AMERICAN JOURNAL OF DIAGNOSTIC IMAGING
2024; 10(3): 58-64
10.5455/ajdi.20240515042632

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RESEARCH ARTICLE

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Focused assessment with sonography for trauma correlated with intraoperative findings among patients with blunt abdominal trauma

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ABSTRACT

Aim: The aim of this study was to assess the correlation between FAST examination with intraoperative findings among patients with blunt abdominal trauma.

Methods: This retrospective cross-sectional study was conducted at Kilimanjaro Christian Medical Centre from January 2022 to December 2022. Data collection started on September 15th, 2022 to September 14th, 2023 and the analysis was conducted thereafter. A total of 77 post-traumatic patients were enrolled. The FAST findings were then compared with intraoperative ones. The parameters evaluated included hemoperitoneum and injury to the visceral organs.

Results: The mean age of the participants was 37.7 years (18.9 SD). The mechanism of injury was road traffic accidents 49 (63.6%), fall from height 15 (19.5%), assaults 10 (13.0%), and other causes (3.9%). The dependent sites for fluid collection during FAST examination were hepatorenal space 43 (55.8%) followed by rectovesical space and splenorenal recess by 36 (46.7%) and 31 (40.3%), respectively. Visceral injuries observed during laparotomy, the bowels, liver, spleen, and the urinary bladder were 36 (46.8%), 26 (33.8%), 23 (29.9), and 8 (10.4%), respectively. FAST showed a 97.4% positive predictive value. The rate of detection of solid organ injury shown by FAST against laparotomy was found to be 21.4%.

Conclusion: A high incidence of blunt abdominal trauma of more than 50% was seen in the economically active age group of 21–45 years, reflecting their participation in high-risk activities that expose them to trauma. This demands an urgent public policy response. In this study, FAST examination showed better results in detecting the presence of hemoperitoneum than in detecting injury to the visceral organs.

ARTICLE HISTORY

Received 15 May 2024
Accepted 23 July 2024
Published July 31, 2024

KEYWORDS

Focused assessment with sonography for trauma; Laparotomy; Blunt abdominal trauma

Introduction

Among the causes of injury worldwide are road traffic accidents (RTAs), acts of violence against others or oneself, and falls [1,2]. The abdomen is the most common part of the body to get injured during trauma [3,4]. Blunt abdominal trauma (BAT) is among the common causes of morbidity and mortality in all age groups worldwide [5–7]. Data show that most BAT occurs in males and young generations [3,8]. Patients with BAT are more likely to get laparotomy, though sometimes these patients can be managed conservatively by close monitoring [9,10].

Focused assessment with sonography for trauma (FAST) is widely adopted as a first and quick diagnostic tool in the evaluation of patients with BAT due to its ability to detect free intraperitoneal fluid (hemoperitoneum in the context of trauma) which accumulates in dependent areas around the liver, spleen, and rectovesical space as a marker of injury and can also detect solid organ injury such as liver, spleen and kidneys [3,11–14]. Also, when it is extended to assess intrathoracic fluid collection and fluid around the heart, it is known as extended FAST (eFAST) [3,11,15]. FAST is reported as positive or negative depending on the presence or absence of fluid in the aforementioned areas [9,11].

FAST provides an immediate, fast, accurate, and reliable assessment of trauma patients that is accessible, portable, and can be done at the bedside

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without the need to move the patient from the resuscitation room [11,16]. The use of FAST is regarded as safe, repeatable, non-invasive, and radiation-free as compared to other diagnostic modalities such as diagnostic peritoneal lavage, exploratory laparotomy, and computed tomography scan [8,10,11,17–19]. Studies have shown that there is an increase in sensitivity when the FAST scan is repeated [20,21].

The use of ultrasound is the key diagnostic screening tool that enables rapid identification of conditions that in the past would have been more difficult and take time to diagnose [20]. Therefore, it was necessary to investigate the correlation between FAST examinations and intraoperative findings among patients with BAT by comparing the FAST findings with the Intraoperative findings. This study provides information on the pattern of injury, common mechanisms of injury, sensitivity, and positive predictive value (PPV) of FAST scans with the purpose of improving clinical practice.

Materials and Methods

Patients

Research Ethical Clearance Certificate no. PG 74/2022 was issued by the Ethical Review Committee of KCMUCo for clearance to conduct the study, and permission for data collection at KCMC was granted by the Executive Director of KCMC hospital. Patient approval and informed consent were waived because of the retrospective nature of its design and the strict maintenance of patient anonymity. This study was done among post-traumatic patients with blunt abdominal injuries who attended Kilimanjaro Christian Medical Centre from January 2022 to December 2022. This study is based on registry data from radiology and surgical reports through the KCMC hospital electronic health management system. Data collection started on 15th September 2022 to 14th September 2023 and data analysis was conducted thereafter, where medical reports from 412 patients were reviewed. Inclusion criteria for the sample included all patients with BAT who had both FAST examination and celiotomy. Patients were excluded if (i). Their FAST or Surgical reports did not adhere to the KCMC reporting format or with incomplete information, (ii). Patients with penetrating abdominal trauma, or (iii). Patients who were managed conservatively. After applying the exclusion criteria, a total of 77 patients were included in the study (Fig. 1).

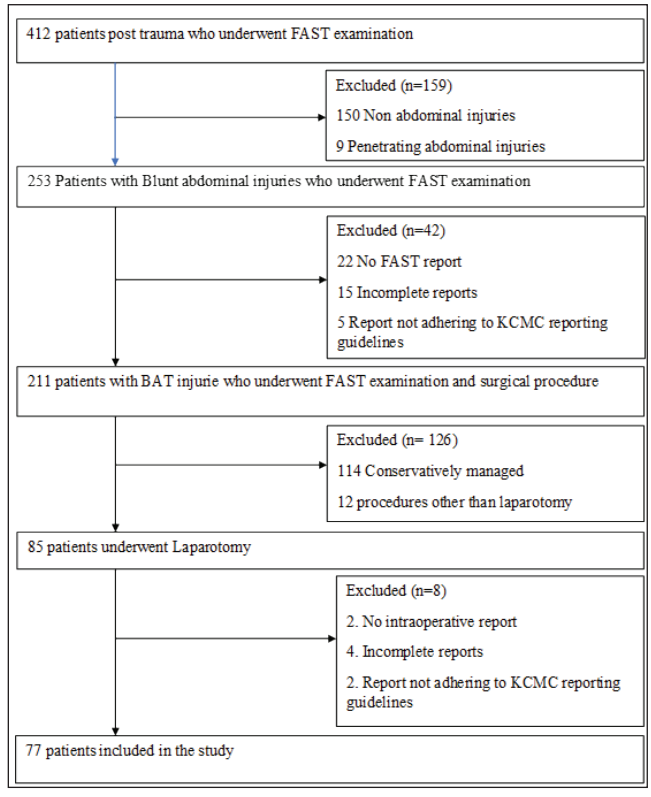


Figure 1. Flow chart showing selection of patients.

Instruments and methods

The FAST examination of each patient was done by either the residents or radiologists adhering to the American Institute of Ultrasound in Medicine practice guideline for the Performance of the FAST Examination with one commercially available ultrasound system, either an Acuson NX3 (Siemens Healthineers) or Acclarix LX3. Subsequently, exploratory laparotomies were performed by experienced surgeons according to the KCMC standard operating procedure.

Interpretation of medical reports

The sonographic findings were reported as FAST positive if free fluid is seen in any of the following spaces: around the liver, spleen, and rectovesical space, or there is evidence of any solid organ injury, including the liver, spleen, kidney, urinary bladder or bowels. The absence of free fluid in the aforementioned spaces with no evidence of solid organ injury was classified as a negative FAST result. Regarding laparotomy, the presence of hemoperitoneum or any solid organ injury including the liver, spleen, kidney, urinary bladder, diaphragm, and bowels as well as any other organ such as the uterus or ureter was defined as a positive laparotomy. The

absence of hemoperitoneum or injury to the aforementioned solid organs was regarded as a negative laparotomy.

Statistical analysis

SPSS software, version 25.0 (Statistical Package for the Social Sciences) was used for all data analysis. Statistical significance was set at $p < 0.05$. Logistic regression analysis was used to show the relationship between variables. The Odds ratio was used to show the strength of the association between independent and dependent variables. The data was also calculated and summarized into frequency tables, charts, graphs, and cross-tabulations for easy interpretation.

Results

Background characteristics of the participants

As shown in Table 1. Among 77 participants who met inclusion criteria, 66(85.7%) males predominated with the male-to-female ratio of 6:1. The overall mean age was 37.7 years (18.9SD) and ranged between 5 and 88 years of age. Most 40(51.9%) of the respondents were in the 21–45 years age group.

Mechanism of injury

As illustrated in Table 2, among 77 patients with BAT 49 (63.60%) had RTA followed by fall 15 (19.5%) and assault 10 (13.0%) while other causes represent the least common mechanism accounted for about 3 (3.9%). Of patients who were involved in RTA, 22 (28.6%) were due to motorcycle accidents, 13 (16.9%) were motor vehicle accidents, and 14 (18.2) were Auto pedestrian collisions. (Table 2).

Pattern of visceral injury

Laparotomy was done on 77 patients and multiple visceral injuries were revealed. Injury to hollow organs (bowel and urinary bladder) was quite common about 44 (57.2%) of all patients. Liver injury was observed in 26 (33.8%) patients and spleen in 23 (29.9) cases. Only 15 cases of solid organ injury (Spleen 8, urinary bladder 4, and liver 3) were detected during FAST examination. In general, the rate of detection of visceral organ injury by FAST examination was found to be 21.4%. (Table 3). The dependent site for the fluid collection in the peritoneal cavity reported during FAST examination it was found to be the hepatorenal space 43 (55.8%) followed by rectovesical space and splenorenal recess by 36 (46.7%) and 31 (40.3%), respectively (Fig. 2).

Table 1. Showing the background characteristics of the participants ($N = 77$).

Variable	Frequency (*n*)	Percentage (%)
Sex		
Male	66	85.7
Female	11	14.3
Age category (years)		
≤20	11	14.3
21–45	40	51.9
46–59	15	19.5
≥60	11	14.3
Mean Age 37.7 (SD: 18.9)		

SD = Standard deviation.

Table 2. Showing the mechanism of injury ($N = 77$)

Variable	Frequency (*n*)	Percentage (%)
Assaults	10	13.0
Fall from height	15	19.5
Road traffic accidents	49 (63.6%)	
Motorcycle accidents	22	28.6
Motorcar accidents	13	16.9
Auto pedestrian collision	14	18.2
Other	3 (3.9%)	
Hit by wood	1	1.3
Animal attack	2	2.6

Table 3. Showing pattern of viscera injury ($N = 77$).

Variable	FAST *n* (%)	Laparotomy *n*(%)	#Rate of detection (%)
No organ injury	62 (80.5)	7 (9.1)	
organ injury	15 (19.5%)	70 (90.0)	**21.4**
Liver	3 (3.9)	26 (33.8)*	11.5
Spleen	8 (10.4)	23 (29.9)*	34.9
Urinary bladder	4 (5.2)	8 (10.4)*	50
Bowel		36 (46.8)*	0

*Some of the patients had multiple organs injury. #Rate of detection of visceral injury by FAST in comparison to laparotomy.

Sensitivity and specificity and predictive value of FAST

In this study, the FAST findings were compared with the surgical findings, the PPV of 97.4% and sensitivity of 100% were demonstrated. (Table 4).

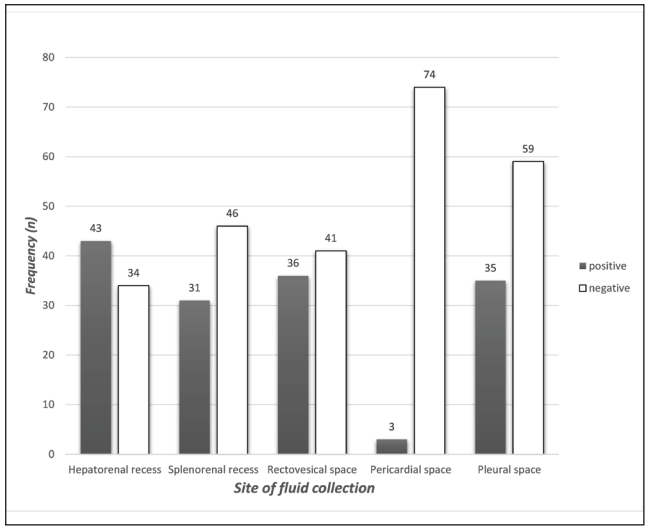


Figure 2. Bar chart showing site of fluid collection.

Table 4. Showing sensitivity and specificity; predictive value of FAST examination (*N* = 77).

	Present	Absent	Total
Positive	75	2	77
Negative	0	0	0
Total	75	75	77

PPV = Positive prediction value 97.4% Sensitivity = 100%.

Discussion

Background characteristics of the participants

BAT involves patients of different age groups and sex. This study found male sex predominates by 85.7% giving a male-to-female ratio of 6:1. This finding corresponds with other studies [4–6,22,23]. The overall mean age was 37.7 years and the majority 40 (51.9%) of the respondents in this study were in the age range of 21–45 years. This is in agreement with other studies [4,5]. This is the ideal economically active age group reflecting their increased participation in high-risk activities such as motorcycling that predispose them to BAT in the process of trying to earn a living.

Mechanism of injury

As reported by other authors, most patients who had BAT were mostly involved in RTA, [2,8,24–26]. A similar finding was reported in other studies done in Africa [27–30]. This observation is reflected in the current study as more than 63.6% BAT was caused by RTA where the majority (28.6% of patients) were due to motorcycle accidents and 16.9% were motor vehicle accidents and 18.2% were due to Auto pedestrian collisions. But contrary to Wambugu [31] in his study done at Kenyatta National Hospital he reported that 58% of all abdominal trauma was caused by assault. Chokotho and his colleagues in Malawi reported a higher incidence of falls as the most common mechanism of injury [32]. One hypothesized cause could be the poor observation of road safety but this requires clarification in future studies. In any case, findings from this study may suggest the need for urgent interventions targeting reducing the occurrence RTA.

Pattern of visceral injury

In this study, the bowels were found to be the most commonly injured intra-abdominal hollow organs among the patients who had therapeutic laparotomy, as 36 (46.8%) patients had injuries involving the intestines. This agrees with the previous study by Sheshe and Yakubu [6] (Nigeria) in which the majority of patients injured the small intestine 29%. Mehta and his colleagues reported that the most common bowel injury was the ileum [25]. Regarding the solid visceral organs, this study showed that the liver was the most injured solid visceral organ 26 (33.8%) followed by the spleen, 23 (29.9%). This observation was also reported by other scholars. Goyal et al. [33] (India) reported that out of 100 patients, the liver was most injured visceral organ 27% followed by the spleen 22%. Similar findings were reported by Calder et al. [24] (USA) and Chalya et al. [4]. This observation is at variant with other study (Bhandari) who reported splenic injuries were the most common 52.0% followed by bowels and then the liver, each by 12.5% [34].

Sensitivity and specificity; predictive value of FAST examination

In this study, the FAST findings were compared with the surgical findings, the PPV of 97.4% and sensitivity of 100% were demonstrated. This is comparable with other studies that showed high PPV of 90.02%, 95.0%, 96.0%, and 100% reported by Kumar et al. [17] (India), Samuel et al. [8] (India), Fleming et al. [35] (London) and Tummers et al. [16] (SA), respectively. This observation is at variant with other studies that reported a low PPV, 73.2% by Wambugu [31] (Kenya), 62.0% by Nnamonuet al. [19](Nigeria), 56.2% by Calder et al. [24] (USA) and McGaha et al. [9] (USA) reported a PPV of 13.0%.

Previous studies have shown that the sensitivity of FAST examination for the detection of solid organ injury is limited [10,24,36]. This observation is in agreement with the current study in which the rate of detecting visceral injury is as low as 21.4%. In this study, FAST failed to identify 88.5% of liver injuries, 63.2% of spleen injuries, and 50.0% of urinary bladder injuries.

Some limitations in the present study warranted further investigation. First, being a retrospective study has a potential limitation in the availability and accuracy of data, including missing vital information (records) from the patients' files such as patients' social demographic data and intraoperative notes. The limited information that lacked key variables led to exclusion from the study. The study is based upon registry data which limits outcomes and the ability to control who performed the ultrasound and the surgical procedures (operator dependent). The third and last limitation that was encountered was a small sample size of 77 respondents. This small number of participants may limit the statistical generalizability.

Conclusion

This cross-sectional study provides insightful data regarding patterns of BAT at a Northern zonal consultant hospital—KCMC Moshi that contributes to a significant number of surgical admissions. It demonstrates the high burden of trauma in the young generation mostly males who are economically productive age group. Motorcyclists were identified as a group having a greater risk of experiencing injuries. Ultrasound examination may be of as much use even in limited-resource settings, as well as having an advantage in simplicity, radiation-free, and portability in examining post-traumatic patients. Also, the diagnostic value of FAST examination in the evaluation of BAT yields better results in detecting the presence of free intra-peritoneal fluid than in detecting injury to the visceral organs. In the future, a follow-up study in FAST-positive patients who are conservatively managed. Another study can be done to assess the knowledge and indications of FAST among medical personnel at KCMC.

Acknowledgment

The authors are grateful to the management and staff of KCMC, especially those in the radiology and surgical departments for their great support and guidance during this research development.

Conflicts of interest

The authors do not have any conflicts of interest to declare.

Funding

This work was supported by the Tanzania Ministry of Health—postgraduate grant.

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