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Basic ultrasound assessment in infertility

Dr.Parvin hakimi
Feloship of infertility and IVF

The use of sonography, in particular EVS, has become an integral component of the evaluation and treatment of infertility

Initial baseline ultrasound examination is used primarily to identify structural abnormalities that might affect fertility such as uterine anomalies, endometrial polyps or submucosal leiomyomas, endometrial adhesions/synechiae, or hydrosalpinges.

Sonography is also used to assess for possible underlying pathologic processes associated with infertility such as adenomyosis, endometriosis, polycystic ovary syndrome (PCOS), and low antral follicular count

Once a treatment plan has been established, sonography plays an important role in monitoring response, particularly in assessing folliculogenesis and endometrial receptivity

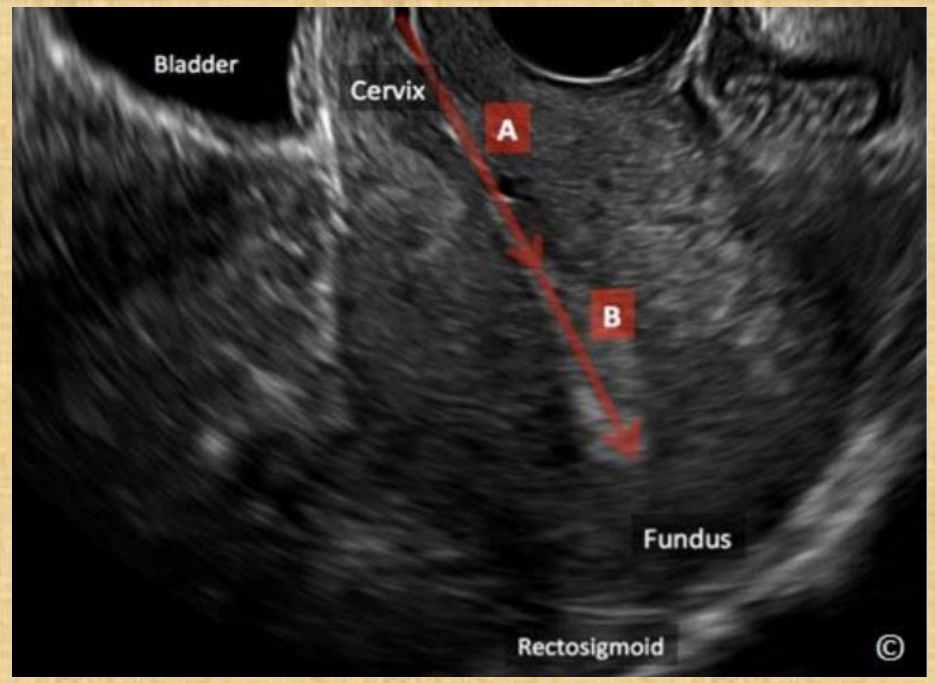
In addition, ultrasound imaging is crucial for guiding infertility treatment such as oocyte retrieval and in assessing post treatment complications

Initial evaluation

- Part of the initial evaluation of all women with infertility is an *assessment of pelvic anatomy*
- Although high-resolution *EVS is the preferred method* for imaging the pelvic organs, an *initial overview* using a *transabdominal* approach should be performed to *evaluate for the possible presence of an* ***enlarged uterus or other pelvic mass***
- A baseline transvaginal sonographic examination consists of images of the *uterus, endometrium, and ovaries*, with additional targeted evaluation of any identified abnormality

Uterus

- the uterus should be imaged in both longitudinal (sagittal) and coronal (or transverse) orthogonal planes, with some views including the full length of the cervix
- In patients with an enlarged or elongated uterus, it is important to ensure that the *entire fundus as well as any exophytic lesion is included*
- *The uterine size, shape, and orientation* should be assessed and documented in both *sagittal (long-axis) and transverse (axial or short-axis) planes*.
- *The endometrium, myometrium, and cervix* should be carefully evaluated, and their appearance documented
- Myometrial masses and contour abnormalities should be recorded in two different planes and their locations recorded


Bladder
Cervix
A
B
Fundus
Rectosigmoid
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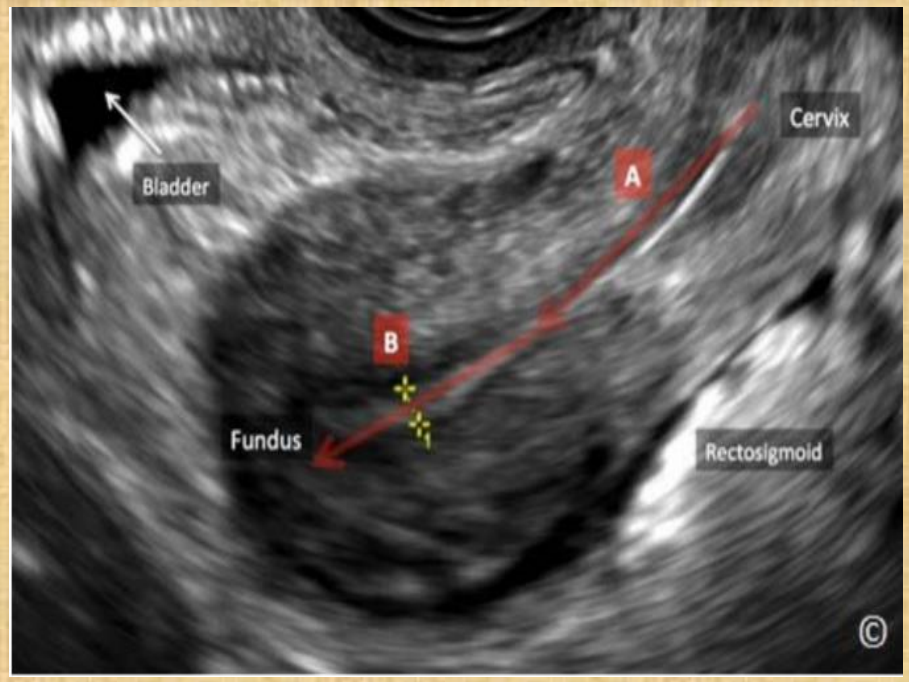
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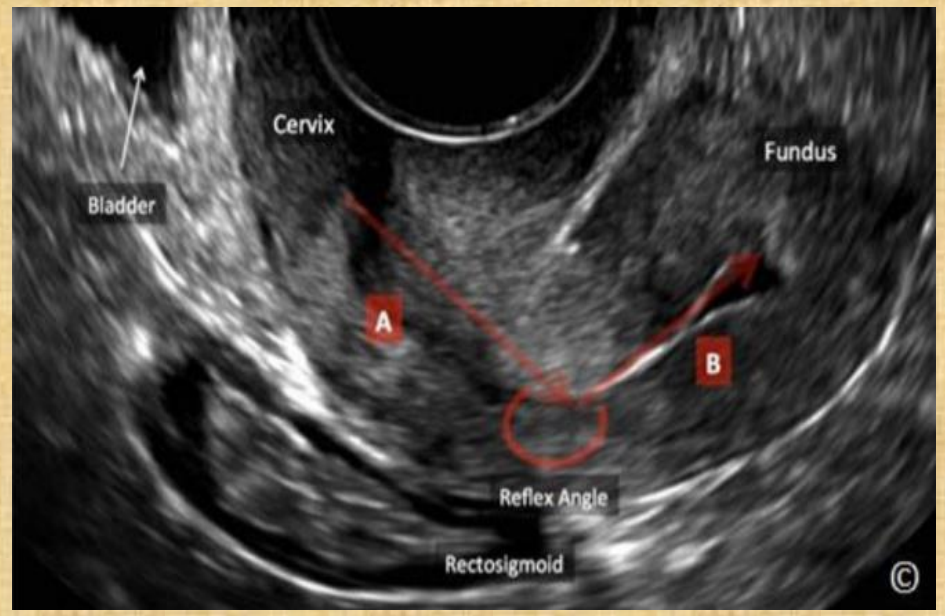
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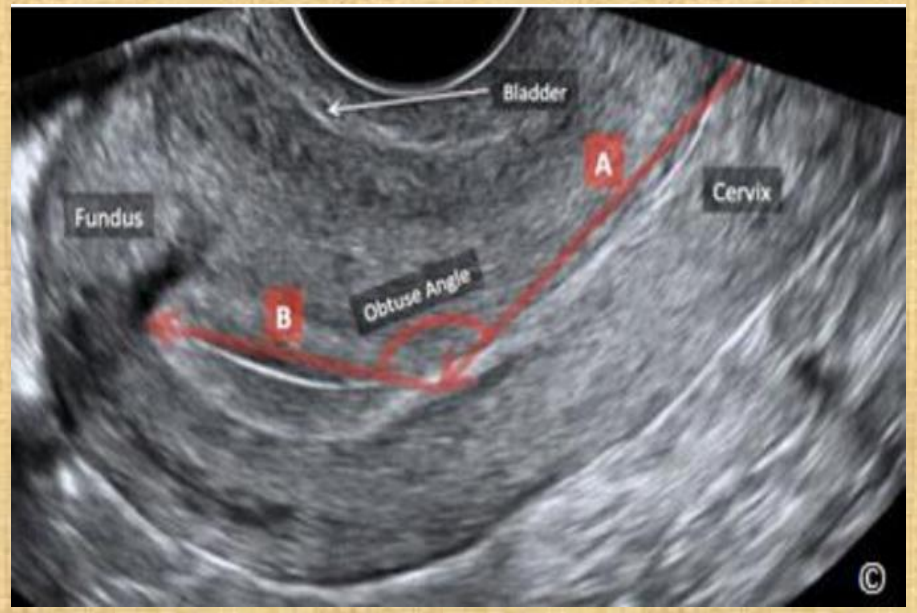
Bladder
A
Cervix
Fundus
B
Obtuse Angle
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The uterine length

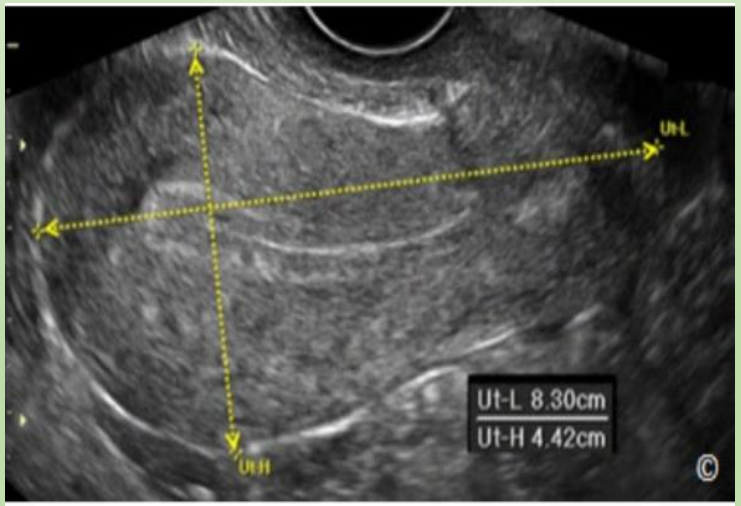
is measured in long axis from the fundus to the external os of the cervix

The anteroposterior dimension

is measured on the same image perpendicular to the long axis

The width

is measured on either a transaxial or coronal imaging plane

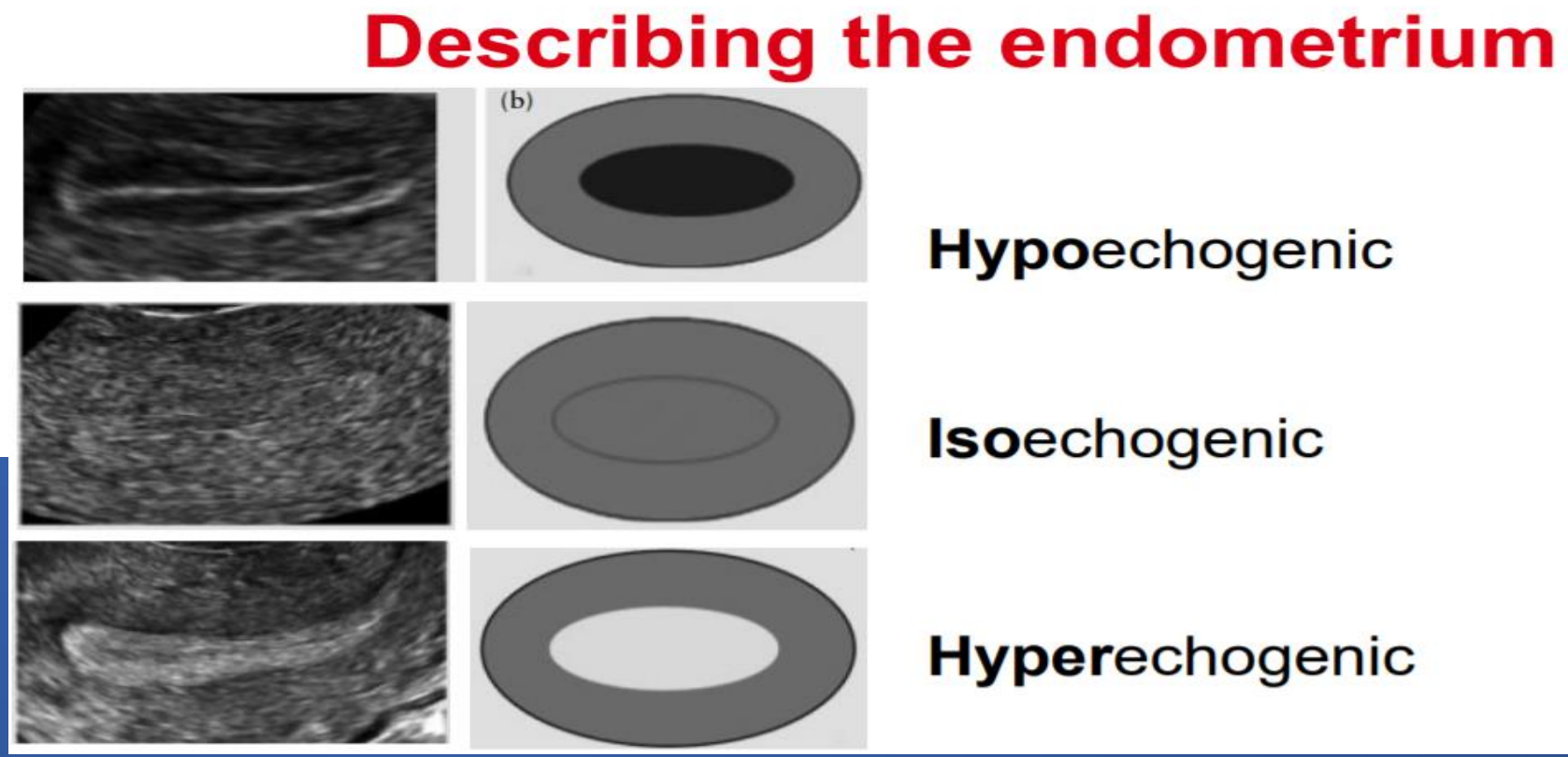


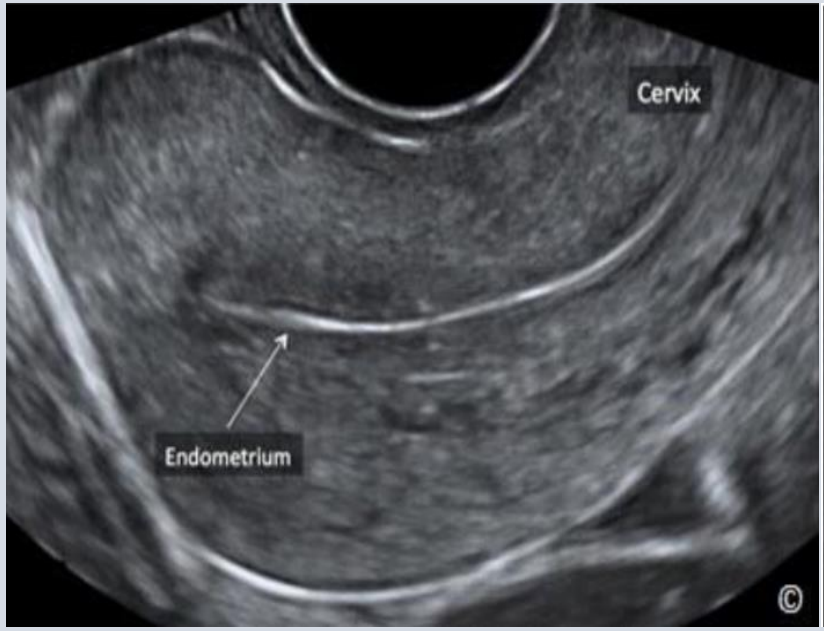
Acquired Uterine Abnormalities

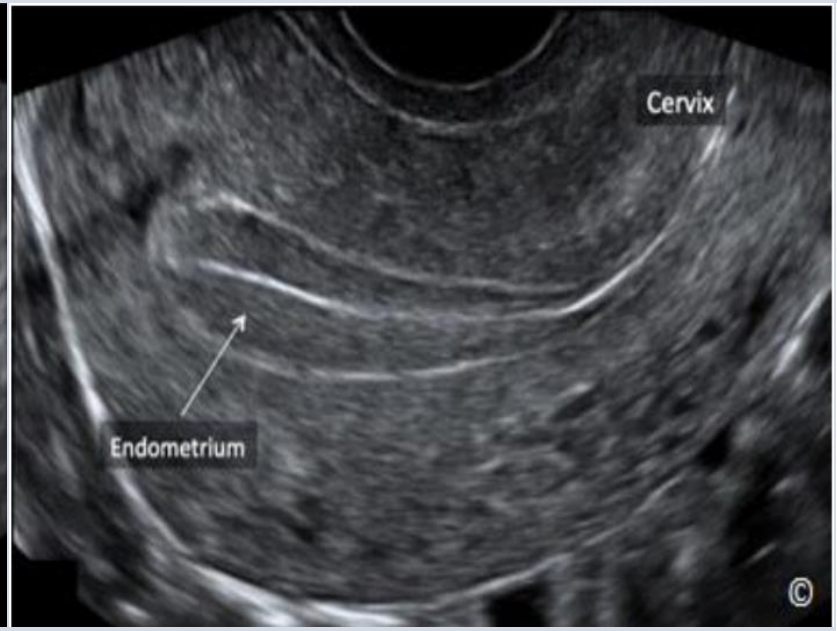
- Myometrial lesions
- Endometrial lesions
- Cervical lesions.

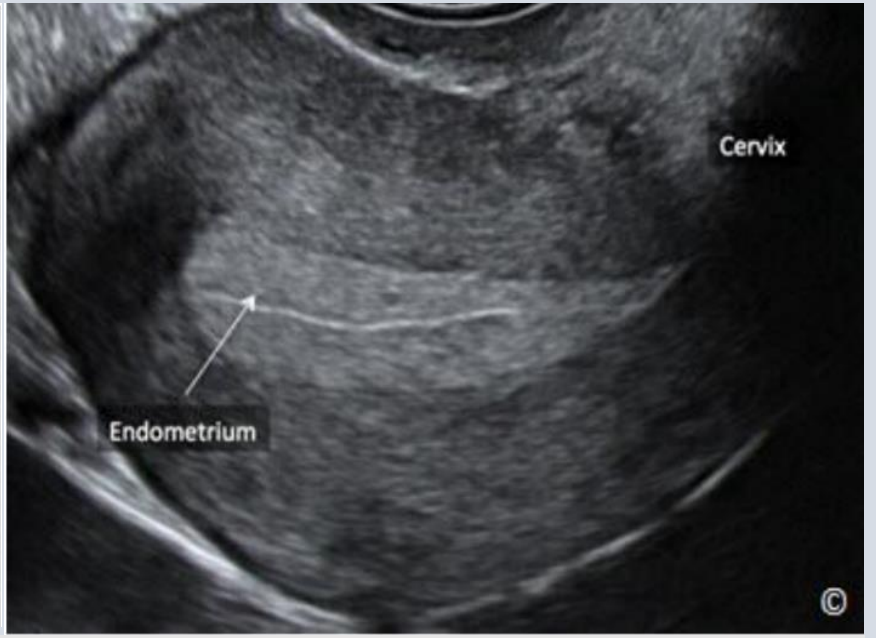
Another major component of the baseline sonogram is evaluation of the endometrial *pattern and thickness*, typically assessed on the midline sagittal long-axis view

The endometrial morphologic *appearance and thickness* change through the menstrual cycle in response to rising serum estrogen concentrations

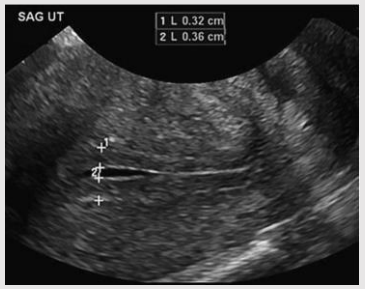








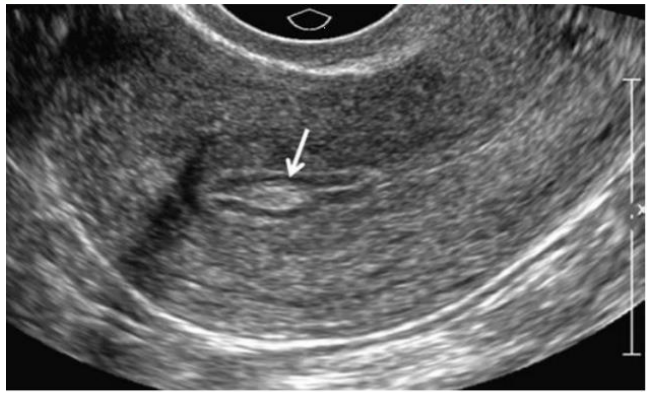
Endometrial thickness is best assessed on TVS, and by convention is reported as *the sum of the measurement of both the anterior and posterior layers of the endometrium at the thickest segment on a midline longitudinal image*

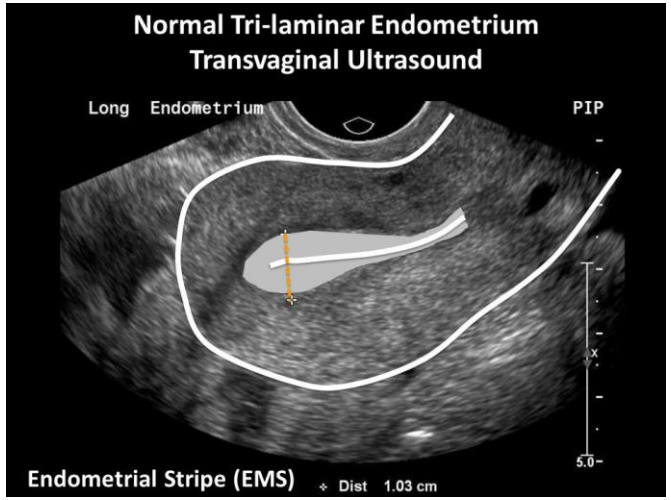


Occasionally a small amount of fluid is present in the uterine cavity
This fluid is not included in the reported measurement
Rather, the two endometrial layers (anterior and posterior) are measured separately and added together for reporting purposes

Most common endometrial pathology

- Polyp
- Submucous myoma
- Endometrial thickening
- Cancer



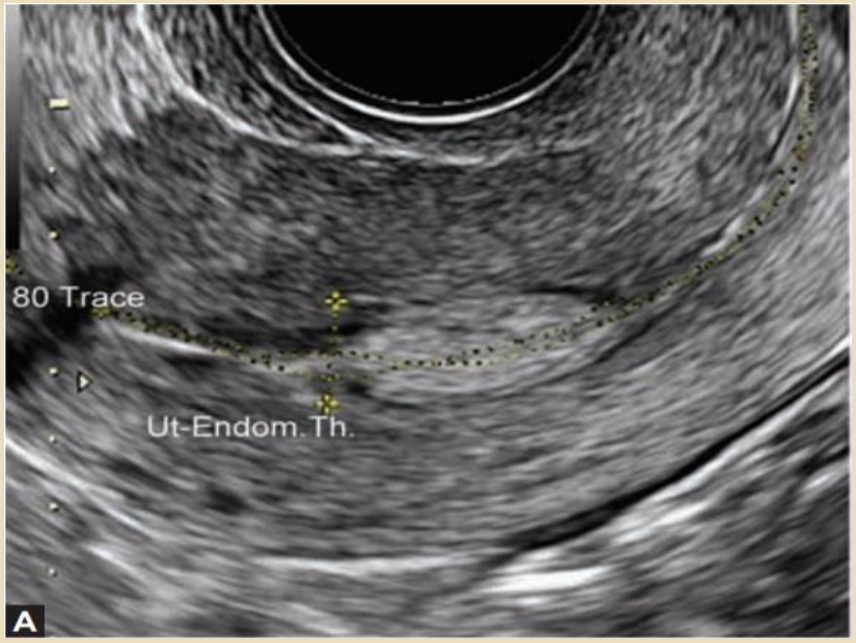


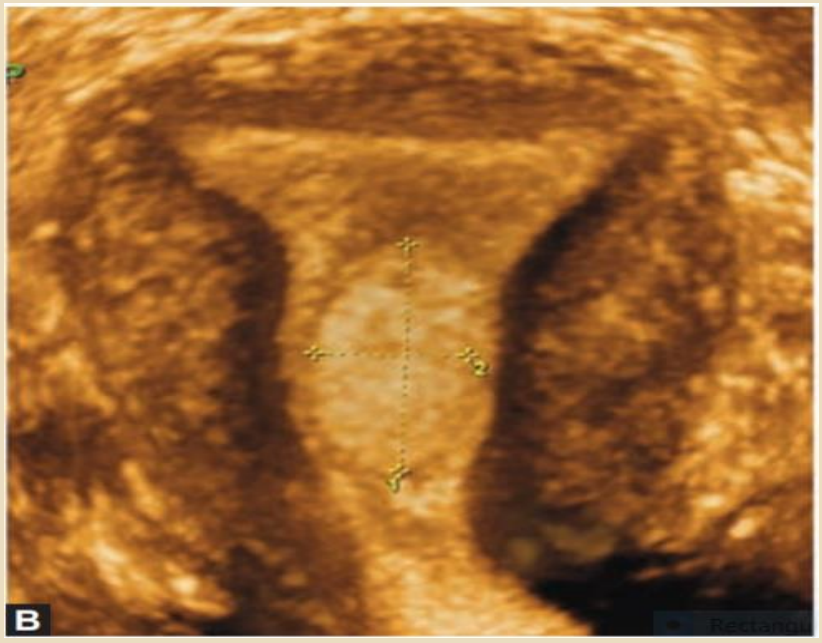
Polyps:

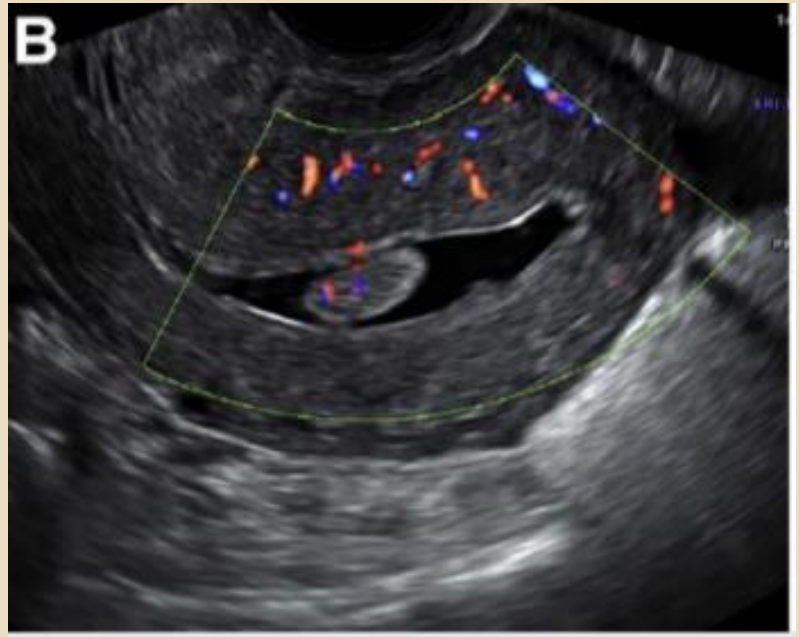
Sonographically, they are seen as solid echogenic lesions in the endometrial cavity

Smaller lesions are easier to diagnose but larger lesions fill up the cavity and look like generalized endometrial thickening but color Doppler helps for differentiation

On two dimensional (2D) US, the polyps are best visible in periovulatory phase or in menstrual phase when there is fluid in endometrial cavity





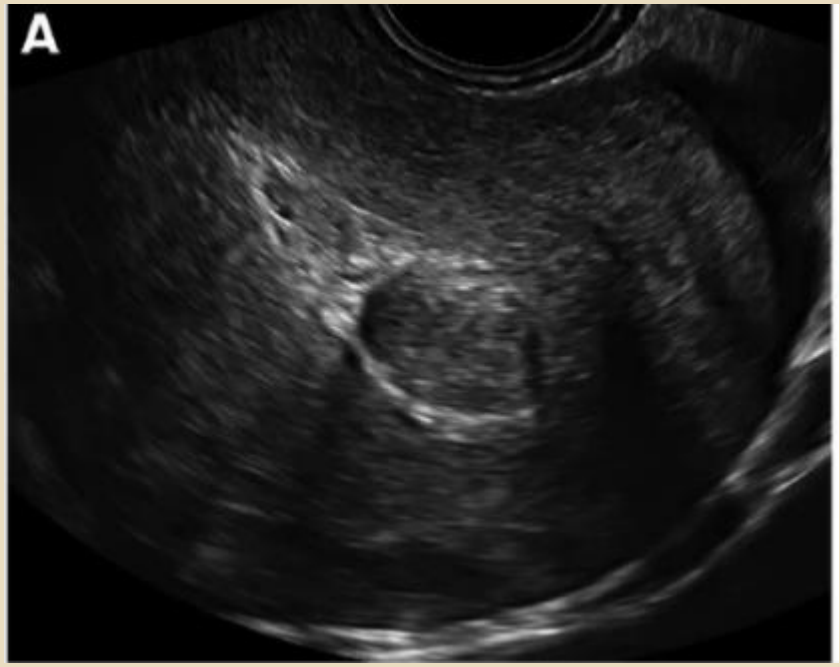


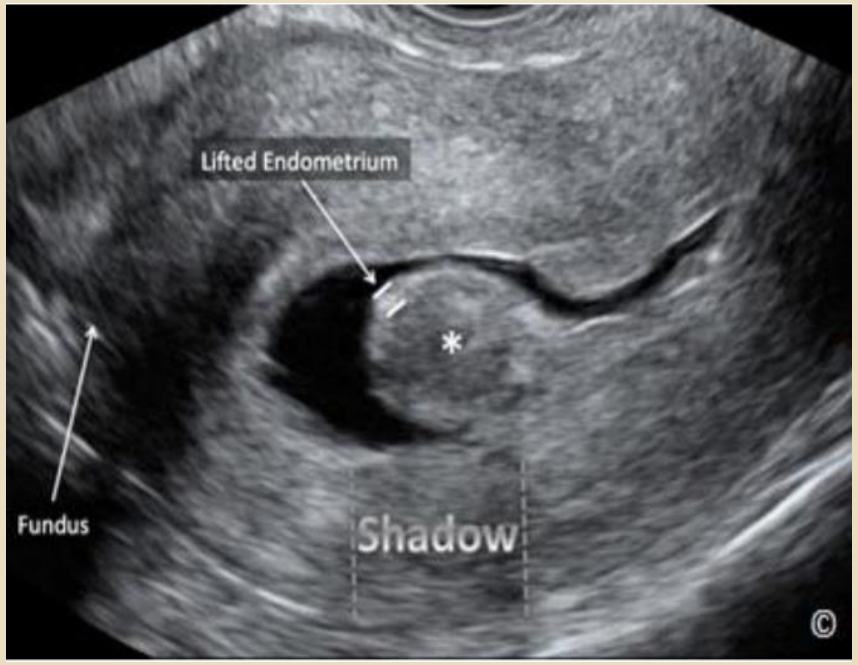
Endometrial fibroids are

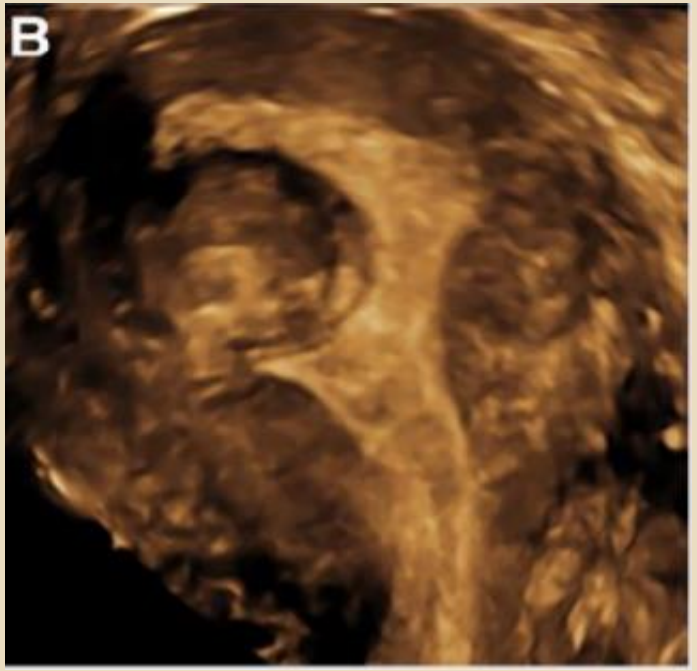
hypoechoic

well demonstrated in echogenic endometrium of secretory phase

have peripheral vascularity, typical of fibroids

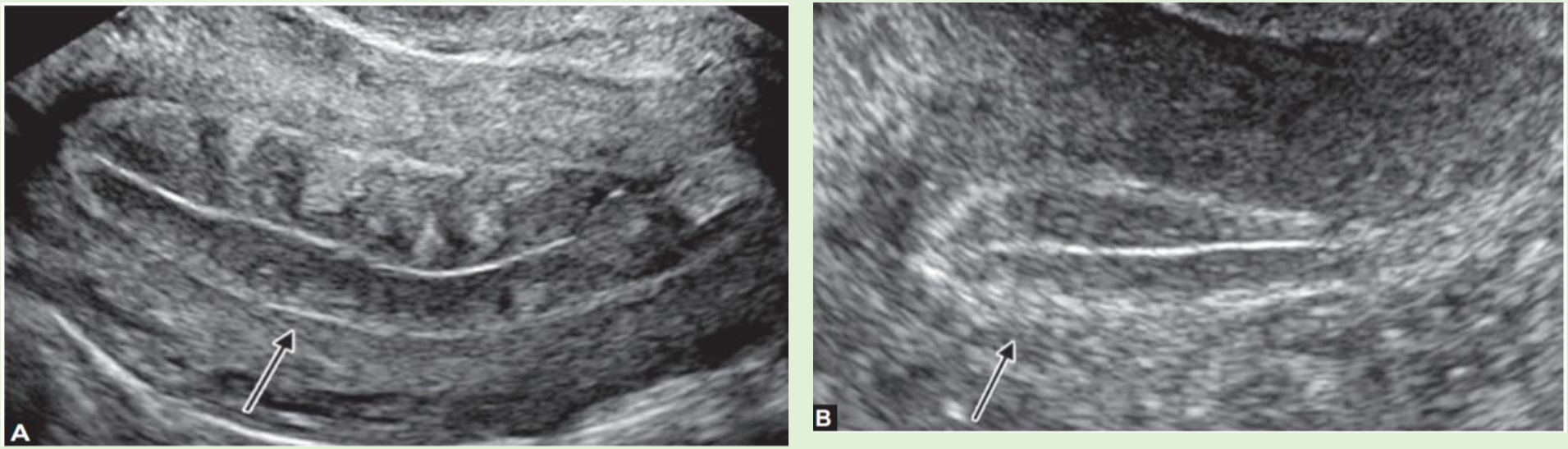






Endomterium:

It is normally pear shaped and has an intact endometriomyometrial junction (junctional zone)



Endometritis. (A) Normal junctional zone (arrow); (B) Obliterated junctional zone (arrow)

Endometritis:

Acute endometritis presents as *thick, isoechoic* endometrium with disruption of junctional zone minimal fluid in endometrial cavity and increased vascularity, even in early follicular phase.

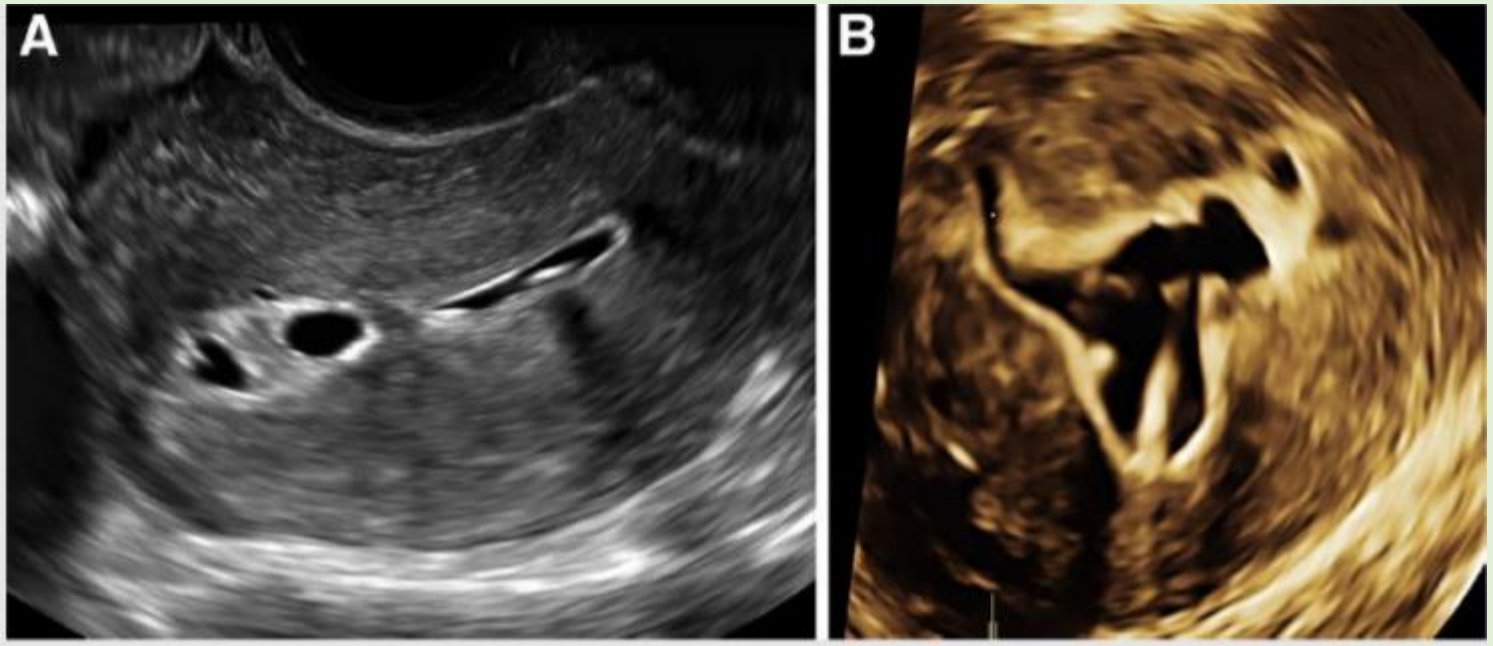
Chronic endometritis presents as persistently *thin avascular* endometrium with *disrupted junctional zone*. *Calcified pelvic lymph* nodes or *calcified spots in the adnexa* are also seen in chronic inflammatory lesions

Synechiae:

When the endometrium is triple line or the cavity is distended with the fluid, synechiae are seen as lines bridging between layers of endometrium

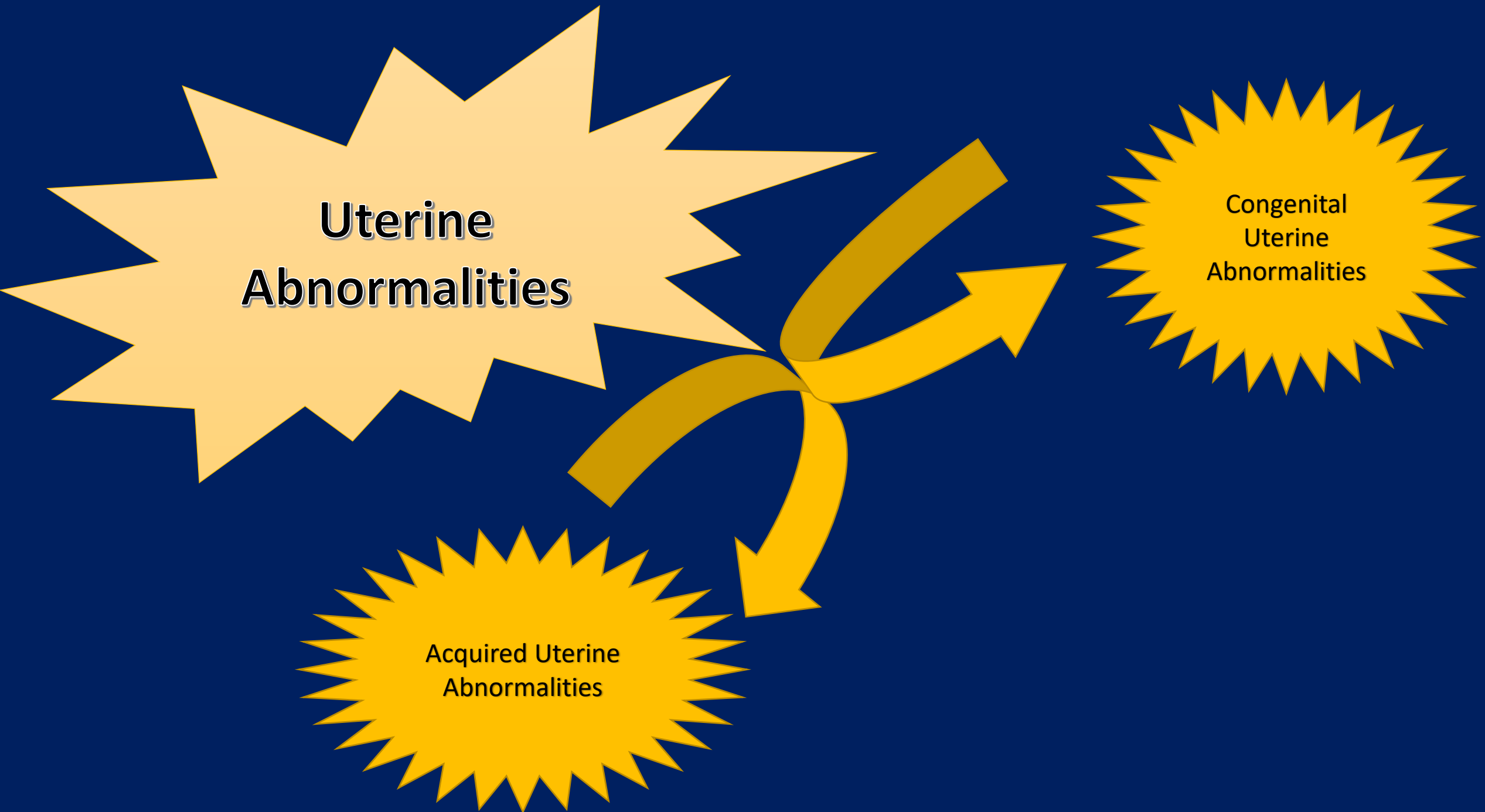
On 3D US, it helps in exact assessment of restriction of cavity in case of bridging adhesions

Sonohysterography has 100 percent sensitivity for the differentiation of all endometrial pathologies



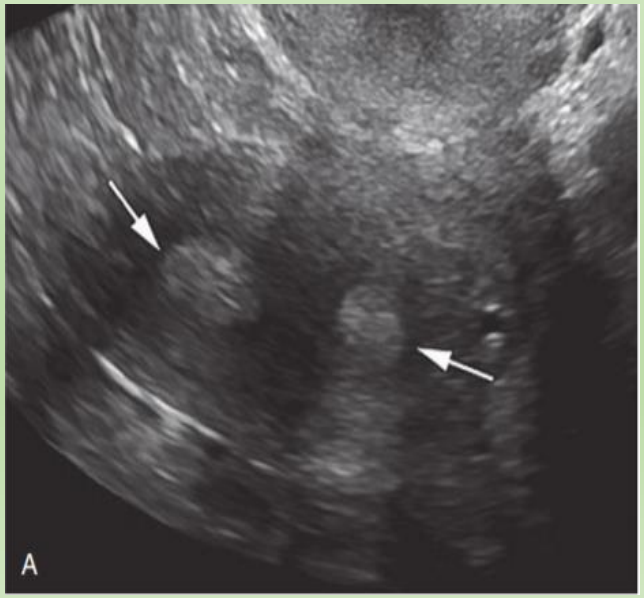
The endometrium

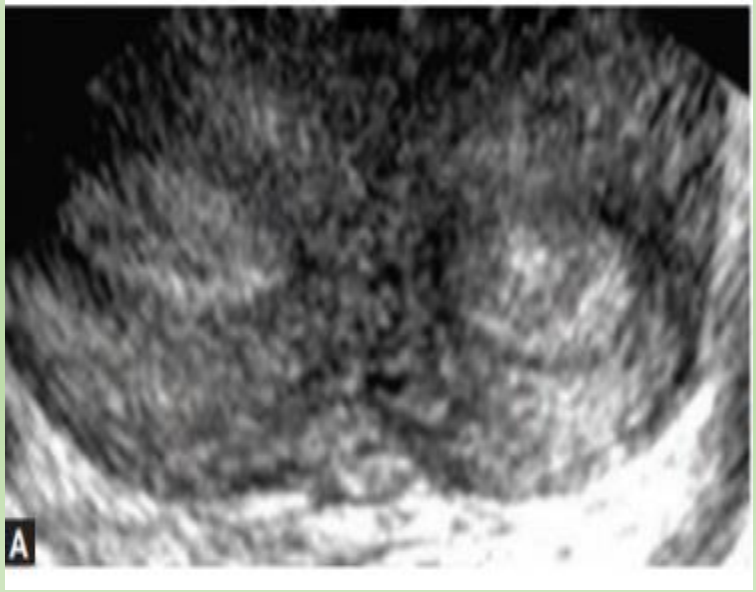
- Symmetry of the endometrial shape(pear shaped)
- Contour and continuity of central endometrial line(cavity)
- Intraendometrial lesions like polyp,adhesions,etc
- Endometriomyometrial junction
- Endometrial morphology corresponding with the phase of the cycle

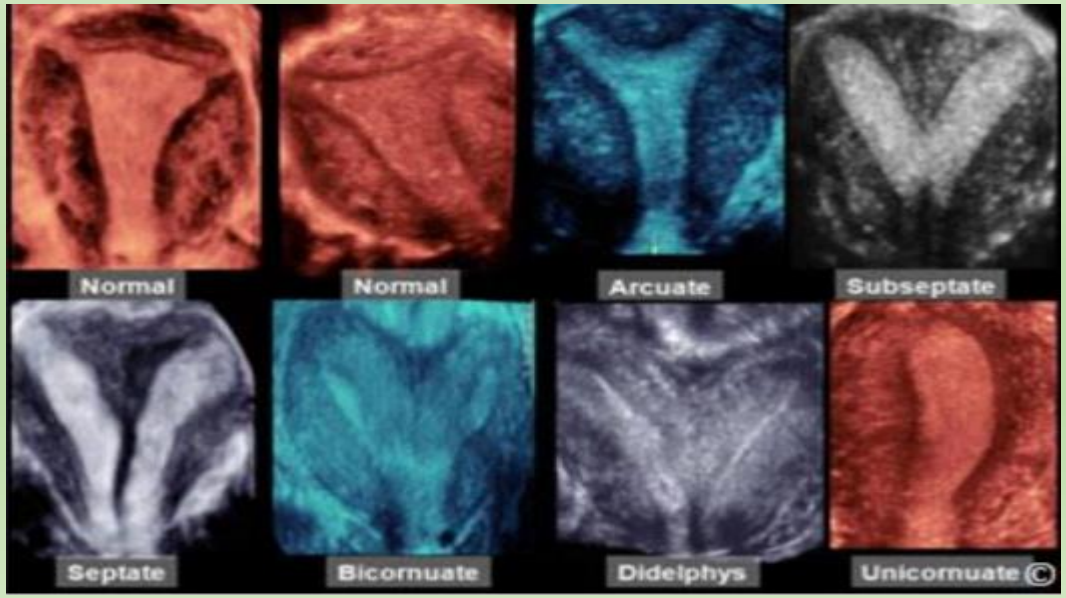

Uterine Abnormalities
Congenital Uterine Abnormalities
Acquired Uterine Abnormalities

Uterus

- The normal uterus is oval in shape with a curved, slightly convex fundal contour
- A uterine anomaly may be suspected at real-time sonography when, in the transverse plane, the endometrium appears to separate toward the fundus





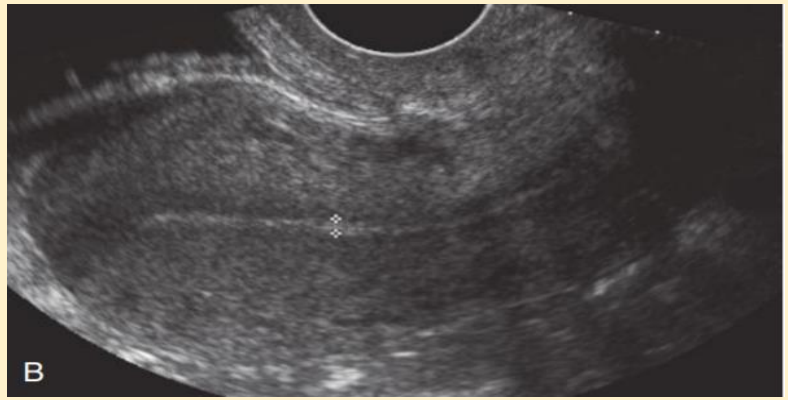


Myometrium:

It is normally homogeneously hypoechoic and serosal surface is smooth and regular

Distortion in any of these two suggests myometrial lesion. Myometrial lesions are fibroids, adenomyosis, adenomyomas and leiomyosarcomas

The normal myometrium is used as a standard to evaluate echogenicity of other structures in the myometrium, i.e.,
structures that are as echogenic as the normal myometrium are considered to be isoechoic. Lesions that are less
echogenic are termed hypoechoic, whereas those which are more echogenic are termed hyperechoic

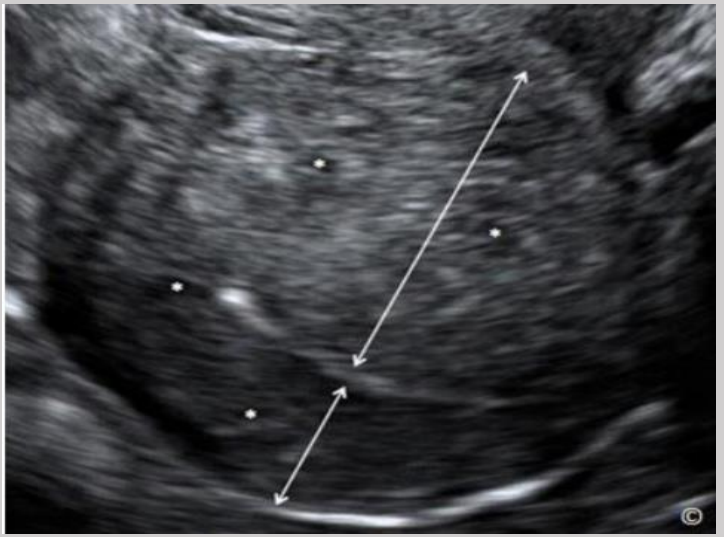


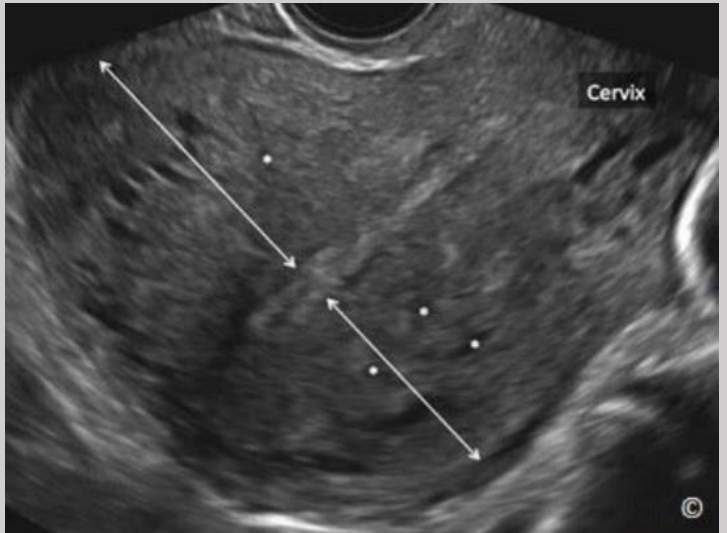
Adenomyosis

occurs when endometrial glands and stroma burrow into the subjacent myometrium

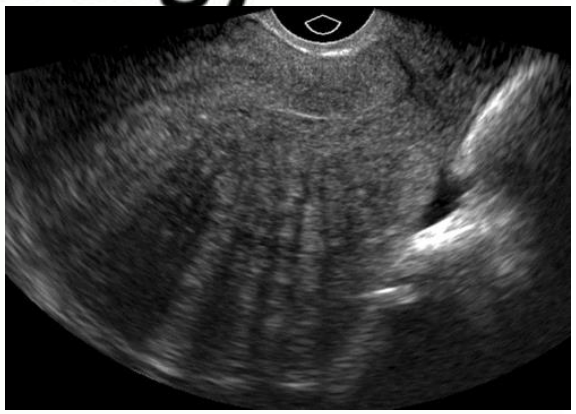
The classic appearance on EVS is

- A globular
- Smooth contoured
- Enlarged uterus with asymmetric wall thickening
- Heterogeneity of the myometrium
- Indistinct margins





Relatively common myometrial pathology - adenomyosis



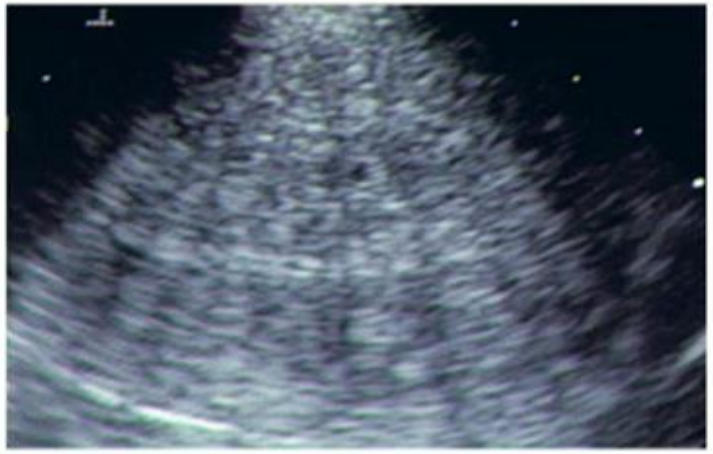
Enlarged uterus

Asymmetrically enlarged

Globally enlarged

Relatively common myometrial pathology - adenomyosis

Abnormal myometrial echogenicity



Fan shaped shadowing

Rain in the forest sign

ISUOG's basic training curriculum

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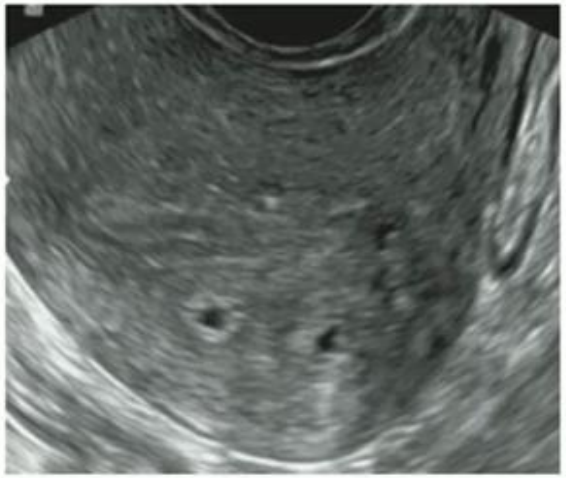
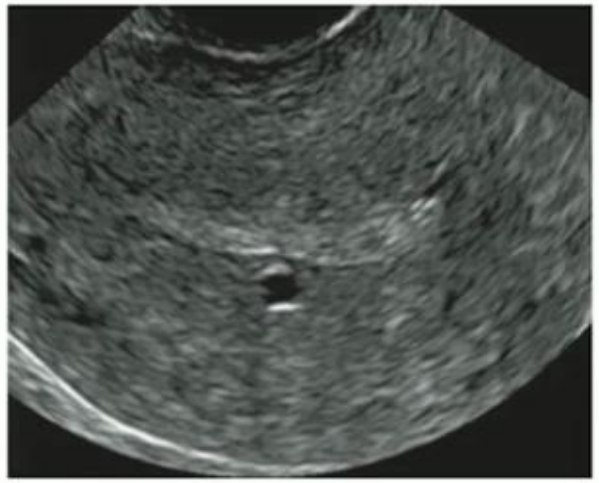
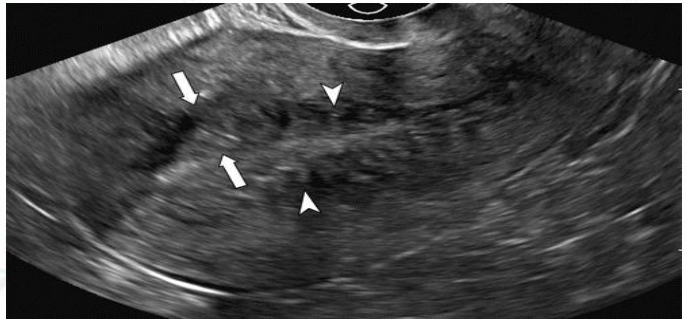
Alternate hyperechoic and hypoechoic zones in myometrium are typically described as a Swiss cheese or rain in forest appearance

Relatively common myometrial pathology - adenomyosis





Cysts in the myometrium



Poorly defined endometrium (subendometrial lines and buds)

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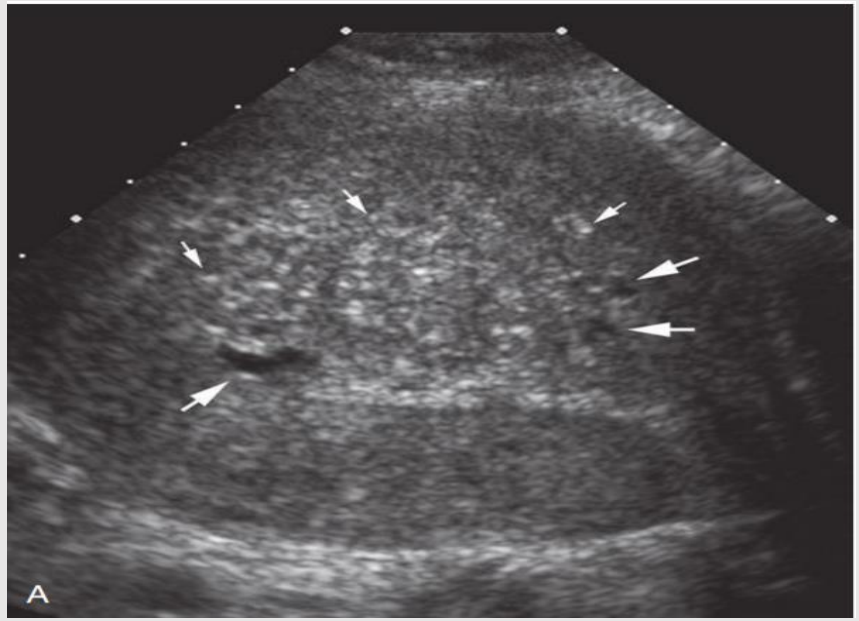
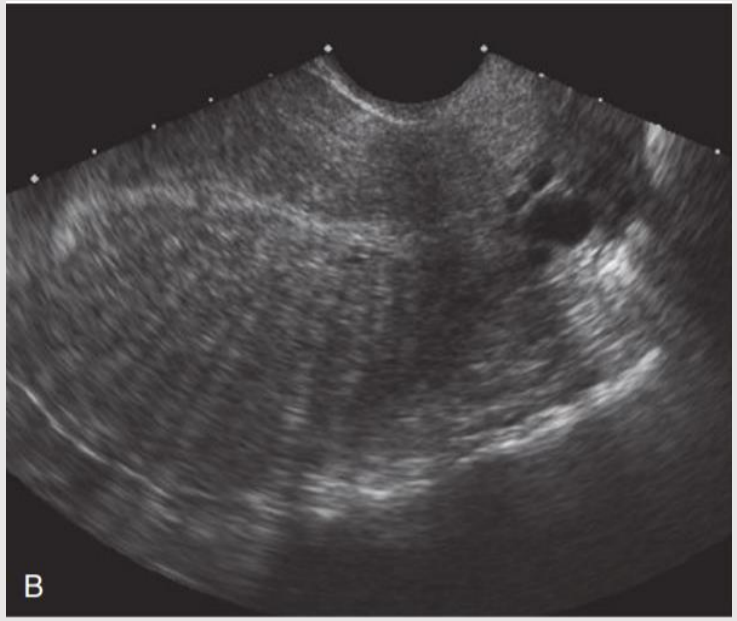
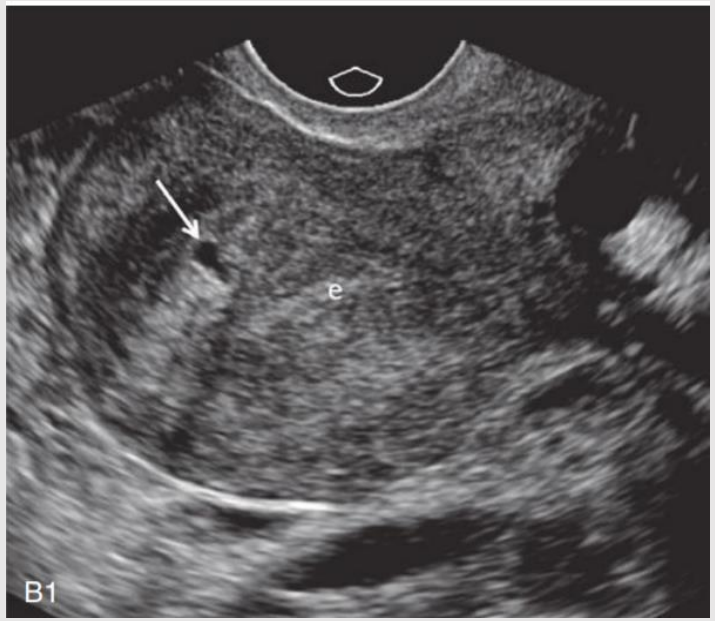
Echogenic spots and anechoic areas (myometrial cysts) are commonly seen close to junctional zone



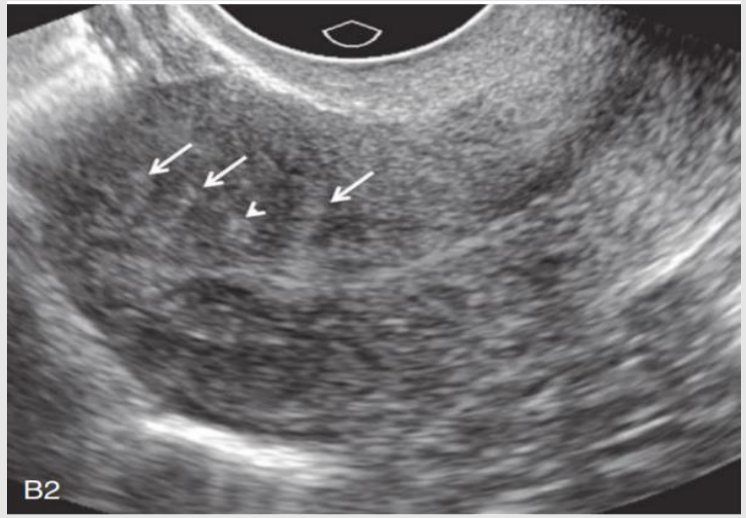
Enlarged uterus
Multiple bright echogenic foci
subendometrial myometrial anechoic cysts



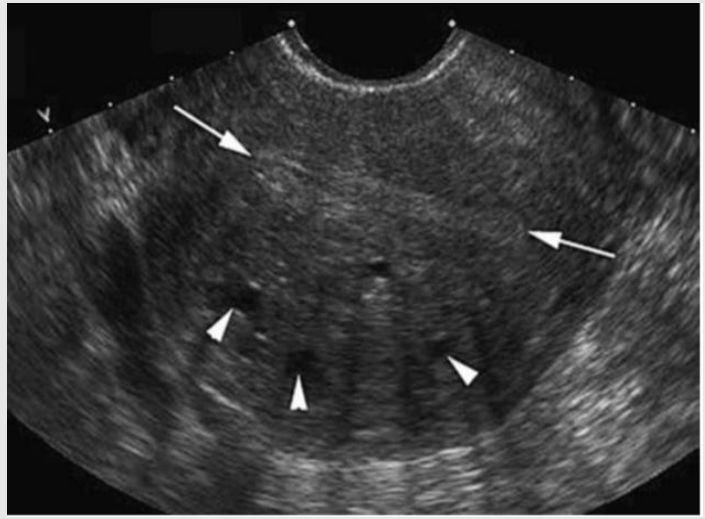
thin hypoechoic, “venetian blind”
or “comb-like” striations in the posterior myometrium



heterogeneity of the myometrium
and two adjacent small myometrial cysts

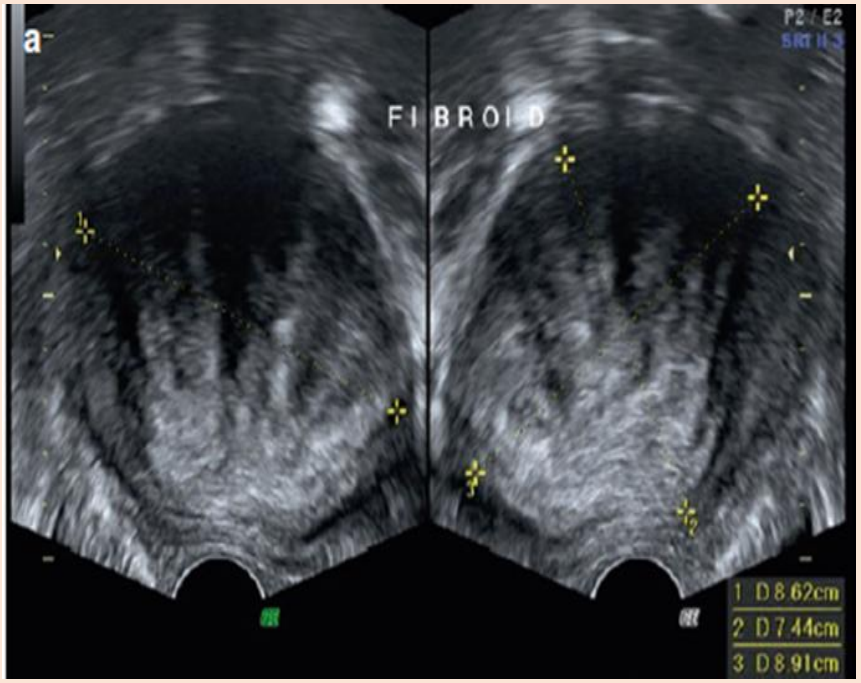


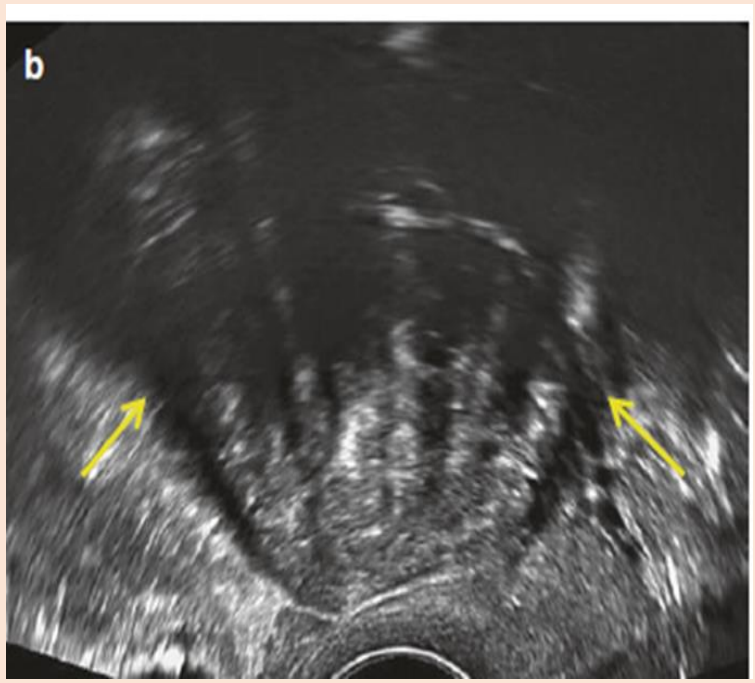
heterogeneity of the myometrium
chogenic linear striations
extending from the endometrium
into the myometrium and one
nodular echogenic area

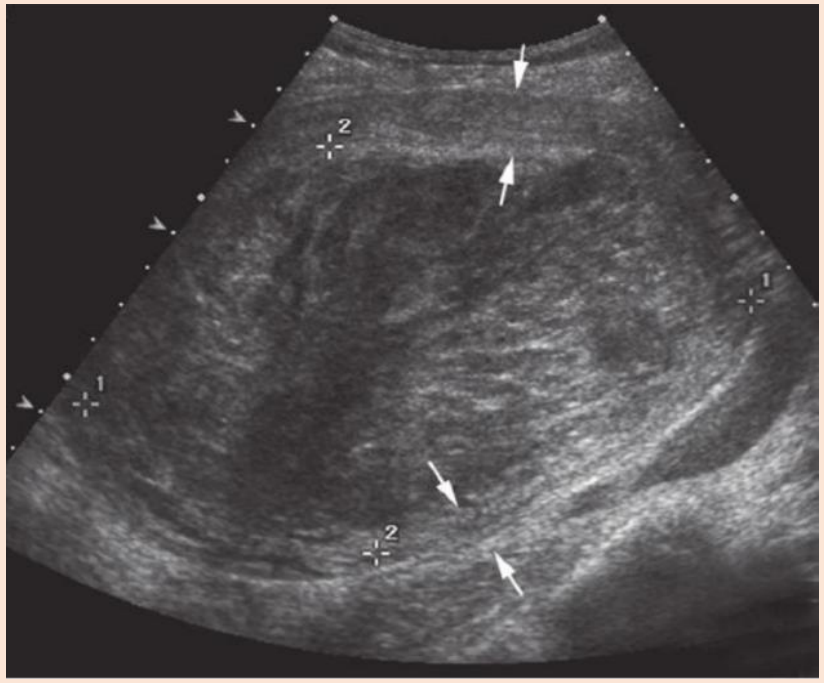


“pencil-thin”
radiating dark
striations and
several small cysts

Fibroids typically appear as round, well-defined, oval or lobulated solid masses seen in the uterus or arising from it
with stripy, linear, fan-shaped, internal shadowing and shadowing from their edges

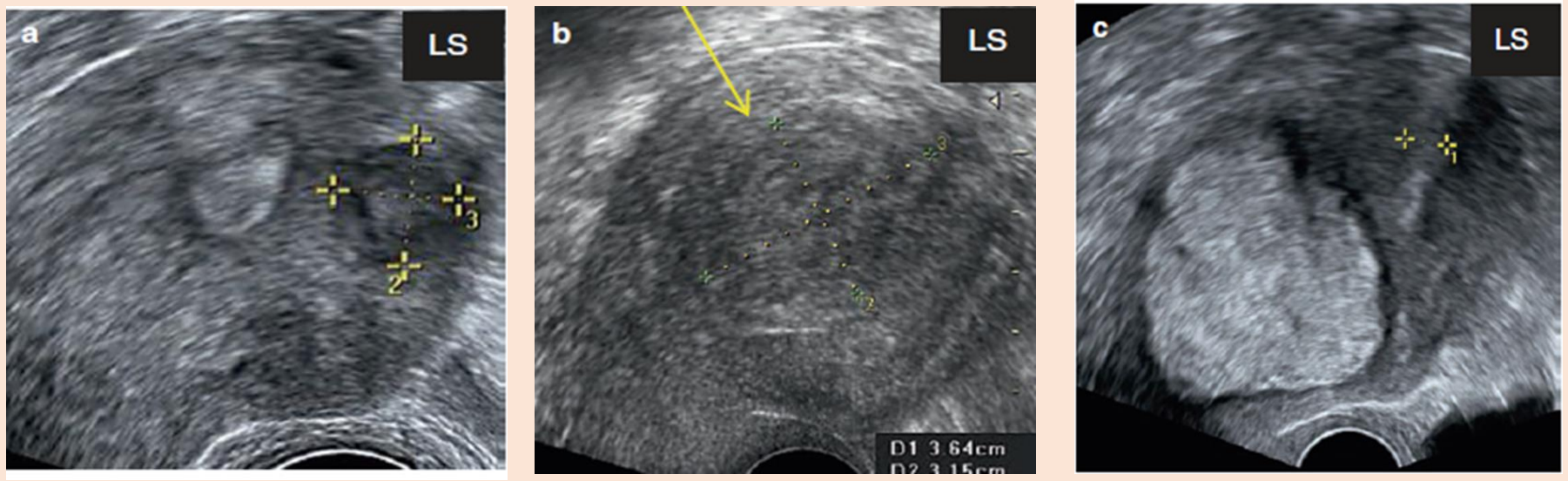






The surrounding myometrium can become compressed and form a pseudocapsule

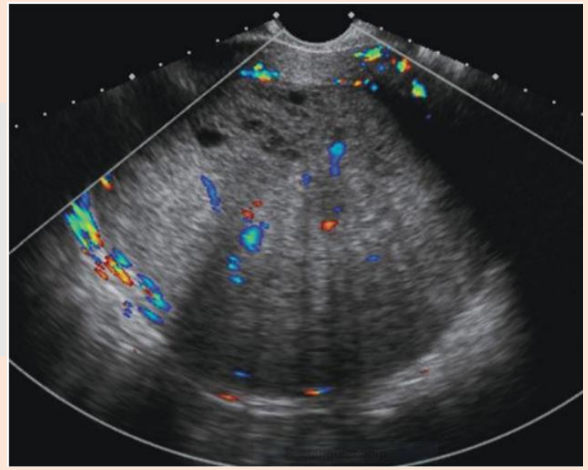
Fibroids show variable echogenicity depending upon the proportion of muscle cells and fibrous stroma and the presence of any degenerative changes
They can appear from hypoechoic to hyperechoic.



Fibroids showing varying echogenicity

(a) Hypoechoic
(b) isoechoic (*arrow*)
(c) hyperechoic

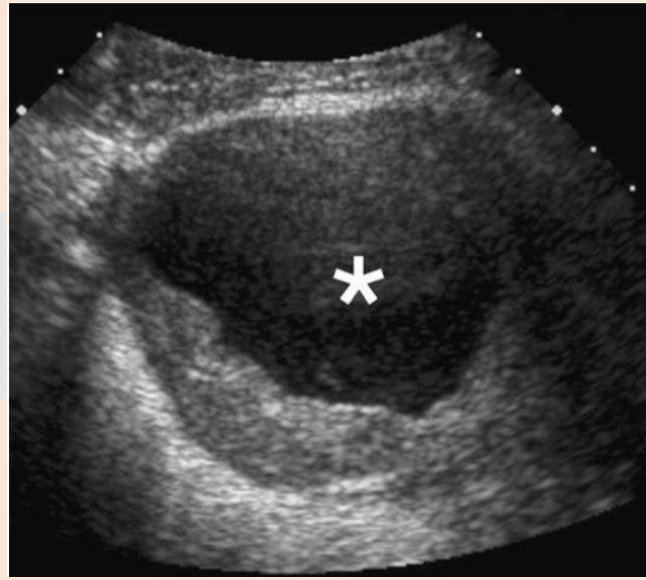
Larger myomas are often heterogeneous and may demonstrate a typical swirling pattern, edge refraction, posterior shadowing, and focal areas of calcification on EVS



Large relatively echogenic leiomyoma demonstrating small anechoic rounded areas of cystic change anteriorly as well as “venetian blind” shadowing

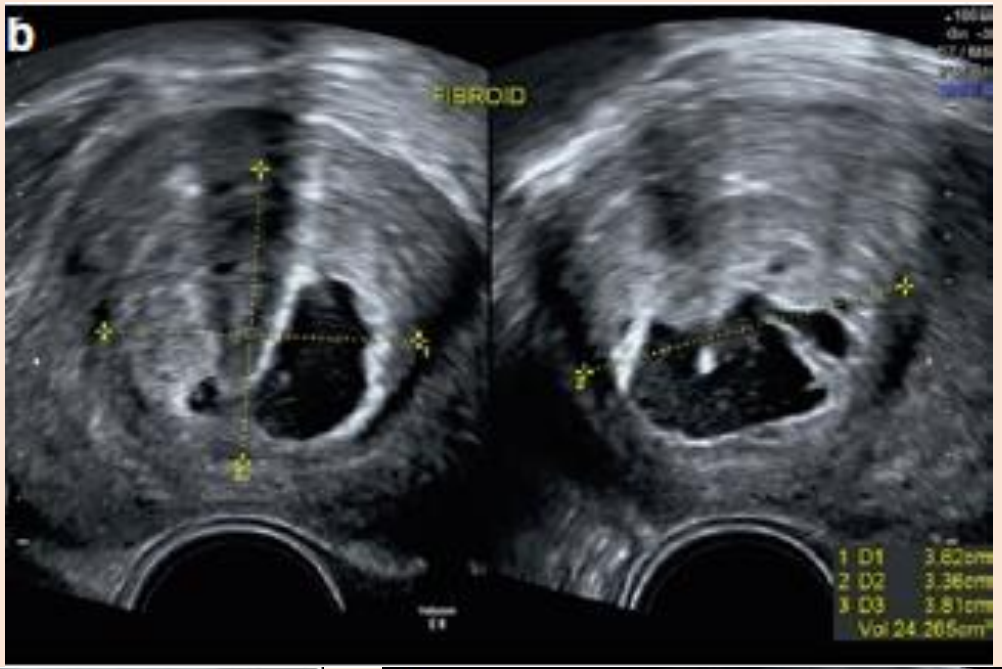
Both of these features are quite similar to ultrasound findings of adenomyosis

As leiomyomas increase in size, they tend to outgrow their blood supply, which leads to degeneration: hyaline, myxoid, cystic, or hemorrhagic

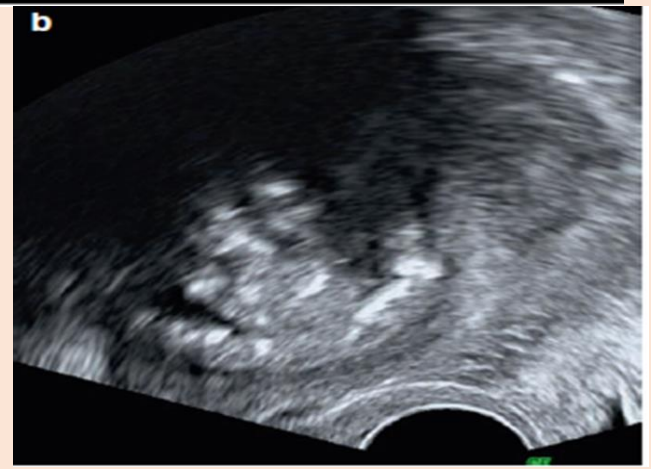


Marked cystic degeneration with large anechoic fluid component (asterisk) of a large intramural leiomyoma.

Fibroids showing cavitation (seen as irregular, anechoic or hypoechoic, cystic areas within the fibroid)



Fibroids showing calcification
(a) Peripheral calcification appearing like a shell around the fibroid



(b) Internal calcification causing acoustic shadowing

- Identifying and documenting the location of all myomas, particularly in relation to the endometrial cavity and lower uterine segment, are important components of the baseline ultrasoundexamination

• Basics of Fibroid Mapping

To map or describe the location of any mass like a fibroid, in the uterus, one must know four parameters:

1. How superior or inferior the mass is. For this, the uterus can be divided into fundus, upper corpus, midcorpus, lower corpus and cervix.
2. How anterior or posterior the mass is

The mass could be in the anterior wall or the posterior wall.

3. How much to the left or right the mass is

The mass could be right sided, left sided or in the midline

- 4. How close is the mass to the inner endometrial mucosa or
- the outer serosa?

The myometrium

- Homogenecity of the myometrium
- Mass lesions
- Scar tissues

The serosa

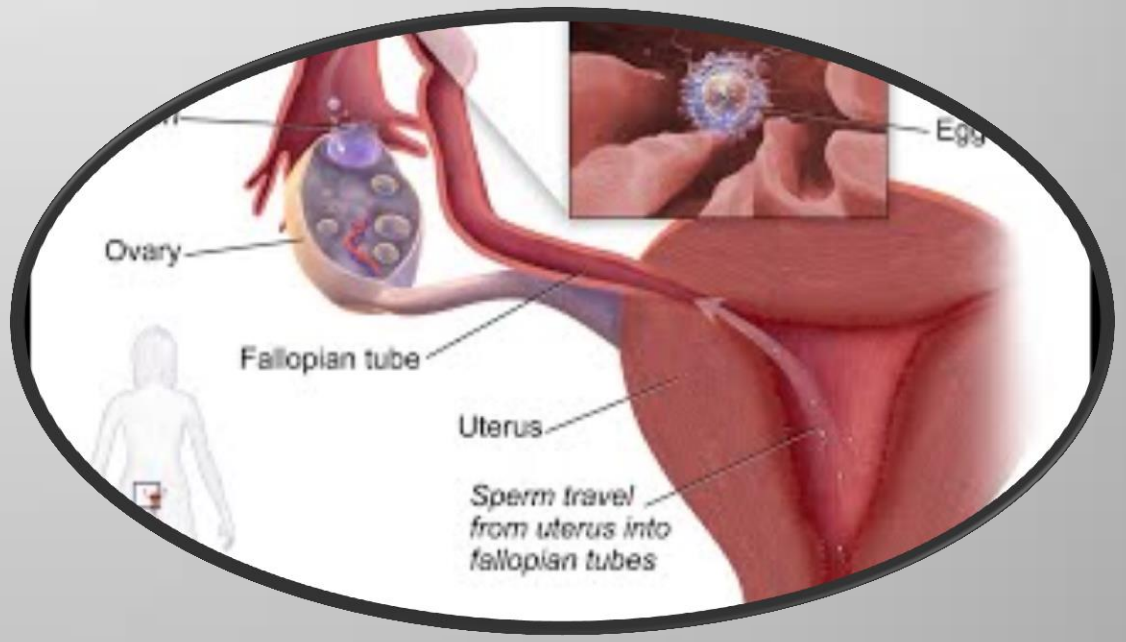
- Smoothness of contour
- Continuity
- Maintenance of tissue interface

Adnexa

Adnexal lesions can be categorized as:

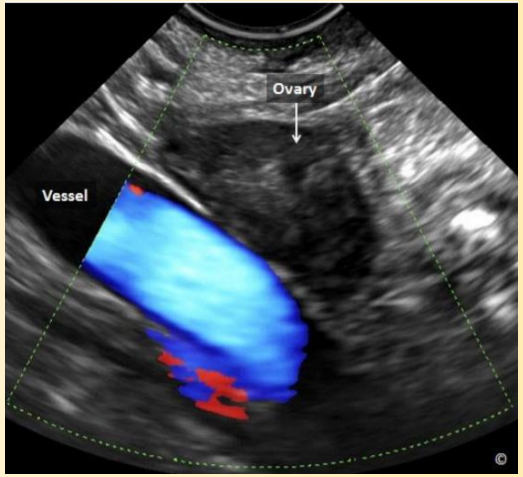
- Ovarian lesions
- Tubal/tuboovarian lesions
- Miscellaneous lesions:

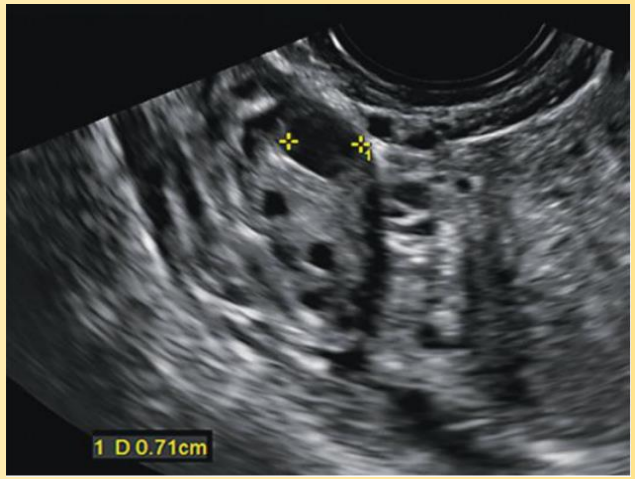
  Paraovarian cysts
  peritoneal inclusion cyst
  broad ligament fibroids



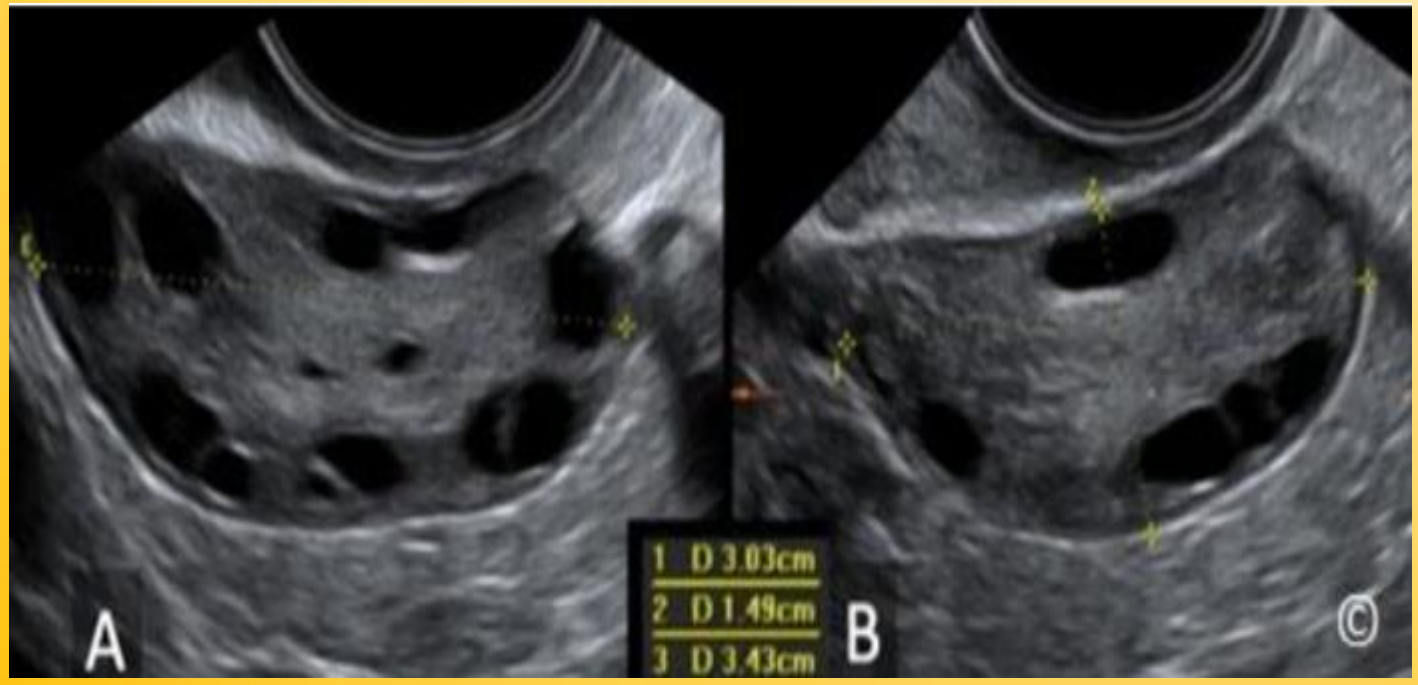
Ovary

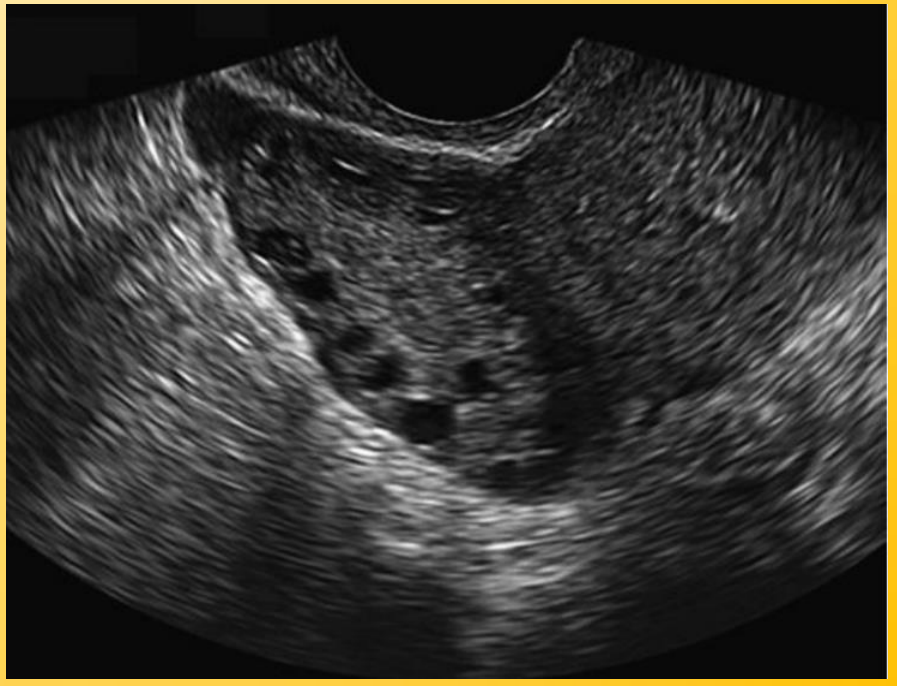
- On baseline imaging, the ovaries are routinely evaluated to assess for normal expected findings and to screen for any abnormality
- In the first portion of the menstrual cycle, a normal ovary will demonstrate multiple antral follicles, which measure between 2 and 9 mm in maximum diameter
- The antral follicle count (AFC) can be correlated with fertility status, response to ovarian stimulation, and success of conception





In 2003, the Rotterdam Consensus workshop published what was considered the standard sonographic diagnostic criteria for PCOS:
12 or more 2- to 9-mm follicles in each ovary and/or increased ovarian volume measuring more than 10 Ml
A modification of the Rotterdam criteria has been suggested with a threshold of over 25 small follicles necessary for the diagnosis of PCOS in patients imaged with state-of-the-art, high resolution sonographic equipment





Ultrasound based classification of ovarian lesions:

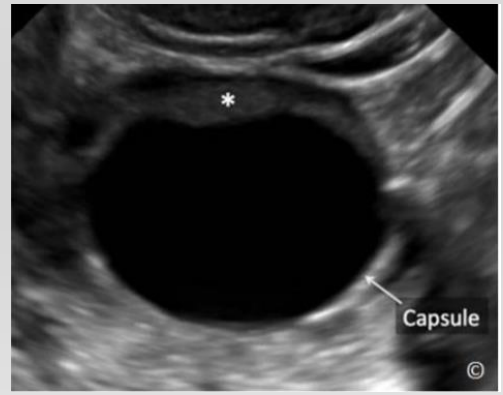
- Nonseptated clear cysts
- Cysts with internal echogenicities and septae
- Solid lesions
- Complex lesions with cystic with solid areas

Nonseptated clear cysts:

These cysts are *thin walled, have no internal echogenicities, no septae or no solid areas in it.*

The lesions/structures in this category are:

- Follicular cyst
- Simple cyst of the ovary



Cysts with internal echogenicities and septae:

The most common lesions in this category are:

- Corpus luteum
- Hemorrhagic cyst
- Luteinized unruptured follicle (LUF)
- Endometrioma

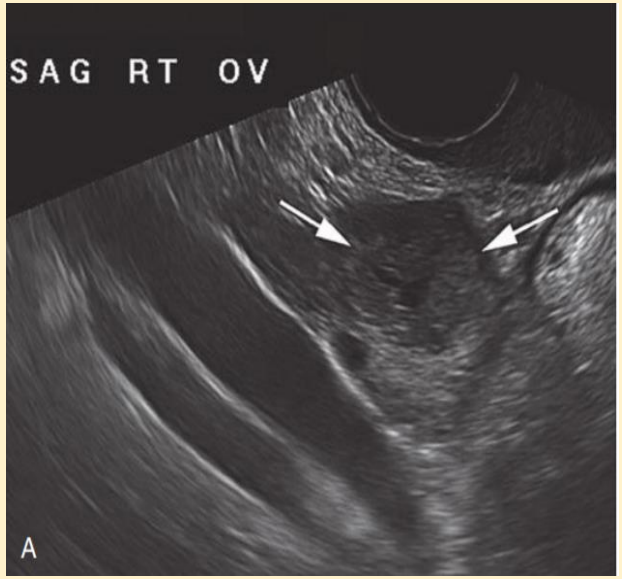
All these structures have

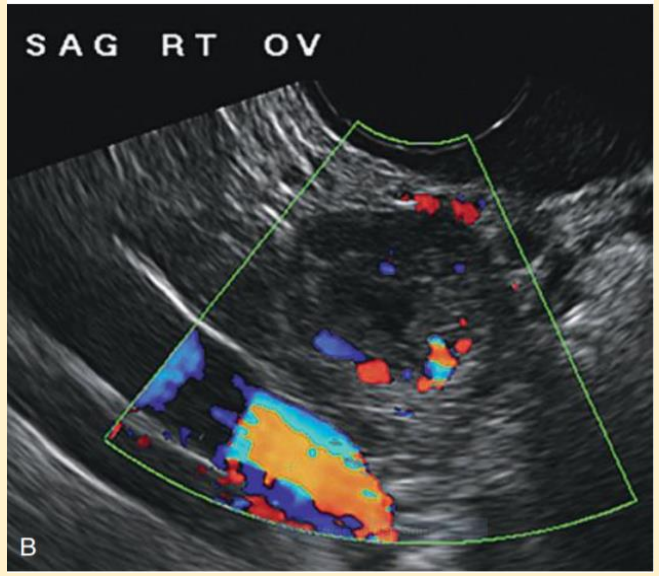
- Thick
- shaggy walls
- internal echogenicities
- nonvascularized septae

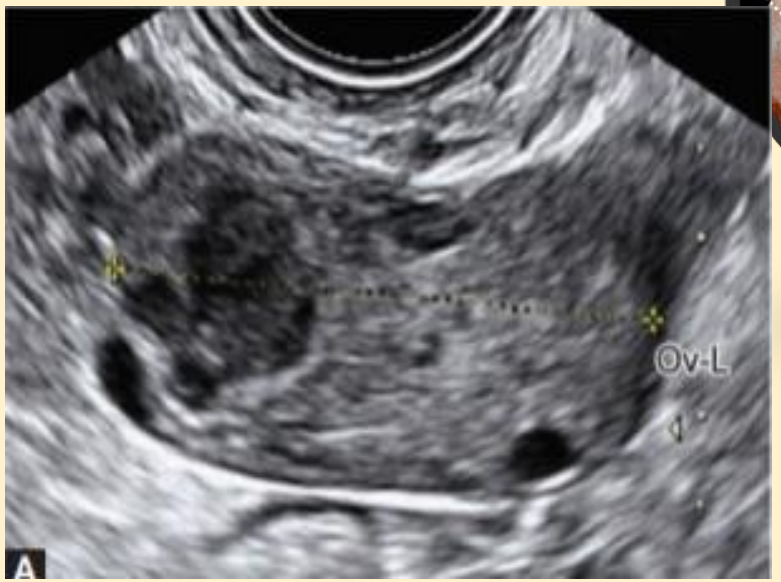
The appearance may vary, viz. absolutely isoechoic homogeneous, clear fluid, lace-like or cobweb pattern or ground glass appearance.

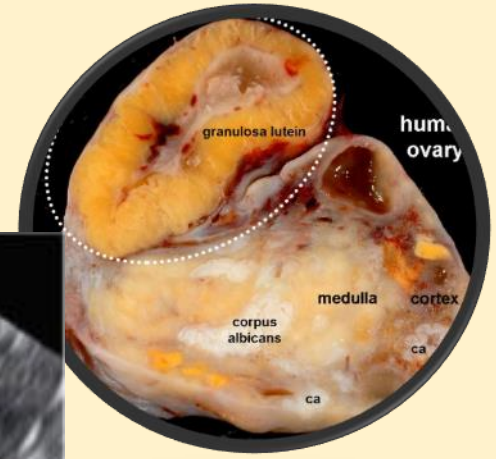
Focal ovarian lesions are frequently found at the baseline ultrasound examination.
The most common is the residual corpus luteum

It has thick, crenulated walls
Contents of the cyst show heterogeneous echogenicity with or without septae

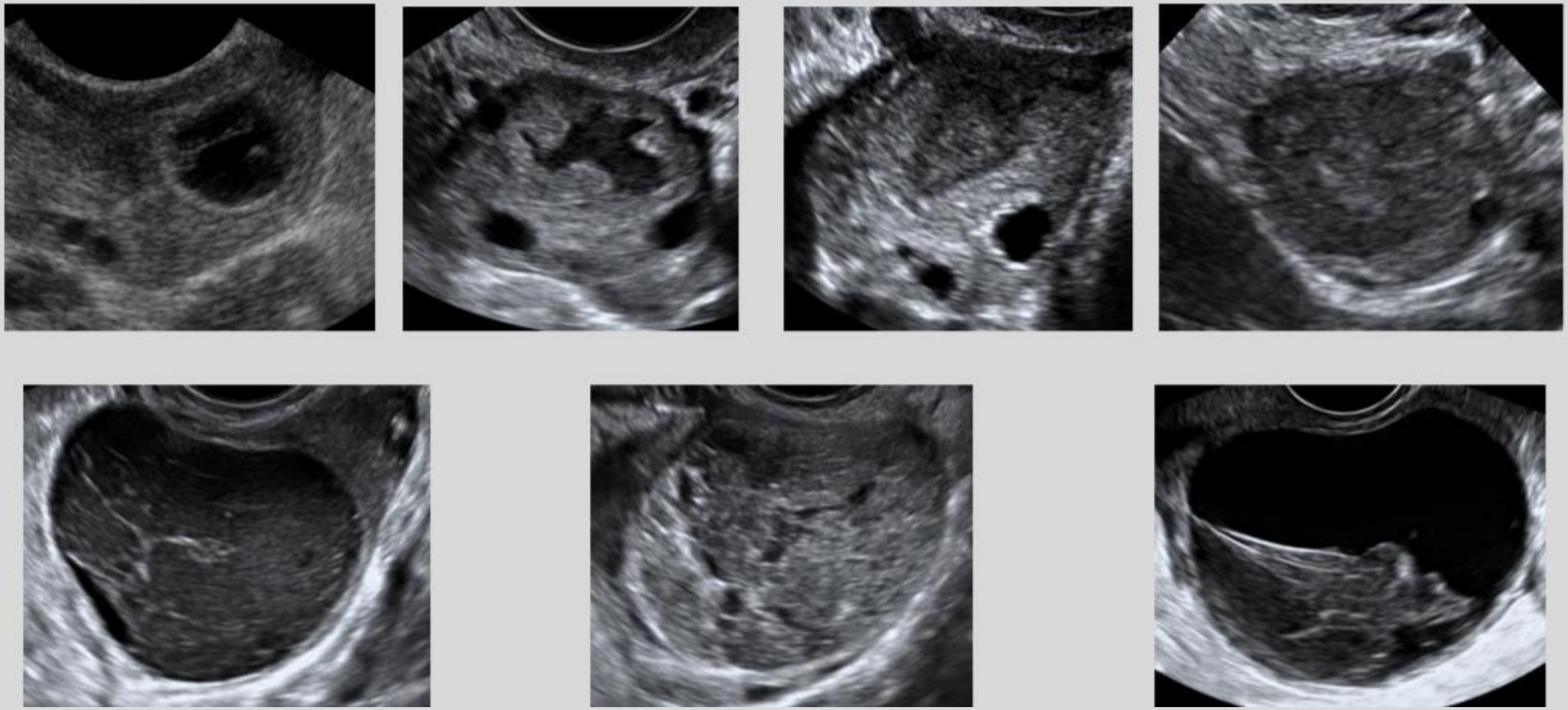








A corpus luteum may look different



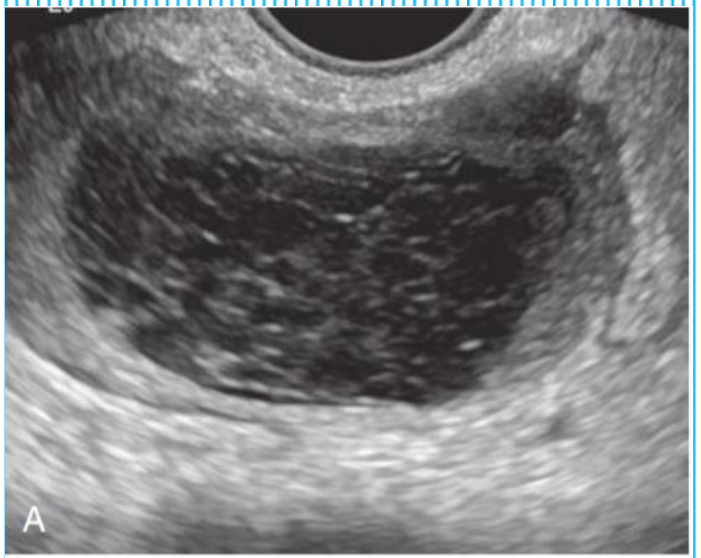
The echogenicity and appearance of the contents may change at different times

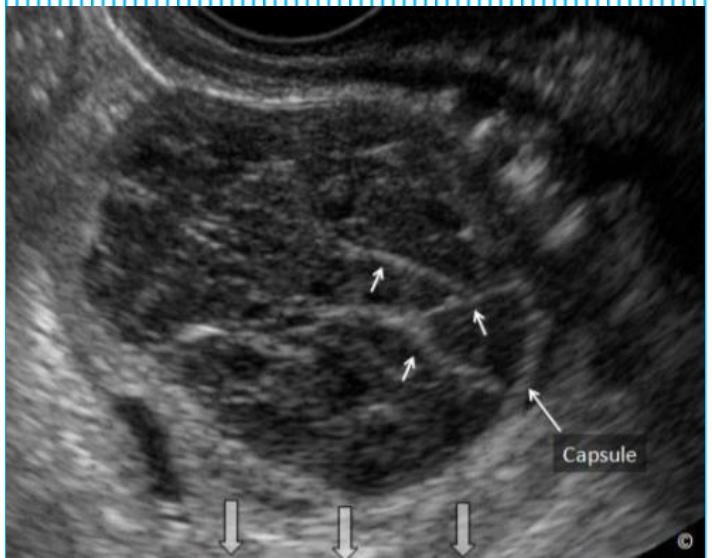
Luteinized unruptured follicle: It has thick, echogenic but not very shaggy walls, and does not contain blood or blood products. Therefore, it does show low level internal echogenicity but never lacelike or cobweb echogenicity

Luteinized unruptured follicle (LUF): echogenic margins and internal echogenicity

Hemorrhagic Cysts

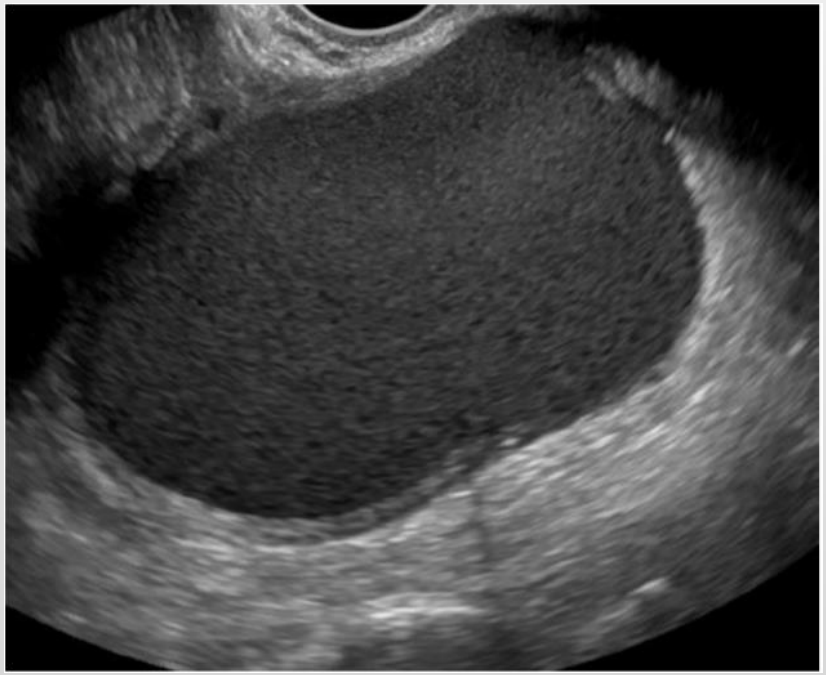
- The fibrin strands are often described as *lacy, reticular, fishnet, cobweb, spider web, or sponge-like in appearance*
- Although retractile clot might be confused with a solid mural nodule, it will have *no detectable flow by Doppler imaging* and typically has *scalloped, concave, or straight margins*





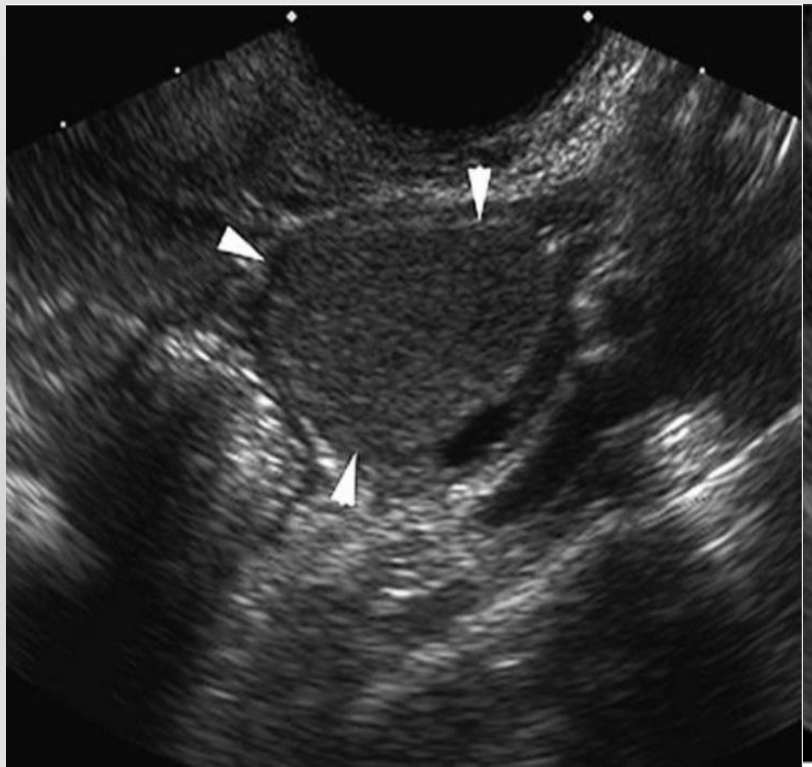
Endometriomas

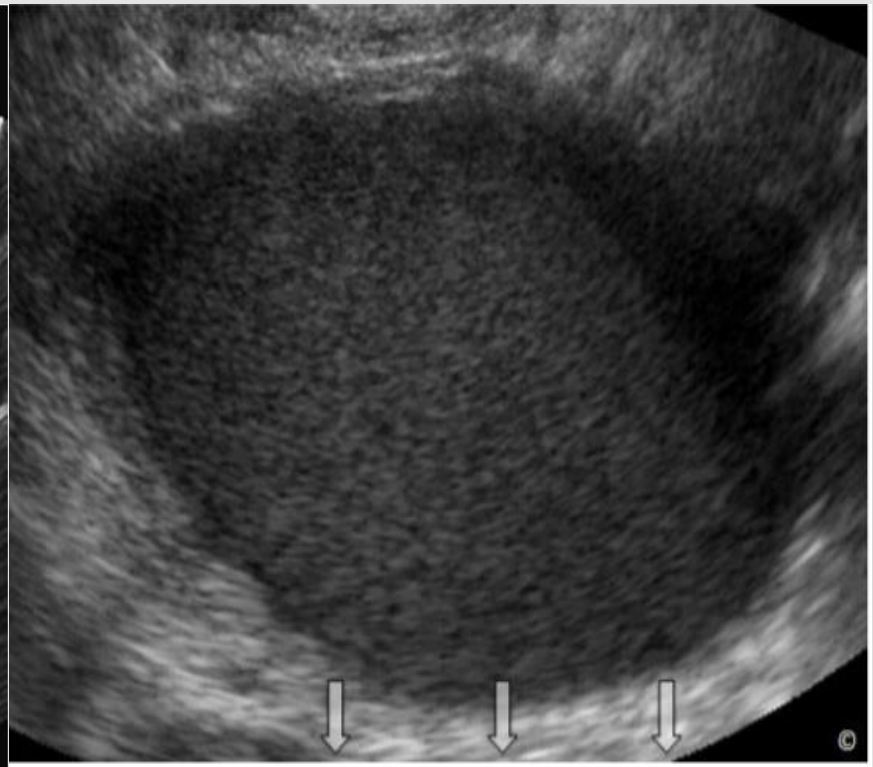
Typically they appear as *well-defined hypoechoic cysts* with *uniform low-grade internal echoes*, which gives them **a 'ground glass' appearance**



posterior acoustic enhancement, suggesting that this is a cystic rather than a solid lesion

There was *no internal flow* demonstrated by color Doppler imaging



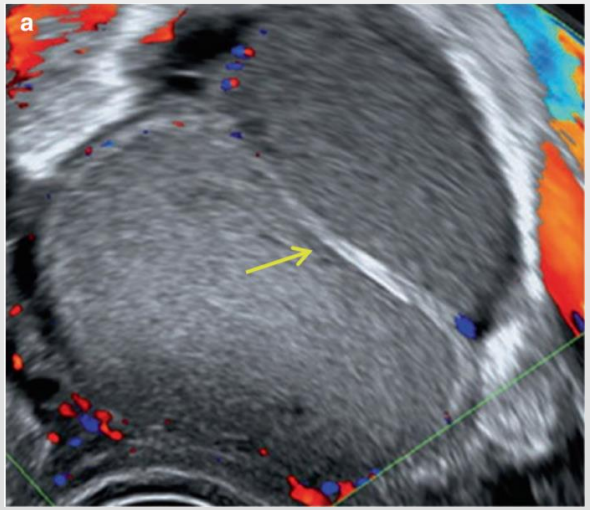


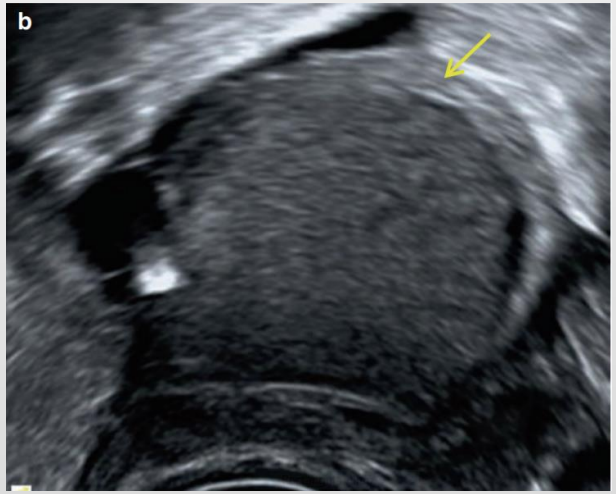
Cyst walls

Typically the cyst walls are thick and regular.

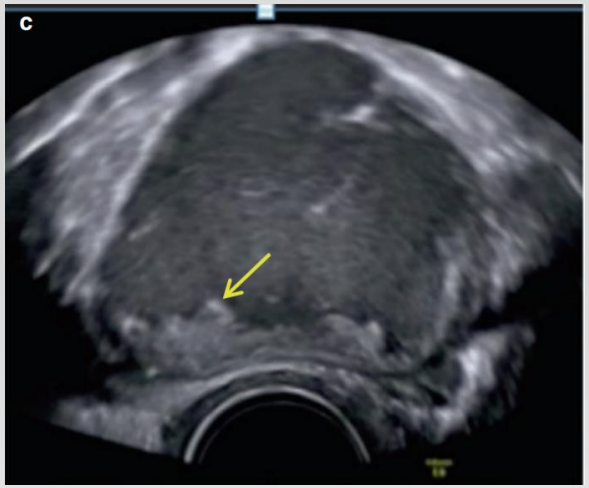
At times, wall nodularity may be noticed because of hyperechoic, irregular areas along the inner cyst walls which are nothing but clot and debris secondary to the haemorrhage within.

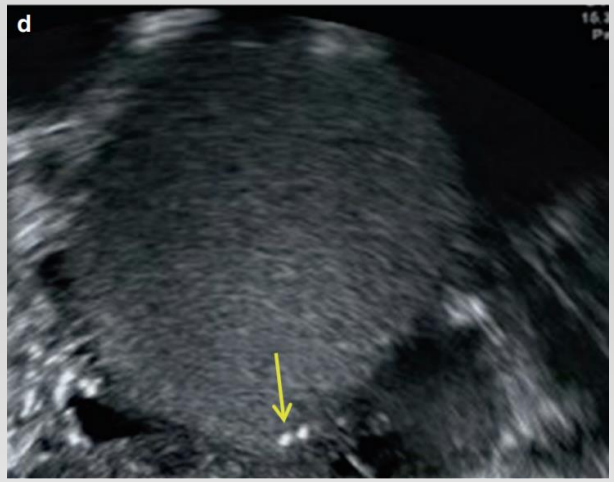
Small hyperechoic foci are often seen in the cyst walls of these endometriotic cysts





Cyst walls are
(a) uniform and regular (arrow)
(b) thick (arrow)



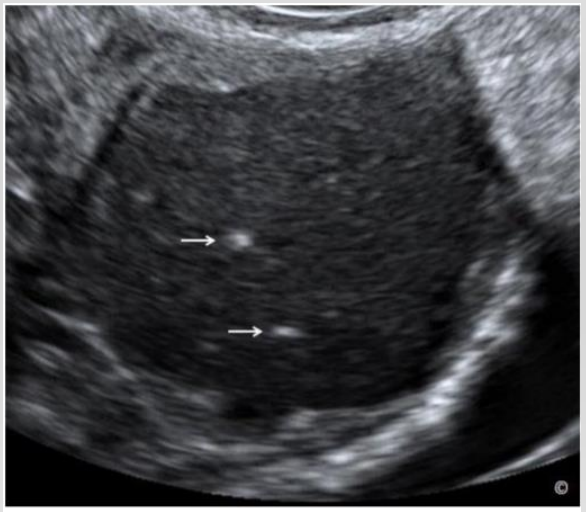


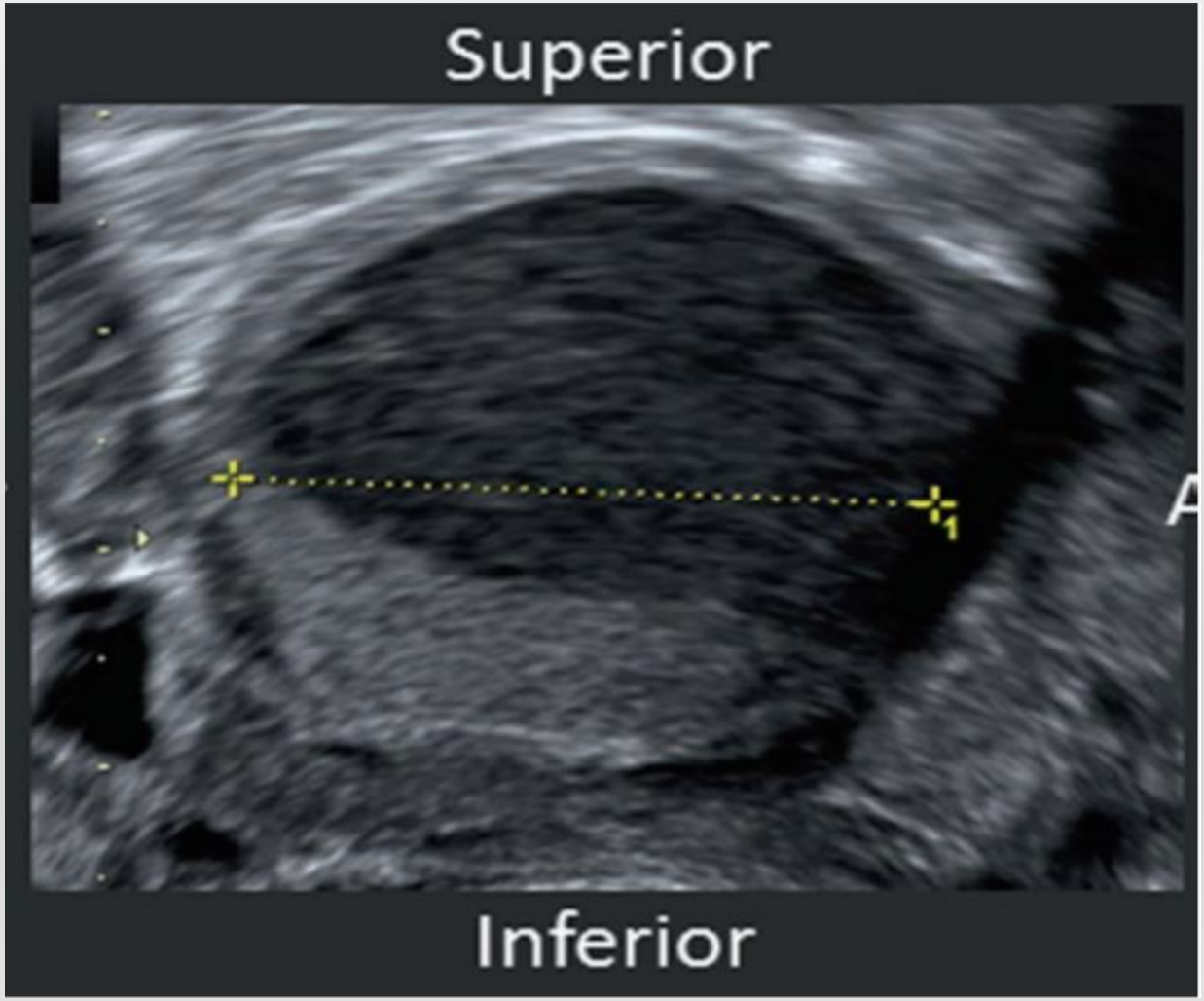
(c) irregular due to clot and debris along the cyst walls (arrow)

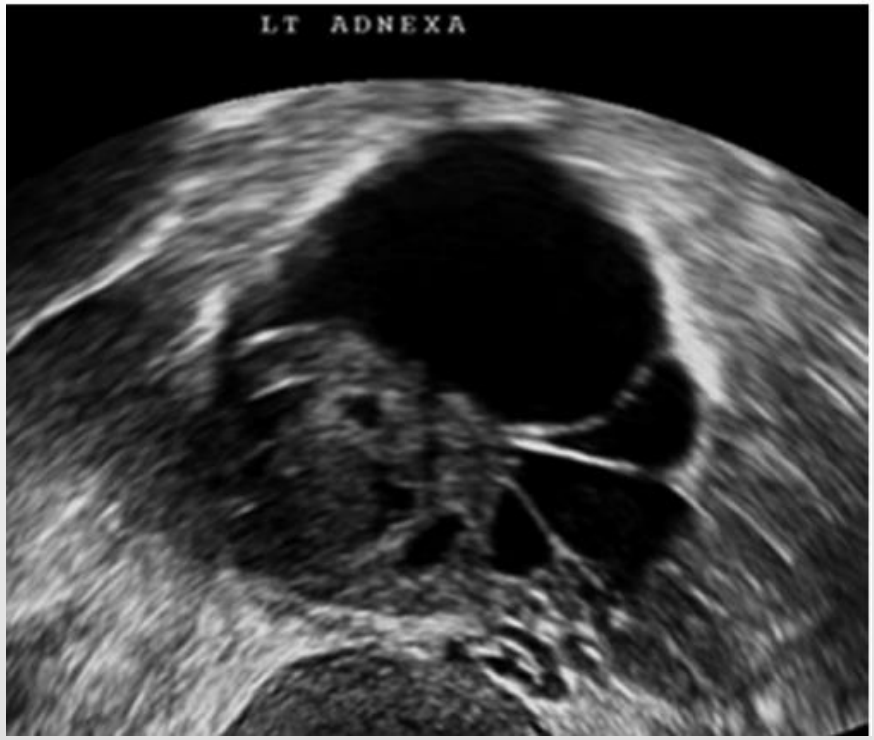
(d) Hyperechoic foci are seen in the cyst wall (arrow)

In some cysts, fluid–fluid level may be seen with the denser fluid in the dependent part (usually the inferior and posterior part) of the cyst

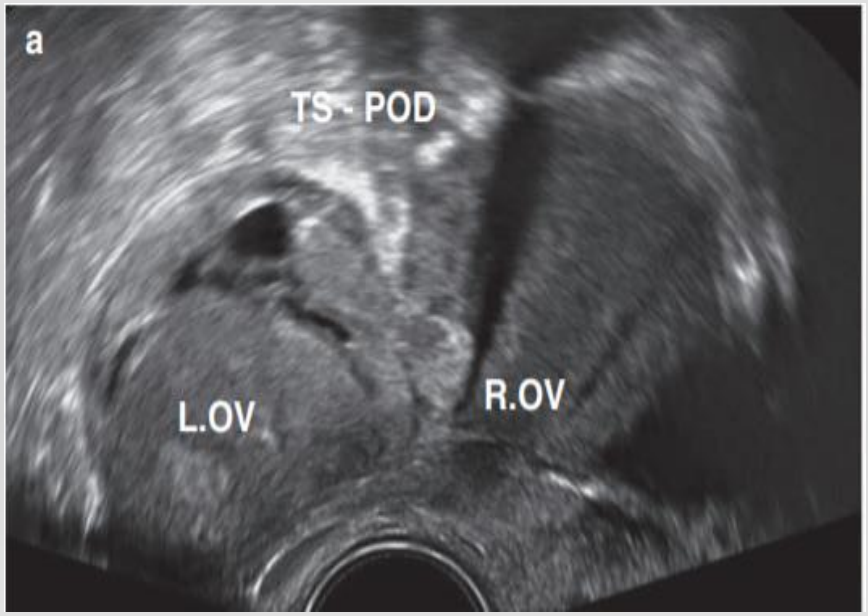
Endometriotic cyst showing fluid–fluid level with denser fluid in the inferior dependent part







Periovarian adhesions with loculated fluid commonly seen in patients with endometriosis



'Kissing ovaries' refer to ovaries with endometriotic cysts, placed beside each other. They are adherent to each other and to the posterior wall of the uterus, in the pouch of Douglas

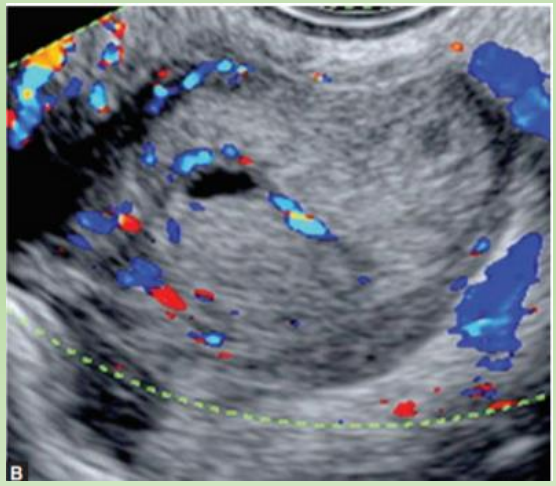
Solid lesions:

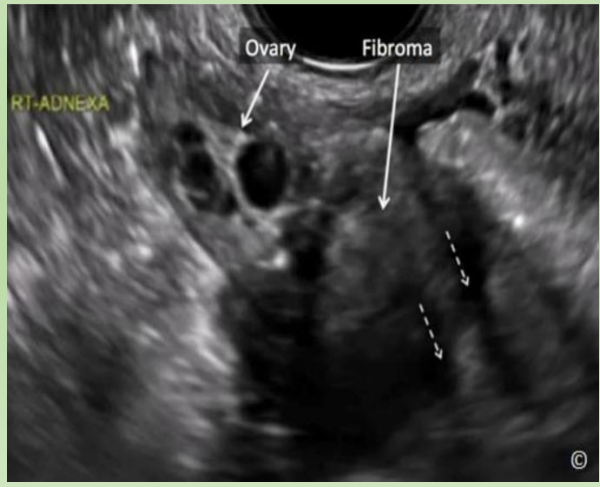
Most common lesion in this group is fibroma

It is well-defined round/oval lesion with echogenicity like that of a fibroid—hypoechoic, homogeneous, but sometimes may be heterogeneous and may also show calcifications

Other lesions in this group are very rare and may be thecoma, fibrothecoma, Brenner's tumor, etc.

Ovarian fibroma with peripheral vascularity





Complex lesions with cystic with solid areas:

Lesions in this group have thick walls, with internal echogenicities and also solid projections arising from the walls.

Lesions included in this group are:

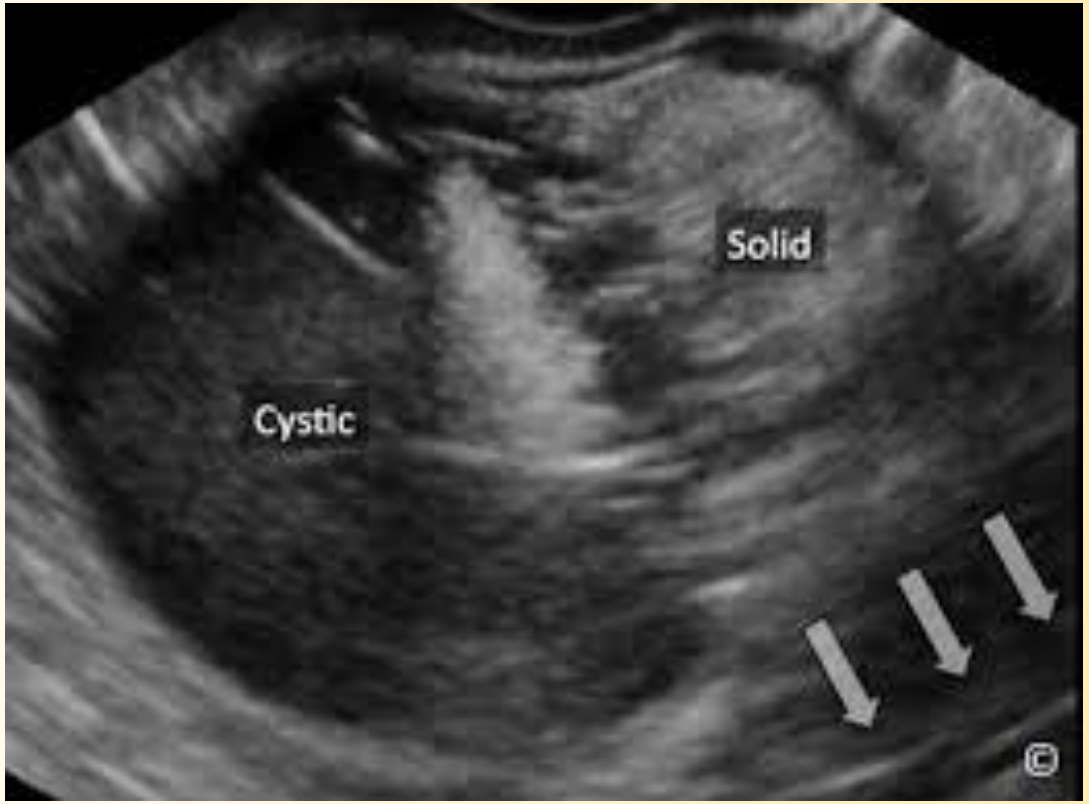
- Dermoids
- Epithelial tumors
- Endometrioid tumors

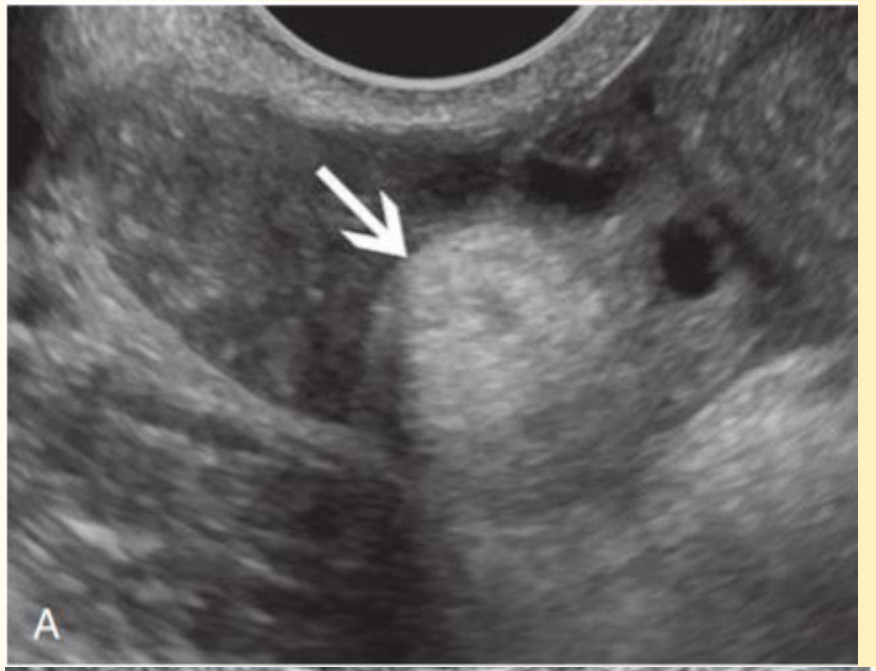
Dermoids: These are often an incidental finding. These are welldefined lesions with thick walls, lowlevel echoes, fluidfluid level, hyperechoic lines and dots due to hair, hyperechoic/calcified echoes like teeth with posterior shadowing, regional diffuse bright echoes with or without acoustic shadowing due to hair clumps or fat in Rokitansky's protuberance

Seventytwo percent of cystic teratomas are avascular.

sonographic appearances

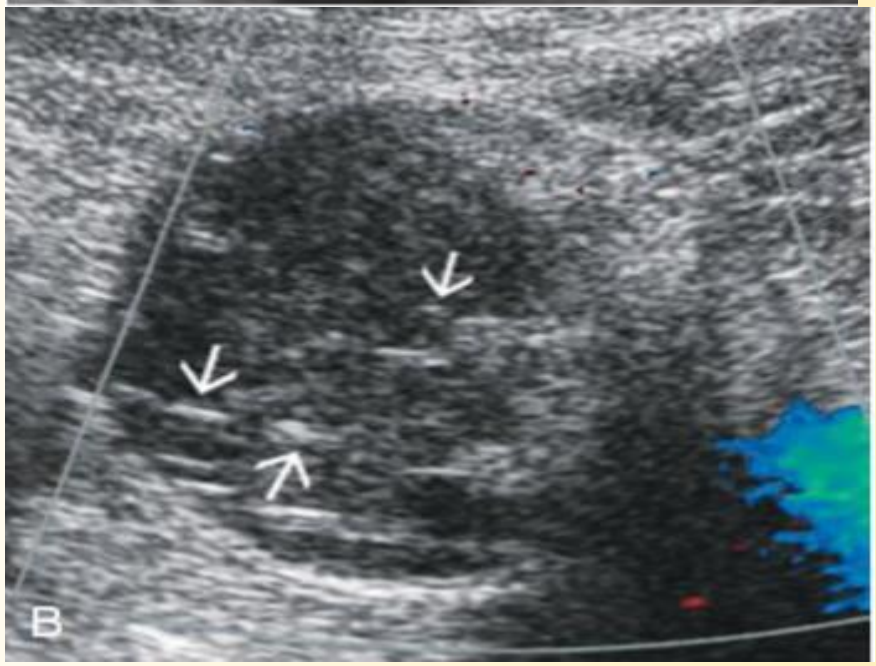
- focal or diffuse hyperechoic component
- areas of acoustic shadowing, also known as the “tip of the iceberg” sign
- echogenic lines and dots, also referred to as dermoid “mesh” or “dot-dash” sign





Ovarian dermoids

This dermoid (arrow) is diffusely hyperechoic. There is adjacent hypoechoic ovarian parenchyma



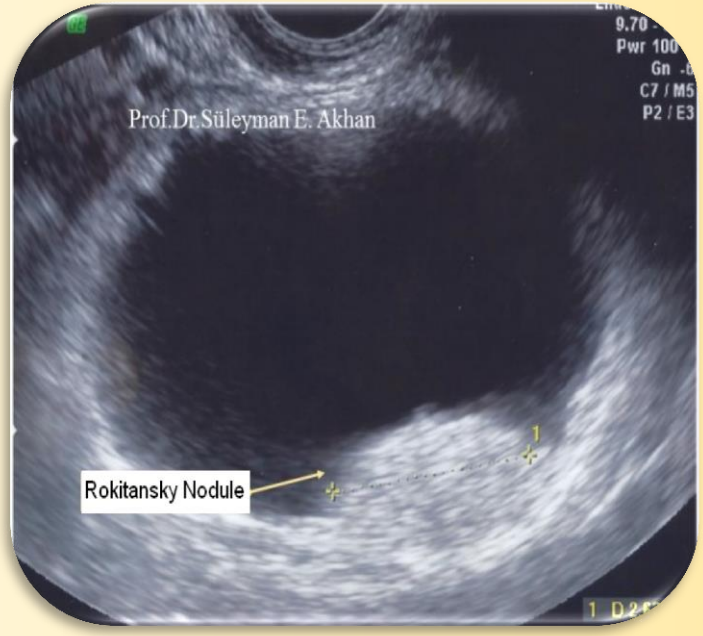
Dermoid with hyperechoic lines and dots , also known as dermoid mesh appearance. This morphologic appearance is usually due to the presence of hair within the lesion. This dermoid also has a hyperechoic peripheral component.

Floating echogenic globules within a large mass is an uncommon appearance but is reported to be highly predictive of a dermoid

Calcifications can occur in dermoids, but calcification alone is not enough to make the definitive diagnosis

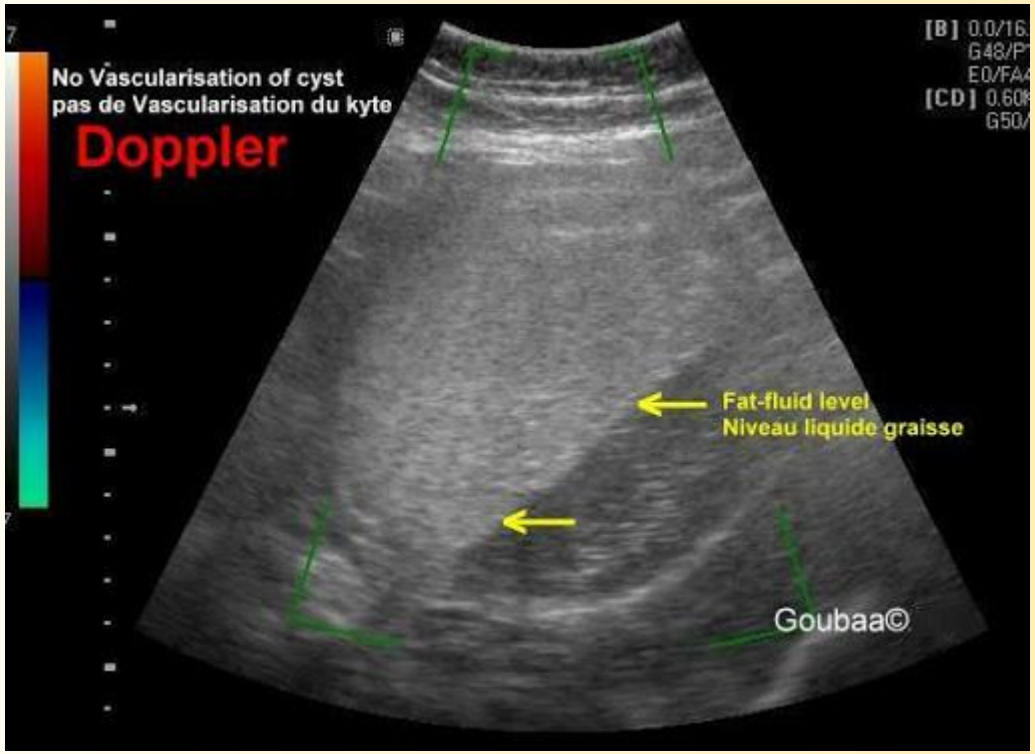
Uncommon but pathognomonic appearance of a dermoid containing several spherical structures, some of which are nondependent, thought to represent floating fat balls. These spherical structures contain fat, which allows them to float.

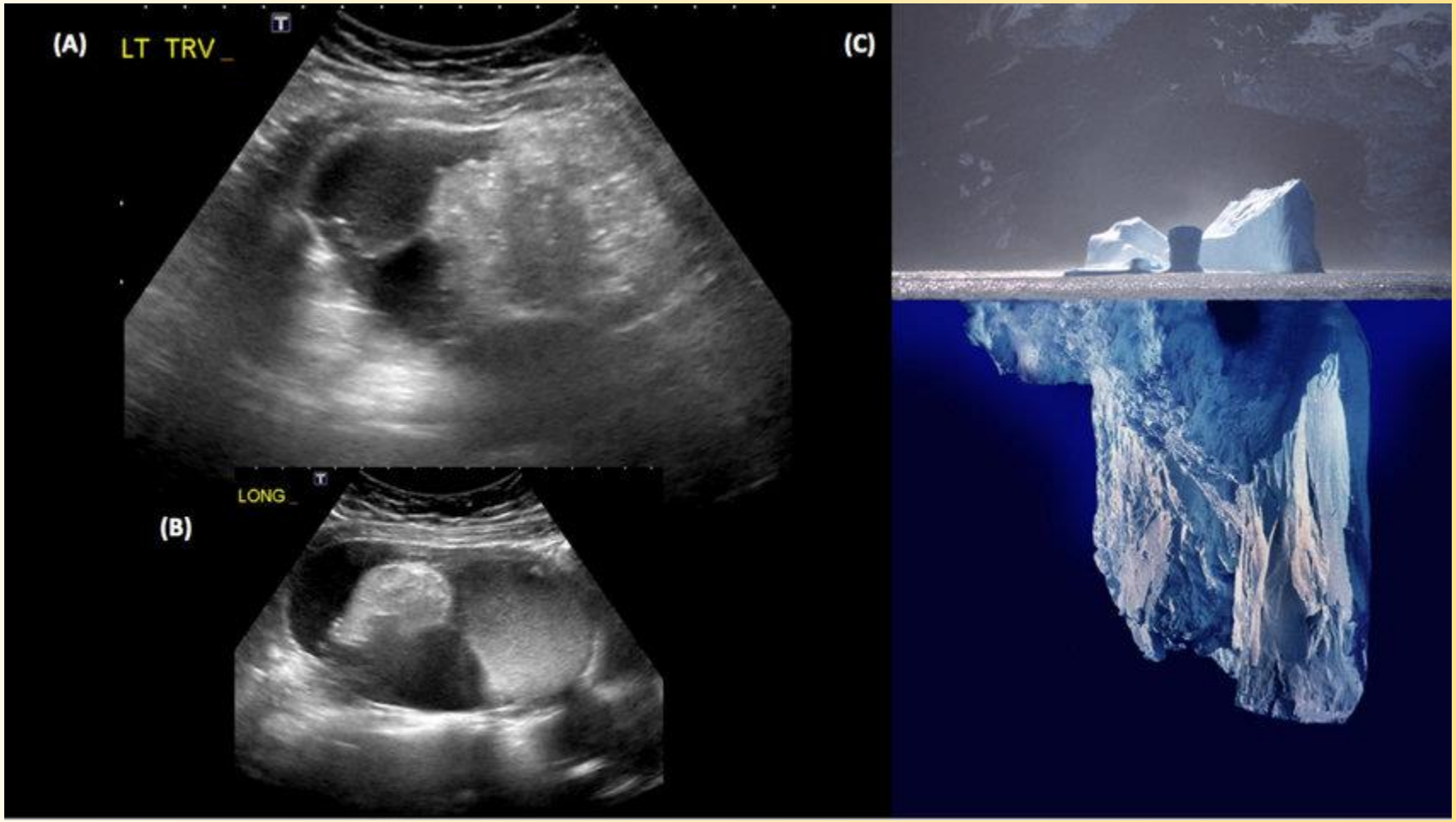
The hyperechoic component, termed a **Rokitansky nodule**, typically corresponds to mixed hair and sebaceous material or occasionally to calcification, sometimes related to a bone or tooth.



Fluid-fluid levels may occur in dermoids but are seen infrequently

A dermoid can be confidently suggested if the nondependent fluid is hyperechoic (indicating fat)



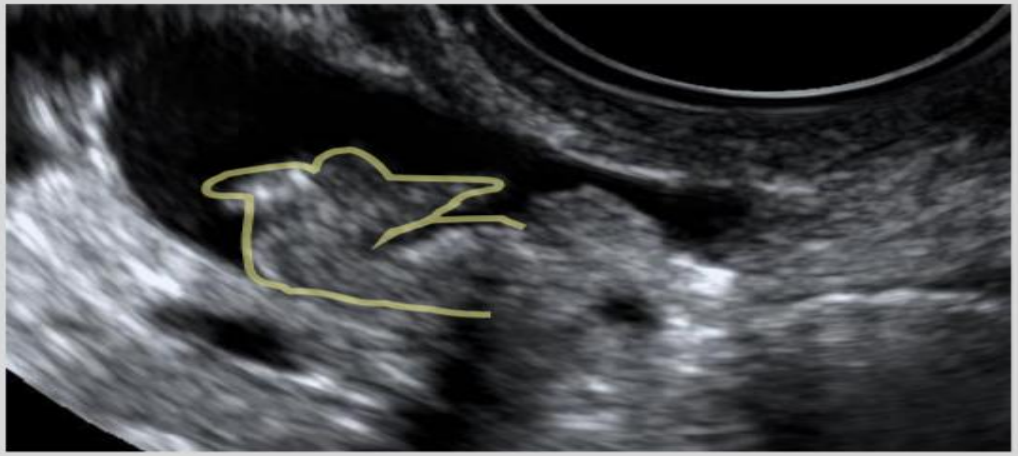


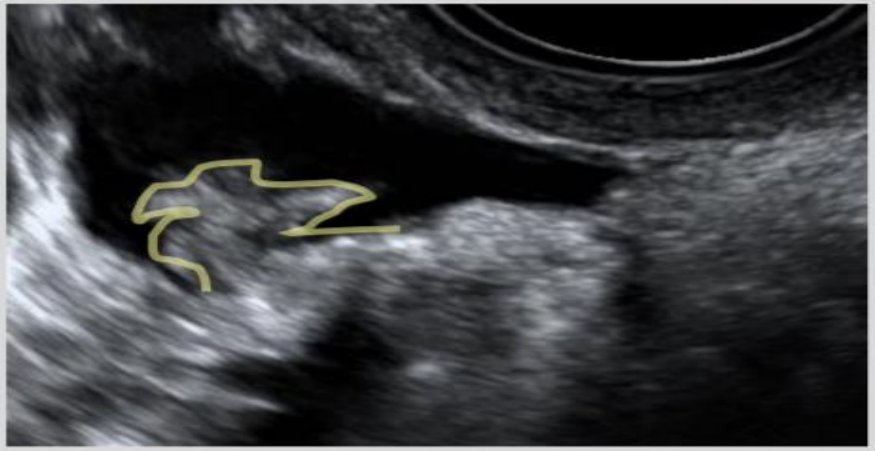
Tip of the iceberg. Transverse (A) and long (B) views of transabdominal pelvic ultrasound showing a left ovarian dermoid cyst with *echogenic components fading into the acoustic shadow*

Fallopian Tube

- The normal fallopian tube is typically not visualized at EVS, although occasionally a collapsed normal tube can be identified , particularly in patients with small amounts of free intraperitoneal fluid

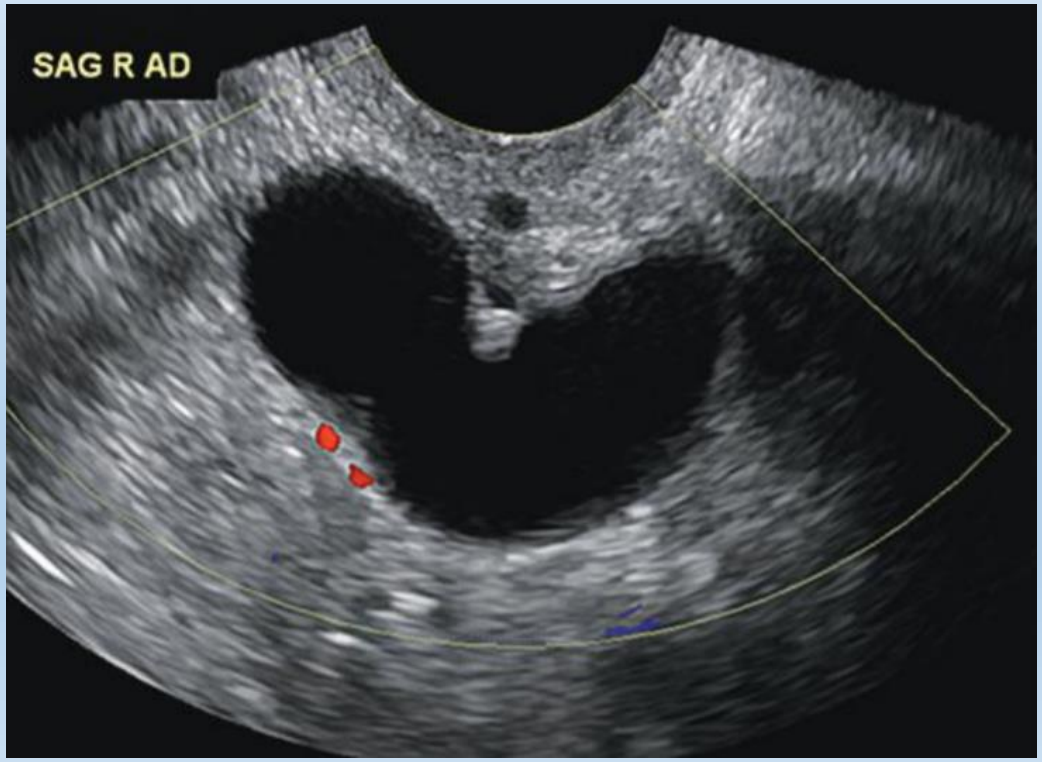
Normal tubes may be seen if there is fluid in the pouch of Douglas





- Obstructed fallopian tubes become distended with intraluminal secretions, resulting in hydrosalpinges, which are readily visualized by sonography

- A classic hydrosalpinx appears as a *tubular, fluid-filled* structure with an *S, V, or U shape* and often a folded configuration demonstrating the ***"incomplete septation sign"*** as the tube folds upon itself



Occasionally small spokes (<3 mm) of similar size or cogwheel-like indentations mimicking small mural nodules can be seen along the wall

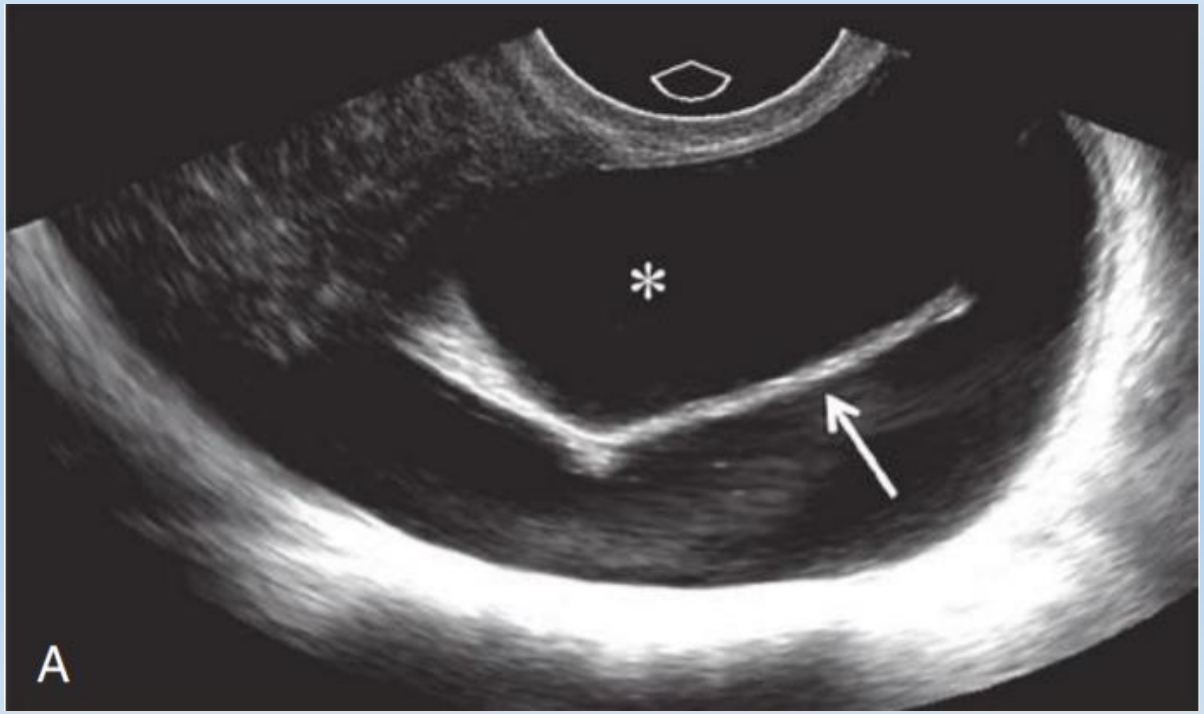
The uniformity and regular spacing of these nodules, in addition to the tubal configuration, are critical features in differentiating chronic salpingitis with dilated tube and redundant or inflamed mucosa from a complex, cystic ovarian mass

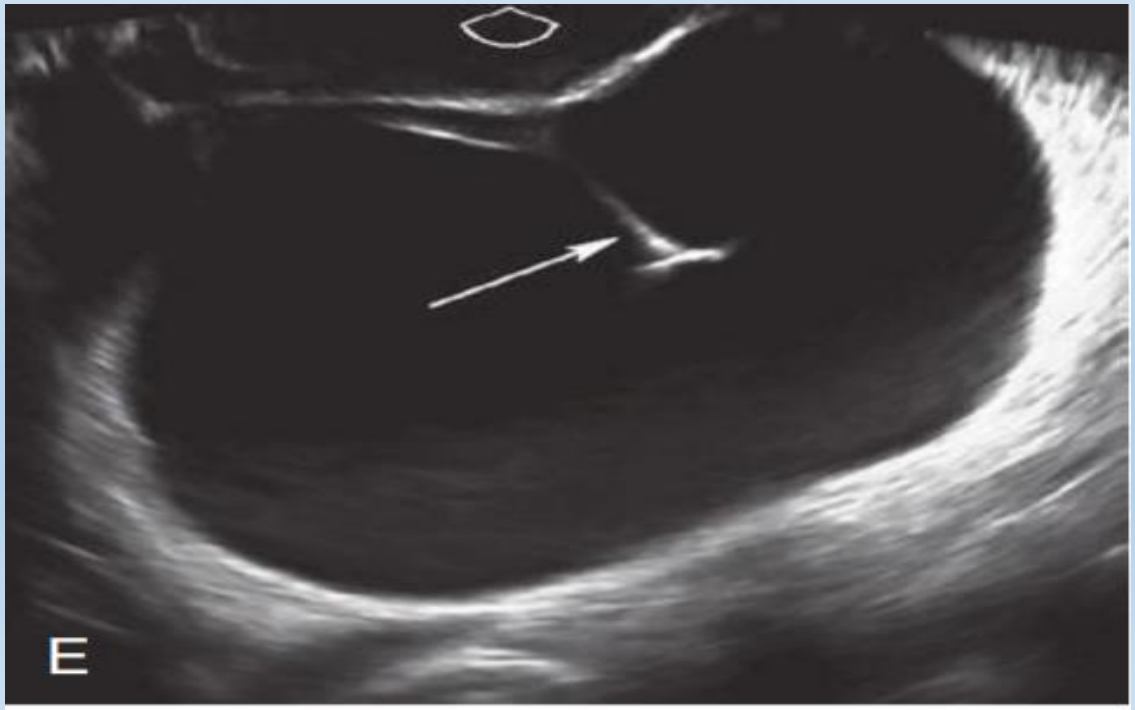
Peristalsis, connection to other loops of bowel, as well as the classic striated echopattern or “gut signature” of the bowel wall will serve to distinguish a fluid-filled loop of bowel from a dilated fallopiantube

A dilated ureter can often be traced to the ureterovesicular junction (UVJ) on transabdominal or transvaginal sonography, and color Doppler should always be used to evaluate any apparent fluid-filled or cystic structure to exclude vascular pathology such as ateriovenous malformations or pelvic varices

Identification of the ovary that is clearly separate from an adnexal mass is the single most helpful finding in distinguishing an abnormal or dilated fallopian tube from a complex cystic ovarian lesion. As the fallopian tube dilates, it often develops an S, U, V, C, or serpiginous shape

Dilated anechoic tubular left adnexal structure in a **U shape** is consistent with hydrosalpinx
Note that the *ampullary end (asterisk) anteriorly is wider than the isthmic portion* of the tube, which is more posterior on this image
The linear echogenic structure (arrow) between the ampullary and isthmic segments represents the two juxtaposed inner walls of the tube as it folds on itself and has been described as the ***"incomplete septation sign."*** Unlike a true septation, the incomplete septation of a folded tube *will not extend from wall to wall* and the *lumen of the tube will remain open around the free edge*. This sign helps to differentiate a folded hydrosalpinx from a complex, cystic adnexal mass



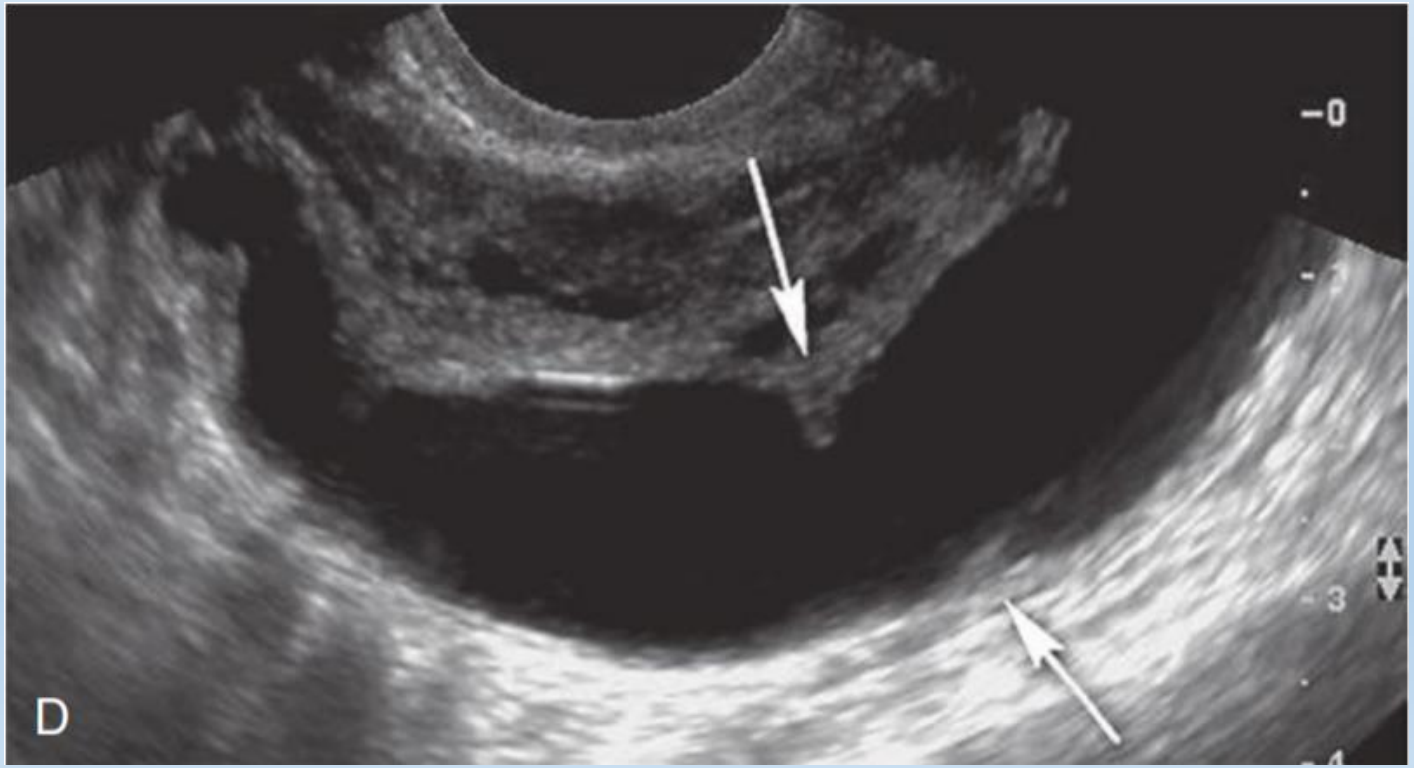


Serpiginous or S-shaped hydrosalpinx

The more lateral ampullary end (asterisk) is wider than the isthmus

A waist sign
consisting of diametrically opposed indentations in the wall, may be observed, usually at the junction of the ampullary portion of the tube with the much wider fimbria. If the dilated tube folds back on itself, the juxtaposition of the two inner walls will create the incomplete septation sign), consisting of a linear echogenic protrusion arising from one wall but not reaching the opposite wall.

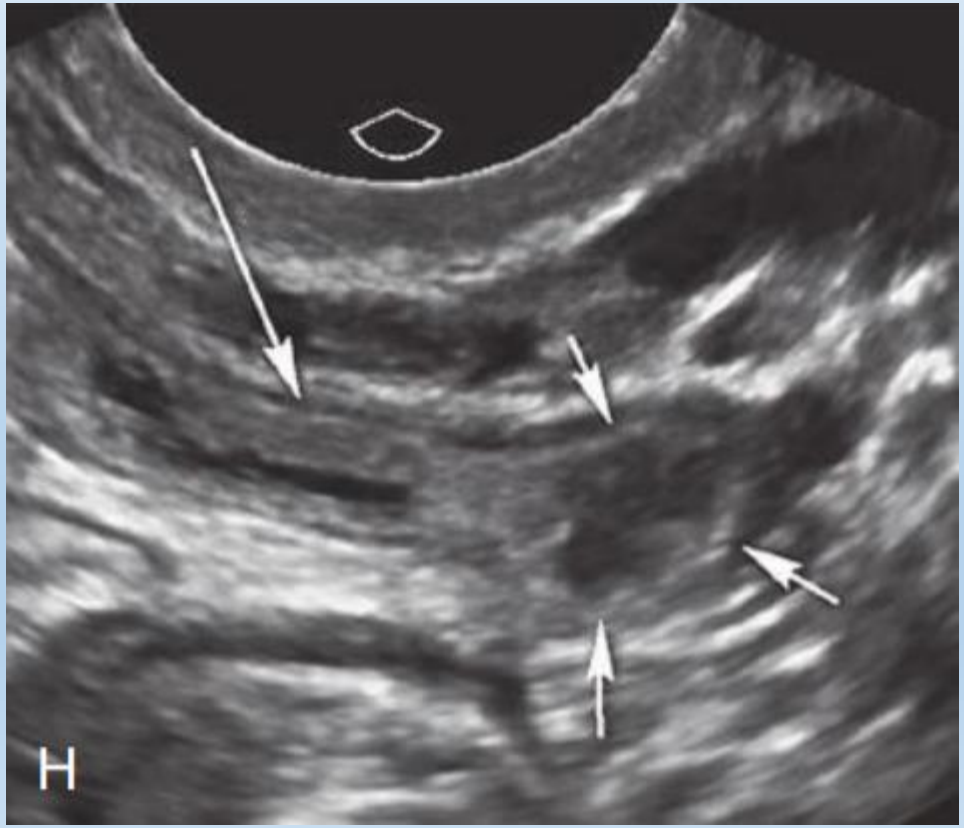
Waist sign: Note indentations (arrows) on opposing sides of the dilated fallopian tube believed to be due to thickening of the endosalpingeal folds

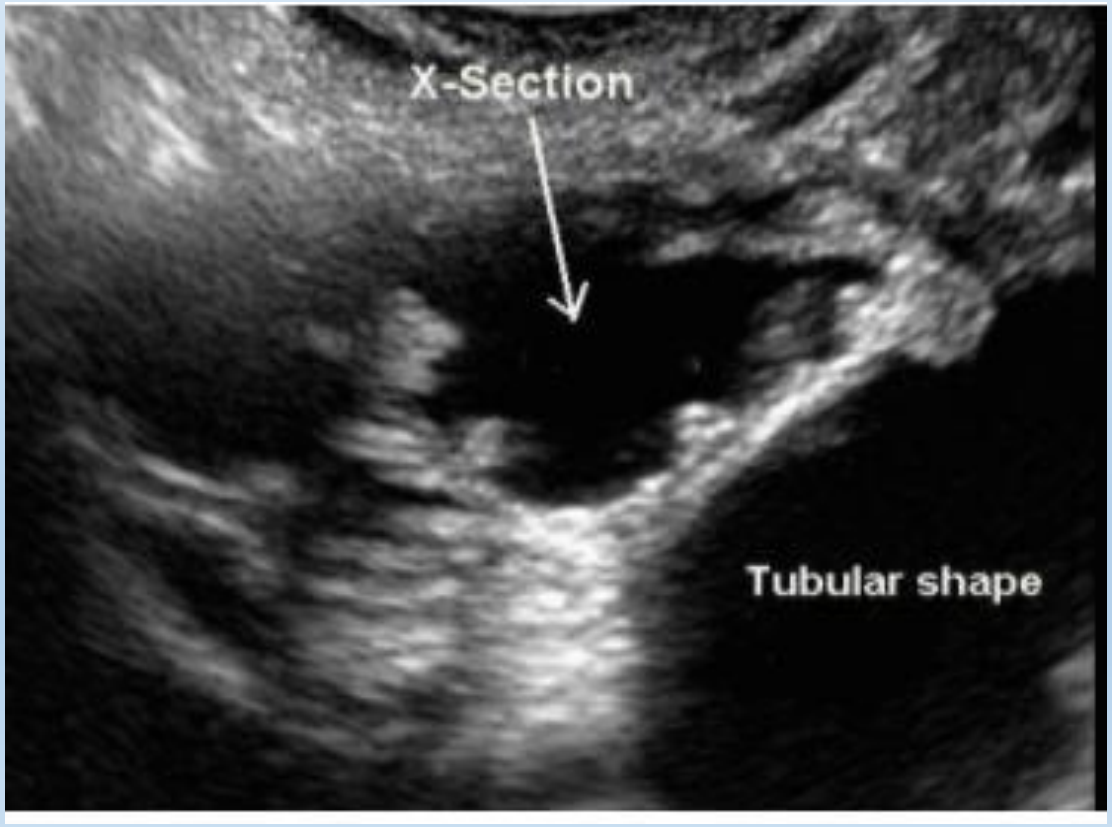


Cogwheel sign:

slightly dilated, thick-walled tortuous fallopian tube

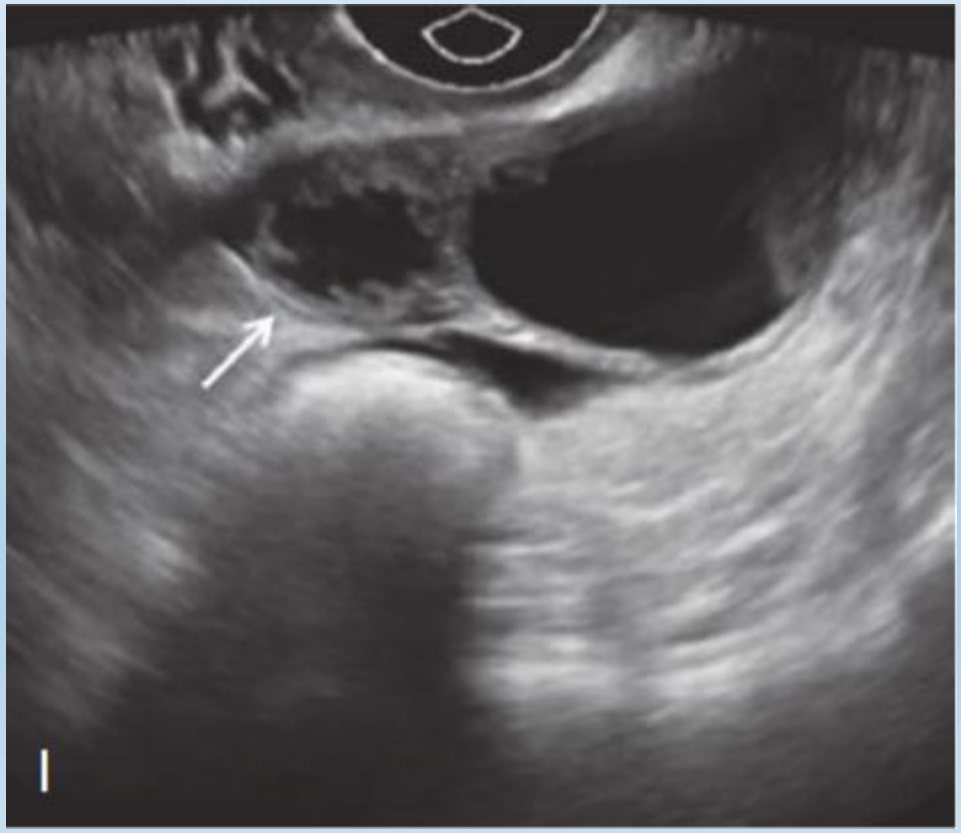
several mural-based small nodules on cross section representing thickened endosalpingeal folds





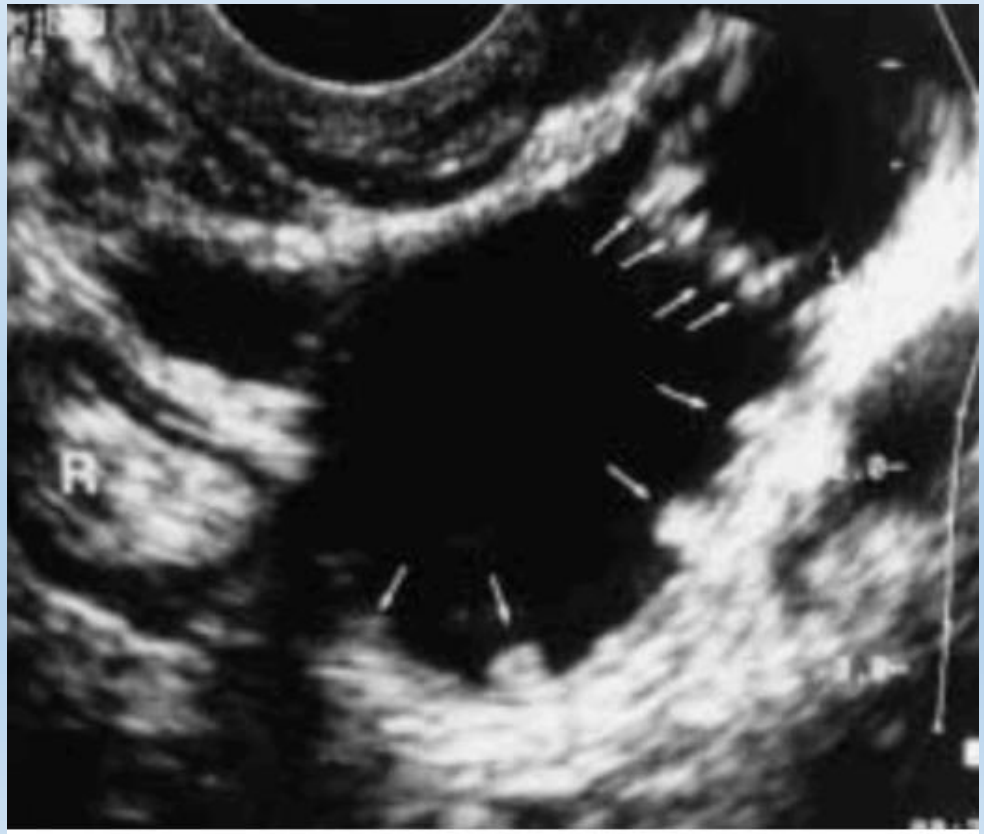
Cogwheel sign:

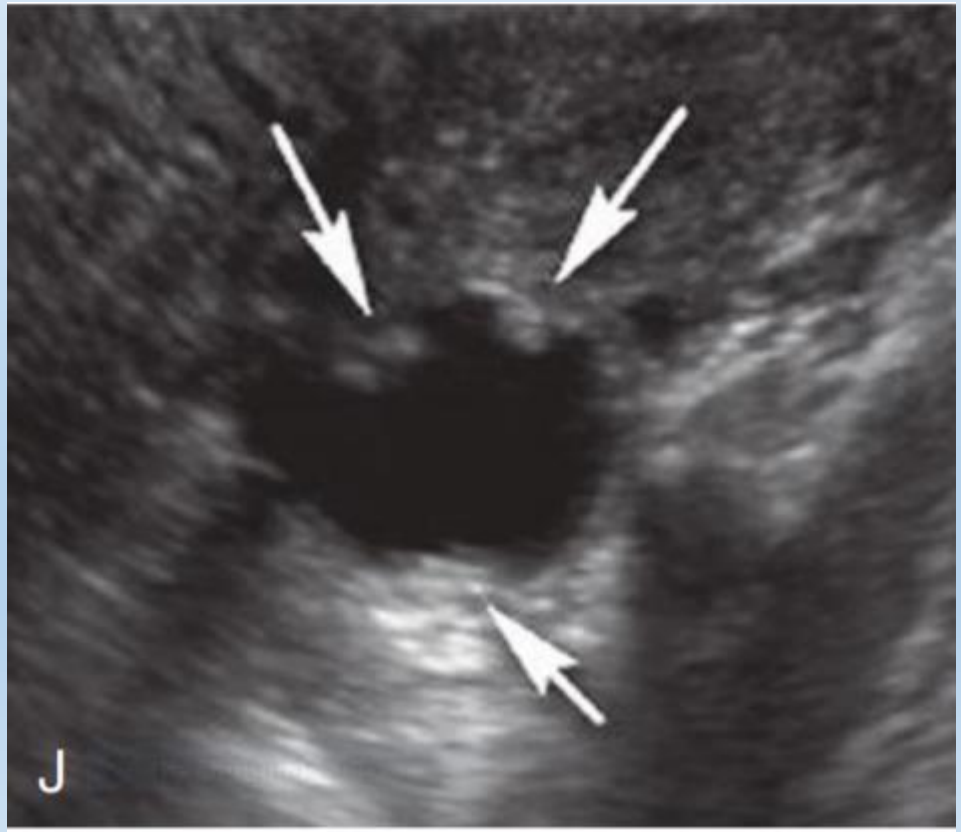
Note numerous echogenic, thickened, endosalpingeal folds regularly spaced around the periphery of the dilated fallopian tube in this patient with chronic salpingitis. In cross section (arrow), these thickened folds may appear nodular, mimicking cystic ovarian malignancy except that these folds are so regularly spaced and symmetric



Beads on a string sign:

the slightly dilated thin-walled fallopian tube in cross section with multiple mural-based echogenic nodules (arrows) due to thickening of the endosalpingeal folds, resulting in the appearance of “beads on a string






Thank You
for Your Attention!