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COMPARATIVE STUDY OF X-RAY, ULTRASOUND AND COMPUTED TOMOGRAPHY(CT) IN THE EVALUATION OF BLUNT INJURY ABDOMEN

Radiology

Dr. Priyanka M PG, RMC, GGH, Kakinada
Dr B. Anuradha* MDRD Associate professor *Corresponding Author

KEYWORDS

INTRODUCTION:

Traditionally, abdominal injuries can be divided into blunt trauma and penetrating trauma. Blunt abdominal trauma (BAT) usually occurs due to road traffic accidents (RTA), falls from heights or during sports[1]. Blunt abdominal trauma may represent an immediate threat to life, requiring rapid diagnosis and treatment. Previously available diagnostic techniques included plain radiographs, contrast studies, and angiography. Diagnostic laparotomy used to play a prominent role in previous days but with the advent of newer modalities of imaging techniques most of the open surgical procedures can be avoided.,"[2]. Plain Radiographs play a limited role in the evaluation of blunt abdominal trauma. Radiographs of the chest and pelvis are often obtained to evaluate for concurrent thoracic or pelvic bony injuries. Abnormal chest x-ray findings like pneumothorax and rib fractures are often associated with abdominal organ injuries and are indications for abdominal imaging. Ultrasonography (US) and computed tomography (CT) have found an increasingly important role in the evaluation of abdominal trauma.[4]

CT by its localizing nature helps in deciding surgical approach or conservative management in appropriate clinical settings. The use of CT along with a trend towards non-operative management of many abdominal injuries has decreased the need for explorative surgery and reduced the frequency of non-therapeutic /diagnostic laparotomies.[3] The popularity of 'emergent abdominal sonography' or 'focussed assessment sonography in trauma' and its validation as to its effectiveness in several trauma centres has renewed its interest in other trauma centres as well, particularly in the current era of cost containment in health scenario.[5]

The purpose of our study is to evaluate the role of X-Ray,US and CT for the depiction of organ injury indirectly by means of detection of free abdominal air (pneumoperitoneum), free fluid)& directly by parenchymal evaluation in patients with blunt abdominal trauma and to compare the findings of these three frequently used modalities so that their optimal use can be maximized.

AIMS AND OBJECTIVES

- To assess the relative role of X-Ray, US, and CT in the evaluation of patients with blunt abdominal trauma.
- Analysis of X-Ray, Sonographic and Computerized Tomography (CT)scan findings and its correlation with a clinical background, and operative findings wherever possible.
- To evaluate the role of imaging in the management of trauma.

MATERIAL AND METHODS

Patients presenting at the casualty department of GGH KAKINADA suspected to have blunt abdominal trauma were investigated. The time, cause and mode of injury were obtained whenever possible. Thirty-One patients who were stable to undergo X-ray, US, and CT examination and had at least one of these studies interpreted as positive were included in this study.

PLAIN RADIOGRAPH:

Erect Abdomen X-Rays were performed on "500 MA ALLENGER'S Machine with FUJI CR SYSTEM"). Particular attention was paid for detecting the presence of free intraperitoneal air (pneumoperitoneum) &multiple air-fluid levels.

ULTRASONOGRAPHY:

US scans were performed on the "ESAOTE-MY LAB SEVEN " machine, with 2-5 and 5-10 Mhz curvilinear and linear probes. Particular attention was paid to the detection of free fluid in the abdomen and pelvis, in addition to the assessment of individual organs.

CT TECHNIQUE:

CT scans were performed on; "GE REVOLUTION ACTS 16 SLICE" helical scanner. Helical CT of the entire abdomen was done from the level of dome of the diaphragm up to the inferior aspect of the ischium.

Scan Parameters & Technique :

Slice Collimation	1.25mm
Table Speed	0.75 mm/sec.
KV	120
mA	180-250

Images were reconstructed at 0.625 mm intervals using a standard reconstruction algorithm.

CONTRAST MATERIAL:

Routine oral contrast was not given to the patients. Patients received IV contrast material (whenever possible) administered with an automated Medrad Power Injector after the initial pilot scan via a large-bore (18-20 G) peripheral venous line. A total of 100 ml, 60% non-ionic iodinated contrast was given intravenously at a rate of 2-4 ml per second. Scanning was initiated 70-90 seconds after the start of contrast infusion. Delayed CT scans were also incorporated whenever there was suspicion of kidney or urinary tract injury.

OBSERVATIONS AND RESULTS

Thirty-one patients with blunt abdominal trauma, who were stable enough to undergo X-Ray, US and CT were evaluated during 12 months from July 2018 to June 2019. All patients show positive findings for abdominal injury at least on one of the tests (X-Ray, US and CT). There was one patient with blunt trauma as well as a penetrating injury. The remaining 30 patients had blunt abdominal trauma due to various causes. RTA was found to be the most common cause of blunt abdominal trauma(77.4%).

There were 24 male and 7 female patients. The age of patients ranged from 8 years to 75 years. The mean age was 37.9 years. One patient was a child (< 12 years). Fourteen patients were 40 years or older.

Table 1: Age and Sex Distribution Table

Age group	No. of patients	Sex		Percentage (%)
		M	F	
0-12	01	0	1	3.2%
13-20	03	02	1	9.6%
21-30	06	05	1	19.3%
31-40	07	06	1	22.5%
41-50	08	06	2	25.8%
51-60	05	04	1	16.1%
61-70	01	01	0	3.2%

ORGAN INJURIES

The organs injured [8] were as follows:

Table 2: Distribution of Organ Injuries

Organ	No. of Patients	Percentage
Liver	13	41.9%
Spleen	17	54.8%
Kidneys	03	9.6%
Bowel & Mesentery	05	16.1%
Pancreas	02	6.4%
Urinary Bladder	01	3.2%
Diaphragm	01	3.2%

Note - the number of organs injured is more because some patients showed multi-organ injuries.

Table 3:

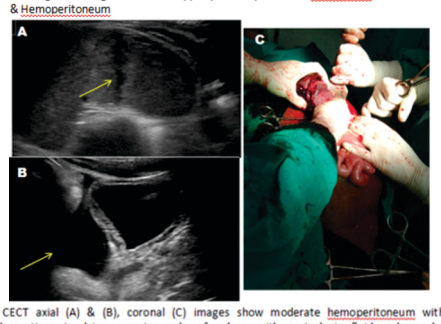
Organ	False Negative	True Positive
Liver	5	7
Spleen	3	14
Kidneys	2	1
Bowel & Mesentery	4	1
Pancreas	1	1
Urinary Bladder & associated pelvic fractures	5	1

Note: Result on ultrasound

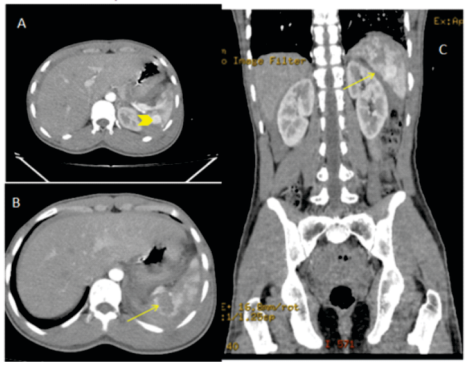
SPLEEN:

Of the 17 splenic injuries, grade III injuries were seen in 5 patients. Two patients had grade I and one patient had a grade II injury. Five patients had grade IV injury. The calculated sensitivity, specificity, and accuracy of US detection of splenic injuries was 58%, 100%, and 64% respectively. One case was excluded from the calculation as overlying subcutaneous emphysema prevented ultrasound evaluation.

US images showing laceration of upper pole of spleen with perisplenic collection & Hemoperitoneum



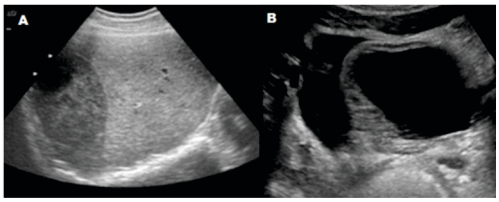
CECT axial (A) & (B), coronal (C) images show moderate hemoperitoneum with lacerations involving superior pole of spleen with perisplenic fluid ,subcapsular hematoma,pseudoaneurysm(arrow head) and areas of devascularisation (Gr-IV AAST SPLEEN INJURY scale)



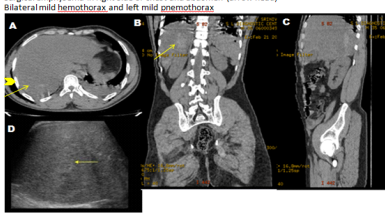
LIVER:

Of the 13 cases of liver injuries, 8 had grade III, remaining were grade I&II injuries. The calculated sensitivity, specificity and accuracy of US in the detection of hepatic injuries was 83%, 100%, and 84% respectively.

US images in a case of blunt abdominal trauma showing sub-capsular hematoma in right lobe of liver with hemoperitoneum



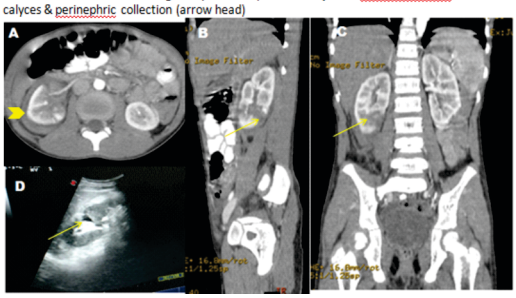
NCCT axial (A), coronal(B),saggital (C) & US(D) images show Hepatic contusions with laceration involving segments VI&VII of liver with adjacent perihepatic fluid
Mild hemoperitoneum.
Surgical emphysema in right side of chest and abdomen (arrow head)
Bilateral mild hemothorax and left mild pnemothorax



KIDNEYS:

There were Three Renal injuries. There was two grade I injuries & One patient had grade IV injury was referred to a higher center. The sensitivity, specificity, and accuracy of US detection of kidney injuries was 33.3%, 100%, and 60% respectively. All patients had associated with other organ injuries.

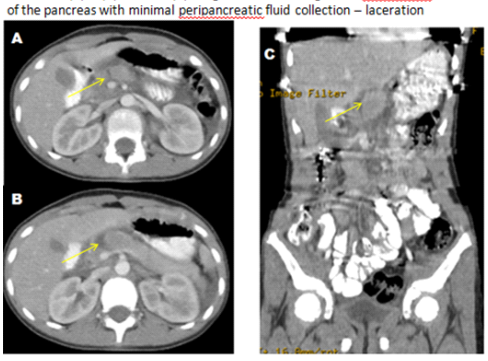
CECT axial (A), coronal(B),saggital (C) & US(D) images reveal non enhancing hypodense area of 17X16mm with cortical irregularity in lower pole with adjacent nonopacification of the calyces & perinephric collection (arrow head)



PANCREAS:

Two patients had a pancreatic injury. The pancreas could not be evaluated on US in either of the cases because of bowel gas. In both the cases, the only hemoperitoneum was detected on US and pancreatic laceration was detected on CE CT.

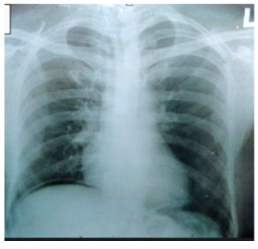
CECT axial (A) & (B), coronal (C) images Non enhancing linear hypodensity in neck of the pancreas with minimal peripancreatic fluid collection – laceration



BOWELAND MESENTERY:

Of the total 5 patients, four patients had only bowel injury and one patient had isolated mesenteric injury. Pneumoperitoneum was present in 3 out of 5 cases of bowel injury. The sensitivity, specificity, and accuracy of US were 20%, 100%, 42.8%, and CT was positive in all patients and showed an overall sensitivity, specificity, and accuracy of 100% respectively.

Plain Radiograph showing air under the both domes of diaphragm (Pneumoperitoneum) in a case of terminal ileal perforation(intra op finding),in a c/o RTA



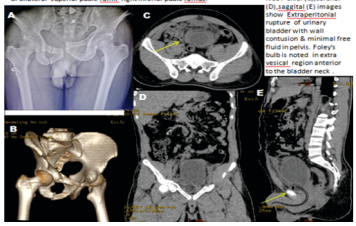
PELVIC FRACTURES AND RETROPERITONEAL HEMATOMA
Six patients had pelvic fractures, One of them had an associated retroperitoneal hematoma on CT.

BLADDER:

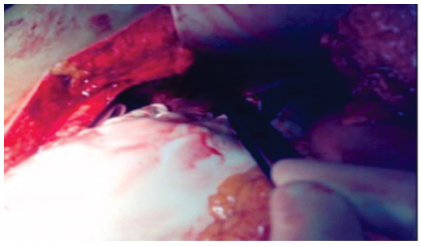
Extraperitoneal bladder injury was detected in one patient with an associated pelvic fracture.

Plain X-ray (A),(B), volume rendered CT images show Fracture of bilateral superior pubic ramii, right inferior pubic ramus.

NCCT axial (C),coronal (D),saggital (E) images show Extraperitonial rupture of urinary bladder with wall contusion & minimal free fluid in pelvis. Foley's bulb is noted in extra vesical region anterior to the bladder neck



DIAPHRAGM:
One patient had a diaphragmatic injury. Diaphragm could not be evaluated on US in those case because of bowel gas. Hemoperitoneum was detected on both US and CT and it was surgically confirmed&managed.



Intra-operative picture with foreceps pointing towards the diaphragmatic rent

PNEUMOPERITONEUM:
Pneumoperitoneum was detected in 3 patients. Two patients showed the presence of air under the diaphragm in the plain erect abdominal radiograph. The sensitivity, specificity, and accuracy of X-Ray were 33.3%, 100%, 60%. All the patients had associated with other organ injuries.

Out of the total 31 patients, in 14 patients US and CT showed similar findings. In 15 patients CT detected additional finding or provided additional information but did not change the management. In 4 patients CT was decisive for the management or surgical planning. However, in all of the US showed the presence of free fluid.

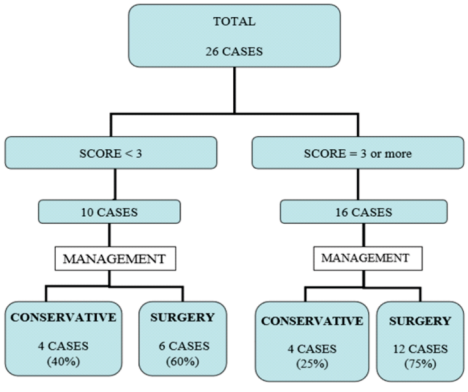
In 30 patients US showed either intra-abdominal free fluid or organ injury or both. In one patient US did not reveal any abnormality. The liver injury was later detected on CT. US had an overall sensitivity of 96%, the specificity of 100% and an accuracy of 96%.

CT was positive (either for intra-abdominal free fluid or organ injury or both) in all the patients and thus showed an overall sensitivity, specificity, and accuracy of 100%.

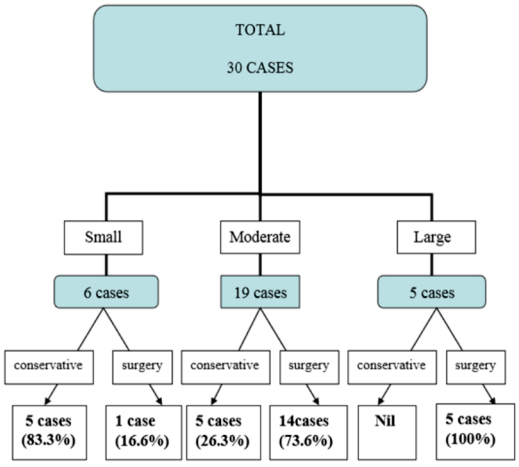
CT showed a distinct advantage in patients with overlying subcutaneous emphysema which prevented normal visualization of underlying structures on US. CT was useful in detecting associated injuries such as hemothorax- (16%), pneumothorax- (3.2%), lung contusions- (3.2%), rib fractures - (25.8%), vertebral fractures- (3.2%), and pelvic fractures- (19.3%) thereby providing additional information in guiding the initial mode of management of such patients.

Of the total of 31 patients, 20 underwent laparotomy (64.5%). Of these, two patients (6.4%) had a non-therapeutic laparotomy. Eleven patients (35.4%) were conservatively managed without any complications. There were no deaths either due to intra-operative, post-operative complications or associated injuries. CT detected additional findings or added information in 15 patients (48%) but did not change the therapeutic option as was felt necessary in the light of US findings. These 29 patients (14 plus 15) would have had adequate care based on US alone (93.5%). CT was decisive in management planning in four patients (12.9%) and US as a sole modality would have led to inappropriate management in this group.

FLOW CHART:1 Outcome of patients with hemoperitoneum on US



FLOW CHART:2 Outcome of patients with hemoperitoneum on CT



DISCUSSION
One of the commonest causes of health problems and death is trauma. The 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 a 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.

In most studies, the major mechanisms of injury are road traffic accidents (RTA), followed by fall34. In the present study, RTA accounted for 77.4% of injuries and 19.3% of patients sustained injuries due to fall from height. The prevalence of trauma was more in males (77%) as reported in earlier studies.[9]

In the present study, the most affected age group was between 16-45 years. In our study X-Ray showed an overall sensitivity, specificity, and accuracy of 33%,100%&60% respectively and CT accurately diagnosed all the three cases. The sensitivity of 33% in our study is similar to that found by Stapakis JC et al.[10] in detecting free air on an abdominal radiograph in comparison with CT.

Focused abdominal sonography for trauma (FAST) is a fast examination method that could demonstrate intraperitoneal fluid. Radwan et al.[7] (2006), evaluated the role of FAST and CT in BAT patients. They suggested that FAST is useful as an initial diagnostic tool to detect intra-abdominal fluid. In our study of a total of 31 patients, US showed good detection of free fluid in 26 patients.

The importance of CT in the diagnosis of abdominal trauma lies in its accuracy of identifying injuries that require early exploration and provides an assessment of the severity of the injury which helps to decide the management. The rate of negative laparotomy is reduced by avoiding surgical intervention in cases that can be managed conservatively.

US is sensitive and a widely available preliminary investigative modality, it is inferior in detecting retroperitoneal and bowel injuries and is operator dependent. The availability of CT is still limited, but it is diagnostically superior to US with its biggest advantage being the ability to assess the severity of trauma and providing a guide to further management. CT can also simultaneously assess other injuries related to trauma. Hemodynamic instability of the patient is a major deterrent for CT examination, although this forms an indication for operative intervention in patients with abdominal trauma.

Hemodynamic instability, disturbed level of consciousness and presence of other injuries in the skull, chest, pelvic bones or extremities, all explain the need for an accurate and rapid imaging tool to diagnose associated abdominal visceral injuries.

In this study spleen injuries were the most common injury detected on both USG and CT; hepatic trauma was also common and were the second most common injuries detected after spleen injuries on both USG and CT.

TABLE 4: Distribution of Injury according to organ

Sr. No.	Organ	Positive on Ultrasound	Positive on CT	Confirmed Cases
1	Liver	07	13	13
2	Spleen	14	17	17
3	Kidney	01	03	03
4	Pancreas	-	02	02
5	Bowel	01	05	05
6	Urinary Bladder	-	01	01
7	Retroperitoneal Haematoma	-	01	01
8	Diaphragm	-	01	01

SUMMARY AND CONCLUSIONS

- Plain X-Ray had a very limited role in the evaluation of blunt abdominal trauma and is of no practical value in detecting intraabdominal bleeding or organ injury. US is a valuable initial modality for the evaluation of patients with abdominal trauma.
- CT is required in most US positive patients to delineate the exact extent of the injury and to exclude any other significant injuries. Also, in a small but significant group, CT may change the management approach.
- Symptomatic patients should have a CT even if US examination is negative.
- Inadequate US evaluation in the presence of gaseous distension or overlying surgical emphysema should be followed by CT.
- US or CT quantification of hemoperitoneum or grading of injury does not always dictate whether the management should be conservative or surgical. However, they reflect the severity of injury and injuries of severe grade with large free fluid are more likely to require a laparotomy

REFERENCES:

1. Shiryazdi M, Modir A. Study of the diagnostic value of ultrasonography in blunt abdominal traumas. Pak J Med 2005; 44:3:130-32.
2. DeitchEiA. 'Commentary' on unnecessary laparotomies for trauma: a prospective study of morbidity. The yearbook of Surgery 1996. St. Louis: Mosby 1996; 106-107.
3. Wolfman NT, Bechtold RE et al. Blunt upper abdominal trauma: evaluation by CT. AJR1992 ; 158:493-501.
4. Kristensen JK, Buemann B, Kuhl E. Ultrasonic scanning in the diagnosis of splenic haematomas. Acta Chir Scand 1971; 137: 653- 57.
5. Rozycki GS, Abdominal US in trauma. Surg Clin North Am 1995; 75: 175-191.
6. Khsitish M, Sushma. Comparative evaluation of US and CT in the evaluation of abdominal trauma.Indian J Radiol Imag-2000;10;237-243.
7. Mohamed M Radwan, Fikri M Abu-Zidan: FAST and CT scanning in Blunt abdominal trauma.-Surgeons perspective. African Health sciences 2006(3): 187-190.
8. Moore EE, Cogbill TH,et al. Organ injury scaling. Surg Clin North Am 1995; 75: 293303.
9. ShiryazdiM, Modir A, et al. Study of the diagnostic value of US in blunt abdominal trauma. Pak J Med 2005;44:3:130-132.
10. Stapakis JC: Diagnosis of pneumoperitoneum: abdominal CT vs. upright chest film;1992 Sep;16(5):713-6.PMID:1522261