บทความปริทัศน์หรือการทบทวนวรรณกรรม (Review article)

ชุดภาพรังสีช่องท้อง: บทบาทที่เปลี่ยนไปในภาวะปวดท้องเฉียบพลัน

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บทคัดย่อ

ชุดภาพรังสีช่องท้องมักถูกใช้เป็นอันดับแรกของการวินิจฉัยทางรังสีในผู้ป่วยภาวะปวดท้องเฉียบพลัน แต่เนื่องจากในปัจจุบันเทคโนโลยีของการวินิจฉัยทางรังสีได้พัฒนาไปอย่างมาก ทำให้บทบาทของชุดภาพรังสีช่องท้องลดลง เนื่องจากมีความไวและความจำเพาะต่ำ อัลตร้าซาวด์หรือเอกซเรย์คอมพิวเตอร์ซึ่งมีความแม่นยำในการวินิจฉัยที่ดีกว่าได้มาทดแทนชุดภาพรังสีช่องท้องในหลายๆ โรคในกลุ่มภาวะปวดท้องเฉียบพลันแต่แพทย์ก็ยังสั่งตรวจด้วยชุดภาพรังสีช่องท้องเป็นอันดับแรกอยู่เช่นเดิม บทความนี้มีวัตถุประสงค์เพื่อทบทวนบทบาทของชุดภาพรังสีช่องท้องในการวินิจฉัยผู้ป่วยภาวะปวดท้องเฉียบพลันในปัจจุบันและเครื่องมือการวินิจฉัยทางรังสีที่เปลี่ยนไปในโรคที่พบได้บ่อยในกลุ่มภาวะปวดท้องเฉียบพลันรวมทั้งประสิทธิภาพของเครื่องมือต่างๆ เหล่านั้น

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Plain abdominal radiographs: the changing trend of imaging in acute abdominal pain

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Abstract

Conventional abdominal radiographs (CAR) have long been used as initial imaging in patients with acute abdominal pain. With the advancement of imaging modalities today, CAR has a limited role in the diagnosis of acute abdominal pain due to its low sensitivity and specificity. The imaging modality for acute abdominal patients has changed to ultrasound or computed tomography with a good diagnostic accuracy but CAR is still ordered by the physician. This study aims to review the current role of CAR and the common abdominal conditions that other imaging modalities replacing the CAR. The accuracy of those imaging modalities is also discussed.

Key Words Acute abdomen, Computed tomography, Imaging, Ultrasound

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Introduction

One of the most encountered problems at the emergency department is abdominal pain, with a broad differential diagnosis to consider ranging from benign to life-threatening causes. Early diagnosis and timely management of these patients is the top priority to avoid the possibility of poor clinical outcomes. However, only the history and physical examination usually provide inadequate information to diagnosis. In most cases, the clinician must resort to laboratory testing or imaging studies, which may be inconclusive. It is important for the clinician to know the accuracy of the test being used to prioritize and weight the information.

Imaging plays a key role in the evaluation of patients with acute abdominal pain. The decision to order an imaging study should come from information gleaned from a comprehensive yet focused history and physical examination. It is also important to consider the risks and benefits of an imaging modality when evaluating a patient. Conventional abdominal radiographs (CAR) either acute abdomen series or plain abdomen series have been the initial imaging modality used for the evaluation of acute abdominal pain, due to its ease of acquisition and low cost.

In this review, we discuss the current role of CAR and the change from CAR to another imaging modality in the common acute abdominal conditions.

Overview of acute abdomen series

A single abdominal X-ray delivers a radiation dose of about 0.25 milli-sievert (mSv), equivalent to 12 chest X-rays.[1] Acute abdomen series includes three views of the supine and upright abdominal radiographs and upright chest radiograph while plain abdomen series comprises of two views of supine and upright abdominal radiographs. Unfortunately, the diagnostic efficacy of CAR is poor, especially due to insufficient sensitivity. In a study of 91 patients by MacKersie et al., they reported a 30% sensitivity, 87.8% specificity, and 56% diagnostic accuracy of acute abdomen series for the detection of any abnormality in non-traumatic acute abdominal pain in adults.[2] In a large study of 1021 patients by van Randen et al. found that two-view plain abdominal radiographs improved the correct diagnosis from 49% by the clinical alone to 50% after evaluation of the radiographs which was a non-significant difference ($p = .14$).[3] In the study by Kellow et al., 50% of patients with non-traumatic acute abdominal pain who has abdominal radiography required additional studies, and CAR helped confirm the diagnosis in only 2%-8% of cases.[4] Sreedharan et al. found that 41% of patients whose plain films showed no abnormality underwent further imaging studies and the results showed abnormality in 53%.[5] In a retrospective study of 871 patients, the best sensitivities of CAR were obtained from the detection of foreign bodies (90%) and bowel obstruction (49%), while

it was 0% from appendicitis, pyelonephritis, pancreatitis, and diverticulitis.[6]

In conclusion, CAR has little or no impact on establishing a diagnosis or adopting a therapeutic attitude for most patients. With the increased availability and technological advances of other imaging modalities such as computed tomography (CT) and ultrasound (US), the usefulness of CAR has diminished. Given the poor performance, added cost, and increased radiation dose, CAR are indicated only in specific, limited settings. The main indications are for suspected intestinal obstruction, for suspected perforation of the gastrointestinal tract, follow-up of urinary tract calculi and foreign bodies due to penetrating injuries or ingestion. Therefore, the decision should be made based on the clinical context and location of pain or according to a conditional strategy.

Evaluation of generalized abdominal pain

Generalized or non-specific abdominal pain can be caused by intestinal obstruction, hollow organ perforation, intestinal ischemia or vascular cause such as dissecting aortic aneurysm. CAR is still in the guidelines if suspicious of bowel obstruction, bowel perforation, exacerbation of colitis and peritonitis.[7]

Intestinal obstruction

The findings in intestinal obstruction in CAR are dilated bowel loops proximal to the site of obstruction, together with air-fluid levels that are different heights in the same loop.[8] Nowadays, CT has become popularly used since CT alone not only confirms the diagnosis but also localizes the site of obstruction and defines its nature (Figure 1-2).[9-11]

Intestinal perforation

Hollow viscus perforation is most commonly due to duodenal ulcer or sigmoid diverticulitis.[8] The reported sensitivity in the detection of extraluminal air on CAR is 50-70%.[12] However, nearly 50% of patients who had hollow viscus perforation at laparotomy failed to demonstrate pneumoperitoneum on CAR (Figure 3).[13] Moreover, the finding of pneumoperitoneum on CAR in patients who have acute abdominal pain is not always associated with the need for surgery for hollow viscus perforation.[13] CT has a superior sensitivity to erect chest radiograph for the diagnosis of pneumoperitoneum.[14] CT lung window is excellent at detecting free intraperitoneal air, but the location of the free air does not necessarily correlate with the site of the perforation.[9]

Mesenteric ischemia

As clinical examination and laboratory tests tend to have limited ability to predict the presence of mesenteric ischemia, imaging tests are often needed. CAR usually remains non-diagnostic in most cases of mesenteric ischemia. If the diagnosis of mesenteric ischemia is concerned, urgent CT angiography should be performed.[15-16] CT angiography can diagnose the arterial or venous nature of ischemia, the site of the vascular obstruction and whether the mechanism is occlusive or

not. CT with IV contrast has sensitivity and specificity for acute mesenteric ischemia of 64% and 92%, respectively.[17] MRI has been proposed recently as a substitute for diagnosis and follow-up of acute mesenteric ischemia.[18]

Evaluation of right lower quadrant pain

Right lower quadrant (RLQ) is the most common location of acute abdominal pain. It may be caused by appendicitis, ovarian pathology, ectopic pregnancy, hernia, intestinal pathology, and renal colic. Here we discussed the two common RLQ lesions included acute appendicitis and gynecologic conditions.

Acute appendicitis

Fourteen percent of patients presenting to the ER with abdominal pain have acute appendicitis.[9] Radiographic signs that suggest appendicitis include appendicolith (Figure 4); the presence of air in the appendix; signs of localized paralytic ileum; loss of the caecal shadow; blurring of the right psoas muscle; dextroscoliosis of the lumbar spine; haziness over the right sacroiliac joint; and free intraperitoneal air or fluid. However, all these signs have a low sensitivity of 1% to 55%.[19] Petroianu et al. have proposed a new radiographic sign of fecal loading in the cecum for differential diagnosis of acute appendicitis compared with other inflammatory diseases of the right abdomen. In their study, this sign has high sensitivity and specificity for acute appendicitis of 95% and 85% respectively.[20] A study in 2010 showed that only 9% abnormality pick-up rate was achieved from CAR in cases of acute appendicitis.[21] US and CT are often used to evaluate patients for acute appendicitis and can also detect other causes of RLQ pain such as mesenteric lymphadenitis, tumors, Crohn's disease, infectious, diverticulitis, complicated Meckel's diverticulum, iliac aneurysm, and adnexal pathology.[10] The addition of imaging studies has decreased the rate of unnecessary appendectomy by two-thirds compared to the clinical alone.[22] Raman et al. reported that first-intention use of CT had decreased the rate of unnecessary appendectomy from 24% to 3% over 10 years but at the cost of increasing the frequency of CT from 20% to 85% in patient undergoing appendectomy.[23] In the 46 patients without appendicitis, an alternative diagnosis was made by CT in 22 patients and by the US in 15. CT scans showed abscesses and/or phlegmons in 28% of patients with appendicitis versus only 17% using the US.[24] Nevertheless, CT has a radiation dose penalty. The radiation dose of abdominal CT is 10–100 times greater than that of an abdominal film at 10 mSv.[8] Tarulli et al. reported 42 cases using focused CT were positive for appendicitis and identical to standard abdominal CT.[25] Literature have suggested using the US as an initial imaging modality, followed by CT if the US result is inconclusive.[26-28] If MRI were more available, it would be a real alternative since its diagnostic performance seems equivalent to CT. In a small study by Isarael et al., when the appendix was visualized on MRI, the sensitivity, specificity, positive predictive value,

and negative predictive for the diagnosis of appendicitis was 100% for all parameter.[29]

Gynecologic conditions

In a female patient with RLQ pain, ruptured ovarian cysts, ovarian torsion, tubo-ovarian abscess, and ectopic pregnancy should be considered. Abdominal radiography has a limited role in the evaluation of the women of gynecologic conditions. The US has an accuracy of 96% for ovarian torsion.[30] In a study by Lee et al., examining ovarian torsion, the twisted vascular pedicle was detected preoperatively by the US in 28 of 32 patients with surgically proven torsion, showing a diagnostic accuracy of 87%.[31] Pelvic US has a sensitivity of 93% and a specificity of 98% in the diagnosis of TOA.[32] MRI can be performed next to the US if non-diagnostic is in concern.

Evaluation of right upper quadrant pain

Right upper quadrant (RUQ) pain may relate to disorders of the hepatobiliary system, right kidney, pancreas, bowel, pleura, and musculoskeletal system. The most common disease that should be considered in the right upper quadrant is biliary disease. Ten percent of the adult population in the United States has gallstones and 35% of them requiring cholecystectomy.[33] The US has been used as the first line imaging study for evaluation of the gallbladder and biliary tree with a sensitivity of 83% and specificity of 95%.[34] However a recent study demonstrated that CT may be the study of choice when the likelihood of acute cholecystitis is high because it is superior at identifying the severity and it is a non-user dependent.[35] The ability of US to detect common bile duct stones is also limited, nevertheless, the diagnosis of intrahepatic calculi by the US may be more accurate than that of CT because these stones lack sufficient calcium to make them radio-opaque.[36] However, CT is often used in the clinical setting because other disease processes such as pancreatitis, gastritis, peptic ulcer disease, and even bowel obstruction may present as RUQ pain.[34] CT with contrast is recommended for complicated cholecystitis, cholangitis and less common causes such as subhepatic appendicitis, right-sided diverticulitis, perforated duodenal ulcer, liver tumor or abscess and omental infarction.[37]

Evaluation of left lower quadrant pain

Diverticulitis and its complications are the predominant causes of left lower quadrant abdominal pain in Western countries whereas right hemicolon is predominant in an Asian population.[38] As for patients with RLQ pain, LLQ pain can be secondary to renal colic, ovarian pathology, ectopic pregnancy, and hernia. For the diagnosis of diverticulitis, CT is sensitive (97%) and specific (98%) with a diagnostic accuracy of 98%. CT is also effective for the diagnosis of complications such as perforation or abscess, with diagnostic efficacy of 96% and 98%, respectively and should, therefore, be the initial study.[39] In a prospective study of 123 patients with clinical signs of acute intestinal inflammation, the sensitivity of US in

comparison with abdominal CT in diagnosing acute colonic diverticulitis was 84.6%, and the specificity was 80.3%.[40] US may be less sensitive than CT in detecting abscesses and micro-perforation. MRI has been shown to be effective for diagnosis and evaluation of diverticulitis[41-42] but its feasibility is needed to establish the clinical utility of MRI in these issues. It can be used as alternative imaging in patients who have a contraindication to iodinated contrast or in pregnancy.

Evaluation of left upper quadrant pain

Localized LUQ pain is a rare clinical presentation. Different possible origins include the spleen, pancreas, stomach, colon, or retroperitoneal sources. Splenic infarct or abscess, splenomegaly, pancreatitis, gastritis, renal colic, pyelonephritis are considered. CT is the best study for evaluation of LUQ pain and can reveal splenic infarct or abscess, gastric malignancy, pancreatitis, pyelonephritis and inflammation of the bowel.[10] In the setting of blunt trauma, the US may detect free fluid in the abdomen as a surrogate marker for acute splenic trauma.

Evaluation of epigastrium pain

Multiple possible etiologies must be considered for epigastric pain, including pancreatitis, peptic ulcer (with or without perforation), mesenteric ischemia, intestinal obstruction, biliary colic, and myocardial infarction. Abdominal plain radiography typically offers little information in the evaluation of acute pancreatitis. The US may be limited by patient habitus and bowel gas but may play a role in the assessment of pancreatitis by identifying gallstones as the cause. Esophagogastroscopy has replaced imaging in the peptic or duodenal diseases.

For patients in poor general condition, or when abdominal guarding raises fears of hollow organ perforation, or when mesenteric ischemia or intestinal obstruction is suspected, CT with IV contrast is the first-choice examination as described earlier. CT is also often used to exclude other sources of pain and to assess the severity of the disease, especially in patients with continued symptoms who are not improving.

Evaluation of flank pain

Ureteric colic is the most common cause of flank pain. Non-injected low dose CT is the fastest and most effective technique to evaluate flank pain.[43-44] However, to limit radiation exposure, the combination of US with abdominal plain films is usually effective, while low-dose CT is reserved for inconclusive studies.[45] In pregnant women, the US is the first-line examination, complemented by MRI if results are non-conclusive. If MRI is not available, low-dose CT is possible because pregnancy is often advanced and the teratogenic risk is much more limited.[46]

Evaluation of pelvic pain

The approach to pelvic pain varies according to gender. In males, we have found

no formal recommendations for imaging evaluation. The US is usually used as initial imaging of the bladder to assess for the etiology of acute urinary retention including bladder stones, clotted blood in the bladder or an enlarged prostate. The US can also be used to confirm Foley placement in a patient who is anuric.

In women of childbearing age, trans-abdominal or trans-vaginal US is the preferred studies when gynecological or obstetric causes are suspected. CT is a more effective study when diagnosis leans toward intestinal or urinary causes.[47] In pregnant women, MRI is preferred to low-dose CT if the US fails to provide an answer.[46]

Summary

The evaluation of acute abdominal pain in the ED is challenging. From this review, we conclude that conventional abdominal radiographs currently have limited role in the exploration of abdominal emergencies and have little impact on establishing a diagnosis or adopting a therapeutic attitude for most patients when compared to clinical examination alone. The current choice lays between routine first-line US with complementary CT if necessary versus routine first-line US for all pain in the RLQ and RUQ with routine CT scan for all other localizations. CT is more accurate than in the US. However, in order to limit radiation exposure, beginning with the US and progressing to CT only if US exam is negative or inconclusive is the current trend. MRI can be performed next to the US if non-diagnostic in a concern in a pregnant or pediatric patient.

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Figure 1 (Top row) Plain abdomen series of a 83-year-old male presented with hematochezia, reveals transition point at splenic flexure region (arrows). (Bottom row) Axial and sagittal CT reformations demonstrate severe bowel swelling (arrows).

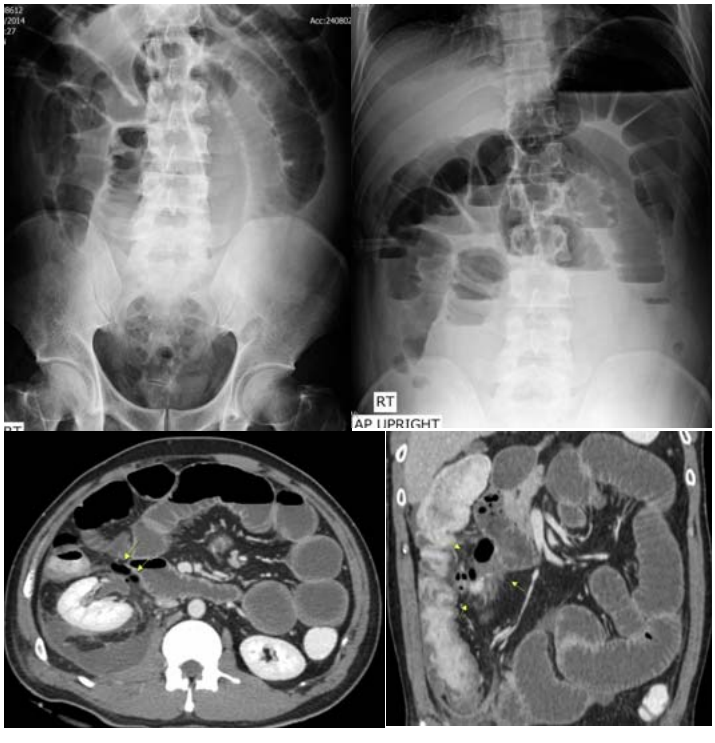

Figure 2 (Top row) Plain abdomen series of a 37-year-old man shows distal small bowel obstruction. (Bottom row) Axial and coronal CT reformations reveal no bowel obstruction. Hematoma and abnormal air are demonstrated at right anterior pararenal space from prior kidney procedure.

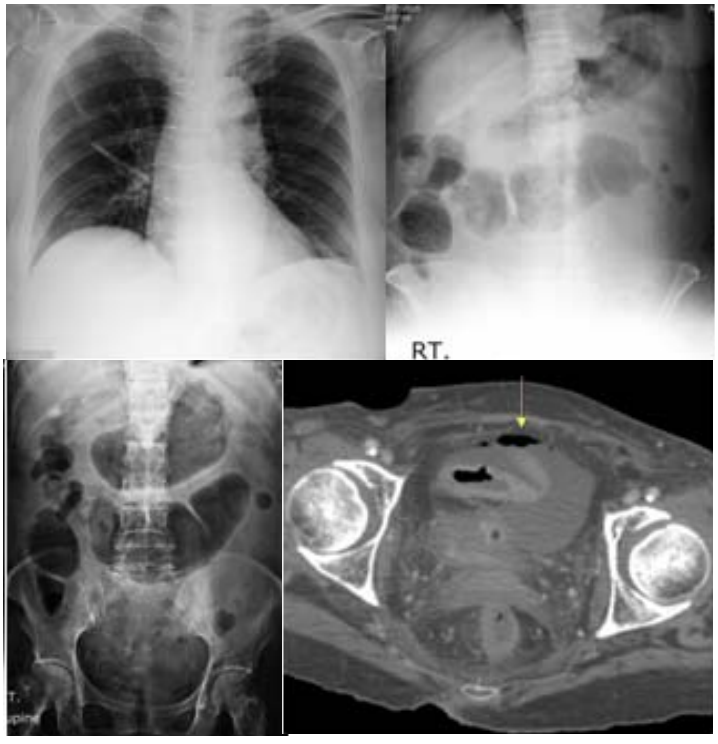

Figure 3 (Top row) Acute abdomen series of a 74-year-old woman fails to depict abnormal air. (Bottom row) Axial CT reformation reveals minimal free air (arrow) in the pelvic cavity together with free fluid from ileal perforation.

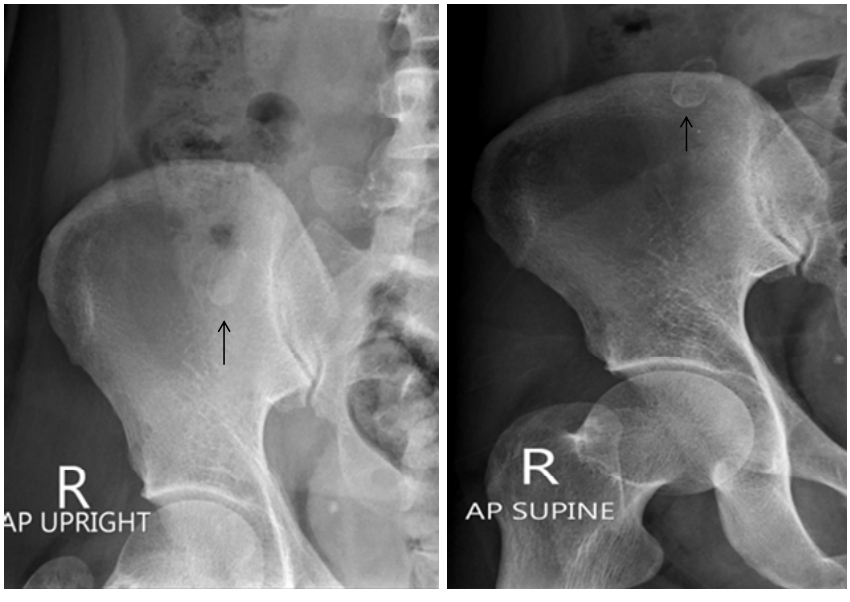

Figure 4 Plain abdomen series, spotted views reveal an appendicolith (arrows).