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Blunt Abdominal Trauma: The Diagnostic Duel Between Ultrasound And Computed Tomography

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I. Introduction

Diagnosis of blunt abdominal trauma is a real challenge even for experienced trauma surgeons. The clinical findings are usually not reliable. Abdominal examination is compounded by different factors like fractures of lower chest ribs, contusion and abrasions of the abdominal wall, presence of fractured lumbar vertebrae with retroperitoneal haematoma, and reduced level of consciousness. Diagnostic tools that help the treating doctor to take critical decisions like the need for laparotomy or conservative treatment are mandatory if we aim for a favourable outcome. Diagnostic peritoneal lavage (DPL) had been the gold standard to detect intraperitoneal fluid since the sixties. Use of Focused Assessment Sonography for Trauma (FAST) and helical CT scan have dramatically changed our methods for diagnosing blunt abdominal trauma, refined the decisions of the surgeons, and enabled the selection of the patients for conservative treatment. The choice of a particular modality depends on the haemodynamic stability of the patient, the reliability of physical examination, the severity of associated injuries, and the availability of a particular diagnostic modality. The aim of this communication is to define the recent role of FAST and CT scan of the abdomen in the diagnosis of blunt abdominal trauma.

FAST was initially started in Europe and Japan in the eighties to be adopted by North America in the early nineties. From there it has spread worldwide [1,2]. FAST is a goal directed study answering a simple question as to whether there is intraperitoneal fluid or not. It is a safe and quick diagnostic tool that can be learnt easily [2,3]. It is of great value for those patients who are haemodynamically unstable and who cannot be shifted to CT scan room. The great value of FAST lies in its high sensitivity for detecting intraperitoneal fluid which accumulates in dependent areas around the liver, spleen and pouch of Douglas [2]. Limitations of ultrasound have to be well understood when using FAST. It will be difficult to visualize intra-abdominal structures in case there is ileus or surgical emphysema under the skin. Ultrasonography is highly accurate in detecting intraperitoneal fluid but it cannot differentiate between blood, urine, bile or ascites. FAST has to be used within a diagnostic algorithm to have a proper role [4] . In case the patient is haemodynamically stable then the CT scan of the abdomen is the diagnostic modality of choice [5]. It is suggested that Ultrasound will miss 25% of intra-abdominal injuries in case it is the only diagnostic tool [6,7]. Furthermore, ultrasound is not accurate in detecting retroperitoneal or gastrointestinal lesions [6,7].

Computed tomography is the imaging modality of choice for evaluating haemodynamically stable patients. [10]. It is sensitive (92-97.6%) and specific (98.7%) [5]. Its main advantage is the ability to detect arterial contrast extravasation [11].Hence, this prospective observational study is to access the role of Ultrasound and Multidetector Computed Tomography in combination, in evaluating the nature, site and extent of abdominal trauma, for their early diagnosis and in predicting the need for surgical intervention.

II. Material And Methods

A prospective hospital-based study was conducted in department of Radiodiagnosis in Sharda Hospital, over a duration of 20 months, from August 2022 to March 2024 on 50 patients with abdominal trauma patients who were fulfilling the inclusion criteria and consenting for inclusion in the study were incorporated in the study, after approval from Institutional Ethical Committee.

Hemodynamically unstable patients, Patients on ventilator, children below 5 years of age and patients allergic to contrast media were excluded from the study. The FAST protocol of ultrasound examination was performed on all the patients to look for the presence of fluid by seeing pericardial, perihepatic, peri splenic and pelvic cavity. Additional scans of the anterior and lateral pleural spaces were also performed (Extended-FAST). Additionally solid organs were scanned for the presence of injuries. All the patients were then subjected to Non-Contrast and Contrast enhanced Computed Tomography with the use of 128 sliced scanner with a slice thickness of 10mm for abdomen. The inter-modality radiological findings were compared . The specificity, sensitivity,

positive predictive value and negative predictive values were also compared using SPSS 22 version software. After radiological evaluation the patients were further closely monitored in association with the department of Surgery. For statistical analysis continuous data was represented as mean and standard deviation. P value (Probability) of <0.05 was considered as statistically significant after assuming all rules of statical tests.

III. Results

Out of the total population, 44 individuals of the sample being male and 12% (6 individuals) being female, with mean age of mean age of 30.74 years. The mean age for females is 33.5 years, while the mean age for males is 30.36 years.

The most common cause of injury is road traffic accidents, accounting for 58. The other causes accounting for 42 % were falls from height, domestic violence, falls from motor vehicles and accidental minor abdominal trauma. The most common site of impact is the left hypochondrium. The anterior abdominal wall, the epigastrium, the anterior chest wall, the right hypochondrium, lateral chest wall, the left iliac fossa, lumbar region and the pelvis were the other primary sites of sustained traumas in the sample.

Out of 50 patients, 98% showed ascites/hemoperitoneum on ultrasound. The patients were divided into three groups on the basis of hemoperitoneum (described by Huang MS et al. and demonstrated by Kranthi Kumar Marathu et al.) Out of 50 observed patients only 6 had a score of 3, 28 had a score of 1. Rest 16 had a score of 2.

Figure 1: Ultrasound image showing free fluid in Morrison's Pouch.

Out of 50, 19 patients are positive for pleural effusion. When compared with CT, the Ultrasound was able to pick up effusion in all the patient, showing high sensitivity.

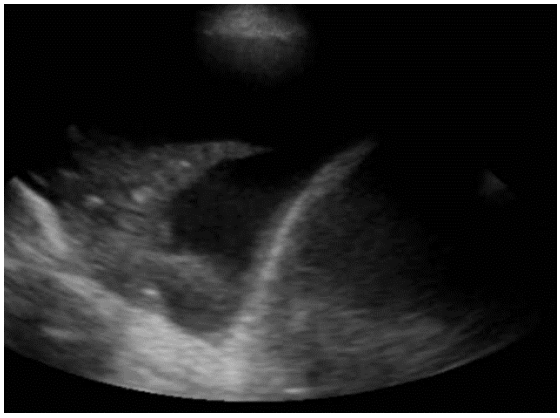

Figure 2: Ultrasound image of pleural Effusion with collapsed lung.

Liver injuries: We were able to detect liver contusion but missed liver laceration, confirmed later by MDCT (AAST III). The ultrasound was not able to detect 6 cases of liver injury, varying from Grade I to grade IV (confirmed by CT scan).

Renal injuries: Identified renal laceration and hematoma in one patient. However, it missed hilum and vascular bed injury which was confirmed as AAST IV on MDCT. Additionally, the ultrasound was unable to diagnose renal injury in 4 cases.

Splenic injuries: Out of 15, the ultrasound was able to detected splenic injury only in four cases. Subcapsular hematoma and splenic contusion were picked up on ultrasound. However, we couldn't detect injury to the vascular bed.

Pancreatic injuries: We were able to diagnose two instances of pancreatic injury, and were able to detect well defined collection around the pancreas but were not confidently label it as pancreatic injury. Three of these cases were diagnosed as AAST II, AAST I and AAST III pancreatic injury. One of the shortcomings with ultrasound was inability to detect ductal injury.

We were not able to detect adrenal haemorrhage in 3 cases on ultrasound, probably due to gross ascites.

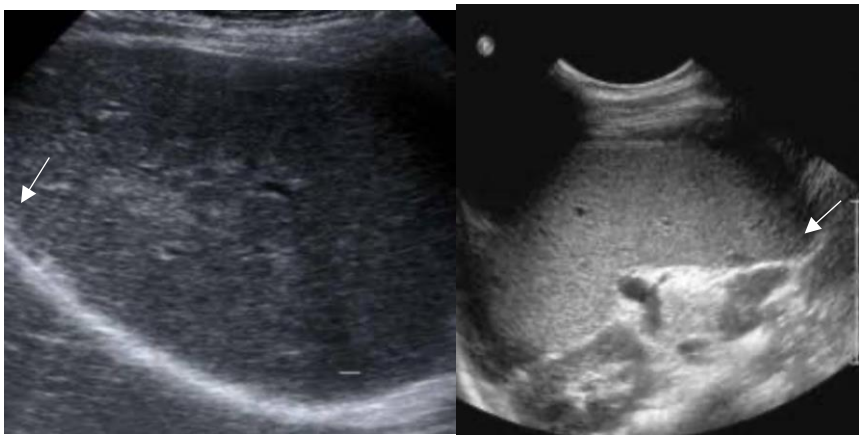

Figure 3: Ultrasound image of hepatic hematoma.
Figure 4: Ultrasound of the spleen representing subcapsular collection.

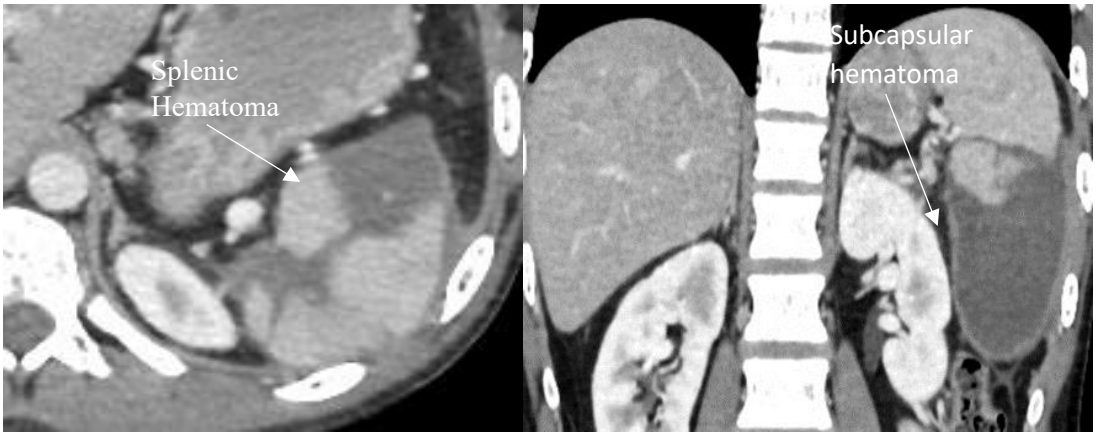

Figure 5 and 6: Post Contrast Axial and Coronal focused images of Spleen representing of Splenic Contusion with hematoma and Sub-Capsular Hematoma.

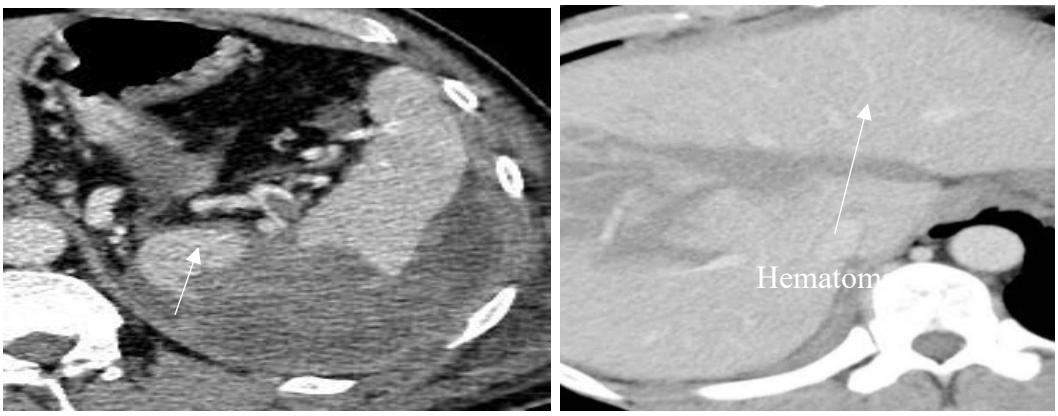

Figure 7: Post contrast images of spleen showing splenic laceration with splenic vein thrombus.
Figure 8: Post Contrast images of Liver laceration. AAST III Liver injury.

Out of 8 cases diagnosed with pneumothorax, the ultrasound was able to detect 5. In total 9 patients were diagnosed with bowel perforation out of which we were able to make suspicion of Pneumoperitoneum in 5 patients on ultrasound.

Additional observations of lung injuries, bladder hematoma and mesenteric tear, splenic vein thrombosis, bowel ischemia and bony injuries were not detected on ultrasound.

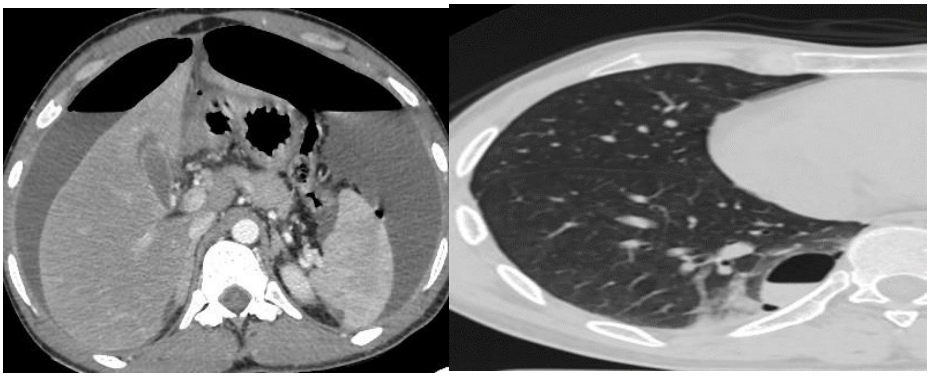

Figure 9: Shows gross Hemo-peritoneum and Gross Pneumoperitoneum. This was a patient had sustained Duodenal and Pancreatic injury.
Figure 10: represents Hemo-Thorax, pneumo-Thorax with Lung Contusion.

Need for surgical intervention: Most of the patients (58%) had low grade injury, hence did not require surgical intervention. Patients with solid organ injury less grade III were managed conservatively. However, there were two instances where patients underwent surgical intervention despite of lower grade on CT. These patients became hemodynamically stable after the scan. This observation concludes that clinical features superseded the radiological features.

Correlation Of Usg With Ct

Ultrasound and CT scans serve distinct roles in medical diagnostics. Ultrasound offers moderate sensitivity (78.12%) and specificity (66.67%), with a low positive predictive value (16.93%) but high negative predictive value (97.23%). It's accessible, cost-effective, and lacks radiation exposure, making it ideal for screening despite its limitations.

In contrast, CT scans provide higher sensitivity and specificity, detailed imaging, and are preferred for precise diagnoses. Though superior diagnostically, CT's use is balanced by ultrasound's advantages in screening contexts.

Statistic	Value	95% CI
Sensitivity	78.12%	60.03% to 90.72%
Specificity	66.67%	40.99% to 86.66%
Positive Likelihood Ratio	2.34	1.19 to 4.62
Negative Likelihood Ratio	0.33	0.16 to 0.68
Disease prevalence (*)	8.00%	
Positive Predictive Value (*)	16.93%	9.37% to 28.66%
Negative Predictive Value (*)	97.23%	94.40% to 98.65%
Accuracy (*)	67.58%	52.87% to 80.13%

IV. Discussion:

The radiological evaluation of abdominal trauma using ultrasound (US) and computed tomography (CT) is crucial in the management of patients with abdominal injuries. Both modalities offer distinct advantages and limitations, and their appropriate use can significantly influence patient outcomes.

The sample data for age reveals a mean age of 30.74 years with a standard deviation of 13.43 years, indicating a moderate level of variability around the mean. The ages in the sample range from a minimum of 5 years to a maximum of 67 years. The mean age for females is 33.5 years, while the mean age for males is 30.36 years. According to the findings of a research conducted by Marathu et al. [15] the youngest patient was ten years old, and the elderly patient was 67 years old. In accordance with the findings of a research conducted by Mallik K et al.[6], the youngest patient was just four years old, while the oldest patient was forty-five years old [6]. In a retrospective study by Zidan et al, patients had a median age of 20 years (range: 4–70 years).

In the present study, the gender distribution in the sample is predominantly male, with 88% (44 individuals) of the sample being male and 12% (6 individuals) being female.In a study by Marathu et al[15], there

were more male patients (71.1%) with blunt injury to abdomen than female patients and male patients outnumbered the female patients in all modes of injury, similar to the findings of the present study.

Kala SK et al., in their study reported that majority of the patients were males (85.5%) [10]. This was similar to the findings of our study.

In a study by Zidan et al there were 23 male patients and two female. The ratio was similar to the findings of the present study[16].

The clinical history data reveals the most common cause of injury is road traffic accidents, accounting for 58% (29 individuals) of the cases. Falls from height are the second most frequent cause, contributing to 26% (13 individuals) of the incidents. Crush injuries are responsible for 4% (2 individuals) of the cases. Several other causes each account for 2% of the cases: domestic violence, falls from motor vehicles, crush injuries from moving vehicles, blunt violent abdominal trauma, and accidental minor abdominal trauma.

In the study by Marathu et al, majority of the patients (59.6%) were involved in motor vehicle accidents[15].

This correlates with findings made by Visrutaratna P et al., who reported that most percent of cases is caused by car accidents (more than 75%) [11]

In a study by Zidan et al, The causes of trauma were road traffic accidents (n = 17; 68%), falls (n = 3; 12%), sport injuries (n = 3; 12%), and other (n = 2;8%)

The data on solid organ injuries assessed via ultrasound (USG) indicates that out of 50 total cases, 46 (92%) showed no evidence of solid organ injury, while 4 cases (8%) confirmed the presence of such injuries. Among the 10 cases (20%) with hollow viscus injuries, jejunal perforations were the most frequently reported, occurring in 5 cases (10%). Duodenal perforations were identified in 3 cases (6%). Additionally, there was 1 case (2%) of an AAST I urinary bladder injury and 1 case (2%) of a bowel hematoma.

Marathu et al showed that out of the 43 patients who were positive for intra-abdominal injury, 40 patients had hemoperitoneum, and 3 patients had visceral injury without hemoperitoneum. US and CT detected hemoperitoneum in all positive cases except in 3 cases[15].

In a study by Marathu et al[15], Hepatic injuries were demonstrated in 11 patients (25.5%). US was not able to detect laceration in one case of liver injury which later was confirmed with CT and surgery. Out of 11 cases 6 cases were managed conservatively and 5 cases were taken up for surgery. Renal injuries: In our study, 5 patients had renal injuries (11.6%).

Ultrasound was able to detect all cases of renal injuries which were confirmed with CT and surgery. However, ultrasound was not able to detect a case of splenic laceration, which was detected on CT and surgery.

In the present study, when we correlated USG with CT, we found that sensitivity is 78.12%, while specificity was 66.67%.

In our study, 40 patients with hemoperitoneum on US, 33% of patients with a score of less than 3 are conservatively managed. In contrast 74% of patients with score of 3 or more required surgical management.

Our findings are comparable with the observations made by Mallik K et al., [6]. In their study, 11% of patients with a score of less than 3 are likely to receive conservative management. 60% of patients with score 3 or more need surgery.

Huang MS et al., found that 96% of patients required therapeutic laparotomy with US score 3 or more and with a US score less than 3 laparotomy was required in only (38%) [8].

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