ADDIS ABABA UNIVERSITY

COLLEGE OF MEDICINE AND HEALTH SCIENCES

SCHOOL OF GRADUATE STUDIES

DEPARTMENT OF RADIOLOGY

Comparison of diagnostic efficacy of ultrasound and CT scan in patients with blunt abdominal trauma at Tikur Anbesa comprehensive specialized hospital and AaBET hospital, Addis Ababa, Ethiopia

Principal investigator: Dori Woldu, MD (Radiology resident)

A thesis submitted for preparation of senior paper to be submitted to radiology department, college of health science, Addis Ababa University in preparation for partial fulfillment of the requirements for the specialty certificate in radiology.

October, 2018

Addis Ababa, Ethiopia

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Principal investigator: Dori Woldu, MD (Radiology resident)

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I hereby certify that I have read and evaluated this thesis Entitled **Comparison of diagnostic efficacy of ultrasound and CT scan in patients with blunt abdominal trauma at Tikur Anbesa comprehensive specialized hospital and AaBET hospital, Addis Ababa, Ethiopia;** prepared under my guidance by **Dori Woldu, MD.** I recommend it be accepted and submitted as partial fulfillment of the requirements for the post graduate study in radiology.

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Abbreviations

AaBET-----Addis Ababa burn, emergency and trauma hospital

BAT--------Blunt abdominal trauma

CT-----------Computed tomography

ETB---------Ethiopian birr

GE----------General electric

SNNPR-----Southern Nations, Nationalities and People's region

US----------Ultrasound

Abstract

Background: Traumatic injuries are a significant public health issue worldwide. Abdomen has been reported to be the third most common region of injury after head and extremities. Imaging plays a key role in the advanced care of trauma patients. US is a recommended initial imaging modality in the evaluation of blunt abdominal trauma but CT is considered the most accurate imaging method.

Objective: To compare the diagnostic efficacy of ultrasound and CT scan in patients with blunt abdominal trauma at Tikur Anbesa comprehensive specialized hospital and AaBET hospital.

Methods: An institution based prospective cross-sectional study was conducted at Tikur Anbesa comprehensive specialized hospital and AaBET hospital using ultrasound (Sonoscape SSI-8000) and CT scan (GE 64-row detector volumetric scanner) was conducted for one-year period from September 1st, 2017 to August 31st, 2018. Non-probability sampling was used to include all patients who fulfill the inclusion criteria in the study. Data collection of 47 patients was done using a well-designed data collection forms by interview of patients or attendants who presented for ultrasound, review of patient's medical record chart and review of diagnostic images. Data was then entered using EpiData 3.1, cleaned and analyzed using IBM SPSS version 25 software according to the study objectives.

Results:
Total of 47 patients were studied, of which 34 (72.3%) of patients were male and 13 (27.7%) were females with male to female ratio of 2.62:1. The age ranged from 3months to 60years with mean of 30.36year and majority of the study population, 72.4%, were adults aged 18-40 years. The commonest mechanism of injury was road traffic accident taking more than half, 28(59.6%) followed by falling down accidents 11 (23.4%). Hemoperitoneum is the most common finding seen in blunt abdominal trauma patients. The sensitivity and specificity of ultrasound is 76.9% and 90.5% in detecting hemoperitoneum with 8 false negative (23.1%) and 2 false positive (9.1%). Overall 22 organ injuries were detected in 47 patients with CT with sensitivity, specificity, positive and negative predictive value of 50%, 100%, 100% and 69.4% respectively.

Conclusion:
The present study supports the view that US and CT have complementary roles in the diagnosis of blunt abdominal trauma. Although US can be used as an initial screening method for blunt abdominal trauma to detect presence of free fluid, CT is still the imaging modality of choice for detecting intra-abdominal injuries in stable patients because about a quarter of the patients with blunt abdominal trauma may be missed on ultrasound.

Key words: Blunt abdominal trauma, road traffic accidents, Ultrasound, CT scan, Tikur Anbesa, AaBET, Ethiopia

1. Introduction

1.1 Background

Traumatic injuries are a significant public health issue worldwide.[1, 2] The Most common age group affected is 18-40 years. This was probably due to the fact that it is this age group that usually is involved in speeding leading to accidents.[3] Trauma has become one of the most common causes of hospitalization especially due to the increase in speed and less adherence to traffic regulations, not to mention, one of the leading causes of death among the younger population. Hence it becomes imperative for improvement in trauma care, especially faster hospitalization, better organization of the trauma centers and well advanced treatments apart from being cost effective.[3]

Abdomen has been reported to be the third most common region of injury after head and extremities. 25% of these individuals require surgical intervention to save life.[3] Abdominal trauma represents a significant proportion of this burden, with 61% of polytrauma cases including an abdominal injury.[1] Blunt trauma mechanisms leading to significant intra-abdominal injuries often include compression and deceleration forces. Blunt injuries cause solid organ trauma more often than hollow viscera. The most frequently injured intra-abdominal organs include the liver, spleen, and kidneys, which are often associated with intra-peritoneal bleeding.[1, 4-6] Multi organ injury and multiple system injury are also more common in blunt injury than in other types. But there are other forms of blunt abdominal injuries like crushing, shearing, bursting, penetration. Presentation varies widely from haemodynamic stability with minimal abdominal signs to complete cardiovascular collapse and may change from one to the other with alarming rapidity.[4]

Motor vehicle collisions are the leading cause of injury, both in the United States and throughout the world. The most common cause of trauma was road or vehicular accidents (58.9%) followed by fall from heights (32.1%). Other causes of injury were due to some sporting accidents (7.1%) or in 1 case (0.18%), due to physical violence. Among the fall from heights, many were women, probably due to domestic violence.[3, 5, 7]

One of the advances in the trauma care is the need for non-invasive diagnosis, so that rapid detection of the patients in need for surgeries and those with unstable hemodynamics can be given proper lifesaving treatment. For other patients, conservative treatment can be given, thereby avoiding the unnecessary invasive procedures and their accompanying complications.[3]

Ultrasonography, for a long time has been considered to be the first imaging method to be employed in the screening of patients with blunt abdominal trauma a number of pathologies such as hematomas, contusions, lacerations and hemoperitoneum can be observed with sensitivity range from range from 63%-100%. However, it has been reported that ultrasound is not a reliable method for diagnosing trauma in hemodynamically unstable patients as the absence of a free intraperitoneal fluid in the images does not necessarily mean absence of serious organ injuries.[3, 4, 8] Hollow viscus injuries are such an entity as they are uncommon and difficult to diagnose. Less than 1% of all patients who present with blunt trauma have hollow viscus injuries, and only 0.3% of all blunt trauma patients have a perforated small bowel injury.[1]

Abdominal computerized tomography (CT) is considered to be the most accurate, noninvasive imaging modality for evaluating trauma victims for the detection of blunt abdominal injuries, especially when it involves solid organs. CT scan of the abdomen can reveal other associated injuries such as those of vertebral and pelvic fractures or the injuries of the thoracic cavity. CT scans provide very accurate imaging of the internal organs and can help to quantify the amount of blood in the abdomen. The accuracy of the CT is said to be very high with 92-97.6% sensitivity and 98.7% specificity.[3, 7] In spite of diagnostic superiority, availability of CT is still limited, increase patient cost, has radiation effect, and it also requires stable patients. On the other hand, inability to consistently detect pancreatic, bowel and mesenteric injuries and inability to functionally assess the kidneys and frequent interference by gaseous distension and associated bone or soft tissue injuries are major limitations of ultrasound.[9-11]

Since 1980's CT has been accepted as a definitive imaging modality for injured patients in the United States.[7]The introduction of computed tomography (CT) scans, hemostatic resuscitation policies, and interventional radiology procedures such as angioembolization have resulted in a significant rise in the rate of nonoperative management of blunt abdominal trauma patients over the last two decades. However, even in 2016, there remain pitfalls to nonoperative management. As some relatively uncommon anatomic injuries cannot be managed without operation, the opportunity for early and appropriate intervention may sometimes be missed through the pursuit of a nonoperative strategy, therefore resulting in patient harm.[1]

Ultrasound can be a valuable initial investigation; however, it can miss crucial injuries and may lead to inappropriate management in some patients. Hence it is imperative that all ultrasound positive cases should be followed by CT. Similarly, CT must also be performed in symptomatic patients with negative ultrasound scans and in patients with suboptimal ultraosund scans. Although a higher ultrasound or CT scoring of hemoperitoneum increases the chances of surgical management, hemodynamic stability and accurate imaging diagnosis are the main determinants which dictate the type of management strategies.[9, 12]

Peritoneal Spaces

The peritoneal cavity contains the liver, spleen, bowel, stomach, and mesentery. In the supine position, the most dependent portion of the abdomen is the hepatorenal fossa (Morison pouch), and the most dependent portion of the pelvis is the pelvic cul-de-sac (pouch of Douglas). Hemoperitoneum starts near the site of injury and flows along expected anatomic pathways.

Hemorrhage from the liver typically flows in a caudal direction from the perihepatic spaces and hepatorenal fossa, along the right paracolic gutter, and into the cul-de-sac, which is the rectouterine space in women and rectovesical space in men. Similarly, hemorrhage from the spleen typically flows in a caudal direction from the perisplenic spaces, along the left paracolic gutter, and into the pelvis. A large volume of blood may collect in the pelvis without an obvious hematoma surrounding the source organ. Thus, the appearance of the cul-de-sac is crucial to the diagnosis of hemoperitoneum. Small amounts of fluid or blood in this region may be the only sign of an intraperitoneal injury and should prompt a careful inspection of images of the viscera.

It is important to bear in mind that, in trauma cases, significant abdominal injuries may be present without apparent hemoperitoneum. For example, intraparenchymal lacerations or contusions may be present without penetration of the organ capsule. Knowledge of the relationship of abdominal organs to the surrounding peritoneal spaces is crucial. For example, because the bare area of the liver is contiguous with the retroperitoneum, retroperitoneal fluid rarely may be the only sign of hepatic injury, although intraperitoneal fluid is more commonly seen in cases of solid organ injury. In a patient with abdominal trauma, a CT finding of free intraperitoneal fluid without solid organ injury should arouse suspicion about the possible presence of a bowel laceration or perforation.(13)

Ultrasound examination

The sonographic examination that is performed for evaluation of the patient with blunt abdominal trauma has changed considerably since first described in the early 1990s. There has been a learning curve within the literature, and this examination has changed appropriately. The main focus of the examination has been on detection of free fluid within the abdomen of patients with acute trauma. Originally, sonography for trauma consisted of obtaining a single view of Morison's pouch. If a stripe of fluid (either clear hypoechoic fluid or with internal echo inside) was seen between the liver and the kidney, the findings were considered positive. (4, 14)

With time, a more comprehensive sonographic examination has evolved for patients with blunt abdominal trauma. There is examination named focused abdominal sonography for trauma (FAST). This usually includes sonography of the right upper quadrant, including the hepatorenal fossa the left upper quadrant, including the perisplenic region; the right and left paracolic gutters; and the pelvis, performed to detect free fluid. Free fluid will gravitate to the most dependent portion of the pelvis and as such, free fluid in the pelvis may be missed if the patient has an empty bladder. In some instances, an examination of the epigastrium to check for free fluid, free air, or both is also performed. Other components of the examination include an intercostal or subdiaphragmatic view of the heart. Examination of the chest is performed if, in fact, there has been chest as well as abdominal trauma; such an examination will be discussed below. (4, 14) Besides the detection of free fluid, sonography also is used to detect parenchymal organ injury at our institution.(14) We examine the entire abdomen and document the findings.

Computed tomography

Specific protocols regarding slice thickness, volume of intravenous contrast administered, timing of image acquisition, and use of oral contrast are continuously reconfigured and vary between institutions. In general, optimal evaluation of the abdomen and pelvis is performed by acquiring axial CT images following intravenous injection 100–150 mL of iodinated contrast material, ideally injected at a rate of 3–5 mL/sec through an 18- or 20-gauge cannula located in a large peripheral vein, during the portal-venous phase of hepatic enhancement (65–80 seconds after the beginning of intravenous contrast material administration). In the past, oral contrast was considered a mandatory part of trauma CT protocols. However, reports in the radiological and surgical literature have suggested that imaging with MDCT without oral contrast is adequate for the detection of bowel and mesenteric injury which is one of the more challenging tasks that face the radiologist interpreting trauma CT scans. Currently, we examine patients without oral contrast material, and reserve its use for follow-up scans if specific questions arise on the initial CT.(5, 15, 16)

In addition to portal-venous phase imaging, the acquisition of delayed images (5–10 minutes after intravenous contrast material administration) has become an increasingly important part of the trauma CT evaluation. Delayed images can be useful in evaluating injury to both the solid organs and to the bowel and mesentery. Delayed CT acquisition allows for improved characterization of solid organ injuries by helping to differentiate arterial pseudoaneurysms (including splenic artery pseudoaneurysms) from uncontrolled active contrast extravasation. On delayed images, active contrast extravasation persists as a hyperattenuating focus (relative to the aorta) and changes configuration as contrast is spilled into the area of injury, while pseudoaneurysms show an attenuation that remains similar to the aorta, with no change in overall size or shape. Delayed images also improve characterization of bladder and renal injuries. The routine use of delayed images is somewhat controversial, since the majority of trauma CT scans performed in emergency rooms today show no evidence of significant abdominal injury.(5, 16)

1.2 Statement of the problem

Abdomen has been reported to be the third most common region of injury after head and extremities. 25% of these individuals require surgical intervention to save life. Blunt abdominal trauma is difficult to diagnose due to the absence of clinical signs as opposed to the penetrating trauma, which can be seen and easily diagnosed.(3)

Blunt abdominal trauma causes an estimated 10% of worldwide deaths and is the third commonest cause of death after malignancy and vascular diseases.(17)

One study done in our institution found the cause of emergent abdominal surgeries was penetrating abdominal injuries in 13%, blunt abdominal injury in 7.6%, and penetrating thoracoabdominal injuries in 3.7%. It also reported significant mortality and morbidity, 8.2% and

9.4% of the total mortality and morbidity respectively, associated with blunt abdominal trauma.(18) Another study done in public hospitals in Mekelle, Tigray, Ethiopia showed abdominal trauma constitutes 2.3% of trauma cases visiting emergency department.(19)

1.3 Objectives

1.3.1 General objectives

- To compare the diagnostic efficacy of ultrasound and CT scan in patients with blunt abdominal trauma at Tikur Anbesa comprehensive specialized hospital and AaBET hospital.

1.3.2 Specific objectives

- To see the demographic patterns of blunt abdominal trauma.
- To determine the sensitivity and specificity of ultrasound in blunt abdominal trauma when compared to CT scan as it is in routine practice.
- To see the patterns of ultrasound findings in patients with blunt abdominal trauma.
- To see the patterns of CT scan findings in patients with blunt abdominal trauma.
- To compare the patterns of ultrasound findings with that of CT findings.
- To assess the prevalence of clinically significant incidental findings.

1.4 Significance of the Study

There are international studies looking on patterns of organ injuries in blunt abdominal trauma with main focus on CT scan findings but there are only few studies at international level comparing the efficacy of CT scan and ultrasound in the diagnosis of patterns of injury in blunt abdominal trauma. To our knowledge there are no such regional or local studies made public.

The purpose of this is study is therefore to study the patterns of injuries in blunt abdominal injury patients presenting to our hospital. The secondary purpose is to compare the detection rate of the injuries by ultrasound and CT scan. So, the study will be the first of its kinds in providing the insights of patterns of injuries in blunt abdominal trauma in our country. It will help the emergency physicians, surgeons and radiologists on development of the local work-up and management protocols for blunt abdominal trauma patients. It will also serve as a base line for other researches.

2. Literature review

326 patient with blunt trauma examined with CT scan examination from June 2009 till July 2011 ultra-sonography at al – Hilla teaching hospital, Iraq, where 22 true positive from the 326 those are of different intra-abdominal injuries; from haemoperitonium, solid organ injury, till mesenteric injury; 292 true negative from the total 326 and two are false positive and10 false negative ; sensitivity of US are of 69%;and specificity of 99%; and diagnostic accuracy is 96%.(4)

In prospective study conducted by the department of Radiology at Mediciti Institute of Medical sciences over a period of 2 years, 56 patients with blunt abdominal trauma and who were stable enough to undergo both US and CT scans were included into the study if any one of the scans had come positive. The most common cause of trauma was road or vehicular accidents (58.9%) followed by fall from heights (32.1%). Of the organs which were affected, the most one was liver (73.2%), followed by spleen (51.8%), 46.4% of kidneys and 12.5% of the pancreas. Hemoperitoneum was identified in all the 56 patients with CT scan while the same was identified only in 47 cases (83.9%) with US.(3)

In Cumhuriyet University, 58140 Sivas, Turkey 96 children with BAT were evaluated prospectively between 1997 and 2001. CT was performed first, followed by US. Overall 128 organ injuries were determined in 96 patients with CT; however, 20 (15.6%) of them could not be seen with US. Free intraabdominal 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, negative predictive value and overall accuracy of the US for free intra-abdominal fluid were 90.2, 100, 100, 63.6 and 91.7%, respectively. (7)

In the study conducted at advanced diagnostics and institute of imaging, Amritsar, 50 patients were stable enough to undergo both US and CT scans. Hemoperitoneum is the most common finding seen in blunt abdominal trauma patients. It was detected in 31 patients. US showed sensitivity, specificity and accuracy of 93.55%, 89.47% and 92% respectively in detecting hemoperitoneum with 2 false positive and 2 false negative cases. The negative predictive value and positive predictive values were 89.47% and 93.55% respectively. CT showed sensitivity, specificity, negative predictive value, positive predictive value and accuracy of 100%, 95%, 100%, 96.77% and 98% respectively. The study also had a good correlation and predictive value to suggest the underlying organ injury especially with scores of 3 and above with $r<0.8199$ and $p<0.001$.(17)

In the prospective study conducted during a 22-month period (January 2000 to October 2001) at a level I emergency trauma center at Hospital Cantonal, University of Geneva, two hundred five hemodynamically stable patients underwent abdominal US and CT. CT revealed free fluid in 83 patients and organ injury in 99. Thirty-one (31%) of 99 patients with organ injury did not have free fluid at CT. Three (10%) of the 31 patients required surgery or angiographic embolization. The sensitivity of admission US was 93% (77 of 83 cases) for the diagnosis of free fluid, 41%

(39 of 99) for directly demonstrating organ injury, and 72% (71 of 99) for suggesting organ injury by means of both free fluid and organ analysis. At second US, these sensitivities were 96% (80 of 83 cases), 55% (54 of 99) and 84% (83 of 99), respectively.[20]

In a prospective study over a period of 22 months (from May 1996 to February 1998), done at department of radiodiagnosis, AIIMS, New Delhi-110 029, India, thirty- three patient of abdominal trauma, who were stable enough to undergo both US and CT and who had at least one of these scans interpreted as positive, were included in the study. Patients with large hemoperitoneum required surgery more often. Grading of organ injuries did not correlate with need for surgery except for splenic injuries. In 25 patients, either US or CT would have been sufficient for arriving at a management decision. In seven patients, CT altered the management decision that was arrived at on the basis of US. One patient required angiography for diagnosis and vascular intervention.[9]

The hospital records of 25 patients who were admitted with blunt abdominal trauma to Southland Hospital, Invercargill, New Zealand, between January 1991 and November 1996 and who had both ultrasound and CT of the abdomen within 48 h of admission were reviewed. Ultrasound missed seven lesions in seven patients (7/25, 28%) compared with CT. Three of these were intestinal lesions that needed laparotomy. Ultrasound had a usefulness index of 1, 0.76, 0.72, 0.69 and 0, respectively, for detecting lesions of the kidneys, free intraperitoneal fluid, the liver, the spleen, and intestines.[12]

In the study conducted at a large university hospital in northern Italy that serves as a regional center for pediatric trauma; US, contrast-enhanced US, and contrast-enhanced CT were performed in 27 consecutive children (19 boys, eight girls; mean age, 8.9 years ± 2.8 [standard deviation]) with blunt abdominal trauma to determine if solid abdominal organ injuries were present. In 15 patients, contrast-enhanced CT findings were negative. Contrast-enhanced CT depicted 14 solid organ injuries in 12 patients. Lesions were in the spleen (n=7), liver (n=4), right kidney (n=1), right adrenal gland (n=1), and pancreas (n=1). Contrast-enhanced US depicted 13 of the 14 lesions in 12 patients with positive contrast enhanced CT findings and no lesions in the patients with negative contrast-enhanced CT findings. Unenhanced US depicted free fluid in two of 15 patients with negative contrast-enhanced CT findings and free fluid, parenchymal lesions, or both in eight of 12 patients with positive contrast-enhanced CT findings. Overall, the diagnostic performance of contrast-enhanced US was better than that of US, as sensitivity, specificity, and positive and negative predictive values were 92.2%, 100%, 100%, and 93.8%, respectively.[21]

3. Methodology

3.1. Study area

- The study was conducted in the department of radiology at Addis Ababa University, college of health sciences, Tikur Anbesa comprehensive specialized hospital and AaBET hospital.

3.2. Study design and period

- An institution based cross-sectional study was conducted using ultrasound (Sonoscape SSI-8000) and CT scan (GE 64-row detector volumetric scanner) was conducted for one-year period from September 1st, 2017 to August 31st, 2018.

3.3. Study population

- All patients with blunt abdominal trauma who present to radiology department of both hospitals for CT scan during the study period.

3.4. Inclusion and exclusion criteria

3.4.1. Inclusion criteria

- All patients who come to both hospitals with blunt abdominal trauma and who are stable enough to undergo both ultrasound and CT scans were included into the study.

3.4.2. Exclusion criteria

- All patients who could not withstand to undergo both ultrasound and CT scans were excluded from the study.
- All patients with incomplete ultrasound data were excluded from the study.

3.5. Study variables

3.5.1. Dependent variables

- Parts of body injured
- Ultrasound findings of the patient
- CT-scan findings of the patient

3.5.2. Independent variables

- Age
- Sex
- Mechanism of injury

3.6. Measurement and data collection

3.6.1. Sampling method

Non-probability sampling was used to include all patients who fulfill the inclusion criteria in the study.

3.6.2. Data collection procedure

Data collection was done using a well-designed data collection forms by interview of patients or attendants who presented for ultrasound, review of patient's medical record chart and diagnostic images. Data was collected from the current routine diagnostic setup and no intervention was done. The data collectors were given training about research objective, the questioner, how to review chart, fill the data and abstract findings to assure the quality of data. Data collectors include residents and medical record office workers who were guided by the investigator.

3.7. Quality control and data quality assurance

Data was evaluated for completeness and patients with incomplete records and medical data excluded from the study to avoid bias in the correlation.

3.8. Data analysis and interpretation

Data was collected, entered using EpiData 3.1, cleaned and analyzed using IBM SPSS version 25 software according to the study objectives. The descriptive statistics (mean± SEM, median ± SD (or range), percentages or frequency) were calculated. The bi-variant logistic regression analysis was used to see the relation between dependent variable and independent variables and those variables which showed association was analyzed using multiple logistic regressions. Finally, the results will be presented in text, charts, graphs and tables.

3.9. Ethical consideration

Ethical clearance was obtained from Addis Ababa University College of health sciences research and ethical clearance committee. Letters was secured from the hospitals. The name of patient was not be mentioned and the information gained from the chart was used only for research purpose. Any information that was obtained during the study will be kept confidential.

3.10. Dissemination of results

The study result will be submitted to Addis Ababa University College of health science department of radiology and presented to the radiology department. The notification of the outcome will also be done to the AaBET hospital. It will be presented on the annual conferences of the radiologic society of Ethiopia. Further effort will be made to publish and present the result on national and international journals and conferences.

4. Work flow

Either of two ways was used to collect the data for this study.

Way 1:

A patient with blunt abdominal trauma presents for ultrasound evaluation

↓

Serial number will be provided on separate excel sheet

↓

Collection of the hospital data
(And tracing the patient chart, if necessary)

↓

Collection of the demographic data using data collection form

↓

Collection of clinical data using data collection form

↓

Senior radiology resident or body radiologist evaluates the patient abdomen using Sonoscape SSI-8000 ultrasound machine.

↓

Collection of ultrasound findings using data collection form

↓

Porto-venous phase CT-scan images (with delayed images at 6 minutes after contrast injection if there is clinical or ultrasound suspicion of splenic pseudoaneurysm or vascular injury) obtained using GE 64-row detector volumetric scanner.

↓

CT scan images evaluated by senior radiology resident and verified by body radiologist who are blinded to the ultrasound findings

↓

CT scan findings collected using data collection form and separate serial number given on separate excel sheet.

↓

Final serial number is given by combining the ultrasound and CT serials and the collected data compiled and stored for further processing

Way 2:

Patient comes for/with abdominal CT scan.

↓

Serial number will be provided for CT scan on separate excel sheet.

↓

CT scan images evaluated by senior radiology resident and verified by body radiologist

↓

CT scan findings collected using data collection form

↓

Separate US serial number given to blind the investigator from ultrasound findings and Collection of the hospital data
(tracing the patient chart back)

↓

Collection of the demographic data using data collection form

↓

Collection of clinical data using data collection form

↓

Collection of ultrasound findings using data collection form

↓

Compile the serial number and collected data and store for further processing

5. **Results and discussion**

5.1. Results

Total of 63 patients were selected for the study; 19 from TASH and 44 from AaBET hospital. Of those 16 patients were excluded from the study because ultrasound was not done for 2 patients and 14 of the patients CT scans were obtained first but we couldn't trace the chart and ultrasound result. (The charts of 17 patients, to whom ultrasound was first done, were also missing from the medical record room). Finally, total of 47 patients for whom both ultrasound results and CT scan were available for interpretation were included in the study.

34 (72.3%) of patients were male and 13 (27.7%) were females with male to female ratio of 2.62:1. The age ranged from 3months to 60years with mean of 30.36±12.75 years (30.18years for males and 30.85year for females). Majority of the study population, 72.4%, were in the age range of reproductive age group (18-40 years). 10.6% of the study population were pediatric patients (age <18) and all patients were within the age limit of 60years.

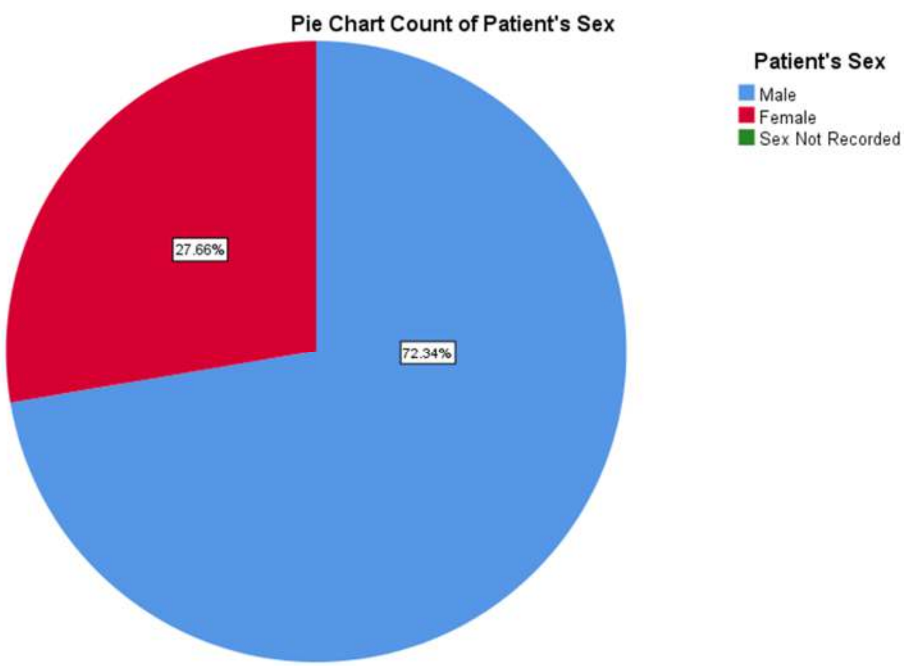

Figure 1 Sex distribution of patients with blunt abdominal trauma

Table 1 Age and sex distribution of patients with blunt abdominal trauma

Age in years	Male	Female	Total	%
<18	4	1	5	10.6
18-25	7	5	12	25.6
26-40	18	4	22	46.8
>40	5	3	8	17

Total	34	13	47	100

The commonest mechanism of injury was road traffic accident taking more than half, 28(59.6%), of the study population. 11 (23.4%) were falling down accidents, 3(6.4%) fighting injuries, 2 (4.3%) accidental injuries and 3 (6.4%) bullet injuries one to the lower back, one to the lower limbs and the other to the chest followed by falling down.

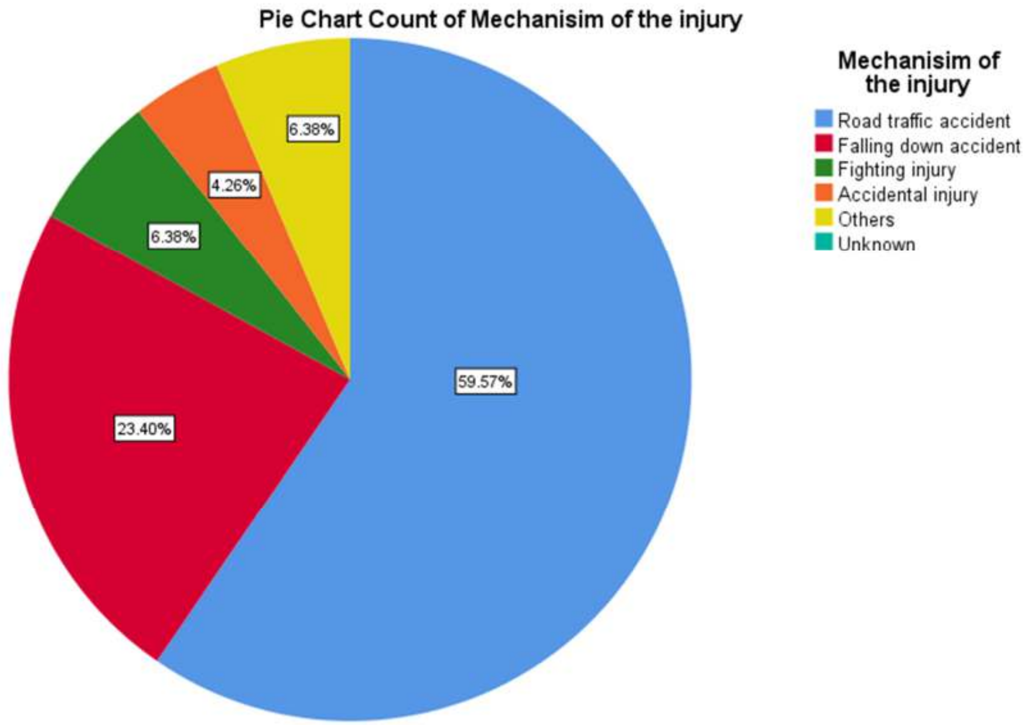

Figure 2 Mechanism of trauma/injury

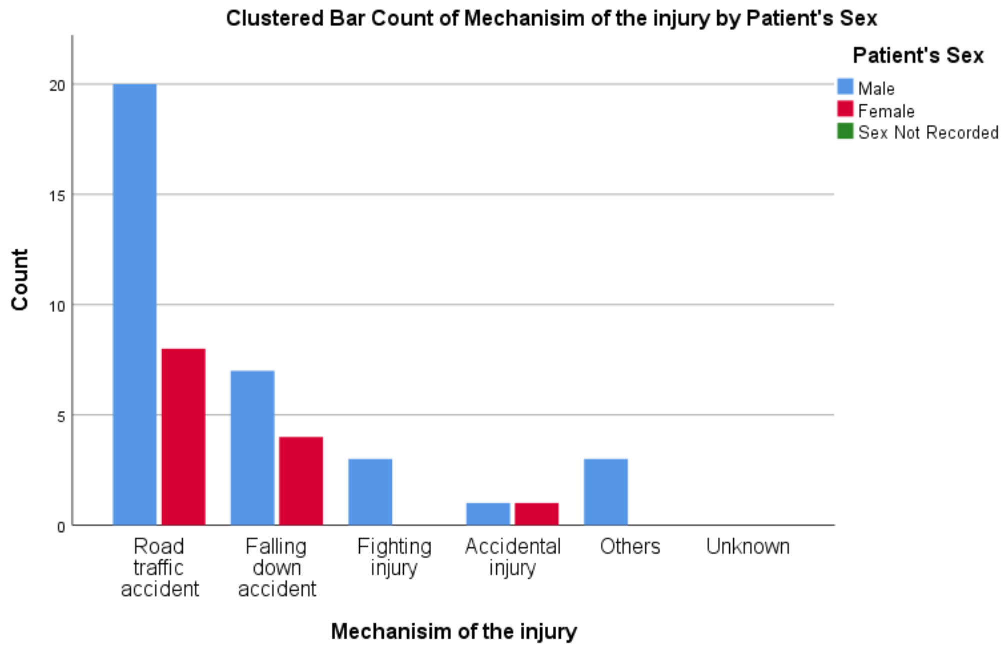

Figure 3 Mechanism of trauma by patient's sex

22 (46.8%) of patients had hemoperitoneum on ultrasound and 26 (55.3%) had hemoperitoneum on CT scan.

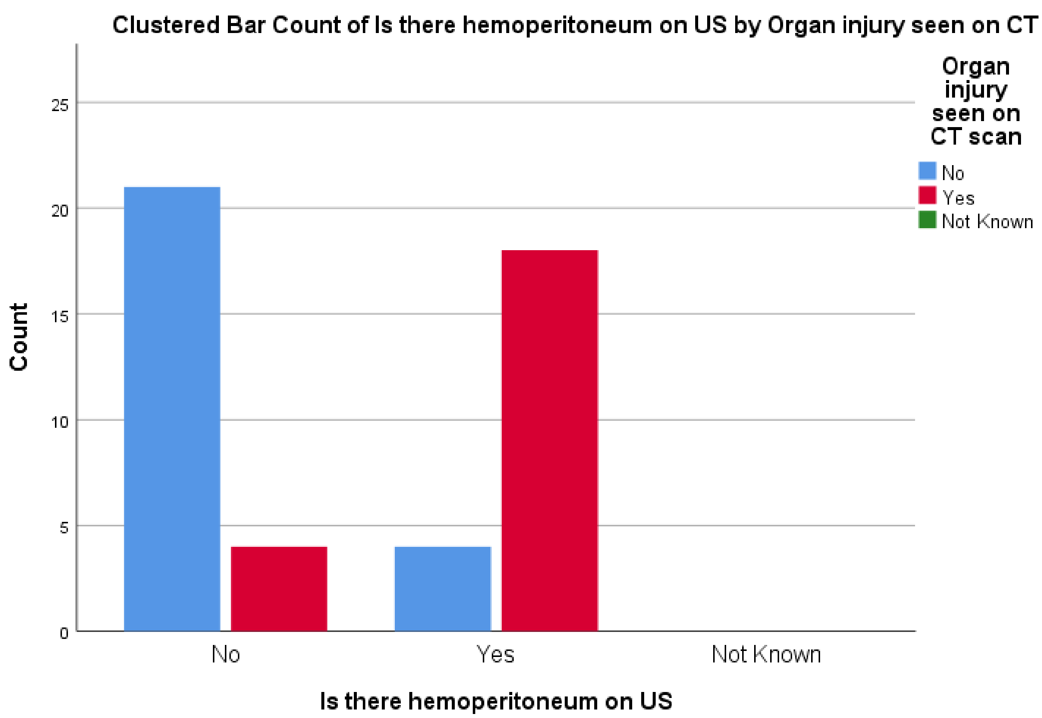

Figure 4 Cross tabulation of free fluid seen on US by organ injuries seen on CT scan

Organ injuries were graded on CT scan based on the injury scoring scales by American association for the surgery of trauma (AAST). All patients who were reported to have organ injury on ultrasound had injury to the mentioned organ except the two patients who were reported to have right renal injury on US but no injury to the right kidney was seen on CT.

Table 2 Organ injuries detected on US and CT scan

Organ			Grade					
	US	CT	0	1	2	3	4	5
Liver	6	12	35	0	2	2	3	5
Spleen	3	8	39	1	1	3	2	1
Right kidney	4	2	45	0	0	2	0	0
Left kidney	2	2	45	0	0	1	1	0
Bowel	0	1						
Adrenal hemorrhage	0	1						
Lung contusion	2	8						

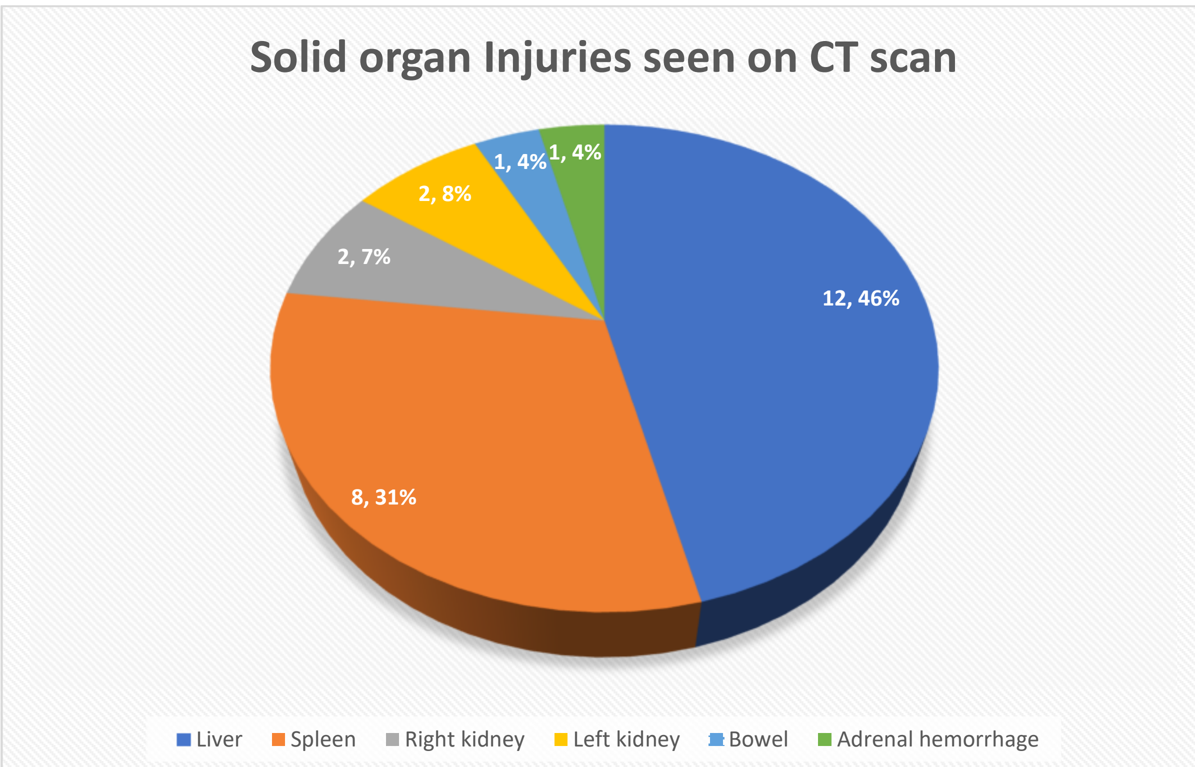

Figure 5 Solid organ injuries seen on CT scan

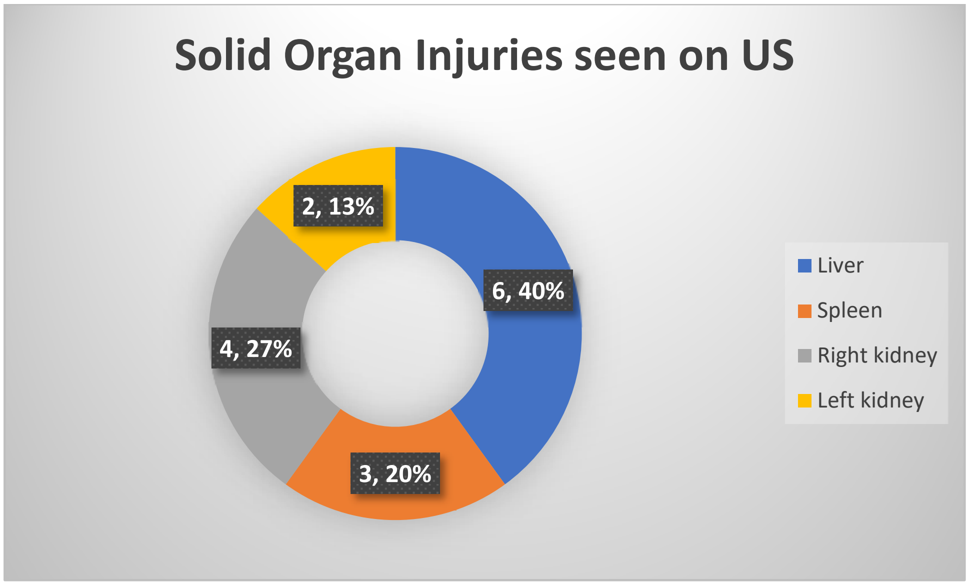

Figure 6 Solid organ injuries seen on ultrasound

5.2. Discussion

Traumatic injuries are a significant public health issue worldwide, the commonest cause being road traffic accident that mainly affects people in reproductive age group.[1-3] Abdomen has been reported to be the third most common region of injury after head and extremities[3] In recent years ultrasound is used for initial evaluation of patients with blunt abdominal trauma followed by CT scan for those who need further evaluation based on clinical and/or ultrasound results, so that rapid detection of the patients in need for surgeries and those with unstable hemodynamics can be given proper lifesaving treatment and the appropriate management decision taken for stable patients.[3, 9] This study also reveals low sensitivity and excellent specificity of ultrasound in blunt abdominal trauma prompting the need for correlation with clinical status of the patient for further decisions.

From our study most of the patients, 72.4%, who sustained blunt abdominal trauma were adults from 18-40 years of age which is similar with similar studies.[9, 12, 17] This was probably due to the fact that it is this age group that usually is involved in speeding leading to accidents. Pediatric patients below age of 18 years accounted 10.6%. The most common cause of trauma was road traffic accidents (59.6%) followed by fall from heights (23.4%) which is comparable to other similar studies.[9, 17, 22]

Hemoperitoneum is the most common finding seen in blunt abdominal trauma patients. In present study, it was detected in 26 patients of whom 6 were not detected on ultrasound. The sensitivity and specificity of ultrasound is 76.9% and 90.5% in detecting hemoperitoneum with 8 false negative (23.1%) and 2 false positive (9.1%).[3, 7, 17] The overall false negative rate in the present study was 23.1%, which supports the finding that a quarter of blunt abdominal injuries may be missed if abdominal ultrasonography is relied on as the sole diagnostic modality.[12] The negative predictive value and positive predictive values were 76.0% and 90.9% respectively This finding also supports other similar study.[17] This study showed lower sensitivity for hemoperitoneum when compared with the studies done by Poletti et al and Taş et al but better sensitivity and specificity with comparably low negative predictive value of ultrasound for detection of peritoneal free fluid when compared to the studies done by Emery et al and McGahan et al [7, 8, 20, 23]

Overall 22 organ injuries were detected in 47 patients on CT scan making the sensitivity, specificity, positive and negative predictive value of ultrasound 50%, 100%, 100% and 69.4% respectively. This study showed low sensitivity ultrasound but comparable specificity with large study on 326 patients study done in Iraq by Albayati HA but higher sensitivity from another larger study done on 439 patients in Switzerland by Poletti et al.[4, 20] On this study there is high false negative, 11 (50%), sonography when compared with the study by Taş et al in children with pediatric patients with blunt abdominal trauma.[7]

The most common organ which was found to be affected was liver (46%) followed by spleen (31%), 5.5% of kidneys, 1.4% bowel and 1.4% adrenal gland which was similar to studies done by Singh K et al and Ravindernath ML and Reddy GM.[3, 17] In other studies by Kshitish et al and Taş et al spleen was the commonest organ involved.[7, 9]

The sensitivity and specificity of ultrasound is 41.7% and 97.1% in detecting liver injury with 7 false negative (58.3%) and 1 false positive (2.9%). The present study showed low sensitivity with comparable specificity when compared with the similar studies done by Taş et al, Kshitish et al and Poletti et al.[7, 9, 20]

The sensitivity and specificity of ultrasound is 37.5% and 100% in detecting splenic injury with 5 false negative (62.5%) and no false positive. This study showed comparable sensitivity compared to the study by Poletti et al; excellent specificity but lower sensitivity of ultrasound in detecting splenic injury when compared with the studies by Taş et al and Kshitish et al.[7, 9, 20]

The sensitivity, specificity, positive and negative predictive value of ultrasound in detecting renal injury is 100%, 95.3%, 66.7% and 100% respectively. This study showed comparable sensitivity with Abu-Zidan et al but better sensitivity and comparable but lower specificity with the studies done by Taş et al and Kshitish et al.[7, 9, 12]

5.3. Limitations

The most significant limitation of this study is that the significant number of charts were missing most likely poor medical record keeping habit in both hospitals; charts of patients for whom ultrasound was done earlier were also missing (total of 33 or 52.4% 63 charts). Other problem was that ultrasound was not done by pretrained radiologist and standardized uniform template. For that reason, ultrasound reports were not uniformly well documented and time gap between US and CT scan was not clearly documented. This may have its contribution to the low sensitivity of ultrasound in this study. In addition, the outcome of the patients was not appropriately followed which if done could have made it helpful for correlation of imaging result and treatment modality.

6. Conclusion and recommendations

6.1. Conclusion

The present study supports the view that US and CT have complementary roles in the diagnosis of blunt abdominal trauma. Although US can be used as an initial screening method for blunt abdominal trauma to detect presence of free fluid, CT is still the imaging modality of choice for detecting intra-abdominal lesions in stable patients because about a quarter of the patients with blunt abdominal trauma may be missed on ultrasound.

6.2. Recommendations

To our knowledge this is the first study comparing diagnostic capacity of ultrasound and CT scan in patients with blunt abdominal trauma in Ethiopia as well as Africa. It is also among few international studies. Number of blunt abdominal trauma patients used in this study is also comparable with most of the international studies. So, this study should be used as a baseline to make appropriate trauma protocol imaging in the teaching and non-teaching hospitals in Ethiopia. Ultrasound scanning protocols for patients with blunt abdominal trauma should be prepared and trainings should be given to the radiologists working on the frontline at the high-load trauma centers and it should be given emphasis in the radiology residency curriculum. The reporting format for the ultrasound findings in blunt abdominal trauma should also be standardized. At the same time large scale study with multidisciplinary team collaboration should be done with the special emphasis given to collaboration.

The administration and health information technology professionals of both hospitals should, seriously consider the loss of more than half of the charts of the patients involved in this study and, take the alarming sign discuss and devise the strong mechanism to keep the medical records of the patients clean and safe at their intended place.

7. References

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Annex I: Data collection form

Serial No.__________

Date_______________

1. **Demographic data.**
   - **a.** Age ____________
   - **b.** Sex ____________
   - **c.** Religion________
   - **d.** Region(Mark √)

Afar	**Amhara**	**Benishangul-Gumuz**	**Gambela**	**Harari**	**Oromia**	**Somali**	**SNNPR**	**Tigray**	**Addis Ababa**	**Dire Dawa**

   - **e.** Area of residence
     - **i.** Urban
     - **ii.** Rural
   - **f.** Literacy level
     - **i.** Non-applicable (child)
     - **ii.** Illiterate
     - **iii.** Primary school
     - **iv.** High school
     - **v.** College and above

2. **What is the mechanism of trauma?** (circle right options)
   - **a.** Road traffic accident
   - **b.** Falling down accident
   - **c.** Fighting injury
   - **d.** Accidental injuries
   - **e.** Other (specify).
3. Time gap between trauma and ultrasound examination (in hours)___________
4. Time gap between trauma and CT-scan (in hours)___________
5. **What body parts are injured?** (Mark √ the involved parts of the body)

Abdomen	**Chest**	**Head**	**Neck**	**Back**	**Extremities**	**Remark**

6. **Abdominal US findings:**

6.1. Is there free fluid in potential spaces? (Mark √ the appropriate box)

Potential spaces	Free fluid collection			
	No collection	Collection present		Remarks
		<2cm	>=2cm	
Pericardial cavity				
Right pleural cavity				
Left pleural cavity				
Morison's pouch				
Right subdiaphragmatic space				
Left subdiaphragmatic space				
Spleno-renal recess				
Pelvis				

6.2. What are the types of solid organ injuries detected? (Mark √ the appropriate box)

Organ	**Normal**	**Subcapsular hematoma**	**Contusion**	**Laceration**	**Shattered (ruptured)**	**Remark**
Liver						
Spleen						
Right kidney						
Left kidney						
Pancreas						
Bowel						
Mesentery						
Urinary bladder						

6.3. Other organ injuries or findings:____

____

____

____

Serial No.__________

Date______________

7. **CT scan findings:**

7.1. Is there free fluid in potential spaces? (Mark √ the appropriate box)

Potential spaces	Free fluid collection			
	No collection	Collection present		Remarks
		<2cm	>=2cm	
Pericardial cavity				
Right pleural cavity				
Left pleural cavity				
Morison's pouch				
Right subdiaphragmatic space				
Left subdiaphragmatic space				
Spleno-renal recess				
Pelvis				

7.2. What are the types of solid organ injuries detected? (Mark √ the appropriate box)

Organ	**Normal**	**Subcapsular hematoma**	**Contusion**	**Laceration**	**Shattered (ruptured)**	**Remark**
Liver						
Spleen						
Right kidney						
Left kindney						
Pancreas						
Bowel						
Mesentery						
Urinary bladder						

7.3. Is there fracture of bony structures? (Mark √ the appropriate box)

Bones	**No fracture detected**	**Fracture detected**	**Remark**
Spine (Please localize)			
Pelvic bones (specify)			
Ribs			
Other bones			

7.4. Other organ injuries or findings:____
____
____
____

7.5. Incidental finding in abdominal scan (these findings are congenital or acquired and are clinically significant) ____
____
____
____