

Acute Abdominal Pain in Pregnancy: How to image when push comes to shove

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Disclosures

There are no financial relationships with a commercial organization that may have a direct or indirect interest in the content.

Objectives

GOALS & OBJECTIVES:

- Understand the risks and benefits of different imaging modalities for a pregnant patient and her fetus in the setting of acute abdominal pain
- Review risks to the fetus associated with radiation exposure and contrast agents
- Gain familiarity with recommended algorithms for imaging studies in pregnant patients based on maternal symptoms
- Review the imaging appearance of common causes of acute pain in pregnant patients

TARGET AUDIENCE:

- Radiology physicians, emergency medicine physicians, medical students

Imaging Modalities in Pregnancy

Ultrasound (US)

- No documented adverse effects
- Recommend minimizing exposure time and acoustic output in Doppler US

Radiographs and Computed Tomography (CT)

- Radiation exposure >100mGy can cause spontaneous abortion (gestational age weeks 3-4), malformations (weeks 5-10), and intellectual disability (weeks 11-17)
- Iodinated contrast is safe

Magnetic Resonance Imaging (MRI)

- Theoretical risks due to heating effects of radiofrequency pulses and acoustic noise

Summary of suspected in utero induced deterministic radiation effects

Gestational Age	< 50 mGy	50-100 mGy	> 100 mGy
0-2 weeks	None	None	None
3-4 weeks	None	Probably none	Possible spontaneous abortion
5-10 weeks	None	Potential effects are scientifically uncertain and probably too subtle to be clinically detectable	Possible malformations increasing in likelihood as dose increases
11-17 weeks	None	Potential effects are scientifically uncertain and probably too subtle to be clinically detectable	Risk of diminished IQ or of mental retardation, increasing in frequency and severity with increasing dose
18-27 weeks	None	None	IQ deficits not detectable at diagnostic doses
>27 weeks	None	None	None applicable to diagnostic medicine

CT Risks

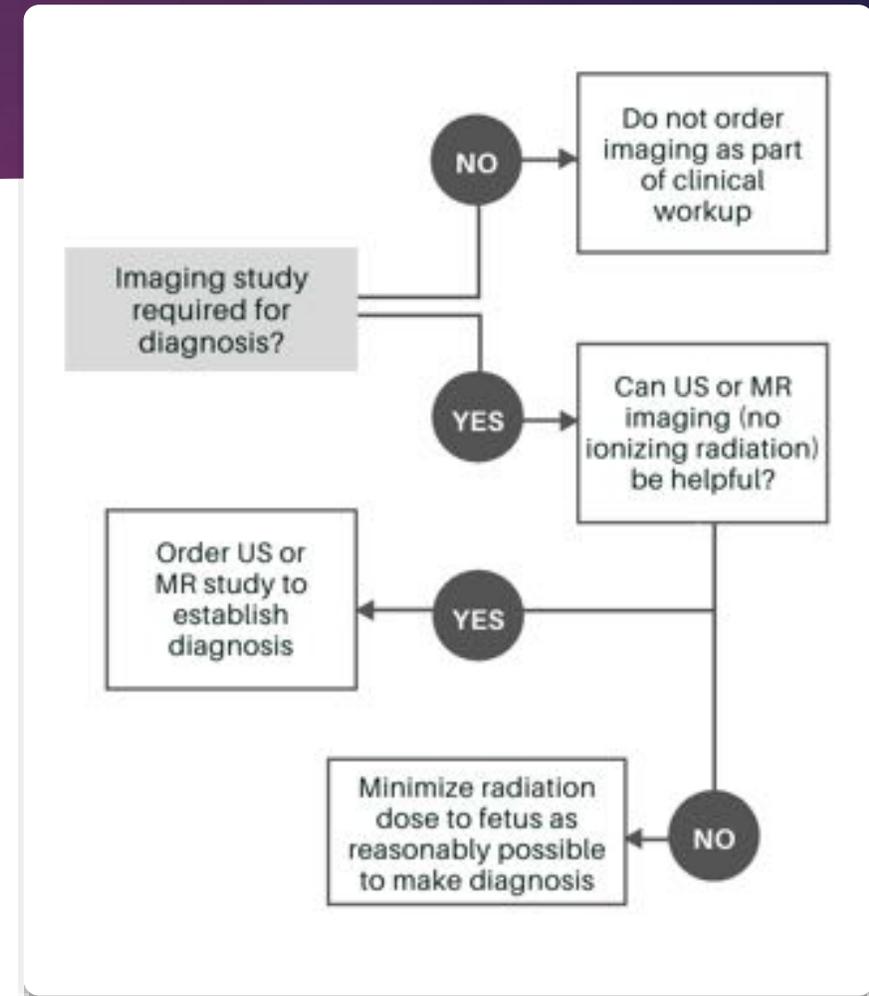
- ▶ Radiation exposure through radiography, CT, or nuclear medicine imaging is usually at a dose lower than the exposure associated with fetal harm and should not be withheld from the pregnant patient if diagnostic imaging requiring radiation is indicated.
- ▶ Risk of subsequent carcinogenesis due to in utero exposure to ionizing radiation is less clear.
- ▶ Fetal exposure from a CT abdomen/pelvis scan may increase the risk of leukemia by a factor of 1.5 over the background rate of approximately 1 in 3000.
- ▶ Although a typical CT abdomen/pelvis scan delivers 10-25 mGy of radiation, the radiation exposure to the fetus may be as low as 4.8 mGy.
- ▶ A special CT protocol can reduce fetal radiation exposure to approximately 2.5 mGy by increasing scan pitch, decreasing the milliampere-seconds value, and using z-axis modulation.

MRI Contrast Risks

- ▶ The risk to the fetus of gadolinium-based MR contrast agent administration remains unknown.
- ▶ Some gadolinium-based MRI contrast agents pass through the placental barrier, enter fetal circulation, are filtered in the fetal kidneys, and then excreted into the amniotic fluid.
- ▶ Gadolinium-chelate molecules may remain in the amniotic fluid for an indeterminate amount of time before being reabsorbed and eliminated.
- ▶ The longer the chelated molecule remains in amniotic fluid, the greater the potential for dissociation of the potentially toxic gadolinium ion from its ligand.
- ▶ Impact of free gadolinium ions is unknown.

Imaging in Pregnancy: The Algorithm

- ▶ Because obstetric etiologies are most commonly the source of abdominal pain in pregnant women, **ultrasound** is usually the first modality of choice.
- ▶ If the ultrasound is not diagnostic or the symptoms point to certain diagnoses better evaluated by cross-sectional, **MR** is the modality of choice.
- ▶ If MR is not available or non-diagnostic, proceed with **CT**, especially in an acute setting, when the benefits of the exam outweigh the risks.



Cases

Appendicitis

Challenges

- Overlap in symptoms between appendicitis and normal pregnancy
- Likely to present with non-classic symptoms during pregnancy
- Anatomical changes related to a gravid uterus
- Physiological leukocytosis with pregnancy

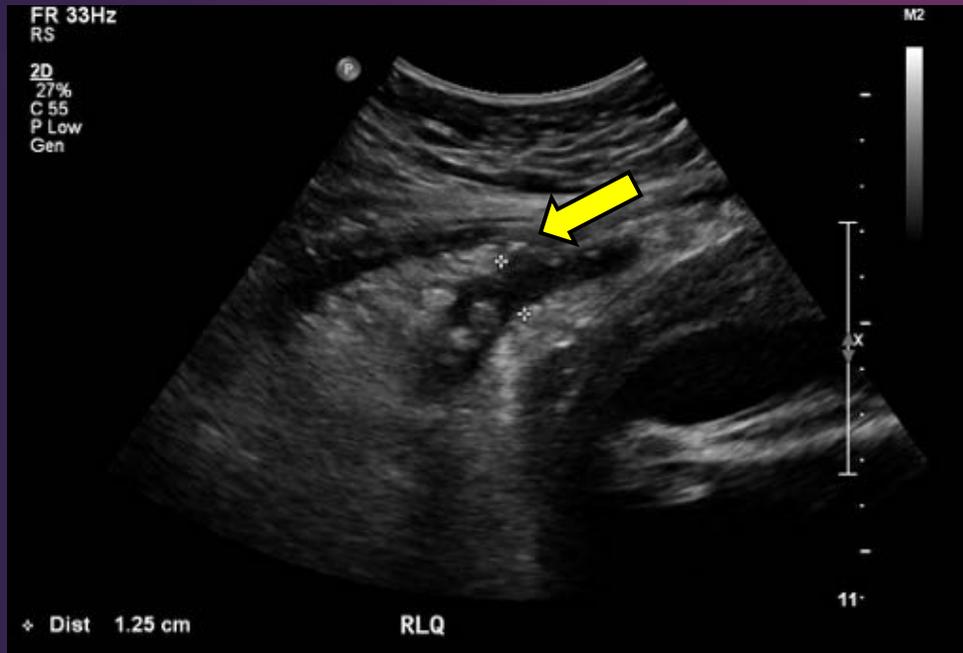
Diagnosis

- Rate of negative appendectomy higher in pregnant women compared with nonpregnant women
- US with graded compression is the initial imaging modality of choice

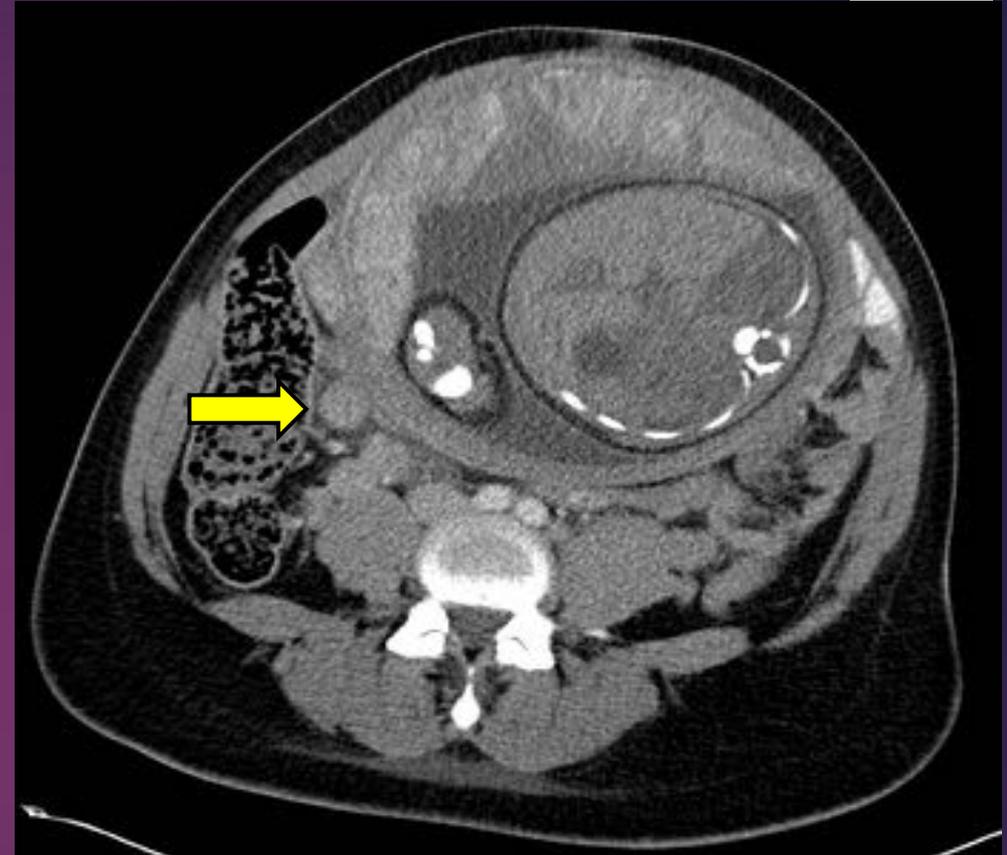
Management

- Treatment is appendectomy
- Delay in surgical intervention for >24 hours after symptom onset increases the risk of perforation
- No difference in morbidity following appendectomy between pregnant and nonpregnant women

Appendicitis

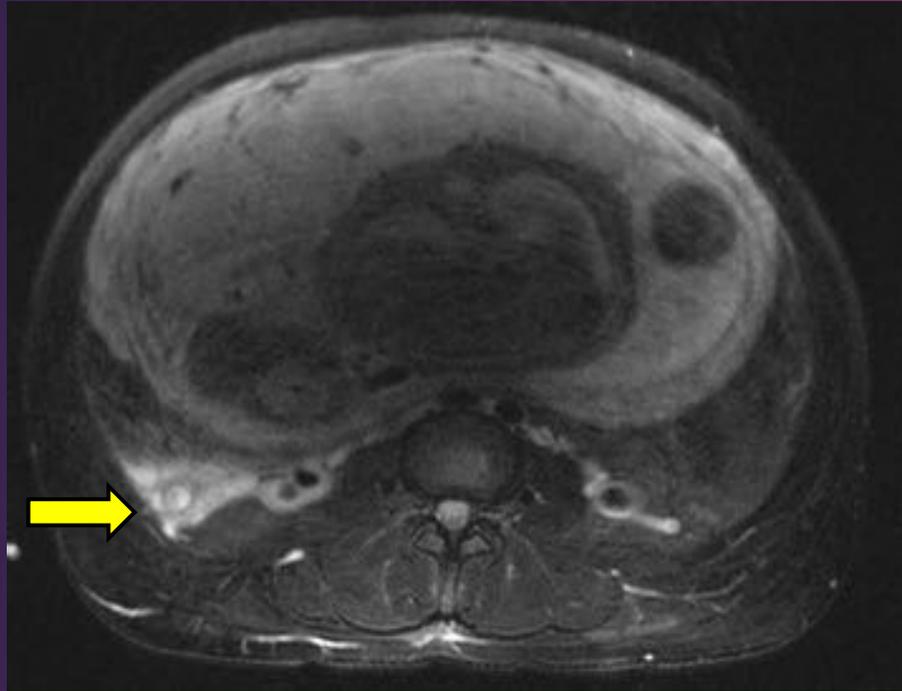


US image of a 28-week pregnant woman with right lower quadrant (RLQ) pain demonstrating a dilated blind-ending tubular structure in the RLQ, measuring 13-mm in diameter with echogenic material within the lumen, suggesting an appendicolith. Pathology demonstrated perforated acute suppurative appendicitis.



Axial CT image of a 36-week pregnant woman with RLQ pain demonstrating a dilated appendiceal tip measuring 16-mm (arrow) with mild surrounding stranding. Pathology demonstrated acute peri-appendicitis with marked pregnancy-related decidualization.

Appendicitis



Axial T2-weighted fat saturated (fat sat) MR image of a 26-week pregnant woman with worsening abdominal pain and leukocytosis, demonstrating a dilated appendix with an appendicolith, measuring up to 13-mm in diameter, with associated minimal surrounding fat stranding.



Coronal T2-weighted MR image of a 34-week pregnant woman with abdominal pain demonstrating a dilated appendix measuring 14-mm, periappendiceal fat stranding and T2 hyperintensity suggestive of inflammation, and a few small appendicoliths in the appendix lumen.

Small Bowel Obstruction (SBO)

Challenges

- SBO risk increases during pregnancy as the uterus enlarges
- Nausea and vomiting can be physiologic in the first half of pregnancy, but SBO should be suspected if new onset of symptoms later in pregnancy or additional peritoneal signs

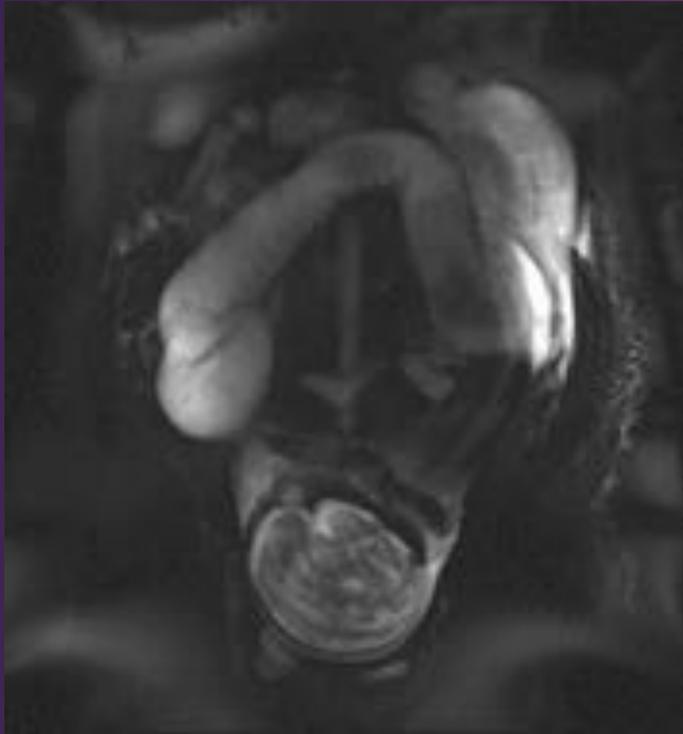
Diagnosis

- US and KUB are the initial imaging modalities of choice
- MRI can help further characterize the site and degree of obstruction

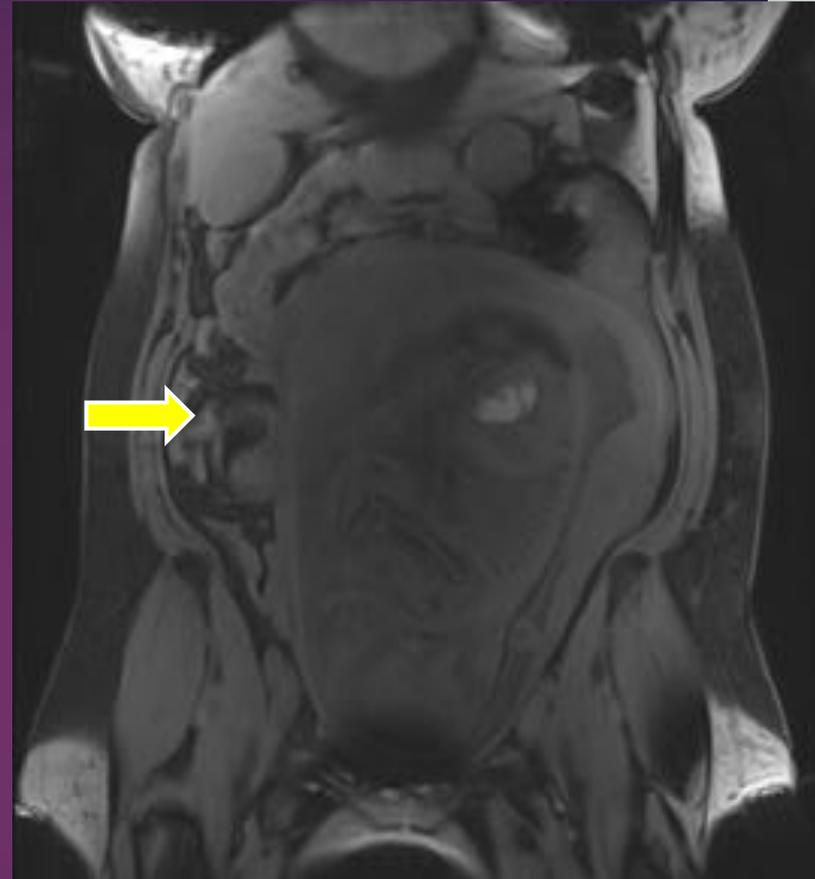
Management

- Same indications for immediate surgery as nonpregnant patients (suspected bowel perforation, necrosis, ischemia, or surgically correctable cause with the exception of adhesions)

Small Bowel Obstruction



Sagittal T2-weighted MR images of a 31-week pregnant woman with abdominal pain demonstrating multiple loops of distended fluid-filled small bowel with a transition point in the left lower quadrant (LLQ).



Coronal T1-weighted fat sat MR image of a 32-week pregnant woman with abdominal pain demonstrating dilated loops of proximal small bowel with transition point in the RLQ (arrow) and collapsed distal small bowel and colon.

Inflammatory Bowel Disease

Challenges

- Increased risk of disease flare in pregnant patients with ulcerative colitis

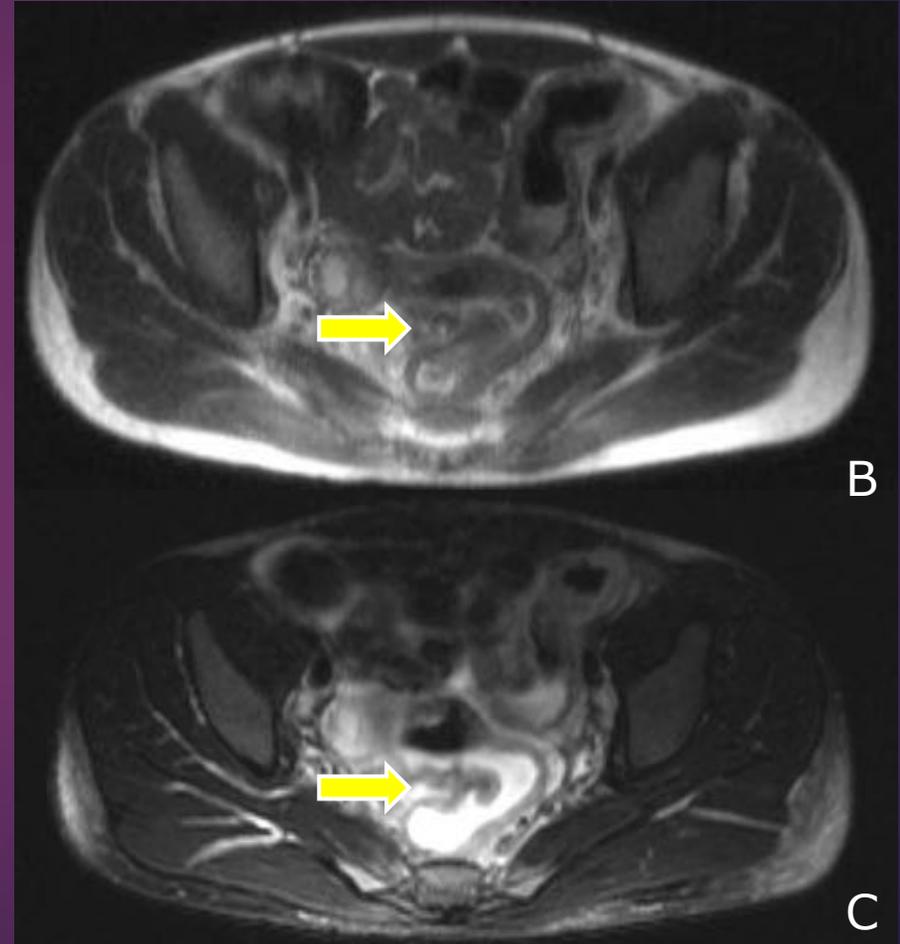
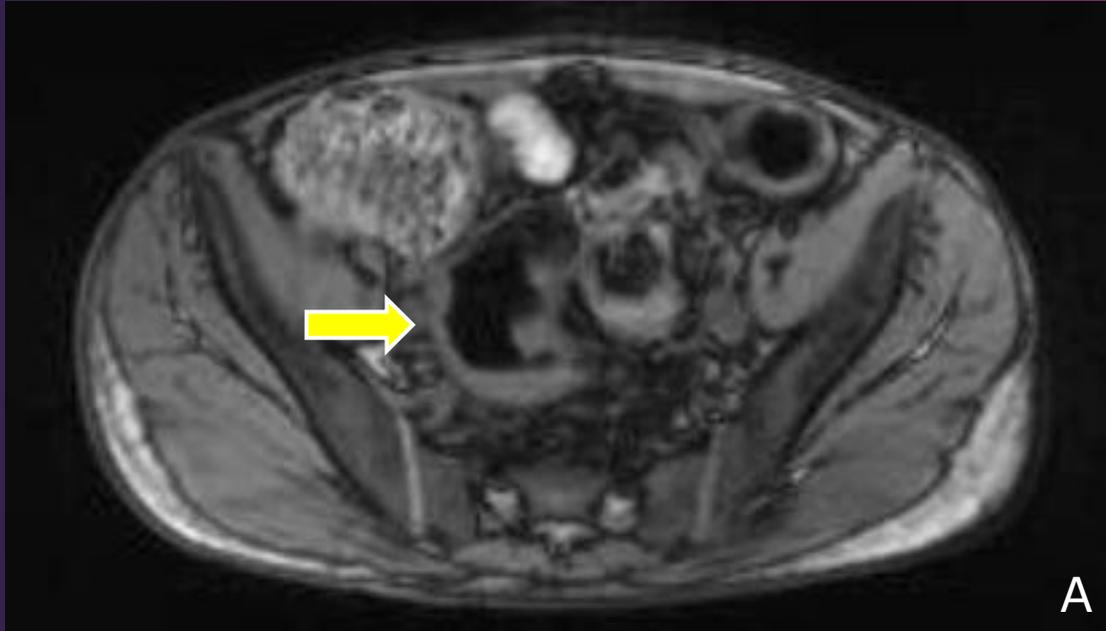
Diagnosis

- US and MRI are the initial imaging modalities of choice
- Oral contrast often used

Management

- Consider medical treatment prior to surgery, as surgery associated with preterm labor and spontaneous abortions
- Surgery warranted in the setting of acute refractory colitis, perforation, abscesses, severe hemorrhage, and obstruction
- Surgery ideally performed in second trimester

Inflammatory Bowel Disease



A) Axial T1-weighted out of phase MR image of a 8-week pregnant woman with abdominal pain showing bowel wall-thickening (arrow). **B)** SSFSE T2-weighted MR image showing bowel wall-thickening (arrow). **C)** T2-weighted fat sat MR image showing fat stranding and diffuse T2 signal suggestive of edema (arrow). Pathology showed ulcerative colitis.

Cholecystitis

Challenges

- Increased risk of gallstone formation during pregnancy due to increase in estrogen (increases cholesterol secretion) and progesterone (delays gallbladder emptying) levels
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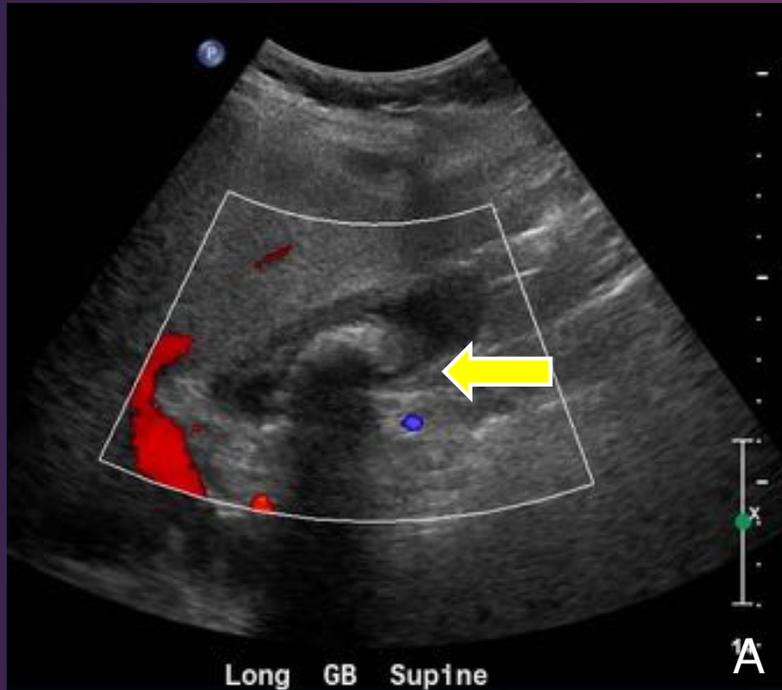
Diagnosis

- US is the initial imaging modality of choice
- MR non-contrast can be helpful if US not diagnostic
- HIDA scan not usually used

Management

- Surgery indicated if sepsis, gangrene, or perforation is suspected
- In the first and second trimesters -> cholecystectomy
- In third trimester -> nonoperative medical management until 6 weeks after delivery, if possible

Cholecystitis



A) US image of a 39-week pregnant woman with RUQ pain showing cholelithiasis and sludge (arrow).

B) US image showing circumferential gallbladder wall thickening measuring up to 4-mm (arrow).



GB Wall Diam 0.41 cm

Long GB Supine

Pancreatitis

Challenges

- Most commonly due to gallstone disease
- Can be associated with acute fatty liver of pregnancy, familial hypertriglyceridemia, preeclampsia, and hyperemesis gravidarum
- Intrapartum recurrence common if initial event managed conservatively

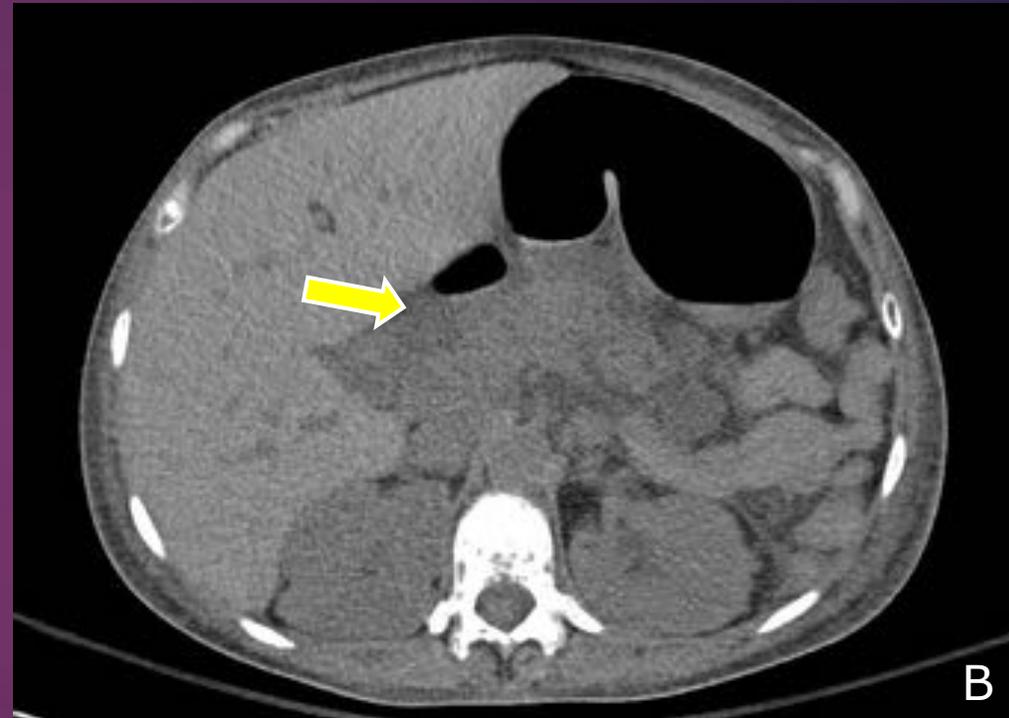
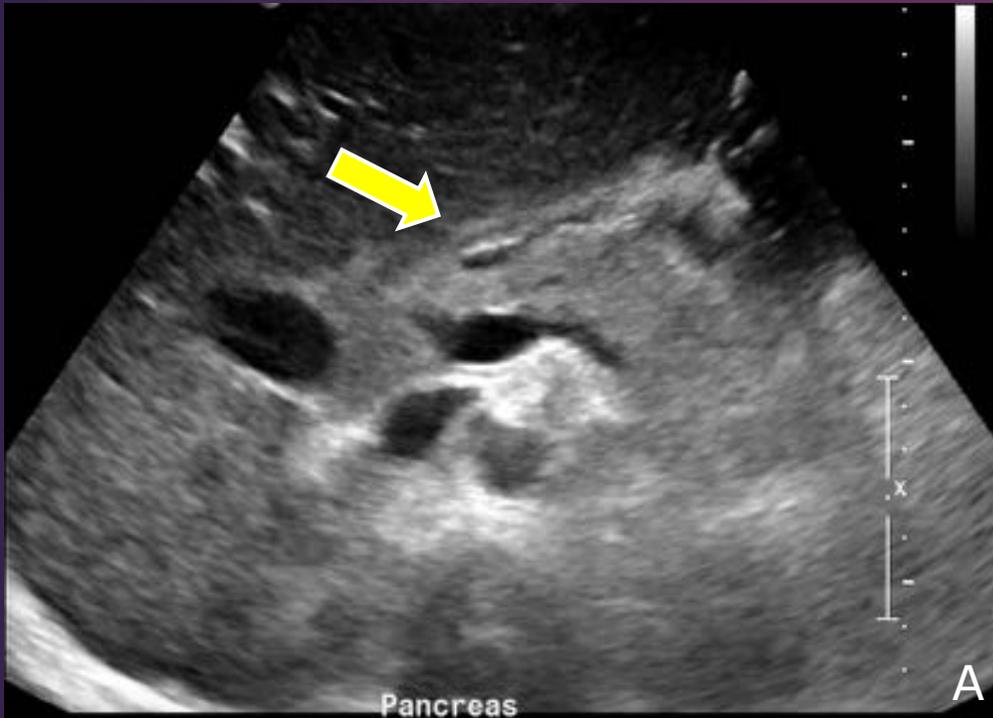
Diagnosis

- US is the initial imaging modality of choice
- Consider MR if US not diagnostic

Management

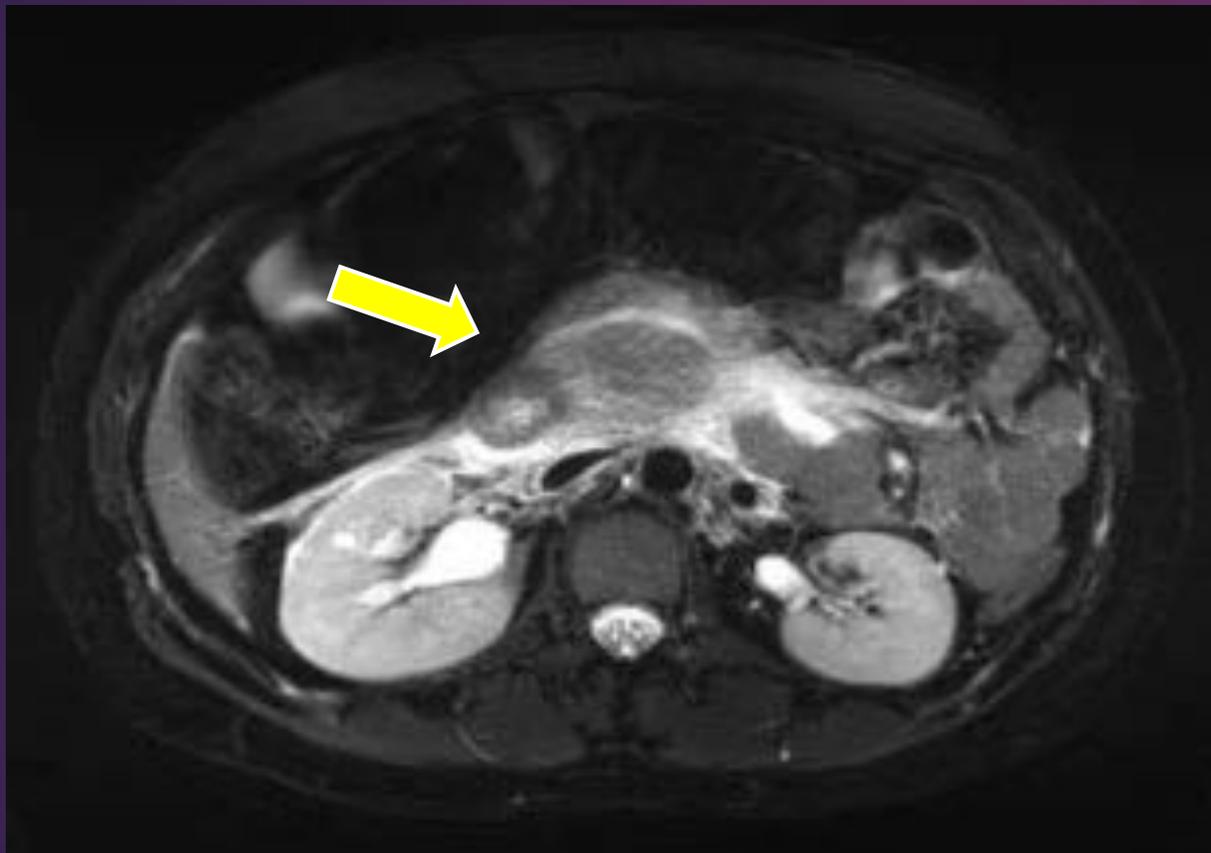
- Consider MRCP without contrast instead of ERCP if suspect biliary pancreatitis
- Avoid fluoroscopy or decrease fluoroscopy time with ERCP
- Consider left lateral decubitus positioning for patients in the third trimester, instead of prone

Pancreatitis



A) US image of a 30-week pregnant woman with abdominal pain, demonstrating pancreatic fullness, heterogeneity, and fluid anterior to the pancreas (arrow). **B)** Axial non-contrast CT image showing peripancreatic stranding and fluid, primarily in the region of the pancreatic head and body (arrow).

Pancreatitis



Axial T2-weighted fat sat MR image of a 22-week pregnant woman with severe periumbilical abdominal pain and elevated lipase levels demonstrating T2 hyperintensity suggestive of peri-pancreatic fluid and edema (arrow). She was found to have acute pancreatitis.

Hydronephrosis

- ▶ Renal collecting system dilation can occur during pregnancy due to progesterone resulting in smooth muscle relaxation and extrinsic compression from the gravid uterus.
- ▶ Hydronephrosis can occur as early as 10 weeks, but more commonly occurs in the second and third trimesters.
- ▶ Abdominal or flank pain is common in pregnancy, and it is important to distinguish between obstructive and physiologic hydronephrosis related to pregnancy.

Hydronephrosis: Physiologic vs. Obstructive

Physiologic

- ▶ Proximal ureter dilation
- ▶ Normal distal ureter
- ▶ Smooth tapering in the middle third of the ureter
- ▶ Right-sided more common

Obstructive

- ▶ Renal enlargement and perinephric edema
- ▶ Dilated side reflects symptomatic side
- ▶ Ureteral jets may be absent

Hydronephrosis: US

Ultrasound

- ▶ Pathological obstruction can be excluded if renal pelvis dilation is absent or trace.
- ▶ Left-sided dilatation with left flank pain is highly suggestive of left pathological obstructive hydronephrosis.
- ▶ Lumbar ureters can be visualized with the amniotic fluid as an acoustic window, the patient in contralateral oblique position, and the transducer positioned longitudinally in the iliac fossa.
- ▶ Ureters often taper at the level of the common iliac artery in physiologic dilatation.
- ▶ Transvaginal US can be helpful in detecting distal ureteral stones.
- ▶ US sensitivity for detection of nephrolithiasis during pregnancy is low, so MR can be used as second-line imaging modality.

Hydronephrosis: CT and MRI

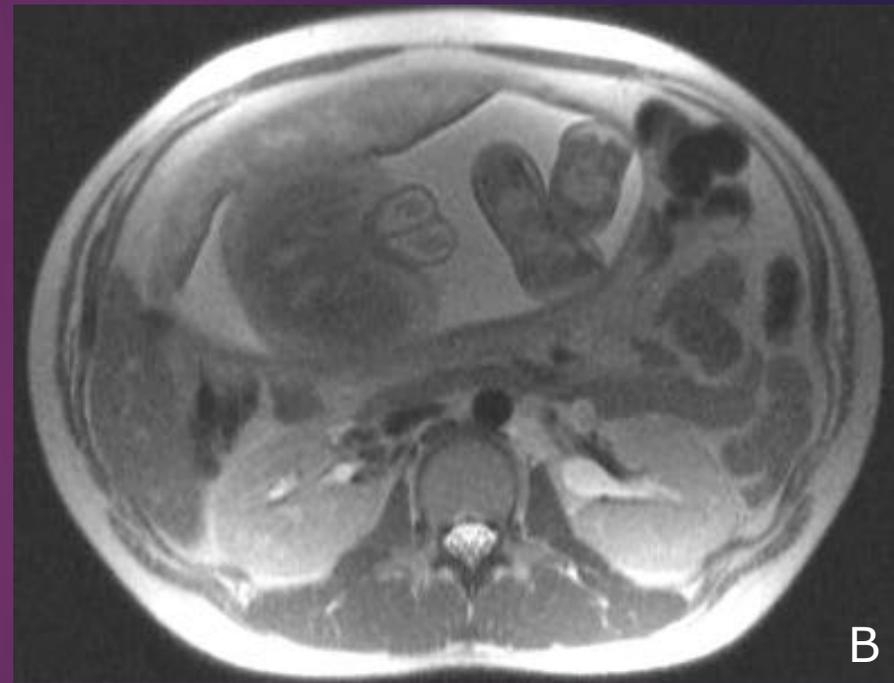
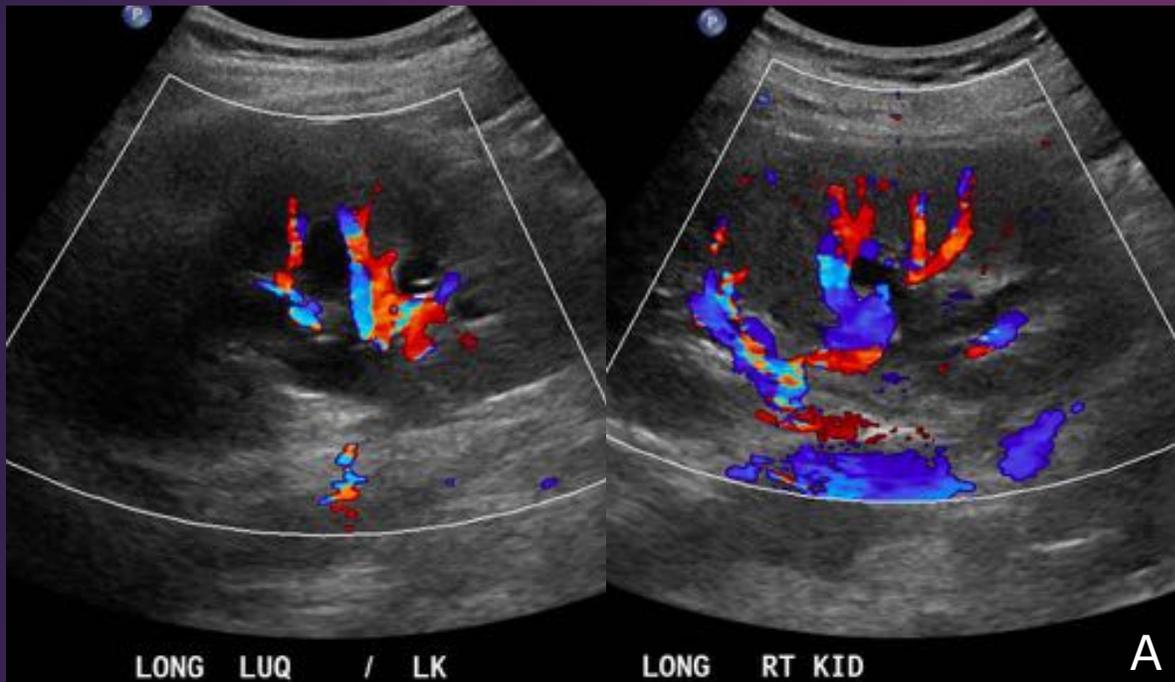
Low-dose CT

- ▶ CT highly sensitive for detecting nephrolithiasis, but has ionizing radiation.
- ▶ Reduce fetal exposure to radiation with narrow collimation and faster image acquisition.

MRI

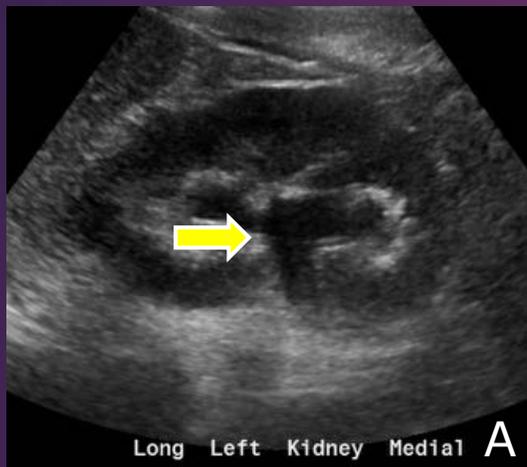
- ▶ Stones appear as signal voids in a dilated ureter. Assess in all planes to avoid confusing air, clot, or flow artifacts.
- ▶ MR is limited in detecting and characterizing small stones.
- ▶ Consider stones in the setting of an abrupt cut-off of signal in the ureter at the ureteropelvic or ureterovesical junction.
- ▶ Obstructive hydronephrosis demonstrated by perinephric or periureteral edema.
- ▶ Physiologic dilatation demonstrated by smooth tapering.
- ▶ MR can detect non-urinary tract pathology.

Physiologic Hydronephrosis

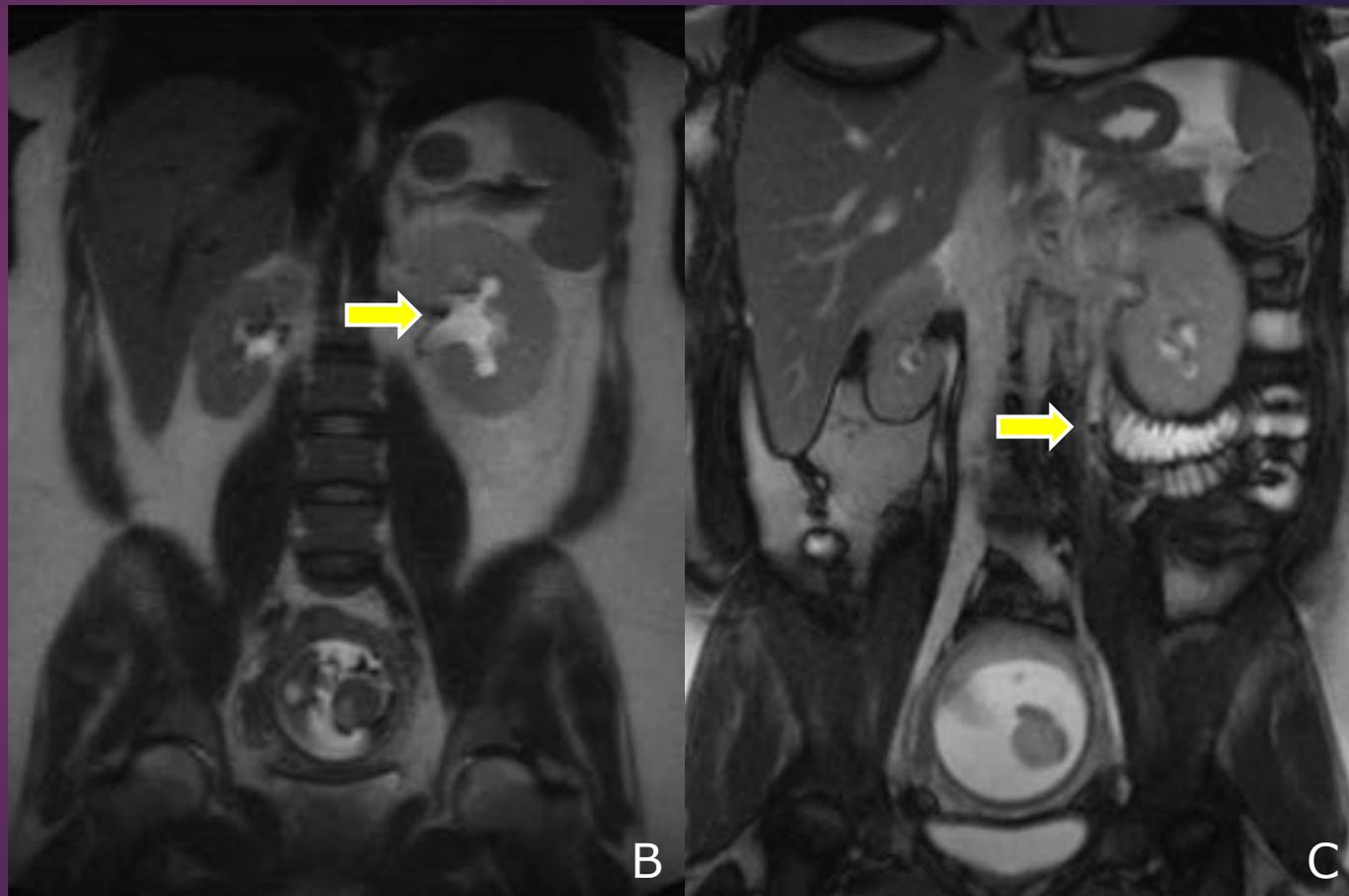


A) US images of a 34-week pregnant woman with abdominal pain demonstrating incidental bilateral, right greater than left, mild dilation of the collecting system. **B)** Corresponding axial T2-weighted MR image demonstrating incidental mild bilateral hydronephrosis.

Obstructive Hydronephrosis



A) US image of a 15-week pregnant woman with left flank pain demonstrating a dilated collecting system (arrow). B) Coronal T2-weighted MR image demonstrating an enlarged and edematous left kidney (arrow). C) Coronal T2-weighted MR image showing proximal ureteral dilatation with stone (arrow), representing obstructive hydronephrosis.



Pyelonephritis

Challenges

- Most cases of pyelonephritis occurs during the second and third trimesters
- Pyelonephritis in the context of pregnancy can cause severe complications including septic shock, acute renal failure, and acute respiratory distress syndrome.

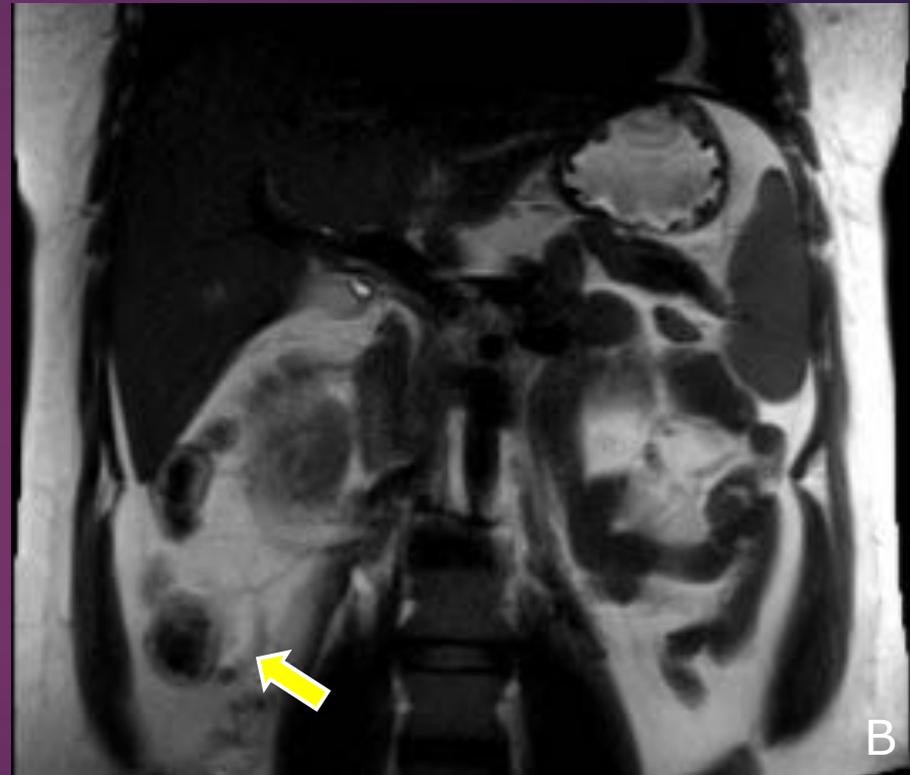
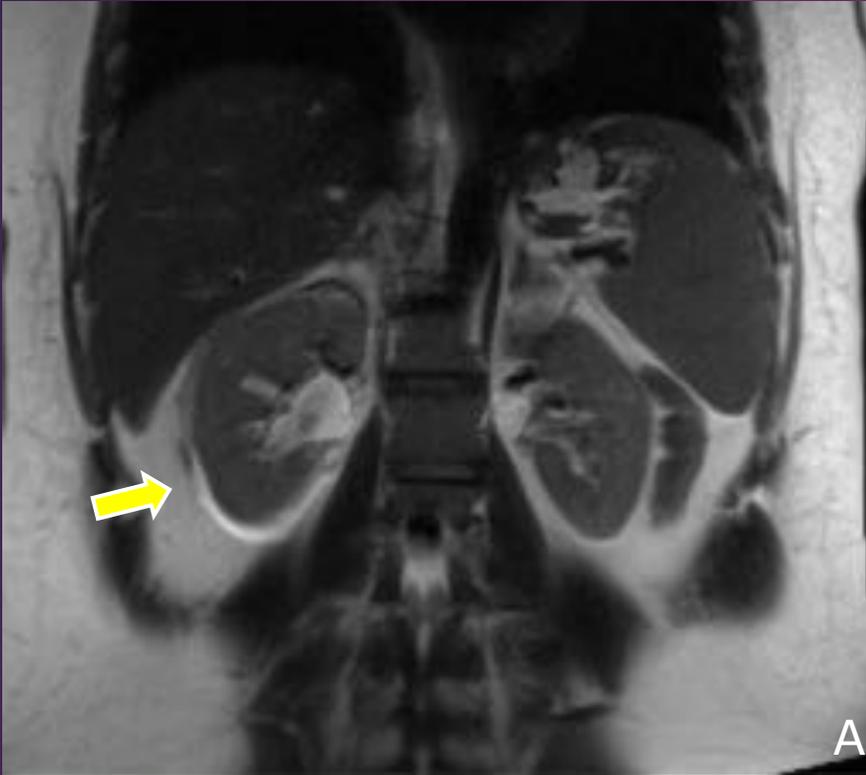
Diagnosis

- Imaging generally not needed for diagnosis
- Imaging can be helpful for diagnosis of complications of pyelonephritis
- US is the initial imaging modality of choice

Management

- Hospital admission for pregnant patients
- Antibiotics

Pyelonephritis



A) Coronal T2-weighted MR image of a 23-week pregnant woman with RLQ pain and hematuria demonstrating right-sided perinephric fluid with surrounding fat stranding (arrow), representing pyelonephritis. **B)** Coronal T2-weighted MR image showing a normal appendix (arrow).

Adnexal Mass

Challenges

- Overlap in nonspecific symptoms with pregnancy
- Initial presentation can be similar to ovarian torsion
- Some ovarian tumors can produce hormonal markers that can skew results of prenatal screening tests

Diagnosis

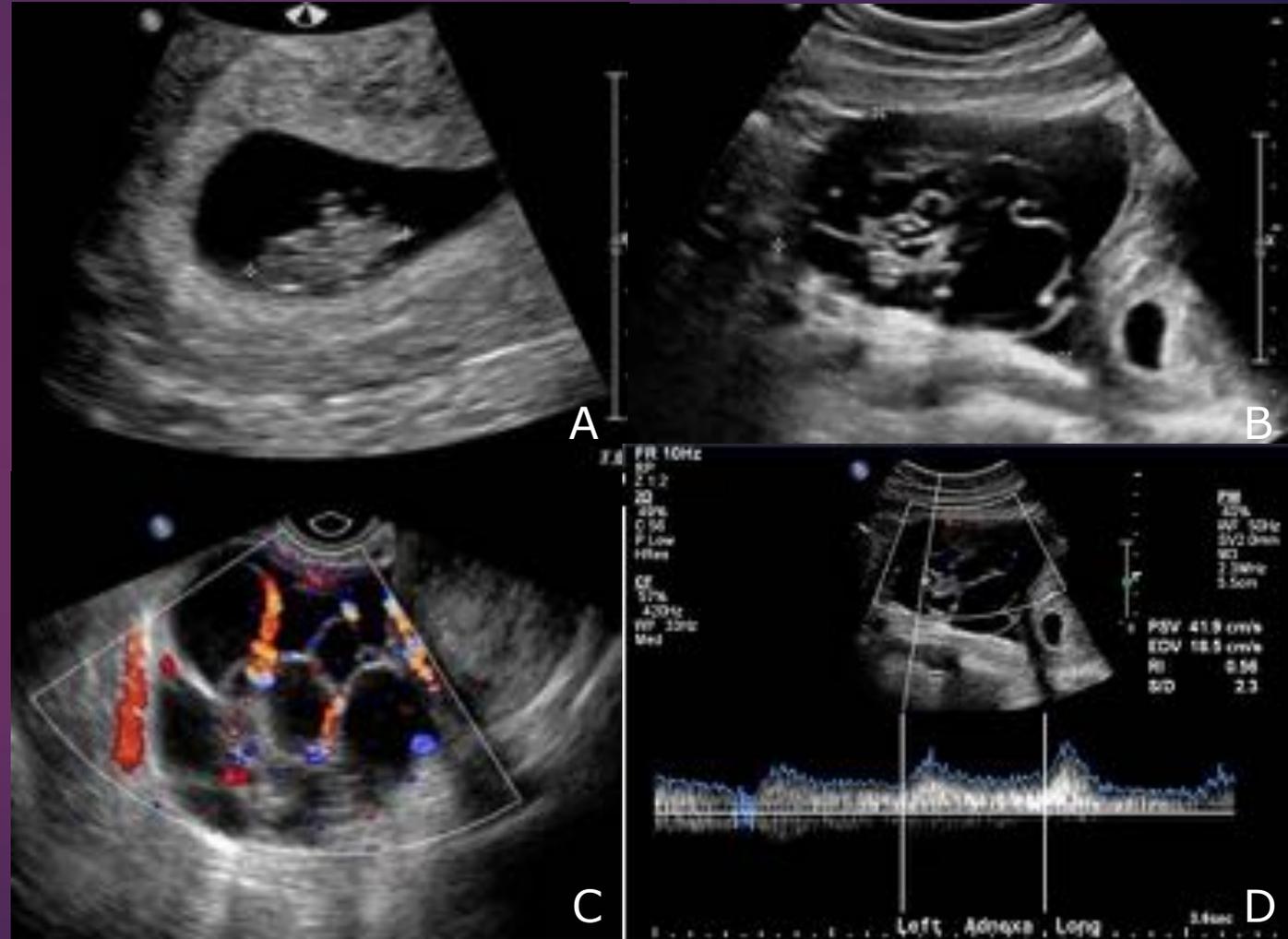
- US is the imaging modality of choice to guide initial management
- MR has great resolution for soft tissue pathology
- Pathology needed for definitive diagnosis

Management

- Exploratory surgery vs. expectant medical management
- Laparoscopic surgery is an option for women in the second trimester

Adnexal Mass

A) US image of a 8-week pregnant woman with LLQ pain demonstrating a crown-rump length of 1.85-cm. **B)** US image showing a complex cystic adnexal neoplasm. **C)** US image showing internal vascularity within the adnexal neoplasm. **D)** US image showing doppler flow within the ovarian cystic neoplasm.



Ovarian Torsion

Challenges

- Increased risk of ovarian torsion in pregnancy
- Most common in first trimester

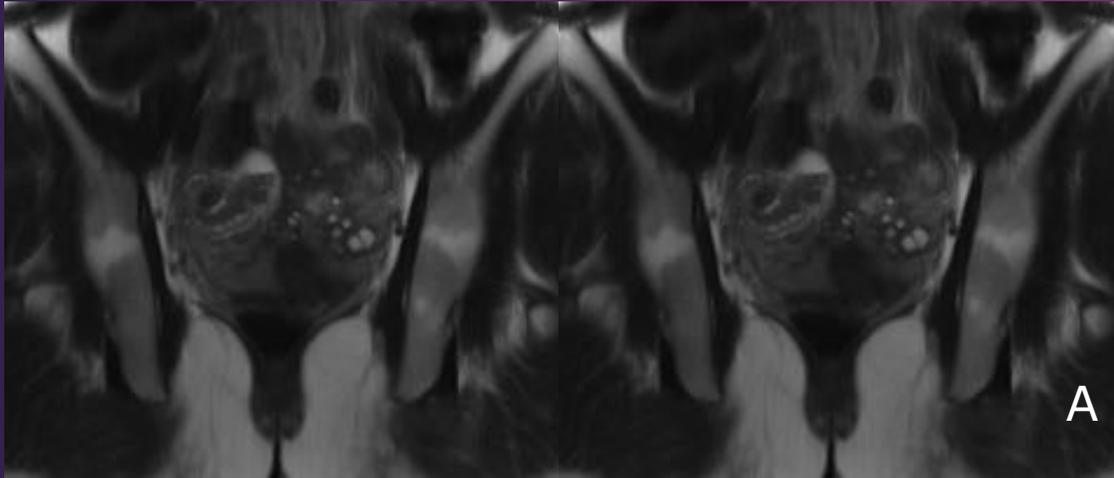
Diagnosis

- Pelvic US is the initial imaging modality of choice, with high sensitivity and specificity

Management

- Same management as nonpregnant patients (laparoscopic surgery)
- Surgery may be more technically difficult due to gravid uterus

Ovarian Torsion



A) Coronal SSFSE T2-weighted images of a 25-year-old woman with pelvic pain demonstrating whirlpool sign in torsion (swirl). **B)** Coronal SSFSE T2-weighted image showing an enlarged ovary (arrow) with peripherally displaced follicles and abnormal T2 signal representing edema. This was surgically proven to be ovarian torsion.



Summary

- ▶ US and MR are the best modalities to evaluate the etiology of abdominal pain in pregnant women.
- ▶ If US and MR are not diagnostic, CT can be used in the acute setting when the benefits of the exam outweigh the risks of radiation.
- ▶ Common challenges in diagnosing etiologies of acute abdominal pain in pregnant women include anatomical changes due to a gravid uterus and overlap in presenting symptoms.
- ▶ Clinicians and diagnostic radiologists should work together to consider the benefits and risks of imaging for diagnosis of acute abdominal pain.

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QUESTIONS?

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