Original Research Article

Analysis of sonographic findings and its correlation with clinical background, laboratory investigations, conventional and contrast radiographic procedures in abdominal trauma

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Abstract

Background: Evidence exists that appropriate training plays a role in the sensitivity and specificity of US. Sonographic results have been shown to be highly variable and dependent on technical expertise of the examiner. They pointed out that differences in ultrasonographic detection of free fluid or parenchymal organ injury varied with the experience of the examiner. **Methodology:** No specific preparation was given prior to examination as the study was done on emergency basis. Very uncooperative patients (mostly of paediatric age group) were studied after giving mild sedation to patient **Results:** Out of 20 cases of haemoperitoneum 12 cases needed laparotomy and 8 were treated conservatively due to insignificant injury. Most of the splenic and liver injuries were associated with hemoperitoneum, however out of 4 patients with renal injuries, 1 case was associated with hemoperitoneum (25%). **Conclusion:** Thus out of 40 patients evaluated by US, a true positive of 20 and a true negative value of 15 were obtained. Thus giving a sensitivity of 83% and a specificity of 93.7% on US. The positive predictive value is 95% and a negative predictive value is 79%.

Key Words: Abdominal Trauma, Ultrasonography, Contrast Radiographic Procedures.

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Received Date: 20/09/2017 Revised Date: 12/10/2017 Accepted Date: 08/11/2017
DOI: https://doi.org/10.26611/1013421

Access this article online	
Quick Response Code:	Website: www.medpulse.in
	Accessed Date: 10 November 2017

INTRODUCTION

In an examination of traumatized and acutely ill patients with ultrasonography and CT, they found that US plays an important role in the evaluation of patients having BAT or presenting with renal failure or bleeding during pregnancy. They concluded that US and CT are invaluable diagnostic tools in the radiological evaluation of traumatic patient[1]. In an investigation of childhood blunt abdominal trauma by using ultrasonography as the initial diagnostic modality, during a 5 year retrospective study, a total of 170 children with BAT were investigated with ultrasonography, intravenous urography and scintigraphy. The results of radiological investigations were compared with clinical outcome and laparotomy. During the study period, real time ultrasonography became the first line screening tool and was combined with intravenous urography in suspected renal trauma. Inspite of permanent accessibility of CT, it was used only in complex diagnostic problem or in multiple injuries[2]. Comparing the role of ultrasonography and diagnostic peritoneal lavage in blunt abdominal trauma, the reliability of US and DPL in assessing the need for immediate surgical intervention in BAT was examined in a prospective study of 71 patients. The study suggested that the performance of US as a screening method is justifiable. DPL is a complimentary examination which is

How to cite this article: Ashwin Kumar Patil, D Devaraja S M. Analysis of sonographic findings and its correlation with clinical background, laboratory investigations, conventional and contrast radiographic procedures in abdominal trauma. *MedPulse – International Journal of Radiology.* November 2017; 4(2): 26-30. http://www.medpulse.in/Radio%20Diagnosis/

indicated in cases with equivocal clinical or sonographic examination. Thus both ultrasonography and diagnostic peritoneal lavage are not competing procedures but rather complimentary in the evaluation of patients with BAT[3]. In a study of the reliability of ultrasonographic detection of haemoperitoneum in blunt abdominal trauma in a prospective study of 72 patients, they concluded that US is a quick, safe screening method in the evaluation of BAT to detecthaemoperitoneum and ultrasonography might take over a great part of the role of diagnostic peritoneal lavage[4]. The reliability of diagnostic US in detecting haemoperitoneum in patients with multiple trauma was evaluated prospectively in 291 patients. According to authors, in cases of multiple traumas there is a need for imaging modality that not only provides a rapid diagnosis for blunt abdominal trauma but can also be used repeatedly with a high reliability to follow the patients' course and ultrasonography meets these demands favorably. They confirm that US has a high sensitivity and specificity in the diagnosis of BAT. In their department ultrasonography has replaced diagnostic peritoneal lavage. DPL is time honoured and is reserved for selected cases only[5]. The validity of US in the evaluation of patients with BAT was investigated in a prospective study. 140 patients with suspected BAT were included in the study. The influence of investigators experience in ultrasonography was manifested in the positive predictive value. They found that US is a suitable test for screening patients with BAT, since it is highly sensitive and specific, complication free and easy tolearn[6]. Evidence exists that appropriate training plays a role in the sensitivity and specificity of US. Sonographic results have been shown to be highly variable and dependent on technical expertise of the examiner. They pointed out that differences in ultrasonographic detection of free fluid or parenchymal organ injury varied with the experience of the examiner. The sensitivity of sonographic detection of free fluid varied from 96 to 100% depending on the examiner's experience; sensitivity of detection of parenchymal organ injury varied from 36 to 45%, depending on examinerexperience.[7]

MATERIAL AND METHODS

The patients were included in the study only if they met the following criteria

- All patients with blunt abdominal trauma
- Cases are included irrespective of age and sex.

Equipments

- Philips envisor CHD 7-12 MHz, in Chigateri General Hospital.
- Flexus SSD 1100 (Aloka) 3.5 MHz in Chigateri General Hospital
- Sonolineadara (siemens) 3.5 MHz in Bapuji Hospital.

Patient Preparation: No specific preparation was given prior to examination as the study was done on emergency basis. Very uncooperative patients (mostly of paediatric age group) were studied after giving mild sedation to patient.

Scanning Technique: Initially, the patient was asked to lie in supine position. This position is most comfortable for the patient. Adequate amount of ultrasonography jelly was applied to reduce the air gap between transducer face and skin surface. Initially, the transducer was placed beneath the xiphisternum in transverse plane, and moved slowly down the abdomen, angling to right and left to complete the survey. This plane shows the following organs. Pancreas, left lobe of liver, retroperitoneal vessels and retroperitoneal collections. Sagittal planes of scan were achieved by sweeping the transducer in the sagittal plane slowly from midline to right and to left starting at xiphisternum and ending in both flanks. The probe was alternately angled up and then down to visualize the dome of the diaphragm and more inferiorly placed structures such as the inferior margin of the liver, gall bladder, and pancreas. The transducer was also kept in both flanks to look for free fluid in paracolic gutters. Subcostal plane of scan on right side was achieved by keeping the transducer subcostally, at a cranial angle of 45 degrees to the body surface. The patient was asked to suspend respiration in deep inspiration (if possible) so that liver was brought down to a more accessible location. The transducer was further angled cranially and caudally, to scan the entire liver. This plane also allowed proper visualization of gall bladder, pericholecystic areas, hepatic veins. This plane was useful for detecting pleural effusion, subdiaphragmatic or subhepatic fluid collection. Intercostal views for liver were obtained by keeping the transducer in right 8^{th}, 9^{th} and 10^{th} intercostal spaces on right side and the scan plane being along the intercostal space to allow maximum visualization of liver parenchyma. The transducer was placed longitudinally in 10^{th} and 11^{th} intercostal spaces in right midaxillary line to identify the hepatorenal recess or Morison's pouch which is the commonest dependent site for the fluid collection. Decubitus (Rt. and Lt) raising alternately the right and left side causes descent of liver and spleen further into the abdomen and allows axial scanning of the kidneys and retroperitoneum. This and the oblique position encourages free fluid into the most dependent position and displaces gas from the mid abdomen. Spleen was best visualized by keeping the transducer in the left 8^{th}, 9^{th} and 10^{th} intercostal spaces, with scan plane along the intercostal spaces and patient in right decubitus position. This view helps to detect splenic lesion, perisplenic

collection and left pleural effusion. Coronal and axial scan planes were used for evaluation of kidneys which were achieved by placing the probe in patient's right and left flank with the patient in leftand right lateral decubitus respectively. While scanning the kidneys in the coronal planes, it was taken into account the fact that the lower poles of the kidneys are more anteriorly placed than the upper pole. The scan planes for kidneys are also helpful for detecting retroperitoneal pathology. Sagittal and transverse scans of the pelvis were obtained by placing the transducer longitudinaly and transversely in the midline just above symphysis pubis. The transducer was angled both cranially, caudally and side ways to delineate the entire pelvic anatomy. The bladder was identified as anechoic structure and the pouch of Douglas was examined for blood collection.

RESULTS

A total of 40 patients were evaluated sonographically with a history of blunt abdominal trauma.

Table 1: Sex distribution of study group

Sex	No of Cases (n=40)	Percentage
Male	29	72.5
Female	11	27.5

Out of 40 patients evaluated sonographically, 29 were males and 11 were females. Thus an overall male predominance of 72.5% was noted.

Table 2: Clinical Presentation

Clinical Presentation	No of Cases (n=40)	Percentage
Pain Abdomen	33	82.5
Abdominal Distention	13	32.5
Guarding and Rigidity	26	65
Hematuria	3	7.5

Pain abdomen (82.5%) and guarding and rigidity (65%) were the most predominant signs and symptoms, followed by abdominal distention (32.5%). Out of 4 patients with renal injury, 3 patients presented with haematuria.

Table 3: Lap Findings Missed On Us

Organs Injured	No of Cases	Percentage
Liver Laceration	1	12.5
Spleen Laceration	1	10
Bowel Perforation	1	100
MesentricHaematoma	1	100

USG detected almost all solid organ injuries, however, one liver laceration (12.5%), one spleen laceration (10%) were missed on sonography which were detected on laparotomy. USG failed to detect 1 case of bowel and 1 case of mesenteric injuries directly. In one patient, a false positive diagnosis of splenic hematoma was made which was not confirmed at surgery.

Table 4: Injuries seen on usg associated withhemoperitoneum

Type of Injury	No of Cases (n=40)
Insignificant Injury	8
Significant Injury (Needed Laparotomy)	12
Spleen	8
Liver	5
Kidney	1
Pancreas	1
Bowel Perforation	1
MesentricHaematoma	1

Out of 20 cases of haemoperitoneum 12 cases needed laparotomy and 8 were treated conservatively due to insignificant injury. Most of the splenic and liver injuries were associated with hemoperitoneum, however out of 4 patients with renal injuries, 1 case was associated with hemoperitoneum (25%).

Table 5: Injuries seen on usg not associated with hp

Type of Injury	No of Cases (n=40)
Spleen Subcapsular hematoma	1
Liver Laceration	1
Liver Contusion	1
Renal Laceration	1
Renal Hematoma	2
Pseudopancreatic Cyst	1

1 case of spleen injury, 2 cases of liver injury, 3 cases of renal injury and 1 case of pseudopancreatic cyst did not show free fluid.

Table 6: USG indicator of laparotomy

USG Indicator of Laparotomy	No of Cases (n=40)
USG Suggested Laparotomy	11
True Positive	10
False Positive	1
True Negative	24
False Negative	4
Sensitivity	66%
Specificity	96%
Positive Predictive Value	91%
Negative Predictive Value	83%

US Suggested Laparotomy in 11 cases. In one operative case no injury detected although USG was positive for splenic hematoma and HP. US was negative for organic injuries in 4 cases which on EL were detected to be 1 case of bowel perforation, 1 case of mesenteric haemotoma and 1 case each of liver and splenic lacerations.

DISCUSSION

Free fluid was detected in 20 cases (50%). Out of 20 cases with free fluid, 12 cases (60%) were operated and had significant organ injuries along with fluid in theperitoneal cavity. 8 cases were treated conservatively in whom lesions resolved on follow up scans. The accuracy of ultrasound in detecting free fluid was 100% in our study. The true sensitivity of sonography may not

be revealed in our study because not all cases were confirmed by CT or laparotomy. Kimura *et al*[4] in their study noted that ultrasound findings of hemoperitoneum should be an integral part for evaluating laparotomy indication in blunt abdominal trauma.Rothlin *et al*[8] in their study of 312 patients found the sensitivity of ultrasound for detection of free fluid close to 98%.Most of splenic and hepatic injuries were associated with free fluid, however, out of 4 patients with renal injuries 1 was associated with free fluid (25%) Spleen was the single most common organ injured in blunt abdominal trauma in the present study.Spleen was injured in 10 cases (25%), out of these 9 were detected on US. The commonest type detected was splenic rupture (44%) followed by intraparenchymalhaemotoma (33%). The other injuries present were subcapsularhaematoma and laceration. This correlates well with the study of Reinhard Hoffman *et al*[5], where splenic rupture was the commonest type of injury (71%) in splenic trauma. 1 case of splenic laceration was missed on US probably due to initial isoechogenicity of the splenic injury and also due to presence of excess bowel gas and inability to scan in different planes due to unco-operative patient.US detected 1 case of splenic haematoma but on laparotomy it was normal.8 cases out of 9 were associated with free fluid, however, 1 case of subcapsularhaemotoma did not show free fluid. 5 cases out of 9, underwent exploratory laparotomy follow up scans were uneventful except in 1 case, where patient died due to ARDS and septicemia. 4 cases were treated conservatively and on follow up scans resolution of lesions noted. Hepatic injuries were demonstrated in 8 patients (20%). Out of these 7 cases were detected on ultrasonography. The commonest lesion detected was laceration (57%) followed by haematoma (28.5%) and contusion.(14%).In the series by R. Gruessner *et al*[9] the major hepatic injuries were laceration and haematoma.1 case of hepatic laceration was missed on US (20%).5 out of 7 cases detected on US were associated with free fluid. 1 case each of liver laceration and contusion did not show free fluid. 3 cases underwent exploratory laparotomy. Follow up scans were uneventful. Remaining 4 cases were treated conservatively. Follow up scans showed complete resolution. 1 case was lost. In our study 4 patients had renal injuries (10%). Out of these haematoma and perinephric collection was noted in 2 cases each (40%) and 1 case of renal laceration noted. (renal laceration and perinephric collection was noted together in one case). US detected all cases of renal injuries. One case with prior bilateral polycystic renal disease haematoma was noted in right kidney. CT was done in a case of renal laceration and another case of renal haematoma in prior bilateral PCKD and US findings were confirmed.1 patient underwent partial nephrectomy while others were conservativelytreated. Out of 4 cases one was associated with free fluid. 2 cases of haematomas and one case of renal laceration did not show free fluid. Follow up scans showed complete resolution of perinephric collection and haematomas, while postoperative scan was uneventful. 2 patients presented to us with history of blunt injury abdomen 2-3 weeks back and showed pseudopancreatic cysts. One case was associated with free fluid and left sided minimal pleural effusion. Both were treated conservatively. On follow up complete resolution was noted in 1 case while the other was lost in follow up. Bowel injury occurred in 1 patient in our study. Free gas under diaphragm was noted on erect abdominal radiography. It was not diagnosed directly by ultrasound, however, US revealed free fluid and missed the organ of injury. Terminal ileal perforation was confirmed on laparatomy. Follow up scan was uneventful. Mesenteric injury was seen in 1 patient, missed on US. It was associated with free fluid. Was confirmed on exploratory laparotomy to be a case of mesenteric haematoma. Follow up scan was uneventful. None of the patients in the present study had injury to diaphragm, adrenals great vessels and urinary bladder. Thus from above, it is concluded that in most of the studies spleen is the most common organ to be injured in BAT and liver or the kidney are the commonest organs involved after spleen. Thus in 21 abnormal scans (positive for organ injury), only in one patient, a complete misdiagnosis was made. US findings were splenic haemotoma with free fluid, however, on subsequent exploratory laporatomy spleen was found to be normal, thus giving a percentage false positivity of 6.2%. Out of 19 normal US findings (no organ injury), 4 false negative scans were reported. 1 patient with ileal perforation, one case of mesenteric haematoma, 1 case each of liver and spleen lacerations were missed, giving a false negativity of 16%. Thus out of 40 patients evaluated by US, a true positive of 20 and a true negative value of 15 were obtained. Thus giving a sensitivity of 83% and a specificity of 93.7% on US.The positive predictive value is 95% and a negative predictive value is 79%.

CONCLUSION

The overall sensitivity of ultrasonography in the evaluation of blunt abdominal trauma was 83% and specificity was 93.7%. Intraperitoneal free fluid collection was the commonest abnormality detected. The sensitivity of real time ultrasonography was 100% in our study because not all cases were confirmed by CT or laparotomy.

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Source of Support: None Declared
Conflict of Interest: None Declared