

## Radiological Investigations of Abdominal Trauma

### Introduction:

Trauma to abdominal organs is a common cause of patient morbidity and mortality among trauma patients.

Causes of abdominal trauma include blunt injuries, penetrating injuries, and blast injuries.

Multiple organ damage and vascular damage associated with chest injuries is a common feature of abdominal trauma. Solid organ damage (liver, kidney, spleen pancreas, Bowel, mesenteric, and vascular damage are common abdominal injuries).

Clinical manifestations of abdominal trauma are not organ specific. Hence precise assessment of the nature of injuries required for patient management is difficult or not possible with symptoms and signs alone.

Radiological investigations are time consuming. Time is spent on transporting the patient to the Radiology department, and for performing and interpretation of Radiological investigations.

Critically ill patients whose lives cannot be saved by surgery and resuscitation, will not be benefited by radiological investigations.

Critically ill patients who need emergency life saving unplanned laparotomy too cannot spare time for Radiological investigations.

## 2.2 Radiological investigations are required for;

- Planned surgery
- Surgery is decided after patient observation
- Monitoring patients who are under observation

## 2.3 Radiological Investigations useful in abdominal Trauma patients are

- Plain radiographs of chest and abdomen
- Ultra sound examinations (Sonography)
- Plain or contrast enhanced Computed Tomography
- Magnetic Resonance Imaging
- Water soluble contrast studies under Fluoroscopy
- Scintigraphy
- Angiography
- Interventional Procedures.

### 2.3.1 Plain Radiographs

Optimal Radiographic technique is important. Following Radiographs are required.

- Supine abdomen
- Erect Chest X-ray

- Lateral Chest X-ray with the right side of chest up (left lateral decubitus)

Findings of Plain Radiographs;

- A collection of gas in the centre of the abdomen
- Double wall sign of bowel loops
- Gas under the diaphragm as an arcuate grey/black band beneath the Right dome of the diaphragm in Erect CXR  
Above findings indicate perforation of bowel
- Associated rib fractures in CXR
- Associated diaphragmatic rupture seen as loss of diaphragmatic contour in CXR
- Associated haemothorax as a pleural effusion in CXR
- Metallic foreign bodies in the Abdomen
- Plain radiographic findings are non organ specific but useful in demonstrating fractures.

**False positives and negatives;** Because Plain Radiographs are performed on a traumatized patient, an optimal quality Radiograph is not always possible. Fractures and pneumoperitoneum may be missed.

### 2.3.2 Ultrasound Examination (Sonography)

Sonography is considered as an initial examination due to its immediate availability in most centers and its noninvasive and non-ionizing nature,

Sonography is particularly useful in patients whose clinical condition is too unstable to allow patient transport to a CT facility.

#### Findings

- **Free fluid** ; Presence of free fluid in the peritoneal cavity indicate hemorrhage, thus indicating the necessity for immediate surgery.
- **Pleural effusions** indicate haemothorax
- **Sub capsular haematomas** of the liver, spleen and kidney. Sub capsular haematomas appear as a curvilinear band beneath the capsule with varying echogenicity depending on the duration of trauma.
- **Parenchymal lacerations** and contusions of the liver, spleen and kidneys which appear as discrete echogenic, hypoechoic and cystic areas in the parenchyma varying with the duration of the injury.
- **Perinephric haematomas** appearing as an echogenic mass.

- **Evaluation of the vascular supply** of the organs and major vessels by application of color Doppler ultra sound
- **Diaphragmatic ruptures** appear as discontinuous line of echoes.
- **Bilomas** are seen as fairly well defined, anechoic (fluid filled) structures in close proximity to the liver and bile ducts.

#### **False positives and negatives;**

Examination is difficult in the presence of a large volume of free fluid, ileus, and with pain, hence diaphragmatic rupture may be missed.

Sonography may not directly depict injuries to bowel, mesentery, pancreas, diaphragm Adrenal gland and bone.

Ultra sound has a limited sensitivity in detecting many vascular injuries as well.

## 2.3.3 COMPUTED TOMOGRAPHY

CT is the main stay of diagnosis of abdominal injuries. Initial CT findings help in determining the type of treatment required. With the use of high speed spiral CT scans predicting the necessity of surgery, angiography or interventional radiological procedures are possible, in patients with abdominal trauma, before the deterioration of the patient's haemodynamic state.

CT has been proven extremely useful in helping make decisions on conservative management of patients and in reducing the laparotomy rates.

#### **CT without IV contrast**

CT without contrast is of limited value, but is useful in detecting the following;

- haemoperitoneum
- pneumoperitoneum

#### **Contrast enhanced CT**

Contrast enhanced CT is accurate in;

- Localizing the site of injury
- Assessing the extent of injury
- Detecting associated injuries.
- Monitoring healing

## **Findings**

- **Detection of subcapsular haematomas** of the liver, spleen and kidneys on non enhanced CT.  
Subcapsular haematomas appear as a low density(low attenuating) lenticular collection of fluid between the liver and relatively high density liver parenchyma. On contrast enhanced CT, appearance of the haematoma is more pronounced with the contrast enhanced liver parenchyma.
- **Detection of intra parenchymal haematomas** of the liver, spleen , and kidneys.  
Acute haematomas appear as irregular high attenuating areas which represent clotted blood. Density/ attenuation of the haematoma decreases with time due to gradual resolution of the haematoma.
- **Detection of lacerations** of the liver, spleen and kidneys  
Lacerations appear as high density linear structures during the acute period.
- **Detection of vascular injuries.**  
CT detects devascularized areas of solid abdominal organs, pseudoaneurysms , Injuries to Inferior vena cava and Aorta

- **Gall bladder and related injuries** are readily detected by CT.  
CT findings in gall bladder injuries include ,irregular collapsed GB, pericholic fluid, intra luminal blood, biloma formation and biliary peritonitis,
- **CT findings in bowel Trauma**  
Bowel injury is suggested by free intra peritoneal air, free intra peritoneal or retroperitoneal fluid, focal areas of bowel wall thickening, abnormal bowel wall enhancement,and haematoma formation.The most specific finding in CT is the extravasation of oral contrast with bowel wall disruption.  
Identification of ischemic bowel or mesenteric haematoma in CT suggests mesentric vascular injury or injury to Coeliac axis, Superior mesenteric artery and vein.
- **Detection of Pnumoperitoneum**  
CT is sensitive in detecting, even a small amount of free intraperitoneal air when plain radiographic findings are non specific.
- **Detection of haemoperitoneum**  
CT is sensitive in detecting small amounts of free intra peritoneal blood which may be missed by Ultra sound.

**False positives and negatives**

False positive and negative errors can occur due to technical artifacts, nasogastric tubes, fatty liver, patient movement and between the extravasated oral contrast in the peritoneal cavity and haemoperitoneum.

**2.3.4 MAGNETIC RESONANCE IMAGING - MRI**

Offers no significant advantage over Computed Tomography in the evaluation of routine abdominal trauma.

Magnetic Resonance Imaging has a limited role in the evaluation of abdominal trauma.

It has no advantage over CT. Theoretically MRI can be used for following;

- Follow up of monitoring patients
- For young and pregnant patients with abdominal trauma in whom the radiation dose is of concern.
- MRCP (Magnetic Resonance Cholangiopancreatography) is used in the assessment of biliary and pancreatic duct trauma and their sequelae.
- Another potential use of MRI is in patients with renal failure and in patients with contrast allergy.

**2.3.5 RADIONUCLIDE IMAGING (NUCLEAR MEDICINE )**

<sup>99m</sup>Tc sulfur colloid or <sup>99m</sup>Tc labelled denatured red cell studies were, widely used in the evaluation of blunt abdominal trauma, particularly in hepatic and splenic trauma.

Limitations of radionuclide scanning are,

- non specific findings,
- inability to evaluate other intra and retroperitoneal organs.

However despite its disadvantages;

- <sup>99m</sup>Tc sulfur colloid scanning is used for noninvasive monitoring of patients with documented evidence of hepatic and splenic trauma
- Labeled RBC can be used to detect the site of active bleeding sites in intra and retroperitoneal haemorrhage.
- <sup>99m</sup>Tc IDA scanning for detection of biliary trauma. Bile leaks and bilomas are demonstrated. This study is performed as adynamic study.

### 2.3.6 ANGIOGRAPHY

Angiography is indicated for stable patients who need the demonstration of the active bleeding site before conservative or therapeutic management by Trans catheter embolization.

#### **Angiography demonstrates;**

- Distortion of vessels in the affected organ
- Accumulation of contrast in the parenchyma of the injured organ
- Vascular (Arterial) occlusions
- Extravasation of contrast
- Arterovenous fistulae
- Psedoanurysms

### 2.3.7 INTERVENTIONAL

#### **RADIOLOGICAL PROCEDURES**

Interventional radiological procedures are performed as therapeutic embolization of active bleeding sites to arrest bleeding.

### 2.3.8 FUOROSCOPIC CONTRAST

#### **STUDIES**

- Water soluble contrast given orally or by Nasogastric tube.
- Contrast studies detects contrast leaks at bowel perforation sites
- Useful when CT findings are inconclusive

## 2.4 Clinical Manifestation of Abdominal trauma

### Variant: Renal trauma and associated injuries

Radiological Procedure	Recommendation	Rating	Comment
X-Ray Abdomen Supine Chest X-Ray Erect	Least appropriate	Y	
CT with Contrast	Most appropriate	X	
CT without Contrast	appropriate	Z	Limited information
Sonography	Initial /preliminary	X	
Contrast Studies	Complimentary or special		
MRI	Least appropriate	Z	
Radionuclide scanning	Complimentary /special	E	
Interventional & Angiography	Complimentary or special		

### Variant: Mesenteric and vascular trauma and associated injuries

Radiological Procedure	Recommendation	Rating	Comment
X-Ray Abdomen Supine Chest X-Ray Erect	Least appropriate	Y	
CT with Contrast	Most appropriate	X	
CT without Contrast	appropriate	Z	Limited information
Sonography	Initial /preliminary	X	
Contrast Studies	Complimentary or special		
MRI	Appropriate	Y	
Radionuclide scanning	Complimentary /special		
Interventional & Angiography	Special		

**Variant: Haemoperitoneum**

Radiological Procedure	Recommendation	Rating	Comment
X-Ray Abdomen Supine Chest X-Ray Erect	Least appropriate	Y	
CT with Contrast	Most appropriate	X	
CT without Contrast	Appropriate	X	
Sonography	Initial/ preliminary	X	
Contrast Studies	Complimentary/S pecial		
MRI	Rarely indicated	Z	
Radionuclide scanning	Least appropriate		
Interventional & Angiography	Complimentary/S pecial		

**Variant: Splenic or Hepatic trauma and associated injuries**

Radiological Procedure	Recommendation	Rating	Comment
X-Ray Abdomen Supine Chest X-Ray Erect	Least appropriate	Y	
CT with Contrast	Most appropriate	X	
CT without Contrast	appropriate	Y	Limited information
Sonography	Initial / preliminary	X	
Contrast Studies	Complimentary or special		
MRI	Least appropriate	Z	
Radionuclide scanning	Complimentary / special		
Interventional & Angiography	Complimentary or special		



**Variant: Pancreatic and associated injuries**

Radiological Procedure	Recommendation	Rating	Comment
X-Ray Abdomen Supine Chest X-Ray Erect	Least appropriate	Y	
CT with Contrast	Most appropriate	X	
CT without Contrast	appropriate	Z	Limited information
Sonography	Initial / preliminary	X	
Contrast Studies	Complimentary or special		
MRI	Appropriate	Y	
Radionuclide scanning	Complimentary / special		
Interventional & Angiography	Complimentary or special		

**Variant: Hepatobiliary and associated injuries**

Radiological Procedure	Recommendation	Rating	Comment
X-Ray Abdomen Supine Chest X-Ray Erect	Least appropriate	Y	Low yield
CT with Contrast	Most appropriate	X	
CT without Contrast	Appropriate	Y	
Sonography	Preliminary / initial	X	
Contrast Studies	Complimentary or Special		
MRI	Complimentary or Special		
Radionuclide scanning	Complimentary Or Special		
Interventional & Angiography	Complimentary or Special		

## 2.5 Reference

- **NHS Radiology Guideline 2001**
- **National Guideline Clearing House - [www.gudeline.com](http://www.gudeline.com)**
- **Imaging Department Protocols – University Hospital Birmingham**
- **[http : // www.emedicine. Com/ radio/ topic 397.htm](http://www.emedicine.com/radio/topic397.htm)**