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Original Research Paper

Radiodiagnosis

USG AND MDCT CORRELATION IN ABDOMINAL TRAUMA(STUDY OF 100 PATIENTS)

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ABSTRACT The challenge in the imaging of abdominal trauma is to accurately identify injuries that require early exploration and at the same time avoid unnecessary operative intervention in cases that can be managed conservatively. A direct abdominal hit or run over accidents are more likely to cause serious internal damage. A number of investigations are available for trauma patients ranging from Plain X ray, USG, Doppler, CECT and MRI. While most of the centres have stopped relying on Plain Abdominal X ray as it is less informative and delays the treatment to the patient. Some centres directly proceed with CECT as CT is the most informative investigation and best investigation in trauma. However some centres advocate USG as primary investigation and decide further management on basis of combination of USG and clinical findings. This avoids unnecessary radiation exposure and increased cost of treatment for the patient. Our study which includes 100 patients with abdominal trauma aims to study the effectiveness of USG as a primary investigation in abdominal trauma.

KEYWORDS : Cect, Laceration, Hematoma , Liver, Kidney , Spleen, Peritoneum

I. INTRODUCTION

Abdominal trauma is one of the most common entities observed in surgical casualty and accounts for approximately 22 % of body region1 injured in major trauma and can be difficult to diagnose and manage. A high index of suspicion should be maintained for any multi-trauma patient as 25 % of all major trauma victims require abdominal exploration. Missed abdominal injuries are a major cause of avoidable death in trauma patient. There are various causes of abdominal trauma like Road traffic accident, assault, fall from height and stab injury. A number of investigations are available for trauma patients ranging from Plain X ray, USG, Doppler, CECT and MRI. Investigations such as the focused assessment of USG and CT scan can determine the presence of injuries in combination with assessment.

II. AIMS AND OBJECTIVES

1. Establish role of USG in screening of patients in abdominal trauma
2. To calculate sensitivity of USG in detection of various major organ injury as compared to MDCT.
3. To evaluate the role of USG in management of patients with abdominal trauma
4. To study various secondary findings on USG which suggest major abdominal organ injury.

III. MATERIALS & METHODS

This is a prospective, single-center, observational study. Our institute serves a primary population of approximately 5 million inhabitants. The Department of Imaging & Radiology provides a full range of services of diagnostic imaging to all the patients of hospital. The study extended from July 2015 to November 2017

We have included 100 patients who presented to Civil hospital, Ahmedabad with abdominal trauma and had clinical signs and symptoms of major organ injury.

Each patient was studied in detail with relevant to clinical history, examination and laboratory investigation. They all underwent ultrasonography as well as MDCT Abdomen.

INCLUSION CRITERIA

Patients All patients with history of blunt abdominal trauma who shows

1. Abnormal physical examinations.
2. Macroscopic hematuria.
3. Unconscious or altered consciousness with suspected abdominal injury.
4. Delayed symptoms like:

i. Progressive abdominal distention
ii. Delayed abdominal pain and tenderness
iii. Delayed hematuria.
iv. Deteriorating vitals.

EXCLUSION CRITERIA

1. Patients in shock.
2. Patients with spinal injuries were excluded from this study.
3. Contraindication for CECT imaging like hypersensitivity to contrast media, pregnant females and altered Renal function test

IMAGING METHODS

1. Ultrasonography was performed with Toshiba Xario ssa 660-A.
2. MDCT was performed with 128 slice CT machine of Siemens
3. Intravenous contrast agent was used in 99 patients. The contrast agent used was low osmolar non ionic iohexol. The concentration used was 350 mg I/ml. The dosage was 1.5 ml/kg. In a normally built adult man and woman, 70ml and 60 ml were used respectively. .
4. In suspected case of enteric perforation, oral contrast agent was used .

5. In suspected cases of urinary bladder or urethral injury, CT cystography was performed by retrograde filling of iodinated contrast with foleys catheter(after ruling out urethral injury) and subsequent CT scan was performed using 128 slice Siemens.

IMAGING TECHNIQUE

USG SCANNING PARAMETERS

All USG are done in supine position with lateral decubitus approach sometimes used for renal injuries. Two probes were used, Convex probe of frequency 3.5 MHz and Linear probe of 7.5 MHz.

MDCT SCANNING PARAMETERS.

POSITION: Supine
kV: 120
mAs:270-300 mAs with automatic tube current modulation
COLLIMATION: 1 mm
SCAN TIME: 1-3 sec for each sequence
MATRIX SIZE: 512x512
HELICAL PITCH: 53
GANTRY ROTATION TIME: 0.5 sec
SUPERIOR EXTENT: Above dome of diaphragm at the level of nipples
INFERIOR EXTENT: Lower border of symphysis pubis.
Triple phase CECT was done. First plain scan was obtained. Then after injection of 300-350 mg/ml of non ionic iodinated intravenous contrast administered by a pressure injector (Mydrad) at a rate of 3.5-4.0 ml/s. bolus racking method was noted and arterial and portal venous phases were obtained. 10 min delayed image was obtained for renal injury. If further indicated 2 hours and 8 hours delayed scan.

IV. RESULTS AND DISCUSSION

DISTRIBUTION OF MAJOR ORGAN INJURY:

Major organ	Number of cases	Detected on USG	% Detection Rate of USG
Liver	47	34	72%
Spleen	33	20	60%
Kidney	31	17	54%
Adrenal	15	2	7%
Pancreas	6	4	67%
Diaphragmatic injury	1	0	-
Enteric perforation	3	0	-
Mesenteric injury	1	0	-
Uterine injury	1	1	100%

Our study included 100 patients with abdominal trauma and high clinical suspicion for organ injury.In our study the most common age group with abdominal trauma was 21-30 comprising 32 patients followed by 11-20 comprising 29 patients. Most common mode of trauma in our study was road traffic accident(43%) followed by assault(22%). The most common organ to be injured in our study was liver comprising 47% of the injuries.

ASSOCIATED INJURIES:

Associated Injury	Number of cases
Lung Injury	16
Rib fractures	34
Vertebral Fractures	11
Pelvis fractures	7
Pleural effusion	35
Pnuemomediadstinum	3
Pnuemothorax	18
Pnuemoperitoneum	6

Pleural effusion was associated in 35% patients and Rib fractures were associated with 34% patients in our study. Vertebral fractures were seen in 11% of the patients. Pelvic fractures were seen in 7% of the patients.Free fluid in pleural cavity was seen in 35% of the patients in our study. 25 cases out of 33 cases of splenic injury showed presence of left sided pleural effusion. Sensitivity of left sided pleural effusion in diagnosing splenic injury was 80%.

LIVER INJURY:

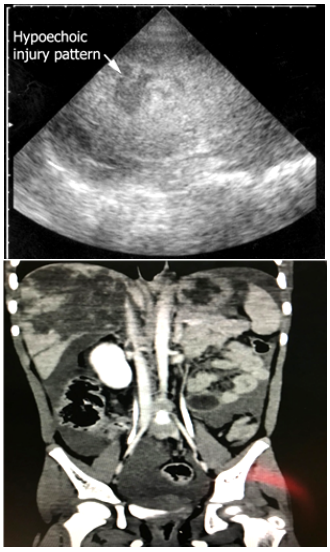

Figure 1 : USG showing altered area of echotexture involving right lobe of liver. ON CECT coronal reformatted images, thrombosis is seen in infrahepatic IVC. Moderate hemoperitoneum is noted.

Liver is the most common organ injured in abdominal trauma. Liver injury is graded on CT on the basis of AAST scale as follows-

Grade	Description
I	Hematoma: Subscapular, <10% surface area; laceration: capsular tear <1 cm in parenchymal depth
II	Hematoma: Subscapular, 10-50% surface area; intraparenchymal >10 cm; laceration: capsular tear 1-3 cm in parenchymal depth
III	Hematoma: Subscapular, >50% surface area; intraparenchymal >10 cm; laceration: capsular tear >3 cm in parenchymal depth
IV	Hematoma: Ruptured with active bleeding Laceration; parenchymal disruption involving 25-75% of liver parenchyma/>3 Couinaud segments
V	Laceration; parenchymal disruption involving >75% of liver parenchyma/>3 Couinaud segments in one lobe
VI	Vascular: hepatic avulsion

CT Imaging Findings of liver injury 2

- Contusion and Laceration- divided into superficial(<3 cm) and deep(>3 cm)
- Hematoma, Active bleeding
- Periportal low attenuation
- Flat IVC/IVC thrombosis
- USG findings
- Presence of free fluid in peritoneum
- Parenchymal injury as demonstrated as area of altered echotexture- which may be isoechoic, hypoechoic as well hyperechoic.
- Acute hematoma are usually isoechoic to liver parenchymal hence difficult to detect on USG. As time progress the hematoma/contusion becomes hypoechoic/hyperechoic.

- Subcapsular hematoma can be seen as anechoic perihepatic collection indenting surface of liver.
- Colour Doppler study helps to rule out vascular injury.

USG Sensitivity

Number of Liver injury cases detected on CT	Number of cases detected on USG	Number of cases where USG was suboptimal
47	32	3

Sensitivity of USG in detection of liver injuries
Number of cases detected on USG /
(Total cases detected on CT - Number of cases with suboptimal USG) X 100
= 34/(47-3) x 100
= 77.2%

Number of false negative USG-10. All of the cases were Grade II injuries.

Suboptimal USG included those in which visualisation of liver was obscured by subcutaneous emphysema.

Most common grade of injury was Grade III. Sensitivity of USG in diagnosing liver trauma was 77.2%. False negative in our study were Grade II injury. Sensitivity of USG in detecting Grade III and higher injuries was almost 100%.

SPLENIC INJURY:

Figure 2 : USG shows large ill defined hyperechoic area with increased through transmission in spleen

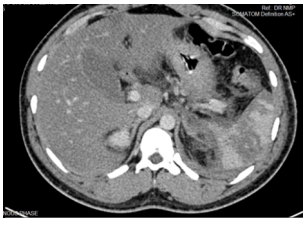

Figure 3 :Large renal contusion with laceration involving more than 75% of parenchyma.

CT features are graded on basis of AAST scale as described below[3]

Grade	Description
I	Hematoma: Subcapsular, <10% of surface area Laceration: Capsular tear, <1 cm in depth
II	Hematoma: Subcapsular, 10-50% of surface area, intraparenchymal <5 cm in diameter Laceration: Capsular tear, 1-3 cm in depth
III	Hematoma: Subcapsular, >50% of surface area, intraparenchymal >5 cm in diameter with/without active bleeding Laceration: Capsular tear, >3 cm in depth
IV	Laceration; laceration involves segmental or hilar vessels causing major devascularization (>25%)
V	Completely shattered spleen, Hilar vascular injury that devascularized spleen

CT Imaging Findings of splenic injury -
- Contusion and Laceration
- Subcapsular hematoma: Hematoma appears as low attenuation encircling spleen. Subcapsular hematoma causes indentation over spleen but perisplenic fluid does not indent splenic surface.3
- Traumatic psuedoaneurysm
- Vascular avulsion injuries
- USG findings-
- Perisplenic fluid collection
- Subcapsular hematoma indenting surface of spleen
- Altered area of echotexture involving splenic parenchyma, which may be iso-hyperechoic or hypoechoic depending upon time of injury
- Associated findings can be left side pleural effusion, left perinephric fluid.
- Doppler can be used to study flow characteristic and rule out devascularizing injury.

Spleen is the second most common organ injured in abdominal trauma.

Number of Splenic injury cases detected on CT	Number of cases detected on USG	Number of cases where USG was suboptimal
33	20	2

Sensitivity of USG in detection of splenic injuries
Number of cases detected on USG /
(Total cases detected on CT - Number of cases with suboptimal USG) X 100
= 20/(33-2) x 100
= 64.5%

Number of cases that were missed in USG-11(False Negatives)
- Grade I- 2
- Grade II- 6
- Grade III- 2
- Grade IV-1

Most common grade of injury was Grade IV. Sensitivity of USG in diagnosing splenic inuries was 64%. Combined sensitivity of USG appearances of splenic contusion and perisplenic fluid/hematoma was near 80%. However specificity of perisplenic fluid was low.

RENAL INJURY:

Figure 4 : USG showing moderate hydronephrosis with PUJ calculus and perinephric hematoma.

Figure 5 : CT coronal image showing Discontinuity in renal cortex with perinephric hematoma.

Renal injuries are commonly seen in abdominal trauma. CT has replaced intravenous urography as investigation of choice.Angiography is not routinely performed in trauma in diagnosis of renal trauma. USG can diagnose hemoperitoneum, but is not efficient in diagnosis of

parenchymal injuries.[4,5]

Grade	Description
I	Minor injury(renal contusion, intrarenal and subcapsular hematoma, minor laceration with limited perinephric hematoma without extension to the collection system or medulla, small subsegmental cortical infarct)
II	Major injury(major renal laceration through the cortex extending to the medulla or collecting system or without urine extravasation, segmental renal infarct.)
III	Catastrophic injury(multiple lacerations, vascular injury involving renal pedicle)
IV	Uteropelvic junction injury- complete transesction

CT findings-

- Contusion and hematoma
- Lacerations
- Active hemorrhage and urinary extravasations
- Renal pedical injury-Renal infarction

USG Findings-

- On USG, renal contusion will appear as area of altered echotexture- hypoechoic/hyperechoic
- Renal laceration appears as linear hypoechoic line reaching upto the capsular surface.
- Perinephric hematoma and perinephric fluid is seen in majority of patients with renal injury.
- Injuries involving vascular pedicle may completely or partially devascularize the kidney. This can be appreciated on Doppler study. However in some cases due to vasospasm, colour flow cannot be appreciated. This returns to normal after sometime.

Number of Kidney injury cases detected on CT	Number of cases detected on USG	Number of cases where USG was suboptimal
31	17	1

Sensitivity of USG in detection of renal injuries
Number of cases detected on USG/
(Total cases detected on CT-Number of cases with suboptimcal USG) X 100
= 17/(31-1) x 100
=53%

Number of cases that were missed in USG-10(False negative)

- Grade I- 5
- Grade II- 2
- GradeIII- 1
- Grade IV-1
- Grade V-1

Suboptimal USG included those in which visualisation of kidney was obscured by subcutaneous emphysema.

Another finding which was constantly seen in patients with kidney injury was perinephric fluid with echoes/hematoma. Number of cases in which perinephric fluid/hematoma was seen was 12.

Sensitivity of USG is low in detection of kidney injury. 50% of the cases that were missed in USG were grade I. However cases of grade IV as well V injury were missed on USG. But when combined with USG findings of perinephric fluid/hematoma, almost 26 cases had either perinephric fluid/hematoma or frank renal contusion or both. Hence combined sensitivity is 86%.

However there were 3 false positive cases in which USG factiously suggested contusion but CECT was normal. The contusion seen on USG was artifact.

Also perinephric fluid was seen in 4 cases of splenic contusion and 5 cases of liver contusion.

Kidney was the third most common organ injured in abdominal trauma. Most common grade of injury was Grade IV. Sensitivity of USG in diagnosing kidney trauma was 53%.

PANCREATIC INJURY:

Out of 6 cases of pancreatic injury, almost 5 patients had been diagnosed on USG, (3 patients had frank sonographic findings of pancreatic injury and two had secondary findings like peripancreatic fluid) accounting 83% overall sensitivity of USG in detection of pancreatic injury.

ENTERIC PERFORATION:

USG was not sensitive in diagnosing enteric perforation. Out of 3 cases, 2 had evidence of free fluid. Third was negative for free fluid in first USG. However repeat USG after six hours showed evidence of free fluid. Hence only sensitive finding in enteric perforation in USG was free fluid in peritoneal cavity. However free fluid is a very non specific finding for enteric perforation.

MESENTERIC INJURY, URETHRAL INJURY AND URINARY BLADDER INJURY:

There was one case each of mesenteric injury, posterior urethral rupture and intraperitoneal urinary bladder rupture. USG cannot diagnose accurately these injuries. In intraperitoneal urinary bladder rupture, foley's bulb was visualised outside bladder boundary. On retrograde filling and dynamic visualization a rent is demonstrated in superior wall of urinary bladder. Mesenteric injury on USG showed presence of free fluid. Posterior urethral rupture had presence of pelvic hematomas in USG.

Figure 6 : CT Abdomen Axial showing Focal Pneumo peritoneum and spillage of contrast in peritoneum, s/o jejunal perforation.

Out of 100 patients in our study, total 91 patients had free fluid in peritoneal cavity. There were total 93 patients with major organ, total 88 patients had free fluid in peritoneal cavity.

Hence sensititvity of free fluid in detection of major organ injury was

=88x100/93
=94.6%

Out of 7 patients witout any abdominal organ injury, three patients had free fluid in the abdomen. Hence Specificity was
=4x100/7
=57 %

Presence of free fluid in peritoneal cavity as an indicator of major organ injury showed high sensitivity(94%) but low specificity(57%). As compared to CT scan sensitivity of USG in detection of free fluid is nearly 100%.

USG can detect free fluid with high accuracy. As far as parenchymal injuries is concerned, its sensitivity is variable

ranging from 58% for renal injuries to 72% for liver injuries. For higher grade Injuries(Grade III and higher) its sensitivity is above 90%. And also Suboptimal USG included those in which visualization of liver spleen and kidneys were obscured by subcutaneous emphysema.

V. CONCLUSION

Hence all patients with abdominal trauma should be first evaluated with USG. Moreover in patients with renal failure and in hemodynamically unstable patients in whom CT scan is not feasible, surgeons may proceed with further management based on ultrasonography. USG negative for free fluid can be followed by follow up USG after six hours in institutions where CT scan is not readily available or in patients where it is contraindicated.

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