

Gynecologic Imaging Reporting and Data System (GI-RADS) for revealing Ovarian Masses based on Ultrasonography

Rana Ibrahim Ali Hassan¹, Ahmed Sabry Ahmed Ragheb², Ahmed Mohammed AlaaEldeen³,
and Mohamed Ibrahim Amin⁴

¹M.B.B; Ch., Faculty of Medicine, Zagazig University.

² Professor of Radiodiagnosis, Faculty of Medicine, Zagazig University.

³Assistant Professor of Radiodiagnosis, Faculty of Medicine, Zagazig University.

⁴Assistant Professor of Radiodiagnosis, Faculty of Medicine, Zagazig University.

Corresponding author: Osama Gamal Abd Elhamid

Email: armn055@yahoo.com

Abstract

Background: The adnexal masses represent a variety of diseases, ranging from normal luteal cysts to ovarian cancer, from gynecological or non-gynecological origins. Transvaginal sonography (TVS) has turned into the first step imaging method for describing adnexal masses. Transvaginal ultrasonography is the initial method for detection of adnexal masses, it can visualize the deeper structures and even note the fine details of the organs like fallopian tube and ovary, also distinguish between benign and malignant lesions. Gynecologic Imaging Reporting and Data System (GI-RADS): is a new system based on BI-RADS for reporting findings in adnexal masses identified by TVS. Thick papillary projections, thick septa, solid areas with/without ascites, defined according to the International Ovarian Tumor Analysis criteria and vascularization within solid areas, papillary projections or central area of a solid tumor on Color or Power Doppler assessment are suggestive signs of malignancy.

Keywords: Ovarian Masses, Gynecologic Imaging Reporting and Data System (GI-RADS), Transvaginal sonography (TVS)

Normal Anatomy of the Adnexa

The uterine adnexa are ovaries, fallopian tubes and ligamentous attachments. The ovaries are usually present on either side of the uterus, fixed to the broad ligament and located in a shallow depression, called the (ovarian fossa) near to the lateral pelvic wall (1)

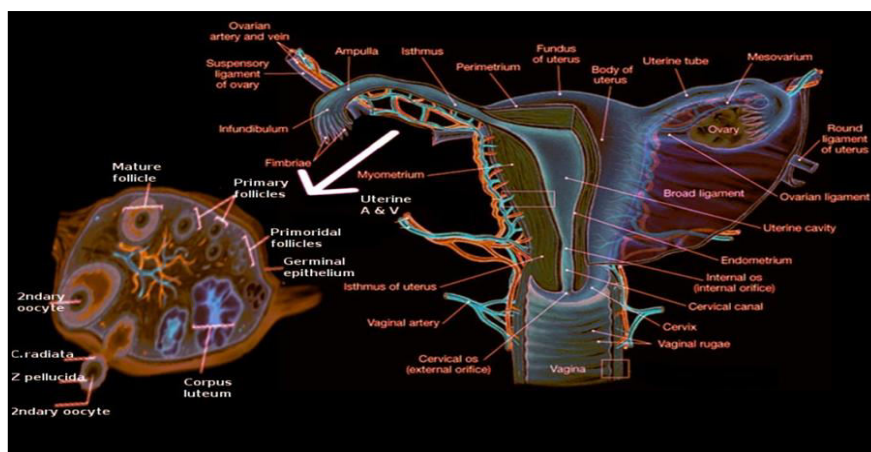


Figure (1): Show Ovary Anatomy (2)

A. Ovary:**Gross Anatomy:**

The normal ovary is 2 cm in width, 3.5 cm in length and 1 cm in thickness; this is comparable to the size of a golf ball. The volume of the ovary changes with females' age. A study found that 69% of changes in ovarian volume may be due to age, stage of menstrual cycle, hormonal changes. At two years old, the volume of the ovary averages 0.7 ml. The volume peaks at 7.7 ml at the age of 20. The volume then reduces gradually until the menopause, which averaged 2.8 ml. It is preferred to use the ovarian volume to obtain the ovarian size (3).

Microscopic anatomy:

The ovary's microanatomy begins with the external epithelium. This coating has a simple cuboidal and is referred to as the germinal epithelium. Below this layer is a connective collagen tissue that is known as the Tunica albuginea. The next part is called the cortex and the ovarian follicles. There you can see follicles of varying sizes and maturity. The medulla is the most central region. It is composed of loose connective tissue that includes essential blood vessels. this region is also called the hilus (4).

Blood supply of the ovary:

Anteromedially, the ovarian artery emerges in 80% to 90% of the cases from the abdominal aorta, some centimetres behind the renal arteries. The lumbar, adrenal or iliac artery seldom leads to an ovarian artery. Ovaries are supplied in 40 percent of cases with ovarian arteries, and 56 percent with uterine and ovarian arteries, and 4 percent with uterine arteries alone. Two veins from the plexus are joined to the ovary's artery by the ovarian veins, which form a plexus in the broad ligament. They unite higher up into a vein that opens to the inferior vena cava on the right and into the left renal vein on the left. (5).

Lymphatic drainage:

Drain along ovarian vessels to para -aortic nodes or through para -uterine vessels to iliac nodes (6).

B. Fallopian tubes**Gross anatomy:**

The fallopian tubes extend from the ovaries to the uterus which transports the ovum. The fallopian tubes are located on the upper edge of the broad ligament and have a length of 10 to 12 cm and a width of 1 to 4 mm. The mesosalpinx formed by the peritoneal reflection over the salpinges. The fallopian tubes extend anteriorly into the peritoneal cavity from the posterosuperior aspect of the uterine fundus. They are composed of four segments (from the medial aspect to the lateral aspect): the intramural (uterine and interstitial) portion, the isthmus, the ampulla, and the infundibulum at the fimbriated end. Throughout its extra-uterine course, the tube lies in a peritoneal fold along the superior margin of the broad ligament, the mesosalpinx (7).

Blood supply of the Fallopian tubes

The blood supply to the Fallopian tube is through the ovarian vessels, although anastomoses with ascending branches of the uterine artery occur within the broad ligament (8).

Lymphatic drainage:

The lymphatic drainage of the tube follows that of the ovary into the para-aortic nodes (8).

Ultra-sonographic (US) imaging of ovarian masses

Transvaginal ultrasonography (TVS) is the initial method for detection of adnexal masses, it can visualize the deeper structures and even note the fine details of the organs like fallopian tube and ovary, also distinguish between benign and malignant lesions. Most of adnexal masses are benign. The TVS also can characterize adnexal lesions, suggesting the etiology of the mass. The mass may be solid, cystic or complex (9).

Table (1): Presents simple US characteristics developed by the International Ovarian Tumor Analysis (IOTA) group. These simple rules can be used to characterize adnexal masses as benign or malignant (10)

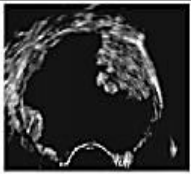
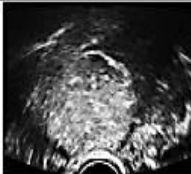
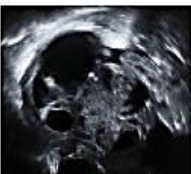

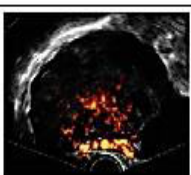
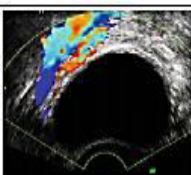

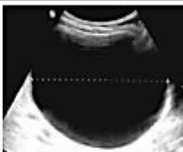

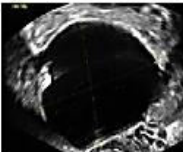
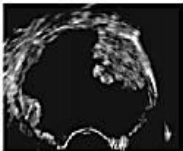

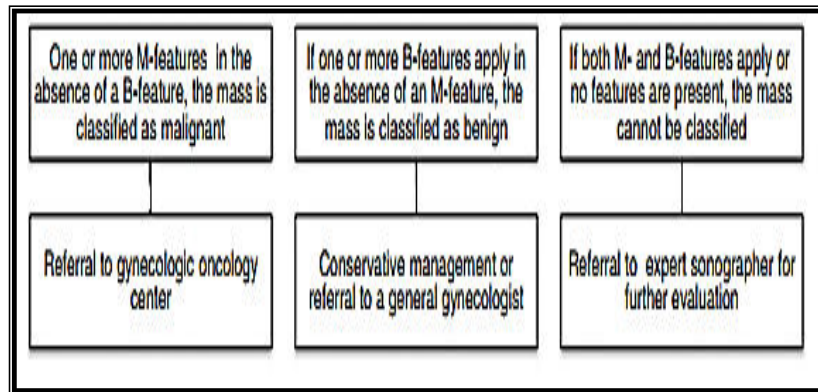
> 4 papillary structures		Presence of acoustic shadows	
Irregular multilocular solid tumor with largest diameter > 100 mm		Smooth multilocular tumor with largest diameter < 100 mm	
Increased blood flow		No blood flow	

Table (2): Showing ultra-sound features suggestive of benignity and malignancy (10):

Malignant features (M-features)		Benign features (B-features)	
Irregular solid tumor		Unilocular	
Presence of ascites		Presence of a solid component, largest solid component has a diameter of 7 mm	
> 4 papillary structures		Presence of acoustic shadows	



Ultrasonographic features of ovarian pathology:

A. Functional cysts:

1) Simple Cyst:

It is anechoic lesion more than 3 cm with posterior acoustic shadowing. It has a thin, smooth wall, unilocular with no solid or vascularized component. Most of them are follicular cysts that occur in premenopausal women and resolve within 1-2 months (11).

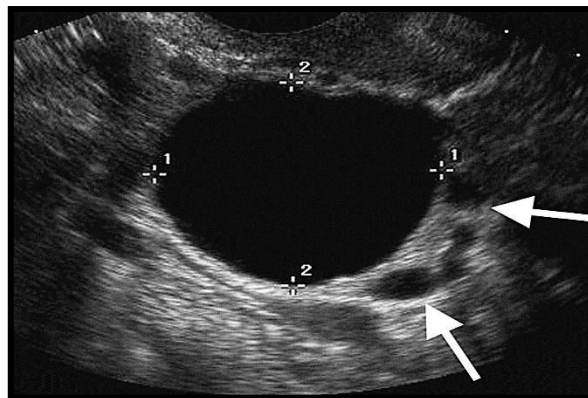


Figure (2): Simple ovarian cyst in a 29-year-old woman. Transvaginal US scan reveals a 3.5-cm simple ovarian cyst (calipers). Normal-appearing ovarian tissue (arrows) with a few follicles around the periphery confirms the ovarian origin of the cyst (12).

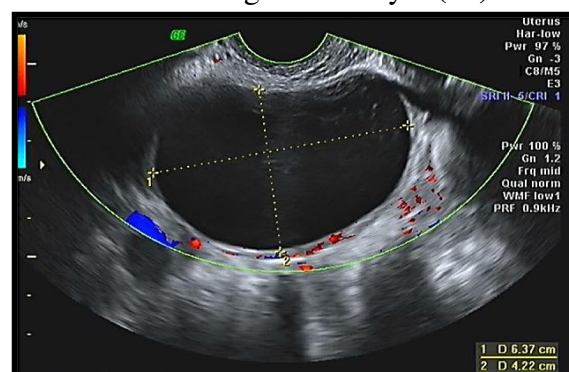


Figure (3): Transvaginal ultrasound in a 25-year-old woman shows a simple cyst with no vascularity (11).

2) Corpus Luteum:

It is a physiologic structure, sometimes appearing as a cystic mass with a thin, granular wall and inner echoes or a fragile iso-echoic or minimal hypo-echoic solid surface due to bleeding or thickening of the wall. Doppler US often reveals hypervascularity around the periphery while the corpus

luteum is normally centrally avascular, also called "a ring of fire (13).

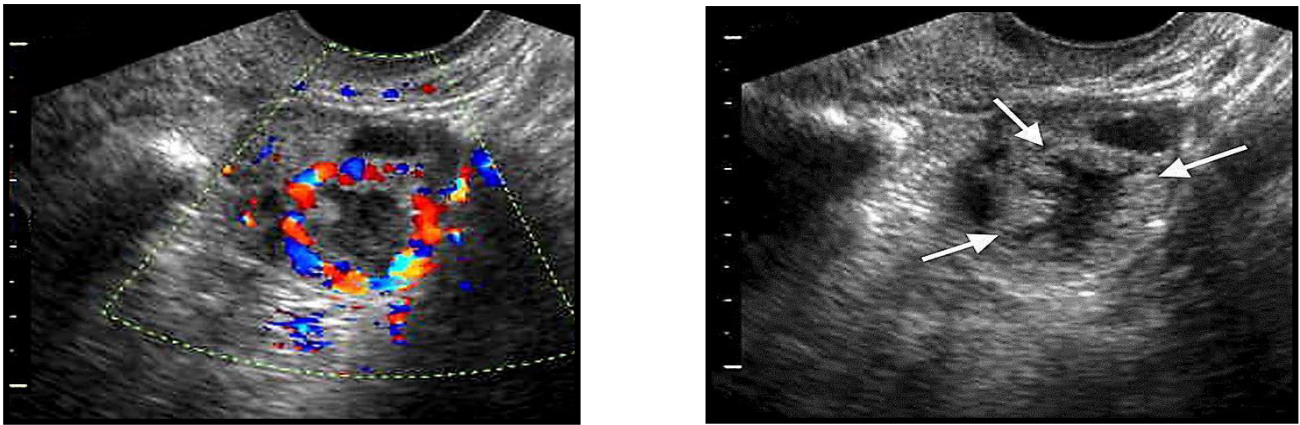


Figure (4): Corpus luteum in a 35-year-old woman. (a) Transvaginal US scan demonstrates a typical appearance of a corpus luteum within the ovary. It has a slightly thick, crenulated wall (arrows) and a small cystic center. (b) Color Doppler US scan shows abundant flow in the wall of the corpus luteum (12).

3) Theca lutein cyst:

It is a functional ovarian cyst occur due to elevated level of Beta-HCG, so it is associated with gestational trophoblastic disease, it is characterized by bilateral enlargement of both ovaries with thin-walled cysts and clear content (14).

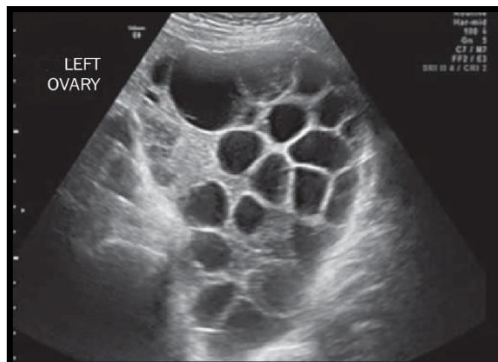


Figure (5): Pelvic ultrasound showing a massive theca lutein cyst in a patient with complete hydatidiform mole (15).

4) Hemorrhagic Cyst:

This cyst is formed when bleeding occur in corpus luteum. A clear prediction for a hemorrhagic cyst is a reticular nature of internal echoes due to fibrin strands. This pattern was also known as spider web. It may contain clot which simulate a solid area but without vascularity. Follow up is needed in postmenopausal woman and in premenopausal woman if the cyst >5cm (16).

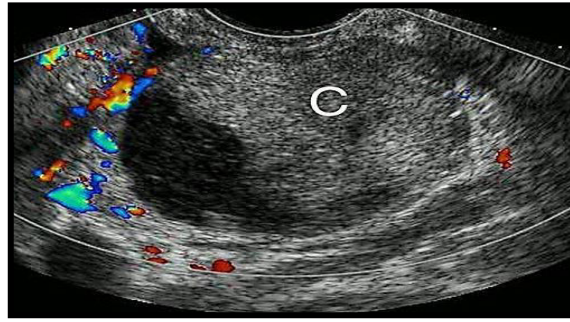


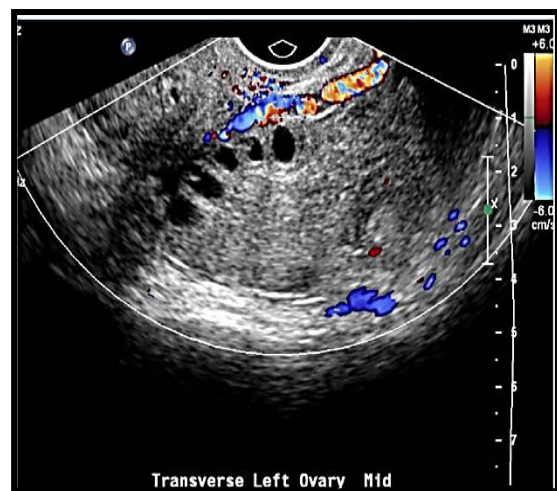
Figure (6):Subacute hemorrhagic cyst in a 37-year-old woman. Color Doppler transvaginal US scan shows a complex ovarian cyst with a solid area due to a clot (C). This could be mistaken for the solid area of a neoplasm. No flow was evident within the solid-appearing area and the cyst resolved at follow-up US 2 months later (12).

5) Ovarian Torsion:

It is an emergency case. It occurs due to rotation of the ovary along its pedicle. TVS shows unilateral enlarged ovary containing one or more large cystic follicles at the periphery, with variable echogenicity. It may show whirlpool sign which is a direct sign, it occurs due to twisting of vascular ovarian pedicle with or without flow. Color Doppler may show absence of both arterial and venous flow or absence of venous flow and persistent high resistant arterial flow. Normal blood flow doesn't exclude ovarian torsion due to dual blood supply of the ovary (16).



(A)



(B)

Figure (7): A case of 37 years old female with lower quadrant pain. (A) Gray scale ultrasound shows enlarged ovary with peripherally located follicles and heterogeneous parenchyma. (B) Color Doppler show complete lack of parenchymal of blood flow (17).

Inflammatory:

6) Tubo ovarian abscess/mass:

It results from pelvic inflammatory disease. There are changes in architecture of one or both adnexa, it appears as multilocular complex mass with internal echoes the ovary is separated, enlarged and edematous, thickness of fallopian tube wall exceeds 5 mm with incomplete septation is seen, also cul-de-sac contain fluid. In case of abscess there is heterogeneous hypoechoic mass with moving internal echoes. There may be tenderness during examination (18).

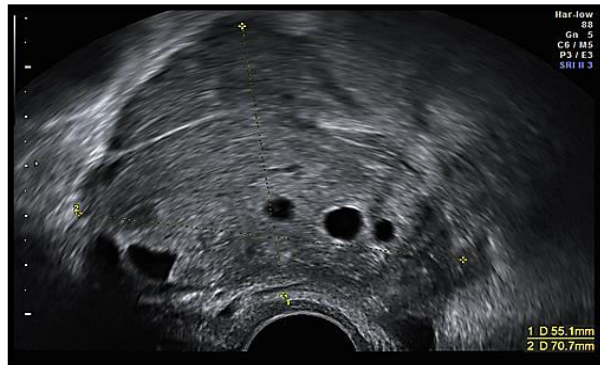


Figure (8) :Tubo-ovariancomplex(19).

7) Endometrioma:

Endometriosis is defined as the presence of endometrial tissue outside the uterus and affects up to 10% of childbearing women. It is a complex cyst contain low level echoes (ground glass appearance) with no internal vascularity, it may contain echoes in its wall. It need follow up for weeks to rule out hemorrhagic cyst, also can be differentiated by the patient symptoms (20).

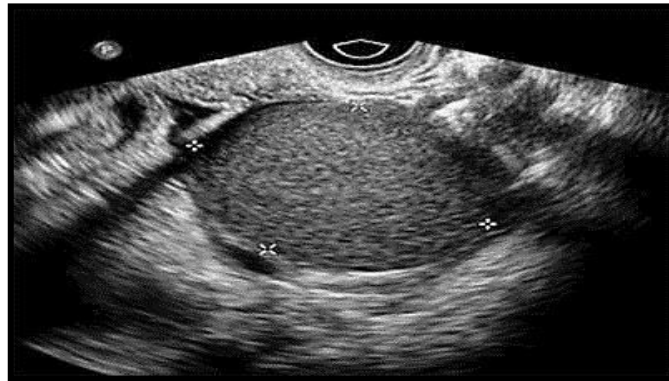


Figure (9): Shows a homogenous ovarian cystic formation with diffuse low-level internal echoes—the classic “ground glass” appearance compatible with endometrioma (21).

B. Pathological:

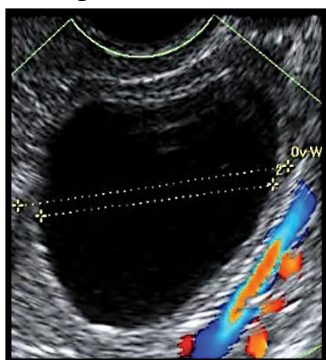
A. Surface epithelial tumors:

1) Serous:

Serous cystadenoma, it appear as anechoic lesion ,thin walled,fluid filled structures ,some contain fine septations .In 15% of cases they are bilateral

Serous cystadenocarcinoma, It is the most common type of malignant ovarian lesions,It is most commonly unilocular solid cyst with single or multiple papillary projections .

Vascular flow is present at solid component (22).



(A)



(B)

Figure (10) Serous cystadenoma. (A) Unilocular serous cystadenoma. (B) Multilocular cystadenoma(23).

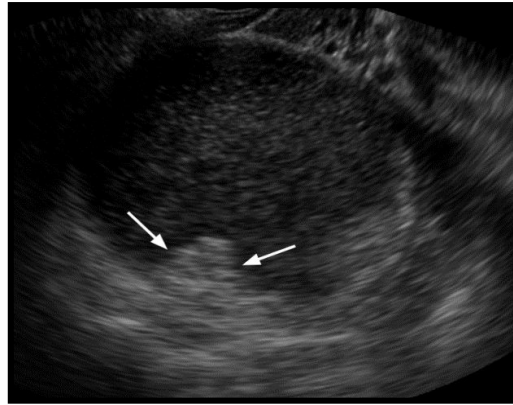
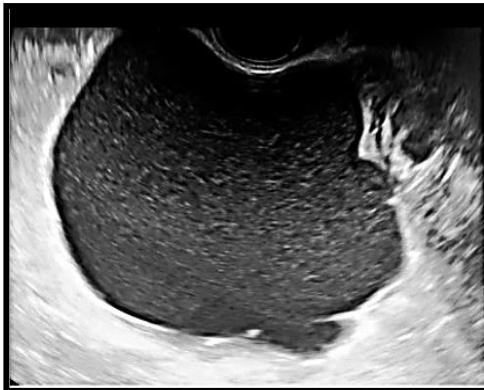


Figure (11): A unilocular cystic mass with internal papillary projection is seen on transvaginal ultrasonography (arrows) (24).

2) Mucinous:

Mucinous cystadenomas, These cysts appear large, thin walled, with internal thin walled locules containing mucin which appear as low level echogenic fluid. (25).



(A)



(B)

Figure (12): Mucinous cystadenomas. (A) Unilocular (B) Multilocular (23).

Mucinous cystadenocarcinoma, it is most commonly unilateral, multi locular with solid component, irregular thick septa and solid papillary projections (24).

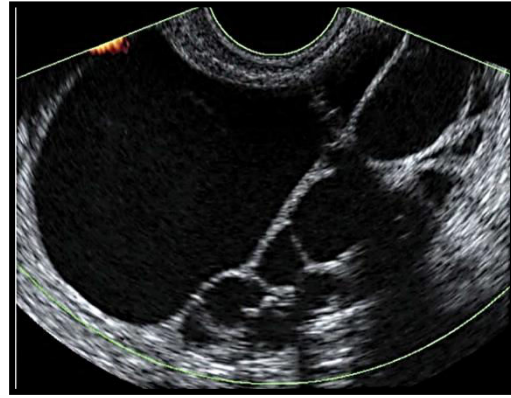
Cystadenofibromas:

It is a rare type of benign ovarian masses, it may be unilocular or multilocular cystic solid mass with anechoic content.

Hyperechoic solid component with acoustic shadows, papillary projection may help in diagnosis (26).



(A)



(B)



(C)

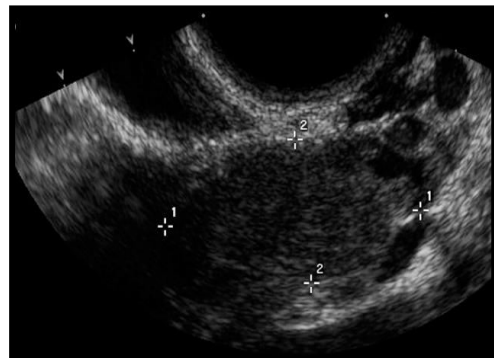
Figure (13): Serous cystadenofibromas. (A) Unilocular solid with a papillary projection and acoustic shadows. (B) Multilocular solid. (C) Another example of serous cystadenofibroma with unilocular solid morphology (23).

3) Brenner tumor:

It is uncommon tumor originate from ovarian stroma, it is commonly benign, unilateral, contain solid component, it may be associated with acoustic shadowing due to calcification. No color flow doppler is detected in the lesion(27).



(A)



(B)

Figure (14): (a) a 5cm purely solid benign Brenner tumor (color score 2) in a 60-year-old woman and (b) a 3cm purely solid benign Brenner tumor (color score 3) in a 40-year-old asymptomatic woman. (27).

B. Germ cell tumors:**1) Cystic Teratoma:**

Mature Teratoma It is also called **Dermoid cyst**, it is a benign tumor of the ovary appear as hyperechoic area with internal dots, it may contain fluid-fluid level or fat –fluid level. There maybe also areas of calcification due to bone or tooth. If it contains hair and sebum, they cause posterior attenuation, so the superficial part is only seen cause (Iceberg sign) (28).

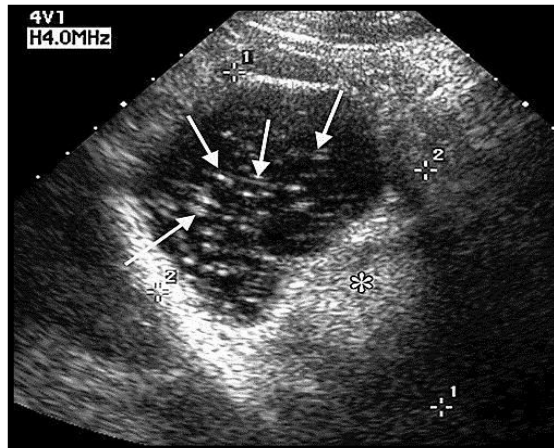


Figure (15): Mature cystic teratoma in a 48-year-old woman. Transvaginal US scan demonstrates a complex cystic ovarian mass (calipers). A portion of the mass consists of fluid with hyperechoic lines and dots (arrows) and has been termed dermoid mesh (23).

Immature teratoma are large tumors that predominantly include mixed-echo masses which are often associated with cystic degeneration and coarse calcification (29).

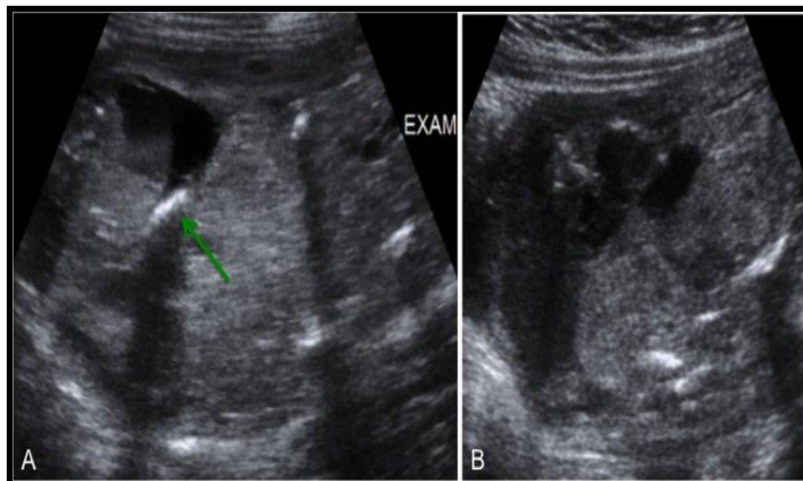
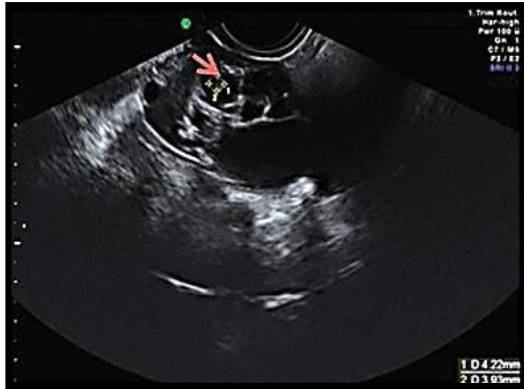


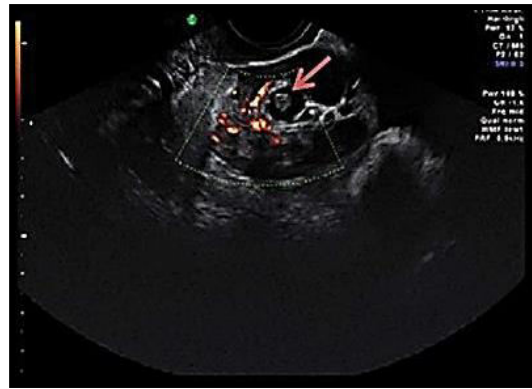
Figure (16): Immature teratoma of the right ovary in a 11-year-old-girl. Ultrasound transabdominal images (A and B) demonstrate a predominantly solid mass with cystic components. Note the presence of highly echogenic material producing posterior acoustic shadowing suggestive of intratumorally calcifications (green arrow) (30).

2) StraumaOvarii:

It is a subtype of ovarian teratoma contain ectopic thyroid tissue. It is mixed adnexal lesion contain cystic and solid areas, with increased vascularity at the center. Struma pearl is a characteristic feature, these are hyper echogenic areas with smooth surface(31).



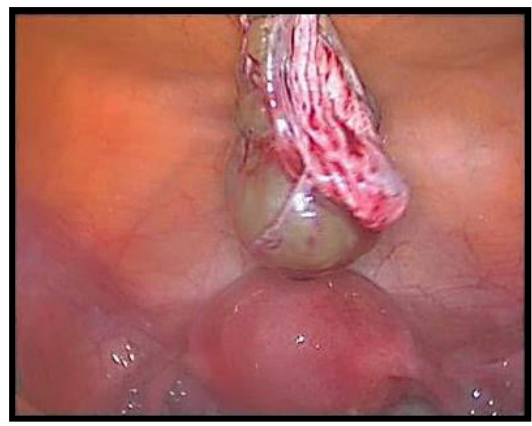
(A)



(B)



(C)



(D)

Figure (17): Struma ovarii showing (A) multilocularity and struma pearl formation (arrow) as well as (B) central vascularity (arrow pointing toward the ‘pearl’). (C and D) Laparoscopic features of the same cyst at the time of cystectomy (20).

3) Dysgerminoma:

It is the most common malignant germ cell tumor of the ovary. By TVS it is large solid lobulated mass with fibrovascular core (32).

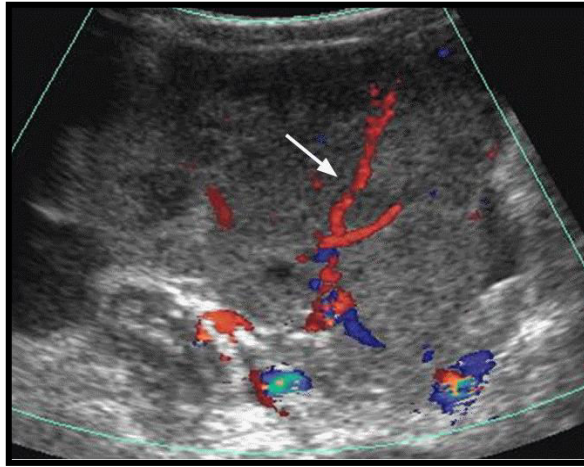
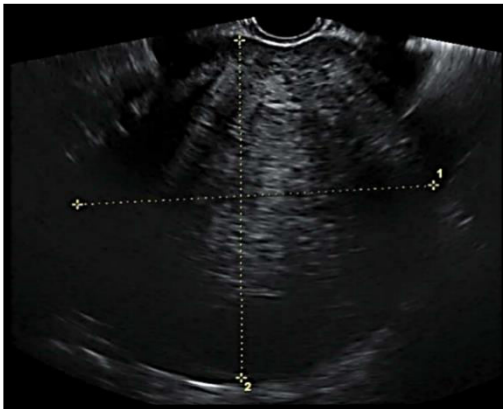


Figure (18): Dysgerminoma in a 41-year-old woman. Transabdominal Doppler ultrasonography shows a lobulated hypoechoic solid mass with prominent blood flow in the fibrovascular septa (arrow). (24).

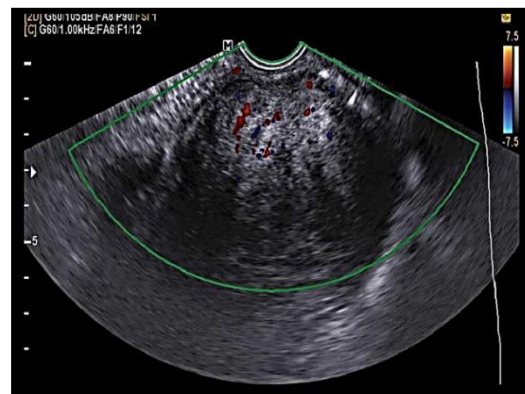
C. Sex cord tumors:

1) Ovarian fibromas and fibrothecomas:

These are rare types of benign ovarian tumor, Fibroma arises from ovarian spindle cells, fibrothecoma arises from both spindle cells and theca cells. By TVS it appears as well-defined mass, solid, hypoechoic, stripy acoustic shadowing (31).



(A)



(B)

Figure (19): Typical round regular ovarian fibroma with (A) acoustic shadows and (B) minimal peripheral vascularity on color Doppler(20).

2) Granulosa cell tumor:

It is the most common malignant of sex cord tumors. It may be multilocular solid cyst with small locules surrounded by solid tissue without papillary projections or may be heterogenous solid mass with necrosis (33).

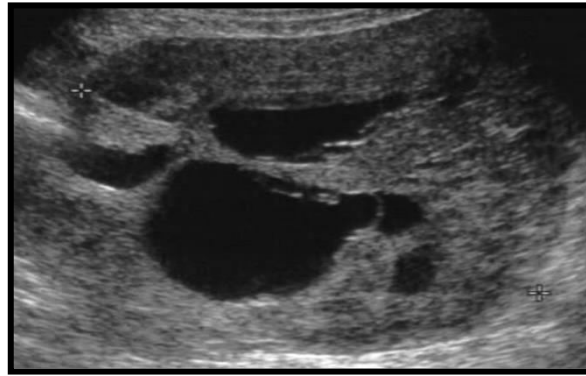


Figure (20): Granulosa cell tumor in a 46-year-old woman. Transvaginal ultrasonography reveals a multilocular solid mass. This tumor has mainly solid components, some with and some without a multilocular cystic appearance (24).

3) Metastatic Tumors (Krukenberg Tumor)

The most common tumors from breast, GIT, Uterus. It is ranging from purely solid to cystic, it is most frequent homogenous solid mass with mucin filled signet ring cells. Large lead vessel branching in tree pattern to nourish it may be present (34).



Figure (21): Multiple hyperechoic nodules are visible in the solid area. Multiple cysts of uneven size form the cystic portion, some of which exhibit dense punctate echo inside (9).

Ultrasonographic features of some non-ovarian lesions:

1) Hydrosalpinx:

It is a fluid filled dilatation of fallopian tube, By TVS, it is hypoechoic cystic mass, tubular shape, waist sign (indentation of the wall) or beads on string sign (In complete septation) The cogwheel sign may occur due to thickening loops of fallopian tube on cross section(35).

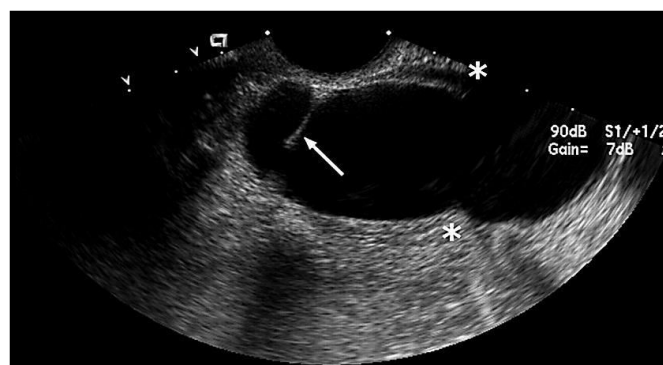


Figure (22): 68-year-old woman with left hydrosalpinx causing cystic adnexal mass. Coronal

sonogram of left adnexa shows mass, which was classified as having tubular shape, with incomplete septation (arrow) and “waist” sign (28).



Figure (23):Cogwheel sign(36).

2) Ectopic pregnancy:

95% of ectopic pregnancy cases occur in fallopian tube, ipsilateral ring of fire is found in 70%-85% of cases with Doppler US. It may be seen as inhomogeneous mass near the ovary but move separately in 60% of cases or hyperechoic mass in 20% of cases or as gestational sac with fetal pole and cardiac activity in 13% of cases. When an ovary is fertilized and held inside the ovary, an ovary pregnancy occurs. 3% of ectopic pregnancies are ovarian. The use of intrauterine devices is closely associated with ovarian pregnancy and is also associated with the use of intrauterine contraception.

The appearance of a gestational sac in the ovary with chorionic villi or atypical cyst with a hyperechoic ring is indicative of an ovarian pregnancy (37).

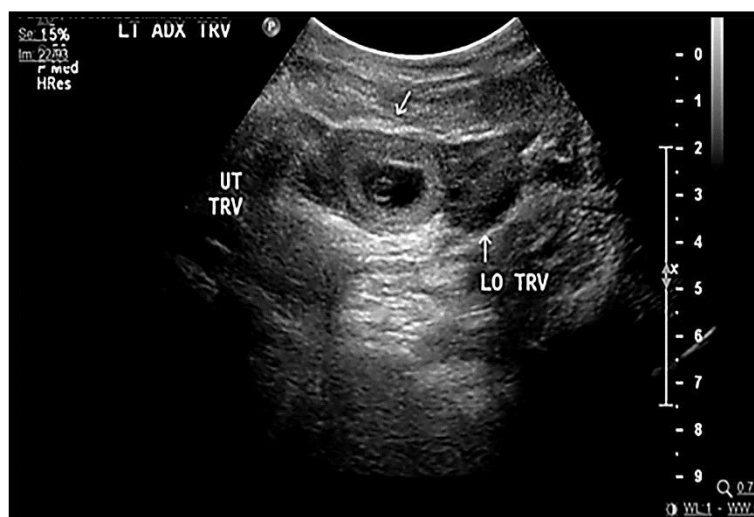


Figure (24): Transvaginal ultrasound of an ectopic pregnancy in the left adnexa. Indicated in the image is the uterus in transverse view and the left ovary. There is a gestational sac in the left adnexa with a yolk sac (white arrow) (38).

3) Para ovarian cyst:

It arises from the broad ligament. It is rare to be malignant. It is anechoic mass, thin walled, unilocular, may have papillary projections. It is separate from the ovary, when pushed by TVS it

moves away from the ovary (Split sign) so it is possible to see ipsilateral ovary (20).



Figure (25): A Paraovarian cyst with a normal ovary seen separate to it (20).

4) Peritoneal Inclusion Cyst:

This lesion is associated with factors that increase the risk for pelvic adhesive disease including endometriosis, pelvic inflammatory disease, post abdominal or pelvic surgery. By TVS there is ovoid or irregular large multilocular cyst with fine internal septations (that move when the area is provided with probe) and anechoic fluid surrounding the ovary, the ovary is suspended in the center or in the lateral aspect give it spider web appearance with or without flow on color Doppler (= (39)).

It is necessary to properly classify an adnexal mass to decide which patient require surgery and to help define the type of surgery and whether a surgical subspecialist is required (28).



Figure (26): Peritoneal inclusion cyst with some adhesion and loculated fluid surrounding normal ovary (40).

Features of Malignant Ovarian Neoplasms (23).

1) Solid Component:

The most important sign of malignancy is the presence of solid component, the solid area of the neoplasm has the same echogenicity of the wall cyst. The malignancy is also characterized by presence of papillary projection, vegetation, nodules and wall irregularity. The papillary projection is 3 mm or more from the cyst wall. Doppler US also can help with this differentiation, with a flow typical of neoplasms (41).

Most of the epithelial ovarian malignancies have a cystic component and rarely a completely solid if present it may be indicator for metastasis from breast or GIT carcinoma which are the most common neoplasm to metastasize (42).

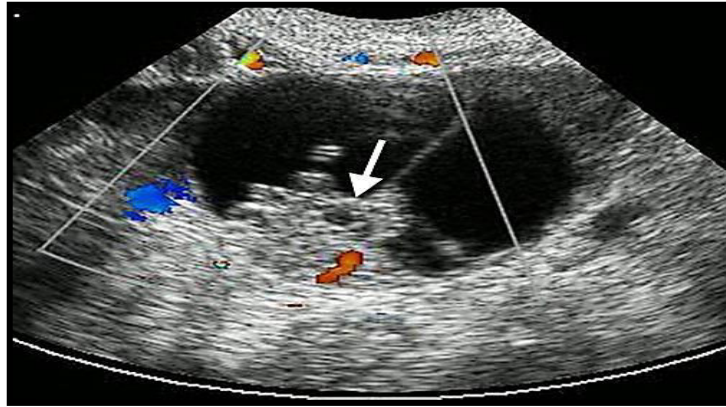


Figure (27): Serous cystadenocarcinoma of the ovary in a 38-year-old woman. Transvaginal color Doppler US scan demonstrates a complex ovarian cyst with septum and a solid nodule (arrow). There is flow within the solid nodule, typical of malignancy (12).

2) Septa:

Septa is an important indicator for malignancy especially if it was thick greater than 3 mm, has a flow on the Doppler US and extend across the cyst (43).

It may be misdiagnosed with fibrin strands of hemorrhagic cyst, but fibrin strands are very thin, more numerous, don't extend across the cyst and form a fishnet appearance (28).

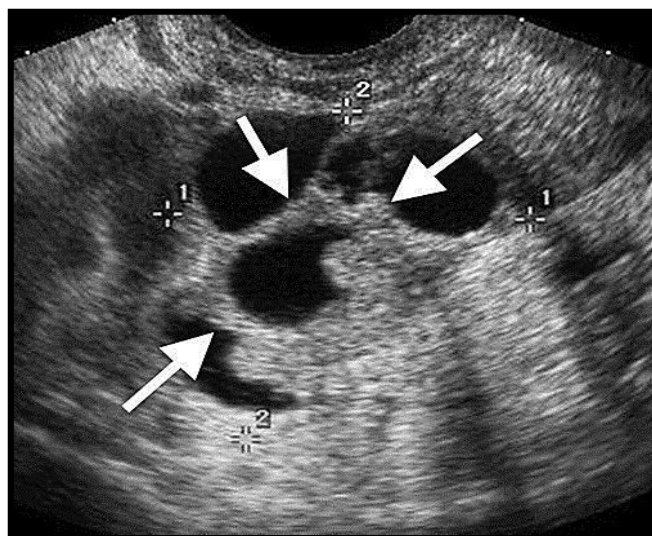


Figure (28): Serous cystadenocarcinoma of the ovary in a 60-year-old woman. Transvaginal US scan shows a complex ovarian cyst (calipers) with several thick septa (arrows) and solid area (28).

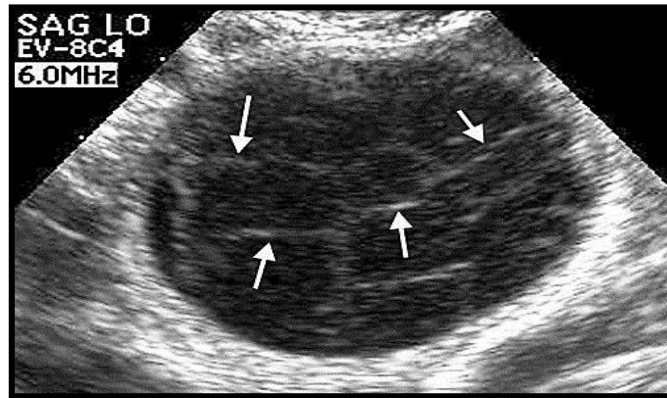


Figure (29): Hemorrhagic cyst in a 30-year-old woman. Sagittal transvaginal US scan demonstrates a complex ovarian cyst with internal echoes. There is a reticular or fishnet pattern to the internal echoes due to fibrin strands (arrows). Note how the fibrin strands are thin and do not extend completely across the cyst, in contrast to the true septa of a neoplasm (44).

3) Ascitis:

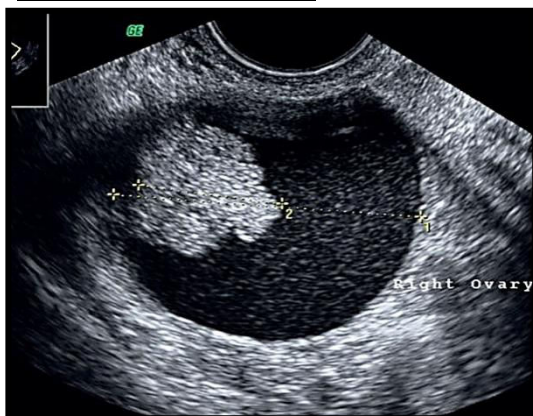
Ascites isn't a sure sign for malignancy, while small amounts of fluid in the cul-de-sac in premenopausal women are normally present, there is a high risk of malignancy when the antero-posterior dimension measures more than 15 mm (42).

4) Doppler US:

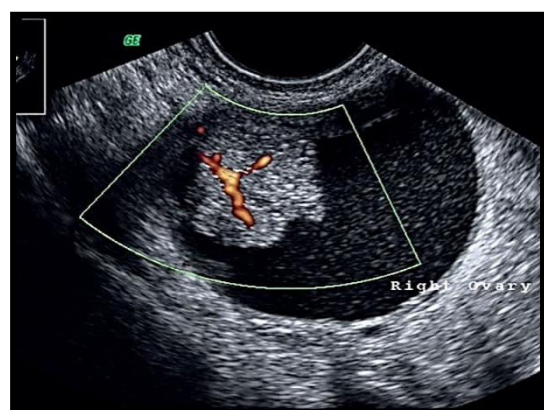
The best way to find flow within a solid component, is to use the Color Doppler US in quality mode. If you can see different vessels with Doppler US color or power, then the flow occurs.

5) Mural nodules.

6) Papillary projections:



(A)



(B)

Figure (30): Ultrasound images of serous borderline tumor recurrence. (a) Gray-scale ultrasound image showing a unilocular solid tumor with low-level echogenic cyst contents and a papillary projection with irregular surface. (b) Power Doppler image showing the papillary projection to be moderately vascularized. The ultrasound examiner was confident that the ovarian lesion was a recurrent borderline tumor (45).

7) **Resistive index (RI) <0.4-0.8.**8) **Ill-defined margins.****Gynecologic Imaging Reporting and Data System (GI-RADS):**

Although TVS is the first step for diagnosis of adnexal masses and has high sensitivity results, the ratio of false-positive results is high and may exceed 24% (22). These high false-positive results may be due to reports are unclear or difficulty in transmitting the data from the sonographer to the clinician (46).

GIRADS is a new system based on BI-RADS for reporting findings in adnexal masses identified by TVS. GIRADS Classification system for adnexal masses is 5 grades depending on criteria recommended by International Ovarian Tumor Analysis as shown in the Table 3.

Table (3): The GI-RADS classifications (9).

Classification	Morphological features	Risk of malignancy, %	Clinical management
GI-RADS 1	Normal ovaries identified and no adnexal mass seen	0	NA
GI-RADS 2	Classic appearance of functional origin cyst (e.g. follicle, corpus luteum, or hemorrhagic cyst)	<1	Assumed to be functional; requires follow-up by sonography
GI-RADS 3	Classic appearance of common benign neoplasms of the ovary (e.g. teratoma, endometrioma, or paraovarian cyst)	1-4	Assumed to persist over time; surgery required (preferably laparoscopy)
GI-RADS 4	Adnexal lesion not included in GI-RADS 1-3, and with 1-2 morphological findings suggestive of malignancy	5-20	Appropriate additional imaging techniques (computed tomography or magnetic resonance imaging); surgical management
GI-RADS 5	Adnexal masses with ≥3 morphological findings suggestive of malignancy	>20	Appropriate additional imaging techniques (computed tomography or magnetic resonance imaging); surgical management

Abbreviations: GI-RADS, Gynecology Imaging Reporting and Data System; NA, not applicable.

Finding suggestive malignancy:

Thick papillary projections, thick septa, solid areas with/without ascites, defined according to the International Ovarian Tumor Analysis criteria (47) and vascularization within solid areas, papillary projections or central area of a solid tumor on Color or Power Doppler assessment (26).

Conflict of Interest: No conflict of interest.

References

1. **Blaustein, A., (2013): Human Ovary.** Pathology of the Female Genital Tract, p.416.
2. **Gibson, E. and Mahdy, H., (2020): Anatomy, Abdomen and Pelvis, Ovary.** StatPearls [Internet].
3. **Zhu, R.Y., Wong, Y.C. and Yong, E.L., (2016): Sonographic evaluation of polycystic ovaries.**

Best Practice & Research Clinical Obstetrics & Gynaecology, 37, pp.25-37.

4. **Zik, B., Kurnaz, H., Güler, S. et al., (2019):** Effect of tamoxifen on the Notch signaling pathway in ovarian follicles of mice. *Biotechnic & Histochemistry*, 94(6), pp.410-419.
5. **Singh I, (2009):** Essentials of anatomy, Part 4, Chapter 30; abdomen and pelvis, posterior abdominal wall and some related structures, 2nd edition. New Delhi, Jaypee, P.279.
6. **Kleppe, M., Kraima, A.C., Kruitwagen, R.F., et al., (2015):** Understanding lymphatic drainage pathways of the ovaries to predict sites for sentinel nodes in ovarian cancer. *International Journal of Gynecologic Cancer*, 25(8).
7. **Kim, M.Y., Rha, S.E., Oh, S.N., et al., (2009):** MR imaging findings of hydrosalpinx: a comprehensive review. *Radiographics*, 29(2), pp.495-507.
8. **Heffner, L.J. and Schust, D.J., (2010):** The reproductive system at a glance (Vol. 23). John Wiley & Sons.
9. **Zhang, T., Li, F., Liu, J. et al., (2017):** Diagnostic performance of the gynecology imaging reporting and data system for malignant adnexal masses. *International Journal of Gynecology & Obstetrics*, 137(3), pp.325-331.
10. **Manegold-Brauer, G., Bellin, A.K., Tercanli, S., et al., (2014):** The special role of ultrasound for screening, staging and surveillance of malignant ovarian tumors: distinction from other methods of diagnostic imaging. *Archives of gynecology and obstetrics*, 289(3), pp.491-498.
11. **Smorgick, N. and Maymon, R., (2014):** Assessment of adnexal masses using ultrasound: a practical review. *International journal of women's health*, 6, p.857.
12. **Brown, D.L., Dudiak, K.M. and Laing, F.C., (2010):** Adnexal masses: US characterization and reporting. *Radiology*, 254(2), pp.342-354.
13. **Baerwald, A.R., Adams, G.P. and Pierson, R.A., (2005):** Form and function of the corpus luteum during the human menstrual cycle. *Ultrasound in Obstetrics and Gynecology: The Official Journal of the International Society of Ultrasound in Obstetrics and Gynecology*, 25(5), pp.498-507.
14. **Skandhan, A.K. and Ravi, V., (2014):** Hyperreactioluteinosis: An often-mistaken diagnosis. *The Indian journal of radiology & imaging*, 24 (1), p.84.
15. **Lima, L.D.L.A., Parente, R.C.M., Maestá, I., et al., (2016):** Clinical and radiological correlations in patients with gestational trophoblastic disease. *Radiologia Brasileira*, 49(4), pp.241-250.
16. **Jain, K.A., (2002):** Sonographic spectrum of hemorrhagic ovarian cysts. *Journal of ultrasound in medicine*, 21(8), pp.879-886.

17. **Dupuis, C.S. and Kim, Y.H., (2015):** Ultrasonography of adnexal causes of acute pelvic pain in pre-menopausal non-pregnant women. *Ultrasonography*, 34(4), p.258.
18. **Hiller, N., Sella, T., Lev-Sagi, A., et al., (2005):** Computed tomographic features of tuboovarian abscess. *The Journal of reproductive medicine*, 50(3), pp.203-208.
19. **Munro, K., Gharaibeh, A., Nagabushanam, S. et al., (2018):** Diagnosis and management of tubo-ovarian abscesses. *The Obstetrician & Gynaecologist*, 20(1), pp.11-19.
20. **Sayasneh, A., Ekechi, C., Ferrara, L., et al., (2015):** The characteristic ultrasound features of specific types of ovarian pathology. *International journal of oncology*, 46(2), pp.445-458.
21. **Bastos, B.B., Fonseca, E.K.U.N., Yamauchi, F.I. et al., (2017):** Chocolate cyst with ground glass appearance in endometriomas. *Abdominal Radiology*, 42(12), pp.2957-2958.
22. **Timmerman, D., Testa, A.C., Bourne, T., et al., (2008):** Simple ultrasound-based rules for the diagnosis of ovarian cancer. *Ultrasound in Obstetrics and Gynecology: The Official Journal of the International Society of Ultrasound in Obstetrics and Gynecology*, 31(6), pp.681-690.
23. **Sayasneh, A., Ekechi, C., Ferrara, L., et al., (2015):** The characteristic ultrasound features of specific types of ovarian pathology. *International journal of oncology*, 46(2), pp.445-458.
24. **Jung, S.I., (2015):** Ultrasonography of ovarian masses using a pattern recognition approach. *Ultrasonography*, 34(3), p.173.
25. **Goff, B.A., (2013):** Advanced ovarian cancer: what should be the standard of care? *Journal of gynecologic oncology*, 24(1), pp.83-91.
26. **Alcazar, J.L., Pascual, M.A., Graupera, B., et al., (2016):** External validation of IOTA simple descriptors and simple rules for classifying adnexal masses. *Ultrasound in Obstetrics & Gynecology*, 48(3), pp.397-402.
27. **Dierickx, I., Valentin, L., Van Holsbeke, C., et al., (2012):** Imaging in gynecological disease (7): clinical and ultrasound features of Brenner tumors of the ovary. *Ultrasound in obstetrics & gynecology*, 40(6), pp.706-713.
28. **Patel, M.D., Feldstein, V.A., Lipson, S.D., et al., (1998):** Cystic teratomas of the ovary: diagnostic value of sonography. *AJR. American journal of roentgenology*, 171(4), pp.1061-1065.
29. **SHEN, Z.Y., Hu, B., Xia, G.L. et al., (2014):** Ultrasonography of immature teratomas: 11 case reports.
30. **Horta, M. and Cunha, T.M., (2014):** March. Malignant Ovarian Germ Cell Tumours: Is there any clue for its diagnosis? *European Congress of Radiology 2014*.

31. **Savelli, L., Testa, A.C., Timmerman, D., et al., (2008):** Imaging of gynecological disease (4): clinical and ultrasound characteristics of struma ovarii. *Ultrasound in Obstetrics and Gynecology*, 32(2), pp.210-219.
32. **Lazebnik, N., Balog, A., Bennett, S., et al., (2009):** Ovarian dysgerminoma: a challenging clinical and sonographic diagnosis. *Journal of Ultrasound in Medicine*, 28(10), pp.1409-1415.
33. **Van Holsbeke, C., Domali, E., Holland, T.K., et al., (2008):** Imaging of gynecological disease (3): clinical and ultrasound characteristics of granulosa cell tumors of the ovary. *Ultrasound in Obstetrics and Gynecology*, 31(4), pp.450-456.
34. **Hiremath, R., Padala, K.P., Mahesh, G.G. et al., (2015):** Bilateral Krukenberg tumours diagnosed primarily by transabdominal sonography-A case report. *Journal of clinical and diagnostic research: JCDR*, 9(12), p.TD01.
35. **Macura, K.J., (2007):** Practical Gynaecological Ultrasound. *American Journal of Roentgenology*, 188(3), pp. W307-W307.
36. **Della Grotta, L.M., Dyer, R.B. and Holbert, B.L., (2019):** The “cogwheel” sign of hydrosalpinx. *Abdominal Radiology*, 44(10), pp.3486-3487.
37. **Sergent, F., Mauger-Tinlot, F., Gravier, A., et al., (2002):** Ovarian pregnancies: reevaluation of diagnostic criteria. *Journal de gynécologie, obstétrique et biologie de la reproduction*, 31(8), pp.741-746.
38. **Murano, T., Shaker, L. and Marco, C.A., (2019):** Evaluation and Management of Ectopic Pregnancy in the Emergency Department. *Emergency Medicine Reports*, 40(14).
39. **Sohaey, R., Gardner, T.L., Woodward, P.J. et al., (1995):** Sonographic diagnosis of peritoneal inclusion cysts. *Journal of ultrasound in medicine*, 14(12), pp.913-917.
40. **Vallerie, A.M., Lerner, J.P., Wright, J.D. et al., (2009):** Peritoneal inclusion cysts: a review. *Obstetrical & gynecological survey*, 64(5), pp.321-334.
41. **Asch, E. and Levine, D., (2007):** Variations in appearance of endometriomas. *Journal of ultrasound in medicine*, 26(8), pp.993-1002.
42. **Barney, S.P., Muller, C.Y. and Bradshaw, K.D., (2008):** Pelvic masses. *Medical Clinics of North America*, 92(5), pp.1143-1161.
43. **Valentin, L., (2004):** Use of morphology to characterize and manage common adnexal masses. *Best Practice & Research Clinical Obstetrics & Gynaecology*, 18(1), pp.71-89.
44. **Zavaleta-Landa, J.M., Sánchez-Portillo, J., Gutiérrez-Espinosa, D.L. et al., (2018):** Características ultrasonográficas benignas y malignas de masas anexiales. *Médica Sur*,

20(2), pp.130-132.

45. **Jones, B.P., Saso, S., Farren, J., et al., (2017):** Ultrasound-guided laparoscopic ovarian wedge resection in recurrent serous borderline ovarian tumours. *International Journal of Gynecologic Cancer*, 27(9).
46. **Timor-Tritsch, I.E., and Goldstein, S.R., (2005):** The complexity of a “complex mass” and the simplicity of a “simple cyst”.
47. **Amor, F., Alcázar, J.L., Vaccaro, H., et al., (2011):** GIRADS reporting system for ultrasound evaluation of adnexal masses in clinical practice: a prospective multicenter study. *Ultrasound in obstetrics & gynecology*, 38(4), pp.450-455.