The Blunt Abdominal Trauma in Children Scores for early detection of intraabdominal injuries in children

Original Article

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ABSTRACT

Background: For children under the age of 18 years, trauma continues to be the main cause of mortality. In order to improve the outcomes of children who have blunt abdominal trauma (BAT) and reduce the percentage of abdominal injuries that are overlooked, our study aims to evaluate the Blunt Abdominal Trauma in Children (BATiC) score for early prediction of intraabdominal injuries.

Patients and Methods: In a cross-sectional observational research, 123 children who had experienced severe BAT within 24 h were seen in the emergency room of Suez Canal University Hospital in Ismailia. Every patient involved in the research had a comprehensive medical history, trauma data collection, clinical examination, regular laboratory testing, and radiographic studies. Next, all of the patients in our department were given the BATiC score upon admission.

Results: The study population included 123 patients. More than half of the study participants (64.2%) have abdominal pain. Focused Assessment with Sonography for Trauma scan showed mild collection in 38 (30.9%), moderate in 21 (17.1%), and marked in 11 (8.9%). Regarding computed tomography with i.v. contrast, it was found to be abnormal in more than half of studied patients 62 (50.4%). Presence of organ injury and organ injury by computed tomography, which showed that slightly more than half, 62 (50.4%) of patients had organ injury. The most commonly injured organ was the liver in 37 (59.7%). The mean BATiC score was statistically significantly higher in patients with organ injury (*P<0.001*), with statistically significantly positively correlated with organ injury (r=0.913) (*P<0.001*). Receiver operating characteristic curves showed that BATiC score test is acceptable with a significant area under a curve of 0.990. It had a maximum sensitivity of 93.5% and a specificity of 90.6%, with an accuracy of 92.2%.

Conclusion: When predicting intraabdominal injuries in children who have experienced BAT, the BATiC is a useful tool.

Key Words: Abdominal injuries in children, Blunt Abdominal Trauma in Children, blunt abdominal trauma.

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INTRODUCTION

According to WHO, Traumatic injuries are the number one cause of death from ages 1 to 18 years. In 2015, more than 140 000 patients aged less than 19 years were injured, resulting in 3400 deaths. More than 73% of these injuries occurred by blunt mechanisms, with most being falls or motor vehicle accidents. Abdominal injuries were documented in almost 13% of these patients[1].

Trauma is still the leading cause of death for children below the age of 18 years, even in well-developed and wealthy countries. Abdominal trauma accounts for about 10% of trauma in children and is considered the leading cause of initially unrecognized fatal injury[2–4].

The types of injury mechanisms are age-dependent. In infants, nonaccidental injury is most prevalent, whereas, for toddlers, falls are the predominant injury mechanism[5].

In older children, road traffic accidents (RTA) and sports injuries predominate. More than 50% of RTA involves the child as a pedestrian and a further 20% as cyclists[5].

One of the main causes of impairment and even death in children is still blunt abdominal trauma (BAT) in the pediatric age range. Numerous causes of damage, including sports injuries, falls from heights, abuse (abdominal kicks), and traffic accidents, can result in BAT[6].

The treatment of trauma in children has special difficulties. The wounded child's management is limited by the patient's developmental stage, the younger patient's lack of linguistic abilities, and the absence of prehospital information[7].

Like adults, children may have a lower Glasgow Coma Scale score and an inaccurate abdominal examination due to a concomitant brain injury. Furthermore, crying

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and stomach distension increases the likelihood of an inaccurate abdominal examination in children[8].

It is not recommended to do routine computed tomography (CT) scans of the head, neck, chest, abdomen, and pelvis on pediatric patients, nor should trauma panels. In addition to increasing the lifelong risk of a deadly cancer, juvenile patients who get unnecessary radiation exposure also face higher medical expenses[9].

The ability to examine wounded children using a variety of scoring methods facilitates the classification of BAT. It is now simple to identify patients who require immediate attention thanks to these grading systems[10].

The Blunt Abdominal Trauma in Children (BATiC) score is a frequently utilized trauma score instrument that is intended to assess the extent of harm sustained by pediatric patients. The BATiC score is a valuable instrument for evaluating if children have had abdominal trauma. Abdominal ultrasonography, regular laboratory data, and physical examination findings are examples of easily accessible parameters that can be used to compute this score. More significant numbers on the BATiC score indicate a greater death rate. The score goes from 0 to 18[11].

In order to enhance the prognosis of children who suffer BAT and reduce the number of abdominal injuries that go unnoticed, the purpose of our research is to evaluate the BATiC score with respect to early prediction of intraabdominal injuries (IAI).

PATIENTS AND METHODS:

In this investigation, which was a prospective cross-sectional observational study, 123 children (above the age of 2 and under the age of 18 years) who had severe BAT within a day after presenting to the emergency room of Suez Canal University Hospital in Ismailia were included. Patients with penetrating injuries, persistent debilitating conditions, trauma lasting more than 24 h, severe head injuries, major chest injuries, fractures of the limbs or pelvis, and referrals from any hospital following surgery or medical intervention were not included in our sample. The patients included in this study gave written informed consent to participate in this research.

Data was collected by the researcher in preorganised data sheet from the children or their parents/relatives' fulfilling inclusion and exclusion criteria in the study, which included:

(1) Full history.

(2) Data of trauma.

(3) Clinical examination by ABCDE approach.

(4) Routine laboratory: complete blood picture, coagulation profile, alanine transaminase (ALT), aspartate aminotransferase (AST), lactate dehydrogenase (LDH), serum lipase, serum creatinine.

(5) Radiological investigations: Focused Assessment with Sonography for Trauma (FAST), plain chest radiograph, plain erect abdominal radiograph, plain pelvic radiograph, and pelvi-abdomianl CT with i.v. contrast when indicated.

Then, the BATiC score was applied on arrival to all the patients in our department (Table 1).

Table 1: Blunt Abdominal Trauma in Children Score value for each item[12]

Items	Score
Abnormal abdominal Doppler US	4
Abdominal pain	2
Signs of peritoneal irritation	2
Hemo-dynamically instability	2
AST >60 IU/l	2
ALT >25 IU/l	2
WBC count >9.5 g/l	1
LDH > 330 IU/l	1
Lipase >30 IU/l	1
Creatinine >50 µg/l	1

ALT, alanine transaminase; AST, aspartate aminotransferase; LDH, lactate dehydrogenase; US, ultrasound; WBC, white blood cell.

Then, the patients were divided into two groups:

(1) Proven to have IAI by CT or laparotomy.

(2) Nonproven to have IAI injury by CT or laparotomy.

The patients had been followed up and recorded till one of the following outcomes was reached:

(1) Treated and discharged without admission or intervention.

(2) Admitted to inward.

(3) Admitted to ICU.

(4) Had surgical intervention.

(5) Death.

Statistical analysis

(1) All analyses were performed using the Statistical Package for Social Sciences (SPSS) for Windows, version 22.0 (SPSS Inc., Chicago, Illinois, USA).

(2) Descriptive data had been presented as mean±SD or percentages. Fisher's exact test and χ^2 test will used for statistical analysis of categorical variables as appropriate.

(3) Analysis of continuous variables would be performed by independent t test or nonparametric Mann–Whitney U test according to the normality of the distributions.

(4) For all tests, a probability value of less than 0.05 was considered statistically significant.

RESULTS:

The mean age of our study participants was 9.49±4.379 years; 45.5% were aged 6–12 years, 30.9% were more than 12 years, and 23.6% were less than 6 years (Table 2).

Table 3 shows that most participants (65.0%) were males. More than half (55.3%) were from rural areas, while 44.7% were from urban areas.

In terms of the mechanism of trauma, it was found that in about half of the participants (50.4%), the mechanism of trauma was RTAs, in 34 (27.6%), it fell from height; in 22 (17.9%) it was direct trauma, in three (2.4%) was quarrel, in two (1.6%) it was sliding.

Tables 4 and 5 demonstrate the primary survey and laboratory investigations of the study population.

Regarding signs and symptoms, it was found that more than half of the study participants (64.2%) have abdominal pain, 25.2%, and 22.8% have vomiting.

Table 6 revealed the radiological results of the study population. FAST scan showed that normal results in 42 (34.1%) of patients, mild collection in 38 (30.9%), moderate in 21 (17.1%), marked in 11 (8.9%). Regarding CT abdomen and pelvis with i.v. contrast, it was applied to 73 (59.3%) patients, and it was found to be abnormal in more than half of the studied patients, 62 (84.9%).

CT was not done in 50 (40.7%) cases; either the children transferred to the OR immediately and died there (eight cases) or cases with no evidence of IPFF by FAST (42 cases). CT with contrast was applied to 73 children and was found to have IAI in 62 children. This difference is due to the fact that those 11 patients had rim and minimal collection by FAST, and after receiving IV contrast, there was no IAI detected by CT contrast.

Table 7 showed the organ injured by CT, which showed that among the 62 patients who had organ injury, the most commonly injured organ was the liver in 37 (59.7%), followed by the spleen in 15 (24.2%), pancreas in eight (12.9%), then kidney and stomach equally in one (1.6%).

Table 8 illustrates the BATiC score result, which found that abnormal abdominal ultrasound (US) Doppler was found in 81 (65.9%) of patients, hemodynamic instability in 44 (35.8%), AST more than 60 in 46 (37.4%), ALT more than 25 in 48 (39%), white blood cells more than 9.5 in 60 (48.8%), LDH more than 330 in 62 (50.4%), lipase more than 30 in 27 (22%), and creatinine more than 50 in eight (6.5%).

Table 9 demonstrates the outcomes of the studied sample. The most common outcome was discharge in 42 (34.1%) of patients, followed by laparotomy in 35 (28.5%), ICU admission in 20 (16.3%), conservative inpatient in 18 (14.6%), and death in eight (6.5%) of patients.

Tables 10 and 11 show that the mean BATiC score was statistically significantly higher in patients with organ injury (13.82±3.232) than in patients without organ injury (1.64±2.010) ($P<0.001$) with statistically significantly positively correlated with organ injury (r=0.913) ($P<0.001$).

Figure 1 and (Table 12) show the receiver operating characteristic (ROC) curve that was used to estimate the diagnostic profile of BATiC score in detecting abdominal organ injury. The BATiC score test is acceptable, with a significant area under the curve of 0.990. At a BATiC score of 6, it had maximum sensitivity of 93.5%, specificity of 90.6%, and accuracy of 92.2%.

Table 2: Age distribution of the studied patients

All patients (*N*=123)	Mean±SD	Median	Range	IQR
Age (years)	9.49±4.379	9.00	3.00, 17.00	6.00, 13.00
Age [*n* (%)]				
>2–<6		29 (23.6)		
6–12 years		56 (45.5)		
>12–<18 years		38 (30.9)		

Table 3: Sex of the studied sample

All patients (*N*=123)	Percentage and frequency
Sex	
Male	80 (65.0)
Female	43 (35.0)

Table 4: Primary survey of the studied sample

All patients (N=123)	Mean±SD	Median	Range	IQR
Respiratory rate (breaths/min)	25.38±7.145	25.00	13.00, 40.00	19.00, 32.00
Pulse (BPM)	106.33±20.581	110.00	65.00, 146.00	90.00, 120.00
SBP (mmHg)	95.20±17.455	100.00	40.00, 130.00	80.00, 110.00
Airway				
Patent	123		100.0%	
Breathing				
Spontaneous	123		100.0%	
Auscultation				
Normal	123		100.0%	
GCS				
9–12	1		0.8%	
13–15	122		99.2%	
Signs and symptoms				
NAD	31		25.2%	
Abdominal pain	79		64.2%	
Vomiting	28		22.8%	

GCS, Glasgow Coma Scale.

Table 5: Laboratory investigations

All patients (N=123)	Mean±SD	Median	Range	IQR
Hb (g/dl)	10.47±1.790	10.00	6.50, 15.00	9.80, 11.00
WBCs×10^9/l	9976±3113	9800	4500, 15000	8000, 11 000
PTT (s)	37.86±3.782	38.00	13.00, 45.00	36.00, 40.00
INR (s)	1.02±0.090	1.00	0.70, 1.30	1.00, 1.00
ALT (U/l)	73.07±100.388	27.00	10.00, 392.00	20.00, 40.00
AST (U/l)	110.56±151.672	49.00	17.00, 660.00	35.00, 68.00
LDH (IU/l).	329.39±109.904	350.00	25.00, 590.00	260.00, 400.00
Lipase (U/l)	105.23±244.510	26.00	8.00, 1400.00	22.00, 29.00
Creatinine (mg/dl)	0.93±0.243	1.00	0.32, 1.90	0.81, 1.00

ALT, alanine transaminase; AST, aspartate aminotransferase; LDH, lactate dehydrogenase; WBC, white blood cell.

Table 6: Radiological investigations of the studied sample

All patients (N=123)	Frequency	Percentage
FAST scan		
Normal	42	34.1
Rim	7	5.7
Minimal	4	3.3
Mild	38	30.9
Moderate	21	17.1
Marked	11	8.9
CT with contrast		
Normal	11	9
Abnormal	62	50.4
Not done	8	6.5
	42	34.1

FAST, Focused Assessment with Sonography for Trauma.

Table 7: Presence of organ injury and organ injured of the studied sample

All patients (*N*=62)	Organ injured	Frequency	Percentage
Organ injured	Spleen	15	24.2
	Liver	37	59.7
	Kidney	1	1.6
	Stomach	1	1.6
	Pancreas	8	12.9

Table 8: Blunt Abdominal Trauma in Children score of the studied sample

All patients (*N*=123)	Frequency	Percentage
Abnormal Abdominal US Doppler	81	65.9
Hemodynamic instability	44	35.8
AST >60	46	37.4
ALT >25	48	39.0
WBCs >9.5	60	48.8
LDH >330	62	50.4
Lipase >30	27	22.0
Creatinine >50	8	6.5

ALT, alanine transaminase; AST, aspartate aminotransferase; LDH, lactate dehydrogenase; US, ultrasound; WBC, white blood cell.

Table 9: Outcome of the studied sample

All patients (*N*=123)	Frequency	Percentage
Discharge without admission or intervention	42	34.1
Laparotomy	35	28.5
Conservative inpatient	18	14.6
ICU Admission	20	16.3
Died	8	6.5

Table 10: Blunt Abdominal Trauma in Children score according to the presence of organ injury in the studied sample

All patients (*N*=123)	No IAI (*N*=53)	IAI (*N*=70)	*P* value
BATiC score (mean±SD)	1.64±2.010	13.82±3.232	<0.001

BATiC, Blunt Abdominal Trauma in Children Score; IAI, intraabdominal injuries.

Table 11: Correlation between Blunt Abdominal Trauma in Children score with presence of organ injury in the studied sample

	Organ injury	*P*
BATiC score (Pearson coefficient)	0.913	<0.001

Data is expressed as mean and SD or as percentage and frequency.
BATiC, Blunt Abdominal Trauma in Children.
P is significant when less than 0.05.

Table 12: Diagnostic profile of Blunt Abdominal Trauma in Children score in detecting abdominal organ injury

BATiC score	
AUC	0.990
95% CI of ACU	0.978, 1.0
P	<0.001
Cutoff point	6
Youden's index	0.935
Sensitivity	93.5%

Specificity	90.6%
PPV	92.1%
NPV	92.3%
Accuracy	92.2%

BATiC, Blunt Abdominal Trauma in Children; NPV, negative predictive value; PPV, positive predictive value.
P is significant when less than 0.05.

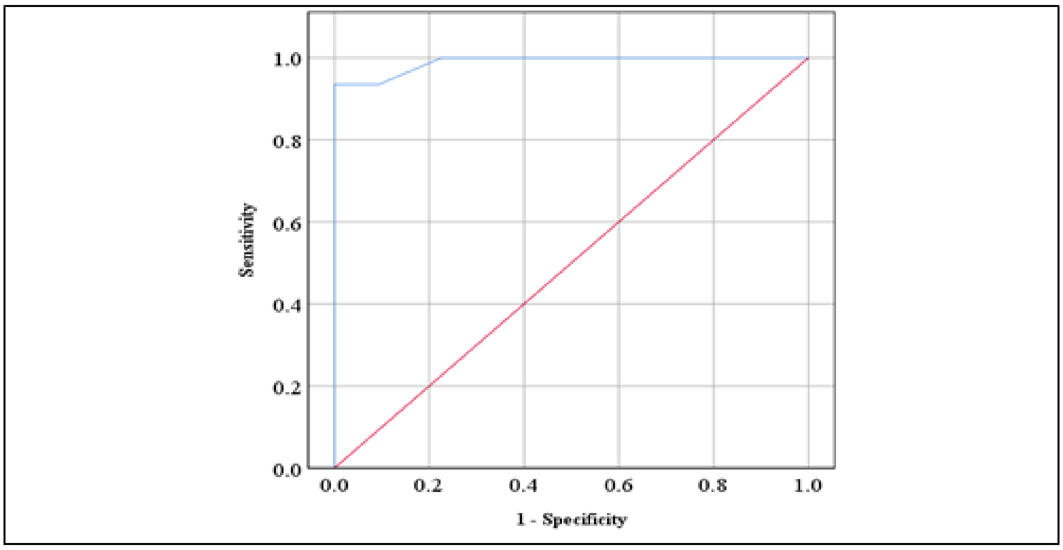

Fig. 1: ROC curve for a diagnostic profile of BATiC score for diagnosis of abdominal organ injury. BATiC, Blunt Abdominal Trauma in Children; ROC, receiver operating characteristic.

DISCUSSION

Recognizing IAI can be difficult, and abdominal trauma is still a major source of morbidity and death in children[13]. Currently, the gold standard for evaluating IAI in both juvenile and adult populations is the abdominopelvic CT scan[14].

Over half of pediatric abdominopelvic CT scans in situations of forceful abdominal injuries are probably unnecessary, and in over 90% of cases, a CT scan has no bearing on the treatment decision[15].

Particular attention should be paid to the danger of radiation exposure from CT scans in the pediatric population. Children have a greater lifetime cancer mortality risk than adults due to radiation exposure from CT scans[16]. Compared to CT scans of other regions, there is an increased incidence of solid organ cancers with abdominopelvic CT scans. Those who are younger and girls are especially susceptible to this risk[17]. Every 300 abdominopelvic CT scans in this cohort are expected to result in radiation-induced solid cancer. Abdominopelvic CT scans account for the great majority of radiation exposure that occurs during a pediatric trauma work-up[18].

Despite the potential for radiation exposure, CT is nevertheless a vital technique for trauma evaluation. Additionally, data from the adult trauma population supports routinely using a "pan" CT scan rather than a selective CT scan[19].

The majority of children who sustain injuries end up at adult trauma centers, therefore, the widespread usage of CT scans has also affected the pediatric population. Notably, nonpediatric-oriented clinics accounted for 89% of pediatric trauma visits linked to CT scans. Obtaining CT imaging is the main reason for the delay in transfer to a level I pediatric trauma hospital in the event of a serious pediatric accident[20].

Clinical decision guidelines have been developed to assist doctors in determining when to obtain an abdominopelvic CT scan by weighing the hazards of ordering unnecessary radiation exposure against the risk of missing an IAI[11,21,22]. This may be even more beneficial for medical professionals working in adult trauma centers. Using frequently acquired clinical factors, pediatric patients presenting with BAT can be risk categorized. One tool used to predict the lack of organ damage in children presenting with BAT is the BATiC score[11].

The prediction tool identified individuals in whom a CT scan or hospital admission could be safely avoided by using laboratory tests, abdominal examination, and abdominal Doppler ultrasonography in hemodynamically stable patients.

The main results of this study were as follows.

The present study enrolled 123 cases with a mean age of 9.49±4.379, ranging from more than 2 to less than 18 years, with 80 (65.0%) males. This can be explained by the fact that boys in our community are more active and, accordingly, more exposed to trauma.

In agreement with our results, the study by Khirallah and Elsayed[23] reported that 250 children presented with BAT to their institute's emergency department over 2 years. The age of the patients ranged from 2 to 18 years, with a mean age of 10.14 years, and in Anıl *et al*.[24] study, 143 (67.1%) of the patients were males.

As regards the mechanism of trauma, it was found that in about half of the participants, 62 (50.4%), the mechanism of trauma was RTAs. In 34 (27.6%), it fell from a height, in 22 (17.9%) it was direct trauma, in three (2.4%) was the quarrel, in two (1.6%) it was sliding.

The development of roads and road transport, noncompliance with safety regulations, and lack of discipline in traffic explain this frequency of RTAs. In addition, this can be explained by unattended children and unsupervised play.

Similar findings were reported by Djordjevic *et al*.[25], who discovered that automobile accidents accounted for 64.5% of all injuries, with falls from a height accounting for 22.5%, bicycle handlebar injuries for 6.45%, contact sports for 6.45%, and child maltreatment for 3.22% of cases.

Arbra *et al*.[22], reported that the most common mechanism of BAT in children was motor vehicle collision (34.5%) followed by pedestrian or bicyclist (25.4%), then fall from height (18.9%).

However, the study by Sigal *et al*.[26] reported that the most common mechanism of BAT in children was a fall (52%) followed by motor vehicle crashes (40.8%).

Regarding signs and symptoms, it was found that more than half of the study participants (64.2%) had abdominal pain, and 22.8% had vomiting.

In the study by Sigal *et al*.[26], they reported that there was 53% of patients complained of abdominal pain and 43% had vomiting.

Furthermore, Streck *et al*.[15] reported that abdominal pain was significantly associated with IAI.

According to the BATiC score, it was found that abnormal abdominal ultrasound Doppler was found in 81 (65.9%) of patients, hemodynamic instability in 44 (35.8%), AST more than 60 in 46 (37.4%), ALT more than 25 in 48 (39%), white blood cells more than 9.5 in 60 (48.8%), LDH more than 330 in 62 (50.4%), lipase more than 30 in 27 (22%), and creatinine more than 50 in eight (6.5%).

The increased number of hemodynamically unstable children may be attributed to the delay in transfer and improper triaging as the ambulance transferred most of the cases at first to the primary health care units, where cases are triaged and transferred to our hospital when needed. In addition, some cases were stable at the time of trauma, deteriorated later, and mainly were brought by their parents or relatives.

However, in the study by Ndour *et al*.[27] on presentation to the ED, 48 (87.27%) patients were hemodynamically stable, and seven (12.72%) patients were unstable. The latter were all poly-trauma patients, so there were associated injuries for the cause of hemodynamic instability.

Regarding CT with i.v. contrast, it was applied to 73 patients. It was found to have IAI in 62 patients. This difference explained by the presence of 11 patients with rim and minimal collection by FAST, and after receiving i.v. contrast, there was no IAI was detected by CT with contrast.

In agreement with our results, Arbra and colleagues aimed to validate a five-variable Clinical Prediction Rule for identifying children at very low risk for IAI following BAT. The study included 2435 patients, and 235 (9.7%) were diagnosed with IAI in the ED or during the initial hospitalization. The most common injuries were liver (40.9%), spleen (39.6%), kidney (18.7%), small bowel (12.3%), mesentery (7.2%), and large bowel (6.4%)[22].

Streck and colleagues study also sought to develop a prediction algorithm to pinpoint kids who, following BAT, are extremely unlikely to develop IAI. Following BAT, 2188 children were included in the trial; 261 (11.9%) patients and 62 (2.8%) patients had IAI-I. According to the study, liver injuries occur most frequently, followed by spleen injuries[15].

As regards the outcome of the studied sample, the most common result was discharge in (34.1%) of patients, followed by laparotomy in 28.5%, ICU admission in 16.3%, and conservative inpatient in 18 14.6%, then death in 6.5% of patients.

In Anil *et al*.[24], 105 patients were hospitalized. According to the disposition type from the PED, 73 (69.5%) were hospitalized in the ward, and 25 (23.80%) were hospitalized in the PICU. Seven patients were admitted to the operating room directly from the ED.

The present study showed that the mean BATiC score was statistically significantly higher in patients with organ injury (13.82±3.232) than in patients without organ injury (1.64±2.010) (*P<0.001*). BATiC score is statistically significantly positively correlated with organ injury (r=0.913) (*P<0.001*).

Karam and colleagues designed the BATiC score to predict the absence of organ injury in children presenting with BAT. When applying the BATiC score to the study population, they found a significant difference between the patients with an intraabdominal organ injury as the mean score was 11.1±3.6 versus 4.4±2.5 for the patients without intraabdominal organ injury (*P<0.0001*)[28].

Furthermore, the 2014 study by de Jong and colleagues sought to verify the application of the BATiC score. Two hundred sixteen individuals were included in the research, and the median BATiC scores for those who had an IAI and those who did not were 9.2 (range, 6.6–15.4) and 2.2 (range, 0.0–10.6), respectively (*P<0.001*). According to the study's findings, the BATiC score can be a helpful supplementary tool in evaluating if abdominal trauma has occurred in children. It can also be used to identify which patients might benefit from additional therapy, such as a CT scan, and which might not[11].

To assess the diagnostic profile of BATiC score in detecting abdominal organ injury, receiver operating characteristic curve was used. BATiC score test had a significant area under a curve of 0.990 with a cutoff point of 6 with a maximum sensitivity of 93.5% and specificity of 90.6% with an accuracy of 92.2%.

Concurring with our findings, de Jong *et al*.[11]. The test displayed 100% sensitivity and 87% specificity when the BATiC score was employed, with a cutoff value of 6. A stable patient with a low BATiC and a normal ultrasound would not require hospital admission or CT scanning, as shown by the area under the curve for injury detection of 0.98.

According to Karam *et al*.[12], infants with IAI may be identified with 91% sensitivity and 84% specificity when their BATiC score is less than 7. Nevertheless, only 31 individuals with IAI were found during the research period, making it a small study.

Limitations of the study

Also, this study had some limitations, such as the study being from one center only, being conducted in a university hospital, and not a special pediatric hospital. There is a need for available laboratory investigations that may take time before defining the child's score, and pain and peritoneal irritation cannot be accurately determined in children younger than 4 years.

CONCLUSION

BATiC has a valuable role in the prediction of IAI in children with BAT.

Recommendation

Further studies with larger sample sizes and multicenter are needed to confirm the current results.

CONFLICT OF INTEREST

There are no conflicts of interest.

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