# The Implants No Woman Wants: A Multimodality Review of Endometriosis

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# Disclosure of Commercial Interest

Neither I nor my immediate family members have a financial relationship with a commercial organization that may have a direct or indirect interest in the content.

# Goals and Objectives

1. Understand the pathophysiology, epidemiology and clinical presentation of endometriosis
2. Recognize:
   - Different manifestations of endometriosis
   - Diagnostic dilemmas
   - Mimics of endometriosis
   - Clinical implications
3. Appreciate the 2010 American College of Obstetricians and Gynecologists (ACOG) management guidelines and indications for medical versus surgical management
4. Be familiar with the Revised American Society for Reproductive Medicine (r-ASRM) classification system

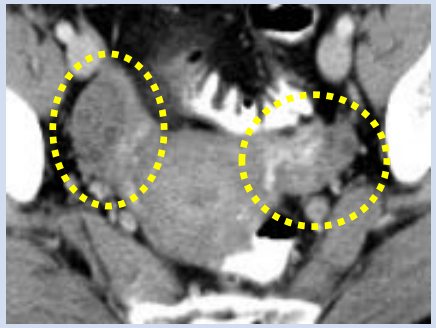
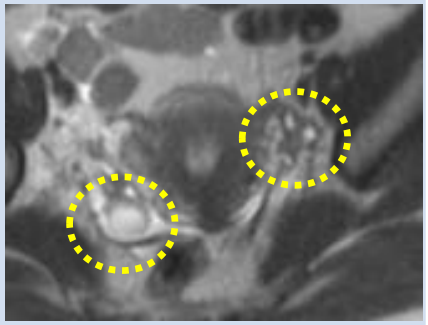
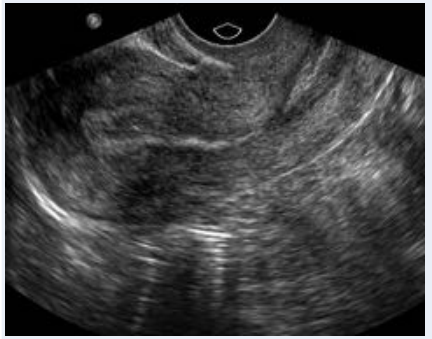
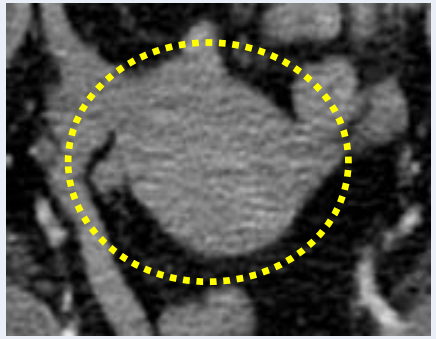
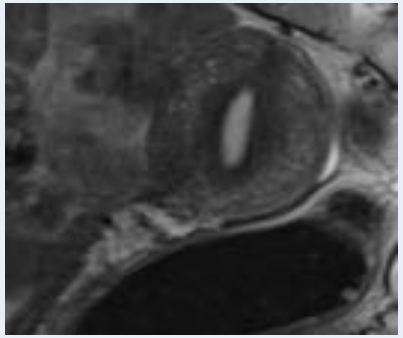
**Target Audience:**
Medical students, residents and radiology attendings interested in a broad pictorial review of the topic.

# Background

- Endometriosis: occurrence of hormone-responsive endometrial glands and stroma outside of the uterine cavity
- Three forms include:
  1. Ovarian endometriomas
  2. Superficial peritoneal implants
  3. Deep infiltrative endometriosis (DIE)
- One of the most common benign gynecological conditions in the pre-menopausal female population
- 6.6%-16.2% of reproductive-aged women in the U.S. are affected
- Peak incidence 24-29 years of age
- Significant morbidity
  - Infertility → one study demonstrated 3-year cumulative conception rates in women with endometriosis compared with controls to be 36% vs 54%
  - Chronic pain → negative impact on social activities, productivity and sexual life

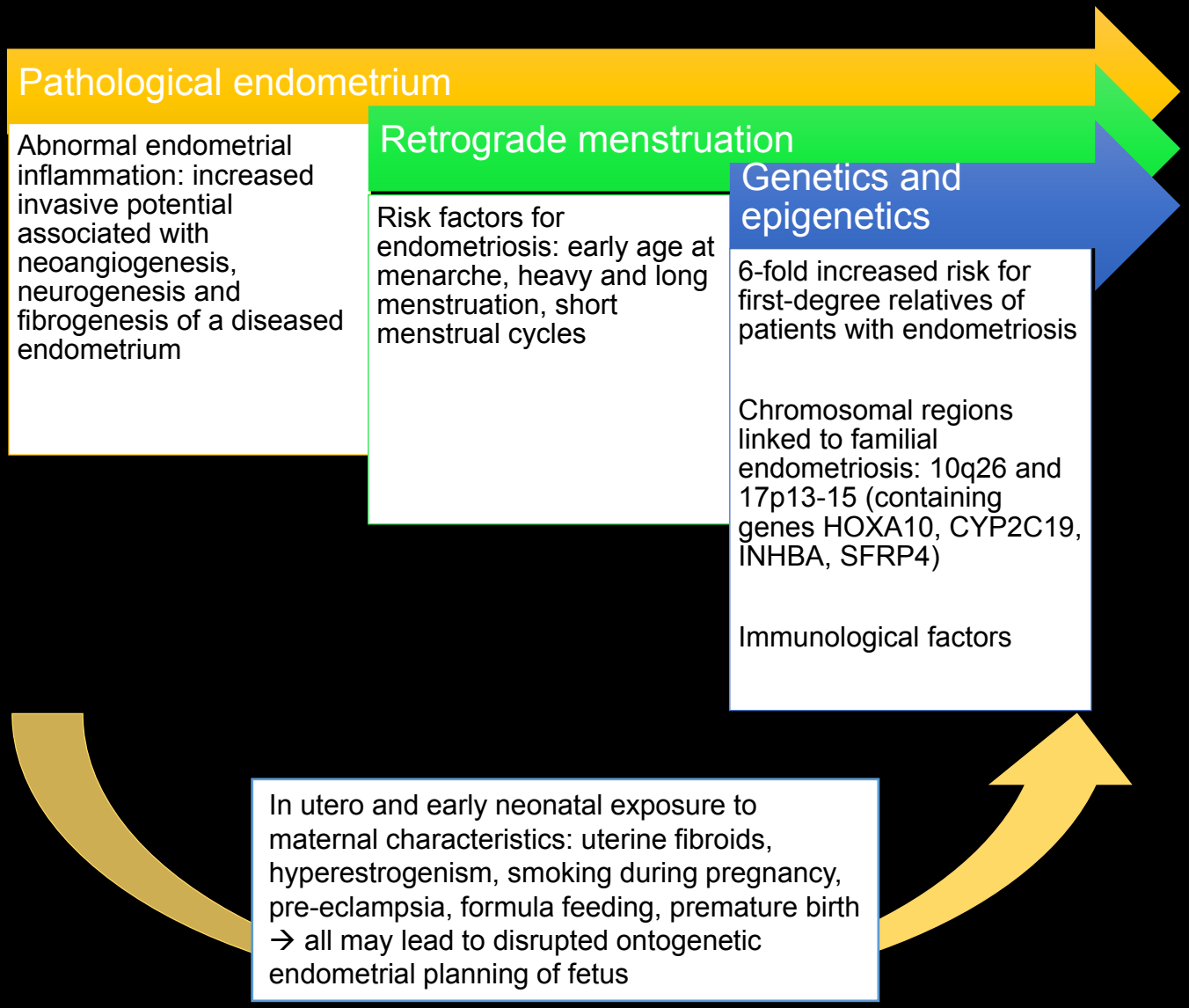
# Anatomy

- Ovarian blood supply
  - Left and right ovarian artery (runs through suspensory ligament) and left and right uterine artery (may anastomose with the ovarian artery in the broad ligament)
  - Left ovarian vein (drains into left renal vein) and right ovarian vein (drains into IVC)
- 3 lymphatic drainage pathways from the ovaries
  - Paraaortic nodes via nodes along ovarian vessels
  - Paraaortic nodes via lateral vessels to hypogastric nodes
  - External iliac and inguinal nodes via vessels close to round ligament
- Uterine blood supply
  - Left and right uterine artery (branches of the anterior division of the iliac arteries)
  - As blood supply enters the myometrium → branches into the arcuate arteries → branch into the radial arteries
  - As they enter the level of the endometrium → branch into the basal and spiral arteries
- Lymphatic drainage of the uterus
  - External iliac nodes
  - Lumbar nodes

| | US | CT | MRI |
|---|---|---|---|
| **Ovaries** |  |  |  |
| **Uterus / Fallopian Tubes** |  |  |  |

# Pathophysiological Models of Endometriosis

- Not well understood
- Most well-accepted hypothesis: Retrograde menstruation
  - Menses transports viable endometrial fragments through fallopian tubes where they implant in the peritoneum
  - Anatomical distribution of endometriotic lesions is the strongest evidence → more commonly distributed among the posterior compartment of the pelvis and the left side (evidenced by effect of gravity on menstrual flow and peritoneal clockwise flow of menses)
  - Another example is pleural endometriosis → clockwise flow of peritoneal fluid and transdiaphragmatic passage of endometrial tissue through a porous diaphragm
  - Unable to explain the mechanism of endometrial implantation on the abdominal wall
- Other hypotheses:
  - Müllerian metaplasia: tissue derived from celomic epithelium (mesothelial cells of the ovary) has the ability to differentiate into functional endometrial epithelium and stroma
  - Lymphovascular dissemination and proliferation of endometrial stem cells/bone marrow progenitors → may be able to explain endometriosis at unusual locations (brain, liver, lung)

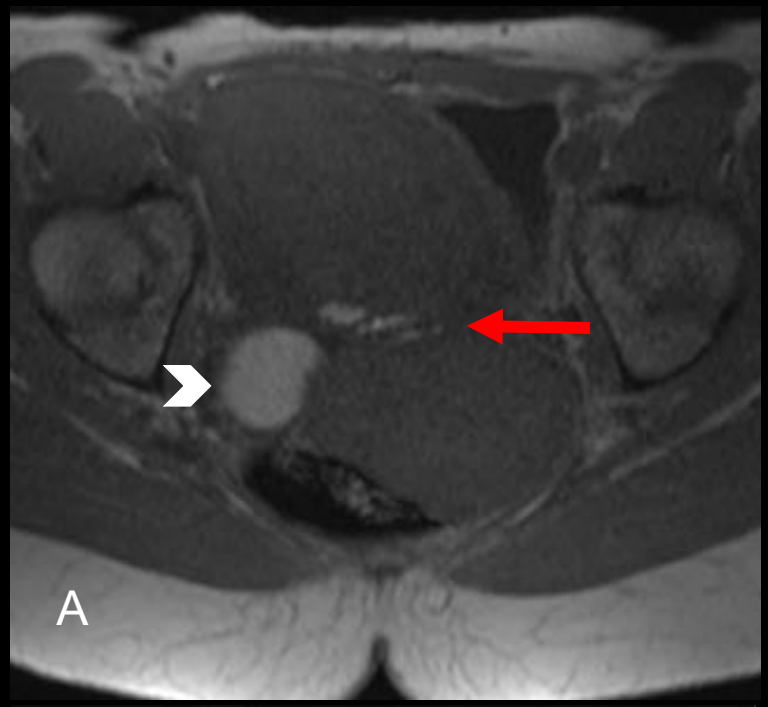


# Case 1

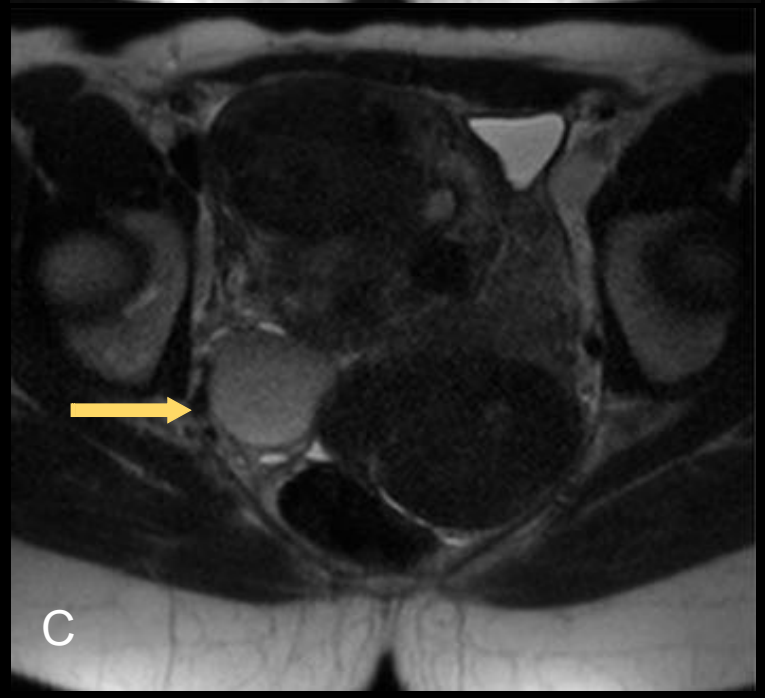
39 year-old woman with a history of fibroids status post myomectomy complains of chronic pelvic pain and pressure.

What is the most frequent clinical presentation of endometriosis?

a. Hematochezia
b. Ataxia
c. Non-specific pelvic pain
d. Dysuria
e. Dysmenorrhea








(A & B) T1 and (C) T2-weighted axial pelvic MRI demonstrate T1 hyperintense foci along the posterior uterine surface and cul-de-sac (red arrows), characteristic of powder burn lesions of endometriosis. Additional T1 hyperintense endometriomas (white arrowheads) with T2 shading (yellow arrow) at bilateral adnexa are present.

# Clinical Presentation of Endometriosis

Ovaries (20-40%) → non-specific pelvic pain

Uterus → non-specific pelvic pain

Ureter (0.1-1%) → flank pain, hydronephrosis, dysmenorrhea, dyspareunia

Bladder (6.4-20%) → dysuria, gross hematuria during menses, urgency, frequency, suprapubic discomfort

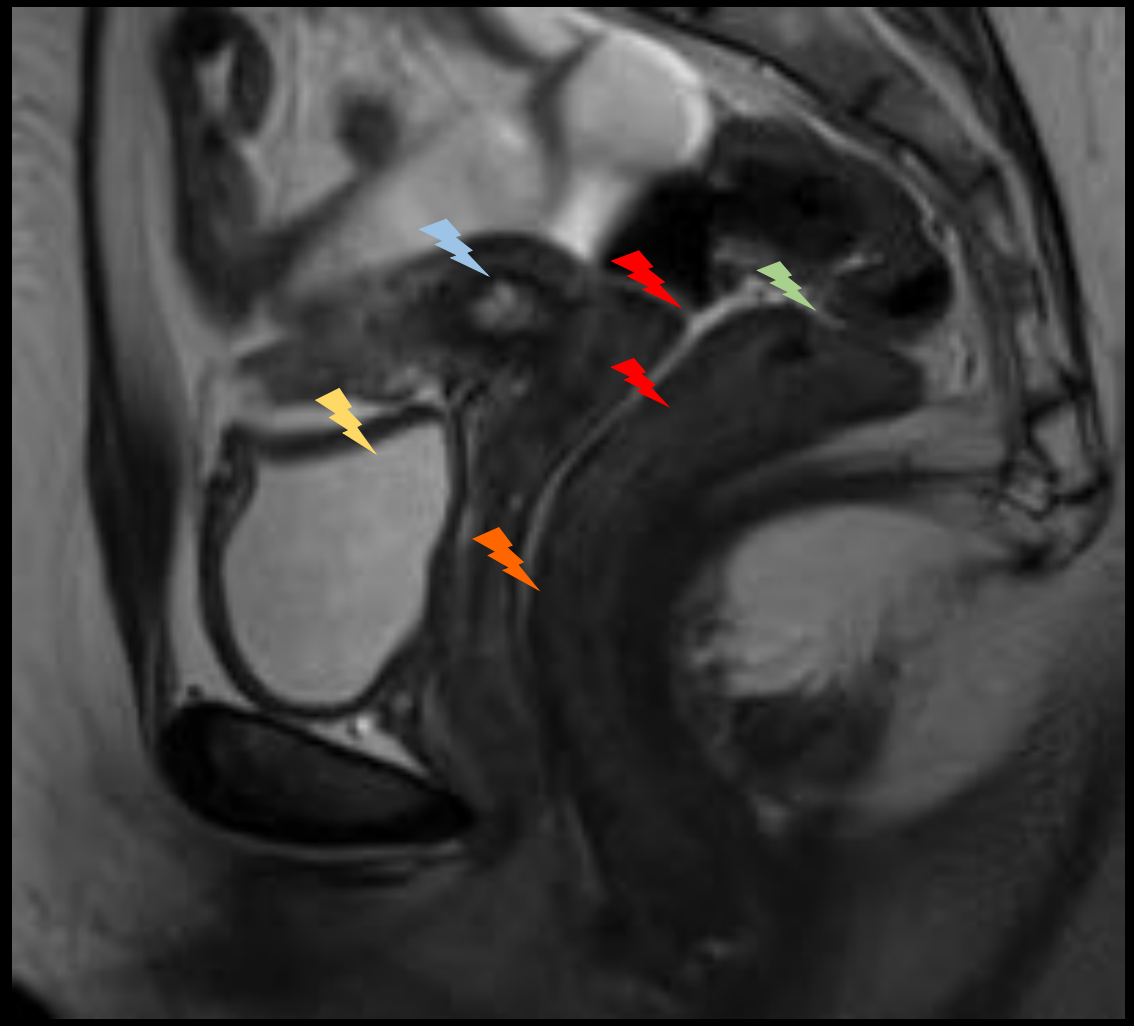


Figure 1. Sagittal T2-weighted MRI with lightning bolts demonstrating primary locations of endometriotic lesions

Rectosigmoid colon (9.9-37%) → cyclic pain during defecation, dyschezia, cyclic hematochezia, catamenial diarrhea, constipation, pencil-like stools, bowel obstruction

Retrocervical region, uterosacral ligaments (69.2%) → severe pelvic pain, dyspareunia

Vagina (14.5%) → dysmenorrhea, dyspareunia, post-coital spotting, prolonged menstruation not responding to medical therapy leading to anemia

Round ligaments (0.3-14%) → painful, palpable inguinal mass, non-specific pelvic pain

# Case 2

43 year-old woman with dyspareunia. On physical exam, an induration of the posterior vagina was palpated.

What is the initial imaging modality of choice according to ACOG management guidelines of endometriosis?

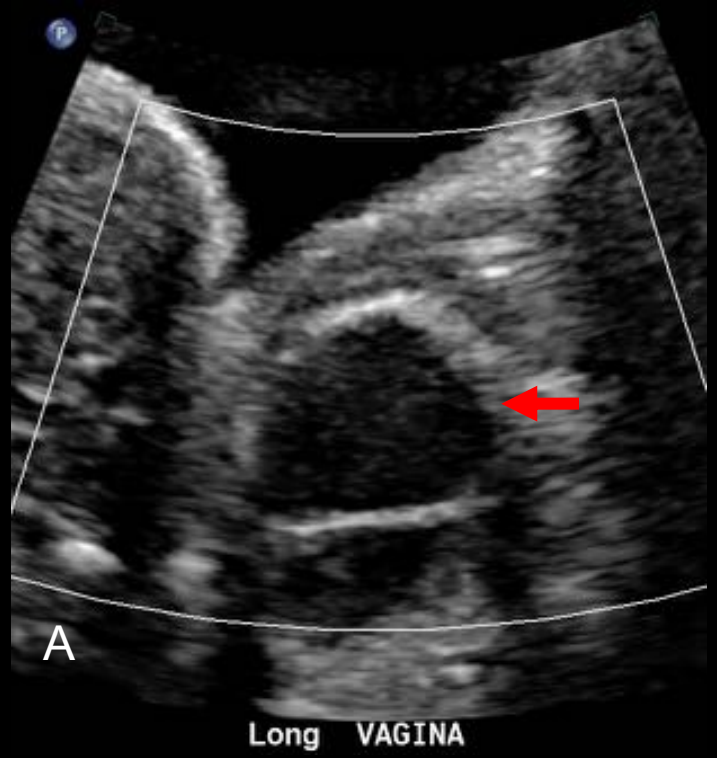
a. FDG PET

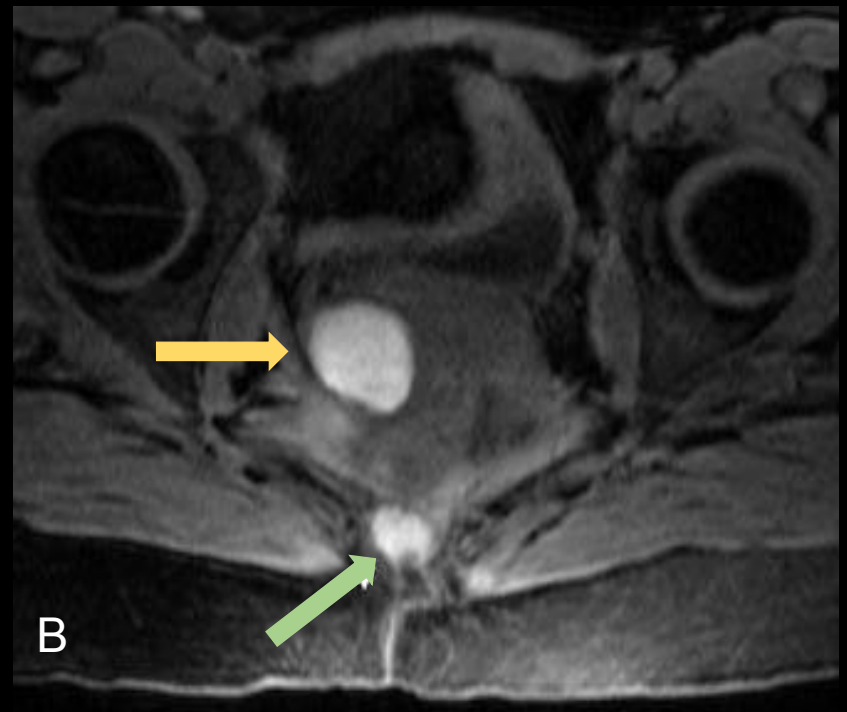
b. Pelvic MRI

c. CT abdomen and pelvis

d. Transabdominal and transvaginal ultrasonography

(A) Transabdominal US demonstrates a 3.3 cm posterior vaginal cystic lesion (red arrow) with low-level internal echoes, without internal vascularity, demonstrating posterior acoustic enhancement. (B) Follow up axial T1-weighted non contrast MRI with fat saturation reveals a T1 hyperintense right perirectal endometrioma (yellow arrow) corresponding to the ultrasound findings. Additional scattered precoccygeal (green arrow) and presacral (not shown) endometriomas were also present.




Transvaginal US is considered the first-line imaging modality of choice when suspecting endometriosis. Like MRI, assessment of even small (<1.5 cm) lesions of DIE, in the hands of an experienced sonographer, is excellent.

MRI is superb for identifying old hemorrhagic content that characterizes endometriomas and is the imaging modality of choice for surgical planning given its large field of view, multi-planar capabilities and outstanding contrast resolution. Extensive pelvic adhesions and ureteral involvement are two important indications for MR imaging.

# Dynamic Maneuvers in US

1. Start at one side, palpate the ovary with the probe and continue posteriorly toward the cul-de-sac in small increments with palpation, guided by patient's discomfort, until reaching the cervix

↓

Allows assessment of: uterosacral ligament, bowel wall

2. Visualize peristalsis of bowel, which should have uniform movement

↓

Bowel wall implant will stand out due to its immobility

↓

Bowel wall implants appear as nodular and fusiform swelling of one side of bowel wall

**Tenderness-guided transvaginal US in 4 distinct steps increases accuracy of diagnosis**

3. Looking at posterior aspect of cervix and top of rectovaginal septum, can evaluate wall of rectum and back of cervix

↓

Physiologic free fluid assists in assessment of the normally smooth aspect of cervix

↓

Small implants will appear as bumps or irregularities to its contour with very little Doppler flow

4. Throughout exam, test mobility of organs with probe

↓

Normal examination will demonstrate organs' ability to glide past each other

↓

Abnormality suggests adhesions

# American College of Obstetricians and Gynecologists (ACOG) Management Guidelines 2010

| Management of Women Who Desire Fertility | Management of Women Who Do Not Desire Fertility | Other Management of Pain Symptoms |
|---|---|---|
| Surgical management of endometriosis-related infertility does improve pregnancy rates, but the magnitude of improvement is unclear | OCs, NSAIDS and oral norethindrone or DMPA are effective compared with placebo for pain control and are equivalent to other more costly regimens; however, recurrence rates are high after medication discontinuation | After conservative surgical treatment (for example, laparoscopic ablation of lesions), studies have shown significant short-term improvement in pain symptoms (however, as with medical management, there is a high rate of pain recurrence) |
| Excision of an endometrioma is superior to simple drainage and ablation of the cyst wall for treatment of endometriosis-related infertility; however, a potential complication is a decrease in ovarian reserve | If failure of initial treatment with OCs and NSAIDS, empiric therapy with a 3-month course of a GnRH agonist is appropriate for ovarian suppression | When relief of pain from treatment with a GnRH agonist supports continued therapy (greater than 3 months), the addition of add-back therapy, or bone-sparing medications, reduces GnRH agonist-induced bone mineral loss and provides symptomatic relief without reducing the efficacy of pain relief |
| In vitro fertilization should be considered over surgery in women who solely desire fertility | In patients with normal ovaries, a hysterectomy with ovarian conservation and removal of the endometriotic lesions should be considered in case of suboptimal medical management outcomes | |
| Medical suppressive therapies such as oral contraceptives (OCs) or GnRH agonists are ineffective for endometriosis-associated infertility | In patients with endometriosis affecting non-reproductive organs, GnRH agonist therapy is the first line approach except in cases of ureter obstruction, where surgical management optimizes outcomes | |

# Case 3

46 year-old woman with history of endometriosis and heavy menstrual bleeding.

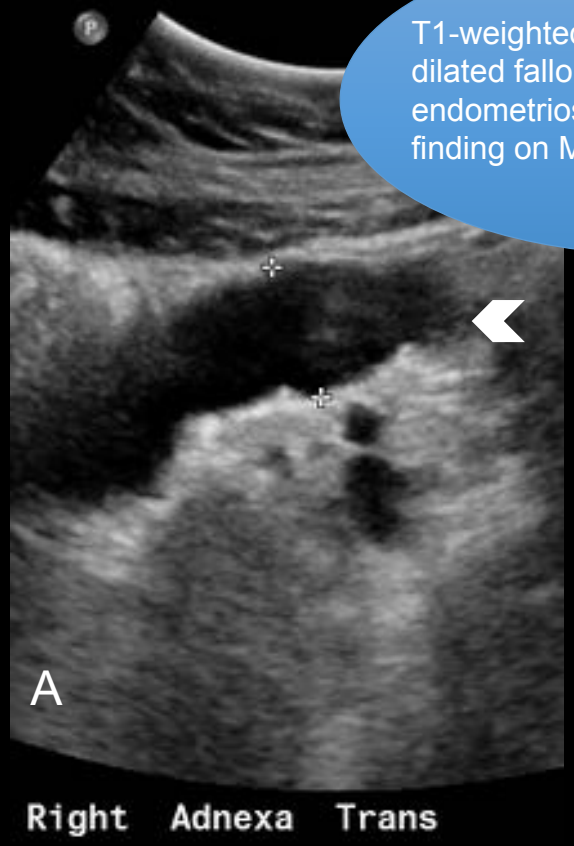
What are the most frequent sites of endometriosis?

a. Abdominal wall, colon, urinary tract

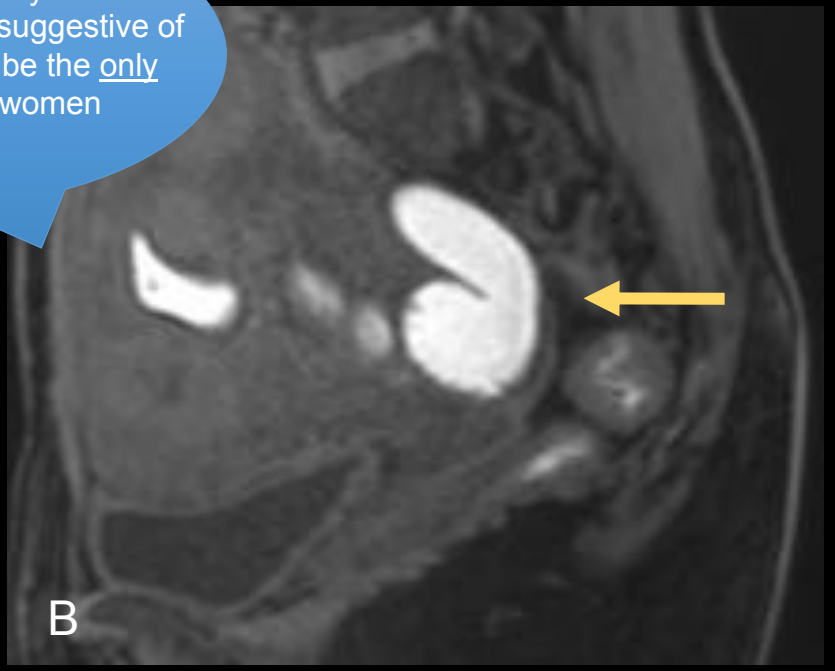
b. Ovaries, fallopian tubes, broad / round / uterosacral ligaments

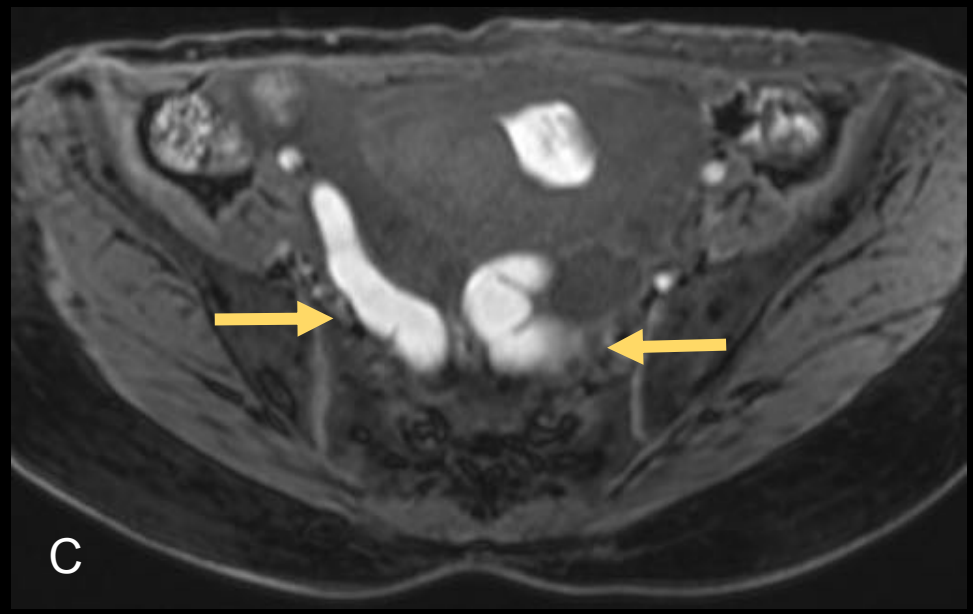
c. Posterior vaginal wall, lower uterine segment, uterine myometrium

d. Rectosigmoid colon, bladder and ureters




T1-weighted hyperintensity within a dilated fallopian tube is suggestive of endometriosis and may be the only finding on MRI in some women




**Hematosalpinx features:**

US

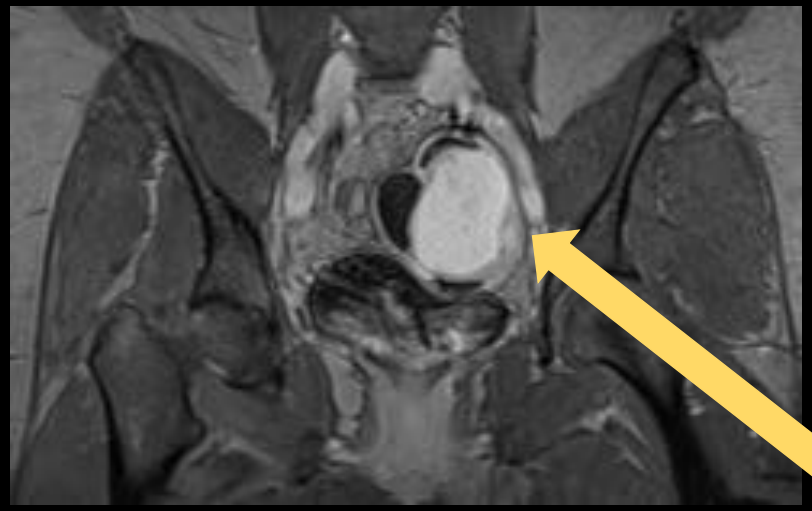
- Tubular, cystic structure with internal echoes and incomplete septa in the adnexa
- "Cogwheel" appearance of fallopian tube folds in cross-section

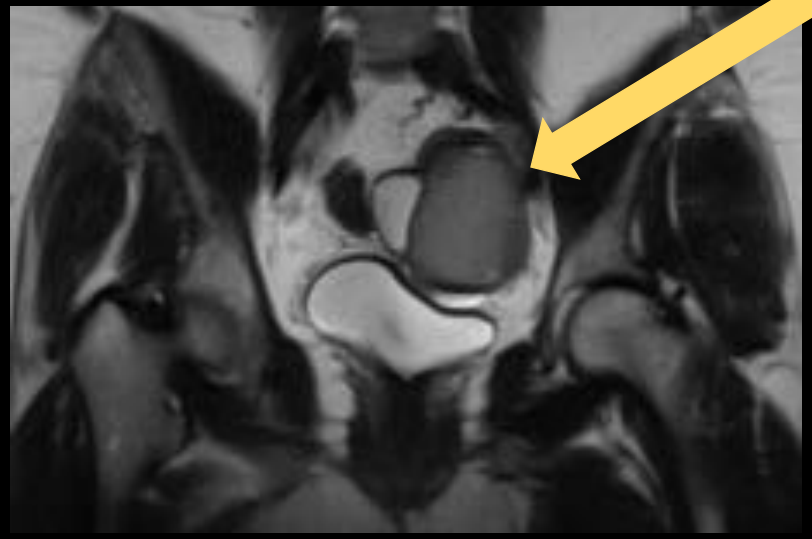
MRI

- T1-weighted hyperintensity and variable T2-weighted intensity within a dilated fallopian tube

(A) Transabdominal US shows right (white arrowhead) and left hydrosalpinx (not shown). (B & C) Sagittal and axial T1 pre contrast MRI with fat saturation demonstrates bilateral dilated fallopian tubes with T1 hyperintense material (yellow arrows) representing hematosalpinx. Other findings include blood products within the endometrial cavity.

# Ovarian Endometriomas





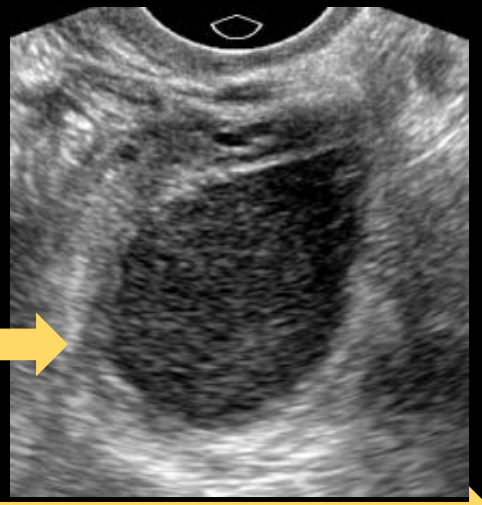
**Classic Features:**

ULTRASOUND

- Unilocular or multilocular (less than five locules) cyst
- Homogeneous low-level echogenicity (ground glass echogenicity) of the cyst fluid

MRI

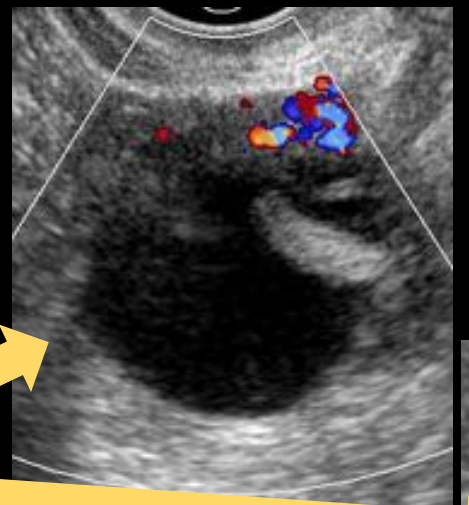
- T1-hyperintense adnexal cysts (singular or multiple)
- T2 shading (signal intensity lower than simple fluid) with low-intensity thick, fibrous capsule



**Atypical Features:**

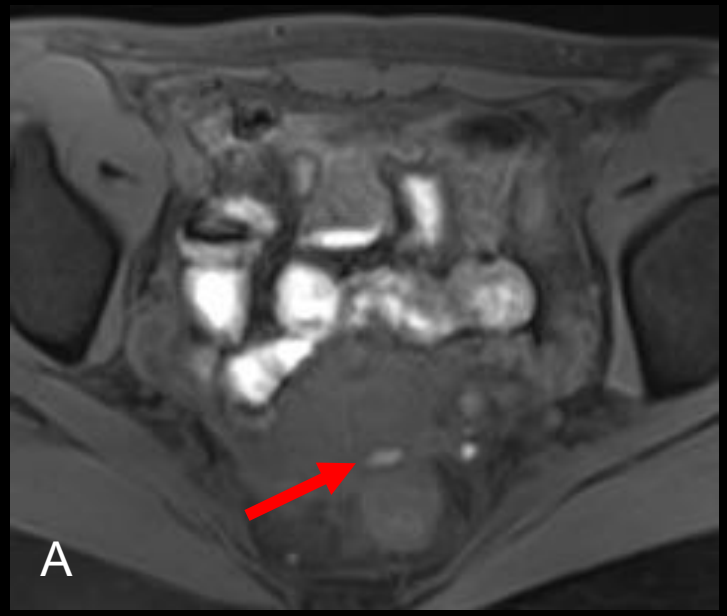
ULTRASOUND

- Nonvascular septations or papillary projections
- Ring down along the wall of the ovary
- Wall thickening and occasional nodularity creating a lobulated appearance



# Superficial Peritoneal Implants

- Soft tissue or cystic deposits of ectopic endometrial tissue on pelvic peritoneum and pelvic organs
- <1 cm in diameter
- Micronodular or microcystic appearance
- Only pigmented implants can be detected on non-contrast MRI → represent presence of hemorrhage





Superficial peritoneal implants manifest as multiple round (cystic or nodular) lesions homogeneously hyperintense on fat-suppressed T1-weighted images (due to old hemorrhagic content) regardless of their signal intensity on T2- weighted images

(A & B) 32 year-old woman with a history of fibroids who presents with a 3 cm induration at the top of the vagina. Axial and sagittal T1-weighted pre contrast MRI show small T1 hyperintense serosal implants of the posterior uterine body, cul-de-sac and posterior fornix (red arrows). The implant at the posterior fornix correlates with the induration of the vagina on physical examination.

# Case 4

36 year-old woman with dysmenorrhea, severe right lower quadrant pain and abdominal fullness.

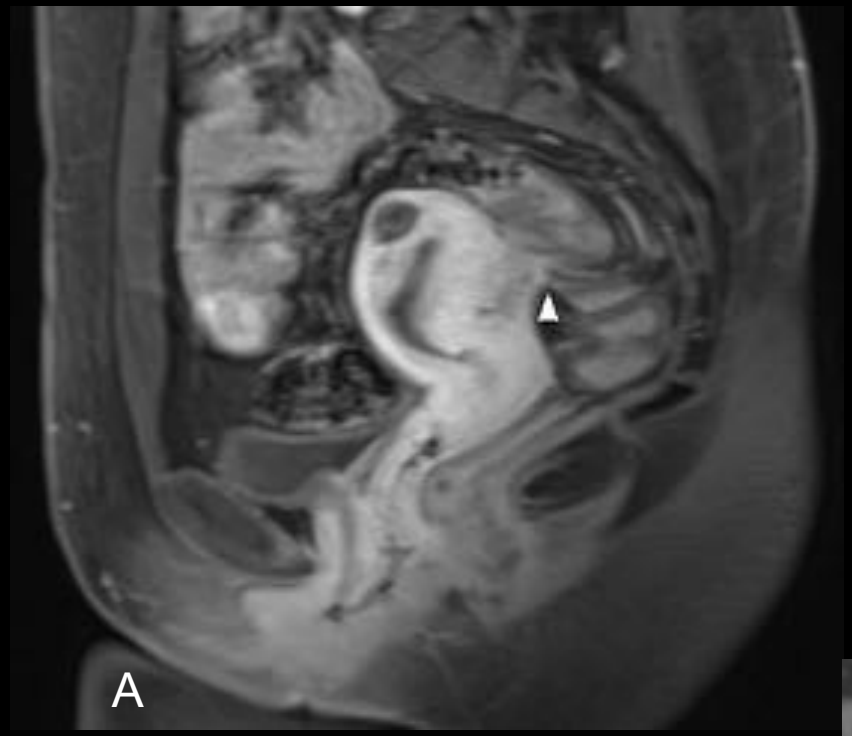
What is the criteria for deep infiltrative endometriosis (DIE)?

a. Invasion of the retroperitoneum and/or solid pelvic organs >5 mm in depth

b. Involvement deep in the myometrium of the uterus only

c. Invasion of the peritoneum and/or abdominal wall >5 mm in depth

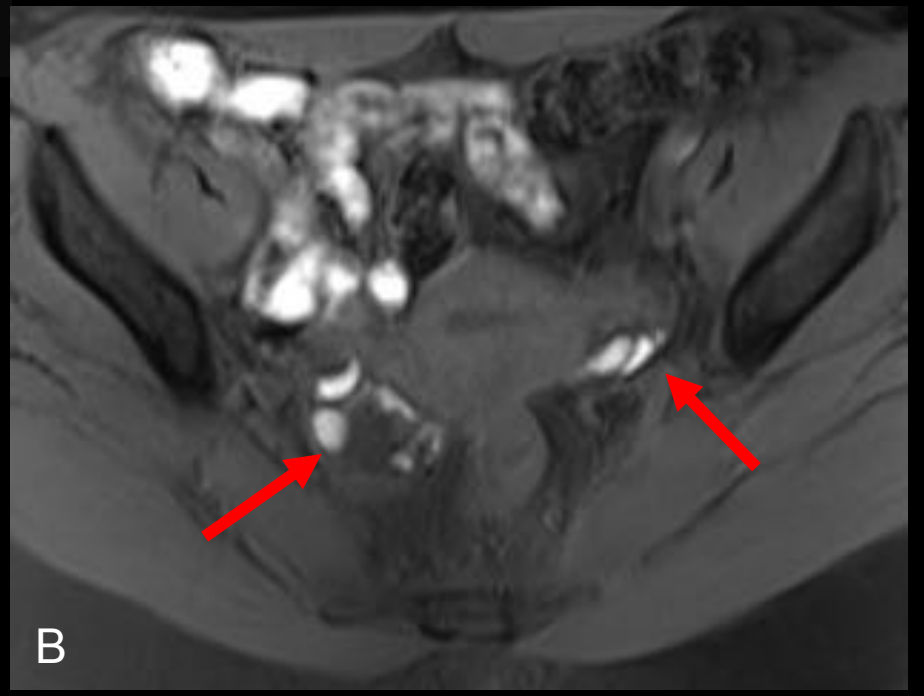
d. Involvement of extra-pelvic organs




(A) Sagittal T1–weighted post contrast MRI demonstrates an adhesion of the posterior body of the uterus to the rectosigmoid (white arrowhead), with associated hypovascular tissue in the subjacent myometrium representing DIE. (B) Axial pre contrast T1-weighted MRI shows few bilateral hyperintense endometriomas (red arrows).

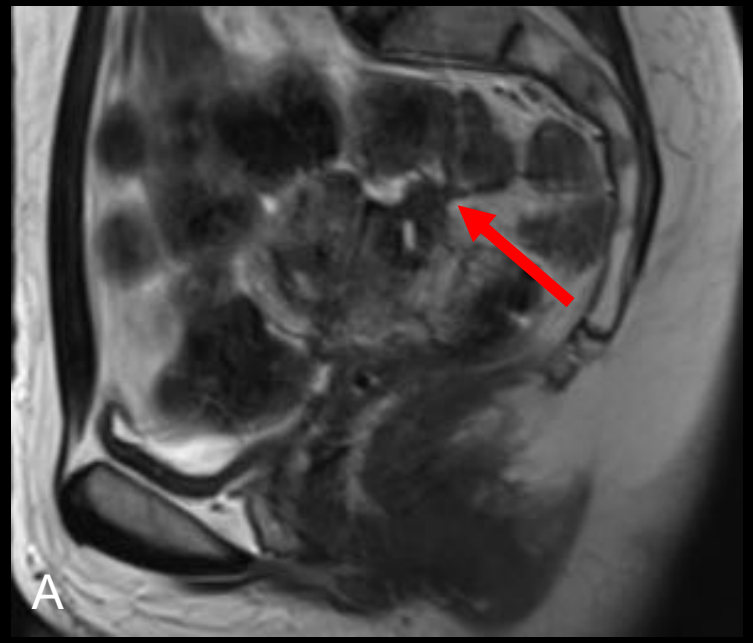
DIE can be a diagnostic challenge because it demonstrates nodular low T2 intensity and may be located adjacent to normal T2 hypointense structures, such as smooth muscle

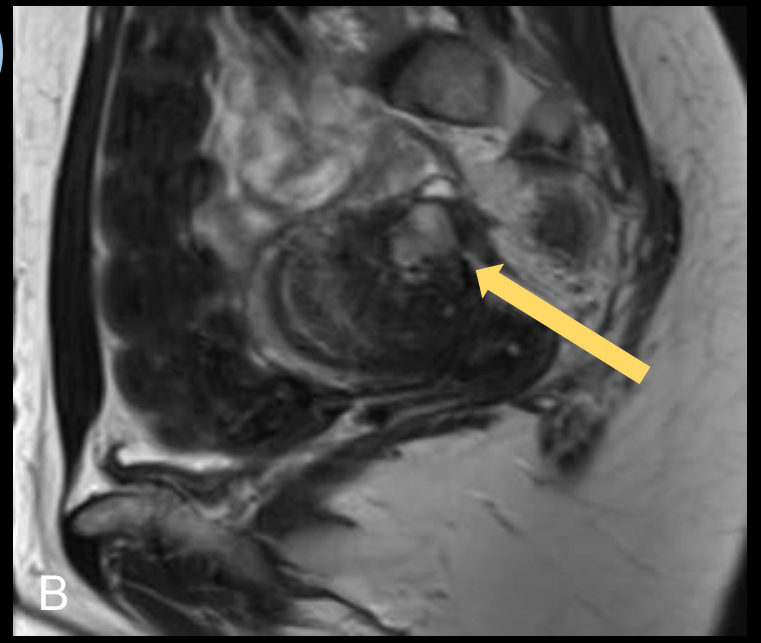
Within solid endometriotic masses, hyperintense foci on T2-weighted images may be seen, which may assist in diagnosis → hyperintense foci represent dilated ectopic endometrial glands

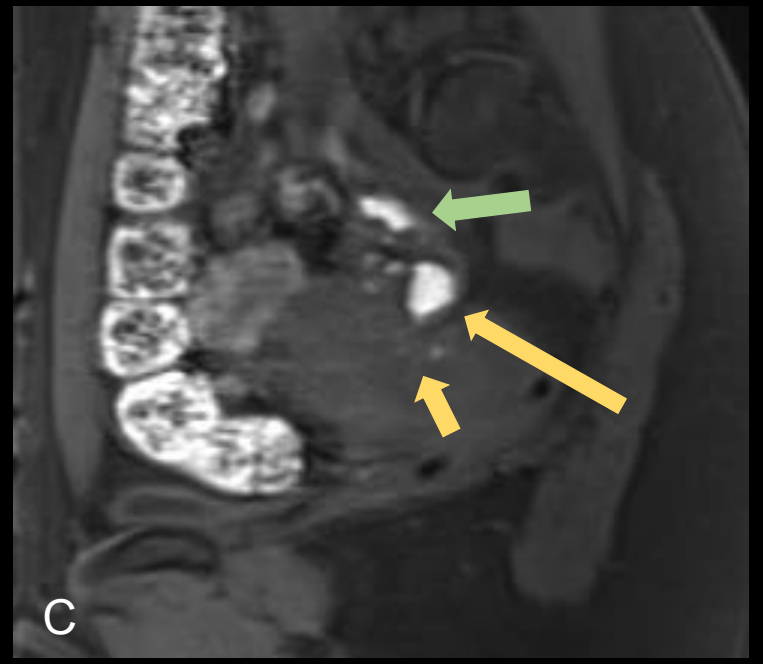


# Deep Infiltrative Endometriosis (DIE)

- Solid subperitoneal lesions that penetrate tissue deeper than 5 mm or that invade the muscularis propria of pelvic organs
- The most severe form of endometriosis
- Severity of symptoms is strongly correlated with the depth of the lesion
- Prevalence: 1% among women of reproductive age[5] and about 20% of all women with endometriosis
- Frequently affected structures: retrocervical region, uterosacral ligaments, rectum, rectovaginal septum, vagina and urinary tract
- DIE nodules rarely isolated → multifocal distribution
- Presence of ovarian endometriomas is an indicator of more severe DIE



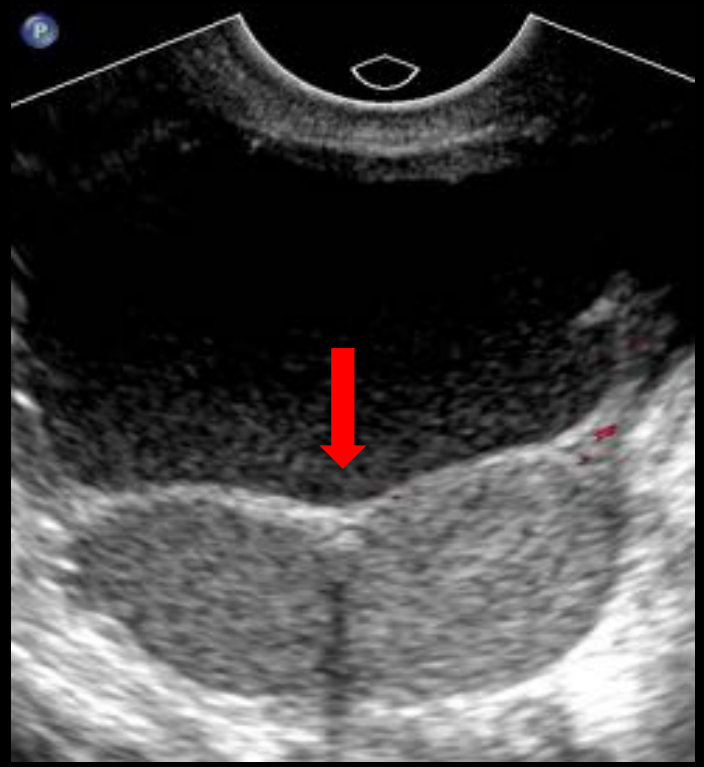



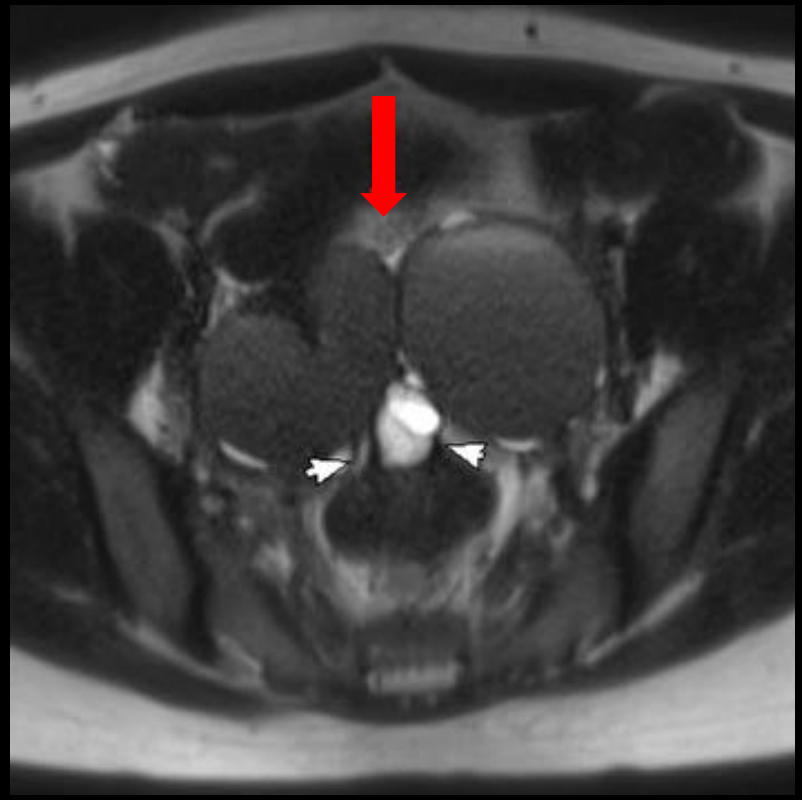




(A & B) 44 year-old woman with endometriosis s/p bilateral ovarian cystectomy and lysis of adhesions has recurrent, persistent pelvic pain. Sagittal T2-weighted MRI demonstrates T2 hypointense spiculated adhesions between the posterior uterine body and sigmoid colon (red arrow) and mixed intensity focus infiltrating into the posterior myometrium (yellow arrow). (C) Sagittal T1-weighted pre contrast MRI with fat saturation shows corresponding T1 hyperintense foci of DIE of the posterior uterine body (yellow arrows) and small T1 hyperintense endometrioma (green arrow).

# Adhesions

- Bands of dense connective tissue mainly composed of type I collagen, macrophages and fibroblasts
- Form between the planes of tissues and organs → connecting structures not normally connected
- Can fixate pelvic organs, causing:
  - posterior displacement of uterus and ovaries
  - elevation of the posterior vaginal fornix
  - angulation of bowel loops
- May also lead to hydronephrosis





(A & B) Transvaginal US and T2 axial MRI demonstrate bilateral endometriomas with a "kissing ovaries" sign (red arrow) indicating adhesions. Note T2-shading in the endometriomas. Other T2-hypointense adhesions were noted between the endometriomas and rectum (short arrows).

**Typical US features:**
Adhesions suggested when there is a lack of free mobility between two structures.

**Typical T1 and T2-weighted MRI features:**
Spiculated, low- to intermediate signal intensity strands arranged in confluent angles

**Other direct and indirect features:**
1. Tethering of pelvic structures → loss of corresponding cleavage planes
2. Distortion of pelvic anatomy with obliteration of the pouch of Douglas
3. When supine, free fluid is located elsewhere in the pelvis rather than in the cul-de-sac

# Case 5

What is the current use of the American Society for Reproductive Medicine (ASRM) Classification System?

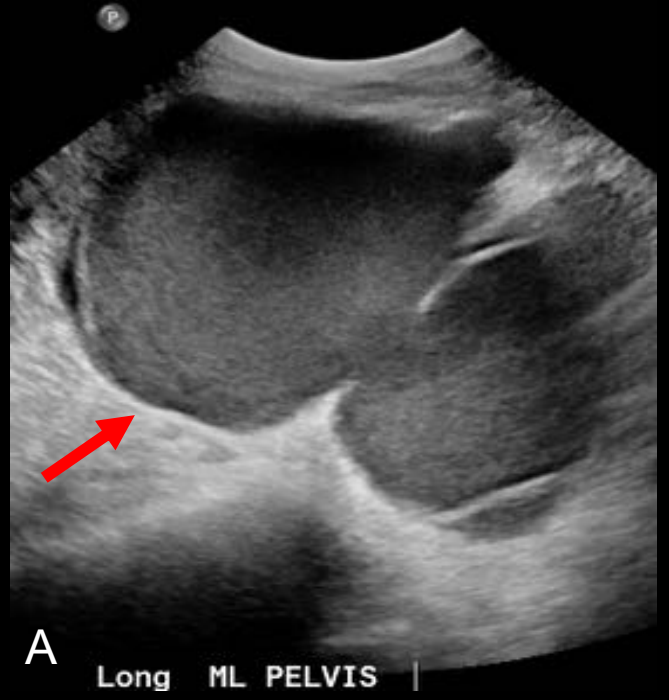
a. to standardize the reporting of anatomic location and disease severity

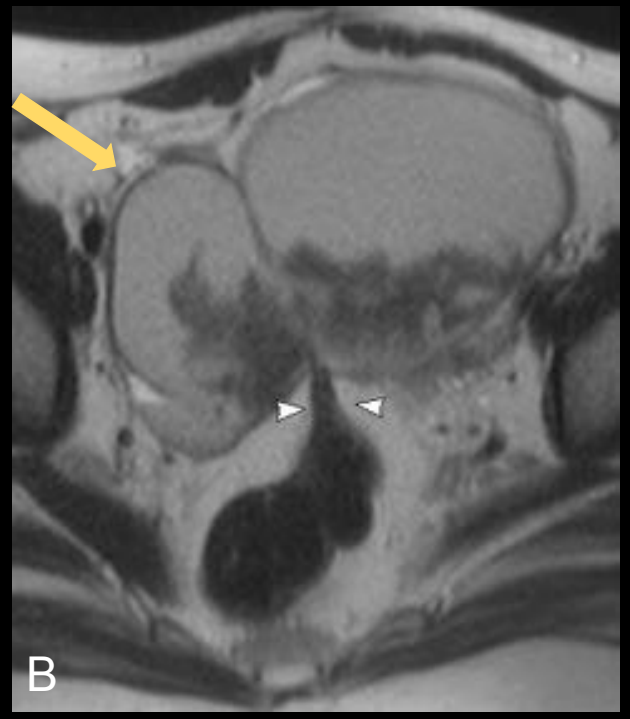
b. to assess fertility post-treatment

c. to grade symptomatology based on anatomic location

d. to distinguish endometriosis-related infertility from other common causes of infertility

This case is an example of stage 4 endometriosis due to the following qualifying factors:
1) Large endometrioma
2) Deep adhesions



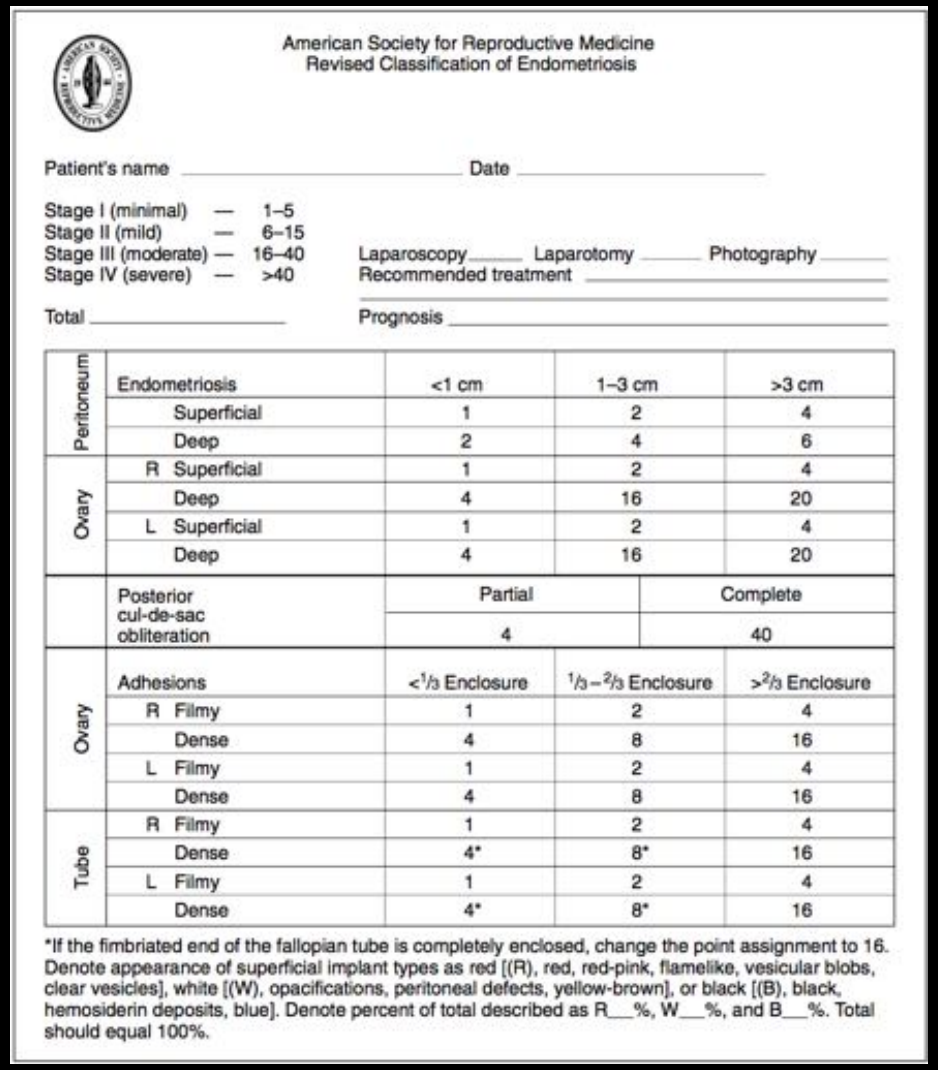





(A) 25 year-old female with history of PID and TOA status post drainage presents with vaginal bleeding. Transabdominal ultrasound shows a large multi-lobed hypoechoic structure (red arrow) originally thought to be a complex fluid collection. (B & C) Follow up T1 and T2-weighted MRI demonstrate large T1 hyperintense and T2 intermediate bi-lobed endometrioma (yellow arrows) with T2 hypointense tethering to the anterior rectum (white arrowheads).

# Revised American Society for Reproductive Medicine (ASRM) Classification System

- ASRM classification system provides a standardized approach for uniform reporting of operative findings by anatomic location and severity
  - Stage 1 (Minimal): small superficial implants, not widespread
  - Stage 2 (Mild): small to medium implants (1-3 cm), slightly deeper in peritoneum and ovary
  - Stage 3 (Moderate): large, widespread implants and dense adhesions
  - Stage 4 (Severe): large implants and endometriomas, deep adhesions
- Was originally an effort to predict probability of fertility following treatment, however; studies have shown that the system was not found to be a sensitive predictor of pregnancy following treatment
- Does not correlate with severity or occurrence of symptoms



American Society for Reproductive Medicine
Revised Classification of Endometriosis

Patient's name _____ Date _____

Stage I (minimal) — 1–5
Stage II (mild) — 6–15
Stage III (moderate) — 16–40
Stage IV (severe) — >40

Laparoscopy____ Laparotomy____ Photography____
Recommended treatment _____

Total _____

Prognosis _____

| | Endometriosis | <1 cm | 1–3 cm | >3 cm |
|---|---|---|---|---|
| Peritoneum | Superficial | 1 | 2 | 4 |
| | Deep | 2 | 4 | 6 |
| Ovary | R Superficial | 1 | 2 | 4 |
| | Deep | 4 | 16 | 20 |
| | L Superficial | 1 | 2 | 4 |
| | Deep | 4 | 16 | 20 |

| | Posterior cul-de-sac obliteration | Partial | Complete |
|---|---|---|---|
| | | 4 | 40 |

| | Adhesions | <1/3 Enclosure | 1/3–2/3 Enclosure | >2/3 Enclosure |
|---|---|---|---|---|
| Ovary | R Filmy | 1 | 2 | 4 |
| | Dense | 4 | 8 | 16 |
| | L Filmy | 1 | 2 | 4 |
| | Dense | 4 | 8 | 16 |
| Tube | R Filmy | 1 | 2 | 4 |
| | Dense | 4* | 8* | 16 |
| | L Filmy | 1 | 2 | 4 |
| | Dense | 4* | 8* | 16 |

*If the fimbriated end of the fallopian tube is completely enclosed, change the point assignment to 16.
Denote appearance of superficial implant types as red [(R), red, red-pink, flamelike, vesicular blobs, clear vesicles], white [(W), opacifications, peritoneal defects, yellow-brown], or black [(B), black, hemosiderin deposits, blue]. Denote percent of total described as R___%, W___%, and B___%. Total should equal 100%.

# Case 6

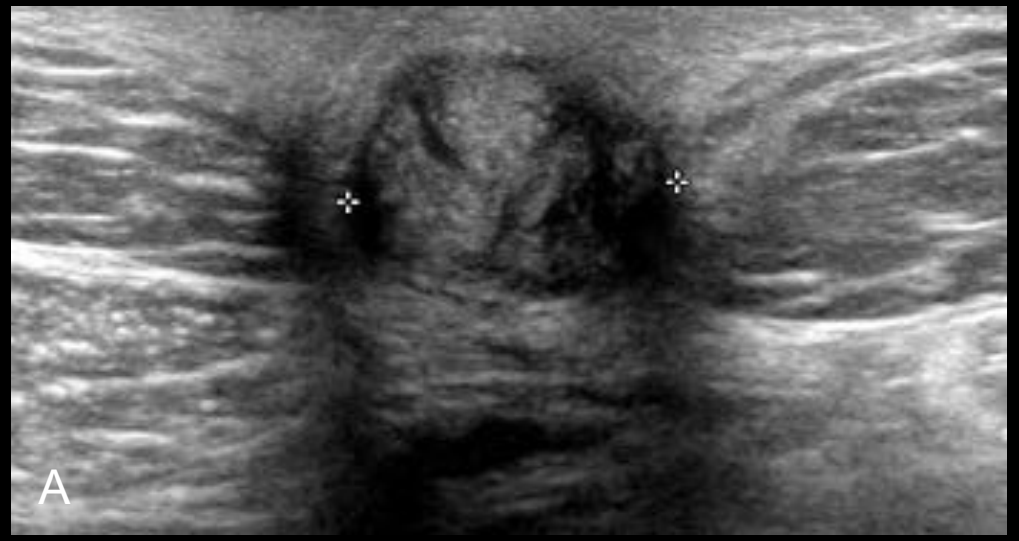
What is the most common extra-pelvic presentation of endometriosis?

a. Kidney

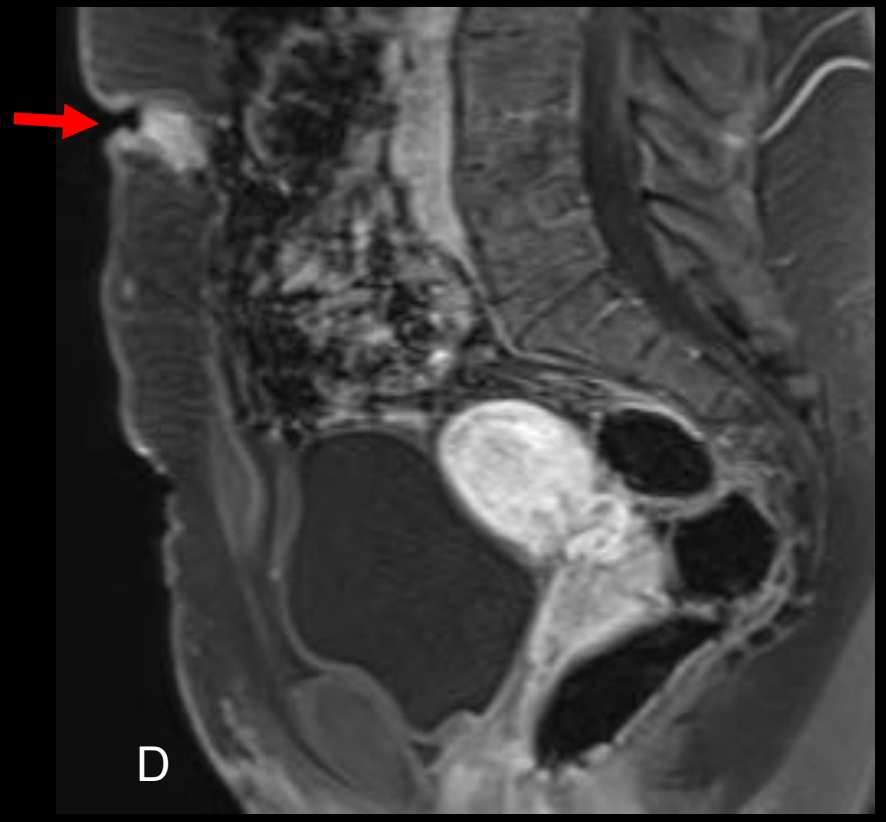
b. Abdominal scar

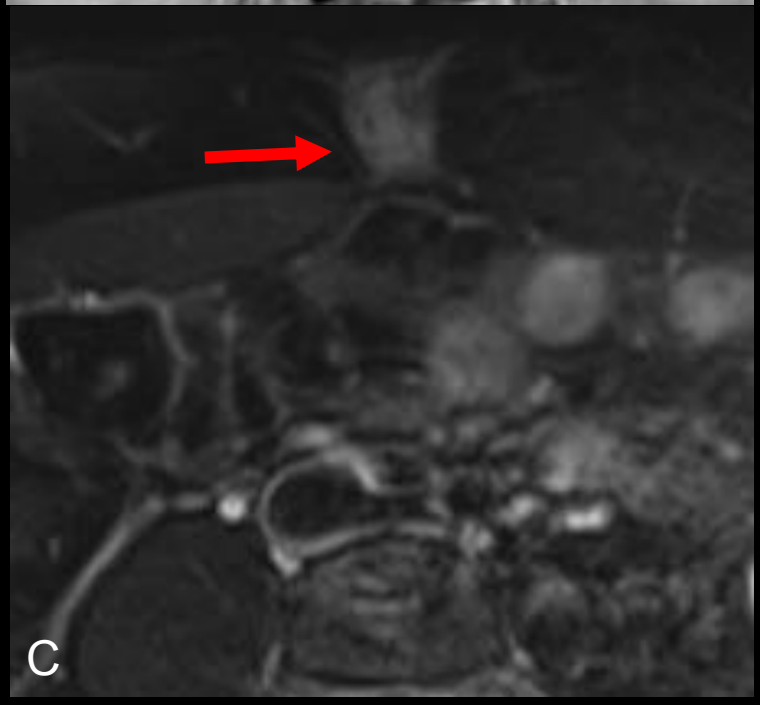
c. Diaphragm

d. Spleen





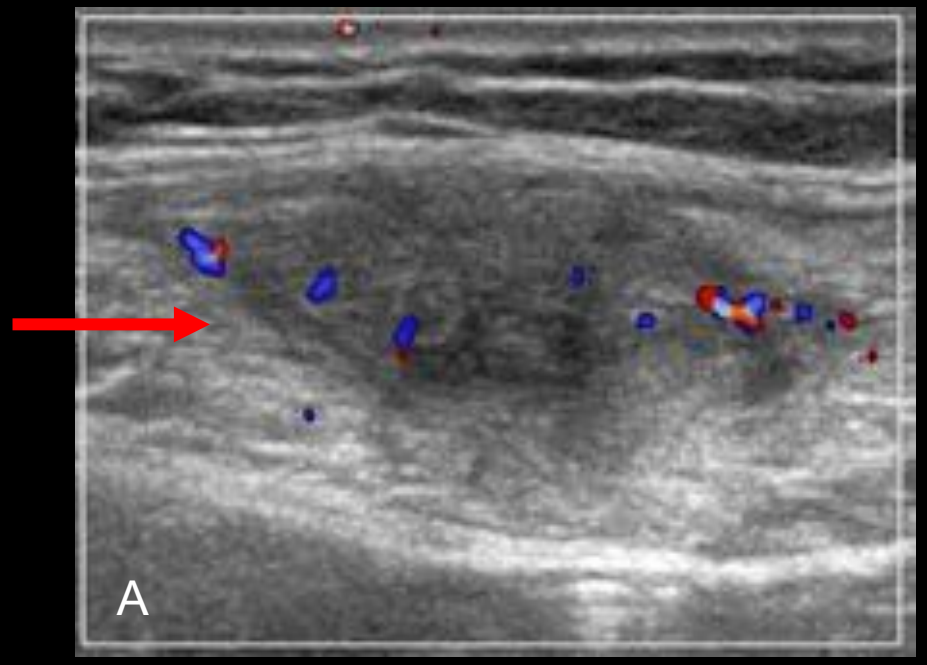



(A) 31 year-old woman with cyclical umbilical pain. Transabdominal US of the anterior abdominal wall demonstrates a hypoechoic solid-appearing mass in the periumbilical soft tissues. (B) Follow up axial T1-weighted pre contrast, (C) fat saturated T2-weighted and (D) sagittal T1-weighted post contrast MRI demonstrate enhancing tissue at the umbilicus with T2 hypointensity and a focus of T1 hyperintensity (red arrows) corresponding to the ultrasound finding. Ultrasound-guided biopsy of the mass revealed umbilical endometriosis.

# Extra-Pelvic Manifestations of Endometriosis

- Abdominal wall implant with associated scar is the most common extra-pelvic manifestation
- Incidence of primary umbilical endometriosis is estimated to be about 0.5%-1% of all extra-genital implantation
- Most frequent extra-pelvic intestinal endometriotic implants: terminal ileum, cecum and appendix
- Other rare but described sites:
  - Thorax (catamenial pneumothorax/hemoptysis/chest pain)
  - Liver (obstructive jaundice)
  - Kidney/intrinsic ureter lesion (pelvic pain, hydronephrosis)
  - Gluteal muscle and L5 nerve (sciatica)




A) 41 year-old woman with a tender nodular mass felt within her C-section scar. Abdominal ultrasonography demonstrated a circumscribed, relatively hypoechoic solid nodule with internal vascularity in the subcutaneous tissues adjacent to the C-section scar (red arrow). Ultrasound-guided biopsy of the nodule revealed scar endometriosis.

# Case 7

40 year-old woman with acute on chronic pelvic pain.

Which type of leiomyoma is most commonly misdiagnosed as adnexal endometrioma or malignancy?

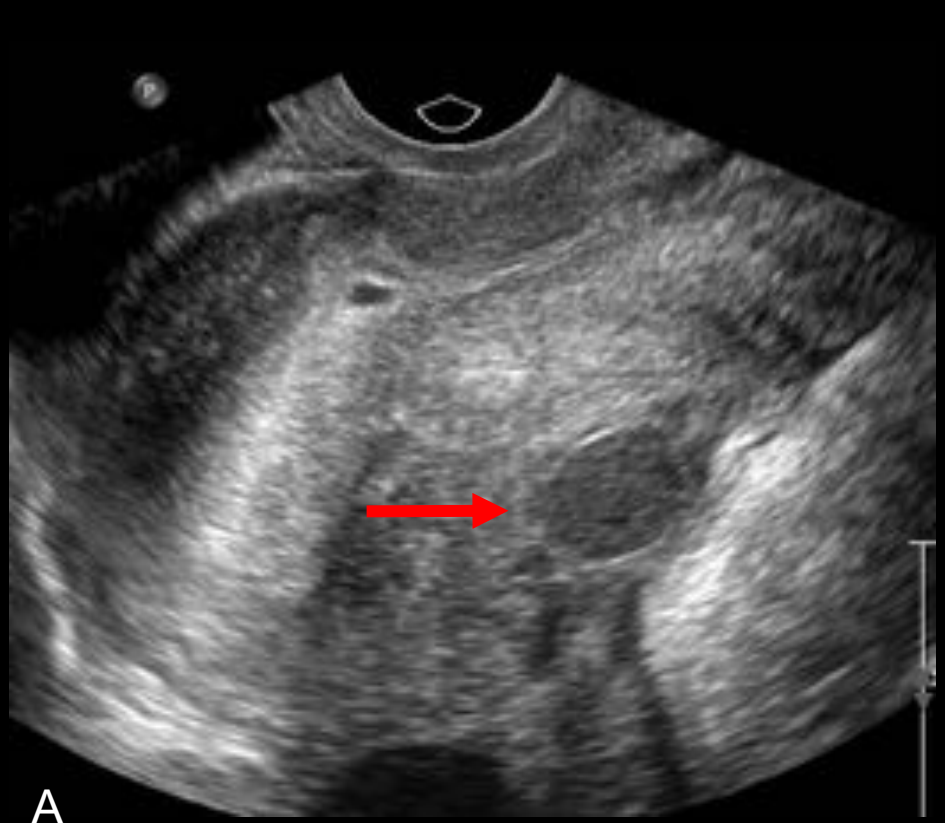
a. Subserosal pedunculated

b. Degenerating

c. Intramural

d. Submucosal

(A) Transvaginal ultrasound demonstrates a heterogeneously hypoechoic intramural uterine mass determined to be an intramural fibroid (red arrow). (B) Sagittal pelvic MRI revealed a T1 hyperintense, T2 hypointense deposit along the serosal surface of the posterior uterine body of the rectouterine space (arrowhead), indicating instead a diagnosis of endometriosis.

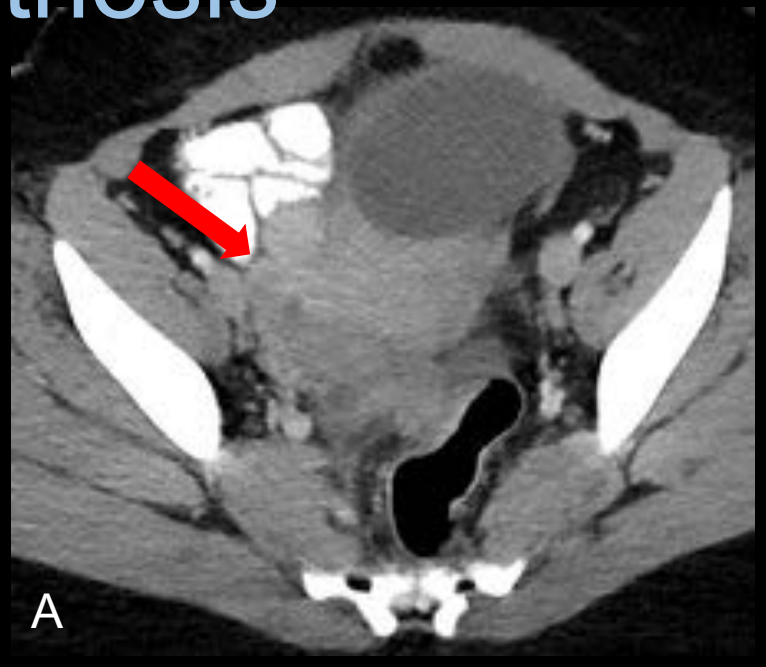


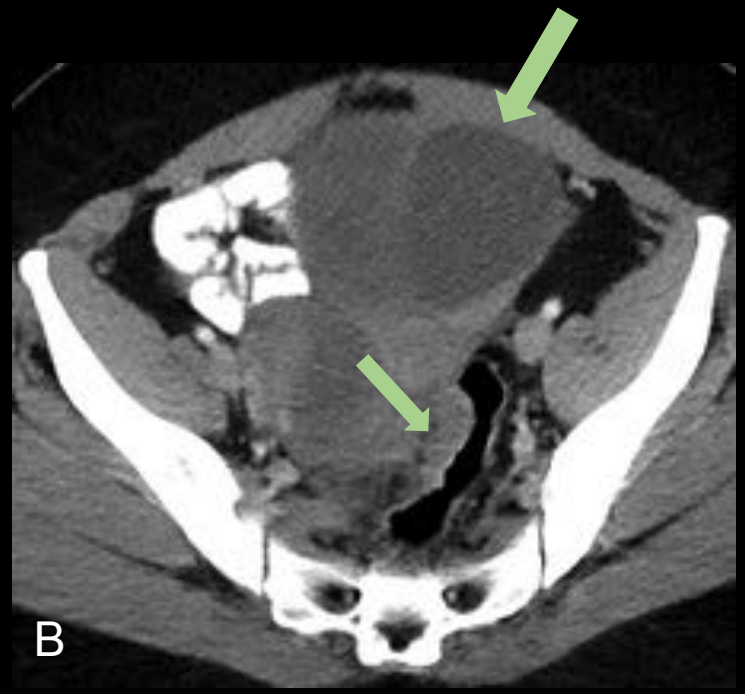
A

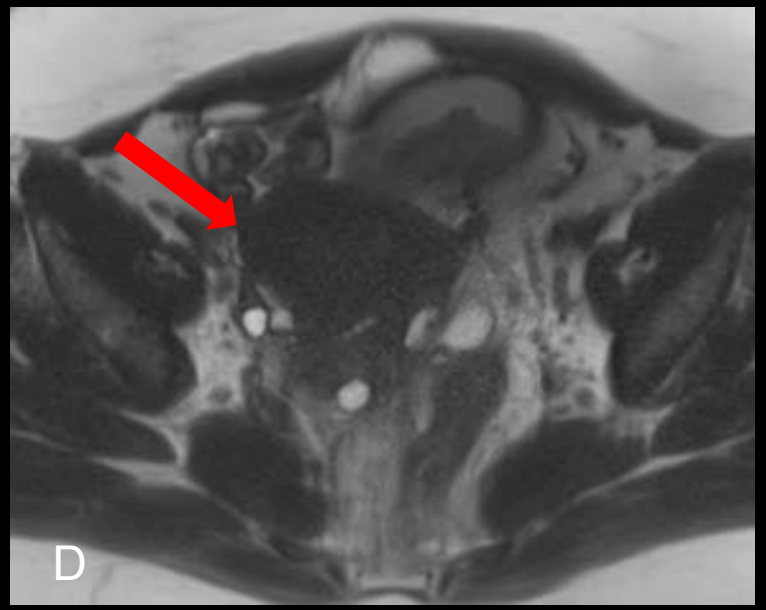
B

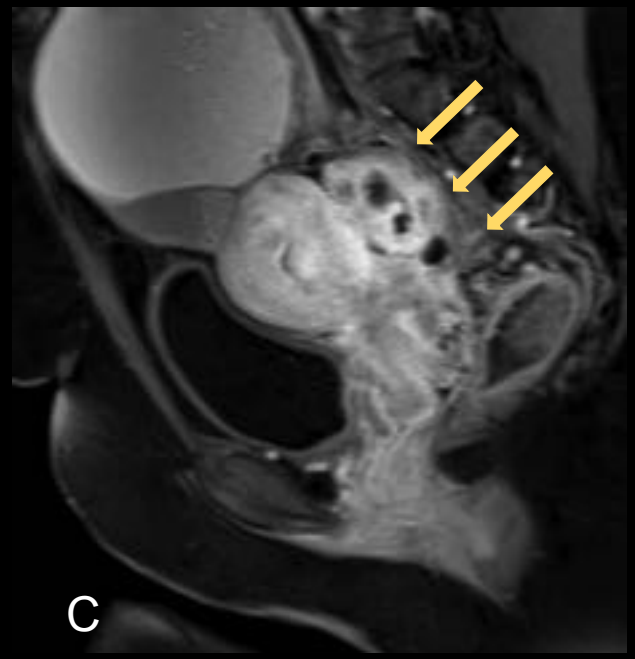
# Mimicry in Endometriosis

- Diagnosis of endometriosis can be challenging because it can mimic other diseases
- DIE of the posterior uterine body can be mistaken for posterior segmental adenomyosis, leiomyoma or pelvic mass
  - Adenomyosis is an outward growing process with abnormal endometrial tissue growth from the endometrium to the subjacent myometrium
  - Solid endometrial implants that extend into the myometrium from the posterior cul-de-sac can appear similar→ however, often <u>spares</u> the uterine junctional zone
  - On US, uterine DIE lesions are mostly hypoechoic in relation to the myometrium and can be mistaken for intramural or subserosal fibroids due to their similar (and variable) ultrasound appearances



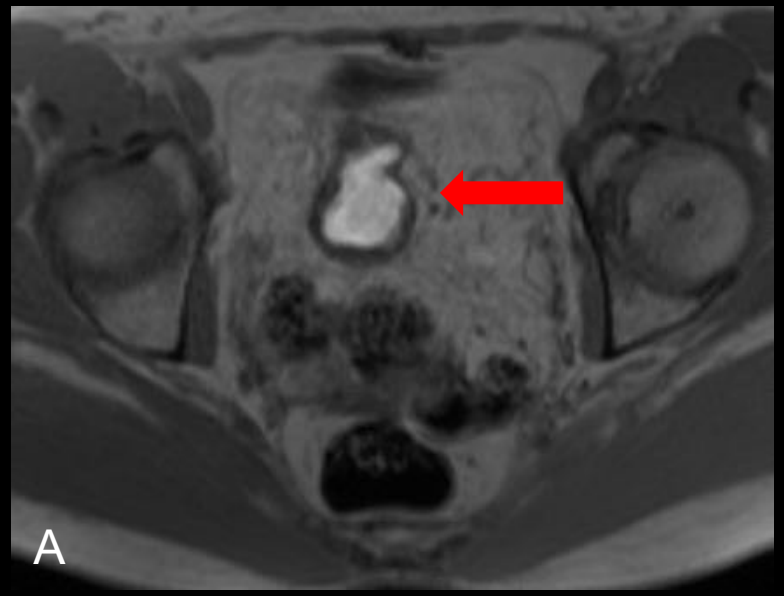



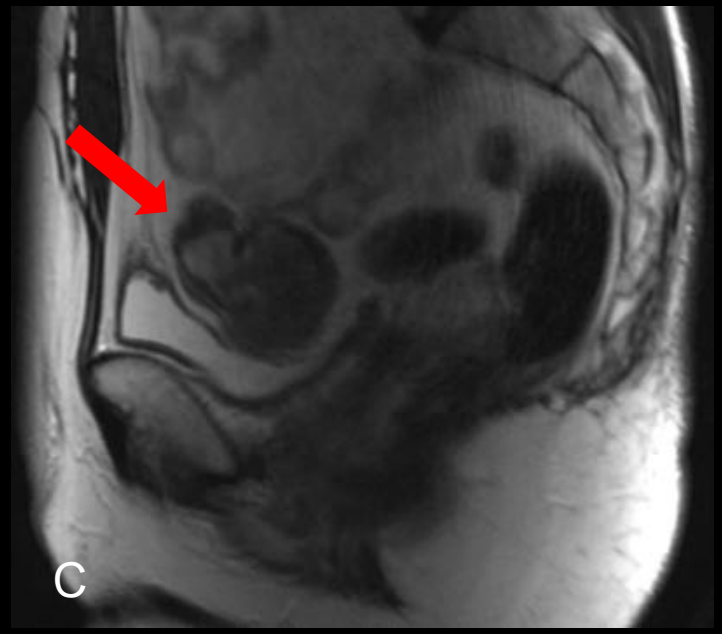

(A) 33 year-old woman with progressive pelvic pain. Axial CT abdomen and pelvis with contrast demonstrates an ill-defined heterogeneous soft tissue mass in the cul-de-sac (red arrow) (B) with asymmetric thickening of the medial wall of the rectum and large adnexal endometriomas (green arrows). (C & D) Follow up sagittal T1-weighted post contrast and axial T2-weighted MRI show a large, ill-defined enhancing mass contiguous with the uterus and inseparable from the sigmoid colon (yellow arrows). Findings were favored to represent changes related to endometriosis over a primary rectal malignancy. Surgical pathology confirmed infiltrative endometriosis.

# Another Example

- Omental endometriosis is a rare entity with few case reports
- Hypothesized that the Müllerian metaplasia theory of pathophysiology explains endometrosis of the omentum
- Leiomyoma, endometriosis and adenomyosis implantation in the pelvis is a known complication of laparoscopic supracervical hysterectomy
- Lesions are a result of uterine fragments dispersed in the pelvic cavity during morcellation



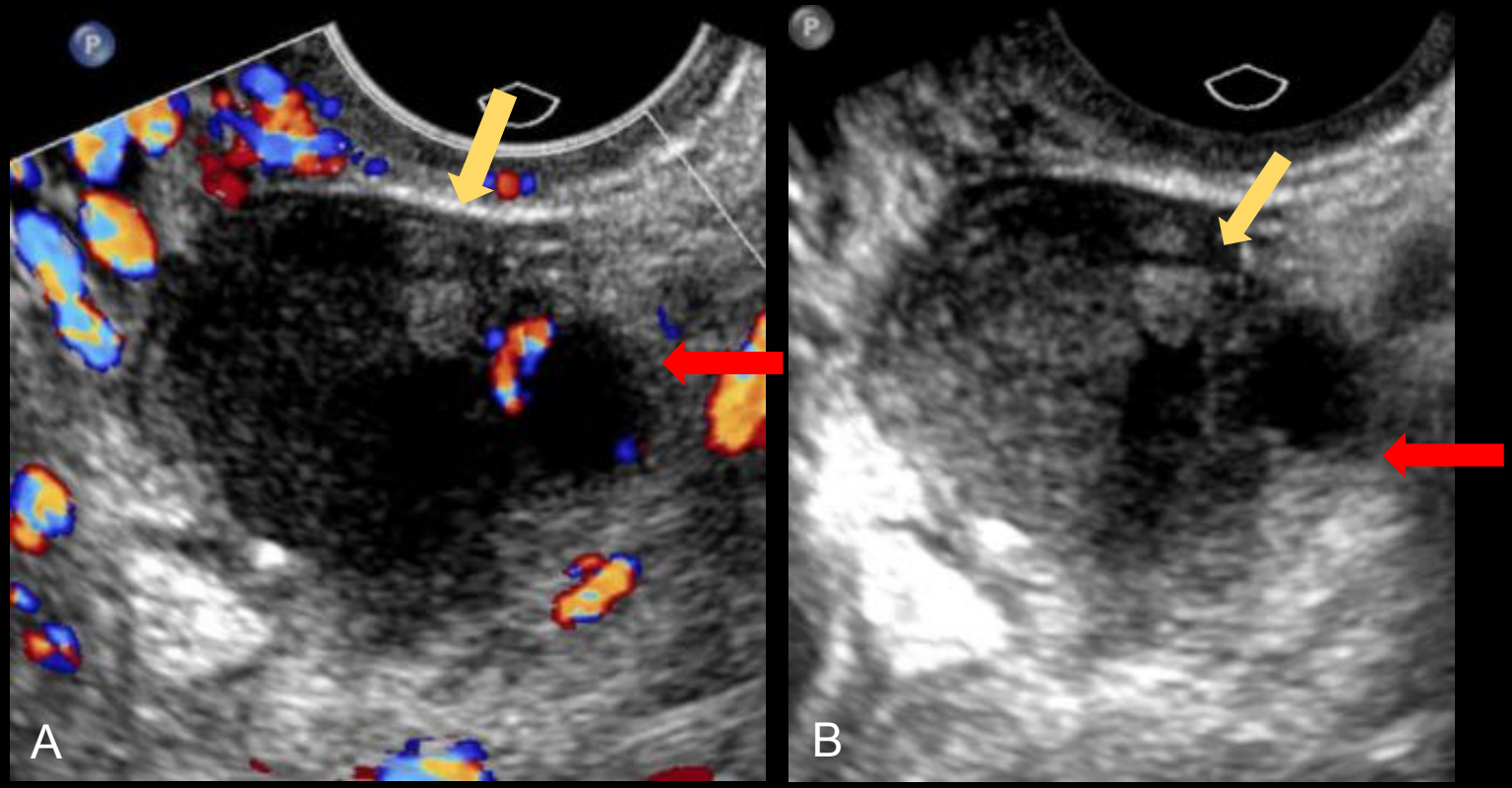





(A, B and C) 53 year-old woman with history of fibroids status post supracervical hysterectomy and left salpingoopherectomy with uterine morcellation was found to have a pelvic mass on bedside ultrasound in the outpatient gynecology office. Axial and sagittal T1 and T2-weighted MRI demonstrates T1 hyperintense and T2 hypointense pelvic mass with some soft tissue ring enhancement, located at the midline superior to the bladder and inferior to loops of small bowel (red arrows). Due to surgical and morcellation history, differential included chronic hematoma and remnant endometrium or myometrium. Hemorrhagic mesenteric mass was also considered. Surgical histology from partial omentectomy demonstrated omental endometriosis.

# Mimicry in Ovarian Endometriomas

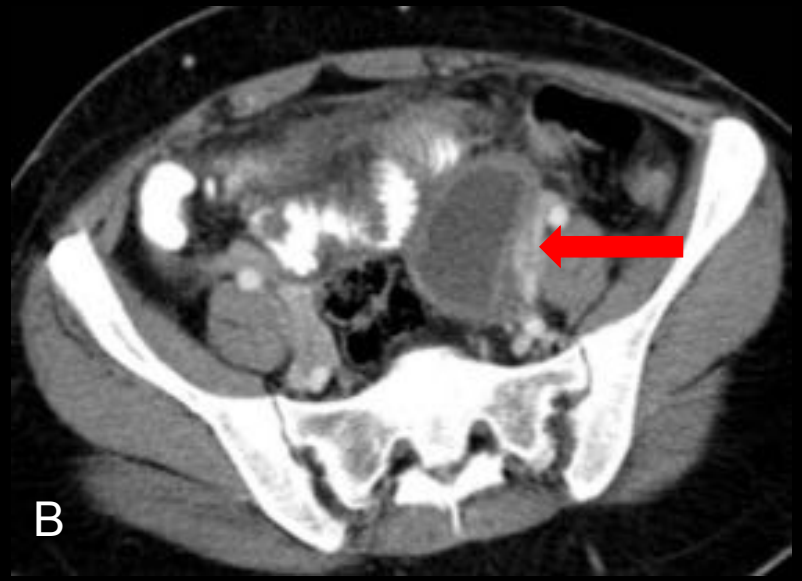
- Endometriomas and hemorrhagic ovarian cysts may both demonstrate T1 relaxation times similar to fat → mimic mature cystic teratomas
  - T1-weighted fat saturation imaging is essential to assist in appropriate differentiation
- In pregnant women, decidualized endometriomas can mimic ovarian cancer on both US and MRI
  - Increase in progesterone levels → hypertrophy of endometrial stromal cells in endometrioma → formation of vascular mural nodules
  - After childbirth, decidualization resolves or regresses to uncomplicated endometrioma




(A and B) 40 year-old asymptomatic woman with history of ovarian cysts found to have a left ovarian mass on TV US. US shows a complex cystic and solid left ovarian mass (red arrows) with diffuse low level echoes and few mural nodules (yellow arrows). The differential included benign mature cystic teratoma, endometrioma and high grade neoplasm. Surgical pathology from left cystectomy demonstrated benign left endometrioma.

All of the following demonstrate restricted diffusion:
1) Endometrioma
2) Benign hemorrhagic ovarian cyst
3) Solid endometrial implants
4) Benign mature cystic teratoma

# Another Example

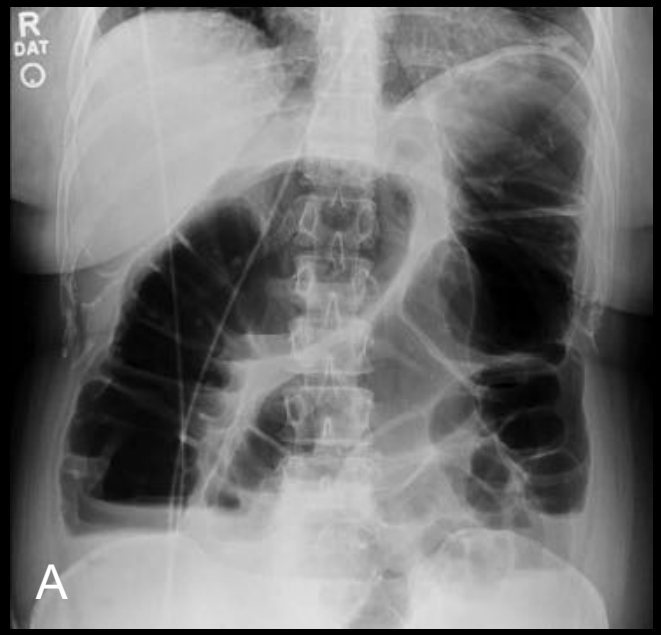



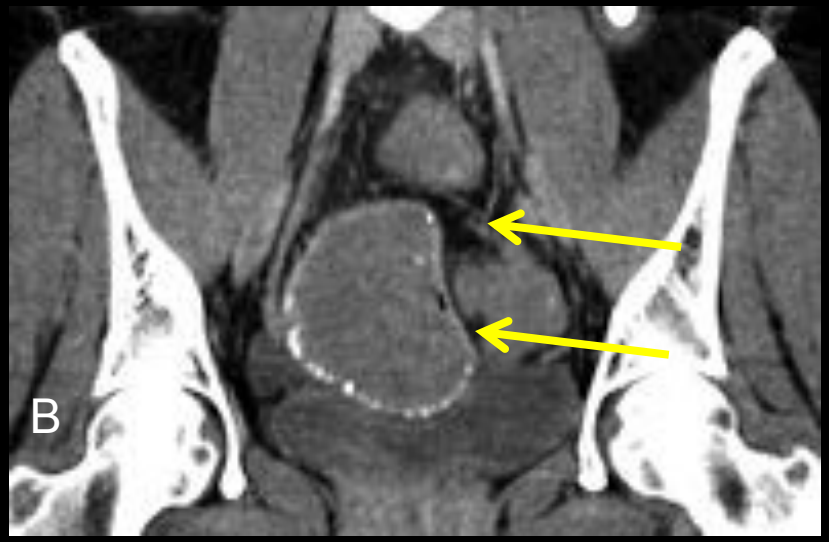


CT is frequently performed when an endometrial cyst ruptures and causes acute pelvic pain

(A, B and C) 33 year-old female with endometriosis presents to the ED with acute right lower quadrant pain. Axial CT with oral and IV contrast demonstrates a thickened appendix with mesenteric stranding (green arrow) and fluid collections in the right and left pelvis thought to represent appendicitis with abscess formation (red arrows). Intraoperative findings revealed ruptured endometriomas with peritonitis mimicking acute appendicitis.

# GI Complications of Endometriosis



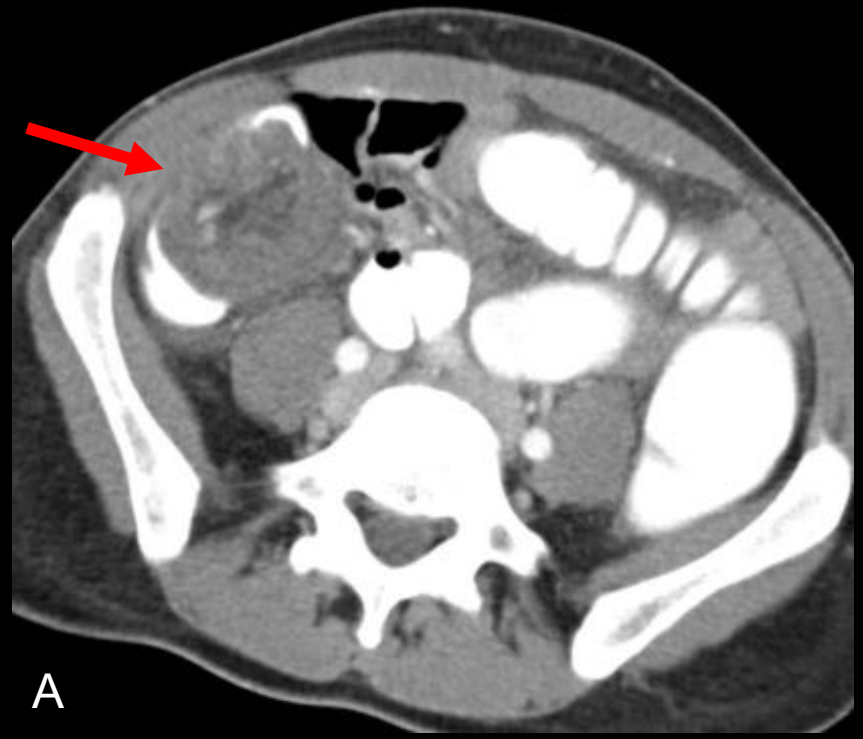



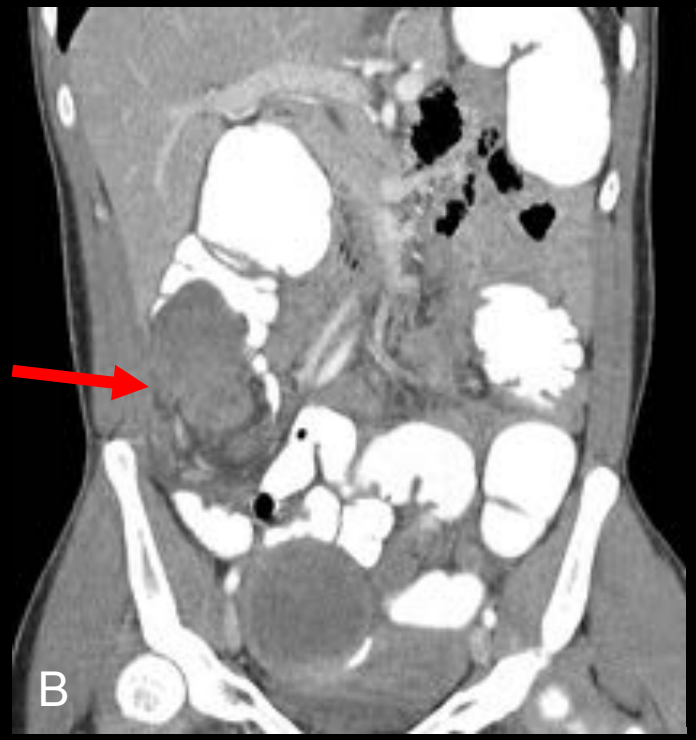


(A) 40-year-old woman with a history of endometriosis presents with acute abdominal pain and nausea. AP X-ray of the abdomen shows marked dilatation of the large bowel to the level of the sigmoid colon and mild dilatation of the small bowel. (B & C) Follow up coronal and sagittal CT abdomen and pelvis with contrast shows findings consistent with large bowel obstruction with a spiculated soft tissue nodularity extending into the sigmoid colon representing the transition point (yellow arrows). Surgical pathology confirmed endometriosis implant invading the sigmoid colon. (D) Endoscopic examination post-diverting colostomy demonstrated patchy, nodular endometrial implants on the mucosal wall of the sigmoid colon.

# Another Example

(A, B and C) 36 year-old woman with acute, intermittent colicky abdominal pain. Axial, coronal and sagittal contrast enhanced CT of the abdomen and pelvis with oral contrast shows ileocecal intussusception with a homogenously, mildly enhancing lesion as the lead point (red arrows). Surgical pathology confirmed extensive serosal endometrial adhesions of the ileocecum, obliteration of the appendix and lymph node involvement.





- GI endometriosis accounts for 3–37% of all endometriosis cases
- Asymptomatic, but may have various presentations: acute or chronic appendicitis, lower GI bleed, intestinal perforation, intestinal obstruction resulting from intussusception

# Case 8

54 year-old woman with longstanding endometriosis undergoes surveillance imaging for her disease.

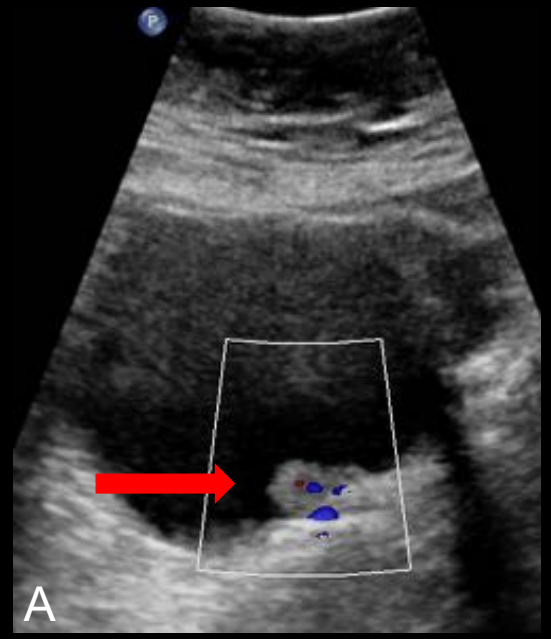
How does subtraction imaging in MRI assist in diagnosis of malignant conversion of an endometrioma?

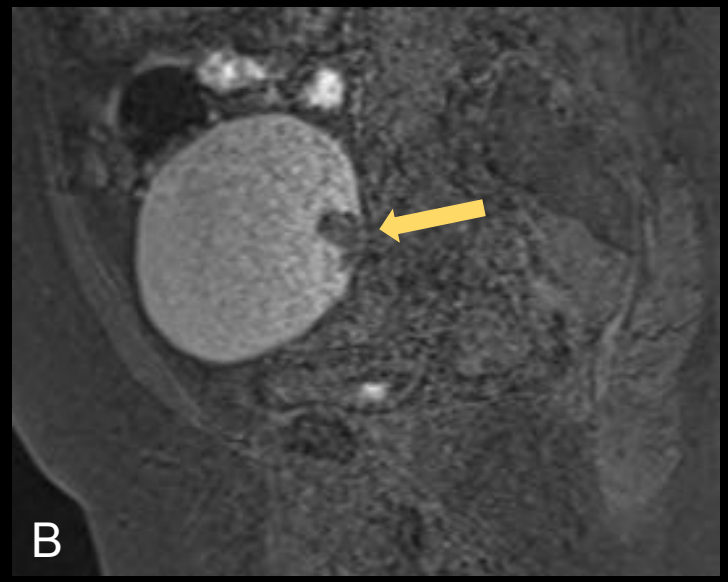
a. Helps to detect overall increase in hyperintensity of the endometrioma

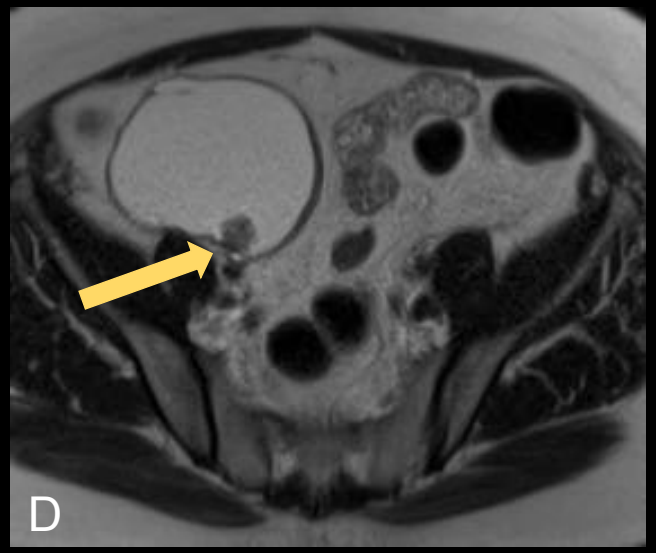
b. Helps to detect vascular structures within an endometrioma

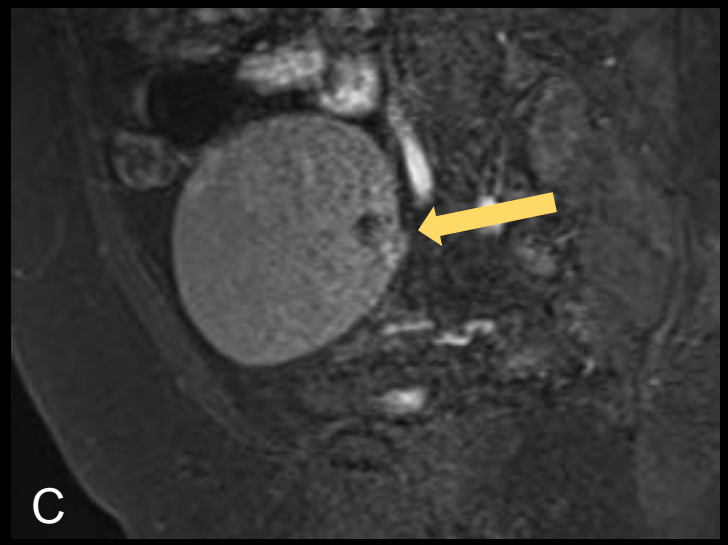
c. Helps to detect abnormal rim enhancement of a hyperintense endometrioma

d. Helps to detect small contrast-enhancing nodules within the hyperintense endometrioma




(A) TA US demonstrates several mural nodules with internal vascularity (red arrow) within an endometrioma. (B) T1-weighted pre contrast (C) post contrast and (D) T2-weighted MRI show an enhancing hypointense mural nodule (yellow arrows) within an endometrioma. Surgical pathology revealed endometrioid type ovarian carcinoma arising from the endometrioma.

# Malignancy in Endometriosis

- Malignant transformation of endometrioma: prevalence is 0.6%-0.8%
- Main histologic subtypes of malignancy:
  - clear cell
  - endometrioid carcinoma
  - serous and mucinous subtypes
- Endometriosis-associated ovarian cancer typically affects women who are 10-20 years younger than those affected by ovarian cancer without endometriosis
  - early detection is critical for prognosis and fertility preservation
- Endometriosis and ovarian cancer share many risk factors and protective factors
  - Risk factors: early menarche, late first gestation, chronic stress
  - Protective factors: tubal ligation, hysterectomy, physical activity
- Elevated CA-125 not specific due to its non-specific, benign elevation in endometriosis itself

**Features suggestive of malignant conversion:**

US

- Interval growth of mural nodules that demonstrate internal vascularity

MR

- endometrioma size increase
- enhancing mural nodules

# Case 9

35 year-old woman with an 8 year history of inability to conceive.

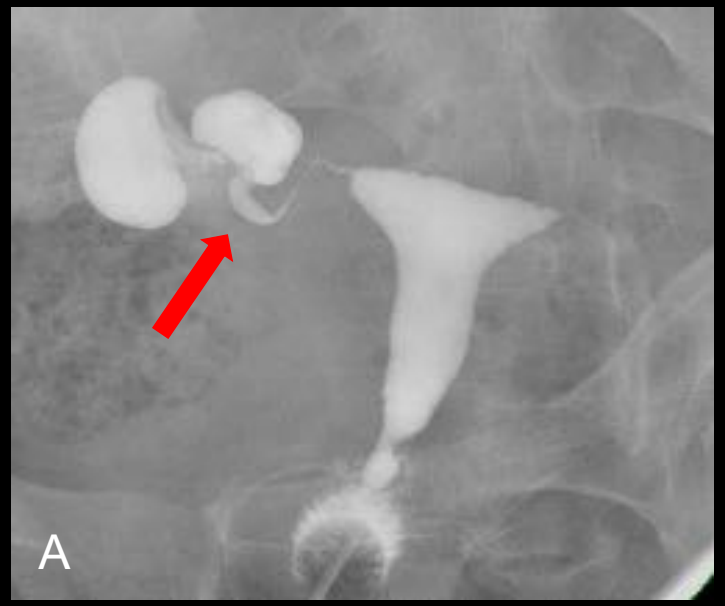
In women with endometriosis-related infertility, what is the value of surgical therapy for endometriosis?

a. Surgical management, including removal of endometrioma, is not effective in improving pregnancy

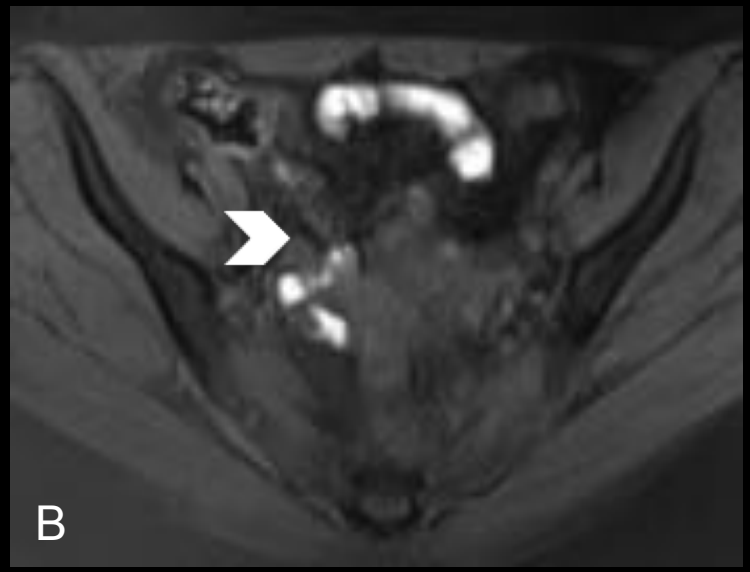
b. Medical suppressive therapies such as OCPs and GnRH agonists are effective alone

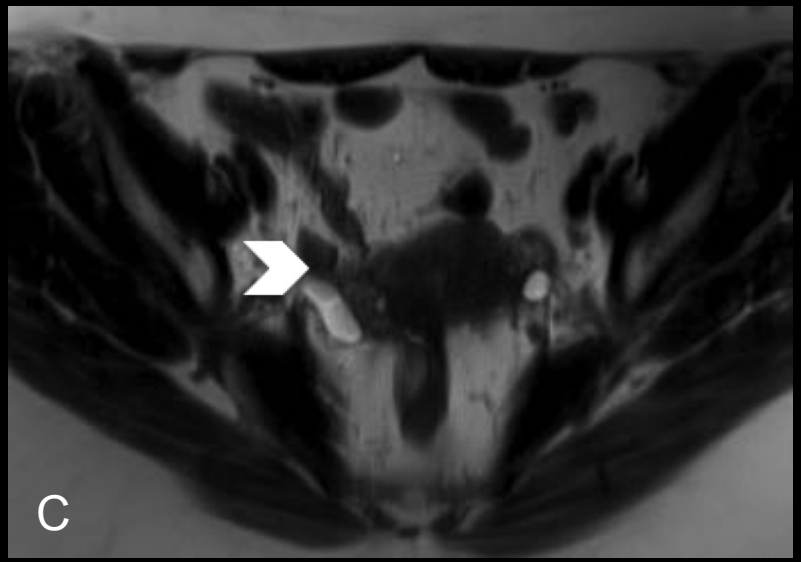
c. After initial unsuccessful surgery for endometriosis-related infertility, in vitro fertilization is superior to re-operation (unless pain is still a limiting factor)

d. Simple drainage or ablation of endometrioma is superior to complete removal of endometrioma




(A) Hysterosalpingogram shows a tortuous and dilated right fallopian tube (red arrow) with no intraperitoneal spill of contrast, demonstrating right hydrosalpinx and bilateral fallopian tube obstruction. (B) Axial fat saturated T1 and T2-weighted pelvic MRI demonstrate hyperintensity in the right adnexa (white arrowheads) indicating hematosalpinx and endometriosis-related infertility.



# Clinical Implications

- Endometriosis-related infertility
  - Etiologies range from anatomical distortions secondary to adhesions (occlusion of tubal ostium compromising sperm passage) to endocrine abnormalities and immunological disturbances
  - Superficial peritoneal implants are more closely associated to infertility than presence of endometrioma and DIE
  - Severity of infertility increases with severity of disease → 50% of women with mild disease will conceive spontaneously, 25% of women with moderate disease will conceive spontaneously and few spontaneous conceptions will occur in severe disease
- Effects on quality of life
  - decreased sexual function (affecting personal relationships), fatigue, analgesia dependence for chronic pain, depression and greater impact on mental health
  - Chronic pelvic pain is multi-factorial: pelvic anatomic distortion/adhesions,  cyclic bleeding within implants, prolonged exposure to pro-inflammatory cytokines and growth factors → peripheral nerve sensitization causing hyperalgesia, neurogenesis
- Economic burden of the disease itself and misdiagnoses, leading to overtreatment costs
  - $69.4 billion in direct (healthcare utilization) and indirect (loss of societal productivity) costs

# Bringing it all Together

*Adhesions can occur in any of the 3 types of endometriosis
Imaging features: immobility between two structures on US, spiculated appearance with low- to intermediate signal intensity strands arranged in confluent angles on T1 and T2 MRI, tethering of pelvic structures, distortion of pelvic anatomy

| | Endometriomas | Superficial Peritoneal Implants | Deep Infiltrative Endometriosis |
|---|---|---|---|
| **Definition** | Cystic mass arising from ectopic endometrial tissue within the ovary or elsewhere in the pelvis<br><br>“chocolate cyst” | Soft tissue or cystic deposits of ectopic endometrial tissue on pelvic peritoneum and pelvic organs that are generally <1 cm in size<br><br>“powder burn lesions” | Solid subperitoneal lesions that penetrate tissue deeper than 5 mm or that invade the muscularis propria of pelvic organs |
| **Common Locations** | Ovary, fallopian tubes, broad / round / uterosacral ligaments, abdominal wall<br>Retrocervical region, uterosacral ligaments, rectum, rectovaginal septum, vagina, urinary tract | | |
| **Imaging Features** | **US:**<br>-Unilocular or multilocular (less than five locules) cyst<br>-Homogeneous low-level echogenicity (ground glass echogenicity) of the cyst fluid<br>-Atypical features = nonvascular septations or papillary projections within endometrioma, ring down along the wall of the ovary, wall thickening and nodularity creating a lobulated appearance<br><br>**MRI:**<br>-T1-hyperintense adnexal cysts (singular or multiple)<br>-T2 shading (signal intensity lower than simple fluid) with low-intensity thick, fibrous capsule | **US:**<br>-Hypoechoic linear thickening or nodularity to superficial aspect of visualized pelvic structures<br><br>**MRI:**<br>-Multiple round (cystic or nodular) lesions homogeneously T1 hyperintense on fat-suppressed imaging<br>-Variable of T2 signal intensity | **US:**<br>-Hypoechoic mass within or infiltrating pelvic organs<br><br>**MRI:**<br>-Nodular T2 hypointensity (challenging to diagnose as it may be located adjacent to normal T2 hypointense structures, such as smooth muscle)<br>-Within solid endometriotic masses, hyperintense foci on T2-weighted images may be seen (aids in diagnosis) |
| **Treatment** | 1. Observation by US every 12 months (small malignant conversion risk)<br>2. Pain symptoms: First line therapy = OCs and NSAIDS, 2nd line = GnRH agonist<br>3. Surgical excision for infertility, symptomatic relief (ureter or bowel obstruction) and for refractory pain | | |

# Conclusion

- Accurate and timely recognition of endometriosis is significant to women's reproductive health and general psychological and physical well-being
- Endometriosis management should be individualized according to the patient's intentions and priorities; management strategies can vary from country to country as pain perception and health-care systems differ around the world
- The radiologist plays a critical role in the healthcare team setting to reach a diagnosis and provide proper treatment tailored to each individual and extent of her disease

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