Invited article

Selecting the Best Imaging Investigation for Your Patient with Abdominal Pain

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Imaging investigations have come to the forefront in present day patient management. Abdominal pain is a chief complaint in clinical practice. Differential diagnosis of "abdominal pain" includes a broad spectrum of clinical entities that range from benign self-limiting conditions to illnesses associated with high morbidity and mortality. It is often difficult on the basis of history, physical examination and biochemical investigations alone to separate the patients those who require urgent intervention or surgery. Increased availability and use of imaging investigations have dramatically changed the management and outcome of the patients presenting with "abdominal pain".

In United States, of all patients who present to the emergency department with abdominal pain, about one-third never have a diagnosis established, one-third have appendicitis, and one-third have some other definitive pathology. In this "other" category, the most common causes include acute cholecystitis, small bowel obstruction, pancreatitis, renal colic, perforated peptic ulcer, cancer, and diverticulitis (1,2,3,4).

If fever is also present, the need for quick, definitive diagnosis is considerably important. With the history and the clinical examination the problem has to be narrowed down before embarking in to the imaging investigations as to decide the most appropriate. In our setup availability and accessibility will influence the selection of the Imaging Investigation.

ACUTE ABDOMINAL PAIN WITH FEVER

The range of pathology that can produce abdominal pain with fever is very broad. It includes appendicitis, pneumonia, hepatobiliary disease, pancreatitis with or without complications, pyelonephritis, gastrointestinal perforation or inflammation, bowel obstruction or infarction, intra abdominal pus collections, abscesses, pelvic inflammatory disease, some of the tumors etc.

In general, computed tomography (CT) is the most important modality of evaluating patients with abdominal pain with fever. The use of contrast agents greatly increases the spectrum of detectable pathology. However the allergic history and the state of renal function are important factors to consider.

Some authors have found that CT is superior to clinical evaluation for finding the cause of abdominal pain and the use of CT in patients with acute abdominal pain increases the emergency department clinician's level of certainty and reduces hospital admissions by about 24% (4,5,6).

Plain radiographs may provide useful information about bowel gas pattern or free air, but they offer no additional information if CT is to be performed. In gut perforation, while radiographs are sensitive to small volumes of free air, CT is more sensitive to even smaller volumes and can detect additional loculated air or air in the mesenteric root (6,7).

Ultrasonography (US) may be useful in

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selected conditions, like cholecystitis, cholangitis, liver abscess, appendicitis and US may be able to detect abscess or malignancy (such as lymphoma). The diagnostic yield in US is poor in the presence of increased bowel gas or free air. The shortcomings of US are partially offset by its lack of ionizing radiation, particularly in younger patients and in women of child bearing age.

Magnetic resonance imaging (MRI) offers imaging without ionizing radiation and has been shown to provide clinically useful information. The draw backs are the time taken for imaging and lack of free availability in our setup.

ACUTE PANCREATITIS

Imaging is done for various reasons in patients with pancreatitis; to detect the cause, for detection and classification of the severity of the process and to see its complications.

CT is the only imaging study that has consistently shown clinical value in predicting not only the severity but clinical outcomes as well. The CT severity index, as described by Balthazar in conjunction with clinical scoring systems is one basis for patient decision-making. The decision of when to perform CT depends on the overall clinical presentation and should be based on clinical assessment (1,8).

US is often performed in the evaluation of patients with acute pancreatitis since it has a high sensitivity in detecting gallstones. However, patients may not have gallstones but another etiology for their pancreatitis.

The use of MRI in evaluating patients with acute pancreatitis is gaining acceptance. It offers several advantages, especially with heavily T2-weighted sequences for assessing biliary and pancreatic ducts in its entirety, and duct disruption can often be assessed easily, compared to other noninvasive imaging modalities.

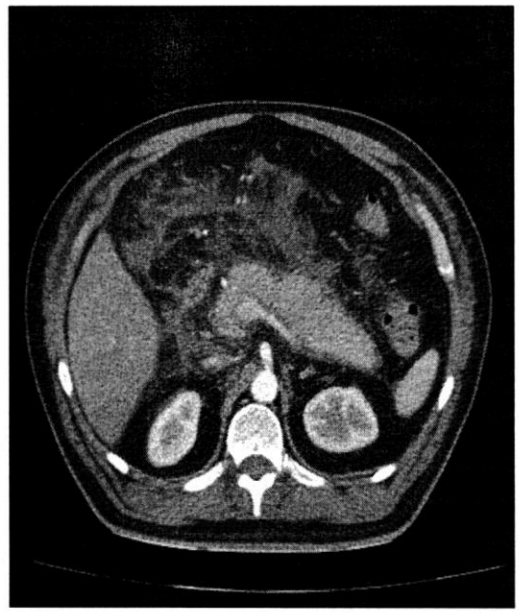

Figure 1: Axial CT scan with intravenous contrast show oedematous pancreas, indistinct pancreatic margins and surrounding retroperitoneal fat stranding, suggestive of acute pancreatitis.

Situation where IV contrast can be administered, it can be very helpful in assessing the presence of necrosis (6,9,10).

The disadvantages of MRI are; it is often not readily available in an acute setting and the acquisition times are considerably longer than with CT.

In acute pancreatitis situation following are to be remembered:

In the acute setting, imaging should be performed only if clinically indicated.

- Initial imaging with CT may underestimate the severity of the disease.
- CT with IV contrast gives best overall assessment of the pancreas and complications related to pancreatitis.

- US is primarily used to assess gall stones.
- MRI with IV contrast and MRCP have the potential to be an all-inclusive examination for assessing pancreatitis.

ABDOMINAL PAIN WITH JAUNDICE

The most common causes of obstructive jaundice are neoplasms of the pancreas, ampulla of Vater or biliary tract, choledocholithiasis, pancreatitis, and iatrogenic strictures of the biliary tree.

The methods used in evaluating the jaundiced patient today include US, CT, magnetic resonance cholangio-pancreatography (MRCP), percutaneous transhepatic cholangiography (PTC), and endoscopic retrograde cholangiopancreatography (ERCP). These are effective to varying degrees in assessing both the cause and the site of obstruction; ERCP can also be therapeutic as well.

US is the least invasive and cheapest imaging technique available for evaluating obstructive jaundice. US determine the presence of obstructive jaundice by detecting dilated bile ducts. Inability to see the extrahepatic biliary tree (often because of interposed bowel gas) and the absence of biliary dilation in the presence of obstruction are drawbacks. US is less effective than CT or direct cholangiography (either PTC or ERCP) in determining the site and the cause of obstruction.

CT is more sensitive and specific than US in detecting biliary obstruction. In addition, the ability to determine the site and the cause of obstruction is greater with CT than with US. CT is strongly recommended as the primary modality for evaluating patients with suspected malignant biliary obstruction, both for diagnosis and for staging (3,6).

MRI can demonstrate both site and the cause of biliary obstruction. MR cholangiography has been shown to be useful in depicting the three-dimensional (3D) anatomy of the biliary and pancreatic ducts. For detection of ductal calculi, MRCP is the most sensitive of all noninvasive techniques.

LIKELIHOOD OF BENIGN BILIARY OBSTRUCTION

Patients in this category present with jaundice and acute abdominal pain. There may be a prior history of gallstones documented by sonography or of prior biliary surgery. Sonography is an accurate and the least expensive method for detecting dilated intrahepatic bile ducts and common hepatic duct at the hepatic hilum. Biliary ductal calculi are not detected with the same sensitivity as gallbladder calculi. The sub hepatic common duct may or may not be visible due to overlaying bowel gas. In addition, intrahepatic bile ducts may not be dilated in the early phase of acute obstruction or in patients with partial obstruction. Despite recognized limitations, sonography is recommended as the initial diagnostic test in patients with suspected calculus obstruction of the common duct.

LIKELIHOOD OF MALIGNANT BILIARY OBSTRUCTION

Patients in this category typically present with insidious development of jaundice and associated constitutional symptoms (weight loss, fatigue, etc). Mechanical biliary obstruction can be confirmed by sonography. Malignant obstruction is most commonly due to pancreatic carcinoma but may be secondary to cholangiocarcinoma

of either proximal or distal duct or to periductal nodal compression. A contrast-enhanced CT examination with multiplanar reformation has high sensitivity in lesion detection and in discriminating resectable and unresectable tumour including important information in tumor staging, tumor contiguity or invasion of the superior mesenteric and portal vein, peripancreatic tumor extension, regional adenopathy and hepatic metastases (6,8).

MRI and MRCP are also accurate in tumor detection and staging.

CT is generally more available and more frequently used, while MRI/MRCP reserved for patients with contraindications to CT.

In summary, the diagnostic approach for adults presenting with jaundice depends to a large extent on whether

a) the jaundice is obstructive or non obstructive;
b) the most likely cause, benign or malignant;
c) the patient is an operative candidate, once the diagnosis is made.
d) Lastly, the availability of each modality and the expertise with which it is offered.

RIGHT LOWER QUADRANT PAIN – SUSPECTED APPENDICITIS

Both CT and US may be effective in detecting suspected appendicitis and alternative etiologies of right lower quadrant abdominal pain.

CT is the most accurate study for evaluating patients without a clear clinical diagnosis of acute appendicitis.

The use of CT to evaluate appendicitis has shown to decrease overall cost and has decrease the negative appendectomy rate (3,10).

Several factors are unique in children, including increased radiosensitivity to ionizing radiation and smaller body size and less body fat, favoring initial use of US.

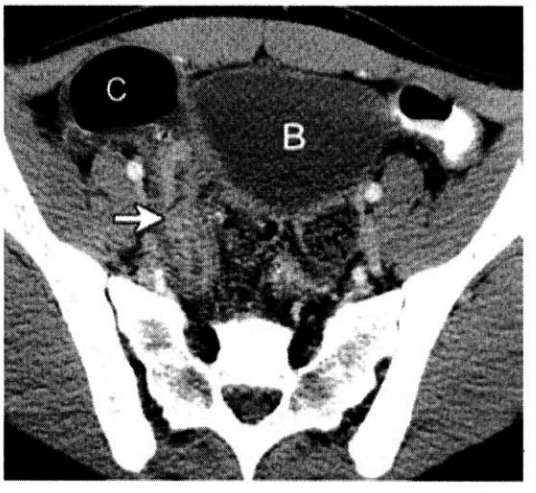

Figure 2: Axial CT images of a patient clinically suspected of having acute appendicitis. CT scan obtained after intravenous and rectal contrast material administration shows appendicitis: a distended appendix with thickened wall (arrow) and surrounding infiltration. B-bladder, C-.cecum. Appendicitis was confirmed at surgery and histopathologic analysis (6).

RIGHT UPPER QUADRANT PAIN

US is the usual initial imaging investigation of choice for patients with right upper quadrant pain, suspected acute cholecystitis (AC), for variety of reasons-availability, lack of ionizing radiation, morphologic evaluation, confirmation of the presence or absence of gallstones, evaluation of intrahepatic and extrahepatic bile ducts, and identification or exclusion of alternative diagnoses. Complications of AC include gangrene, empyema and perforation can also be evaluated with US (1,4). Other clinical conditions that can simulate AC can present with acute right upper quadrant pain are chronic cholecystitis, peptic ulcer disease,

pancreatitis, gastroenteritis, bowel obstruction and many others.

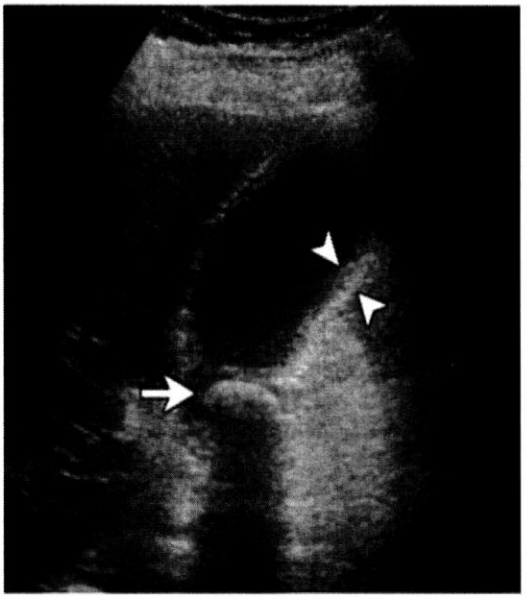

Figure 3: US image of a patient with 4 day history of right upper quadrant pain, nausea, and vomiting shows a thickened gallbladder wall (arrowheads) and an obstructing gallstone (arrow) (6).

If US is negative for AC and an alternative diagnosis is not identified, CT is the next preferred imaging examination for the identification of these disorders. Although not advocated as a primary imaging examination for acute right upper quadrant pain, in equivocal cases on US, CT can confirm or refute the diagnosis of AC and demonstrates complications of AC, including gangrene, gas formation, and perforation (8).

ACUTE ONSET FLANK PAIN – SUSPICIOUS OF RENAL STONE DISEASE

In renal calculus disease, treating physician wants to know the size of the calculus, location and its effect on renal function.

Patients with suspected diagnosis of renal colic have traditionally been evaluated with urinalysis, abdominal radiography of the kidney- ureter - bladder (X-ray KUB), or intravenous urography (IVU). More recently, US, and CT have been used.

Radiography of the abdomen may be sufficient to diagnose urolithiasis in patients with known stone disease. The sensitivity of the X-ray KUB for diagnosing urolithiasis in other patients is poor.

Since the introduction of the use of helical (spiral) Non Contrast CT (NCCT) it is confirmed to be the study with the highest sensitivity and specificity for urolithiasis. Virtually all stones are radio-opaque, and stone size can be measured accurately in cross-section, aiding in predicting outcome. Stone location, accurately depicted by NCCT, has also been associated with spontaneous stone passage rates, with the more proximal stones having a higher need for intervention (11,12).

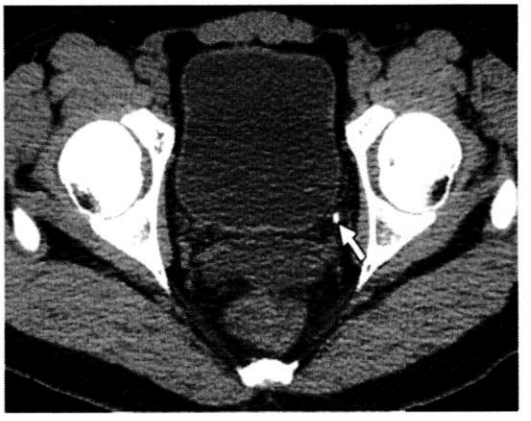

Figure 4: Ureteric stone in a patient who presented with acute left flank pain. Axial unenhanced CT scan shows a 4mm stone in the left distal ureter (arrow) (11).

Secondary signs such as ureteral dilatation and perinephric stranding allow CT to make the diagnosis of recent passage stone. NCCT is rapid and safer than IVU since it uses no contrast media.

If there is uncertainty about whether a calcific density represents a ureteral calculus or a phlebolith at NCCT, intravenous contrast can be administered and excretory phase images obtained for definitive diagnosis.

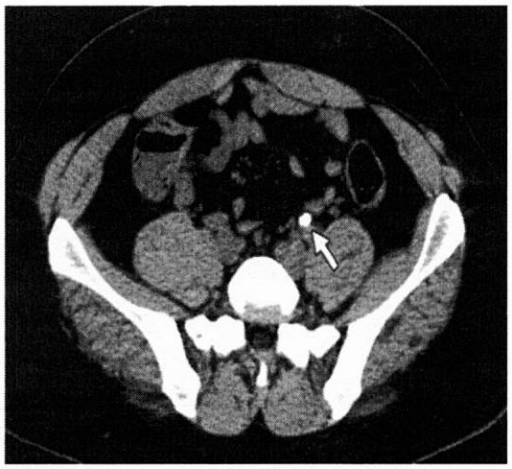

Figure 5: Axial CT scan without intravenous contrast shows a calculus in the left mid ureter (arrow).

US is a safe, noninvasive imaging modality that can be used to study the urinary tract effectively. The diagnosis of obstructive urinary tract calculi depends on identification of the offending calculus and concomitant pelvicaliectasis and ureterectasis extending to the obstructing site. Because it may take many hours for hydronephrosis and hydroureter to develop, US will miss some of the acute obstructions caused by a ureteral stone in patients who are not specifically hydrated for the study.

US has been found to be very sensitive for signs of obstruction (hydronephrosis, ureteral dilatation). However, the sensitivity of US as compared to NCCT for detecting renal calculi is quite low, and is especially poor for small stones (6).

US can also evaluate the presence and type of ureteral jet.

LEFT LOWER QUADRANT PAIN

Appropriate imaging for patients with suspected diverticulitis (i.e., left lower quadrant pain) should address two major clinical questions:

1) what are the differential diagnostic possibilities in this clinical situation
2) what information is necessary to make a definitive management decision.

Some patients with acute diverticulitis may not require any imaging, notably those with typical symptoms of diverticulitis (e.g., left lower quadrant pain and tenderness, fever) or those who are diagnosed history of diverticulitis who present with clinical symptoms of recurrent disease. Some patients with diverticulitis require surgery because of associated abscesses, fistulas, obstruction, or perforation. As a result, there has been a trend toward greater use of radiologic imaging tests to confirm the diagnosis of diverticulitis, evaluate the extent of disease, and detect complications before treatment (6,10).

CT is now widely advocated as the imaging test of choice for evaluating patients with suspected sigmoid diverticulitis because of its high sensitivity and specificity and its ability to diagnose other causes of left lower quadrant pain that mimic diverticulitis (eg, genitourinary and gynecologic abnormalities) that have a similar clinical presentation.

CT also has a major role in determining disease extent; this assessment is rarely possible with contrast enema.

A variety of contrast media have been used for CT to optimize the sensitivity and specificity of the examination, including oral, rectal and intravenous contrast agents.

Transabdominal US has limited use.

Transvaginal US is particularly of value when left lower quadrant pain occurring in women of childbearing age. In this setting, gynecologic problems such as ectopic pregnancy and pelvic inflammatory disease are also important diagnostic considerations. US is therefore an excellent choice for the initial imaging of these patients, because it is more sensitive in detecting gynecologic abnormalities that cause left lower quadrant pain (6).

SUSPECTED SMALL BOWEL OBSTRUCTION

There is no single generally accepted approach for evaluating patients with suspected small-bowel obstruction (SBO). Radiography has been the traditional starting point for imaging evaluation of suspected SBO.

In such a setting, gastrointestinal contrast studies (small-bowel follow-through [SBFT], enteroclysis, and barium enema) are controversial due to problems like intravascular volume depletion, electrolyte imbalance, barium impaction etc (13).

CT is useful in suspected high-grade SBO in identifying the cause of obstruction. Patients with suspected high-grade obstruction may not require any oral contrast medium since the fluid in the bowel provides adequate contrast. Low-grade obstruction is a relative "blind spot" for standard CT (7).

CT is very useful for detecting complications of bowel obstruction such as ischemia and strangulation. CT has been useful in effectively triaging patients into operative versus non operative treatment groups. In the pediatric age group, US have proven benefit in evaluating intussusceptions, midgut volvulus and other causes of SBO.

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