DISCUSSION

Blunt abdominal trauma is a frequent reason for admission to a pediatric emergency department, and can lead to severe morbidity and mortality. Therefore, it is important to assess the probability of abdominal organ injury following such events.

Liberal use of diagnostic imaging has become an integral part of the initial assessment of pediatric blunt abdominal trauma because both the sole use of clinical assessment and laboratory evaluation are considered unreliable. Many diagnostic methods currently exist, such as abdominal radiographs, FAST, CT, diagnostic peritoneal lavage (DPL), and diagnostic laparoscopy (DL). In spite of these technologies, it is still often difficult to evaluate the presence of intra- abdominal injuries in children, where management decisions are based on the physiologic response to the injury rather than the radiologic features of the injury.

Ultrasound combined with clinical assessment presents an effective method for safe diagnosis and appropriate surgical decision making in pediatric blunt abdominal trauma. The management of blunt abdominal trauma in children differs from adults as most solid organ injuries are treated conservatively, so the role of imaging is different. Selected cases with polytrauma and/or unequivocal findings in the ultrasound should undergo abdominal CT. It is clear that CT scanning is an expensive modality in developing countries where a more selective use for patients with minor abdominal injury could lead to a large reduction in health-care costs.

Efforts to improve ED treatment protocols for patients with blunt abdominal trauma in pediatric age group include formulation of clinical decision and rapid decision making to identify patients who require specific imaging, hospitalization, conservative management or surgical intervention.

Many reports have been published regarding the role of imaging in blunt abdominal trauma in children in the accident and emergency (A&E) department. A total of 150 patients were admitted to the level III trauma center of Alexandria main University hospital during the period of 6 months from May 1st till October 30th 2013.Then, we conducted a literature review to identify all studies that measured the test performance of FAST as well as CT for identifying children with IAIs. We searched for articles published up to December 2014. Search terms included abdominal, ultrasound, ultrasonography, FAST, tomography, hemoperitoneum, children, blunt and trauma. The search was limited to children aged up to 18 years. The search was supplemented with a manual search of the bibliographies of all selected articles. We found 82 articles down to the year 1997.

Our preference has always been to do bedside FAST in primary survey because we are confident of its diagnostic accuracy while keeping the radiation dose to a minimum. Our study shows that FAST is a sensitive first-line examination and that CT scanning should only be performed when there is clinical suspicion of significant injury that has not been demonstrated on FAST.

1) Demographic data

Age and gender

Our study prospectively reviewed 150 pediatric cases with age ranging from 3 days up to 17 years and a mean ± Standard Deviation (SD) of 8.8 ± 4.93 years. This agrees with a study done by Orak M. et al. [71] that showed that mean age was 7.88±3.403 years. Another prognostic and epidemiologic study done by Menaker J et al.[72] and Intra-abdominal Injury Study Group of the Pediatric Emergency Care Applied Research Network (PECARN) found a median age of 11.8 years in a sample of 6468 patients.

Regarding the gender, 72.7% of our cases were males, while females were 23.3%. This agrees with the studies done by Faruque AV, et al.[73] Karam O et al[74] described a 77% of cases with male sex. Van Schuppen J et al.[75] with 61% male predominance.

Relation between age group and sex

In our study, males were more frequently injured than females in each sub group of age as well as overall. However, a higher incidence (66.7%) was found in the age group of >5 years with a mean age of 8.8 years. Similar observations regarding age distribution of pediatric abdominopelvic trauma were made by multiple studies as Faruque AV, et al[73] where the Majority of children, (71%) were of school age; followed by pre-school age, (23%); and infants, (6%). Ameh et al.[76] and Mir M et al.[77] had the same findings.

The incidence is higher in males because of their outdoor life as compared to the female children who stay at homes. The higher incidence seen in the age sub-group of >5 years is due to their more exposure to day-to-day hazards of life.

Studying MOT

Studying the MOT has showed that RTA was the commonest cause of blunt abdominal trauma in our study followed by FFH which was agreed with Holmes et al.[78] who retrospectively studied 1,324 children and also localized abdominal trauma was the 3rd common cause in both studies. Browning GJ, et al.[79] found a nearly equal presentation between RTA and FFH (33% versus 31% respectively) in a sample of retrospectively studied 80 children. Faruque AV, et al[73] in Pakistan reported similar rates of 37% each.

Road traffic accident was the commonest cause of BAT due to the rapid increase in the number of vehicles, in addition to the over population, the lack of proper strategy for prevention of RTA and also drivers and many pedestrians do not adhere to traffic rules. Also, bad design of roads in Alexandria and lack of knowledge about the rules of traffics.

2) Examination

Identifying children with intra-abdominal injury (IAI) after blunt abdominal trauma is critical, and clinical prediction rules for identifying children at high risk and low risk for IAI are useful. Overuse of CT scans in injured children also carries risk of radiation-induced malignancy[80]. However, determining the need for CT often relies on patient history and physical examination findings. The exact characteristics of certain elements of the abdominal examination, such as location of tenderness and degree of pain, are not well

understood, particularly in children with varying degrees of alertness from blunt head trauma or other causes[81].

Our study showed that 20% of cases had GCS < 15. DLC was because of traumatic brain injury (TBI) or due to severe shock. No cases due to intoxication. Regarding the hemodynamic state, 56.7% of cases had no evidence of hypovolemic shock, 15.3% with grade 1 hypovolemic shock, 10.0% with grade 2, 11.3% with grade 3 and 6.7% with grade 4.

Abdominal examination in our results was normal or unreliable in 71.3%, tenderness in 11.3% rigid abdomen or ecchymosis in 6.0% and abdomen was tender with rigidity and distension (Surgical abdomen) in 11.3%.Abdominal examination was not accurate in the children with DLC either due to severe head injury or severe shock. Also children with distracting severe injuries as high grades open fractures.

There are a lot of researches that studied the abdominal examination in pediatric BAT. Our results were agreed with Jateen C. Pate et al.[82] who studied 94 children. Reliable initial physical examination of the abdomen was possible in only 41% children. Of those; they found abdominal tenderness in 47%, distension in 2.6%, and abdominal wall abrasions or ecchymosis in 7.9%. Eighteen percent had benign abdominal examination findings with regard to tenderness, distension, ecchymosis, or guarding.

Cotton et al.[83] reported a retrospective study assessing the utility of 23 clinical variables potentially associated with IAI in children. In a cohort of 351 patients, 25% underwent CT scan to determine the presence of IAI, and 12% had an identifiable IAI identified. Cotton identified a number of factors that predicted IAI: abdominal ecchymosis, abdominal abrasions, tender abdomen, increase ALT, and decreased HCT.

Several small single-center studies conducted by Holmes JF, et al.[78], Sokolove PE et al.[84], Holmes JF et al.[85], and Chandler CF et al.[86] have provided estimates of the risk of IAI based on certain abdominal findings. These studies are of limited precision because of small sample sizes, however, and cannot provide reliable risk estimates for children with minor head trauma and those with varying Glasgow Coma Scale (GCS) scores.

Our study showed significant relation between abdominal examination and patient outcome with $p < 0.001$

This was agreed with Holmes JF et al.[87] , performed a prospective observational study of 1095 children and determined abdominal tenderness to be predictive of IAI as in our study, the authors did not calculate positive predictive value or negative predictive value, but the article's data indicate that abdominal examination was highly significant in determination of patient outcome.

3) Patient outcome

In our study, we had 46% of patients were discharged home after screening for trauma, 40% were managed conservatively and one case failed to be managed conservatively and was operated after the patient deteriorated and follow up FAST showed increases in intra-abdominal hemorrhage. 10% were operated for IAIs and 4% of cases died mainly due to TBI.

This was in agreement with J. van Schuppen et al.[75] (2014) who studied retrospectively the outcome of 173 pediatric patients with blunt abdominal trauma where the decision to observe or to perform an intervention depends on the vital parameters of the patient, in combination with the presence or absence of free fluid at and the findings on imaging studies. Of them, Sixty six (53%) were discharged and fifty one (43%) patients were observed. In one (0.8%) patient observational management failed and an intervention was necessary and 4% of patients were operated. The study excluded cases who died during his study.

4) Laboratory findings

Laboratory studies are one potential adjunct in the evaluation of children with abdominal trauma. Our study found an association of elevated liver enzymes as an indicator of IAI, presence of anemia according to age was an indicator for blood loss and a monitor for the effectiveness of the transfusion therapy. Various cutoff values for liver transaminases to assess for liver injury have been proposed to aid in the decision making for CT evaluation after abdominal trauma.

Two retrospective studies and a review by Holmes JF[88].et al., Karam O[89]. et al. and Ritchie AH.[90] et al. about aspartate aminotransferase (AST) and alanine aminotransferase (ALT) levels in the setting of blunt abdominal trauma found a correlation between AST/ALT levels and severity of liver injury; however, even among patients with no discernable liver injury on CT, half had elevated AST/ALT levels. Therefore, the authors concluded cutoff values for AST/ALT under which liver injury could be excluded could not be determined, as it is likely that elevated AST/ALT levels may be due to moderate hepatic cytolysis in the setting of trauma, even though a specific injury may not be visualized on CT scan.

5) Radiologic investigations

X-ray

X-ray in our study was not of value in diagnosis of children with blunt abdominal trauma. Where 23% of case it was difficult to obtain erect abdomen X-ray due to mechanical ventilation, coma, use of sedation, shock or difficult of transportation. 82% of the cases had X-ray it was normal and this agrees with a study done by Antonio Muñiz et al.[91] on patients and showed that X-ray use in blunt trauma is less useful since they are normal in greater than 95% of cases and only serve to delay evaluation and management of these patients.

FAST scan

FAST is a rapid and noninvasive bedside ultrasound examination used for the evaluation of blunt abdominal trauma. The focus of this sonographic technique is to evaluate the right upper quadrant, left upper quadrant, pelvis and pericardial windows for free peritoneal fluid, as evidence of hemorrhage or other abnormal fluids (e.g., bile, urine)[92]. The American College of Surgeons in the Advanced Trauma Life Support (ATLS), ninth edition, recognizes FAST as an adjunct diagnostic option for the evaluation of abdominal trauma in pediatric patients[67], but the optimal use of FAST in pediatric

trauma remains controversial, with great variability in its use[74,93,94]. FAST aims to detect free intraperitoneal fluid (presumed to be blood in the setting of trauma), but more than one-third of low-grade pediatric liver or spleen injuries are not associated with free fluid[95].

Our study showed that FAST examination played a specific role in surgical decision making in a subset of patients, including the hemodynamically unstable child, in whom sonographic free fluid should prompt rapid blood transfusion and/or emergent laparotomy without further imaging. FAST was positive for intra-abdominal fluid collection in 51.3% of cases..

This was matched with the results of the study that was created by Browning J et al.[79] where 80 patients were investigated by FAST after BAT and 52% of cases had positive FAST findings. 16 demonstrated solid organ injury, 8 free fluid and 1 suspected bladder rupture; 2 of these children went on to have a CT scan because of a high index of suspicion for small bowel perforation due to their mechanism of injury and clinical signs.

Also, a systematic review by Eppich and Zonfrillo[96] mentioned the FAST exam as a rapid, convenient, inexpensive, radiation-free tool used for initial assessment of both intra-abdominal free fluid and parenchymal injury. They mentioned some prospective studies at general trauma centers promote the use of FAST.

Regarding FAST results in diagnosis of intraperitoneal fluid collection, 48% of cases had no collection. Pelvic collection was the commonest site of collection and this was accepted as it is a normal finding in young children. Subhepatic collection came next as it is the most dependent area while child is supine during examination.

This was similar to Mehmet Selim, et al.[97] where pelvic site was the commonest site in 25% of cases and subhepatic was the second common site in 14.7% of cases.

One meta-analysis by Stengel D. et al.[98] pooled pediatric data from 4 trials encompassing 501 patients. The authors found that a positive FAST examination had a likelihood ratio for organ injury of 17.35 (95% CI). The difference in sensitivity from center to center was because of the difference in experience and it is operator dependent

In our study, FAST showed sensitivity for detection of intra-abdominal free fluid collection of 95.12% and specificity 100% with PPV of 100% and NPV of 0%. A lot of researches had studied the sensitivity of FAST in diagnosis of BAT. Of them, many studies were matched with our results. Studies conducted by Coley et al.[99] , Holmes et al.[100] , Souack et al.[101] , and Soundappan et al.[102] compared FAST exam to computed tomography for the identification of BAT in hemodynamically stable children. They demonstrated variable sensitivity (55–92.5%) and NPV (50–97%), but consistently good specificity (83–100%). Also, a meta-analysis conducted by Holmes et al.[103] to determine the test performance of FAST had a sensitivity of 66% (95% CI 56– 75%) for identifying children with hemoperitoneum.

Sensitivity showed variations in all studies as it is mainly operator dependent.

Our study showed that FAST had significant relation between FAST and patient out come as it was a significant tool for rapid decision making, patient life saving and evacuation of overcrowded ED. Where a child was managed operatively after FAST was

positive and he was hemodynamically unstable. 46% of cases was discharged safely after being examined by FAST.

This was in agreement with the study that was conducted by Faruque AV et al.[73] who studied 174 cases. Of these 31 children, sonography had been positive in 53.54% (2 of them were hemodynamically unstable and were sent immediately to OR. There were all patients who had negative sonography were discharged later (46.6%), and had no complication on clinical follow-up. They added that FAST was a reliable tool to pick high-grade solid and hollow viscous injury.

Abdominal CT

Abdominal CT remains the diagnostic test of choice for the evaluation of IAI. The CT diagnosis of abdominal injury also guides non operative decisions such as duration of hospitalization, intensity of care, length of activity restriction, and follow up[104]. CT imaging, however, results in substantial exposure to ionizing radiation, which may significantly increase a child's lifetime risk of lethal malignancy[105-106]. Unfortunately, children who are initially evaluated with abdominal CT at community hospitals frequently undergo repeat CT scans after transfer to pediatric trauma centers, further increasing their exposure to ionizing radiation[107].

In this study we followed the protocol applied in our main university hospital in management of children with blunt abdominal trauma where FAST was performed as a screening test for all cases with blunt abdominal trauma while CT was needed for certain patients with unhelpful result of FAST or need for identification of special organ injury, grading of injuries in organs or detection of injuries can't be detected by sonography. We found that 27.3% of cases only needed CT abdomen and it was positive in all of them either with or without contrast. CT was done upon the surgeon request.

CT should be used only to selected cases and this was the aim of our study. It was also the aim of study searched by Oliver Karam et al.[74] and Brenner D. et al.[108], which both concluded that the use of CT should be restricted to selected patients.

A prospective cohort study of patients aged up to 17 years was conducted over 6 months by Mueller et al.[109] studied the effect of radiation on children where they showed that radiation exposure should be avoided whenever possible and this is described in the 'As low (radiation) As Reasonably Achievable' (ALARA) principle[110]. Where he measured the radiation dose received in pediatric blunt trauma patients during initial CT evaluation and determined that 71% of study patients fell within the dose range historically correlated with an increased risk of thyroid cancer and whole body effective doses fell within the range of historical doses correlated with an increased risk of all solid cancers and leukemia. Selective scanning of body areas as compared with whole body scanning results in a statistically significant decrease in all doses. The author recommended that in the trauma, the future risk of malignancy should be continuously counterbalanced against the potentially large and immediate benefits of identifying (potentially) life threatening injuries.

A study conducted by Weishaupt et al.[111] concluded that in the hemodynamically stable patient, computed tomography scan remains the study of choice for identification IAI. Fewer than 15% of pediatric patients sustaining blunt trauma are found to have IAI on CT scan, and most of these injuries are managed non-operatively. Limitations of CT include time,

cost, need of personnel for transport, potential need for sedation, and long term risk of malignancy. Screening tools such as FAST combined with selected physical examination and laboratory data may in the future minimize the need for CT in those pediatric patients at low risk for intra-abdominal injury. And this was agreed with our results and the aim of our study.

Also, a review by Holmes et al.[112] of three prospective observational studies with a collective sample size of 2596 patients suggested that screening tools such as FAST combined with selected physical examination and laboratory data may in the future minimize the need for computed tomography in those pediatric patients deemed at low risk for intra-abdominal injury.

CT was not needed for all cases for diagnosis of fluid collection and organs injury in our study. It was needed for 41 cases only out of 150 patients. Distribution of cases according to fluid collection was agreed with a retrospective study on 125 patients by Streck CJ Jr. et al[113] where CT was not need for all cases. Minimal fluid collection was found in 10.6% of cases, mild in 15.2 % and moderate in 0.5% of cases. Also, spleen was the commonest organ to be injured in this study accounting 14% of the cases followed by the liver that accounted 8%.

In our study, we found a significant relation between patient outcome and CT results in cases who were in need for CT. Hershkovitz Y et al.[114] prospectively studied 42 pediatric patients who have underwent CT upon their evaluation for blunt abdominal trauma. Among these, (74%) had a normal CT scan. Two patients of 11 with an abnormal CT scan required a surgical management, 9 were referred for observational management. This indicated an abuse of CT abdomen without gaining extra benefit.

Also, Fenton et al.[115] retrospectively reviewed a cohort of 1422 children receiving computed tomography scans after traumatic injury, of whom 897 had abdominal computed tomography scans. The authors found that only 2% of all children with an abdominal computed tomography scan had surgical exploration. The authors advocate for the development of screening tools and decision rules to minimize the frequency of abdominal computed tomography.

FAST versus CT

CT should be used only to selected cases and this was the aim of our study. It was also the aim of study searched by Oliver Karam et al.[74] and Brenner D. et al.[116], which both concluded that the use of CT should be restricted to selected patients.

In a multicenter study by Karam et al.[74], where a scenario-based survey was carried out among 81 Swiss pediatric surgeons. The survey was carried out between May and June 2009. Respondents were asked to report on their management of children with blunt abdominal trauma. The results showed that 42 % pediatric surgeons were of the opinion that all patients with abdominal trauma should undergo an abdominal ultrasound, whereas 42 % would have reserved it for patients having abnormal laboratory exams and / or abnormal physical exam. 15% considered that some patients might not need an abdominal ultrasound, despite abnormal laboratory exams or abnormal physical exam. 92% of physicians reported that in their hospital, radiologists perform the ultrasounds. 10 pediatric surgeons 39 % were of the opinion that all patients with abnormal abdominal ultrasounds should undergo a CT scan, whereas 58 %

were of the opinion that some patients might not need a CT scan even though they had either an abnormal physical examination, abnormal laboratory tests or abnormal ultrasound. When a CT scan was performed, 77% of physicians 77% used IV contrast only, 12 % used oral and IV contrast, and 12 % used no contrast at all.

1) Time

As the time is the worst enemy of all emergency physicians, it was so important to be taken into consideration in our study. Our FAST average time was 11.0 minutes with the least time needed was 4 minutes and the maximum time needed was 11 minutes. .The mean time for CT scan was 50 minutes and the least time needed was 20 minutes and maximum time was 115 minutes where the need for transportation of the stable patient, stabilization of unstable patient before transportation, the need for sedation and previous laboratory results and consent before contrast administration when was needed.

In May 2000, Brian D. Coley et al.[99] data showed that the average time required to perform the FAST examination was 2 minutes, with the longest examination taking just under 5 minutes. But they didn't study the timing for CT scan. Melniker et al.[117] published the First Sonography Outcomes Assessment Program Trial, a randomized, controlled clinical investigation. The authors found that use of ultrasound significantly reduced the time from ED presentation to operative care (57 vs 166 minutes). Patients in the ultrasound group were also found to have shorter lengths of stay, fewer complications, and decreased total charges, which the authors hypothesize may have been the result of a more rapid diagnosis in both operative and non-operative patients, thus facilitating other types of care.

2) *FAST versus CT according to free fluid collection*

In our study, there was no difference between FAST and CT in diagnosis of hemoperitoneum and this was agreed with Menaker J et al.[72] conducted a prognostic and epidemiologic study (Level of Evidence II) to study the variability of clinician-performed (FAST) and its impact on abdominal CT use in hemodynamically stable children with BAT. They included 6468 hemodynamically stable children with a median age of 11.8 years. 887 (13.7%) underwent FAST examination before CT scan. A total of 3,015 (46.6%) underwent abdominal CT scanning, and 373 (5.8%) were diagnosed with IAI. They concluded that patients with a low or moderate clinician suspicion of IAI are less likely to undergo abdominal CT if they receive a FAST examination. The limitation of that study was the authors Included only hemodynamically stable children with suspected IAI with different grades of suspicion.

But this was not in agreement with a prospective observational study by Fox et al.[118] to determine the test characteristics of FAST to detect any amount of intraperitoneal free fluid compared to CT. FAST which was done by radiologists had a low sensitivity for clinically important but has high specificity. A positive FAST suggests hemoperitoneum and abdominal injury, while a negative FAST aids little in decision-making. This may be due to the low sensitivity found by the authors as ultrasound is an operator dependent diagnostic tool.

Again the difference between both studies may be due to the main disadvantage of ultrasound being an operator dependent diagnostic tool.

3) FAST versus CT according to organ injury

In our study the FAST and CT both equally identified parenchymal organ injury with no difference between them. Hollow viscus organ was diagnosed by CT scan only with spleen was the most commonly injured organ followed by the liver.

This was similar to a study by James F. Holmes et al[88]. The authors studied retrospectively how to identify children with blunt torso trauma who are undergoing acute intervention. Specific organ injuries included the spleen 299 (39%), liver 282 (37%), kidney 147 (19%), gastrointestinal tract 115 (15%), adrenal gland 89 (12%), pancreas 51 (7%), intra-abdominal vascular structure 16 (2%), urinary bladder 18 (2%), ureter 4 (0.5%), and gallbladder 4 (0.5%), and a traumatic fascial defect was identified in 4 patients (0.5%).

It was also in agreement with TasF et al.[119], who concluded the U/S for BAT in children as highly accurate and specific. It is highly sensitive in detecting liver, spleen and kidney injuries whereas its sensitivity is moderate for the detection of gastrointestinal tract (GIT) and pancreatic injuries. In the prospective study, overall 128 organ injuries were determined in 96 patients with CT; however, 20 (15.6%) of them could not be seen with U/S. Free intra-abdominal fluid was seen in 82 of 96 patients by CT (85.4%) and eight of them (9.7%) could not be seen by US. We found that sensitivity, specificity, positive predictive value, NPV and overall accuracy of the U/S for free intra-abdominal fluid were 90.2, 100, 100, 63.6 and 91.7%, respectively. FAST is not reliable to diagnose bowel injury.

Coley et al. [99] was not in agreement with our results. They studied 117 pediatric patients with blunt abdominal trauma were prospectively investigated using FAST. Thirty-two patients had CT documented injuries. There were no injuries missed by CT. FAST detected free fluid in 12 patients. Ten patients had solid organ injury but no free fluid and, thus, were not detected by FAST. The sensitivity of FAST relative to CT was only 0.55 and the NPV was only 0.50. This study had proposed that the FAST exam should be used solely as a screening tool to detect free fluid and that a positive FAST exam necessitates evaluation with computed tomography scan to delineate organ injury in the hemodynamically stable patient.

This may be explained as ultrasound has better sensitivity for detecting parenchymal spleen injuries than liver injuries. Moreover, children have a relatively higher incidence of solid organ injury without free fluid[120]; consequently, a negative FAST scan may not obviate the need for an abdominal CT when there is clinical suspicion of significant injury.

4) *FAST versus CT according to patient outcome*

A negative FAST scan was an excellent predictor of the absence of significant intra-abdominal injury. As all cases with negative FAST were discharged home with no complications. CT didn't add any more information to FAST in decision making regarding the patient outcome. Selected cases with polytrauma and/or unequivocal findings in the ultrasound should undergo abdominal CT. Patients requiring abdominal CT should have an anticipated benefit that exceeds the radiation risk. The importance of repeated clinical assessment cannot be overstated.

Conservative management was the most common decision to be taken for treatment of children with IAIs who didn't showed hemodynamic instability or who responded for fluids management with no need for blood transfusion. A risk factor was found in a 9 years male patient presented with local trauma to his abdomen. He was known as A type haemophilia (factor VIII deficiency) diagnostic tools reveled mild intraperitoneal fluid collection, and splenic and liver contusions. Patient was successfully managed conservatively after receiving fresh frozen plasma and factor VIII.

One missed injury that were found on CT (i.e. a splenic contusion and a minor renal laceration) did not require operative intervention and were successfully managed conservatively.

This was agreed with a retrospective descriptive study of 172 patients designed by Benjamin Terry et al.[121] where ultrasound findings were correlated with CT scan findings, operative findings if managed surgically, clinical outcomes whether managed surgically or conservatively, as well as postmortem findings in deceased patients.

Operative management which was done in 15 cases (10%) of our cases, it was also was found to be safe, with success rates by pediatric surgeons of 89-99%.

CT and FAST both were equally helpful in operative decision making and FAST was superior to CT in managing a patient with moderate intraperitoneal fluid collection and was hemodynamically unstable to be sent for CT. Patient was operated for splenic laceration with active extravasation.

Our results was matched with Retzlaff et al. [122] carried out a Retrospective analysis included 35 children with intraabdominal organ injury diagnosed by FAST. Twenty eight patients had an isolated blunt abdominal trauma. All patients underwent FAST. Two patients were immediately operated because of hemodynamic instability. Four of 7 polytraumatized patients and 7 of 28 patients with isolated blunt abdominal trauma were additionally diagnosed by CT. Only 1 patient underwent subsequent surgery because of the findings in the CT. Ultrasound was effective in more than 97% (34/35) of the patients for diagnosis and appropriate surgical decision making. They concluded that Ultrasound combined with clinical assessment presents an effective method for safe diagnosis and appropriate surgical decision.

6) Analysis of operated cases

Multivariate analysis of operated cases in our study was significant to all studied parameters which was a predictor for IAIs and operative management.

This was matched with Coley et al. [99] who studied 117 pediatric patients with blunt abdominal trauma were prospectively investigated using FAST. Thirty-two patients had CT documented injuries. There were no injuries missed by CT. FAST detected free fluid in 12 patients. Ten patients had solid organ injury but no free fluid and, thus, were not detected by FAST. The sensitivity of FAST relative to CT was only 0.55 and the NPV was only 0.50. This study had proposed that the FAST exam should be used solely as a screening tool to detect free fluid and that a positive FAST exam necessitates evaluation with computed tomography scan to delineate organ injury in the hemodynamically stable patient.

In another retrospective study by Paris et al.[123] of children with abdominal bruising after a RTA, a multivariate logistic regression analysis determined that predictors for intestinal injuries included abdominal bruising when combined with a pulse rate of more than 120 per minute, presence of free intra-abdominal fluid on ultrasound or CT, and an associated lumbar fracture. The authors concluded that an abdominal exploration should be considered for these patients.

Limitations

There are a number of limitations to this study. During the study period, there was no uniform approach to the evaluation of blunt abdominal trauma.

Renal injuries were seen rarely and pancreatic injuries were not seen in our study population; therefore, insufficient data was available to be fully evaluated. Furthermore, some patients were not CT scanned so the possibility of missing minor intra-abdominal injuries with little clinical significance exists. It is unlikely, however, that any significant injuries were missed because we have an extensive trauma registry and peer review process. As with many studies in the pediatric population, the number of patients in the study was relatively small, and the number of identified injuries was low.

"Low risk" patients with no other major injuries and no limitation to reliable physical exam can be safely discharged home in most cases. A potential limitation to an approach that reduces abdominal CT utilization could be a collateral increase in cost from admission and use of other hospital resources. In practice, the majority of pediatric patients which are evaluated as "pediatric trauma alerts" require admission at our institution. The vast majority of admissions were related to other injuries, most commonly traumatic brain and orthopedic injuries. Social and transportation issues which are not infrequent in our institution must be taken into account as well. The high rate of pediatric trauma alert patients requiring admission for non-abdominal injuries and social issues further supports a strategy of selective abdominal CT utilization as there is often ample opportunity for serial abdominal examinations at no additional cost to the patient who is admitted for other organ system injuries. The hospital charge and interpretation cost for abdominal pelvic CT at our institution is about 500 L.E, so avoidance of unnecessary CT scan, performed in at least 33% of our trauma alert population in this study, could represent a significant amount of savings to the health care system.

Another potential limitation to a strategy of selective CT utilization based on a prediction model which includes laboratory values is a delay in imaging while waiting on lab results. Fortunately, hypotension for age was infrequently seen and operative intervention for abdominal injury was rarely required in our pediatric trauma alert patients. In hemodynamically stable patients with no "high risk" clinical variables from our model and a reliable physical examination, a decision to CT scan can safely wait until the screening labs and plain films are obtained.

Also, another limitation of our study is that most of the patients considered as truly negative by FAST did not undergo a CT scan and were only followed clinically or follow up FAST scan. All ultrasound scans in our emergency department were performed by radiologists and not by the trauma team. However, this appears to be common practice, as in 16 studies of 23 reviewed for a meta-analysis, the ultrasound was interpreted by radiologists.

SUMMARY

Trauma is a leading cause of morbidity and mortality in childhood. The abdomen is the second most common site of injury. The most common reported mechanism for abdominal injury is motor vehicle crashes.

Any trauma patient should be managed according to ATLS guidelines and stabilization of the patient general condition should be the first priority. Abdominal examination, laboratory investigations and imageings are the methods of diagnosis and decision making.

FAST has become part of the initial trauma management, replacing diagnostic peritoneal lavage. It is rapid, bedside tool that can be done in the primary survey and resuscitation.

CT is the imaging method of choice in the evaluation of BAT in hemodynamically stable patient. IV and oral contrast and sedation may be needed. CT primarily guides non operative decisions such as the duration of hospitalization, intensity of care, and length of activity restriction.

This prospective study was conducted on all patients with blunt abdominal trauma who were admitted to Alexandria main university hospital through the Emergency Room from 1st of May 2013 to 30th of October 2013.

The aim of this study is to determine the Assess feasibility and accuracy of FAST and Computerized Tomography (CT) in the emergency department (ED) as screening for the detection of intra-abdominal injuries in pediatric patients with BAT.

During the study period 150 patients below the age of 18 years with blunt abdominal trauma with 109 males, 41 females with a median age of 9 years (range 3 days -17 years). 54% had Road traffic Accident (RTA), 39.3% reported fall from height (FFH). 73 (48.7%) children did not show hemoperitoneum upon FAST and 1 patient with minimal collection. Of them 68 (45.3%) cases were discharged home immediately after primary survey. Positive cases with FAST had hemoperitoneum that was minimal in 53 (68.8%), mild 19 (24.7%), and moderate in 5 (6.5%) cases. 50 patients were conserved. 15 patients were operated (12 had mild or moderate collection upon FAST), and 6 cases died. FAST findings were significantly related to the grade of shock (95% confidence interval [CI], P<.001). FAST showed 95.2% sensitivity, 95.12% specificity, 100% positive predictive value, and 0% negative predictive value (95% CI). 38 patients underwent contrast CT. Significant relations were found between FAST and CT as regards the mean examination time (11.29 vs. 54.72 minutes) (95% CI, P<.001), detection of grade of fluid collection (95% CI, P=.004) The Spleen was the most common injured organ in children in both investigation tools where in FAST 18 (23.4%) cases versus 16 (39%) cases with CT (95% CI, P=.002), followed by the liver; 14 (18.2%) cases detected by FAST versus 14 (34.1%) cases by CT (95% CI, P=.05).

Our data favors FAST as a rapid, sensitive, safe, bed side and cost effective screening and follow up tool for free fluid in children with BAT. CT scan is a secondary measure that is used in selected cases for grading of organ injuries shows higher cost, time consumption and require more facilities in the crowded ED.