Management of pediatric blunt abdominal trauma in resource-restricted settings: A cross-sectional study

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Abstract

Introduction: Management of pediatric blunt abdominal trauma in resource-restricted settings requires precise clinical expertise. In this study, we reviewed pediatric patients who were suspected to have blunt abdominal trauma in a level III trauma center in Iran.

Materials and methods: In a cross-sectional study, 66 injured children were studied from October 01, 2014 to October 01, 2015 in Nikshahr, Sistan-va-Balouchestan, Iran. Patient characteristics, type of trauma, initial evaluation and final decisions were analyzed.

Results: Mean age was 8.2 ± 13.3 years. Thirty five patients (53%) were boys and 31 patients (47%) were girls. Focused Assessment with Sonography for Trauma (FAST) was done for all patients. Diagnostic Peritoneal Lavage (DPL) was done on five patients (7.6%). Laparatomy was conducted on seven patients (10.6%). Ten patients (15.2%) were referred to a higher level trauma center. There were three mortalities (4.5%). Positive FAST was associated with hemodynamic instability ($p<0.05$) and the need for laparatomy ($p<0.05$). Positive FAST was also associated with more admission days (5.9 ± 5.1 days versus 2.1 ± 2.6 days; $p<0.05$). There was also a significant relationship between the length of hospital stay and associated traumas ($p<0.001$).

Conclusion: Computed tomography and intensive care unit may be unavailable in resource restricted settings with level III and IV trauma centers. However, physical examination, FAST and DPL are useful diagnostic tools for assessment of injured children with blunt abdominal trauma.

Keywords

- abdominal trauma
- blunt trauma
- pediatric trauma
- laparatomy

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Introduction

Trauma is the main cause of death in children over one year of age. Most pediatric trauma is blunt and boys are injured twice as girls.[1] The initial evaluation of abdominal trauma in the pediatric patient is similar to that in the adult.[2] However, current evidence has become available that may change the management of pediatric abdominal injury, and is being translated into new evidence-based management guidelines.[3] In addition, it has been suggested that pediatric trauma centers may increase standard of care in injured children when compared to general trauma centers.[4, 5]

It is essential that general surgical care be available in areas with lower access to advanced medical facilities. Pediatric trauma is of potential concern regarding the availability of global pediatric surgery.[6] However; high resolution computed tomography (CT) scan and intensive care unit are not available at some areas with access to level III or level IV trauma centers.[7] Management of blunt abdominal trauma in pediatric injured patients is of potential clinical importance and needs surgical expertise, especially in resource-restricted settings.

Now a day's non-operative management in children with solid organ injury who are hemodynamically stable is the standard of care.[5] Thus, unavailability of CT would require precise attention to manage pediatric injured patients with blunt abdominal trauma.

In this study, we assessed management and outcome of injured children who were suspected to have blunt abdominal trauma in a level III trauma center in Nikshahr, Sistan-va-Balouchestan province of Iran.

Material & Methods

In this cross-sectional study we evaluated 66 pediatric patients with blunt abdominal trauma who were admitted to a level III trauma center in 22 Bahman Hospital, Nikshahr, Sistan-va-Balouchestan, Iran. The study took place from October 01, 2014 to October 01, 2015. The hospital had transfer agreements with two level II trauma centers situated in Iranshahr and Chabahar cities (in Sistan-va-Balouchestan province of Iran). The distances of Nikshahr to Iranshahr and Chabahar were 169 and 143 kilometers respectively. Both centers had access to brain computed tomography (CT). However, IV contrast abdominopelvic CT was only available in Chabahar. The study hospital had 24-hour access to general surgery, anesthesiology and radiology specialists but CT was not available. Intensive care unit was also not available. However, the emergency department had intensive resuscitation room for unstable trauma patients.

DPL was done through a para-umbilical incision and gross results and laboratory analysis were recorded. The aspirate was considered to show positive findings if more than 10 mL of blood was aspirated. If less than 10 mL was withdrawn, normal saline was instilled and the effluent was withdrawn and sent to the laboratory for analysis. A Red Blood Cell (RBC) count more than 100,000 per mL, a White Blood Cell (WBC) count more than 500 per mL, Amylase level more than 19 International Units (IU) per liter, Alkaline phosphatase level more than 2 IU per liter and bilirubin level more than 0.01 mg per deciliter (dL) were considered positive findings.

The data were analyzed by student T test, ANOVA and chi-square test. The associations between study variables were described based on exploratory analysis. The analyses were carried out by SPSS 19.0 software. Informed consent was obtained from parents of all studied patients.

Results

We studied 66 consecutive pediatric injured patients who were suspected to have blunt abdominal trauma. The mean age of patients was 8.2 ± 13.3 years. Thirty five patients (53 %) were boys and 31 patients (47 %) were girls. Table 1 shows characteristics of the study population on their admission to emergency department. Five patients (7.6%) were pedestrian victims. Figure 1 illustrates the distribution of trauma mechanism in the study patients.

Table 1: Characteristics of the study patients on their admission to emergency department

Patient Factor	Male mean ± (SD)	Female mean ± (SD)	Total
Age (years)	6.1(3.8)	10.5(18.8)	8.2(13.3)
Location:			
-Rural n(%)	12 (34.3%)	11 (36.7%)	23 (35.4%)
-Urban n(%)	23 (65.7%)	19 (63.3%)	42 (64.6%)
Pedestrian n(%)	2 (5.7%)	3 (9.7%)	5 (7.6%)
Hemodynamic instability n(%)	5 (14.3%)	2 (6.5%)	7 (10.6%)
Positive abdominal examination n(%)	1 (2.9%)	0 (0.0%)	1 (1.5%)
Positive FAST	6 (17.1%)	1 (3.2%)	7 (10.6%)
GCS ≤ 13	3 (8.6%)	5 (16.1%)	8 (12.1%)
Intubation at ED	1 (2.9%)	2 (6.5%)	3 (4.5%)
Associated trauma:			
Chest	1 (2.9%)	1 (3.2%)	2 (3.0%)
Pelvis	1 (2.9%)	0 (0.0%)	1 (1.5%)
Extremities	5 (14.3%)	2 (6.5%)	7 (10.6%)
Head	6 (17.1%)	8 (25.8%)	14 (21.2%)

ED, Emergency Department --- FAST, Focused Assessment with Sonography for Trauma --- GCS, Glasgow Coma Scale

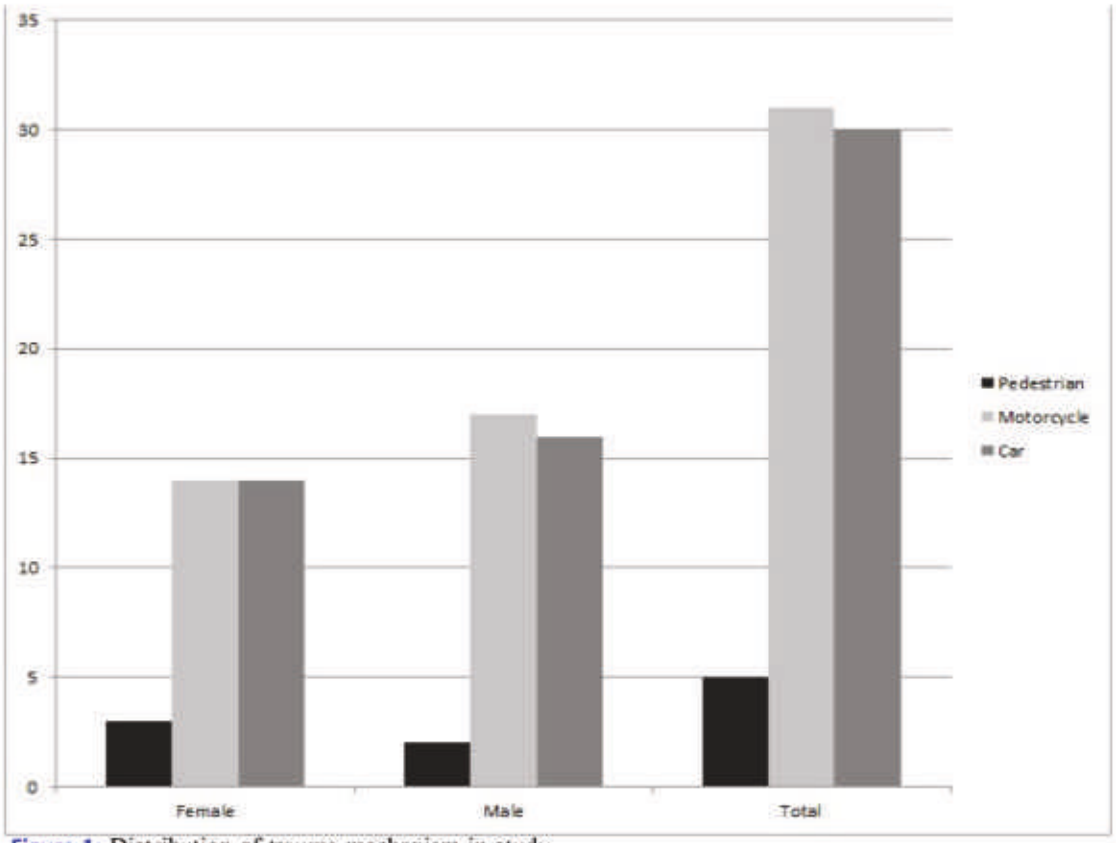

Figure 1: Distribution of trauma mechanism in study patients

FAST sonography was conducted for all study patients. DPL was done on five patients (7.6%) based on patient factors and FAST results. Table 2 shows the decisions made for the study patients based on their hemodynamic status and initial evaluations at the emergency department. Laparatomy was conducted on seven patients (10.6%). Four patients underwent splenectomy, one patient underwent liver packing, one patient underwent small intestine mesenteric repair and one patient underwent pelvic packing together with mesenteric hemostasis and repair. Table 3 shows characteristics of laparatomy patients of the study.

Table 2: Decisions made on the study patients after their initial evaluations at the emergency department

	Male n(%)	Female n(%)	Total
Total DPLs	2 (5.7%)	3 (9.7%)	5 (7.6%)
Positive DPLs	0 (0.0%)	1 (3.2%)	1 (1.5%)
Laparatomy	5 (14.3%)	2 (6.5%)	7 (10.6%)
Admission days	2.7 ± 3.8	2.2 ± 2.1	2.5 ± 3.1
Referral	5 (14.3%)	5 (16.7%)	10 (15.4%)
Mortality	1 (2.9%)	2 (6.5%)	3 (4.5%)

DPL, Diagnostic Peritoneal Lavage

Table 3: Laparatomy results in the study patients

No.	Age	Sex	Associated Trauma	Indication of Laparatomy	Result of Laparatomy	Ad. Days	Mortality
1	12	Male	Chest	US & Positive FAST	Splenectomy	4	No
2	9	Female	None	US & Positive FAST	Splenectomy	5	No
3	8	Male	None	US & Positive FAST	Liver packs	12	No
4	5	Male	None	US & Positive FAST	Splenectomy	4	No
5	6	Male	Pelvis	US & Positive FAST	Pelvic packs & mesenteric repair	14	Yes
6	12	Male	None	US & Positive FAST	Splenectomy	4	No
7	16	Female	None	Abdominal rigidity	Mesenteric repair	9	No

Ad. Days, Admission Days --- FAST, Focused Assessment with Sonography for Trauma --- US, Unstable hemodynamics

Ten patients (15.2%) were referred to higher level trauma centers in Iranshahr and Chabahar. Eight of these patients (80.0% of referrals) were referred due to low GCS score to undergo brain CT. Two patients (20% of referrals) were referred due to the need for intensive care unit (ICU) admission.

Table 4 shows the characteristics of referred patients during the study. Follow-up of patients revealed three mortalities (4.5%). Two children (3.0%) died because of traumatic brain injury and one patient (1.5%) died due to unstable pelvic fracture (Table 4).

Table 4: Characteristics of patients referred to higher level trauma centers

No.	Age (Years)	Sex	Hemodynamic stability at ED	Laparatomy	DPL	GCS	Intubated at ED	Head Trauma	Indication of referral	Mortality
1	6	Male	Stable	No	Not indicated	13	No	Yes	Brain CT	No
2	5	Female	Stable	No	Not indicated	13	No	Yes	Brain CT	No
3	1	Male	Stable	No	Not indicated	12	No	Yes	Brain CT	No
4	1.5	Female	Stable	No	Negative	6	Yes	Yes	Brain CT	Yes
5	6	Female	Stable	No	Negative	4	Yes	Yes	Brain CT	Yes
6	8	Male	Unstable	Yes	Not indicated	14	No	No	ICU Bed	No
7	10	Male	Stable	No	Negative	9	Yes	Yes	Brain CT	No
8	6	Male	Unstable	Yes	Not indicated	15	No	No	ICU Bed	Yes
9	12	Female	Stable	No	Not indicated	12	No	Yes	Brain CT	No
10	9	Female	Stable	No	Not indicated	13	No	Yes	Brain CT	No

CT, Computed Tomography --- DPL, Diagnostic Peritoneal Lavage --- ED, Emergency Department --- GCS, Glasgow Coma Scale --- ICU, Intensive Care Unit

Traumatized children were assessed initially based on their hemodynamic status. Hemodynamically unstable patients with positive FAST results underwent laparatomy (6 patients); while DPL was done for unstable patients with negative FAST results (1 patient). Meanwhile, resuscitative therapy with fluid and blood products was done for all injured children with diminished hemodynamic stability. Children with stable hemodynamics who were suspected to have blunt abdominal trauma were evaluated based on physical examination and FAST results. One stable patient underwent laparatomy because of generalized abdominal rigidity and tenderness. Figure 2 illustrates the diagram of management of study patients have abdominal trauma.

Living area (rural or urban) was not associated with age, sex or type of the injury ($p>0.05$). In addition, unstable hemodynamics, FAST findings, indication for laparatomy, GCS score, referrals and mortality did not have significant associations with living area ($p>0.05$).

Positive FAST was associated with hemodynamic instability ($p<0.05$) and the indication for laparatomy ($p<0.05$). The association between FAST findings with referrals or mortalities was not significant ($p>0.05$). Positive FAST scan was also associated with more admission days (5.9 ± 5.1 days versus 2.1 ± 2.6 days; $p<0.05$). The relation between FAST and age was not significant ($p>0.05$; t-test).

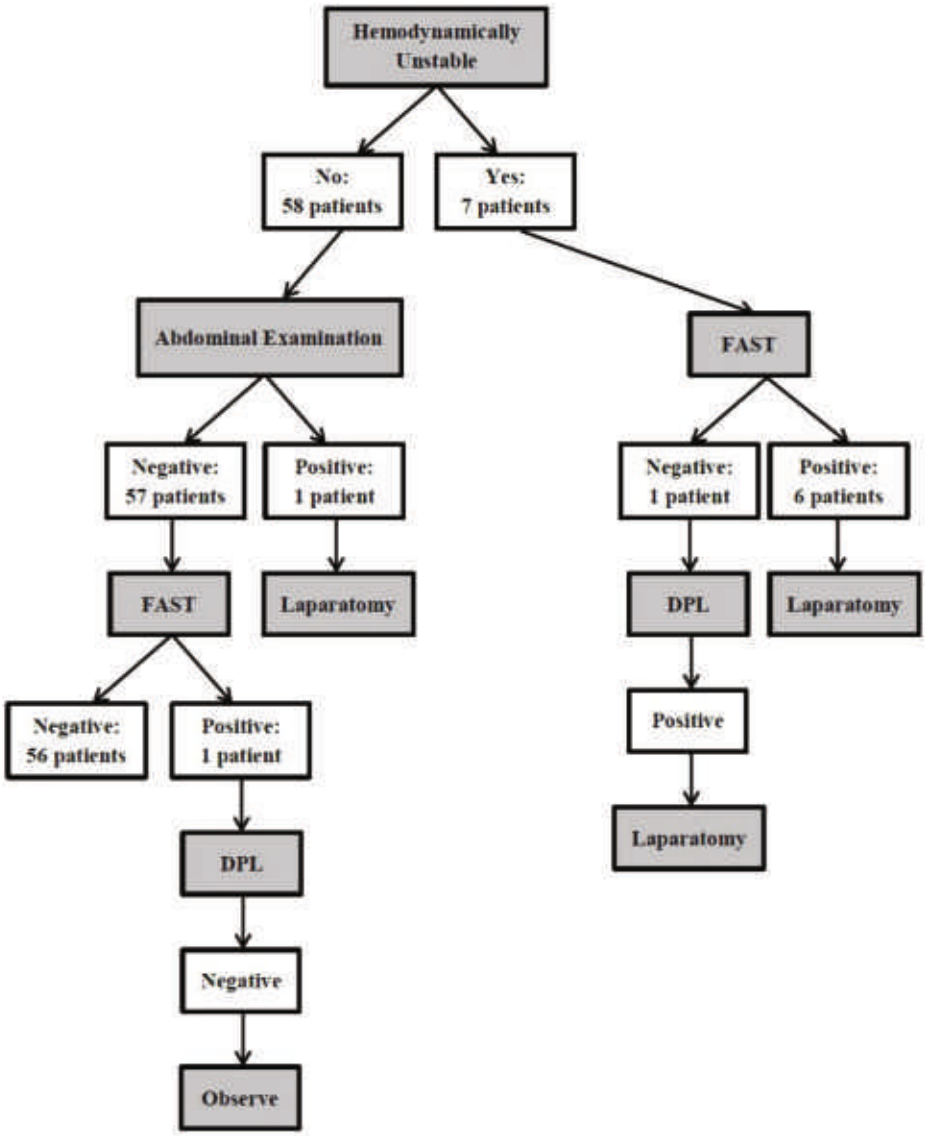

Figure 2: Management of patients suspected to

Pedestrian trauma did not have significant association with hemodynamic stability or FAST results ($p>0.05$). Pedestrian trauma was not associated with longer hospital stay ($p>0.05$).

A significant relationship was found between the length of hospital stay and associated traumas ($p<0.001$; ANOVA test). The length of admission for associated traumas to head, pelvis, chest, and extremities were 5.2 ± 3.9, 14, 2.5 ± 2.1 and 1.0 ± 0.0 days respectively, while it was 1.5 ± 1.9 days for children without associated traumas. Age and mortality were also not associated ($p>0.05$).

Discussion

We studied outcome of pediatric patients with blunt abdominal trauma in a resource restricted area in Iran. The center was a level III trauma center without access to CT and ICU. Laparatomy rate was 10.6%. Referral rate was 15.2%. Non-operative management was not possible because of unavailability of CT and difficulties of patient transfers to higher level trauma centers.

Non-operative management (NOM) of pediatric trauma patients with solid organ injury is now of great clinical interest.[8, 9] The response to NOM is higher in children than adult population.[1, 8] Two principle necessities for possibility of NOM are stability of hemodynamics and availability of IV contrast abdominopelvic CT.[1, 9-12] Patients with solid organ injury who are candidates of NOM should be admitted to ICU.[8] However, level III and IV trauma centers in resource restricted settings do not have access to CT and ICU in some areas. Thus, management of blunt expertise with precise attention to hemodynamics and FAST results in these settings.

Although FAST is a precise technique to assess the presence of blood and free fluid in abdominal cavity in children,[1] it could neither quantify the amount of free fluid nor the degree of solid organ injury in children with blunt abdominal injury.[2] FAST should have a high positive predictive value to indicate laparatomy. In addition, a high negative predictive value is necessary to rule out abdominal injury for negative FAST results.[13] A positive FAST together with hemodynamic instability is an indication for prompt laparatomy. Likewise, a negative FAST in a hemodynamically stable child would rule out abdominal injury. Unstable hemodynamics and a negative FAST are indications for DPL.[1, 9] In patients with stable hemodynamics and free fluid on FAST examination; CTscan is required in order for the patient to undergo NOM.[1, 14-17]

NOM is available in centers with 24-hour access to CT, ICU and blood products. It is also available in small and lower level trauma centers[18] but when CT is unavailable, NOM is not recommended. Children with blunt abdominal trauma and positive FAST results who are hemodynamically stable are candidates for NOM. However, the degree of solid organ injury should be determined by CT before the decision to conduct NOM.[1, 9, 17] FAST may also have false positive results. Thus, all injured children with stable hemodynamics and positive FAST results are not candidates for laparatomy. We carried out DPL first in order to determine false positive results when hemodynamics were stable. In our study, one patient had stable hemodynamics and positive FAST and subsequent DPL ruled out intraperitoneal hemorrhage. Figure 3 illustrates the algorithm for managing blunt abdominal trauma in children in centers where CT is

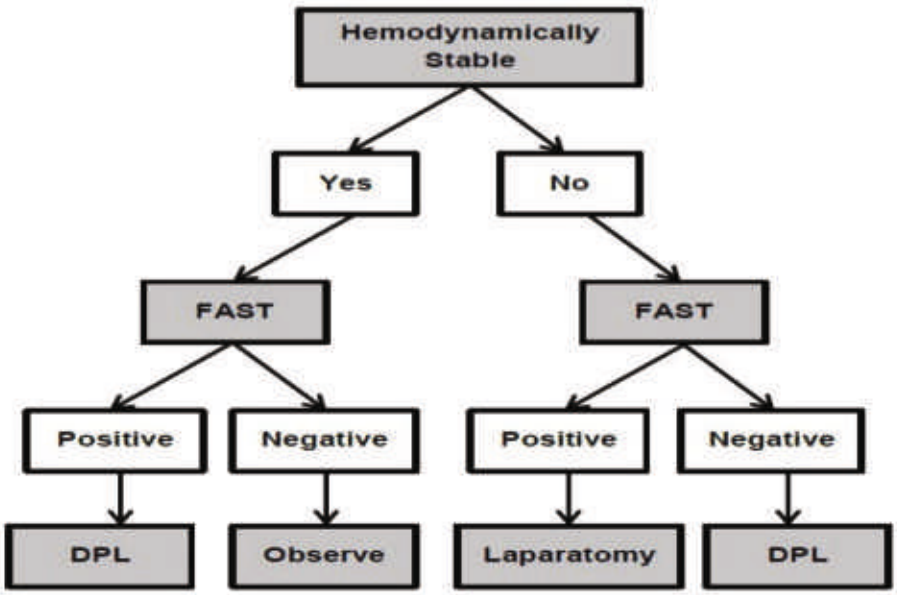

Figure 3: Algorithm of management of blunt abdominal trauma in children in resource restricted settings

DPL could not replace CT for patient selection for NOM.[1, 18] We do not recommend NOM for patients with blunt abdominal trauma and positive FAST results when CT is unavailable. However, DPL may diminish laparatomy rate by discovering false positive results of FAST sonography. In addition, we do not recommend referring patients with positive FASTresult for abdominopelvic CT to higher level trauma centers when transfers are not managed quickly and safely.

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