ULTRASOUND EVALUATION OF THE ADNEXAE

12

INTRODUCTION

Ultrasound is the preferred imaging modality for the assessment of the pelvis and in particular the uterus and the ovaries for the presence of pathology. Advantages that ultrasound has over other imaging modalities, such as Computed Tomography and Magnetic Resonance Imaging, are obvious and includes the lower cost of ultrasound, its bedside portability, and the ability of the transvaginal ultrasound transducer to obtain high resolution images which allow for outstanding detailed anatomic evaluation of the pelvic organs. Furthermore, the transvaginal ultrasound transducer can be used by the examiner as an extension of the gynecologic examination and thus can help in correlating the patient’s symptoms with the exact anatomic location on ultrasound. The use of color and pulsed Doppler can also be added to assess the vascularity of tissue, which may help in the characterization of some adnexal masses. The presence of an abnormal adnexal mass should be evaluated by ultrasound in details. The relationship of the adnexal mass to the ovary and or the uterus should be assessed and the possibility of malignancy should be evaluated.

THE NORMAL OVARY

The most optimal approach to assess the ovaries on ultrasound is the transvaginal approach using the transvaginal ultrasound transducer as it allows for the best resolution of morphologic details. The transvaginal approach is best performed with an empty bladder. The transabdominal approach, which should be reserved for situations where the transvaginal approach is not feasible, is a limited approach to the evaluation of the ovaries due to the lower resolution of the abdominal ultrasound transducers and the presence of bowel loops, which often shadow the ovaries in the pelvis.

The normal ovary is relatively easy to detect in the reproductive years. The presence of ovarian follicles **(Figure 12.1)**, or a corpus luteum, serves to differentiate the ovary from surrounding tissue in the pelvis on ultrasound. The normal ovary’s typical anatomic location in the pelvis is lateral to the broad ligament and overlying the hypogastric vein (**Figure 12.2**). Bowel peristalsis helps to differentiate between moveable structures and the static ovary. The authors recommend the following steps for the localization of the normal ovaries by transvaginal ultrasound:

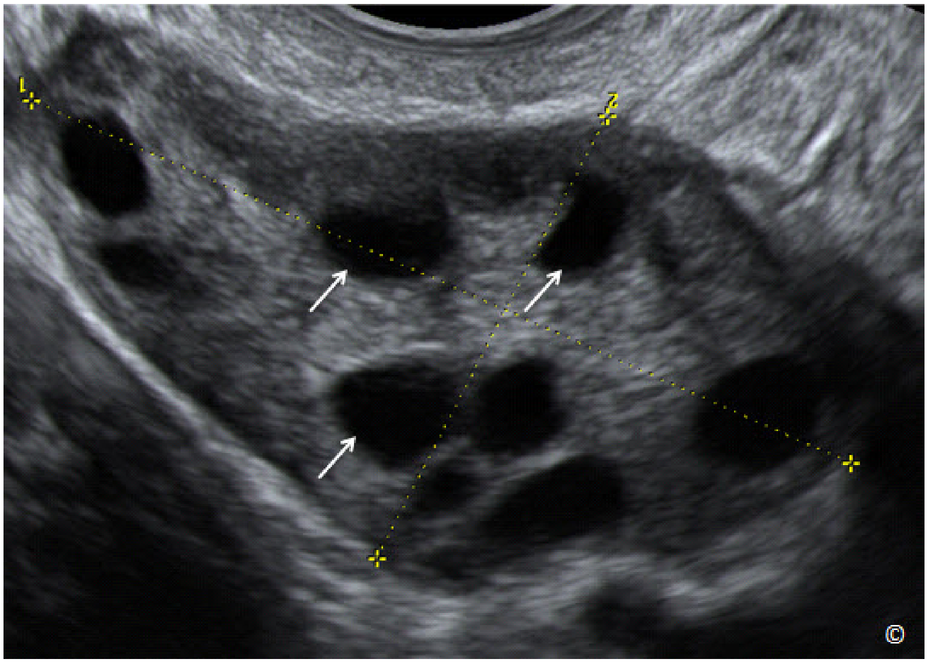


Figure 12.1: Transvaginal ultrasound of a normal ovary. Note the presence of multiple ovarian follicles (arrows) that help to differentiate the ovary from surrounding tissue. Image is courtesy of Dr. Bernard Benoit.

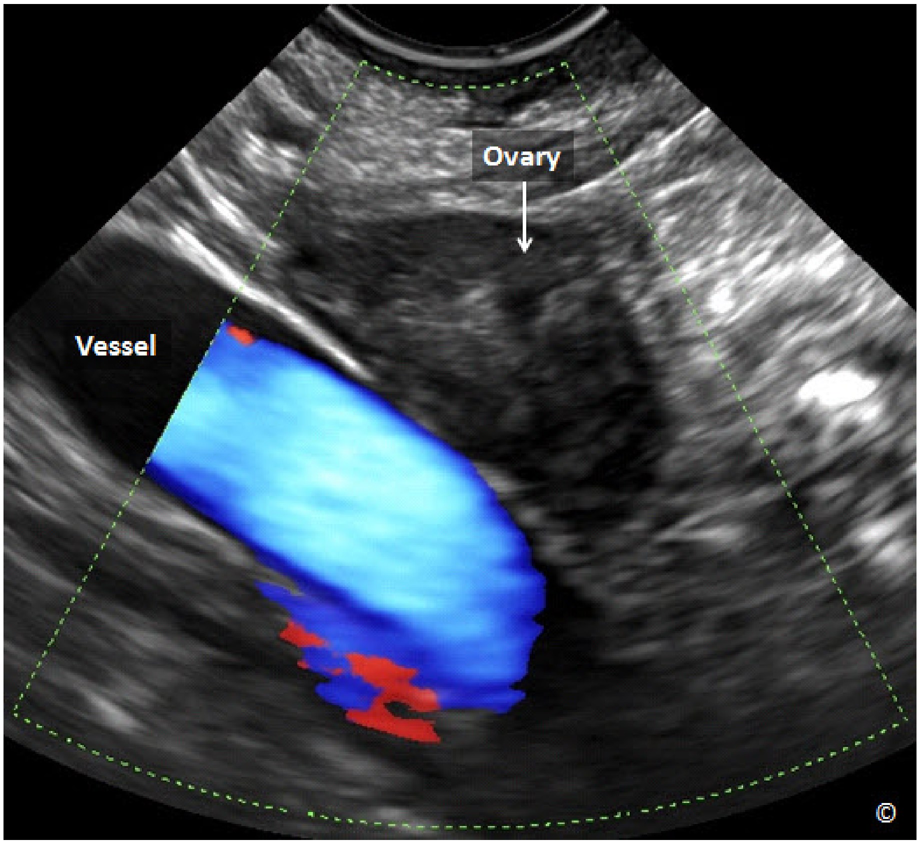


Figure 12.2: Transvaginal ultrasound of a normal ovary (labeled). Note the anatomic location of the ovary, overlying the hypogastric vein (labeled as vessel).

Step One: Insert the transvaginal transducer and obtain a mid-sagittal plane of the uterus (**Figure 12.3**).

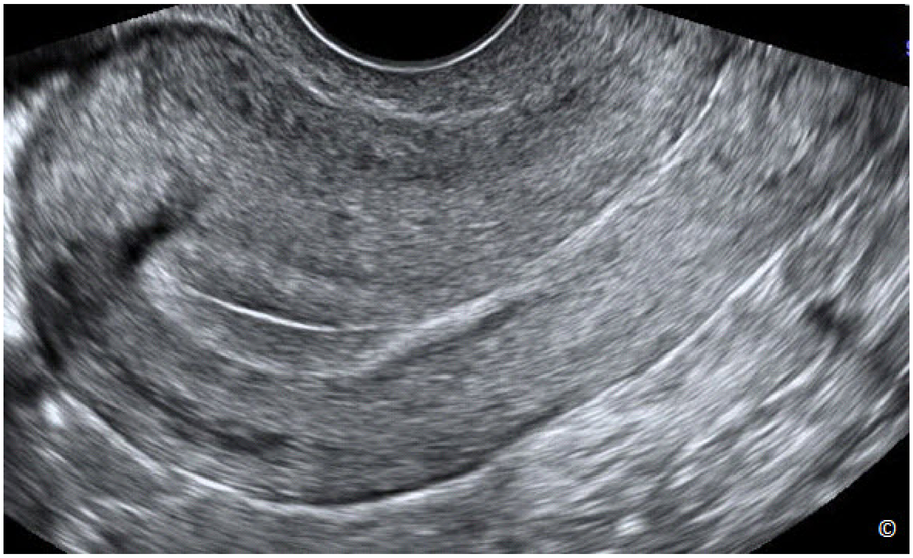


Figure 12.3: Transvaginal ultrasound of the mid-sagittal plane of the uterus. For more details on ultrasound imaging of the uterus, refer to chapter 11.

Step Two: Rotate the transvaginal transducer ninety degrees and obtain a transverse plane of the uterus at the level of the fundus (**Figure 12.4**). Ensure that the transverse plane is at the level of the fundus and not at the uterine isthmus.

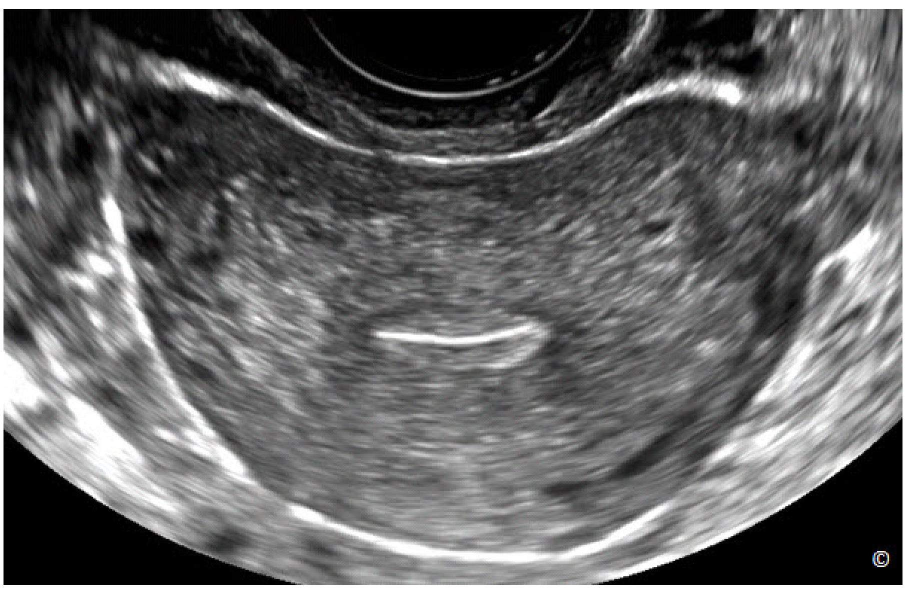


Figure 12.4: Transvaginal ultrasound of the transverse plane of the uterus, obtained by rotating the transducer 90 degrees from the midsagittal plane (see **Figure 12.3**). For more details on ultrasound imaging of the uterus, refer to Chapter 11.

Step Three: While maintaining the transverse orientation, angle your probe towards the right side of the patient, looking for the right ovary – (the handle of the transducer should get close or touch the patient's left inner thigh). Follow the right ovarian ligament as it commonly leads you to the anatomic location of the right ovary (**Figures 12.5** and **12.6**). The right ovary should come into view overlying the right hypogastric vein (**Figure 12.2**). Repeat the same maneuver for the left side. **Clip 12.1** shows a movie of these suggested steps.

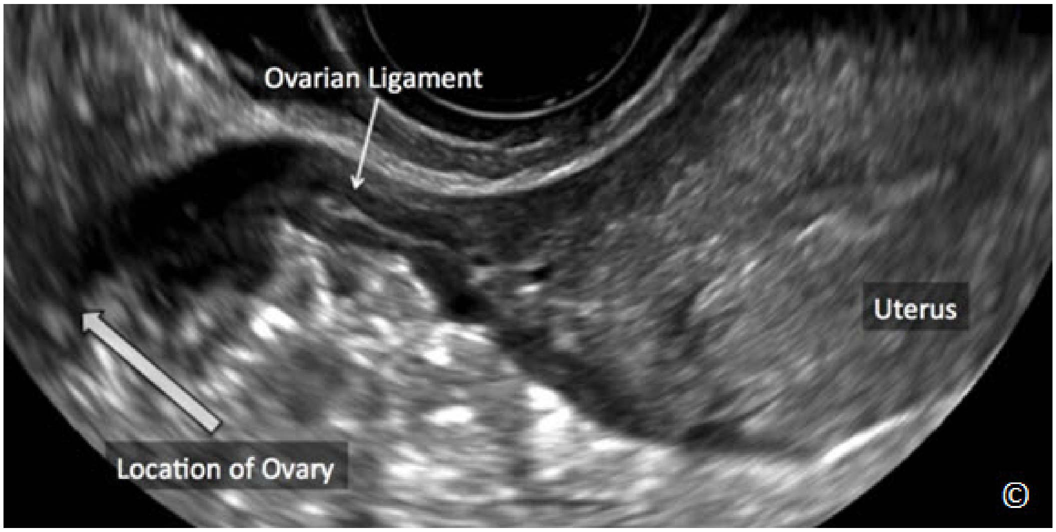


Figure 12.5: Transvaginal ultrasound of the uterus in transverse orientation looking for the right ovary. Note that if you follow the ovarian ligament (labeled), this commonly leads you to the ipsilateral ovary.

The size of the normal ovary varies slightly with the time of the menstrual cycle as well as the woman's age. The ovary should be measured on ultrasound in 3 dimensions; width, length and depth on views obtained in 2 orthogonal planes (**Figure 12.7 A** and **B**). The ovary appears ovoid (like a chicken egg) in shape and typically contains numerous follicles especially in the reproductive years (see **Figure 12.1**). The ovaries may not be identifiable in some women. This occurs most frequently prior to puberty, after menopause, or in the presence of large uterine fibroids, which shadow the adnexal regions. If a woman has undergone hysterectomy, the ovaries are typically more difficult to image by ultrasound because the bowel fills the space left by the removal of the uterus, and makes ultrasound imaging less optimal. The normal fallopian tubes are not commonly identified as separate structures on ultrasound unless they have pathology.

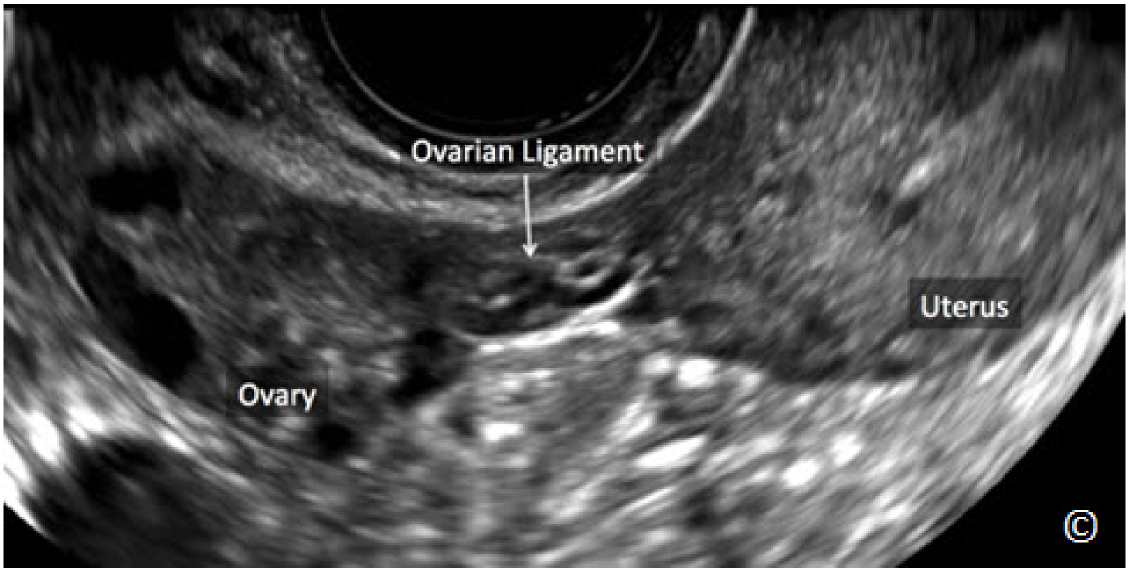


Figure 12.6: Transvaginal ultrasound of the uterus in transverse orientation showing the ovarian ligament and the ovary. Note the relationship between the transverse plane of the uterus (uterus), the ovarian ligament and the ovary (both labeled). By following the ovarian ligament, the ovary can commonly be seen. See text for details.

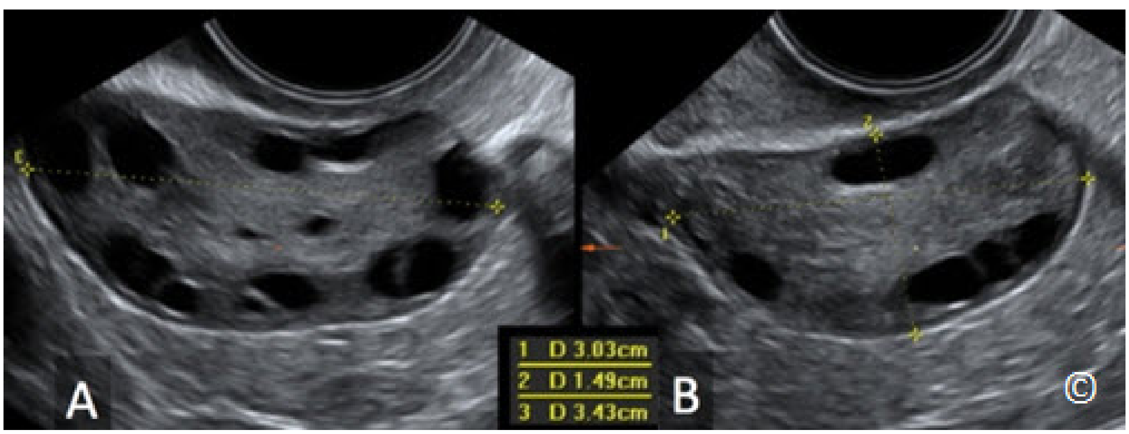


Figure 12.7 A and B: Transvaginal ultrasound showing the measurement of an ovary in its 3 dimensions; length in A and width (measurement 1 on figure B) and depth (measurement 2 on figure B). Figures A and B are orthogonal planes. Image is courtesy of Dr. Bernard Benoit.

Table 12.1 lists benign adnexal masses that are commonly encountered in women of reproductive age. Detailed sonographic characteristics of these masses are discussed in the following sections.

TABLE 12.1	Common Benign Adnexal Masses in Reproductive Age Group
- Simple Cyst - Endometrioma - Pedunculated leiomyoma - Tubo-ovarian Abscess	- Hemorrhagic Cyst - Dermoid Cyst - Hydrosalpinx - Peritoneal Inclusion Cyst

SIMPLE CYST

Characteristics of a simple ovarian cyst on ultrasound include a thin well-rounded capsule with smooth wall and excellent sound transmission (**Figure 12.8**). There should be no internal irregularities on the capsule wall and no internal papillary projections (**Figure 12.8**). The cyst content should be anechoic with no reflection of echo, which typically suggests clarity of the fluid (**Figure 12.8**). The presence of recognized ovarian tissue on ultrasound in the capsule of the cyst is a normal finding (**Figure 12.8**). The presence of septations or papillary projections within a cyst (**Figure 12.9**) may represent signs of malignancy and thus should warrant a referral to an experienced sonographer or sonologist for further evaluation of the adnexae.

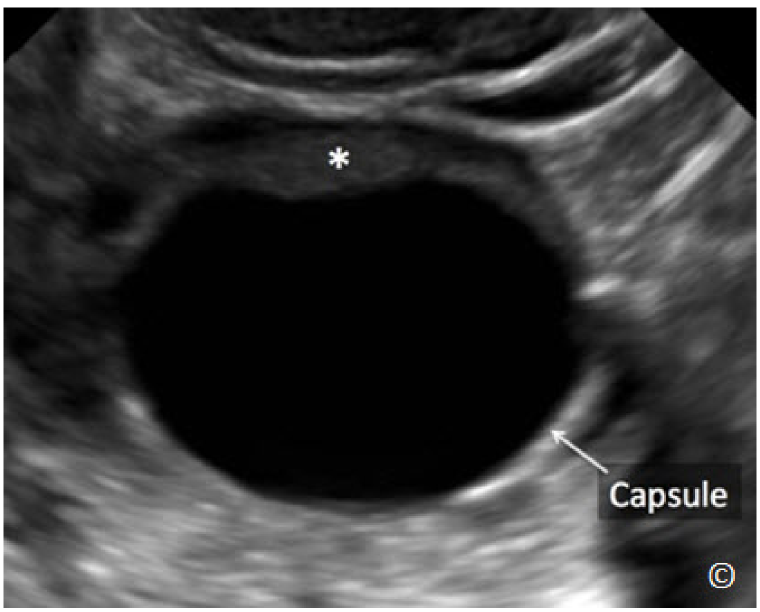


Figure 12.8: Transvaginal ultrasound of a simple ovarian cyst. Note the presence of a thin round, smooth capsule (labeled) with no papillary projections and with excellent sound transmission. Note the presence of ovarian tissue (asterisk).

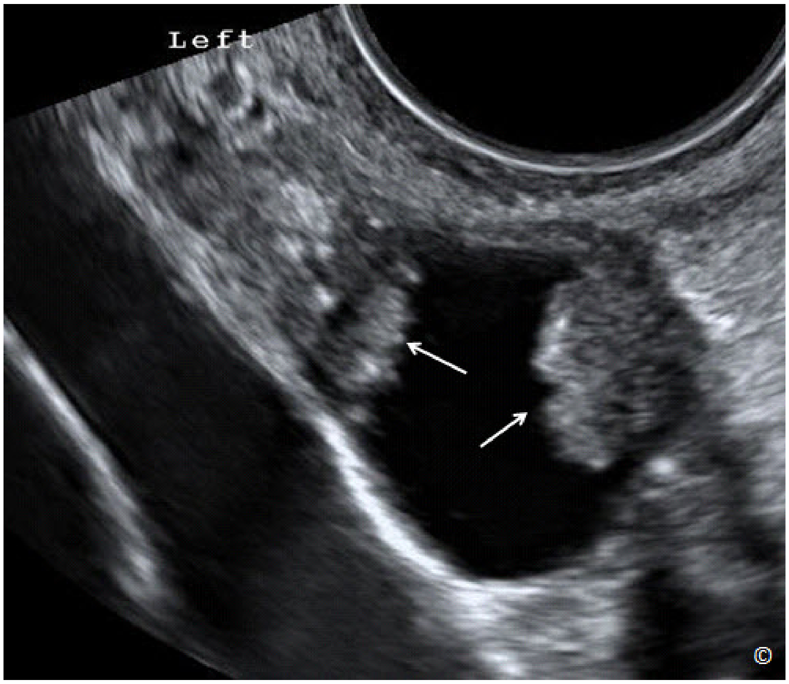


Figure 12.9: Transvaginal ultrasound of a left adnexal mass. Note the presence of papillary projections (arrows), which may suggest the presence of malignancy and thus requires referral to experienced sonography.

HEMORRHAGIC CYST

Hemorrhagic cyst, also commonly referred to as hemorrhagic corpus luteum, results from bleeding inside an ovarian cyst. The event is typically noticeable by the woman and is described as an acute pain in the right or left lower quadrant of the abdomen. The hemorrhagic cyst typically goes through a temporal pattern of clot formation within the cyst, clot lysis, clot retraction and clot resolution. The sonographic appearance of the hemorrhagic cyst is thus dependent on the stage of evolution of the cyst's content. Given that hemorrhagic cysts present in symptomatic women and that the sonographic appearance on ultrasound resembles a "solid appearing adnexal mass" at some phases of development, it is a common reasons for unnecessary pelvic surgery.

In its early stages, hemorrhagic cysts appear as solid masses with smooth thin walls and excellent sound transmission (**Figure 12.10**). The cyst content has variable echogenicity with characteristic thin linear reticular strands (**Figure 12-10**). Upon follow-up, blood clot retracts within the hemorrhagic cyst and a fluid layer develops within the cyst itself, resulting in another sonographic characteristic of a hemorrhagic cyst (**Figure 12.11**). At a point of clot retraction, the clot may appear like a papillary projection within the cyst (**Figure 12.12**). It is important to make the distinction between a retracted blood clot and a papillary projection resulting from a malignant growth. We propose several differentiating features:

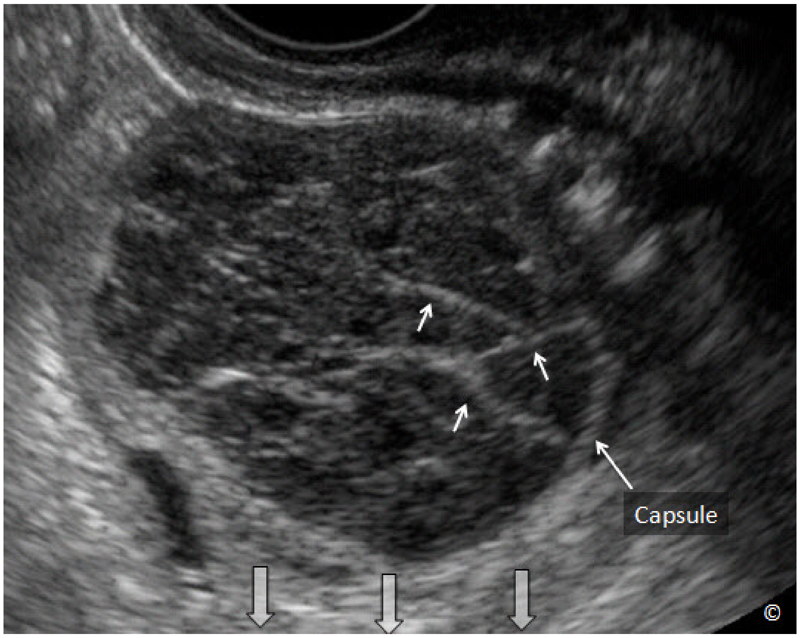


Figure 12.10: Transvaginal ultrasound of a hemorrhagic cyst. Note the solid appearance with smooth capsule (labeled) and excellent sound transmission (big arrows). Note the variable echogenicity and the characteristic thin linear reticular strands (small arrows).

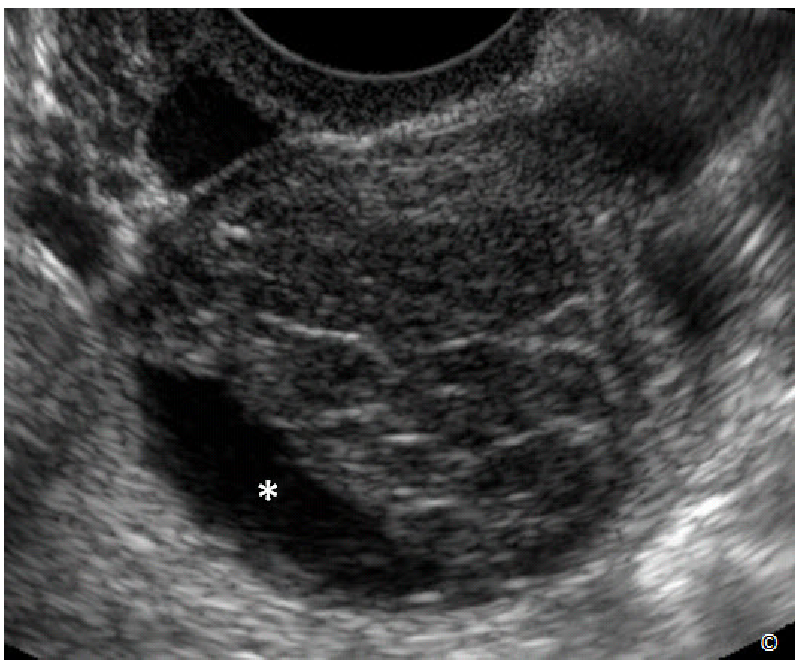


Figure 12.11: Transvaginal ultrasound follow-up of the hemorrhagic cyst in figure 12.10. Note the retraction of the blood clot (asterisk) with the development of a fluid layer.

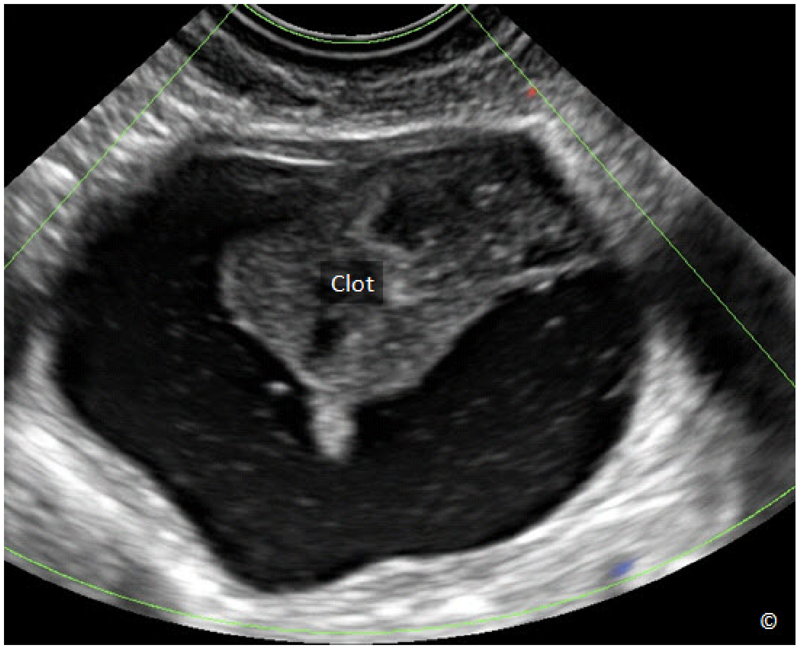


Figure 12.12: Transvaginal ultrasound of a hemorrhagic cyst with blood retraction. Note the appearance of the retracted blood clot (labeled), similar to a papillary projection. Read text for differentiating features between a retracted clot and a papillary projection.

1) A blood clot within an ovary (hemorrhagic cyst) should never have any capillary flow within it on color Doppler sonography. We therefore recommend the placement of color Doppler sonography (using low velocity scale, around 5-10 cm/sec and low filter settings) on all adnexal masses to assess for capillary flow. The absence of capillary flow within an adnexal mass with the sonographic appearance of a hemorrhagic cyst confirms its diagnosis (**Figure 12.13**). The presence of capillary flow within the content of an adnexal mass (**Figure 12.14**) on the other hand, is not compatible with a hemorrhagic cyst and should be referred to expert sonography for further evaluation.

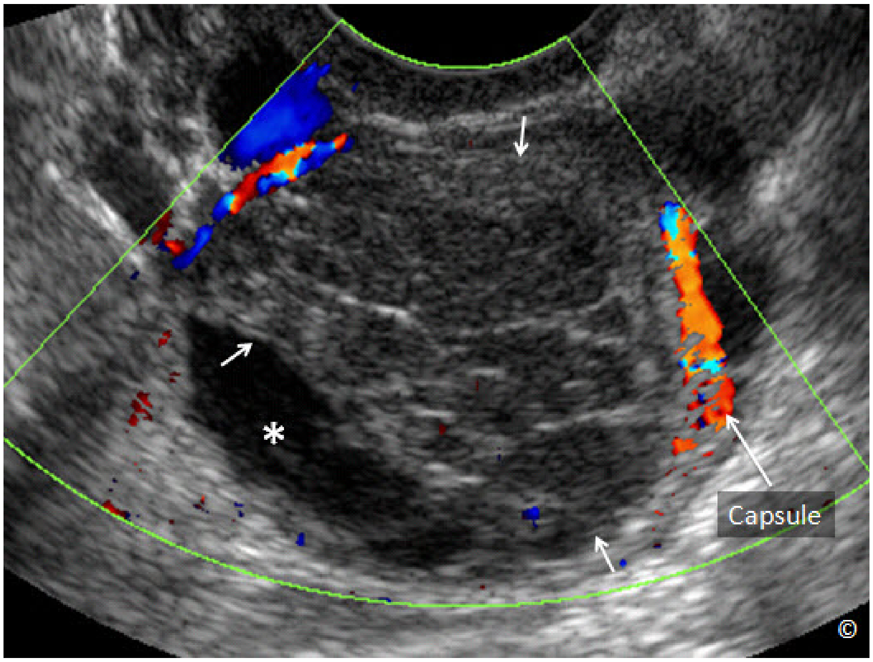


Figure 12.13: Transvaginal ultrasound with color Doppler of the hemorrhagic cyst in figure 12.11. Note the retraction of the blood clot (asterisk) with the development of a fluid layer. Color Doppler shows vascular flow in the capsule (labeled) but none within the blood clot (arrows).

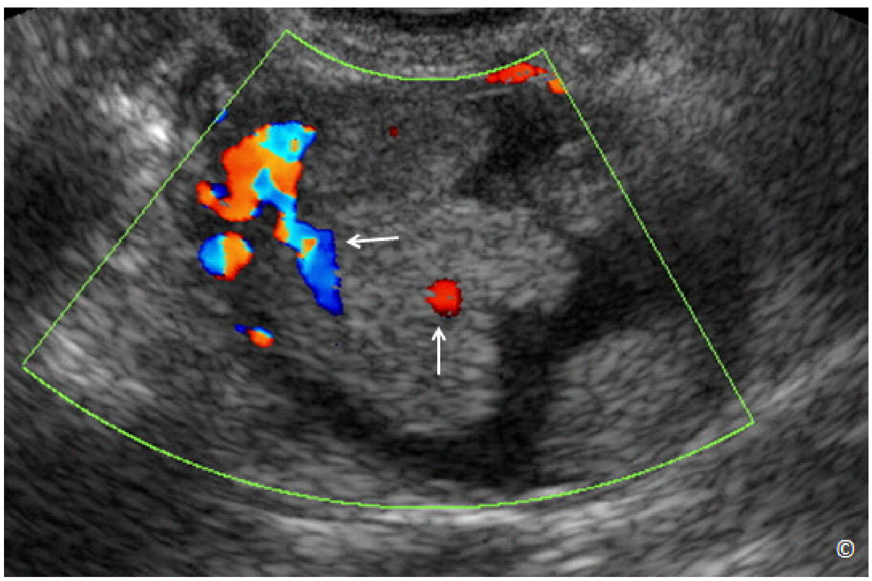


Figure 12.14: Transvaginal ultrasound with color Doppler of an ovarian cancer. Note the presence of multiple papillary projections. Color Doppler shows vascular flow within the papillary projections (arrows).

2) A blood clot within a hemorrhagic cyst tends to jiggle when probed by the transvaginal ultrasound transducer (**Clip 12.2**). Use this technique to confirm the content of a hemorrhagic cyst.
3) Blood clots within hemorrhagic cysts also tend to have broad bases (**Figure 12.12**) and the content tends to shift with patient repositioning.
4) The blood clot retraction typically results in a single mass of clotted blood within the cyst (**Figure 12.12**). The presence of multiple papillary projections (**Figure 12.14**) within a cyst therefore is more compatible with a neoplastic process.
5) Follow-up examination is also one of the most important tools to help in the differentiation. Given the important temporal change of hemorrhagic cysts; a follow-up ultrasound examination within 4-6 weeks should help in differentiating a hemorrhagic cyst from a borderline or malignant tumor. Hemorrhagic cysts tend to resolve and regress with time whereas solid adnexal masses of malignant origin tend to grow. **Table 12.2** lists the characteristics of a hemorrhagic ovarian cyst.

TABLE 12.2	Characteristics of an Ovarian Hemorrhagic Cyst
	- Excellent sound transmission - Thin Reticular lacy pattern - Temporal changes - Solid – Fluid level - Jiggles when probed - Absence of vascular signals on low-velocity color Doppler - Single mass of clotted blood when retracted - Follow-up shows resolution

ENDOMETRIOMAS

Endometriomas are thin walled "solid" appearing ovarian masses that are typically unilocular and have a characteristic "ground glass" appearance (**Figure 12.15**). They are commonly homogeneous and have low-level echoes with excellent sound transmission (**Figure 12.16**). Hyperechoic foci are commonly seen within endometriomas and are sometimes referred to as calcific stippling (**Figure 12.17**). Unlike hemorrhagic cysts, the sonographic appearance of endometriomas tends to remain stable over time. An endometrioma should not have any blood vessels within its content. The application of color Doppler at low velocity scales, around 5-10 cm / sec with low filter settings, for the demonstration of absence of vascularity within the endometrioma, is therefore an essential component of the diagnosis (**Figure 12.15** and **12.18**). The presence of vascularity on color Doppler in the setting of an endometrioma-like mass

(**Figure 12.19**) should raise suspicion for malignancy (endometrioid tumor) and a referral to expert sonography should be immediately performed. **Table 12.3** lists the sonographic characteristics of endometriomas.

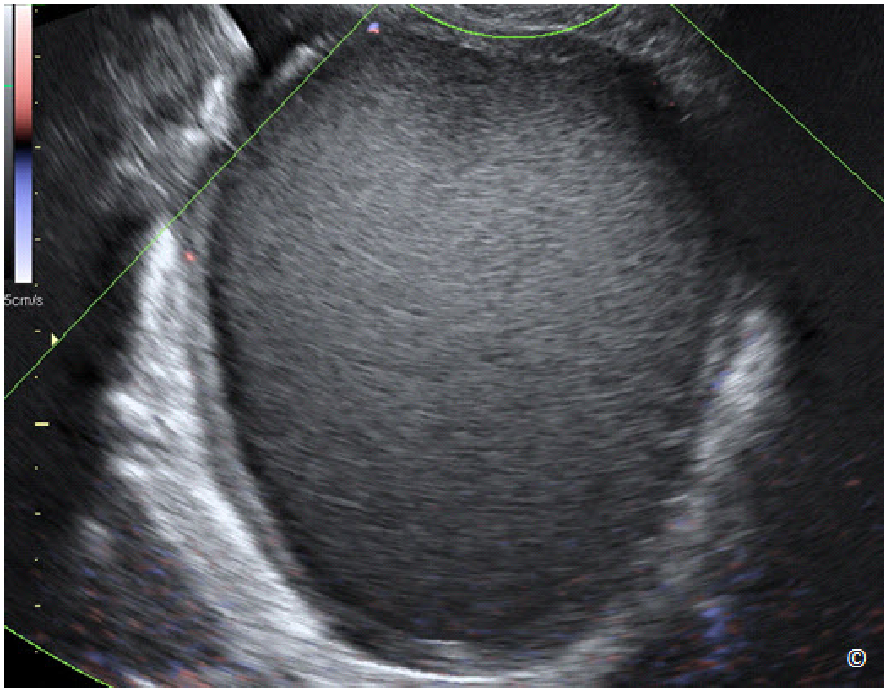


Figure 12.15: Transvaginal ultrasound with color Doppler of an endometrioma showing a unilocular mass with ground glass appearance. Note the absence of vascularity within the content of the mass on low velocity scale (5 cm/sec) color Doppler.

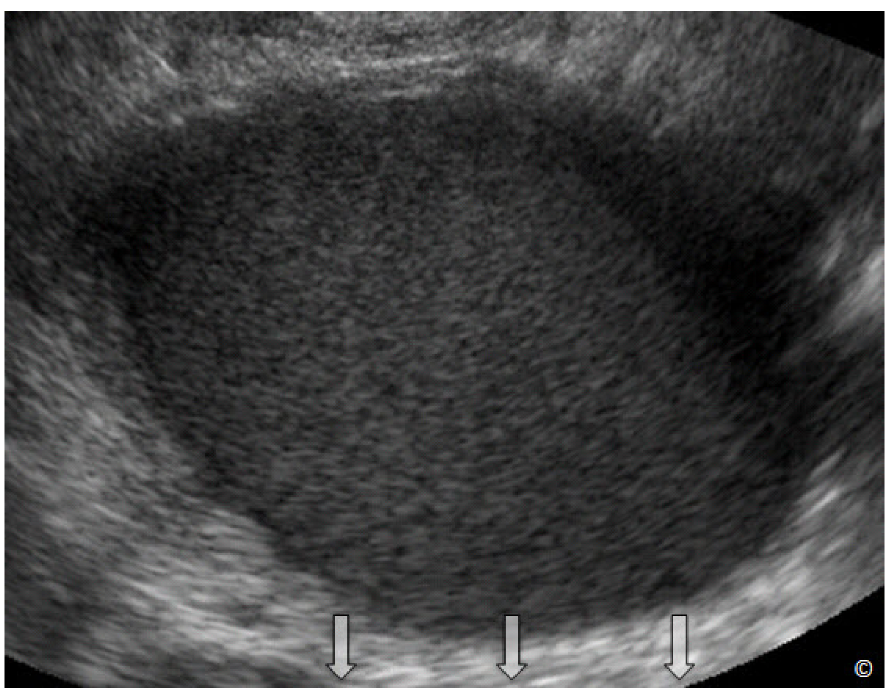


Figure 12.16: Transvaginal ultrasound of an endometrioma showing a unilocular mass with ground glass appearance and excellent sound transmission (arrows).

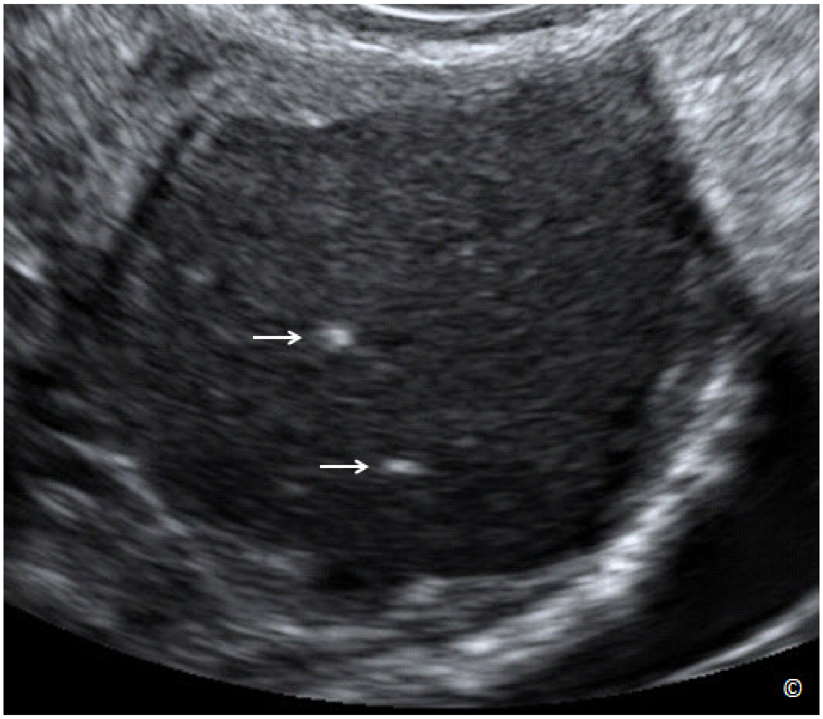


Figure 12.17: Transvaginal ultrasound of an endometrioma showing a unilocular mass with ground glass appearance. Note the presence of hyperechoic foci (arrows) that are also referred to as calcific stippling.

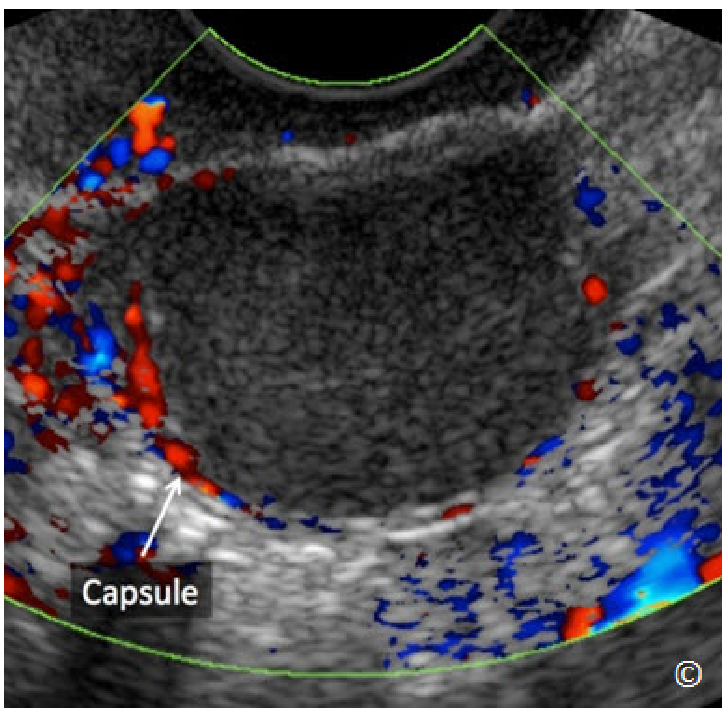


Figure 12.18: Transvaginal ultrasound with color Doppler of an endometrioma showing the absence of vascularity within the content of the mass on low-velocity color Doppler. Vascular flow can be demonstrated in the capsule (labeled).

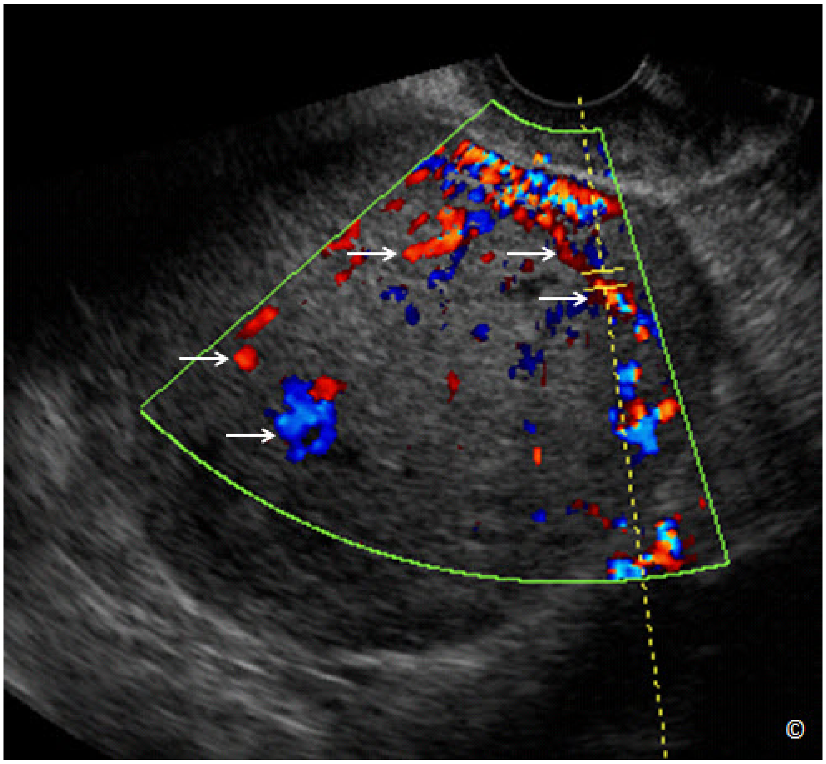


Figure 12.19: Transvaginal ultrasound with color Doppler of a solid mass that appeared similar to an endometrioma on grey scale imaging. Note the presence of extensive vascularity within the solid component (arrows). Pathologic examination revealed an endometrioid ovarian cancer.

TABLE 12.3	Sonographic Characteristics of Endometriomas
	- Excellent sound transmission - Homogeneous, ground glass appearance - Typically unilocular - No or minimal temporal changes - Hyperechoic foci - Absence of vascular signals on low-velocity, low-filter color Doppler settings

DERMOID CYST (MATURE CYSTIC TERATOMA)

Dermoid cysts, or mature cystic teratomas, originate from the ovarian germ cells. They affect younger age groups than epithelial tumors, are slow growing and are bilateral in about 10 % of cases. The most common sonographic appearance of a dermoid cyst is a complex, cystic and solid mass, with echogenic internal content that shadows extensively resulting in a "tip of the iceberg" effect (**Figure 12.20**). Characteristic features on ultrasound include a white echogenic "ball" which typically corresponds to the sebum and hair content of the dermoid, long and short echogenic linear strands which correspond to the hair in the fluid content of the cystic components, and significant attenuation of sound (**Figure 12.21 A and B**). The white echogenic ball is referred to as the Rokitansky nodule or dermoid plug (**Figure 12.21 A and B**). Dermoid cysts may be small and located within the ovary (**Figure 12.22**) or may assume different shapes and sizes (**Figure 12.23 A and B**). They tend to be located superiorly in the pelvis and thus on occasions may be outside the reach of the transvaginal transducer. The presence of excessive papillary projections within a dermoid cyst, in addition to the presence of vascularity on color Doppler evaluation, (**Figure 12.24**) should raise the suspicion for the presence of immature or neuronal elements within and thus appropriate referrals should be made. **Table 12.4** lists the sonographic characteristics of dermoid cysts.

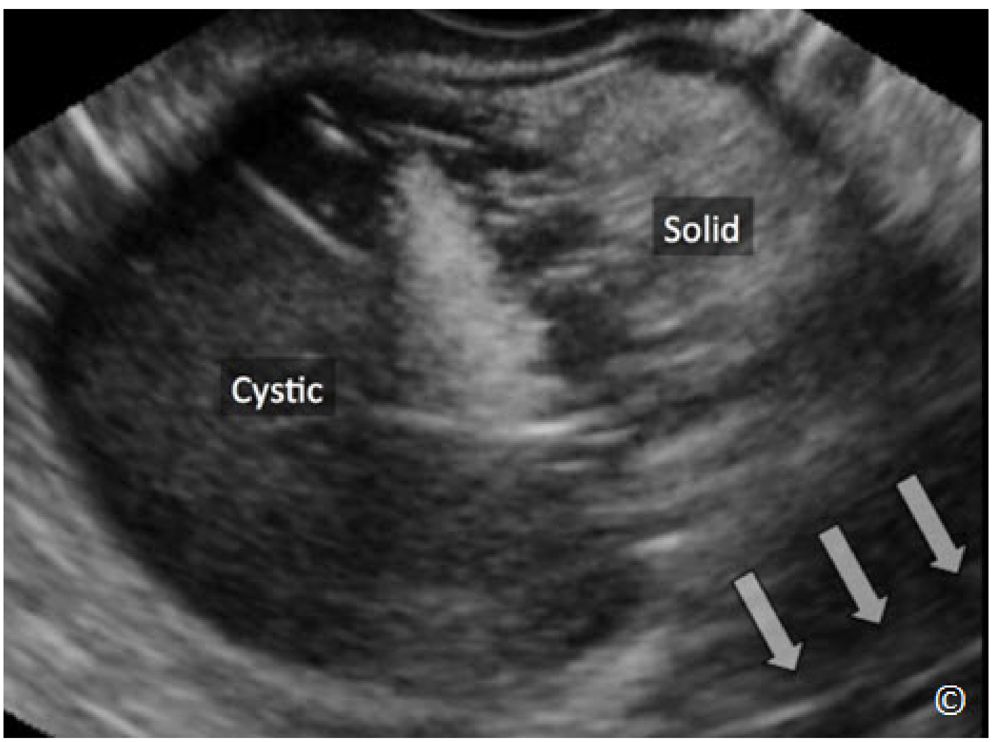


Figure 12.20: Transvaginal ultrasound of a dermoid cyst. Note the complex, cystic and solid content (labeled) with extensive shadowing (arrows). This has been compared to the "tip of the iceberg". See text for details

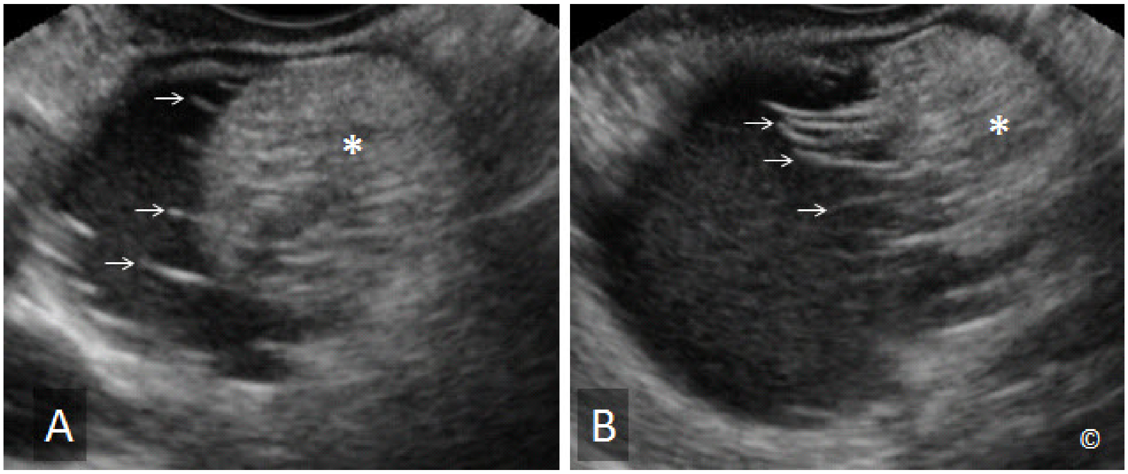


Figure 12.21 A and B: Transvaginal ultrasound of dermoid cyst A and B. Note the white echogenic "ball" (Rokitansky nodule) in A and B (asterisk). Note the long and short echogenic linear strands, which correspond to the hair content (arrows).

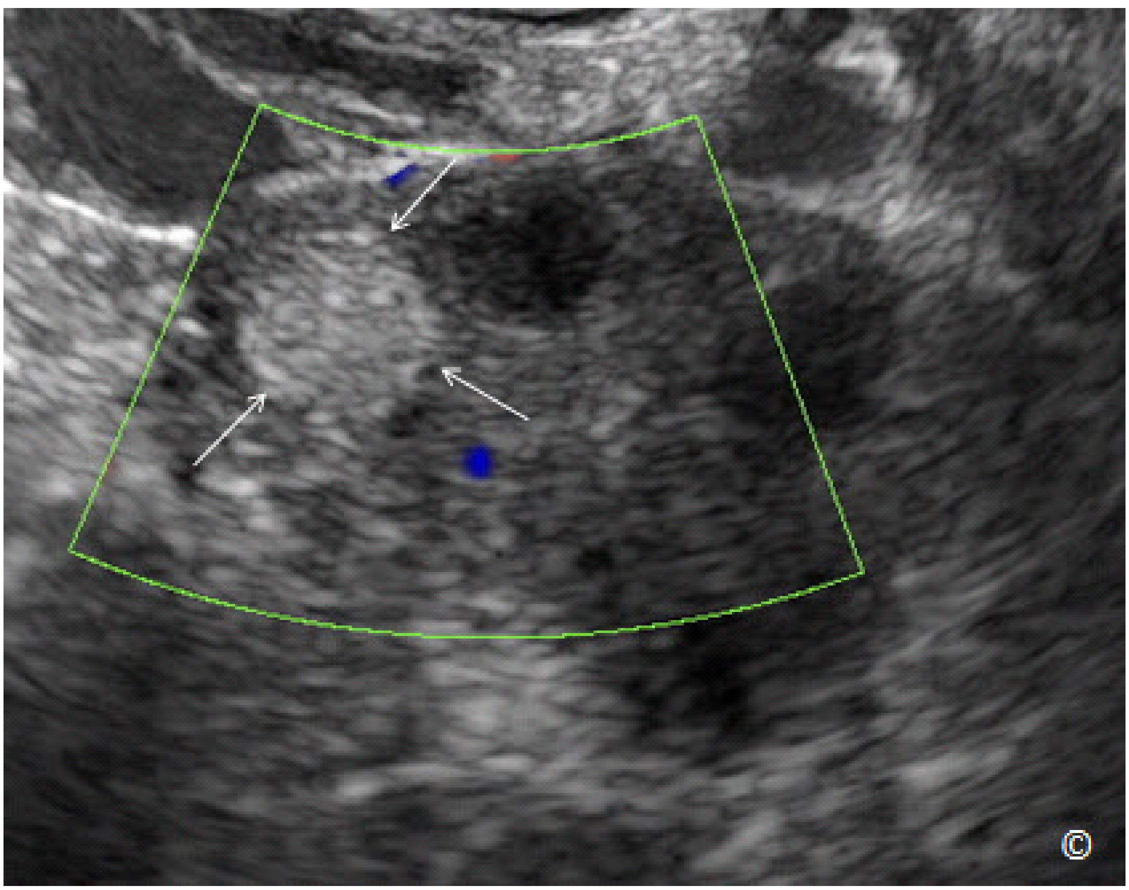


Figure 12.22: Transvaginal ultrasound with color Doppler of a small dermoid (arrows), located within the ovary.

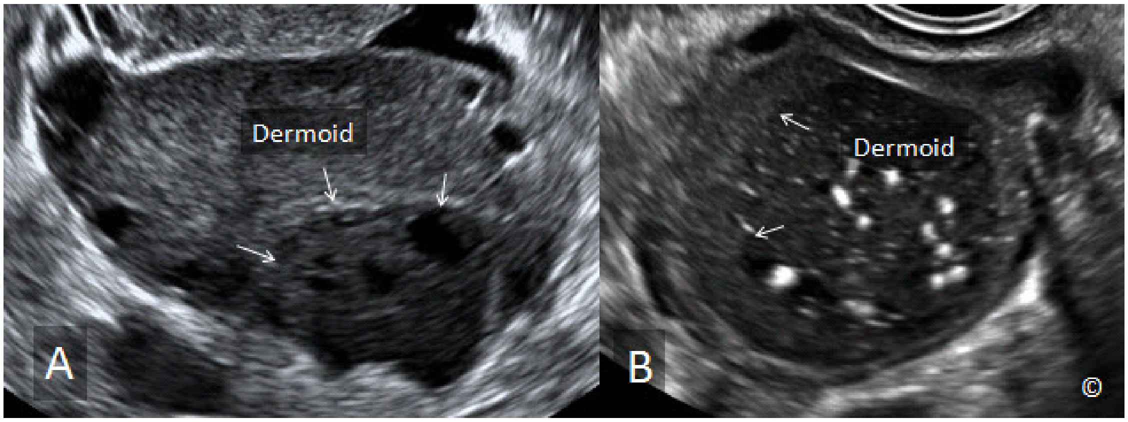


Figure 12.23 A and B: Transvaginal ultrasound of dermoid cysts in A and B. The dermoid cysts are labeled in A and B. The arrows point to normal ovarian tissue. In B, the dermoid is cystic with echogenic foci corresponding to the fat content within the fluid.

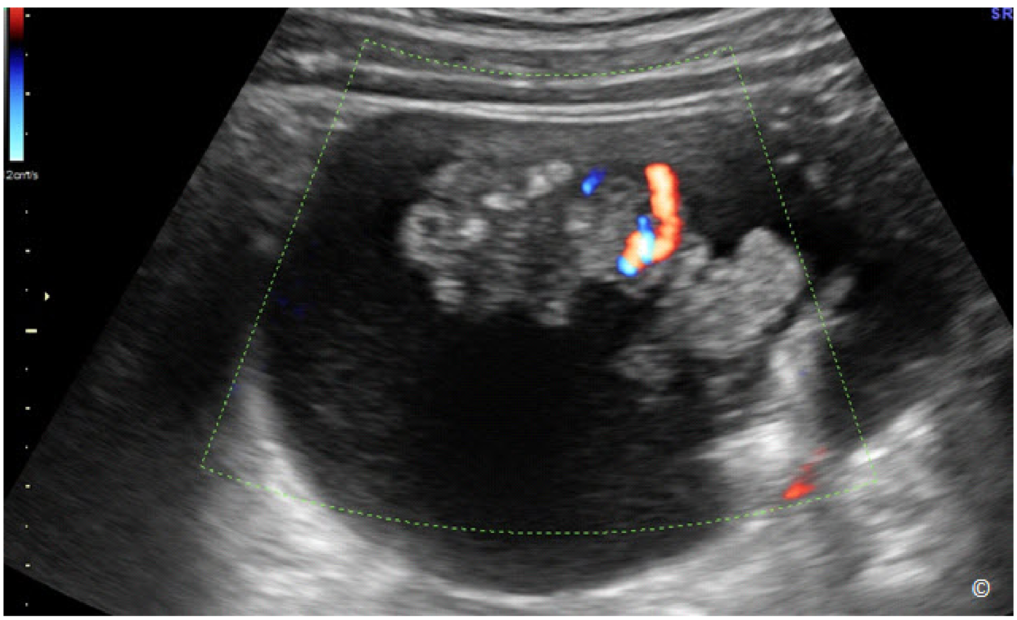


Figure 12.24: Transvaginal ultrasound with color Doppler of an immature teratoma with neuronal elements. Note the presence of papillary projections with vascularity noted on color Doppler.

TABLE 12.4	Sonographic Characteristics of Dermoid Cysts

- Poor sound transmission (tip of iceberg effect)
- Complex, solid tumors, heterogeneous content
- White echogenic ball (Rokitansky nodule)
- Thin linear strands
- Superior location in pelvis
- Absence of vascular signals on low-velocity, low-filter, color Doppler settings

PEDUNCULATED LEIOMYOMA – OVARIAN FIBROMA

Pedunculated leiomyomas are included in this chapter as they typically present as solid adnexal masses with extensive shadowing (**Figure 12.25**) and are commonly associated with a vascular pedicle that can be traced by color Doppler to the uterus. They are commonly round or oval with a regular striped echogenicity. Leiomyomas display a characteristic shadow pattern of the ultrasound beam described as "venetian blinds shadowing" (blinds that are partially open with the sun rays coming through) (**Figure 12.25**). This shadowing pattern is present in most leiomyomas and helps differentiate leiomyomas from other solid tumors. Identifying a separate normal ovary in the adnexal region, when a pedunculated leiomyoma is suspected, helps in confirming the diagnosis. The ovary should be freely movable and separate from the pedunculated leiomyoma thus insuring that the leiomyoma and the ovary are not anatomically attached (**Clip 11.1**). **Table 12.5** lists the sonographic characteristics of pedunculated leiomyomas. For more detailed discussion on leiomyomas, please refer to chapter 11.

An ovarian fibroma is a solid tumor that arises from the ovary and it shares several of the sonographic characteristics of a pedunculated leiomyoma (**Figure 12.26**). The ovarian fibroma however is an ovarian tumor and thus is not freely movable in the adnexa as it is attached to the ovary (**Clip 12.3**).

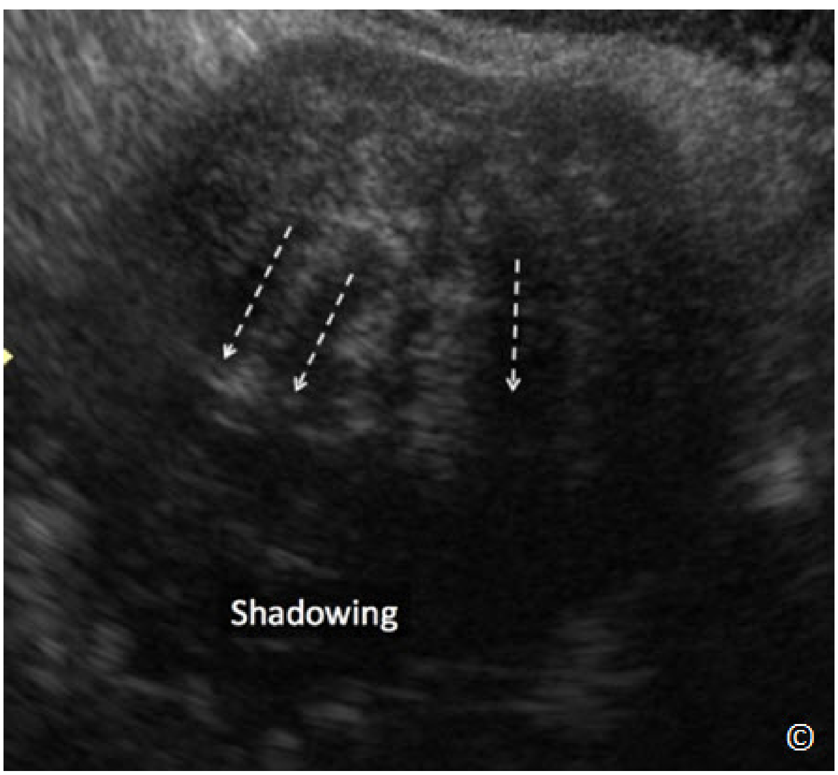


Figure 12.25: Transvaginal ultrasound of a pedunculated leiomyoma with the characteristic "venetian blinds shadowing" (dashed arrows). Note the extensive shadowing (labeled) on the posterior aspect of the leiomyoma.

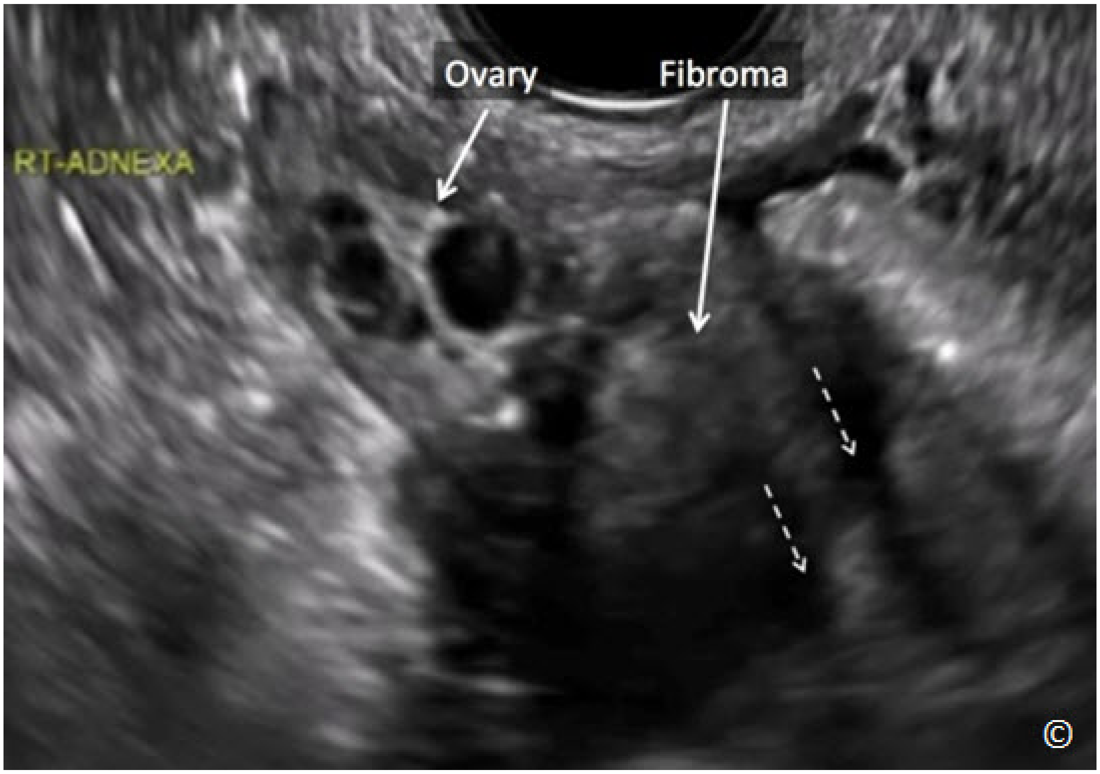


Figure 12.26: Transvaginal ultrasound of an ovarian fibroma. Note the characteristic "venetian blinds shadowing" (dashed arrows). The fibroma is attached to the ovary and does not move freely in the adnexa. See **Clip 12-3** for details.

TABLE 12.5	Sonographic Characteristics of Pedunculated Leiomyomas
	- Poor sound transmission - Solid tumors, regular striped echogenicity - Vascular pedicle to the uterus - "Venetian blinds shadowing" - Separate freely movable ovary

HYDROSALPINX

The normal fallopian tube is rarely seen on transvaginal ultrasound. When the tube is filled with fluid however, it is easily seen as a fluid-filled sausage-shaped structure, with thin walls, incomplete septations (**Figure 12.27**), and a cogwheel appearance on cross section. There is lack of peristalsis, a feature that differentiates the elongated fluid filled structure from bowel. Furthermore, the hydrosalpinx, with its elongated sausage-shaped structure tends to taper near its uterine origin. The presence of a tubular structure filled with clear fluid in the adnexal region should raise suspicion for a hydrosalpinx, especially when a separate ovary is seen. Hydrosalpinges are typically asymptomatic and are commonly seen in postmenopausal women. If the diagnosis of a hydrosalpinx is entertained, a follow-up ultrasound is helpful, as it typically shows no sonographic change in appearance. The application of three-dimensional ultrasound in inverse mode, if available, can confirm the diagnosis (**Figure 12.28**). **Table 12.6** lists the sonographic characteristics of a hydrosalpinx.

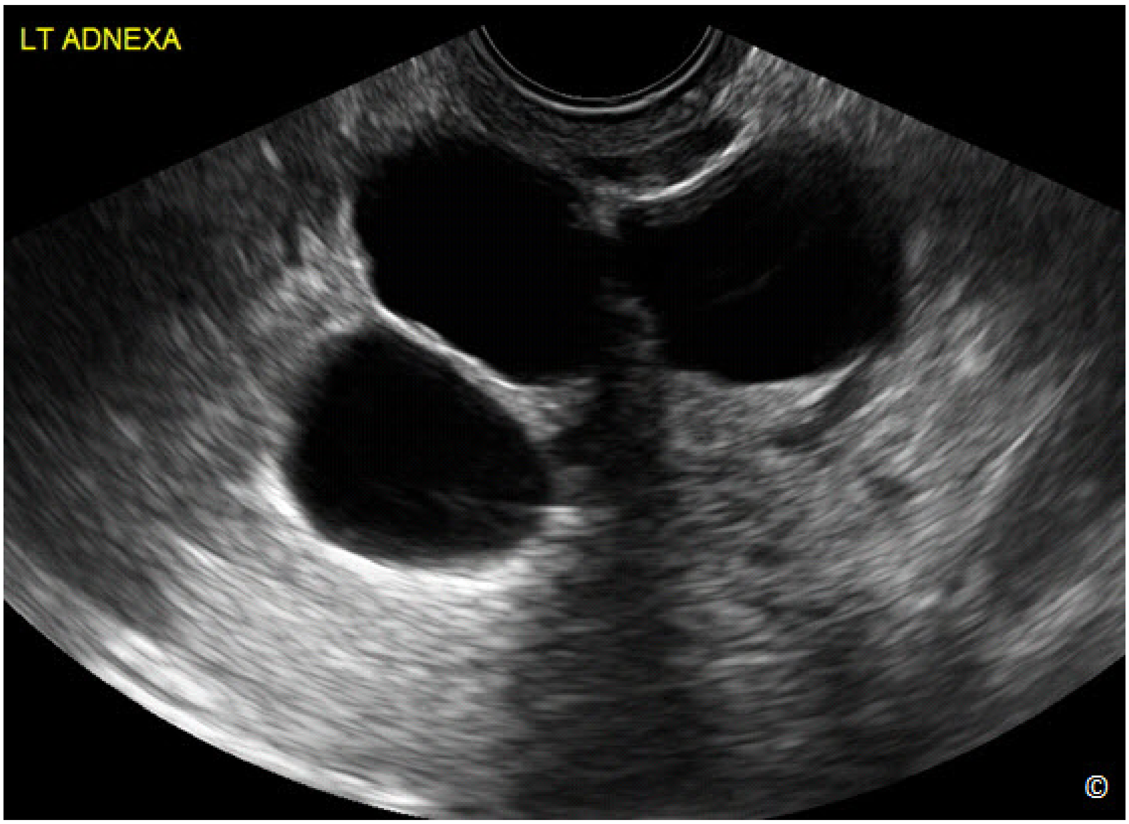


Figure 12.27: Transvaginal ultrasound of a hydrosalpinx. Note the presence of a tubular structure with thin walls and multiple septations.

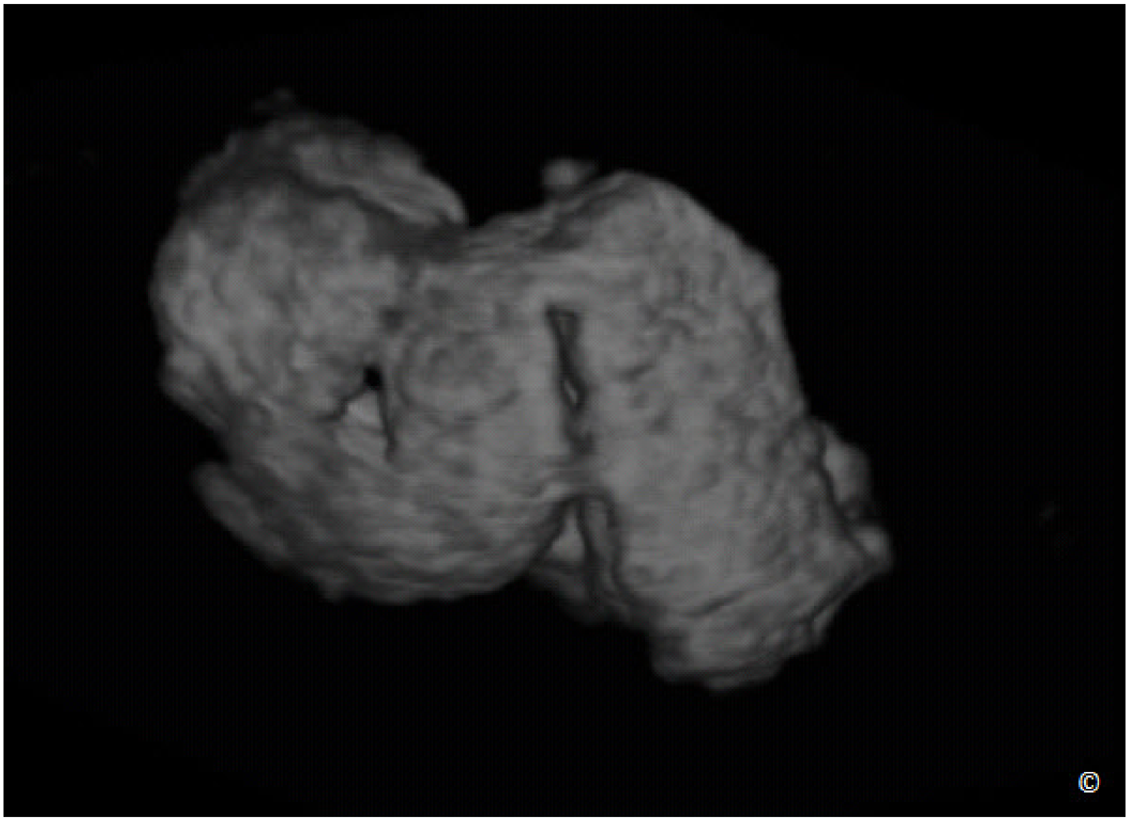


Figure 12.28: Three-dimensional ultrasound in inverse mode of the cystic mass in figure 12.26. Note the display on 3D of a folded tubular structure confirming the diagnosis of hydrosalpinx.

TABLE 12.6	Sonographic Characteristics of Hydrosalpinges
	- Fluid filled, sausage shaped structure - Structure tapers near the uterine origin - Thin walls - Multiple and incomplete septations - Absence of peristalsis - Cogwheel appearance on cross section

TUBO-OVARIAN ABSCESS

A tubo-ovarian abscess occurs when an ascending infection involves the tube and ovary as part of an acute process. Women are typically symptomatic with fever and pelvic pain and tenderness, but on occasions tubo-ovarian abscesses may be silent. The ultrasound characteristics include a multilocular mass with thick walls and thick incomplete septae that are filled with an echogenic fluid of ground glass appearance (**Figure 12.29**). The fluid content derives from the inflammatory process. The sonographic appearance may be similar to endometriomas, but endometriomas are more commonly unilocular in asymptomatic women and do not have incomplete septations. Differentiating a tubo-ovarian abscess from other pelvic abscesses may be difficult. The involvement of the ovary in the process is helpful in that differentiation. **Table 12.7** lists the sonographic characteristics of tubo-ovarian abscesses.

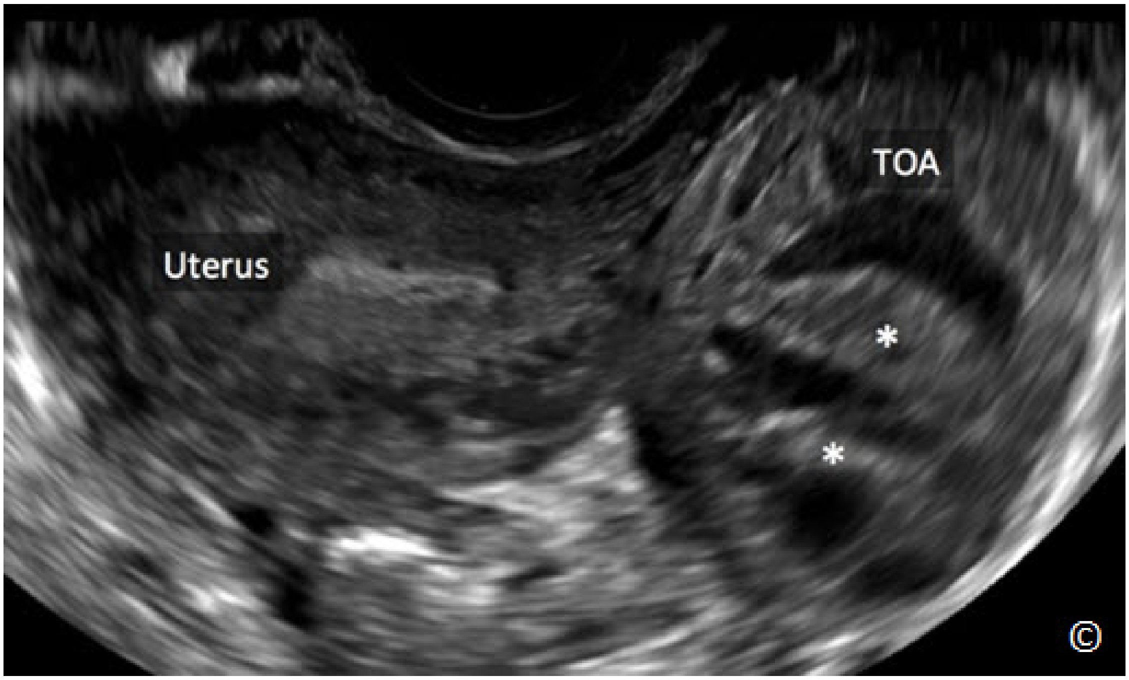


Figure 12.29: Transvaginal ultrasound of a tubo-ovarian abscess (TOA). Note the ovoid shape of the TOA, with thickened walls and septations (asterisks). The uterus (labeled) is noted adjacent to the TOA.

TABLE 12.7	Sonographic Characteristics of Tubo-Ovarian Abscesses
	- Multilocular mass with thick walls - Thick incomplete septae - Fluid content is echogenic, with ground-glass appearance - Involvement of the ovary

PERITONEAL INCLUSION CYSTS

Peritoneal inclusion cysts also referred to, as pseudocysts are cystic structures within the pelvis that entraps peritoneal fluid. These cysts primarily occur following pelvic surgery or infection and result from pelvic adhesions that entrap fluid. Ultrasound characteristics include multiple primarily thin (**Clip 12.4**), but occasionally thick septations that attach to pelvic organs such as the uterus, bowel and ovaries (**Figure 12.30**). The fluid content is typically clear and normal looking ovaries can be seen on occasions, which confirm the diagnosis (**Figure 12.30**). Peritoneal inclusion cysts are typically asymptomatic and women are commonly referred with the finding of a septated pelvic mass diagnosed on CT scan or Magnetic Resonance Imaging (MRI). Inquiring about the patient's surgical history is important, as pelvic adhesion from prior pelvic surgery is an etiological factor for peritoneal inclusion cysts. **Table 12.8** lists the sonographic characteristics of peritoneal inclusion cysts.

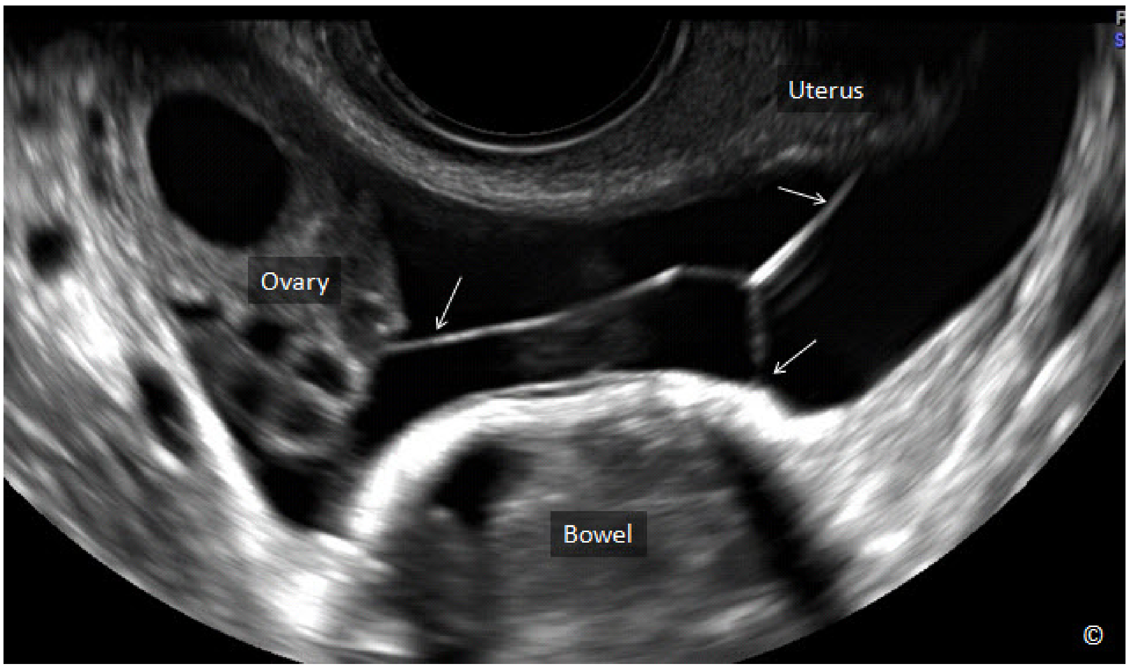


Figure 12.30: Transvaginal ultrasound of peritoneal inclusion cysts. Note the presence of multiple primarily thin septations (arrows) that entrap fluid and attach to pelvic organs such as the uterus, bowel and ovary (labeled).

TABLE 12.8	Sonographic Characteristics of Peritoneal Inclusion Cysts
	- Multiple primarily thin septations - Septations attach to pelvic organs - Fluid within the cysts is primarily clear - Normal looking ovaries can be occasionally seen

THE POLYCYSTIC OVARY

Polycystic ovary syndrome is a metabolic disorder that is characterized by menstrual disorders, such as anovulation, hyperandrogenism, infertility and a spectrum of metabolic abnormalities. The presence of polycystic ovaries, unilaterally or bilaterally, is part of the polycystic ovary syndrome but having polycystic ovaries is not a requirement for diagnosis. The morphologic criteria for the diagnosis of polycystic ovaries have changed throughout the years. Since 2003, most investigators have used a threshold of 12 follicles (measuring 2-9 mm in diameter) per ovary, with increased stromal echogenicity. An increase in ovarian volume at greater or equal to 10 ml has also been suggested. Recent data suggest a follicular number per ovary of 25 or greater for the diagnosis of polycystic ovaries when transvaginal ultrasound is used (1) (**Figure 12.31**). If transvaginal ultrasound is not available and transabdominal ultrasound is used, an ovarian volume of 10 ml or greater is then recommended for diagnosis (1). Finally, the finding of polycystic ovaries in ovulatory women not showing clinical or biochemical androgen excess may be inconsequential, even though there is a suggestion that this may represent the milder end of the polycystic ovary syndrome spectrum.

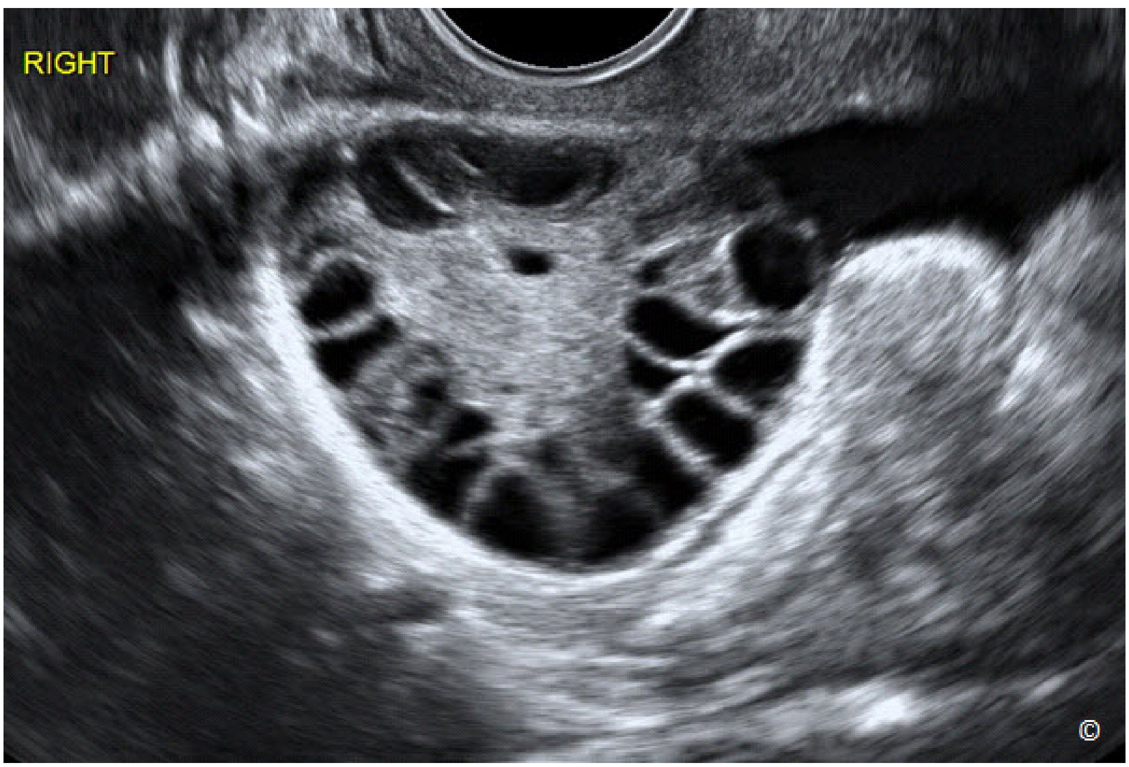


Figure 12.31: Transvaginal ultrasound of a polycystic ovary. The ovary is more spherical in shape and has an increased number of follicles that are situated in the periphery of the ovary. Note also the presence of increased stromal echogenicity.

BORDERLINE AND MALIGNANT ADNEXAL MASSES

Ultrasound evaluation of adnexal masses is primarily performed to differentiate benign from malignant lesions. Several common benign adnexal masses have sonographic characteristics (**Tables 12.1** to **12.8**) that allow the examiner to make the diagnosis with near certainty. Borderline and malignant adnexal masses also have certain characteristics that allow for a high index of suspicion. Sonographic characteristics of malignant adnexal masses are listed in **Table 12.9** and include irregularities in the capsule, thick septations, solid papillary projections (2) and vascularity seen on color Doppler evaluation. Purely cystic masses that are unilocular or even multilocular are overall benign with the exception of a large number of septae, which correlates with borderline mucinous tumors.

TABLE 12.9	Sonographic Characteristics of Borderline and Malignant Adnexal Masses
	- Irregularities in capsule and content - Thick septations - Solid content - Papillary projections - Vascularity on color Doppler

The use of pulsed Doppler in the evaluation of adnexal masses has been shown to be inaccurate due to high degree of overlap between benign and malignant masses, especially in premenopausal women (3). In postmenopausal women where ovarian angiogenesis is nonexistent, pulsed Doppler evaluation, looking for low impedance circulation and timed-average maximum velocity, has some predictive value (4). In the authors' experience, pattern recognition of grey scale ultrasound is still the most important in differentiating benign from malignant masses and the use of color and pulsed Doppler are adjuncts to grey scale evaluation. **Figures 12.32** to **12.36** show some borderline and malignant adnexal masses.

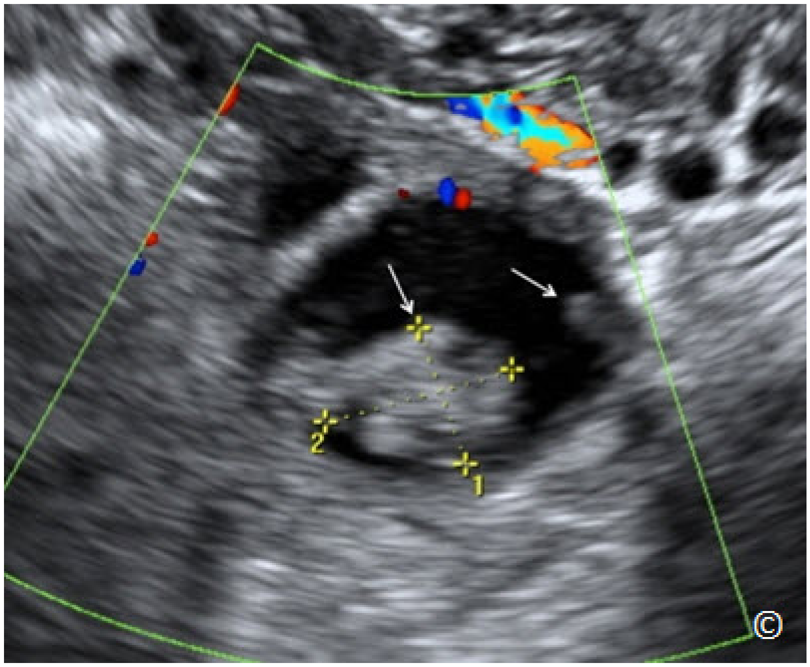


Figure 12.32: Transvaginal ultrasound of a borderline serous cystadenocarcinoma. Note the presence of papillary projections (arrows) in a small cystic mass.

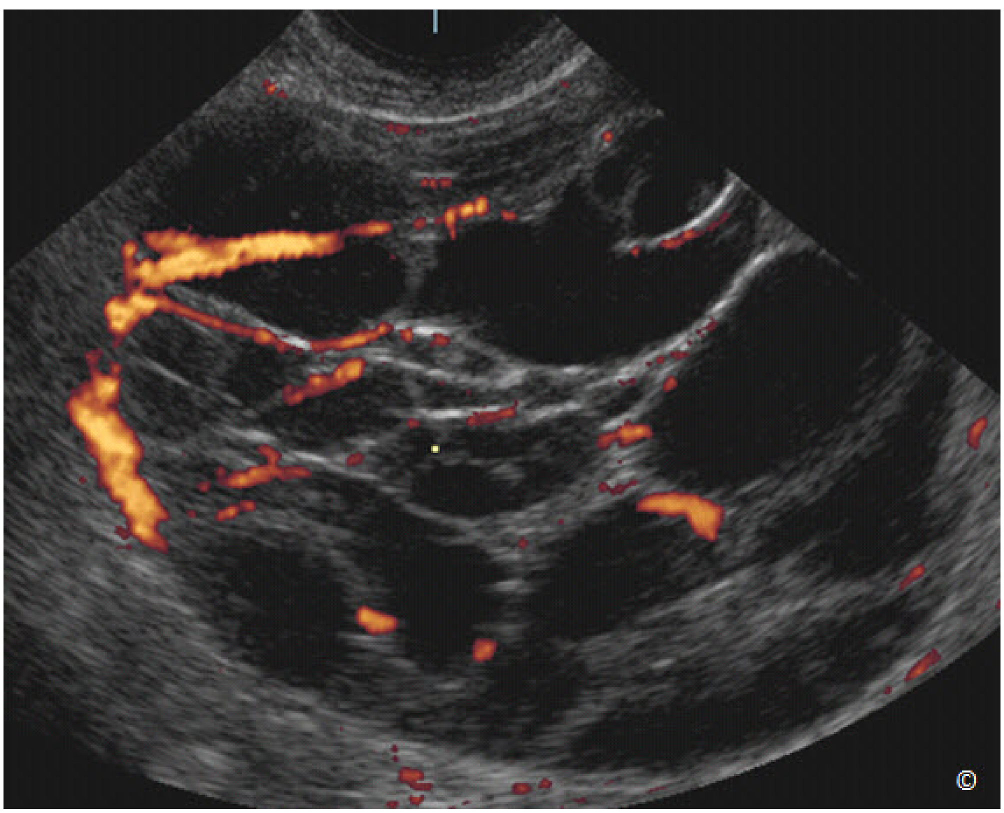


Figure 12.33: Transvaginal ultrasound with high definition color of a borderline mucinous cystadenocarcinoma. Note the presence of multiple thick septations with vascularity noted on high definition color Doppler.

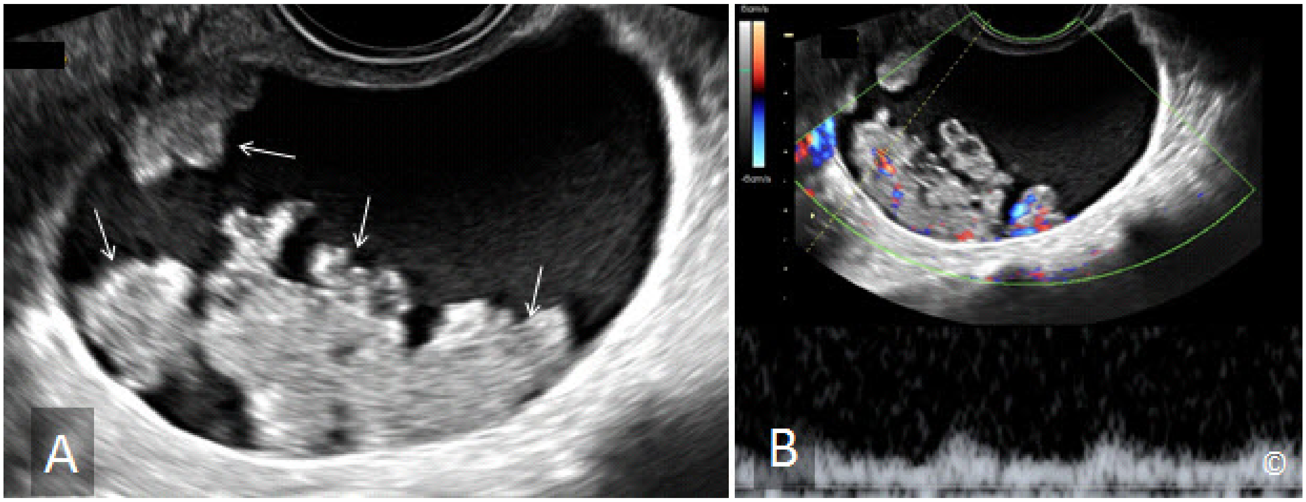


Figure 12.34 A and B: Transvaginal ultrasound of serous cystadenocarcinoma of the ovary. Note the presence of multiple papillary projections in A (arrows) and in B, color and pulsed Doppler shows vascularity within the papillary projections.

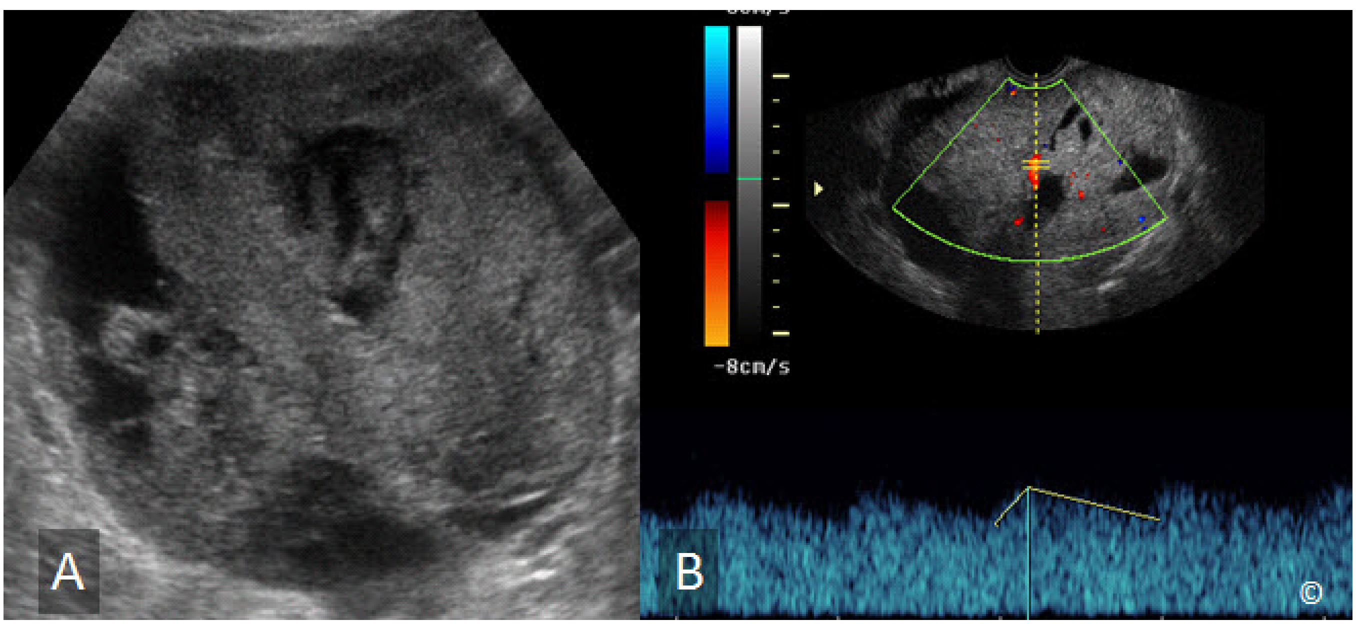


Figure 12.35 A and B: Transvaginal ultrasound of an endometrioid carcinoma of the ovary. Note the presence of a solid mass with thick septations in A and vascularity with low impedance flow in B on color and pulsed Doppler ultrasound.

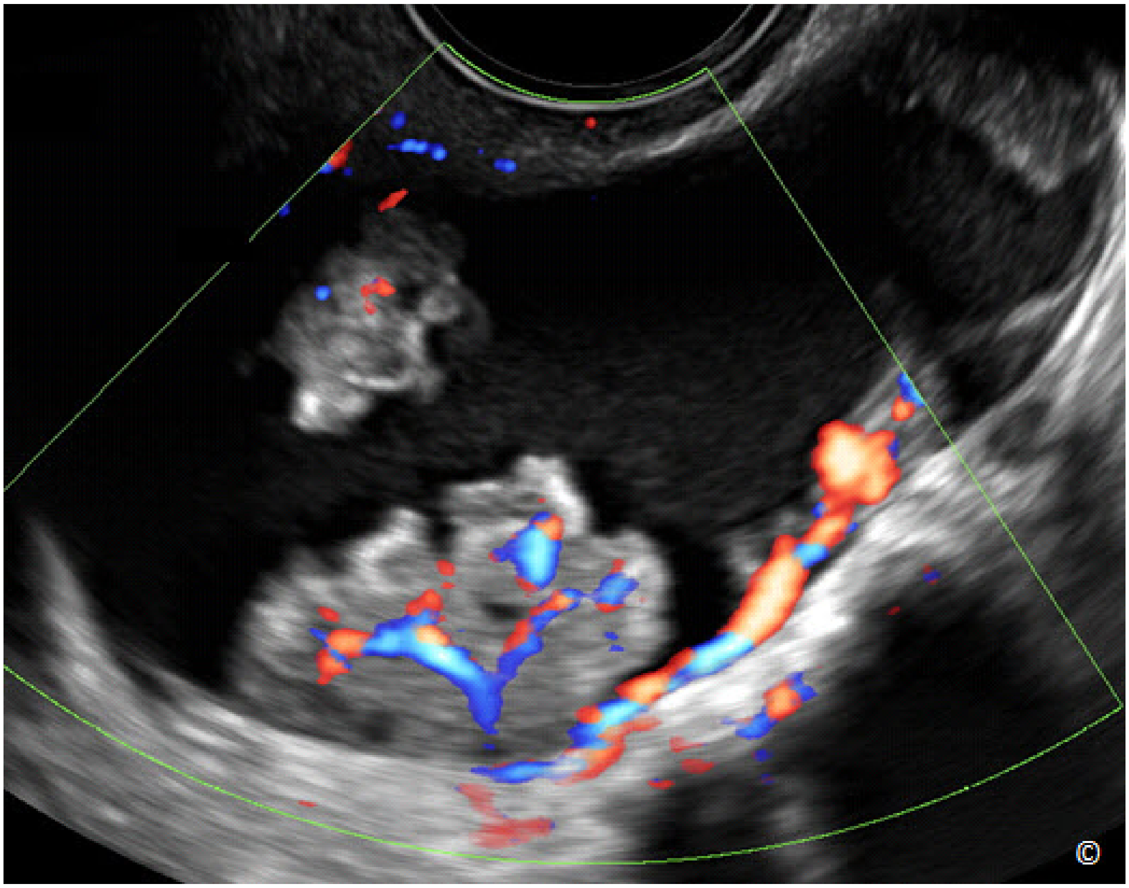


Figure 12.36: Transvaginal ultrasound of a serous cystadenocarcinoma of the ovary. Note the presence of papillary projections with vascularity noted on color Doppler.

ADNEXAL TORSION

Patients presenting with an adnexal torsion are typically symptomatic with acute pelvic pain and tenderness. It is a common gynecologic presentation in the emergency department. Although there are sonographic signs suggestive of the presence of adnexal torsion, ultrasound is not diagnostic of such entity and a high suspicion should occur based upon the presenting symptoms of the patient. Torsion results in obstruction of lymphatic and venous drainage of the ovary and tube and thus is commonly associated with an enlarged, edematous adnexal mass. Hemorrhagic infarction may occur and result in the presence of fluid with varying degrees of echogenicity. Color and Doppler ultrasound does not confirm or rule out the diagnosis, as significant variations with vascular occlusions exist. Intraperitoneal fluid may be present and is thought to result from transudate from the capsule of the ovary with lymphatic and venous obstruction. **Table 12.10** lists the sonographic characteristics of adnexal torsion.

TABLE 12.10	Sonographic Characteristics of Adnexal Torsion
	- Enlarged edematous adnexal mass - Cystic areas within the mass with varying degrees of echogenicity - Tender mass on probing with the transvaginal transducer

PREDICTION MODELS FOR OVARIAN CANCER

Several models have been developed to characterize adnexal masses on ultrasound in order to improve differentiation between benign and malignant tumors (5-7). One of the most widely used classification method is that by the International Ovarian Tumor Analysis (IOTA) (8). IOTA is a collaborative that standardized the approach to the ultrasound description of adnexal pathology (8). A prospectively collected large database tested prediction models like the IOTA risk of malignancy index (RMI) and showed excellent consistency and predictability of malignant pathology. Their test performance almost matches subjective assessment by experienced examiners, which is accepted to be the best way to classify adnexal masses prior to surgery. Simple rules, many of which have been discussed in this chapter, can be applied to classify tumors into benign or malignant (**Figure 12.37**). Alternatively, a logistic regression model can be adopted for that purpose. For more information on the IOTA classification, the readers are encouraged to review reference 8 in this chapter. Acquiring the expertise in the subjective ultrasound evaluation of adnexal masses, on the other hand, provides excellent differentiation between benign and malignant adnexal pathology.

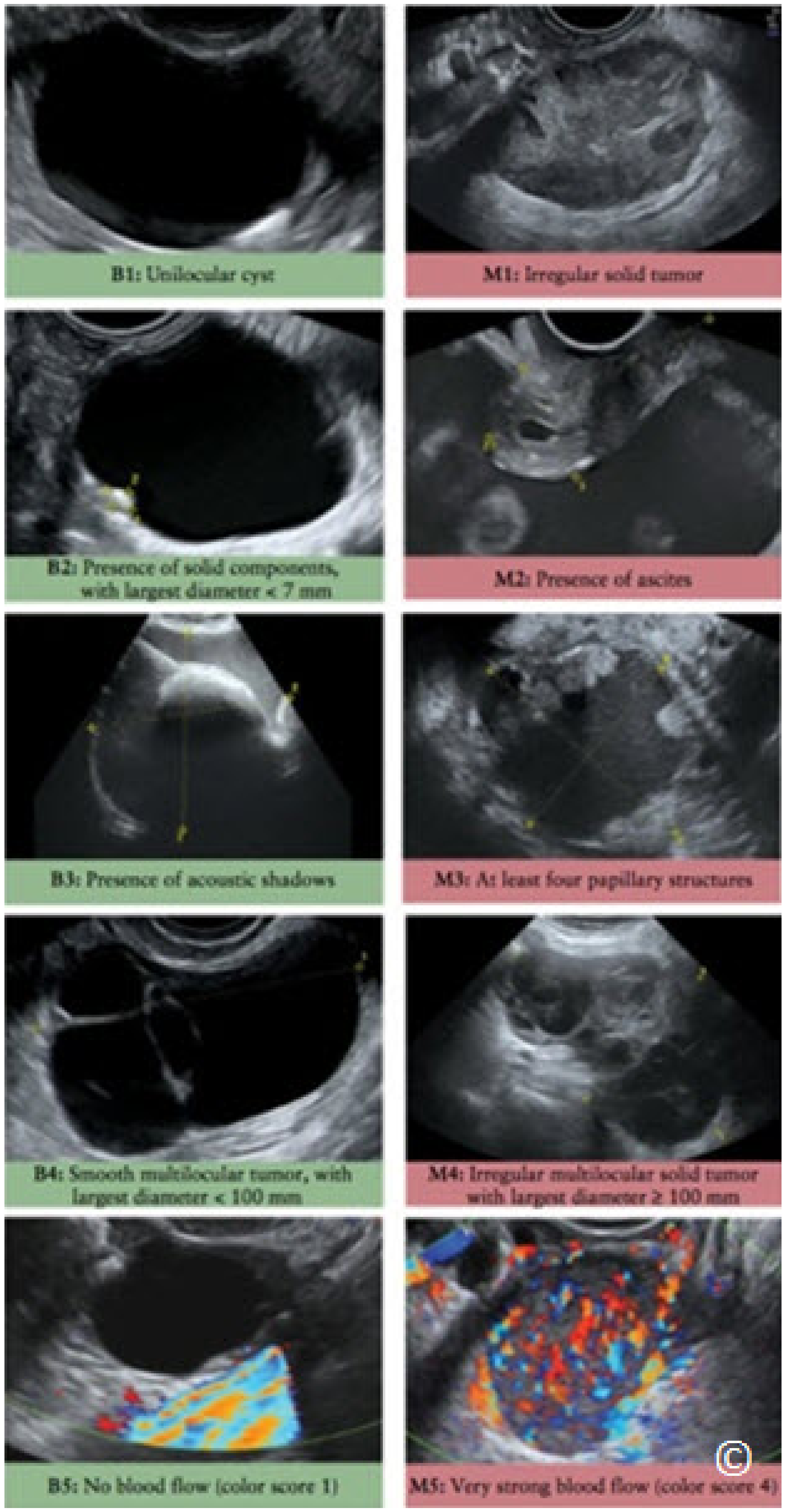
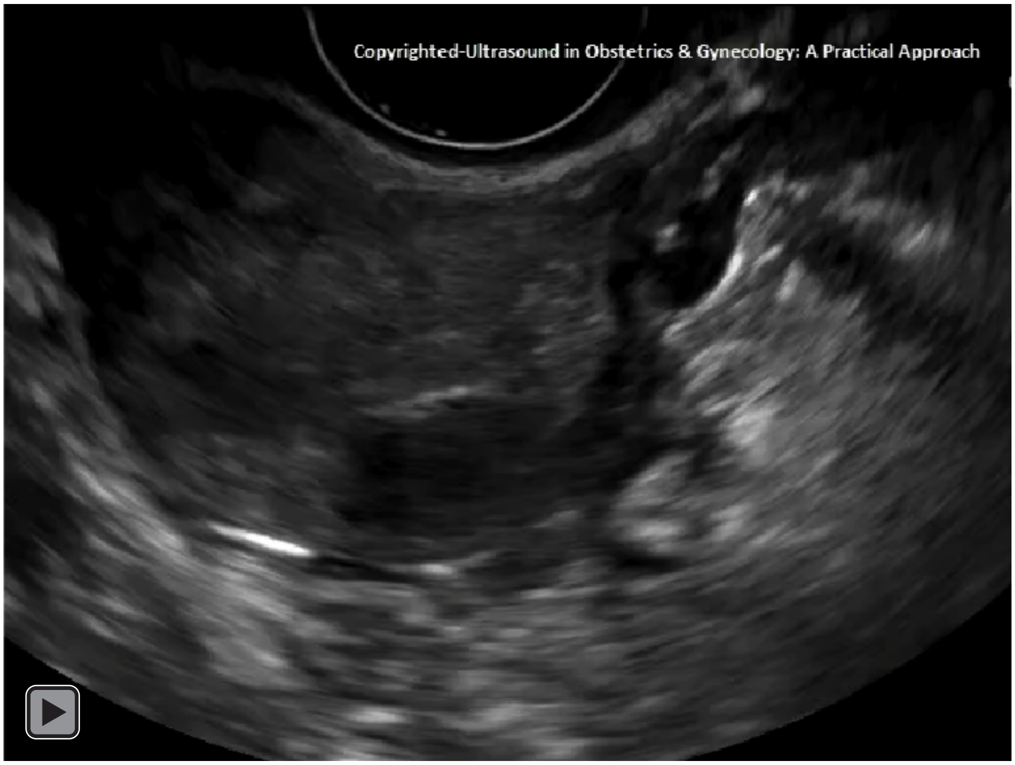
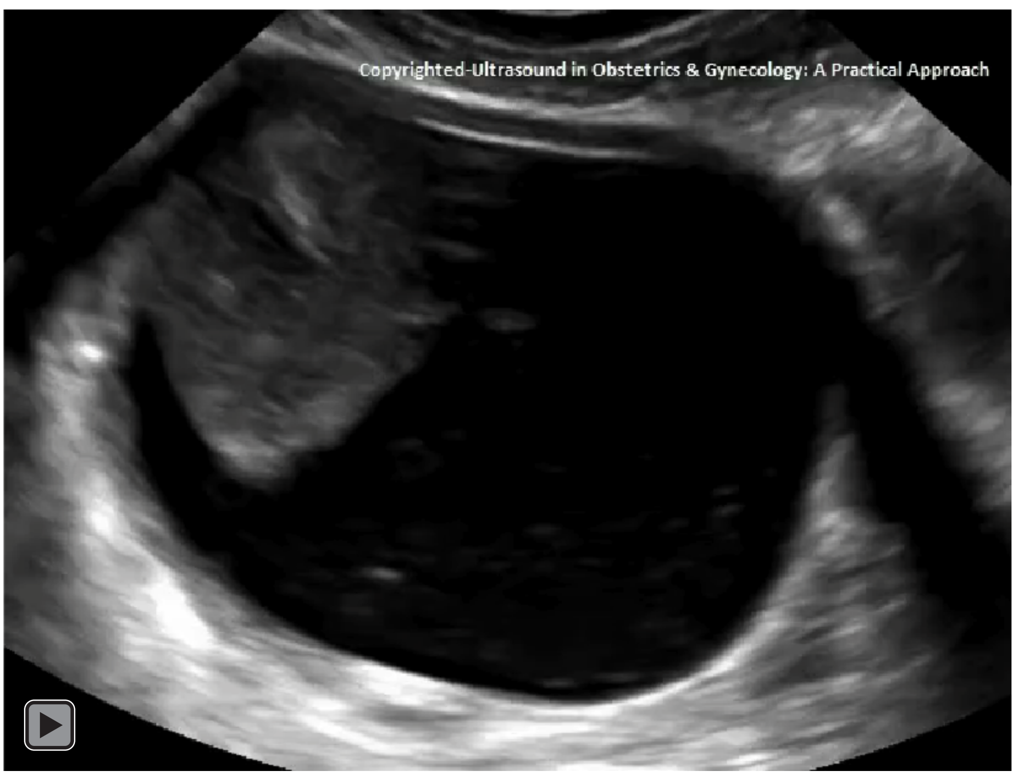


Figure 12.37: Ultrasound features used in the International Ovarian Tumor Analysis (IOTA) simple rules, illustrated by ultrasound images. B1–B5, benign features; M1–M5, malignant features. Reproduced with permission from reference 8.

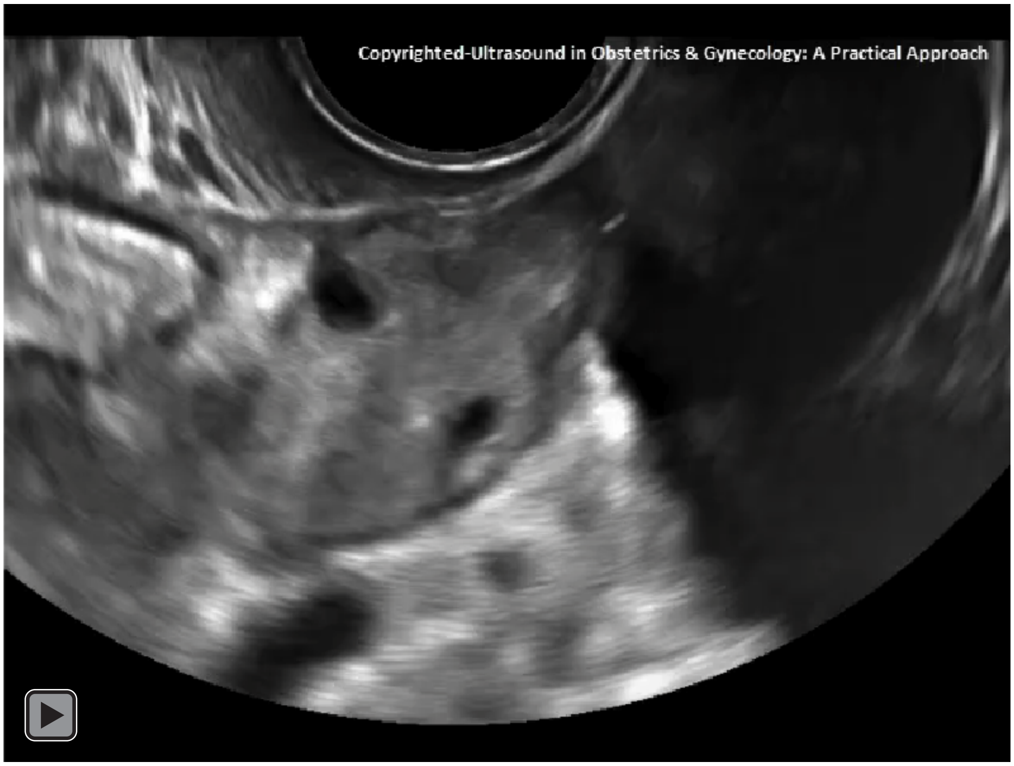
CLIP 12.1



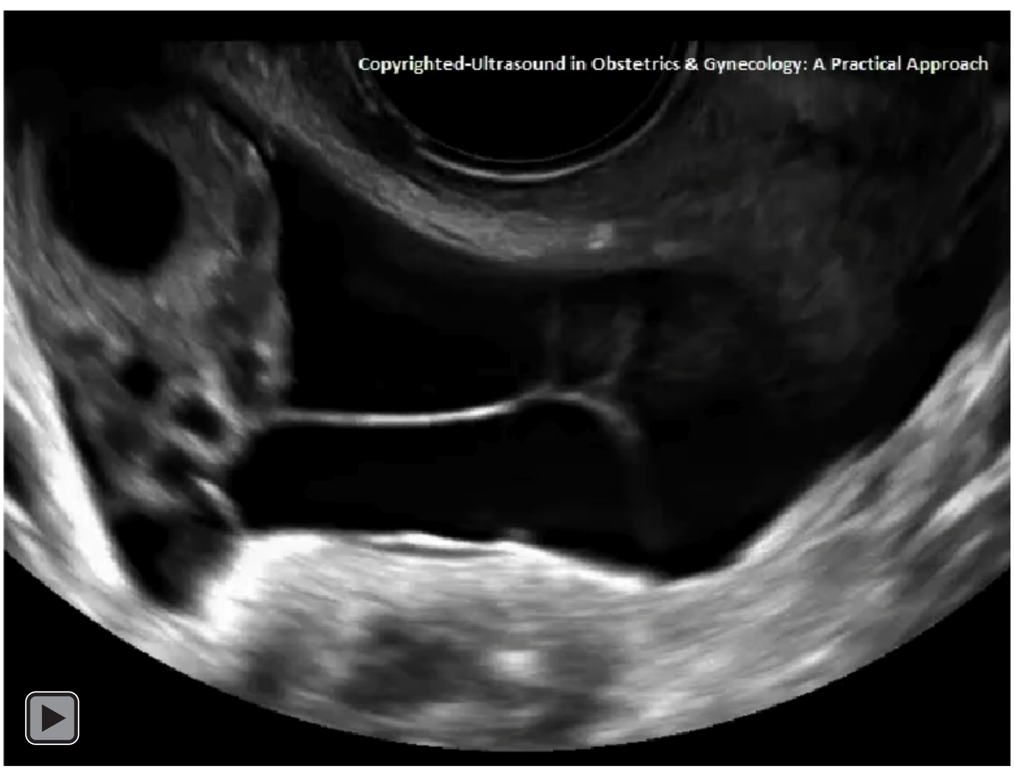
CLIP 12.2



CLIP 12.3



CLIP 12.4



References:

1) Dewailly D, Lujan ME, Carmina E, Cedars MI, Laven J, Norman RJ, Escobar Morreale HF. Definition and significance of polycystic ovarian morphology: a task force report from the Androgen Excess and Polycystic Ovary Syndrome Society. Hum Reprod Update. 2013 Dec 16. [Epub ahead of print]
2) Granberg S, Wikland M, Jansson I. Macroscopic characterization of ovarian tumors and the relation to the histological diagnosis: criteria to be used for ultrasound evaluation. Gynecol Oncol 1989;35:139
3) Tekay A, Jouppila P. Controversies in assessment of ovarian tumors with transvaginal color Doppler ultrasound. Acta Obstet Gynecol Scand 1996;75:316
4) Fleisher AC, Brader KR. Sonographic depiction of ovarian vascularity and flow: current improvements and future applications. JUM 2001; 20:241.
5) Mol BW, Boll D, De Kanter M, Heintz AP, Sijmons EA, Oei SG, Bal H, Bro¨lmann HA. Distinguishing the benign and malignant adnexal mass: an external validation of prognostic models. *Gynecol Oncol* 2001; **80**: 162 – 167.
6) Ferrazzi E, Zanetta G, Dordoni D, Berlanda N, Mezzopane R, Lissoni AA. Transvaginal ultrasonographic characterization of ovarian masses: comparison of five scoring systems in a multicenter study. *Ultrasound Obstet Gynecol* 1997; **10**: 192 – 197.
7) Aslam N, Banerjee S, Carr JV, Savvas M, Hooper R, Jurkovic D. Prospective evaluation of logistic regression models for the diagnosis of ovarian cancer. *Obstet Gynecol* 2000; 96: 75 – 80.
8) Kaijser J., Bourne T, Valentin L, Sayasneh S, Van Holsbeke C, Vergote I, Testa AC, Franchi D, Van Calster B and Timmerman D. Improving strategies for diagnosing ovarian cancer: a summary of the International Ovarian Tumor Analysis (IOTA) studies. *Ultrasound Obstet Gynecol* 2013; 41: 9–20.