4 What Imaging Strategies Are Effective for Rapid and Accurate Diagnosis of Abdominal Pain Etiologies?

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Pearls and Pitfalls

- Specific imaging often is necessary to supplement a patient's physical exam findings to identify the cause of pain.
- Inappropriate imaging can cause a delay in appropriate interventions.
- Bedside ultrasound has become a rapid diagnostic modality that can be utilized at bedside by trained emergency providers.

Abdominal pain is a common complaint for patients who present in the emergency department (ED) [1–4]. Non-traumatic abdominal pain can be a symptom of a serious disease and should be approached in a systematic manner. Significant advances in technology and diagnostic studies in the acute care setting are now available, and it is important to have a clear understanding of which imaging modality will expedite patients' care and help establish an accurate diagnosis [4, 5].

General Imaging Approach

Though abdominal radiographs were once a mainstay for evaluation of acute abdominal pain, recently they have been displaced by computed tomography (CT) and ultrasound [6]. Several studies have shown that overall, CT imaging leads to the highest diagnostic accuracy (sensitivity 89% compared to ultrasound at 70%) [7]. However, ultrasound can also be a useful diagnostic tool in the acute care setting. In fact, a study from the *British Medical Journal* demonstrated that ultrasound followed by CT imaging in only those with negative or inconclusive ultrasound studies was an effective approach to distinguish urgent from nonurgent causes of abdominal pain. In this study, only 6% of urgent cases were missed, and there was a significant reduction in CT utilization [7].

A special population to note is the elderly patient (older than 75 years of age) presenting to the ED with acute abdominal pain. They can often be a diagnostic challenge due to multiple underlying comorbidities and atypical presentations. Many of these patients will require a CT scan to delineate the cause of their pain. While a CT scan with intravenous (IV) contrast is standard for abdominal pain, in the elderly population, the diagnostic accuracy and general management is often maintained without the use of IV contrast [8].

Focused Imaging Approach

A focused imaging approach based on the location of abdominal pain is often an effective strategy for diagnosis, reducing the need for excess CT imaging. Right upper quadrant (RUQ) pain generally derives from a hepatobiliary source, while epigastric and left upper quadrant (LUQ) most commonly are gastric, pancreatic, or associated with other etiologies. Lower abdominal pain, both on the right and left side, is associated most commonly with intestinal or genitourinary problems.

Right Upper Quadrant (RUQ) Pain

The differential diagnosis of right upper quadrant pain includes cholelithiasis, acute cholecystitis, common bile duct etiologies (e.g., dilation or choledocholithiasis), liver abnormalities (e.g., tumors, abscesses, cholestasis, hepatomegaly), and right kidney disorders. Ultrasound has emerged as the imaging modality of choice for most causes of RUQ pain and is the initial diagnostic choice to evaluate the liver as a cause of pain [9, 10].

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Gallbladder disease is one of the most common causes of RUQ pain in the United States and accounts for approximately 20 million cases per year [1, 4, 11, 12]. Ultrasound has become an indispensable tool in the ED, allowing rapid bedside evaluation [4–7, 9]. In select undifferentiated patients presenting with acute abdominal pain, CT imaging has shown good diagnostic accuracy. According to the American College of Radiology Appropriateness Criteria, US is considered the most appropriate modality for patients suspected of having acute cholecystitis [10]. It has also been shown that gallstones can be detected using bedside ultrasound with a sensitivity of 94%, a positive predictive value (PPV) of 99%, a specificity of 99%, and a negative predictive value (NPV) of 73% [4, 6, 12].

Epigastric Pain

Common differential diagnoses include gastritis, acute pancreatitis, peptic ulcer disease, atypical acute coronary syndrome, perforated peptic ulcer, and ruptured abdominal aortic aneurysm (AAA) [1, 3, 4]. The diagnosis of gastritis or peptic ulcer disease (PUD) typically does not require imaging. These maladies of the intestinal lining often are made clinically and confirmed with outpatient specialty tests. If PUD progression to perforation of the stomach or proximal intestine is suspected, an upright chest x-ray can reveal free intraperitoneal air under the diaphragm. Unfortunately, the sensitivity of upright plain abdominal radiographs alone varies, and up to 40% of free air may be overlooked [1–4, 13, 14]. Identification and localization of a perforated viscus is achieved best with computer tomography (CT) imaging [4, 14]. In severe cases of acute pancreatitis, CT imaging is recommended to evaluate for complications such as pseudocysts, abscesses, or necrosis [1, 3–5]. In patients with a suspected AAA, bedside ultrasound may assist the clinician in rapidly risk stratifying patients with epigastric pain radiating to the back or hemodynamic instability. A systematic review published in 2013 found that bedside aortic ultrasound performed by a trained EP has a sensitivity of 99% and a specificity of 98% in identifying a AAA, thus expediting a very time-sensitive diagnosis [3–5, 15].

Right Lower Quadrant (RLQ) Pain

RLQ pain has a broad differential diagnosis, including appendicitis, inflammatory bowel disease, colitis, bowel obstruction, right renal colic, and gynecological disorders. Acute appendicitis is the most common cause of RLQ pain, and in many studies, a CT scan with IV contrast has been found to be the imaging modality of choice to diagnose acute appendicitis accurately with a sensitivity of 91% and specificity of 90% [1, 4, 16]. In pediatric and pregnant patients with a presenting complaint of RLQ pain, ultrasound is the imaging modality of choice, followed by MRI if ultrasound results are equivocal to avoid radiation exposure [4, 17]. For other intestinal etiologies that cause RLQ pain, i.e., inflammatory bowel diseases, colitis, or bowel obstruction, CT imaging has been found to be the most useful [1–5, 10, 13] The physician should be concerned about an intrinsic gynecological problem as the cause of abdominal pain in a female with RLQ pain, especially in the case of a normal CT scan. Studies have shown that the use of transabdominal pelvic ultrasound to diagnose ovarian torsion has a specificity of 93% and positive predictive value of 87% [1, 4, 18].

Left Lower Quadrant (LLQ) Pain

Causes of LLQ pain in adults are similar to those that cause RLQ pain. The most common cause of LLQ pain is acute sigmoid diverticulitis [1, 4, 19]. CT imaging with IV contrast has been found to be the modality of choice to detect acute diverticulitis and its complications (abscess formation, fistula formation) with a sensitivity of 99–100% and specificity of 91–97% [4, 10, 19]. Further, the use of oral and rectal contrast has been reported to increase the accuracy of diagnosing diverticulitis to almost 100% but may lead to delayed diagnosis and long ED stays compared to IV contrast alone [20]. In patients who present with complaints of left (or right) flank pain that radiates to the groin, one should strongly consider renal colic. A study in 2001 found that a non-contrast CT scan was associated with less time in the ED with the same diagnostic accuracy as the traditional intravenous urography [21]. A con-contrast CT is the modality of choice to evaluate renal or ureteral colic, while renal ultrasound is preferred when acute pyelonephritis is suspected or in the patient with classic renal colic symptoms and a prior history of kidney stones [1, 4, 21]. For young patients with few comorbidities, classic symptoms and prior history of ureterolithiasis, ultrasound or close outpatient follow-up may be sufficient.

Left Upper Quadrant (LUQ) Pain

LUQ pain is the least specific of all abdominal pain complaints and is less likely to be associated with a diagnostic concern for classic intra-abdominal emergencies considered in other abdominal locations. Differential diagnoses for LUQ pain can include splenic injury, such as infarction or malig-

nancy, gastric ulcer, gastritis, pyelonephritis, constipation, pancreatitis, or even diabetic ketoacidosis [1, 3–5]. For non-traumatic splenic etiologies, such as infarction or malignancy that leads to splenomegaly, a CT scan with IV contrast is the study of choice. Other more frequent causes of LUQ pain overlap with those of RUQ and epigastric pain.

Summary

In summary, non-traumatic abdominal pain is a common reason for patients to present in the ED. A systematic approach in evaluating the patient and an understanding of diagnostic imaging recommendations can lead to a timely diagnosis of intra-abdominal emergencies and allow the EP to make favorable interventions.

Suggested Resources

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