My patient has RUQ pain

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Abdominal Pain

- “Is the presenting complaint in 1.5% of office visits, and in 5% of ER visits”
- This talk will focus on the more specific complaint of RUQ abdominal pain

Differential Diagnosis

- GI
- GB or biliary tract disease:
  - acute cholecystitis
  - gangrenous cholecystitis
  - Choledocholithiasis
  - GB cancer
- Liver: hepatitis; abscess; cancer; hepatomegaly (CHF)
- Pancreas: pancreatitis; pancreatic cancer
- Peptic ulcer
- Retrocecal appendicitis

Differential Diagnosis

- Cardiopulmonary
- Myocardial infarct; ischemia
- Pericarditis
- Pneumonia (RLL)
- Empyema

- Miscellaneous
- Right renal pain:
  - Pyelonephritis
  - Hydronephrosis
  - Herpes zoster
  - Subphrenic abscess

Imaging Strategy

- Based on clinical history and physical exam; lab test results may help as well
- Imaging Modalities
  - Plain radiographs
  - US
  - CT
  - MRI

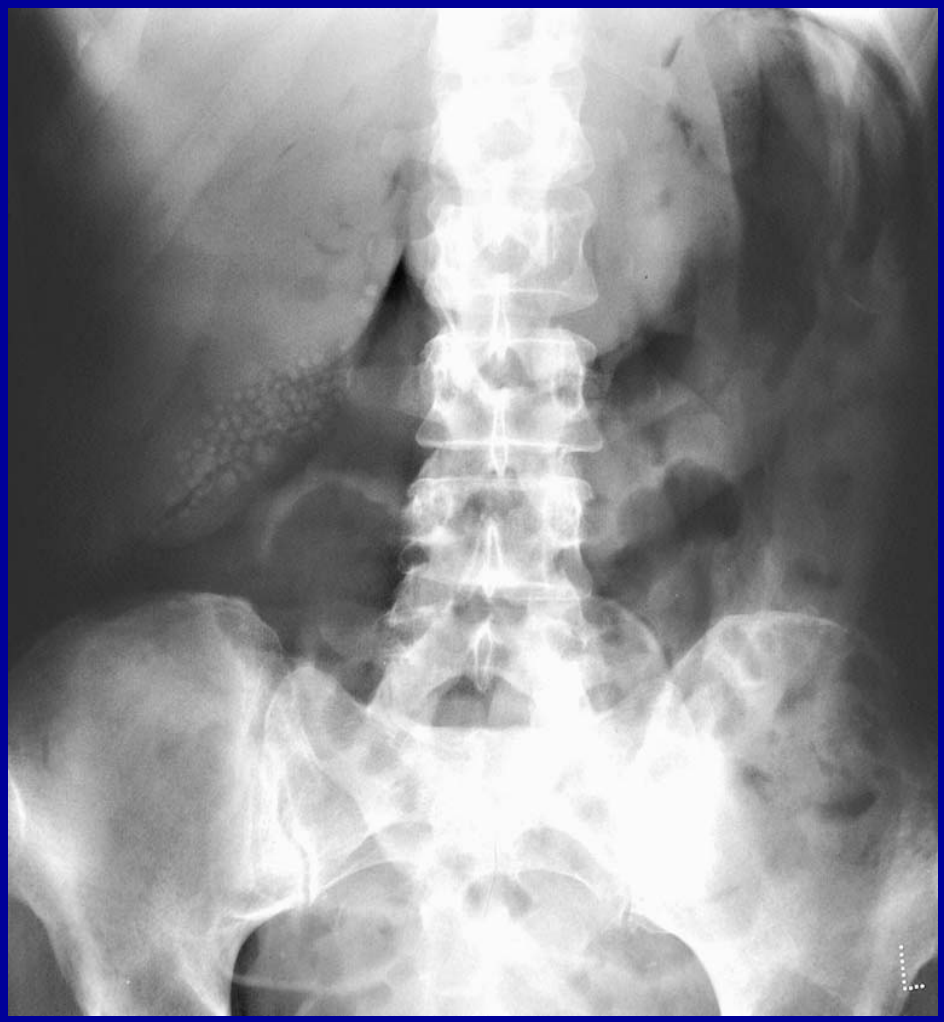
Plain Radiographs

Can detect:

- Free air (perforation; emphysematous cholecystitis)
- Calcifications: 10% of gallstones; 90% of renal stones
- Dilated bowel loops and air-fluid levels (ileus or obstruction)

May be normal; therefore limited usefulness

Helpful to exclude non-biliary etiologies



Imaging Strategy

- Based upon history, physical, lab results
- If biliary etiology suspected: US
- If non-biliary etiology suspected: CT
- If unsure, then start with US because focal RUQ pain is usually biliary

Biliary Symptoms

- RUQ pain
- Recurrent pain several hours after eating (particularly fatty meals)
- Jaundice
- Vomiting
- Nausea

Ultrasound

- Primary imaging modality for assessment of acute RUQ pain, esp. if biliary
- Sensitive and specific in demonstrating gallstones, biliary dilatation, and features that suggest acute inflammatory disease

Ultrasound

- Advantages:
- Relatively inexpensive
- Widely available
- Portable
- Safe (no ionizing radiation)
- Accurate
- No contrast

- Limitations:
- Not as good as CT in evaluating adjacent structures (liver; pancreas)
- Limited visualization (obesity: bowel gas)
- Operator dependent

CT

- Valuable in confirming the extent and nature of the complications of acute cholecystitis (AC)
- Detection of non-biliary etiologies of RUQ pain (> 1/3 of patients with RUQ pain do not have AC)
- Allows assessment of all structures in lower chest and abdomen

CT

- Limitations:
  - More expensive
  - Limited availability
  - May require oral and/or IV contrast
  - Ionizing radiation exposure

Patient Medical Imaging Exposure

- In 2006, National Council on Radiation Protection and Measurements (NCRP) reported that Americans were exposed to > 7x as much ionizing radiation from medical procedures compared to the early 1980s

- This is mostly due to the higher utilization of CT and nuclear medicine

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NCRP 1929 2009

Medical Radiation Exposure of the U.S. Population Greatly Increased Since the Early 1980s

In 2006, Americans were exposed to more than seven times as much ionizing radiation from medical procedures as was the case in the early 1980s, according to a new report on population exposure released March 3rd by the National Council on Radiation Protection and Measurements (NCRP) at its annual meeting in Bethesda, Maryland. In 2006, medical exposure constituted nearly half of the total radiation exposure of the U.S. population from all sources.

The increase was primarily a result of the growth in the use of medical imaging procedures, explained Dr. Kenneth R. Kase, senior vice president of NCRP and chairman of the scientific committee that produced the report. "The increase was due mostly to the higher utilization of computed tomography (CT) and nuclear medicine. These two imaging modalities alone contributed 36 percent of the total radiation exposure and 75 percent of the medical radiation exposure of the U.S. population." The number of CT scans and nuclear medicine procedures performed in the United States during 2006 was estimated to be 67 million and 18 million, respectively.

The NCRP Report No. 160, *Ionizing Radiation Exposure of the Population of the United States*, provides a complete review of all radiation exposures for 2006.

Background radiation, which in 2006 contributed fully half of the total exposure, comes from natural radiation in soil and rocks, radon gas which seeps into homes and other buildings, plus radiation from space and radiation sources that are found naturally within the human body.

Other small contributors of exposure to the U.S. population included consumer products and activities, industrial and research uses and occupational tasks.

NCRP is working with some of its partners like the American College of Radiology (ACR), World Health Organization and others to address radiation exposure resulting from the significant growth in medical imaging and to ensure that referrals for procedures like CT and nuclear medicine are based on objective, medically relevant criteria (*e.g.*, ACR appropriateness criteria).

This year marks the 80th anniversary of NCRP's founding and the 45th anniversary of its charter from the U.S. Congress under Public Law 88-376.

Typical doses from radiology exams

- Plain films — Dose (mrem)
  - Chest, 2 view — 6
  - C-spine series — 27
  - L-spine series — 180
  - Mammogram — 13
- CT exams — Dose (mrem)
  - CT head — 200
  - CT chest — 800
  - CT abdomen — 1000
  - CT pelvis — 1000

Therefore, a typical CT abdomen/pelvis exam results in a total of 2000 mrem of exposure, that's equal to exposure from > 300 two view chest X-ray studies!

Medical Radiation Exposure

- We are exposing patients to a lot of radiation when we do CT exams.
- Please use CT imaging judiciously, especially with children and younger adults

Follow-up Imaging

- If US is negative, then consider CT
- If CT suspects abnormal GB, then consider US
- MRI: Performed if CBD stones are suspected; often prelude to ERCP
- NM biliary scan: performed if both CT and/or US are equivocal for AC

Acute Cholecystitis

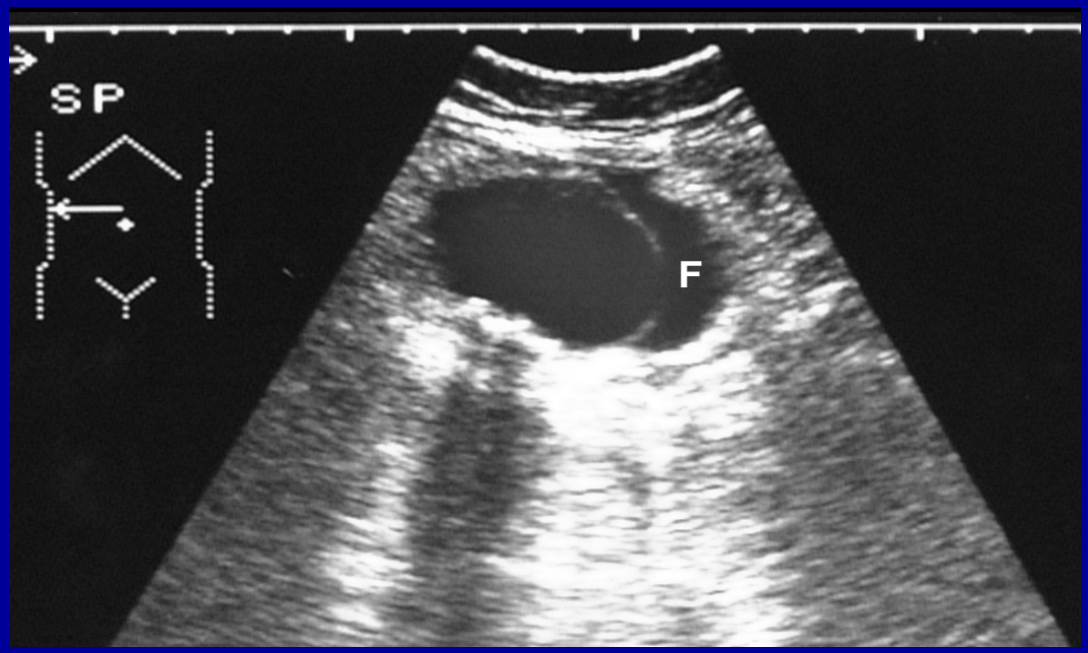
- Most common cause of acute RUQ pain
- Etiology:
  - 90-95 % caused by gallstones obstructing the cystic duct
  - 5-10% acalculous
- Clinical: guarding RUQ, tenderness to palpation

Acute Cholecystitis, US findings

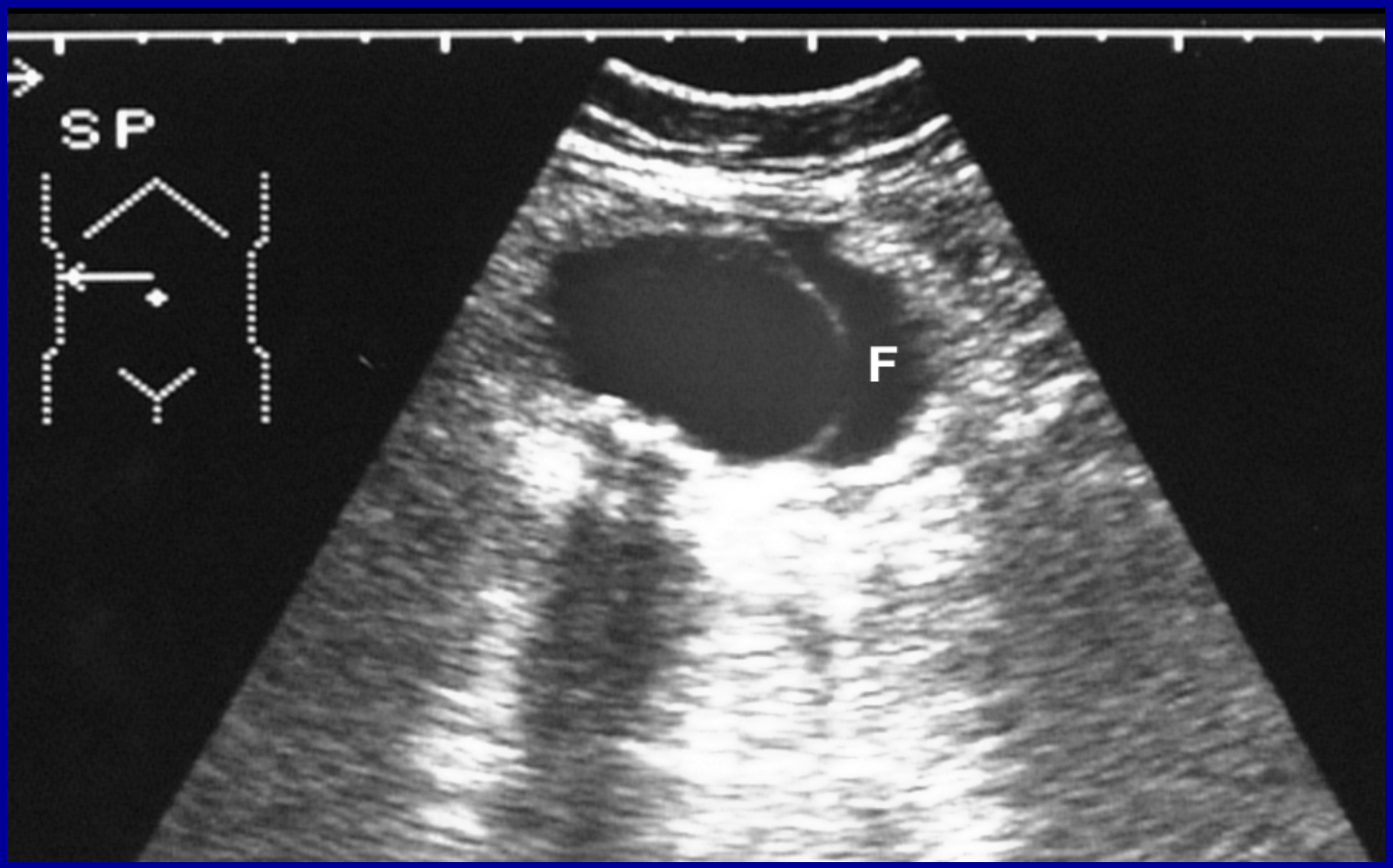
- Gallstones
- GB wall thickening >3mm
- Sonographic Murphy's sign
- Pericholecystic fluid
- Dilated GB

Acute Cholecystitis

- US has reported sensitivity of 81-100% and specificity of 60-100% in diagnosis of AC



Acute Cholecystitis

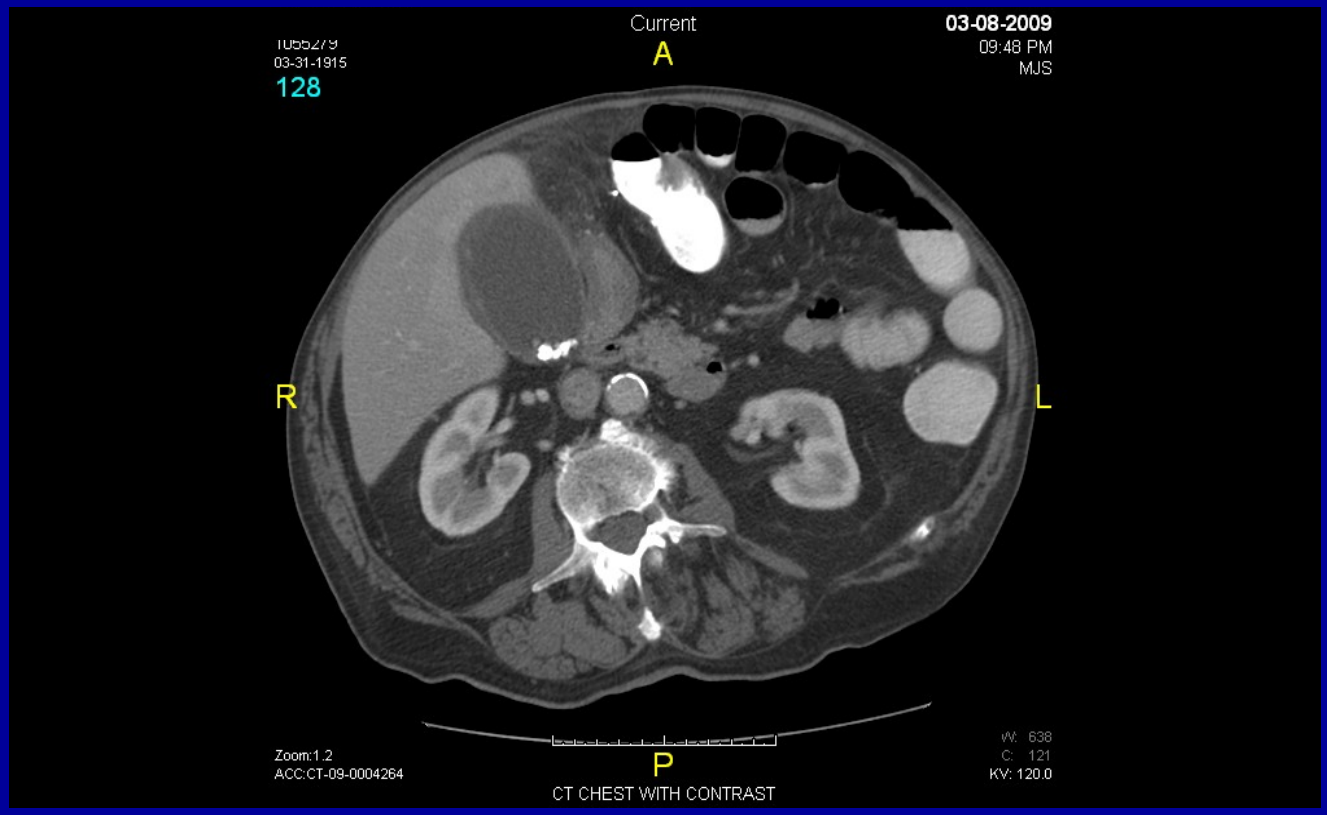


Acute Cholecystitis, CT findings

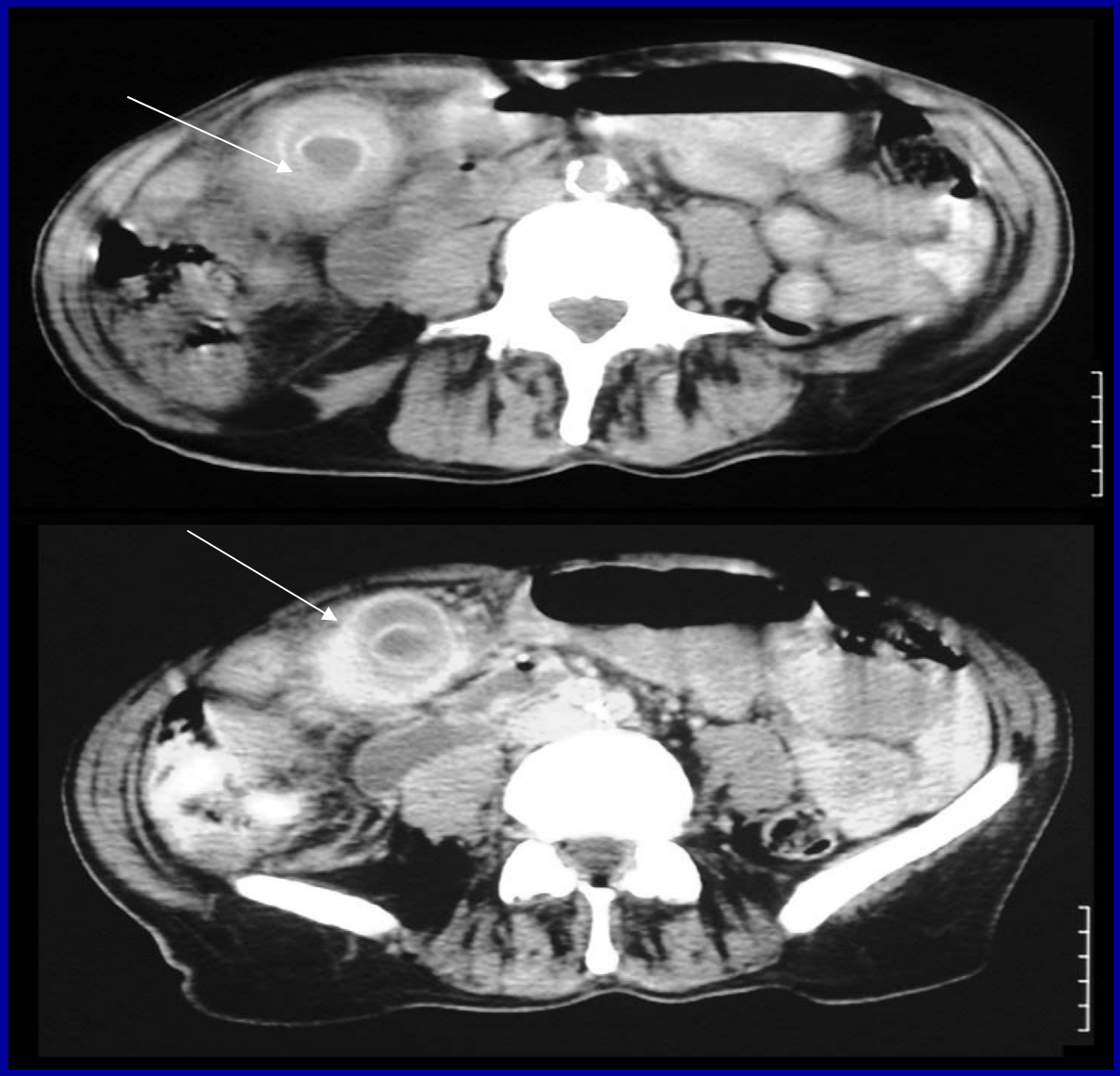
- Focal or diffuse wall thickening > 3mm in non-contracted GB
- Indistinct liver-GB interface
- Fluid in GB fossa in absence of ascites
- GB enlargement (> 5cm in transverse dimension)
- Infiltration of surrounding fat (SPECIFIC sign for AC)
- GB mucosal sloughing
- Intramural GB gas

Acute Cholecystitis

- Sensitivity and specificity of CT findings for AC reported as 90-95%

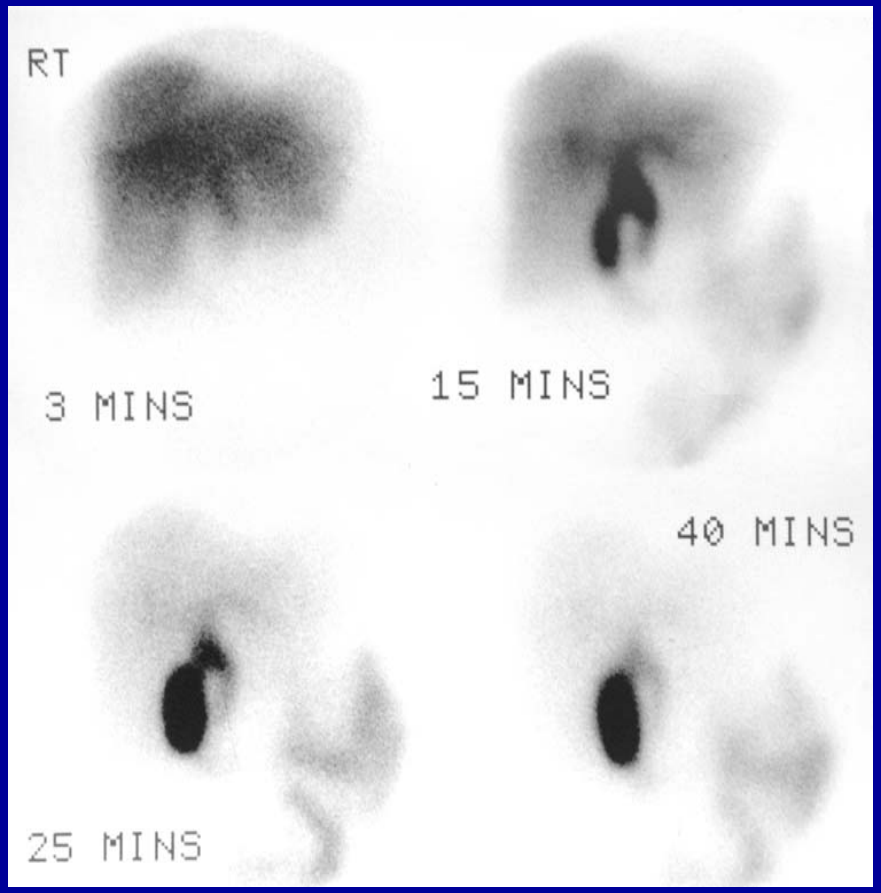


CT of Acute cholecystitis

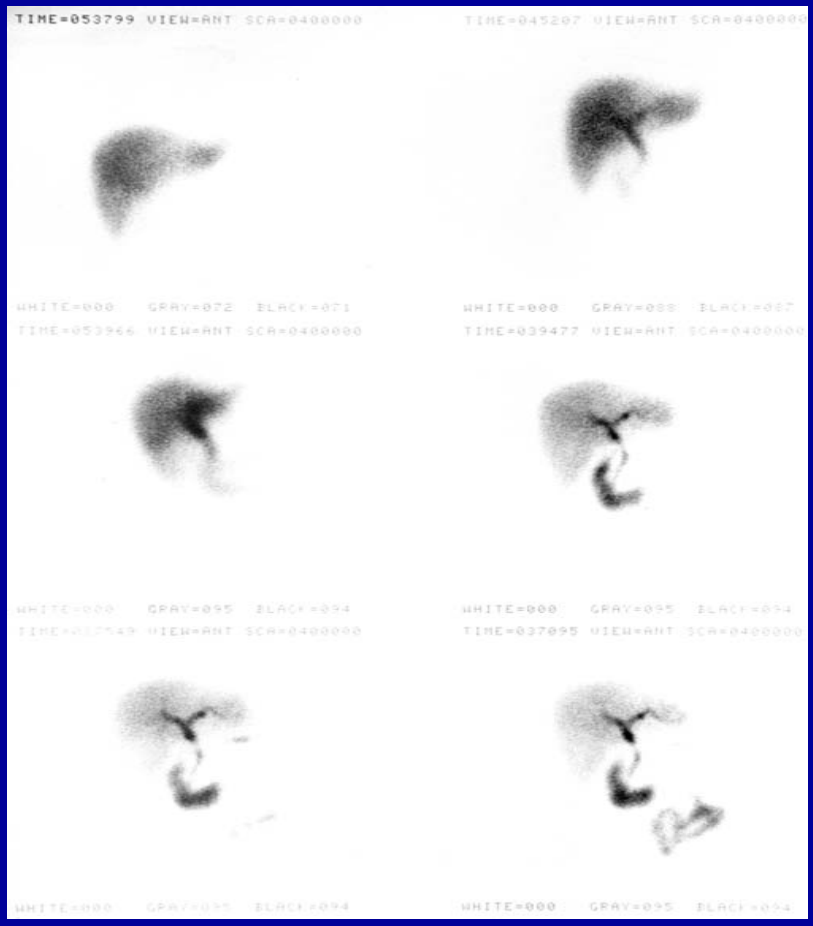


Acute cholecystitis, NM

Normal



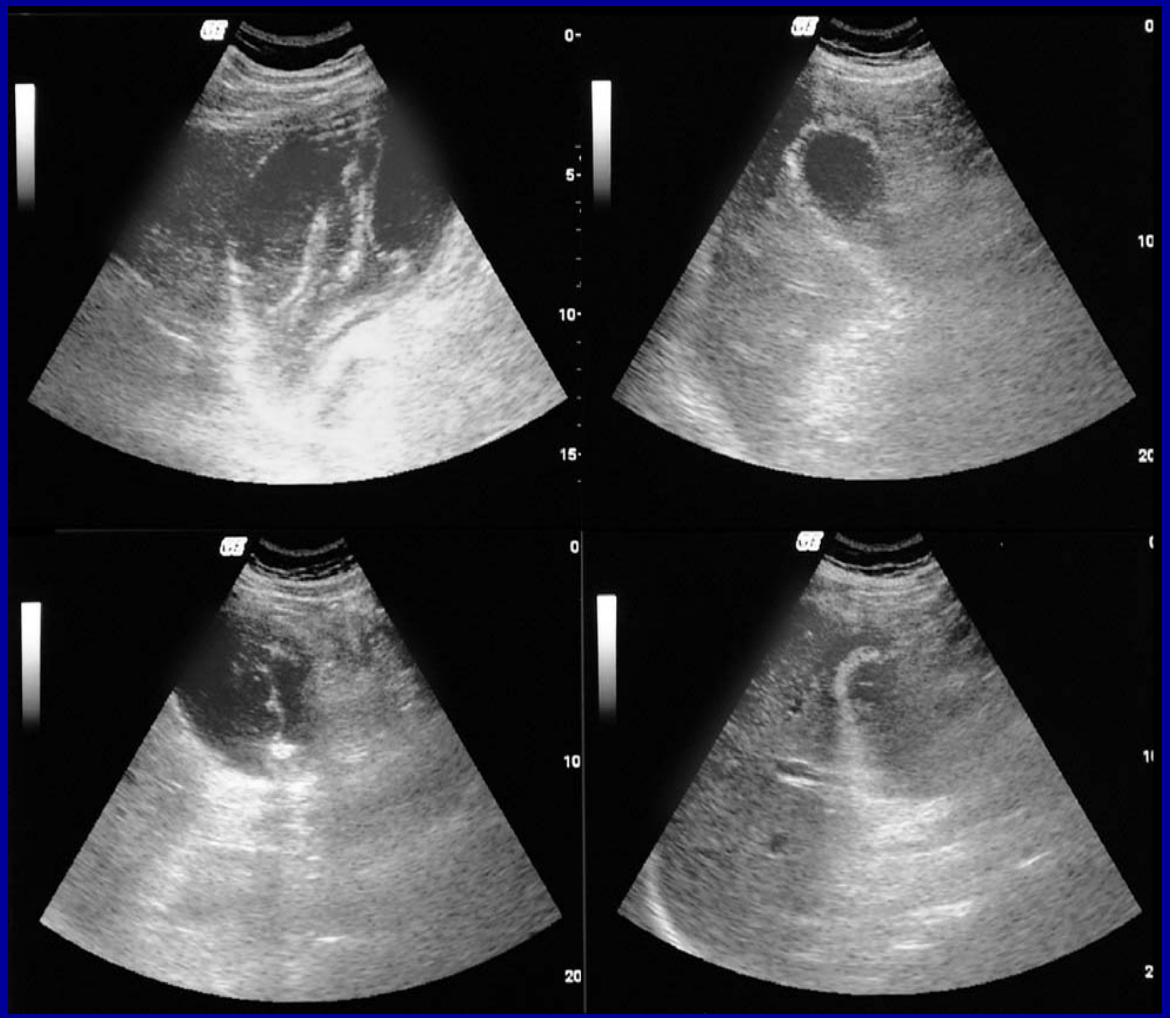
Cystic duct obstruction



Acalculous Cholecystitis

- 5-10 % of cases
- Occurs more often in males (usually children), and persons > 65 y.o.
- More difficult to diagnose
- Higher incidence in ICU patients, esp. those with burns and trauma
- Associated factors: surgery, esp. abdominal; severe burns/trauma; TPN; mechanical ventilation, DM

Acalculous Cholecystitis



Complications of Acute Cholecystitis

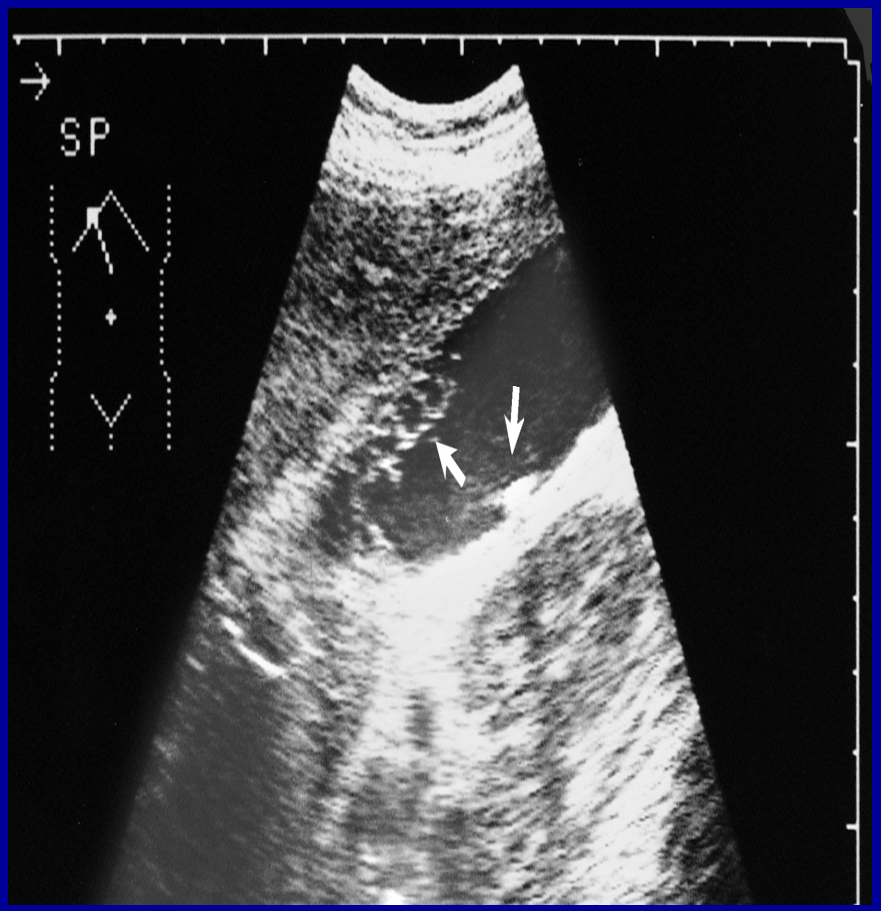
- Gangrenous cholecystitis
- Emphysematous cholecystitis
- GB perforation
- Cholecysenteric fistula

Gangrenous Cholecystitis

- Due to ischemia and ultimately necrosis of GB wall
- Small number of patients with AC
- 10% develop perforation, increased mortality and morbidity
- Clinical: often pain paradoxically moves away from RUQ

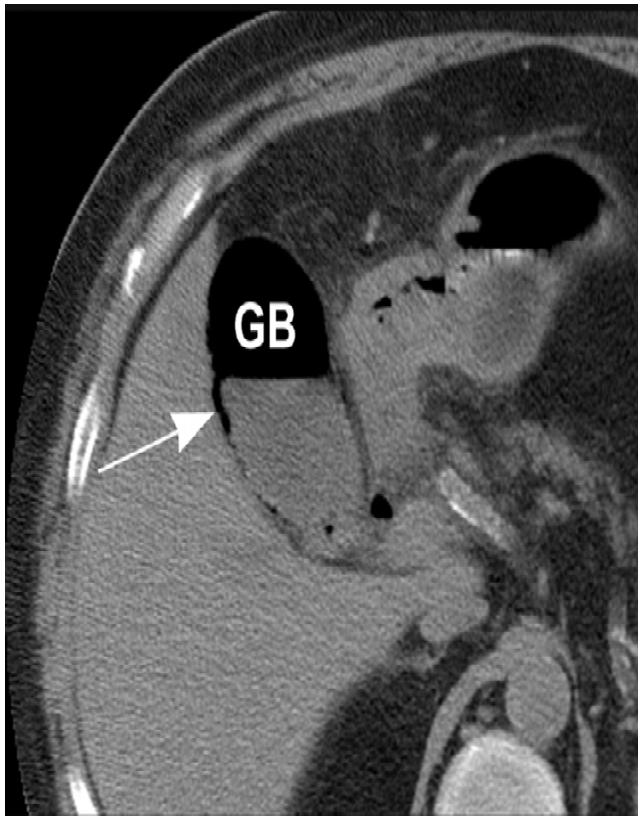
Gangrenous Cholecystitis

- Findings:
  - Focal wall thickening
  - Marked wall irregularity
  - Intramural membranes



Gangrenous Cholecystitis

- CT findings (higher specificity):
  - Gas in wall or lumen
  - Intraluminal membranes
  - Irregular or absent wall
  - Abscess



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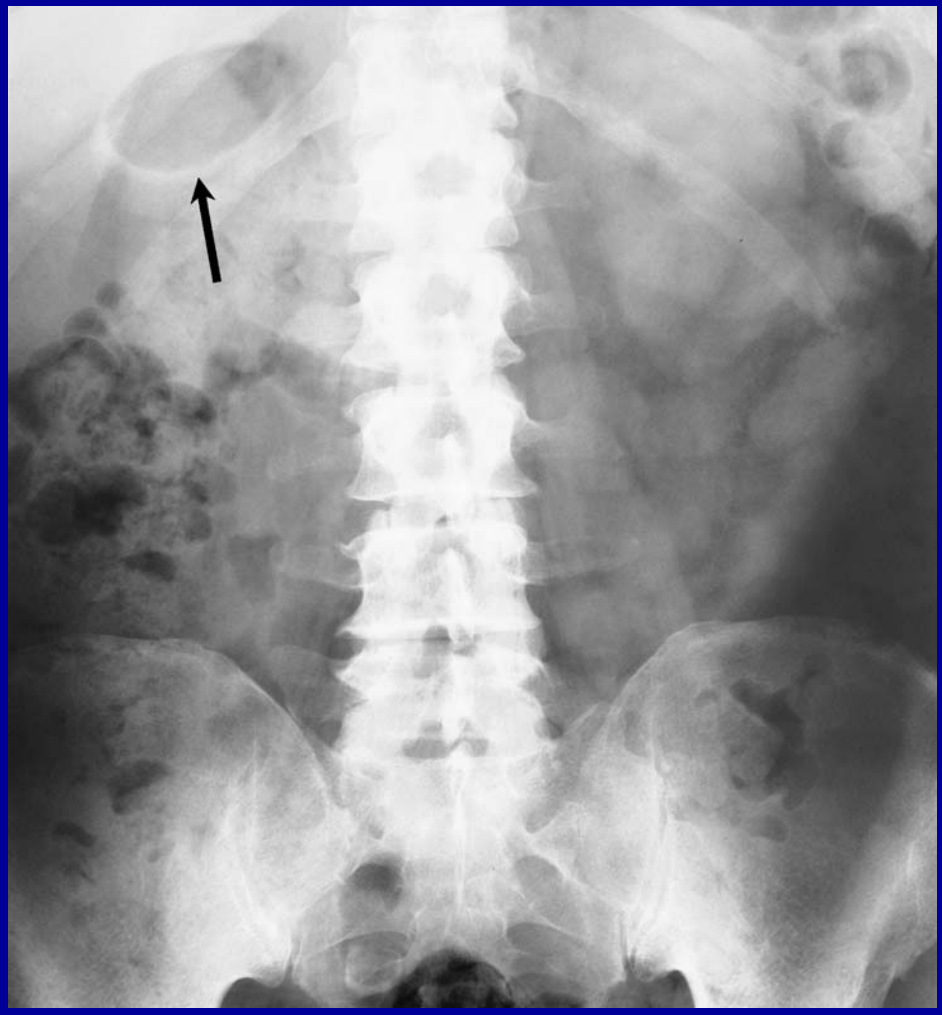
Emphysematous Cholecystitis

- Rare condition
- Surgical Emergency
- Ischemia of GB wall, followed by infection with gas-forming organism
- Predisposition for gangrene formation and perforation
- Pre-existing DM in 30-50% of cases
- Mortality rate = 15% (vs 5-10% associated with AC)
- Clinical symptoms are mild
- Complication in > 50 % of cases of acalculous cholecystitis

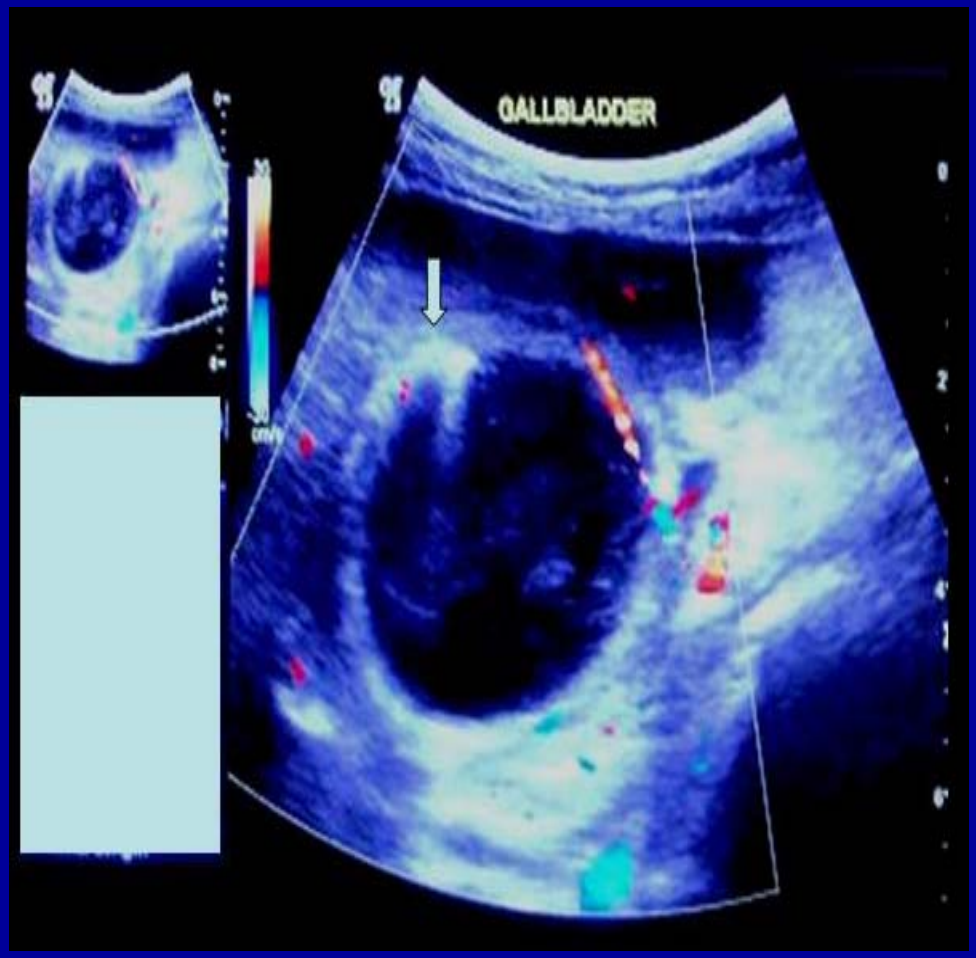
Emphysematous Cholecystitis

- AIR in GB lumen, wall, or both; rest of biliary tree in 20%



Emphysematous Cholecystitis

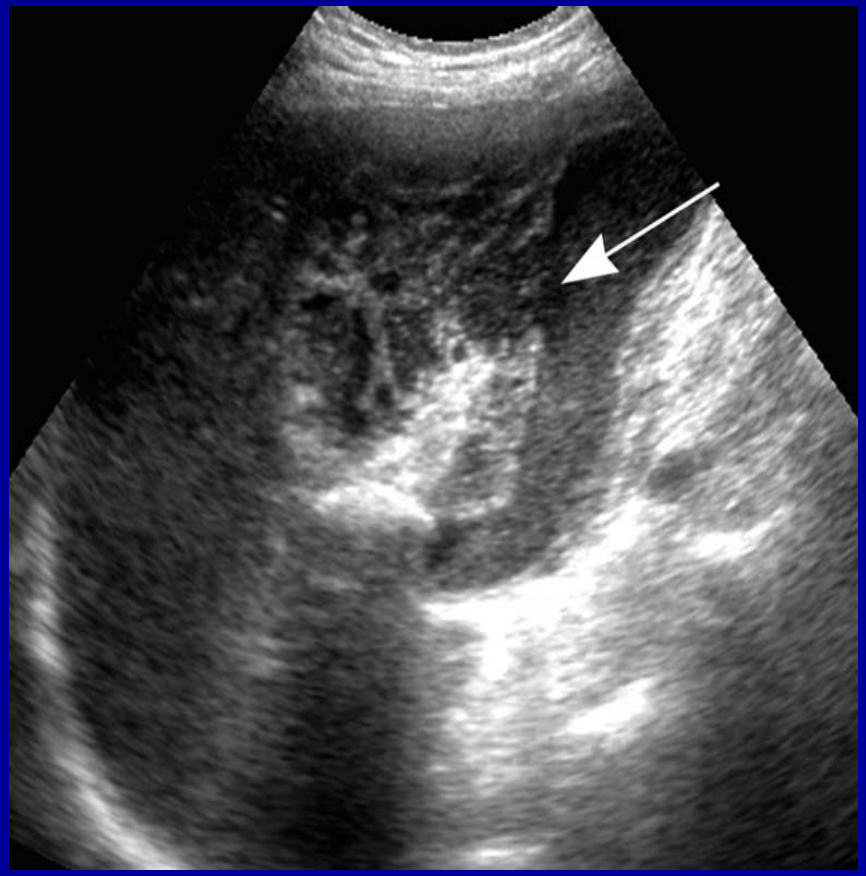
- US:
- Air in GB wall or lumen is hyperflective, may have reverberation artifact

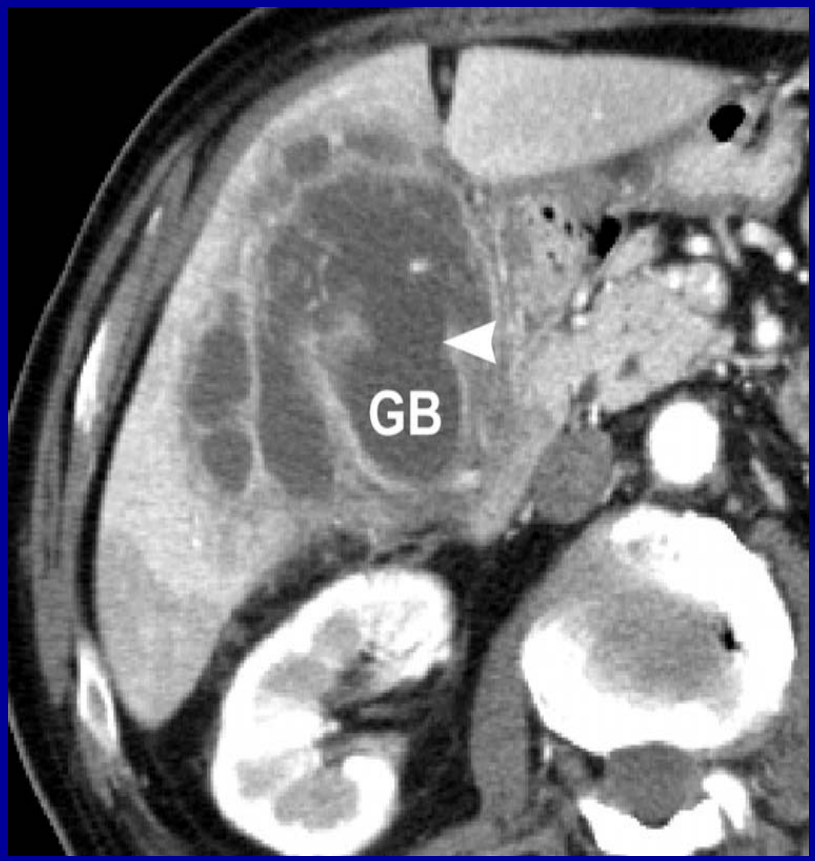


GB Perforation

- Occurs in up to 10% of cases
- Associated mortality rate of 19-24%
- Types:
  - Acute 10% (worst prognosis)
  - Sub-acute 60% (contained; pericholecystic abscess)
  - Chronic 30% (may result in internal biliary fistula)
- Findings: Defect in GB wall

GB Perforation, subacute





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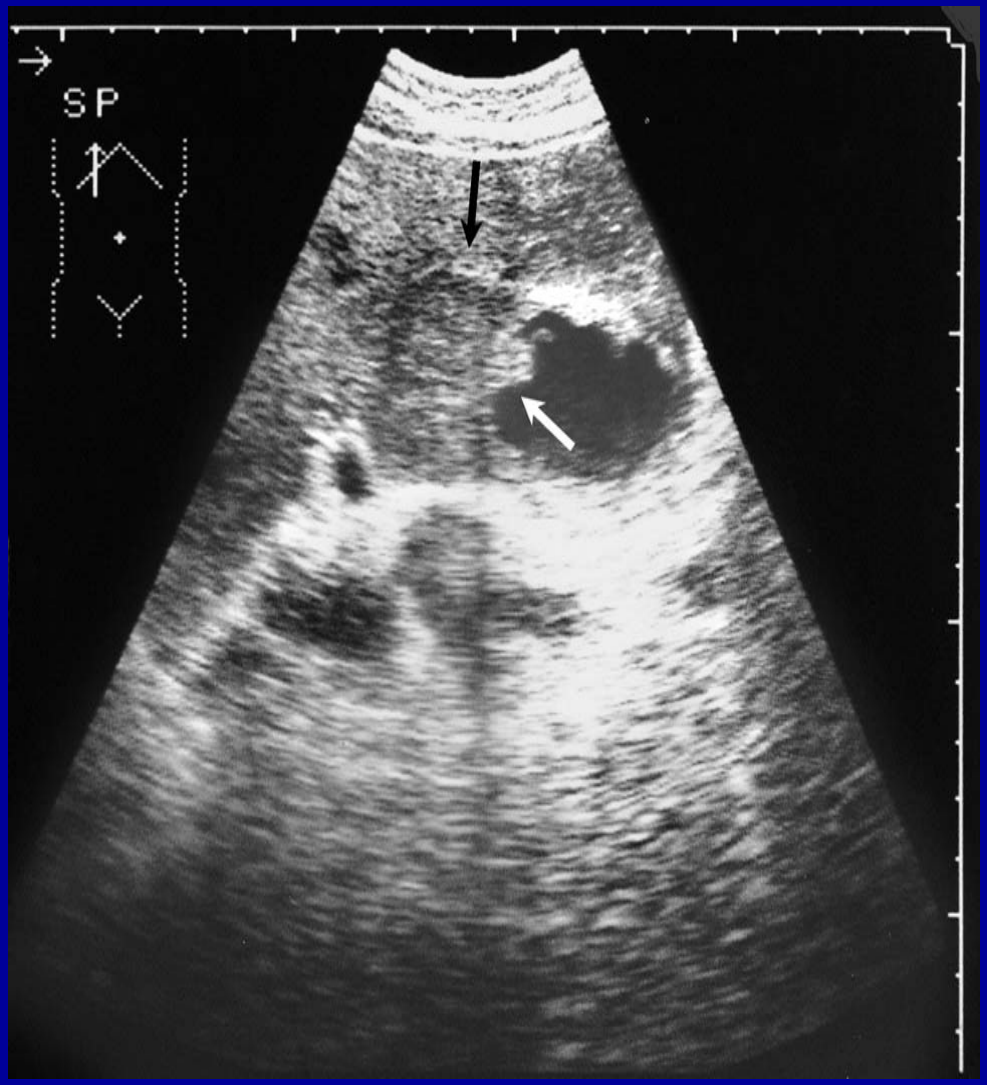
GB Cancer

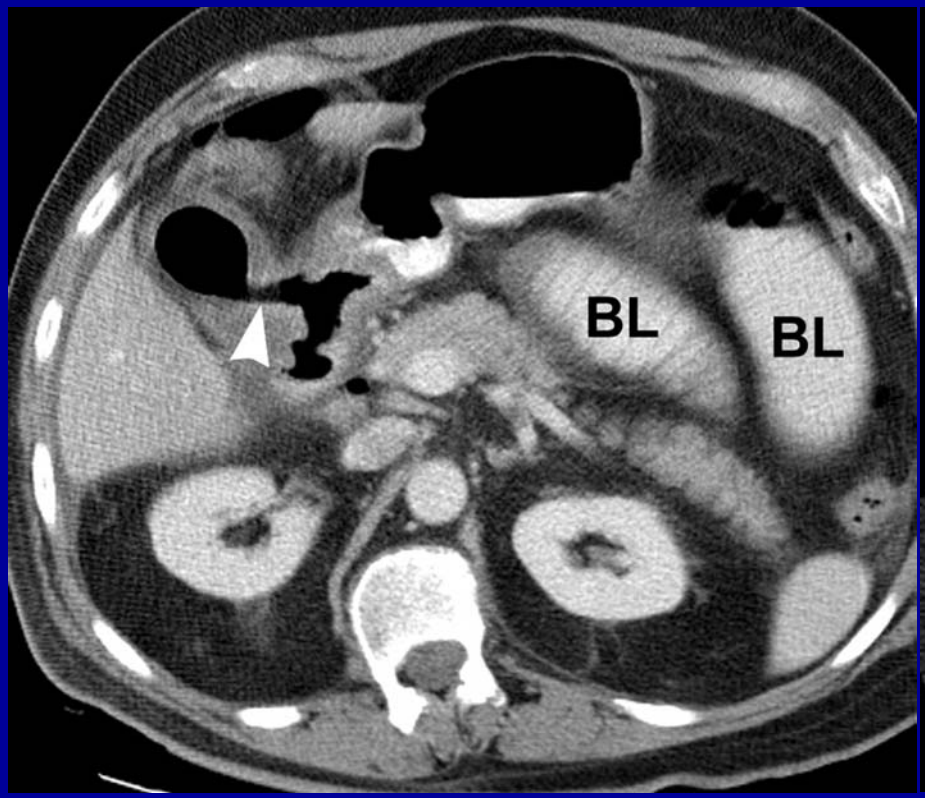
- Most common biliary cancer
- 85% adenocarcinoma
- Clinical: RUQ pain, jaundice, weight loss, anorexia, vomiting
- Findings:
  - Focal, irregular wall thickening,
  - GB wall calcification (porcelain)
  - Metastasis



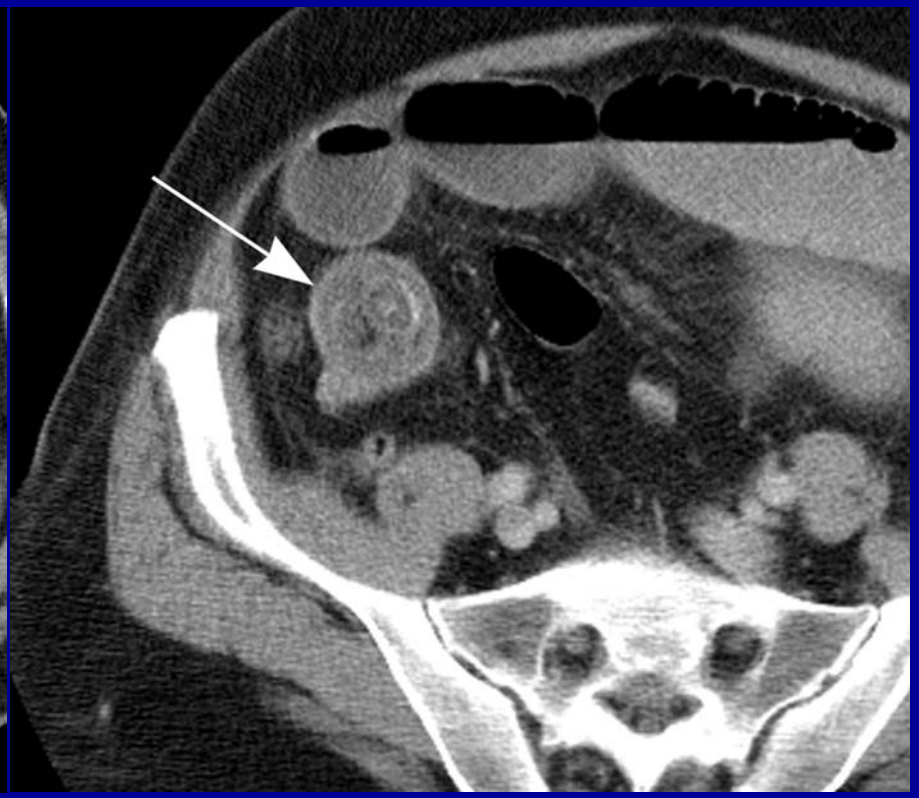
Cholecystoenteric Fistula

- GB inflammation leads to chronic perforation and fistulous communication to adjacent bowel (duodenum; colon)
- Cholecystoduodenal fistula is more common
- GB stones, if large enough, can cause mechanical obstruction (e.g. in ileum = GB ileus)

Cholecystoenteric Fistula



Arrowhead points to
fistulous connection
between GB and duodenum



Obstructing GB stones
in ileum

Choledocholithiasis

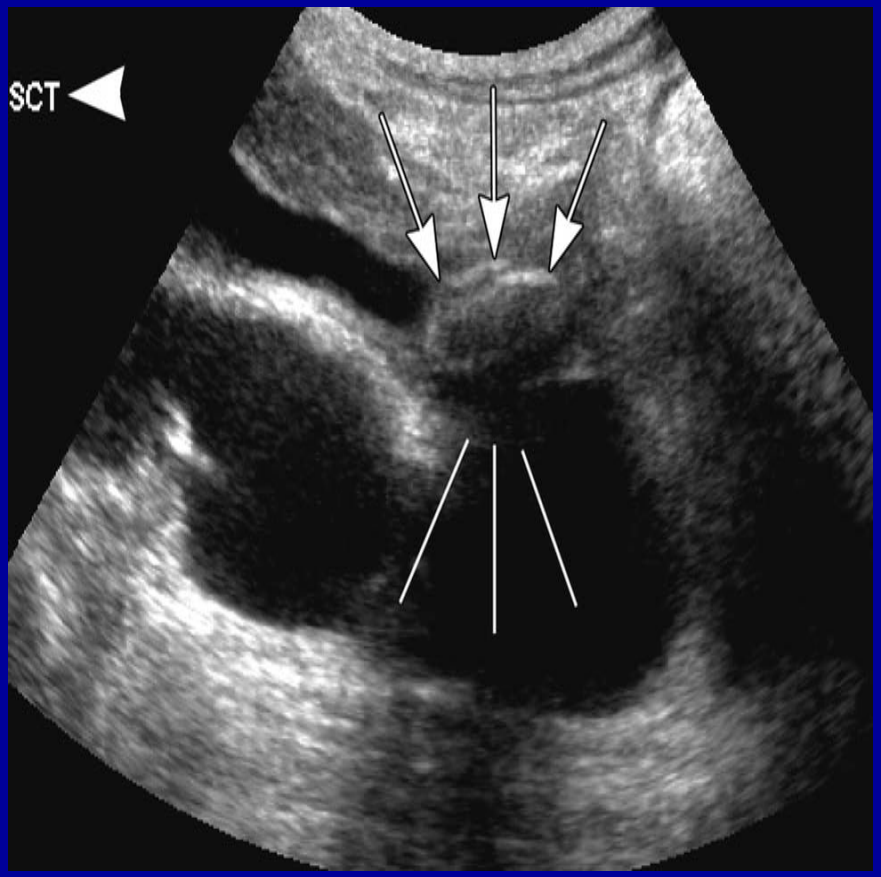
- Stones within the common bile duct
- Most stones form in GB and pass into duct
- Normal CBD
- 7mm, or 1/10th age in mm (e.g. 8mm at age 80)
- S/p cholecystectomy: 10mm
- Clinical: pain and jaundice

Choledocholithiasis

US finds only about 70% of CBD stones

US

- Primary use: identify dilated ducts
- Secondary use: identify etiology



Choledocholithiasis

- MRCP
- Most sensitive (95%) and specific (100%) for CBD stones
- Usually done after US, prior to ERCP

Acute Pancreatitis

- Etiology: biliary (40%), EtOH (35%); unknown (25%)
- Clinical: acute pain often with vomiting, fever, leukocytosis, elevated pancreatic enzymes
- US not usually helpful
- CT:
  - Not necessary in mild forms
  - Often helpful in equivocal or severe cases

Acute Pancreatitis

- CT can be normal in 1/3 of mild ceases
- CT findings
  - Enlargement of gland
  - Border irregularity
  - Inflammation of peripancreatic fat

Acute Pancreatitis

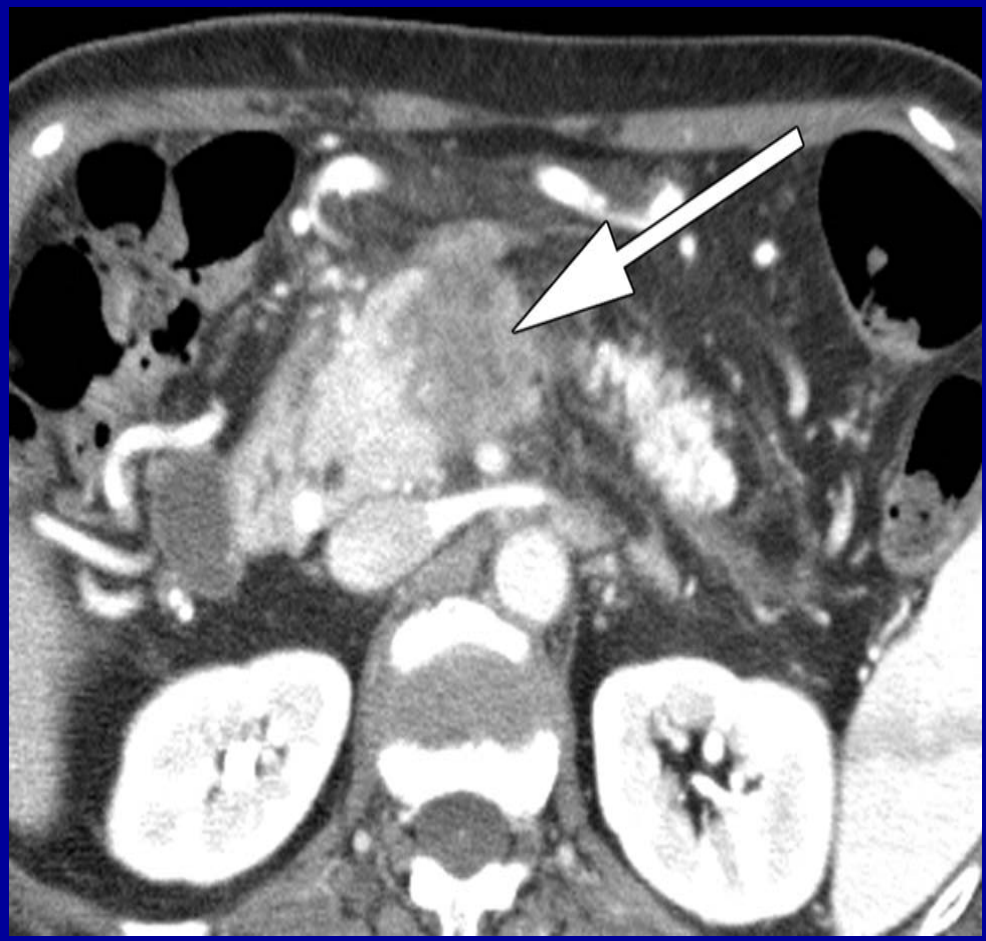
- Associated findings:
  - focal fluid collections
  - pseudocyst (fibrous tissue wall)
  - splenic vein thrombosis
  - aneurysms
  - necrosis
  - hemorrhage

Pancreatic Cancer

- 5th most common cause of cancer death
- 85% adenocarcinoma;
- Poor prognosis: < 1% 5 year survival
- Clinical findings: pain; weight loss; anorexia; jaundice (sometimes painless)
- CT is the best initial test
- MRI is also useful

Pancreatic Cancer

- Findings:
  - Ill-defined mass, most commonly in head
  - Duct dilatation, tail atrophy, invasion of adjacent structures (e.g. duodenum)
  - Vascular encasement
  - Celiac axis, SMA, SMV
  - >180 degrees = non-resectable



Pancreatic Cancer

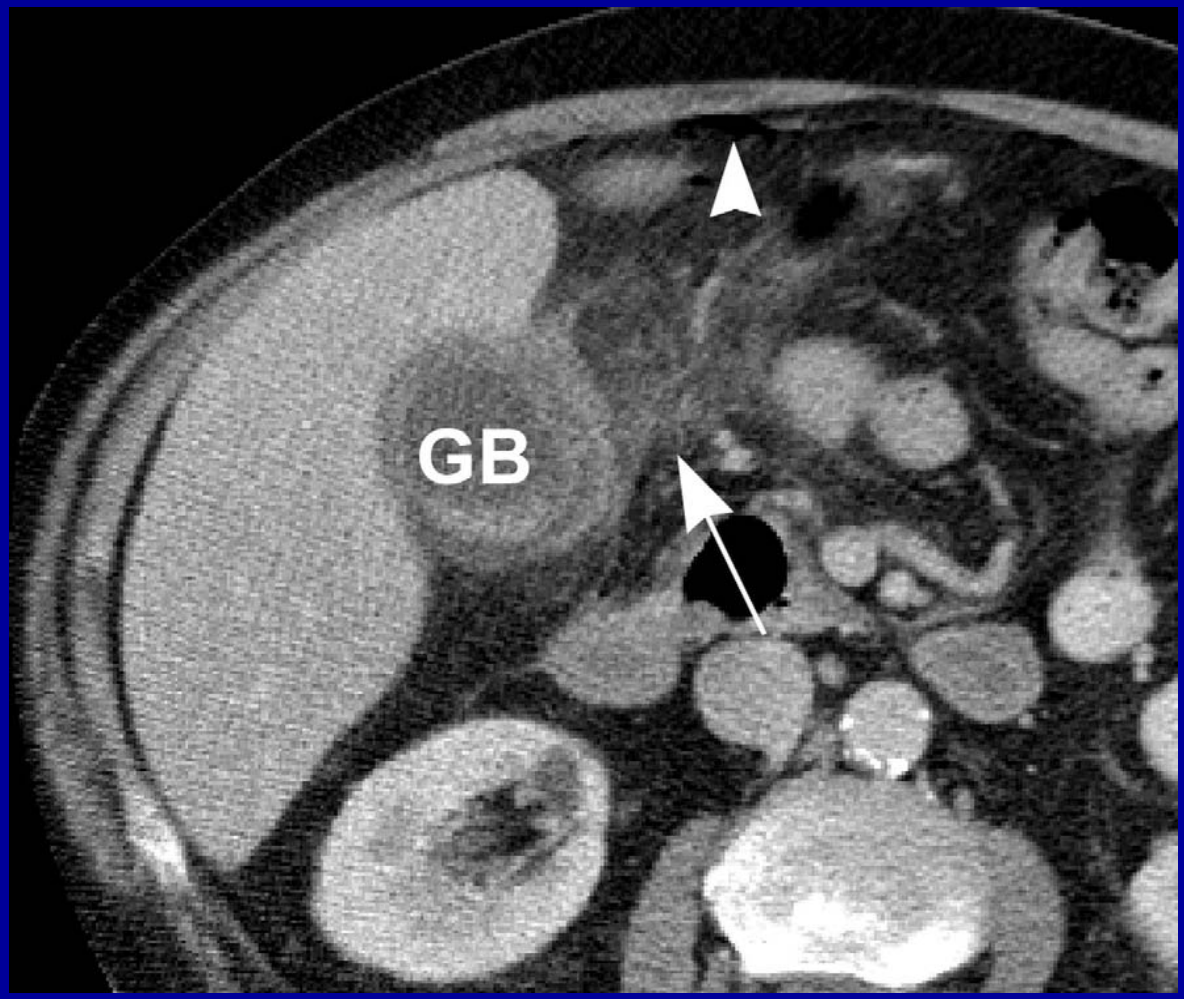
Pancreatic cancer encasing and partially narrowing the main portal vein, non-resectable

Perforated Duodenal Ulcer

- Etiology: too much acid in duodenum
- More common in: steroids; head injury; COPD
- Perforation occurs in < 10%
- CT findings:
  - Duodenal wall thickening
  - Ascites
  - Free air

Perforated Duodenal Ulcer, CT

Arrowhead points to free air in abdomen



Pneumonia

- RUQ pain occurs in RLL pneumonia from irritation of diaphragm
- Clinical findings: pain; cough; fever; leukocytosis; dyspnea
- CXR: focal air space opacity

RLL Pneumonia

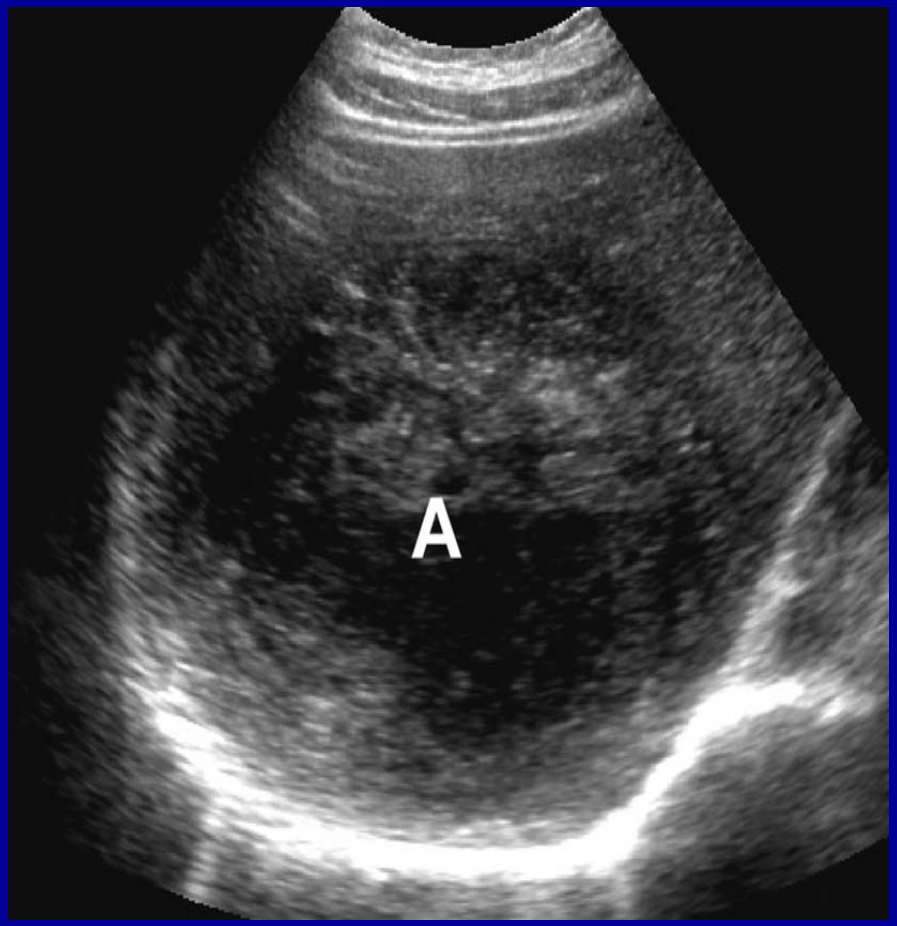
- Chest x-ray showing
- Density and pleural effusion at right lung base

Liver

- Inflammatory: Abscess
  - Clinical: acute abdominal pain; fever; RUQ tenderness; may have insidious onset
  - Sources: cholangitis; GI tract (appendicitis; diverticulitis); endocarditis; direct contiguous spread; no source can be found in 50% of cases
- US is diagnostic in > 90% of cases
- Variable appearance: complex cystic; solid
- CT has complimentary role

Liver Abscess

US



CT

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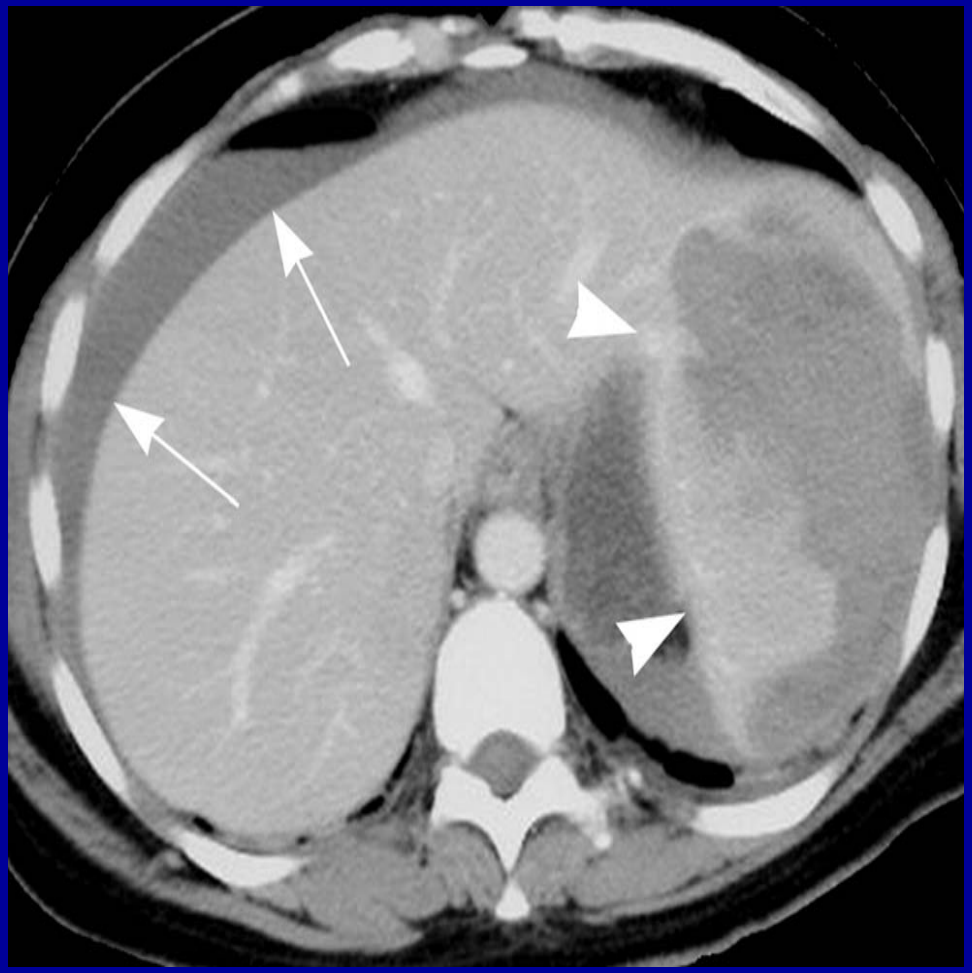
Liver Neoplasms

- Any large liver mass (mets; primary liver tumor) can cause RUQ pain because of pressure on the liver capsule
- Acute pain generally results from a complication such as rupture or hemorrhage
- Vascular liver mets: renal cell Ca; neuroendocrine tumors
- Liver masses: hepatic adenoma ; HCC; FNH, large cavernous hemangiomas

Hepatic Adenoma

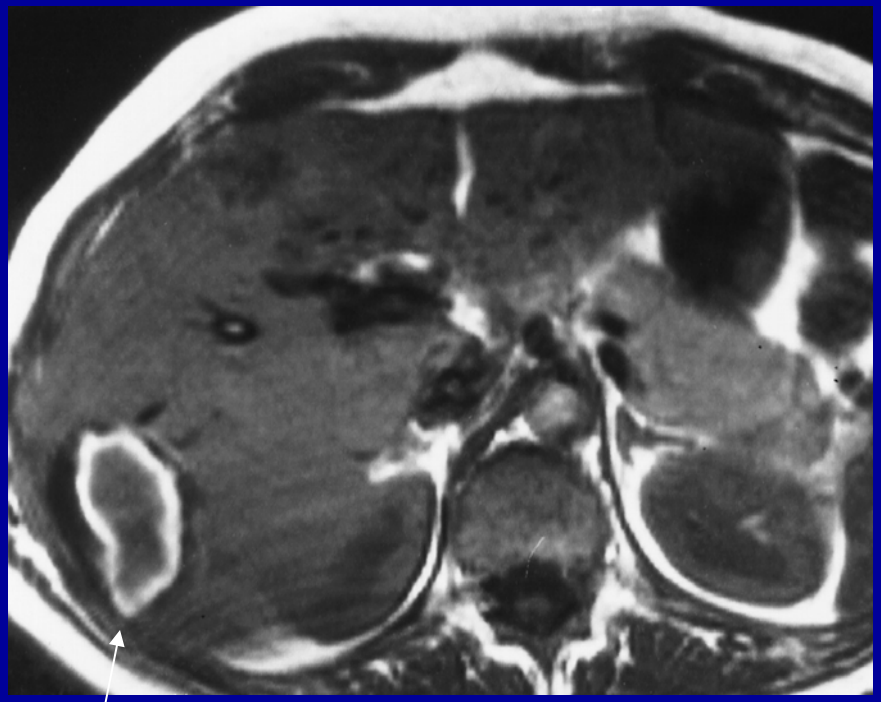
- Rare
- Seen in women of reproductive age using oral contraceptives; also in patients taking large doses of androgen-containing steroids for prolonged periods
- Most are asymptomatic
- Large and multiple adenomas are more prone to risk of rupture and hemorrhage



Hepatic Adenoma with Hemorrhage

CT

MRI, T1 axial



Acute bleed within mass

Summary

- US is the first imaging study in most patients with RUQ pain
- CT may be first in certain clinical situations
- MRI and Nuclear Medicine may be helpful follow-up studies

Thank You