After trauma, some children develop temporary or permanent disability requiring care and it has a significant impact on their psychosocial health. The present study helps in understanding the spectrum of paediatric blunt abdominal trauma and how the grade of injury and type of treatment offered to affect the final outcome.

Materials and Methods

Approval from the institutional ethical committee was taken for conducting the study. Sixty-eight consecutive patients with blunt abdominal trauma below 12 years of age were studied prospectively from January 2015 to December 2020. Penetrating injuries, thermal injuries and sexual assaults were excluded. Patient demographic data which include age,

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sex, mode of injury, place of injury, time of presentation to hospital after the incident, general condition at the time of presentation, organ injured and its grade, type of treatment offered and final outcome were recorded. Grade of injury was assigned in each patient based on contrast-enhanced computed tomography (CECT) and intraoperative findings as per the revised American Association for the Surgery of Trauma grading. Outcome variables including length of hospital stay, restriction of activity, re-admission rate were studied. All patients were followed up for a minimum of 6 months and maximum of 5 years, to look for any long-term complications like disability and morbidity.

Statistical analysis

Statistical analysis was performed with help of Epi Info™ 7.2.2.2 which is a trademark of the centres for disease control and prevention. Descriptive statistical analysis was performed to calculate the mean with corresponding standard deviations. Test of proportion was used to find the standard normal deviate (Z) to compare different proportions and Chi-square (χ^2) test was performed to find the associations. Odds ratio with 95% confidence interval had been calculated to find the risk factors. Pearson correlation co-efficient was calculated to find the correlation between variables, $P < 0.05$ was taken to be statistically significant.

Results

A total of 68 patients with blunt abdominal trauma were included in the study. Demographic data of the study population are presented in Table 1. Most of the patients were in the age group between 6 and 12 years (47%). The median age of presentation was 6.5 years. Male to female ratio was 3:1. Fall from height (FFH) was the most common mode of injury ($n = 42$, 62%). Most of the injuries occurred at home ($n = 42$, 62%) followed by on-road ($n = 24$, 35%) and then in the park ($n = 2$, 3%). Except seven patients all others were hemodynamically stable at the time of presentation. Clinical predictors of intra-abdominal injury (IAI) were also evaluated [Table 2]. All patients had free fluid in peritoneal cavity on focussed assessment with ultrasonography in trauma (FAST) and grading was done based on CECT and intraoperative findings. Haemoglobin (Hb) at admission ranges from 4.0 to 6.9 gm% in 12% of the patients, 7–9.9 gm% in 47% and > 10 gm% in 41% of patients. Blood transfusion was given in 23 patients (34%). The most commonly injured organ in our study was liver ($n = 28$, 41%) followed by spleen ($n = 18$, 26%) and kidney ($n = 15$, 22%) [Figure 1]. Other injuries were bowel perforations (jejunal [$n = 4$] [Figure 3], ileal [$n = 1$] and large bowel [$n = 1$]; 9%), pancreatic ($n = 3$, 4%) duodenal ($n = 2$, 3%), urinary bladder [contusions ($n = 2$), intraperitoneal rupture ($n = 1$); 4%], abdominal vascular injury (iliac vein-1, inferior vena cava-1), adrenal hematoma ($n = 2$) [Figure 2] and common bile duct (CBD) injury ($n = 1$) [Table 3]. Thirteen patients (19%) had injuries involving more than one organ (e.g., Liver + spleen, liver + kidney, kidney + spleen and liver + pancreas). Most of the patients sustained a higher grade of injury IV ($n = 36$, 53%) [Table 3]. More than half of the patients ($n = 38$, 56%) had associated injuries like chest injuries ($n = 19$,28%; haemothorax, hemopneumothorax, pneumothorax, minimal pericardial effusion); musculoskeletal injuries ($n = 11$, 16%; fracture pelvis, femur, tibia, fibula, humerus) and head injuries ($n = 9$, 13%; undisplaced fracture of frontal, temporoparietal and occipital bones, pneumocephalus and facial nerve palsy). Conservative management was successful in 57 patients (84%) and exploratory laparotomy was done in 11 cases (16%) on first admission, which include 2 cases of duodenal injury, 4 cases of jejunal perforation, one case of ileal perforation and one case of transverse colon perforation, one case of Grade III liver injury with active bleeding (angioembolisation is not available in our institute), one case of CBD injury and one case of intraperitoneal bladder rupture. In the current study, only 17 patients (25%) were discharged from the hospital as per the American Paediatric Surgical Association (APSA) guidelines and remaining all other patients stayed more than the recommended stay. Activity restriction was as per APSA guidelines in all the patients. The majority of patients ($n = 60$, 88%) had good outcome even in cases of higher grade (Grade IV and V) injury, and the complications during follow-up were noted in eight patients (12%) [Table 4].

Table 1: Demographic data of the study population

Serial number	Variable	Category	Total, *n* (%)
1	Age distribution (years)	≤3	12 (18)
		3.1–5.9	24 (35)
		6–12	32 (47)
2	Gender distribution	Male	52 (76)
		Female	16 (24)
3	Mode of injury	FFH	42 (62)
		RTA	24 (35)
		Miscellaneous	2 (3)
4	Time of reporting to hospital (h)	Within 24	36 (53)
		24–72	19 (28)
		After 72	13 (19)

FFH: Fall from height, RTA: Road traffic accidents

Table 2: Clinical predictors of intra-abdominal injury

Serial number	Clinical predictors	*n* (%)
1	PCV (<30)	42 (62)
2	Abnormalities detected through clinical examination/AAE	51 (75)
3	AST (>200 U/L)	18 (26.4)
4	Hematuria (>5 RBC)	12 (17.6)
5	Hypotension	7 (10)
6	Amylase (>100 U/L)	5 (7.3)

PCV: Packed cell volume, AAE: Abnormal abdominal examination, RBC: Red blood cell, AST: Aspartate aminotransferase

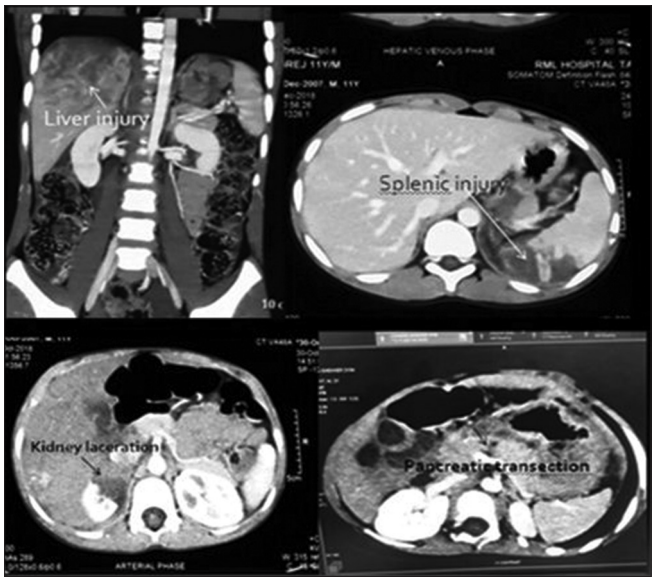


Figure 1: CECT abdomen showing solid organ injuries, CECT: Contrast-enhanced computed tomography

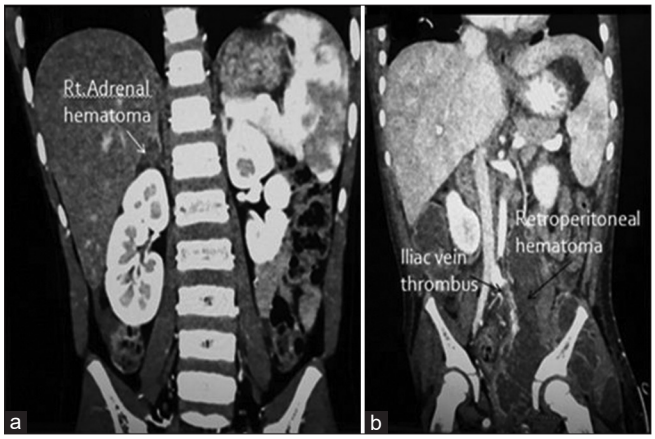


Figure 2: CECT abdomen showing (a) right adrenal haematoma (b) iliac vein thrombus with retroperitoneal haematoma, CECT: Contrast-enhanced computed tomography

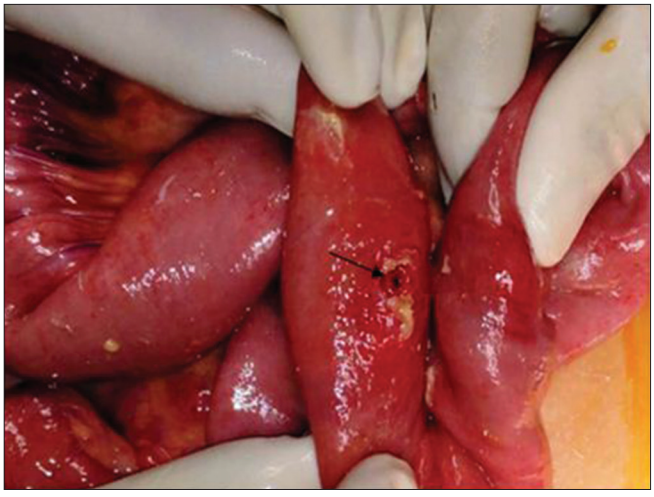


Figure 3: Intraoperative picture showing jejunal perforation

Discussion

Most of the children who sustained injury in our study were school-going children (6–12 years). It is similar to the study according to Hegde *et al.* and Bhatti *et al.*[2,3] In the present study, 76% (n = 52) of the injured children were males while females accounts for 24% (n = 16). It may be due to social factors like more freedom, opportunities and facilities given to males in our society in India and environmental factors such as playing on roads, trees, rooftop and near construction sites makes them more vulnerable to get injured. All these factors were mentioned in the study of Kundal *et al.*,[1] it is similar to the previous studies according to Kulshrestha *et al.,* Verma *et al.* and Sharma *et al.*[4-6]

The most common mode of injury in our study was FFH (n = 42, 62%) while road traffic accidents account for 35% (n = 24), miscellaneous causes like hit by animal and fall of heavy object on the abdomen were seen in 3%. Similar results were noted in the previous study by Sharma *et al.* and Bangdiwala *et al.*[6,7] In our study fall from roof, fall from stairs, fall from bed and fall on the ground while playing were more common which signifies the need for proper supervision at home and play areas.

In the present study, majority (53%, n = 36) of patients presented within 24 h after injury and 28% (n = 19) of them presented between 24 and 72 h after injury; according to the study of Hegde *et al.,* 80% of patients presented within 24 h.[3] Usually retroperitoneal injuries presents late because the signs and symptoms will be subtle and associated intra-abdominal and multisystem involvement further delays the diagnosis.[8] In our study, late presentation is observed in children with Grade I or II injuries and retroperitoneal injuries.

At the time of presentation majority of the patients (90%, n = 61) were hemodynamically stable. Fifty-one out of 68 patients (75%) had abnormal abdominal examination (AAE) which includes abdominal distension, abdominal wall contusion/seat belt sign, tenderness on palpation and other signs of peritonitis. This is statistically significant (z = 8.29, $P < 0.001$). Increase in abdominal girth (AG) was observed in 11 patients (16%) on serial measurement and all of them underwent laparotomy. Streck *et al.* proposed a clinical prediction rule to identify IAI, thus reducing unnecessary CT scans of abdomen.[9] It includes six high risk clinical factors which can predict IAI and those are hypotension, AAE, haematocrit < 30, aspartate amino transferase (AST) >200, serum amylase > 100 U/L and haematuria (>5 Red Blood Cells (RBC)/hpf). These clinical predictors taken into consideration in our study are enumerated in Table 2, all our patients had at least one parameter positive among the six, confirming the IAI, but CECT was done to know the exact grading of injury after stablilising the patient. According to Holmes *et al.,* the six variables which can predict IAI are systolic blood pressure, AAE, haematocrit, liver function tests, urine analysis and femur fracture and application of this prediction rule helped in reducing abdominal CT scans by 33% in patients with low

Table 3: Solid and hollow visceral organ injuries with grading

Grade	Solid organ injuries					Total
	Liver	Spleen	Kidney	Pancreas	Adrenal	
I	4	1	2	-	1	8
II	6	5	1	-	-	12
III	7	6	2	-	1	16
IV	11	4	7	3	-	25
V	-	2	3	-	-	5
Total	28	18	15	3	2	66

Grade	Hollow visceral injuries								Total
	Duodenum	jejunum	ileum	Transverse colon	Urinary bladder	CBD	Abdominal vascular		
							Iliac vein	IVC	
I	-	-	-	-	1	-	-	-	1
II	-	-	-	-	-	-	-	-	-
III	-	-	-	-	-	-	1	-	1
IV	2	4	1	1	1	1	-	1	11
V	-	-	-	-	1	-	-	-	1
Total	2	4	1	1	3	1	1	1	14

CBD: Common bile duct, IVC: Inferior vena cava

Table 4: Complications observed during the follow-up

Serial number	Complication	Number of patients, *n* (%)	Grade of injury with the organ involved
1	Pseudoaneurysm of hepatic artery	1 (1)	III - Liver injury
2	Liver abscess	2 (3)	II, III - Liver injury
3	Non-functioning kidney	1 (1)	V - Kidney injury
4	Pseudocyst of pancreas	1 (1)	IV - Pancreatic injury
5	Subacute intestinal obstruction	1 (1)	IV - Jejunal injury
6	Biliary stricture	1 (1)	IV - CBD injury
7	Urinary incontinence	1 (1)	V - Bladder injury

CBD: Common bile duct

risk for IAI in their study.[10] These clinical predictors were not taken into consideration in our study.

About 59% ($n = 40$) of patients had Hb < 10 gm% and 62% ($n = 42$) of children had haematocrit packed cell volume (PCV) <30 at admission, both indicating the requirement for blood transfusion. In our study, 68% ($n = 46$) of patients received blood transfusion. Both clinical assessment and response to fluid resuscitation were taken into consideration before transfusing blood. Considerations for blood transfusion in our study include low Hb (<10 gm%) and PCV (<35) at the time of admission (intra-abdominal bleed) and a decreasing trend of Hb on serial monitoring (@>1 gm% fall/24 h), preexisting anaemia in most of the children in Indian scenario, signs of hypovolemia like tachycardia and hypotension appear late as children can tolerate up to 20% loss of blood volume.

FAST plays an important role in the initial evaluation of trauma child. Holmes *et al*.'s study on the role of ultrasonography (USG) (FAST) in trauma concluded that a hemodynamically stable child with positive USG should undergo CT.[11] CT is readily available nowadays and is highly sensitive in detecting IAI, hence it became the procedure of choice in evaluating injured children.[12] Ellison *et al.* concluded in their study that routine use of oral contrast is not necessary and it delays the time taken for CT scans and angiographic studies and only intravenous contrast is adequate.[13] In the current study, CT scans were done with intravenous contrast.

Most of the patients in our study ($n = 36$, 53%) sustained Grade IV injury, lower grade injuries (Grade I, II, III) might be under-reported in the present study because some of the asymptomatic patients might have not reported or referred to our hospital.

Multisystem involvement is common in children. Two or more organ system involvement is called polytrauma. The most commonly associated injury in the current study was thoracic injury (28%). This is similar to other studies by Peres *et al.,* Bhatti *et al.*[3,14] In our study, one male child who was 3-year-old had facial nerve palsy with a deviation of mouth along with head injury and it resolved after oral corticosteroid.

The current management of stable children with solid organ injuries is non-operative management (NOM) and it depends on haemodynamic status, not grade of injury.[15,16] Success rate of NOM of liver injuries is 85%–90% and for splenic injuries it is 90%–98%.[17] Indications for emergency laparotomy include free air in peritoneal cavity, hemodynamic instability despite maximum resuscitation, evisceration of intra-abdominal contents, gunshot wounds of abdomen or any penetrating injury with breach in peritoneum.[18] All the patients who underwent laparotomy had AAE and increase in AG on serial examination with guarding and rigidity. Decision to proceed for surgical exploration was made on the basis of hemodynamic

stability and serial clinical examination. According to Cohn *et al.* sensitivity of all grading systems is poor in predicting the necessity of intervention like surgery or angioembolisation in solid organ injuries.[19]

In our study, two patients had Grade III and Grade IV abdominal venous injuries (iliac vein and Inferior Vena Cava [IVC]) and were managed conservatively. Virgilio *et al*. Reported conservative management for patients with established venous thrombus.[20] Literature regarding the distribution and management of major abdominal venous injuries in children is not widely available. If there are no risk factors such as associated arterial injury, multiple injuries, seat belt injury and high energy mechanism of injury, trial of NOM should be considered for these injuries.[21]

APSA has given guidelines for hospital stay (grade of injury + 1 day) and activity restriction (grade of injury + 2 weeks) for solid organ injuries.[22] In the current study, only 25% (n = 17) were discharged from the hospital as per the APSA guidelines, remaining all other patients (75%, n = 51) stayed in the hospital more than the recommended stay. Reasons may be, treating surgeon being extra cautious for rebleed and poor compliance, patient factors like fear of taking the child home early and medicolegal nature of these cases.

In the current study, only four patients (6%) were treated in intensive care unit (ICU). Fremgen *et al.* described that ICU admission is not required in stable children and it should be based on haemodynamic status rather than imaging findings.[23] McVay *et al.* also suggested that the management should be based on haemodynamic status not on grade of injury.[24] Graziano *et al.* suggested that bed rest was not required in case of renal injuries.[25] In our study, we advised activity restriction because on resuming to normal activities early in renal injury patients caused haematuria.

In the current study, mortality rate was zero. Low mortality in our study may be because the patients with abdominal trauma were referred to us after initial stabilisation and FAST in the emergency department by the trauma team as our institute is a specialised trauma centre. Those who have expired in the emergency department were not reported to us. Most of the patients (88%, n = 60) had good outcome despite high grade of injury which suggest that grade of injury does not correlate with the outcome (χ^2 = 1.67; P = 0.79, statistically not significant). Good outcome in these patients may be because of early presentation in higher grade of injury, timely intervention and regular follow-up. Angiogenesis, revascularisation and transforming growth factor-β (TGF-β) kinetics controlling collagen deposition and extracellular remodelling were better in children leading to a better outcome.[26] During follow-up, morbidity is seen in three patients (4.4%), which include one child who underwent laparotomy for jejunal perforation re-admitted twice for gastritis and sub-acute adhesive intestinal obstruction which resolved with conservative management, CBD repair patient had stricture at the site of repair who was managed with endoscopic stenting and urinary bladder rupture patient planned for bladder neck reconstruction in view of incontinence. Other complications observed were pseudo aneurysm of hepatic artery in the patient who was operated for Grade III liver injury. Two patients of liver injury developed liver abscess which managed by pigtail catheter insertion for drainage of abscess. One child with complete pancreatic transaction developed pseudocyst of pancreas which was managed by endoscopic internal drainage. One more child with Grade IV kidney injury had scarred and nonfunctioning kidney on radionuclide scan (Dimercapto Succinic Acid [DMSA]) but there is no evidence of hypertension on regular follow-up. Fuchs *et al.* described that late hypertension and renal insufficiency are uncommon after renal injuries.[27] Giss *et al.* and Notrica *et al.* described in their studies that re-imaging is not needed in asymptomatic children.[28,29] Even the current APSA guidelines recommend the same.[22] In our study also, reimaging was done only in symptomatic patients.

Conclusion

Trauma is the leading and preventable cause of death which is prevalent in school-going children. Solid-organ injury is more common for which conservative management is the gold standard. The decision regarding surgery depends on hemodynamic stability and serial clinical examination rather than grade of injury. The grade of injury does not correlate with the outcome. Despite higher grade of injury children with blunt abdominal trauma had good outcome without any long-term morbidity. Good outcome was possibly because of better angiogenesis, revascularisation and TGF-β kinetics in children. Routine re-imaging is not necessary in asymptomatic patients, but proper evaluation of the symptomatic patients and regular follow-up can pick up the complications early. Health education to the parents in relation to preventive aspects and proper supervision at home and play areas may help in reducing the incidence.

Level of evidence – Level IV, prognostic

Highlights – the study adds to the literature that the grade of injury in paediatric blunt abdominal trauma does not correlate with the outcome in a higher grade of injury and these children had good outcome.

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Conflicts of interest

There are no conflicts of interest.

References

1. Kundal VK, Debnath PR, Sen A. Epidemiology of pediatric trauma and its pattern in Urban India: A tertiary care hospital-based experience. J Indian Assoc Pediatr Surg 2017;22:33-7.
2. Hegde S, Bawa M, Kanojia RP, Mahajan JK, Menon P, Samujh R, *et al*. Pediatric trauma: Management and lessons learned. J Indian Assoc Pediatr Surg 2020;25:142-6.
3. Bhatti KM, Taqi KM, Al-Harthy AZ, Hamid RS, Al-Balushi ZN, Sankhla DK, *et al*. Paediatric blunt torso trauma: Injury mechanisms, patterns and outcomes among children requiring hospitalisation at the

Sultan Qaboos University Hospital, Oman. Sultan Qaboos Univ Med J 2016;16:e210-6.
4. Kulshrestha R, Gaind BN, Talukdar B, Chawla D. Trauma in childhood-past and future. Indian J Pediatr 1983;50:247-51.
5. Verma S, Lal N, Lodha R, Murmu L. Childhood trauma profile at a tertiary care hospital in India. Indian Pediatr 2009;46:168-71.
6. Sharma AK, Sarin YK, Manocha S, Agarwal LD, Shukla AK, Zaffar M, *et al*. Pattern of childhood trauma. Indian perspective. Indian Pediatr 1993;30:57-60.
7. Bangdiwala SI, Anzola-Pérez E, Romer CC, Schmidt B, Valdez-Lazo F, Toro J, *et al.* The incidence of injuries in young people: I. Methodology and results of a collaborative study in Brazil, Chile, Cuba and Venezuela. Int J Epidemiol 1990;19:115-24.
8. Coran AG, Caldamone A, Adzick NS, Krummel TM, Laberge JM, Shamberger R. Pediatric Surgery E-Book. Philadelphia: Elsevier Health Sciences: Abdominal Trauma; 2012. p. 299.
9. Streck CJ Jr., Jewett BM, Wahlquist AH, Gutierrez PS, Russell WS. Evaluation for intra-abdominal injury in children after blunt torso trauma: Can we reduce unnecessary abdominal computed tomography by utilizing a clinical prediction model? J Trauma Acute Care Surg 2012;73:371-6.
10. Holmes JF, Sokolove PE, Brant WE, Palchak MJ, Vance CW, Owings JT, *et al.* Identification of children with intra-abdominal injuries after blunt trauma. Ann Emerg Med 2002;39:500-9.
11. Holmes JF, Gladman A, Chang CH. Performance of abdominal ultrasonography in pediatric blunt trauma patients: A meta-analysis. J Pediatr Surg 2007;42:1588-94.
12. Wegner S, Colletti JE, Van Wie D. Pediatric blunt abdominal trauma. Pediatr Clin North Am 2006;53:243-56.
13. Ellison AM, Quayle KS, Bonsu B, Garcia M, Blumberg S, Rogers A, *et al*. Use of oral contrast for abdominal computed tomography in children with blunt torso trauma. Ann Emerg Med 2015;66:107-14.e4.
14. Peres A, Chaves M, Vieira M, Santos E, Cruz J, Feijó S, *et al.* Polytraumatism in childhood – It can be more than it seems. Acta Med Port 2010;23:511-4.
15. Gaines BA. Intra-abdominal solid organ injury in children: Diagnosis and treatment. J Trauma 2009;67:S135-9.
16. Notrica DM. Pediatric blunt solid organ injury: Beyond the APSA guidelines. Curr Surg Rep 2015;3:1-6.
17. Partrick DA, Bensard DD, Moore EE, Karrer FM. Non operative management of solid organ injuries in children results in decreased blood utilization. J Pediatr Surg 1999;34:1695-9.
18. Lynch T, Kilgar J, Al Shibli A. Pediatric abdominal trauma. Curr Pediatr Rev 2018;14:59-63.
19. Cohn SM, Arango JI, Myers JG, Lopez PP, Jonas RB, Waite LL, *et al.* Computed tomography grading systems poorly predict the need for intervention after spleen and liver injuries. Am Surg 2009;75:133-9.
20. De Virgilio C, Mercado PD, Arnell T, Donayre C, Bongard F, White R. Noniatrogenic pediatric vascular trauma: A ten-year experience at a level I trauma center. Am Surg 1997;63:781-4.
21. Rowland SP, Dharmarajah B, Moore HM, Dharmarajah K, Davies AH. Venous injuries in pediatric trauma: Systematic review of injuries and management. J Trauma Acute Care Surg 2014;77:356-63.
22. Stylianos S. Evidence-based guidelines for resource utilization in children with isolated spleen or liver injury. The APSA Trauma Committee. J Pediatr Surg 2000;35:164-7.
23. Fremgen HE, Bratton SL, Metzger RR, Barnhart DC. Pediatric liver lacerations and intensive care: Evaluation of ICU triage strategies. Pediatr Crit Care Med 2014;15:e183-91.
24. McVay MR, Kokoska ER, Jackson RJ, Smith SD. Throwing out the "grade" book: Management of isolated spleen and liver injury based on hemodynamic status. J Pediatr Surg 2008;43:1072-6.
25. Graziano KD, Juang D, Notrica D, Grandsoult VL, Acosta J, Sharp SW, *et al*. Prospective observational study with an abbreviated protocol in the management of blunt renal injury in children. J Pediatr Surg 2014;49:198-200.
26. Buganza Tepole A, Kuhl E. Systems-based approaches toward wound healing. Pediatr Res 2013;73:553-63.
27. Fuchs ME, Anderson RE, Myers JB, Wallis MC. The incidence of long-term hypertension in children after high-grade renal trauma. J Pediatr Surg 2015;50:1919-21.
28. Giss SR, Dobrilovic N, Brown RL, Garcia VF. Complications of nonoperative management of pediatric blunt hepatic injury: Diagnosis, management, and outcomes. J Trauma 2006;61:334-9.
29. Notrica DM. Pediatric blunt abdominal trauma: Current management. Curr Opin Crit Care 2015;21:531-7.