Sensitivity of Point of Care Ultrasound in Blunt Trauma Abdomen and Thorax at a Tertiary Care Center in Northern Kerala

Jobin Jose Maprani[1], Binoy Xavier K.P.[2], Nisanth Menon Nedungalaparambil[3], Sandra Paulson[4]

[1, 2, 3] Department of Emergency Medicine, Amala Institute of Medical Sciences, Thrissur, Kerala, India.
[4]Department of Community Medicine, Amala Institute of Medical Sciences, Thrissur, Kerala, India.

ABSTRACT

BACKGROUND

Road traffic accidents are the most common cause of thoracic and abdominal trauma. The role of point of care ultrasound especially in developing countries is gaining evidence in management of acutely ill. We wanted to test the reliability of Fast and E-Fast in blunt abdominal and thoracic trauma cases and evaluate their role in the management of RTAs.

METHODS

A cross sectional study was conducted over a 12-month period among patients presenting at Emergency Medicine Department at Government Medical College, Kannur (then known as Academy of Medical Sciences, Pariyaram)**.** After clinical examination and recording details, fast and E-Fast was done in the emergency department by emergency physicians trained in ATLS using a standard curvilinear probe of 2 - 5 MHz using Sonosite M-Turbo portable ultrasound machine (Fujifilm Sonosite) and compared with the gold standard CT. The CT used was 16 slice Spiral CT scan machine by GE Healthcare (Chicago, Illinois, United States). Results on continuous measurements presented on mean $\pm$ SD (min-max) and results on categorical measurements were presented in numbers (%). Sensitivity and specificity were computed for analysis.

RESULTS

The overall sensitivity of Fast is 72.8 % and the specificity is 92 %. The overall sensitivity and specificity of E-Fast are 87 % and 92.3 % respectively. The reliability of point of care ultrasound as a screening tool to triage patients with blunt abdominal and thoracic trauma is 100 %.

CONCLUSIONS

Fast and E-Fast are quite reliable as screening tools in the management of acutely ill blunt trauma abdomen and chest patients.

KEYWORDS

Point of Care, Ultrasound, Blunt Trauma, Sensitivity, Fast, E-Fast

Corresponding Author:
Dr. Nisanth Menon Nedungalaparambil,
Department of Emergency Medicine,
Amala Medical College,
Thrissur - 680555, Kerala, India.
E-mail: jobinjosem@gmail.com

DOI: 10.18410/jebmh/2020/551

How to Cite This Article:
Maprani JJ, Xavier BKP, Nedungalaparambil NM, et al. Sensitivity of point of care ultrasound in blunt trauma abdomen and thorax at a tertiary care center in northern Kerala. J Evid Based Med Healthc 2020; 7(46), 2680-2684. DOI: 10.18410/jebmh/2020/551

Submission 10-07-2020,
Peer Review 02-08-2020,
Acceptance 07-10-2020,
Published 16-11-2020.

BACKGROUND

Trauma has been called the neglected disease of the modern society.[1] Ever since the White paper revolution, there has been increased attention regarding this specialty. Prompt care given to the acutely ill patient can save their lives and instil hope in the Allopathic care system. Management of trauma patients in the community sets us apart from alternative branches of medicine and stamps our presence as competent health care providers. The ultimate objective of trauma resuscitation is to correctly diagnose all injuries and to treat them in time. On presentation in the emergency medicine department, delay in diagnosis as well as missed diagnosis can prove to be deadly to the patient. In case of haemodynamically unstable patients as in penetrating trauma cases, the patient has to be shifted to the procedure room without doubt. The real question arises in case of blunt trauma patients who are quite stable, whether to just observe them, discharge them or quickly investigate to rule out air or free fluid in pleural cavity or free fluid in peritoneal cavity. Mortality following blunt trauma of thorax ranges from 9.5 % - 47 %. RTA is the most common cause of thoracic and abdominal trauma followed by fall from height.[2] More than 35 % of blunt trauma patients thought to have a "benign abdomen" on initial physical examination are later found to have significant intra-abdominal injury requiring laparotomy.[3] Therefore a thorough, methodical and comprehensive approach to the diagnosis and management of torso trauma is essential. Point of Care Ultra-Sound (POCUS) has been in recent times gaining many evidence-based support in the management of acute ill patients. There have been many studies supporting its role in pleural procedures, respiratory arrest, abdominal aortic aneurysm and shock. Though its role in cardiac arrest and abdominal blunt trauma is questionable according to several studies.[4] The role of E-Fast (Extended Focused Assessment with Sonography in Trauma) in the ATLS (Advanced Trauma Life Support) protocol was recently added to benefit the trauma patients as well as the doctors managing them.[5] 93 % of the world's fatalities on the roads occur in low and middle income countries.[6] According to the National Crime Records Bureau India, a total of 4,73,050 road traffic accidents were reported during the year 2016. The fatalities in road accidents have increased by 2.1 % during 2016 over 2015. State-wise, Kerala ranks sixth in the number of road traffic accident cases during the year 2016.[7] This study was undertaken to test the reliability of the FAST and E-Fast in blunt abdominal and thorax cases presenting at a tertiary care centre in Northern Kerala.

We wanted to test the reliability of Fast and E-Fast in blunt abdominal and thoracic trauma cases and evaluate its role in their management.

METHODS

This study was undertaken over a 12-month period from April 2014 to March 2015. The sample size adequacy was estimated as a minimum of 100 cases (at 5 % level of significance) based on the results of a pilot retrospective study conducted at the centre irrespective of age and sex.

Inclusion Criteria: All patients presenting to emergency department who sustained polytrauma with clinical or physical signs of blunt abdominal and / or chest trauma within 24 hours of presentation of any age or any sex were included.

Exclusion Criteria: Patients with known causes of fluid collection including CCF (Congestive Cardiac Failure), renal failure, portal hypertension with ascites, hypoproteinaemia's, pleural effusion or tuberculosis, any other medical conditions causing accumulation of fluid in third space, patients who underwent laparotomy within the past 3 months, pregnant women, patients with gross subcutaneous emphysema were excluded.

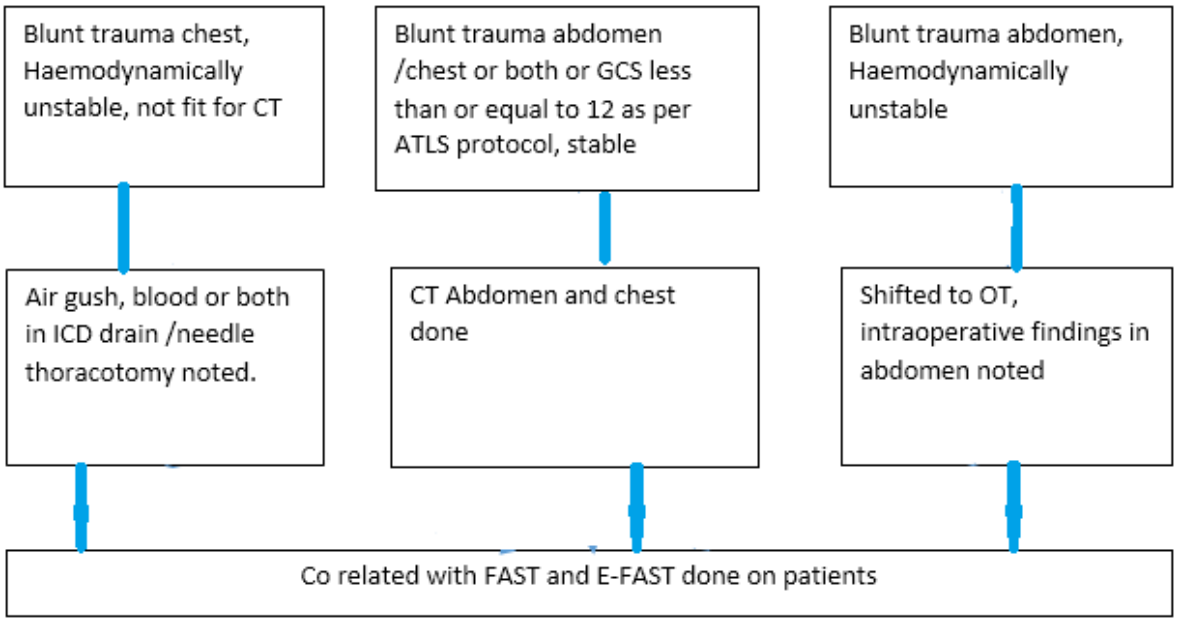

Figure 1. Flowchart of the Methodology Followed

On presentation at the ED (Emergency Department), the patients were quickly assessed, followed by clinical examination and recording of vitals and other information if time permitted. In blunt trauma patients, airway, respiratory rate, SpO2, chest crepitus, percussion, auscultation, head trauma, GCS score, pulse rate, blood pressure (systolic, diastolic & mean), capillary refill time, presence of intercostal drainage, guarding, rigidity, pelvic compression and management was noted. After clinical examination and recording details, FAST and E-Fast was done in emergency department by emergency physicians trained in ATLS using a standard curvilinear probe of 2 - 5 MHz using Sonosite M-Turbo portable ultrasound machine (Fujifilm Sonosite, Inc.) and the CT used was 16 slice Spiral CT scan machine by GE healthcare (Chicago, Illinois, United States).

4 sites scanned for FAST were right upper quadrant, left upper quadrant, subxiphoid and pelvis. Additional sites scanned for E-Fast were right and left 3rd or 4th intercostal space along with right and left costophrenic angles. Views recorded from individual patients and confirmed by radiologist. Fast and E-Fast were done only in supine positions.

Repeat Fast and E-Fast were done only in patients who had negative results initially, after 1 hour of presentation in the Emergency Department following fluid resuscitation if indicated or if patient becomes unstable. Repeat Fast and E-Fast were not done on patients who were unstable and had to be shifted to OR (Operating Room) within 1 hour. Repeat Fast was done in all patients who were initially Fast negative and also Fast positive but CT negative. (false positivity confirmation. E-Fast was repeated only for E-Fast negative patients and those patients who turned out to be false positive).

3795 enrolled during the study period
231 met inclusion criteria
81 excluded (44 discharged against medical advice, 16 presented after 24 hours, 17 expired during resuscitation / before CT scan / in OT and 4 patients did not give consent
150 study participants enrolled

Figure 2. Flowchart of Selection of Study Subjects

The results of Fast and E-Fast were compared with the gold standard CT abdomen and CT chest respectively. Those of the serious patients were compared with the intraoperative findings. Sensitivity and specificity of the point of care ultrasound was then calculated.

The study was certified by the Institutional Ethical and Research Committee of Academy of Medical Sciences, Pariyaram, Kannur as per reference no. 23/2014/ACME dated 07/02/2014. A verbal consent was taken from conscious patients and from attenders of unconscious patients. If not present, they were directly included in the study and consent taken later on.

Results on continuous measurements were presented on mean + SD (min-max) and results on categorical measurements were presented in numbers (%). The sensitivity and specificity were computed for analysis.

RESULTS

Males were greater in number, accounting for 83 % of the study population. The majority of population belonged to 41 - 60 years followed closely by the 21 - 40 year old group. The most common mechanism of injury was Road Traffic Accident (RTA) for both blunt trauma abdomen and thorax.

Patient Characteristics	Frequency / Mean
Age	46.5 + 16.69
Sex (Males)	124 (82.7 %)
Mechanism of Injury (Road Traffic Accidents)	94 (62.7 %)
Delay in Presentation	1.55 + 0.82
Glasgow Coma Scale Score	12.73 + 2.98

Table 1. Study Subjects Demographic and Clinical Profile

Out of 150 patients FAST was positive in 45 of them i.e. free fluid detected in peritoneal cavity through screening ultrasound in the ED. E-Fast was positive among 68 patients out of 150 which meant either air or blood was detected inside chest wall.

A repeat FAST was done among 107 patients, out of which seven turned out to be positive. By using chi square test, statistical significance was observed in the repeat FAST positivity among the FAST negative group. ($P < 0.0001$). Repeat E-Fast did not yield any positive results.

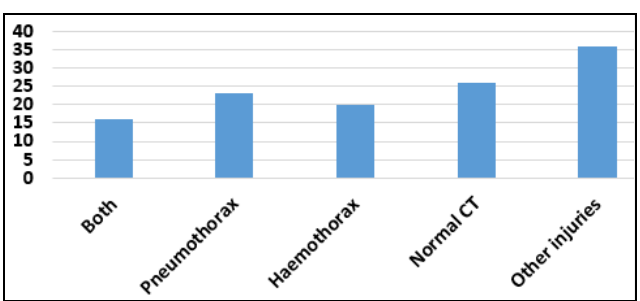

Figure 3. Gold Standard CT Thorax Findings

Confirmatory CT studies done were sub classified as CT thorax and CT abdomen. Out of the total cases of blunt thoracic trauma, 121 patients (81 %) required CT thorax. Group with other injuries included rib fractures, lung contusions or chest wall contusions and haematomas.

Out of a total of 45 pneumothorax cases, 12 cases (21 %) were unstable tension pneumothorax cases that required needle decompression followed by tube thoracostomy. Other cases were treated with tube thoracostomy alone.

On comparing the CT and Tube thoracostomy findings with E-Fast, for the case of pneumothorax detection the sensitivity was found to be 100 % and specificity 93.9 %; whereas for haemothorax detection the sensitivity was 86.1 % and specificity was 100 %. The total E-Fast positivity values were calculated as sensitivity 87 % and specificity as 92 %.

Of the total 93 cases of blunt trauma abdomen, injuries were ruled out among 34 patients as they had normal CT. Among the rest, 16 patients were treated conservatively whereas 43 cases required laparotomy.

Laparotomy findings of blunt abdominal trauma patients showed haemoperitoneum to be the most common finding, followed by splenic injury and hepatic injury.

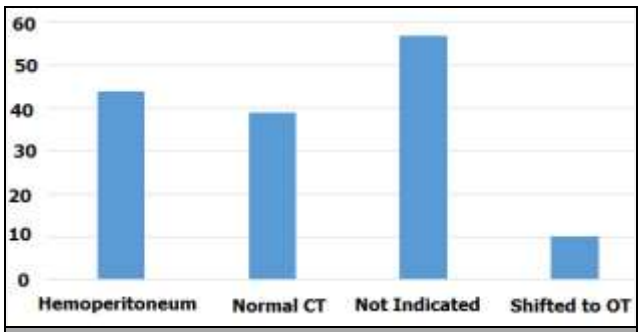

Figure 4. Gold Standard CT Abdomen Findings

On comparing the Fast findings with the gold standard, 93.3 % were confirmed as true positives. 75 % of the patients who were Fast negative turned out to have no injuries on further CT scans. The total FAST positivity rates were calculated as sensitivity 72.8 % and specificity of 92.3 %.

The number of false negatives is zero i.e. the reliability is 100 %. Out of the 83 Fast positive patients, 10 were shifted to operation theatre while 39 of them had normal CT findings; 44 had haemoperitoneum. In case of E-Fast out of the 121 patients in whom it was positive, 95 of them had positive findings whereas 26 had normal picture. The reliability thus comes as 100 %.

Condition	Normal USG	Abnormal USG	Normal CT	Abnormal CT
Pneumothorax	98	52	80	41
Haemothorax	114	36	107	43
Free abdominal fluid	25	68	34	59

Table 2. Ultrasound Scan and CT Findings

DISCUSSION

231 patients out of 3795 patients enrolled to Emergency Department Trauma Registry were identified as meeting the inclusion criteria for blunt abdominal or thoracic trauma over a study period of 12 months of which 150 patients were included in the study.

The most common mechanism of injury (for both blunt trauma abdomen and thorax) was road traffic accident, accounting for 62 % of total cases. This was in agreement with others who found RTA to be the most common mode of injury, by Saini et al where it constituted 77 % of cases, by Yogish et al who found it to be 53.3 % and Yadollahi et al who found it to be 53.5 % of cases.[8,9,10]

Males were in greater proportion accounting for 83 % of the population. The majority of population belonged to 41 - 60-year-old followed closely by the 21 - 40-year-old group. This was attributable to a majority of drivers involved in RTA being males and their predominant high-risk work like construction activities and professional tree climbing. The intraoperative findings included haemoperitoneum in all 43 cases, followed by splenic injury (53.5 %) and hepatic injury (39.5 %).

In detecting pneumothorax with E-Fast, the sensitivity was 100 % whereas specificity was 93.9 % in this study. In a prospective study of blunt trauma patients, Rowan et al found a sensitivity of 100 % and a specificity of 94 %, similar to our study.[11] Blaivas et al, on the other hand found that the sensitivity of ultrasound in detecting pneumothorax was 98.1 % and the specificity was 99.2 %.[12] Another study by Nandipati et al, showed the sensitivity to be 100 % and specificity to be 99 %.[13]

Kirkpatrick et al found out a sensitivity of 58.9 % and a specificity of 99.1 % for detection of pneumothorax with ultrasound.[14] Apart from Kirkpatrick et al and Blaivas et al, Soldati G et al also concluded that the absence of lung sliding is 99.4 % specific for pneumothorax.[15]

For detection of haemothorax with E-Fast, the sensitivity was 86.1 % and specificity was 100 %. Similar conclusions were arrived upon by PAC Abboud, J Kendall, K McEwan and others.[16] In another study O J Ma et al, concluded that 96.2 % sensitive, 100 % specific and 99.6 % accurate for the detection of haemothorax.[17]

The overall sensitivity and specificity for detecting lung pathology was 87 % and 92 % respectively. In another prospective study of patients with blunt trauma, Zhang et al found a sensitivity of 86 % and a specificity of 97 % with sonography.[18]

The sensitivity and specificity of FAST in detecting free fluid in peritoneal cavity in our study were 77.8 % and 92.3 % respectively. According to Healey MA et al, Boulanger BR, Brenneman FD, McLellan BA et al and McKenney MG et al, the FAST exam had a sensitivity of 73 – 88 % and specificity of 98 - 100 %, depending on the operator.[19, 20] In the hands of an experienced operator, the specificity approaches 100 %.

Serially repeating the Fast exam, significantly increases the sensitivity of the test. 7 out of 107 patients were positive, a similar finding was observed in a study conducted by Nunes et al.[21]

Though the ultrasound is strongly operator dependent, in this study for performing ultrasound scans only ATLS trained Emergency Physicians were deployed. Limitations include that the FAST and E-Fast cannot be used to isolate which organ or structures have been injured. It is a single-cantered study with a small sample size so the results have to be taken with due considerations.

According to a study by M'O Keefe et al, Whole Body Computed Tomography protocols compared with traditional ATLS-based protocols show significant savings in time.[22] decreasing the time between injury and definitive management is associated with a decrease in preventable death. A retrospective study compared the use of a traditional ATLS-based protocol with that of a WBCT (Whole Body Computed Tomography) protocol. They found a reduction from 70 - 23 minutes for completion of imaging. Time savings were also seen in the time of arrival to the time of emergency surgery, with a savings of 15 minutes.[23]

Several workflow practices can also be implemented to decrease the time requirement for use of CT. These include moving the CT scanner into the emergency department or trauma bay and having standardized protocols such as the Rapid Imaging Protocol In Trauma (RIPIT).[24] In a study the implementation of a single-pass protocol decreased the time of acquisition by 42.5 %. All these may be suitable alternatives for the high-income countries but for the middle- and low-income countries point of care ultrasound

still remains a viable option especially setting it up in all primary health centers.

CONCLUSIONS

Despite a few limitations, Fast and E-Fast are rapid and non-invasive bedside tests. This fact when read in line with lack of radiation exposure and well proven sensitivity and specificity should make them highly accurate diagnostic tools in detecting clinically significant trauma to thorax or abdomen. For the developing countries, accessibility and affordability are genuine concerns; in such a setup, point of care ultrasound may prove to be an excellent alternative especially at primary health centers; triaging of serious patients can be done provided MBBS doctors are given ample training for detecting fluid in the thorax or abdomen regions.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.
Financial or other competing interests: None.
Disclosure forms provided by the authors are available with the full text of this article at jebmh.com.

REFERENCES

[1] Accidental death and disability: the neglected disease of modern society. Washington DC: National Research Council, National Academy of Sciences 1966.
[2] Beauchamp R, Evers B, Mattox K, et al. Sabiston Textbook of Surgery: the biological basis of modern surgical practice. 19th edn. Elsevier Saunders 2012: p. 447-455.
[3] Raza M, Abbas Y, Devi V, et al. Non-operative management of abdominal trauma – a 10 years review. World Journal of Emergency Surgery 2013;8:14.
[4] Smallwood N, Dachsel M. Point-of-care ultrasound (POCUS): unnecessary gadgetry or evidence-based medicine? Clinical Medicine (Lond) 2018;18(3):219-224.
[5] American College of Surgeons. Advanced trauma life support program for doctors. 9th edn. Chicago: American College of Surgeons 2012.
WHO.https://www.who.int/news-room/fact-sheets/detail/road-traffic-injuries.
[6] Accidental deaths and suicides in India. National Crime Records Bureau, Ministry of Home Affairs, New Delhi. 2018.
[7] Engles S, Saini NS, Rathore S. Emergency focused assessment with sonography in blunt trauma abdomen. Int J Appl Basic Med Res 2019;9(4):193-196.
[8] Yogish V, Venkateswaran PS, Rajkamal C. A study of blunt injury abdomen in patients attending the emergency department in a tertiary hospital. International Surgery Journal 2016;3(1):153-157.
[9] Yadollahi M, Arabi AH, Mahmoudi A, et al. Blunt thoracic injury mortality and clinical presentation. Trauma Mon 2018;23(4):e13079.
[10] Rowan KR, Kirkpatrick AW, Liu D, et al. Traumatic pneumothorax detection with thoracic US: correlation with chest radiography and CT—initial experience. Radiology 2002;225(1):210-214.
[11] Volpicelli G, Elbarbary M, Blaivas M, et al. International evidence-based recommendations for point-of-care lung ultrasound. Intensive Care Med 2012;38(4):577-591.
[12] Nandipati KC, Allamaneni S, Kakarla R, et al. Extended focused assessment with sonography for trauma (E-FAST) in the diagnosis of pneumothorax: experience at a community based level I trauma center. Injury: Int J Care Injured 2011;42(5):511-514.
[13] Kirkpatrick AW, Sirois M, Laupland KB, et al. Hand-held thoracic sonography for detecting post-traumatic pneumothoraces: the Extended Focused Assessment with Sonography for Trauma (EFAST). J Trauma 2004;57(2):288-295.
[14] Soldati G, Testa A, Pignataro G, et al. The ultrasonographic deep sulcus sign in traumatic pneumothorax. Ultrasound in Medicine and Biology 2006;32(8):1157-1163.
[15] Abboud PAC, Kendall JL. Ultrasound guidance for vascular access. Emerg Med Clin 2004;22(3):749-773.
[16] Ma OJ, Mateer JR, Ogata M, et al. Prospective analysis of a rapid trauma ultrasound examination performed by emergency physicians. J Trauma 1995;38(6):879-885.
[17] Zhang M, Liu ZH, Yang JX, et al. Rapid detection of pneumothorax by ultrasonography in patients with multiple trauma. Critical Care 2006;10(4):R112.
[18] Healy MA, Simons RK, Winchell RJ, et al. A prospective evaluation of abdominal ultrasound in blunt trauma: is it useful? J Trauma 1996;40(6):875-883.
[19] Boulanger BR, McLellan BA, Brenneman FD, et al. Prospective evidence of the superiority of a sonography-based algorithm in the assessment of blunt abdominal injury. J Trauma 1999;47(4):632-637.
[20] Brun PM, Bessereau J, Chenaitia H, et al. Stay and play eFAST or scoop and run eFAST? That is the question! American Journal of Emergency Medicine 2014;32(2):166-170.
[21] O'Keeffe M, Clark S, Khosa F, et al. Imaging protocols for trauma patients: trauma series, eFAST, selective and whole-body computed tomography. Seminars in Roentgenology 2016;51(3):130-142.
[22] Stengel D, Rademacher G, Ekkernkamp A, et al. Emergency ultrasound-based algorithms for diagnosing blunt abdominal trauma. Cochrane Database Syst Rev 2015;2015(9):CD004446.
[23] Montoya J, Stawicki SP, Evans DC et al. From FAST to E-FAST: an overview of the evolution of ultrasound-based traumatic injury assessment. Eur J Trauma Emerg Surg 2016;42(2):119-126.