Approach to Pelvic Pain: The Role of Ultrasound

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Objectives

Emphasize the importance of sonography
the imaging modality of choice for the evaluation of suspected gynecological etiologies of pelvic pain.

Objectives

Illustrate the use of US when a non-gynecological etiology of pain is suspected
as an effective substitute to CT for pregnant patients as well as patients in the reproductive age group in view of the lack of ionizing radiation.

Objectives

Illustrate the use of MRI as a problem solving tool:
- when the US exam is not adequate
- in place of computed tomography in pregnant patients with suspected appendicitis

What is the concern?

- Frequency—may account for up to 40% of gynecological visits
- Most common reason for hysterectomies
- Common reason for laparoscopy
  - Most common reason in United Kingdom
  - 2nd most common reason in United States
Imaging determined by diagnostic considerations

- Gynecological and obstetrical causes
- Gastrointestinal and genitourinary causes

Selection of imaging

ACR Appropriateness Criteria® on Acute Pelvic Pain in the Reproductive Age Group

- Determined by clinically suspected differential diagnosis following careful evaluation
- Sonography the modality of choice for a suspected gynecologic or obstetric abnormality
- CT more useful for a GI or GU abnormality although MRI is favored over CT in the pregnant patient

Sonography as the modality of choice for gynecologic etiologies

- Non-invasive
- Radiation free
- Cost effective

Use of both sonographic techniques

- Transvaginal US (TVS) whenever possible (no contraindications) due to better resolution
- Transabdominal sonography provides more information when structures are beyond field of view of vaginal probe

Imaging gives high resolution anatomic detail of uterus and adnexa!
Sonography with abdominal compression

- Displaces bowel
- Brings structures closer to the transducer
- Identifies focal areas of tenderness
- Can use the "sliding organ sign" to separate structures

"sliding organ sign"

Role of Doppler

- Spectral and color or power Doppler imaging can be used to characterize vascularity to the:
  - ovaries
  - fallopian tubes
  - uterus
- And narrow the differential considerations

Pelvic pain and a normal pelvic sonogram

- Likely to have improvement or resolution of pain (66 of 86 patients)
- Further imaging is unlikely to yield positive results (1 of 13 studies)

Pelvic pain and MRI

Problem-solving tool for specific indications:
- If further characterization of a disorder is required
- If the patient’s pain fails to resolve, or is more chronic in nature

Approach to imaging of pelvic pain in the female patient

- Acute pelvic pain
- Chronic pelvic pain
- Dysmenorrhea

Acute and chronic pelvic pain

Definition

- Acute pain is intense pain characterized by sudden onset.
- Chronic pain is non-cyclic pelvic pain that lasts 6 months or longer which is severe enough to cause functional disability or the need for medical care.

Cyclic pain

Pain associated with the menstrual cycle

Dysmenorrhea

Acute Pelvic Pain

Pregnancy status and acute pelvic pain

- Should ectopic pregnancy be under consideration?
- Is there concern for fetal exposure to ionizing radiation, making ultrasound the initial imaging modality of choice?
- Check a serum β-hCG! Negative level essentially excludes the diagnosis of an intrauterine pregnancy and ectopic pregnancy.

Obstetrical causes of acute pelvic pain in the first trimester

- Failed intrauterine pregnancy
- Ectopic pregnancy
Gynecologic causes of acute pelvic pain

Most common causes
- Functional ovarian cysts
- Pelvic inflammatory disease
- Ovarian torsion

Non-neoplastic cysts
Simple or hemorrhagic
- Follicular cyst: abnormal follicular enlargement due to anovulation, commonly associated with hemorrhage with rapid resorption
- Corpus luteum: normal structure often enlarges with hemorrhage
- Corpus luteum cysts: associated with pregnancy with resolution usually by 14 weeks gestation
- Theca lutein cysts: associated with trophoblastic disease, multiple gestations, usually large and numerous and may persist for weeks after withdrawal of stimulus

Ovarian functional cyst
Acute abdominal pain caused by:
- large size (> 2.5-3 cm)
- hemorrhage
- rupture or leakage

Hemorrhagic functional cyst
Sonographic appearance
With hemolysis and retraction of clot a reticular network of stranding is demonstrated
Fluid-fluid level between fluid components and congealed red blood cells

Hemorrhagic functional cyst
Sonographic appearance
Acute hemorrhage is hyperechoic and may be suggestive of a solid mass
Hemorrhagic functional cyst

**Sonographic appearance**

- A diffuse pattern of low level echoes
- More commonly associated with an endometrioma

Doppler evaluation

- Peripheral color Doppler signal
- No central vascularity
- Low impedance arterial flow

**Evolution**

10 days later

**Hemorrhagic functional cyst**

- Internal echoes and septations
- Leakage of hemorrhagic fluid with associated peritoneal irritation is common
Pelvic inflammatory disease

- Consists of inflammation of the endometrium, fallopian tubes, pelvic peritoneum and adjacent structures causing fever, leucocytosis and cervical motion tenderness.
- Ascending infection usually by N. Gonorrhea, Chlamydia and super infecting organisms from the vagina
- Manifested by tubo-ovarian complexes, peritonitis and abscess formation
- Usually bilateral but may be unilateral in patients with IUD’s

No simple diagnostic test exists!

Imaging diagnosis of PID
Transvaginal sonography

Can usually only detect complications of PID
- Early changes are often subtle although color Doppler may enhance our capabilities
- Difficulty visualizing tubal wall without fluid

Salpingitis
Imaging diagnosis of PID
Transvaginal sonography

- In the presence of fluid, common findings include:
  - wall thickness > 5 mm
  - incomplete septa
  - thickening of endosalpingeal folds (cogwheel sign)

- Nonspecific findings:
  - fluid in the endometrial cavity and/or cul-de-sac
  - ovarian enlargement often with numerous small cysts ("polycystic ovary" appearance)

Salpingitis

Salpingitis

Increased vascularity within fallopian tube wall
Incomplete septa

Tubo-ovarian complex

Progression of disease with exudation of pus from the distal fallopian tube
An inflammatory mass including the tube and adjacent ovary is formed
The ovary is still visualized as a separate structure

Tubo-ovarian abscess

Imaging definition consists of a complete breakdown of architecture so that separate structures are no longer identified
**Tubo-ovarian abscess**

- Breakdown of architecture
- Incomplete septa

**Tubo-ovarian abscess**

- Cogwheel sign

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**Ovarian Torsion**

- Diagnosis strongly considered with abrupt onset of severe unilateral pain
- Most commonly seen with associated nausea and vomiting
- Pain constant or intermittent (with partial or intermittent torsion)

However:
- Symptoms may be variable

The diagnosis of adnexal torsion has remained a clinical and imaging enigma

**Due to:**
- Vague clinical presentation
- Abdominal pain being the only consistent symptom

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**Common denominator:**
**Enlarged abnormal appearing ovary**

- Commonly benign ovarian tumors or cysts (50-80%) may act as a fulcrum to potentiate torsion due to increased ovarian volume or weight.
- Ovarian hormone induction leading to ovarian hyperstimulation syndrome and enlargement
- Hemorrhagic corpus luteum of pregnancy
- Hyper mobile adnexa

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**Ovarian torsion**

**Vascular supply to the ovary**
Complete Ovarian Torsion
Pathophysiology

- Can progress rapidly to occlusion of the arterial circulation.
- The organ may quickly become very dark black in color due to hemorrhage, necrosis and gangrenous changes.

Early intervention is key!
Decreases the incidence of complications and improves ovarian salvage rates

The use of pelvic sonography has enhanced our ability to determine when intervention is advisable.

Sonographic findings of ovarian torsion

- Enlarged ovary or ovarian complex
- Irregular internal texture suggesting hemorrhage and edema

Doppler evaluation of ovarian torsion

Assumption:
Color and spectral Doppler would prove to be an accurate tool for the evaluation of ovarian torsion.

In actuality:
Doppler findings vary depending on degree of torsion and its chronicity.

Non-specific findings of ovarian torsion

- Peripherally placed follicles
- "Ground glass" pattern centrally consistent with edema
Doppler evaluation of ovarian torsion

- Lack of arterial and venous signal should enable confident diagnosis
- False positive diagnoses may be obtained
  - Depth of penetration greater than beam capabilities
  - Improper Doppler or grayscale settings (ie. PRF setting)

Paratubal cyst as fulcrum for torsion

Doppler evaluation of ovarian torsion

Ovarian color Doppler signal has been frequently reported in cases of surgically proven torsion!

Presence of Doppler signal and ovarian torsion

Patients with pathologically proven ovarian torsion
- 1/2 have been shown to have documented ovarian arterial Doppler signal only
- 1/3 have been shown to have documented ovarian venous and arterial signal

Presence of arterial and venous Doppler signal

The diagnosis of ovarian torsion

- An enlarged edematous ovary or ovarian complex is the most consistent finding
- Doppler findings vary likely depending on degree and chronicity.
- Lack of Doppler flow enables fairly confident diagnosis but ovarian arterial and venous Doppler signal has been reported in a third of surgically proven cases of ovarian torsion.
The Role of CT and MRI

- Sonography is initial exam of choice
- Computed tomography is being used more frequently
  Appendicitis most common reason!

CT features

- Thickening of fallopian tube
- Target sign
- Deviation of uterus
- Infiltration of fat

MRI ovarian torsion

*Is there a role at this time?*

MRI of ovarian torsion

- Role in the diagnosis of ovarian torsion has not been established
- Rha and colleagues* have shown similar diagnostic findings both on MR and CT
  
  *Rha SE et al. CT and MR imaging features of adnexal torsion. Radiographics 2002; 22(2)283-94.

MRI of ovarian torsion

- Marked ovarian enlargement
- Heterogeneous, hyperintense pattern due to edema and hemorrhage
- Peripherally displaced follicles

Non-gynecologic causes of acute pelvic pain

Images courtesy of Dr. Susanne Lee, Dept of Radiology
Massachusetts General Hospital, Boston, Mass.
Common gastrointestinal and genitourinary causes where imaging plays a role

- Most commonly appendicitis
- Diverticulitis
- Intestinal obstruction
- Inflammatory bowel disease
- Ureteral calculi

Appendicitis

- Most common GI cause of pelvic pain in women
- Diffuse or periumbilical pain that migrates to the right lower quadrant

Sonographic features of appendicitis

- Blind ended thick walled, tubular, non-compressible, aperistaltic structure
- At least 3 mm single wall thickness
- Appendicolith highly specific
- Surrounding echogenic fat

Appendicitis

- CT with contrast imaging modality of choice to confirm diagnosis in non-pregnant female (sensitivity 95%-100% and specificity 87%-98%)
- But US may be an effective substitute with a sensitivity (67%-100%) and specificity (83%-96%)

Appendicitis

- US with graded compression initial imaging test in pregnant females but often inconclusive due to large uterus
- MRI next appropriate imaging modality due to lack of ionizing radiation
Sonographic features of appendicitis

- Increased color Doppler vascularity within wall

CT features of appendicitis

- Enlarged appendix (>6mm) with thickened enhancing wall (>2mm)
- Pericecal fat stranding

MR features of appendicitis

- Similar to CT
- A negative oral contrast agent (Gastromark) may be used to demonstrate low signal in bowel and in a normal appendix

Ureteral calculi

- Costovertebral angle pain that radiates to groin rather than true pelvic pain
- Best detected by non-contrast CT (sensitivity of 96% and specificity of 93%-98%)
- Alternative for evaluation of distal ureter is TAS or TVS, especially in pregnant females (sensitivities 34%-95%)
Inflammatory bowel disease

Valette, European radiology. 2001,11:10 pg.1859 -66

Monitoring activity of inflammation in inflammatory bowel disease with CE US.

Wilson S R , Burns P N Radiology 2010;257:24-39

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Approach to Pelvic Pain

Acute pain

Suspect Ob or gyn cause

Suspect non-gyn cause

US

+β-hCG

-β-hCG

US or MRI

CT or US

Chronic pelvic pain

Common etiologies with imaging findings

- Endometriosis
- Adenomyosis
- Pelvic varices
- Malpositioned IUD’s

Chronic pelvic pain

• Disabling condition which may have more than one cause
• Often goes undiagnosed (up to 60%)
• Gyn, GI, GU and MSK abnormalities involved

Approach to Pelvic Pain

Acute pain

Suspect Ob or gyn cause

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Chronic pelvic pain

Common etiologies with imaging findings

- Endometriosis
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**Endometriosis**

- Most common benign gynecological disorder
- Functional endometrial tissue outside of the uterine cavity and musculature
- Cysts (endometriomas), plaques, implants or nodules

**Endometriosis: Sites involved**

- Ovary
- Uterine ligament
- Pouch of Douglas
- Pelvic peritoneum
- Abdominal scars

**Symptoms of endometriosis**

- Dysmenorrhea
- Dyspareunia
- Abnormal bleeding

*Severity of pain may not correlate with the extent of disease!*

**Role of ultrasound**

- Historically the endometrioma is only form of disease readily diagnosed and confirmation obtained with time.
- Majority of implants and adhesions not detectable

**Sonographic features of endometriomas**

- Single or multiple thick walled cystic masses with diffuse low level homogeneous echoes
- Hyperechoic foci adjacent to the wall are commonly demonstrated

*Internal vascularity only with decidualization due to pregnancy*
The role of MRI as a problem solving tool

- High sensitivity and specificity in diagnosing deep and nodular endometriosis in addition to cystic type
- Plaque-like lesions may go undetected until laparoscopy

Hemorrhagic cyst or endometrioma?

MRI appearance

- Cystic endometriosis
  - T1 increased signal
  - T2 shading or heterogeneous, or homogeneous increased signal
- Nodular endometriosis
  - T1 intermediate signal with foci of high intensity signal
  - T2 variable signal characteristics

NRI and cystic endometriosis

MRI and cystic endometriosis

Images courtesy of Dr. Susanna Lee, Dept of Radiology Massachusetts General Hospital, Boston, Mass.
MRI and cystic endometriosis

Images courtesy of Dr. Susanna Lee, Dept of Radiology
Massachusetts General Hospital, Boston, Mass.

MRI features
Nodular endometriosis

T1 fat sat
T2

The Tender Uterus

Adenomyosis
Pelvic congestion

Symptoms

Uterine tenderness
Dysmenorrhea
Menorrhagia

Abnormal myometrial echogenicity

• Hypoechoic areas corresponding to smooth muscle hyperplasia
• Echogenic heterotopic endometrial tissue
Abnormal Myometrial Echogenicity

Myometrial cysts

- Myometrial cysts corresponding to dilated glands or hemorrhagic foci

Heterogeneous Myometrial Echotecture

Linear Striations

Abnormal Myometrial Echogenicity

Echogenic nodules

- Ectopic glands

Heterogeneous Myometrial Echotexture

- Focal or diffuse

Endometrial myometrial junction

Poor definition

Endometrium

Pseudo-widening
Mass Effect

- Elliptical myometrial abnormality
- Uterine contour unchanged

Adenomyosis and Fibroids

MRI as a problem solving tool in the diagnosis of adenomyosis

Mass Effect with Leiomyomas with change in uterine contour

Color Doppler

- Is not present peripherally as with leiomyomas
- May be present or increased throughout the area in question
- Optimized for low flow may be the most valuable technique for differentiation of the two processes.

MR Imaging of Adenomyosis

- Highly accurate with sensitivity and specificity of 86-100% and an overall accuracy of 85-90.5%
- Accuracies of sonography and MRI similar
- MR may give additional information when TVS is indeterminate
**MR Imaging Signs**

- Abnormal myometrial signal intensity
  - low signal intensity (hyperplastic smooth muscle)
  - areas of high signal intensity (heterotopic glands)
- Thickening of the junctional zone >11mm
- Linear striations of high signal intensity (associated with pseudowidening of the endometrium)
- Poor definition of the endometrial-myometrial junction

**Pelvic congestion syndrome**

- Chronic pelvic pain that is associated with dilatation of pelvic veins (i.e. pelvic varices) and reduced venous return
- Dull chronic pain exacerbated by prolonged standing and relieved by lying down and elevating the legs

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**Sonography and pelvic congestion**

- Used in the initial assessment to rule out other pelvic etiologies with similar symptoms
- Shown to be of value in the diagnosis

**Pelvic congestion: sonographic criteria**

- Presence of tortuous and dilated pelvic venous plexuses
- Dilated arcuate veins crossing the uterine myometrium

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**Pelvic congestion: sonographic signs**

- Dilatation of the left ovarian vein with reversed caudal flow
- Polycystic-like changes of the ovary
- Variable spectral Doppler waveforms in the veins during the Valsalva maneuver

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47-year-old woman with pelvic congestion syndrome

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Other causes of chronic pelvic pain

Ovarian remnant syndrome
- Uncommon condition occurring after unilateral or bilateral oophorectomy, with or without a hysterectomy
- A fragment of ovarian tissue is left behind encased in adhesions and becomes functional and cystic

Ovarian remnant syndrome
Imaging findings
- Cystic or multiseptated ovarian masses
- Masses contain a rim of ovarian tissue

Intrauterine contraceptive devices
- Easily visualized by transvaginal sonography due to their increased echogenicity and marked attenuation of the sound beam
- Abnormal position may cause chronic pain

IUD visualization
- TVS with 3D reconstructions in the coronal plane can confirm the position of the entire IUD in the uterus
- When abnormally located, may show that part of the IUD is imbedded in the myometrium

Satisfactory IUD location
Dysmenorrhea

- Cyclic pain during menstruation
- Primary dysmenorrhea if there is no underlying pelvic pathology and no direct imaging findings but imaging may be useful to exclude other causes
- Secondary dysmenorrhea due to underlying pelvic pathology
Secondary dysmenorrhea

- Common causes
  - Endometriosis
  - Adenomyosis
  - Intrauterine devices
- Less common causes
  - Mullerian anomalies of the uterus or vagina with obstruction of menstrual flow
  - Intrauterine synechia
  - Fibroids
  - Pelvic congestion syndrome

Approach to Pelvic Pain

Cyclic Pain

Primary dysmenorrhea

Secondary dysmenorrhea

No imaging findings

US

MRI

Thank you!