

Adnexal Masses

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Disclosures

Ilan E. Timor-Tritsch
Ana Monteagudo

We have no relevant financial relationships

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Learning Objectives

After completing this presentation, the learner will be able to:

1. Understand the technical aspects transabdominal and transvaginal ultrasound probes and effectively use them to characterize sonographic, adnexal features on the road to a clinical diagnosis.
2. Recognize the most frequently occurring adnexal pathologies using gray scale, color and power Doppler as well 3D ultrasound techniques
3. To use the most advanced scoring systems to distinguish benign from malignant ovarian tumors.

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Lecture Outline

1. Introduction
2. General & technical aspects
3. The bladder and the cervix
4. The normal ovary
5. Pathology of the ovary
 1. PCO
 2. Non neoplastic ovarian cysts
 3. Ovarian neoplasms
 4. Malignant neoplasms
6. Scoring systems
 1. The Kentucky system
 2. The IOTA systems
7. The Fallopian tube
 1. Inflammatory Tubal disease
 2. Tubal cancer
8. Additional sites to check
9. Summary and conclusions

1. Introduction

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Scanning for adnexal pathologies

- It IS the **hardest gynecologic** scanning task.
- You **MUST** arrive at a **conclusion!**
 - Use **primarily transvaginal sonography (TVS)**, and as needed, **combine it with transabdominal sonography (TAS)!!**
 - In addition to the adnexae, **do not skip** the bladder, kidneys, Morrison's pouch etc...
 - Use a **variety of transducers** for depth, color and power Doppler, employ 3D....

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Scanning for adnexal pathologies

- Remember: not all masses are ovarian.
- If you scan your own patient:
 - Take a short **history** ; examine the patient before the scan, but do so after the scan to confirm your ultrasound findings.
- If you scan a referred patient:
 - Take a short **history yourself**: don't trust the referral slip; it is usually useless!!
 - If in doubt: perform a **bimanual exam yourself**.

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Important!!

- In the reproductive years, physiologic as well as pathologic processes are driven by the menstrual cycle or by (therapeutic or pathologic) hormonal stimulation.
- **Know the day of your patients' day of the cycle, therefore...**

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Important!!

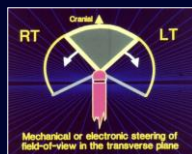
-clearly mark the LMP on the screen to avoid erasure every time you unfreeze the picture (type in the LMP or the letters PM 1998 [for: postmenopausal since 1998] to carry them over to every picture).
- Judge EVERY US finding (ovarian findings, pelvic fluid, endometrium etc) as a function of the hormonal status (or day in cycle)

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2. General and Technical Aspects

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Technical aspects

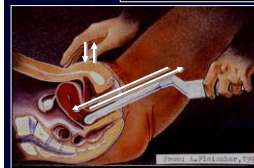


1. The most efficient pelvic evaluation is by using **transvaginal US probes**.
(If the bladder is full you may want to do first a transabdominal scan)
2. Vaginal probes operate at frequencies of 5-9 (or 6-12) MHz.
3. Their most effective scanning depth is 2 to 10-12 cm.
4. They accommodate Doppler, harmonic imaging & 3D.

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Technical aspects

"Sliding organs sign"



What is the sliding organs sign...?

Generated by the to-and-fro movement of the vaginal probe aided by the abdominal hand moving the cervix, uterine body, ovaries to evaluate their movement relative to the pelvic floor and/or each other, to **diagnose or rule out pelvic adhesions**.

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Sliding organs sign

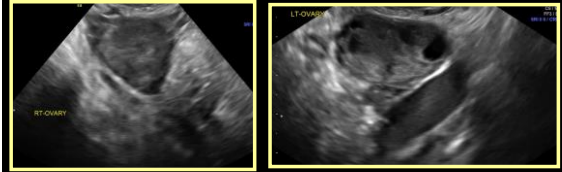
Useful to diagnose adhesions in the pelvis as well as the upper abdomen.
Useful even at the time of laparoscopy
(selection of safe port placement site)

Example: If patient with infertility or suspect for a frozen pelvis, a discrete endometrioma on US has absent sliding pelvic or abdominal organs, she most probably has pelvic adhesions.

• * First described in: Transvaginal Sonography, (eds): Timor-Tritsch IE and Rottem S Elsevier Science Publishing Co. New York 1988; Pages 24,35,52,55,72,84

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Sliding organs sign: the ovaries



Timor-Tritsch IE and Rottem S Elsevier Science Publishing Co. New York 1988; Pages 24,35,52,55,72,84

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Record the mobility or fixed nature of pelvic organs

- Lately US machines are equipped with the ability to record scanning sequences using two kinds of features: “on-the-fly” (going forward) or “retro-view” (reviewing a structure just seen before)
- Use them to record the mobility (“sliding”), or fixed nature of pelvic organs.
- Add credibility to your report!
- Acquire also a “sweep” of the adnexa

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3. The Bladder and the cervix

Even though it is not strictly the adnexum,* on the way in, look at the bladder and the cervix.

* Latin: **Adnexum** = singular, **adnexae** = plural;

adnexa = grammatically incorrect but can be used, since it is already deeply rooted in our vocabulary!

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4. The Normal Ovary

General

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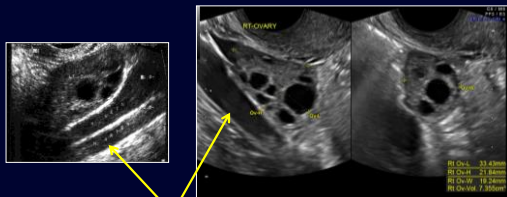
Location of the normal ovaries

- Best imaged by TVS (TAS may be of help)
- In the reproductive age:
 - Follicles are their sonographic markers.
 - They “live” close to the hypogastric vessels.
 - In the secretory phase look for the **corpus luteum (CL)** with color or power Doppler.
- In menopause:
 - Harder to find (no, or rare follicles as markers).
 - Linger on the adnexae and look for **hypoechoic** 1-3-cm structures amidst constantly moving bowel.

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Location of the normal ovaries in

- Best imaged by TVS (TAS can be of help)
- In the reproductive age:
 - Easy to see **follicles**: their sonographic markers.

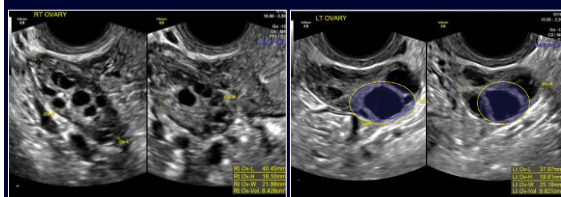


- They “live” close to the hypogastric vessels.

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Physiologic follicles of the ovary

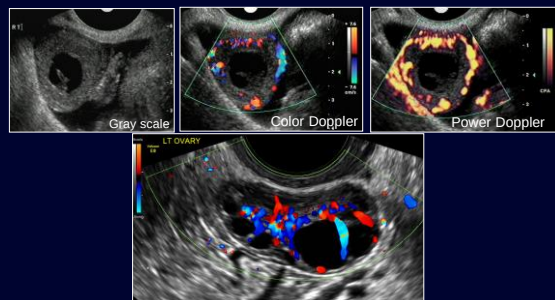
- During a normal (NL) cycle 1 or MORE follicles mature.
- At midcycle one matures achieving 2-2.5 cm.
- **DON'T CALL THEM CYSTS, THEY ARE FOLLICLES !**



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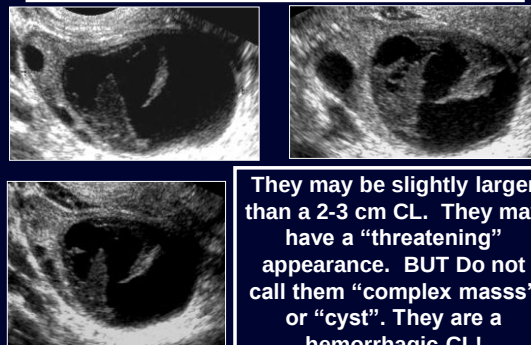
Timor-Tritsch and Goldstein. Ultrasound Obstet Gynecol Editorial 2005

In the secretory phase of the cycle look for the corpus luteum using color Doppler



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Hemorrhagic Corpus Luteum

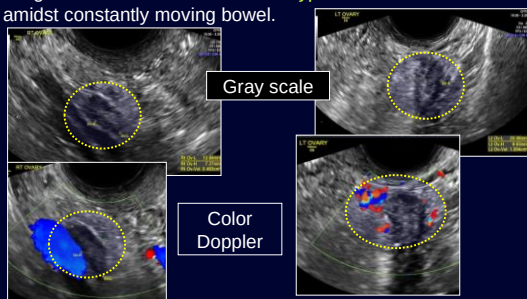


They may be slightly larger than a 2-3 cm CL. They may have a “threatening” appearance. BUT Do not call them “complex mass” or “cyst”. They are a hemorrhagic CL!

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Postmenopausal ovaries

- Harder to find (no, or rare follicles as markers).
- Linger on the adnexae & look for **hypoechoic** 1-3 cm structures amidst constantly moving bowel.



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Ovarian sizes

- **Data from 58,673 observations of ovarian volume.**
- **Less than 30 years: 6.6cm³**
- **30-39 years: 6.1cm³**
- **40-49 years: 4.8cm³**
- **50-59 years: 2.6cm³**
- **60-69 years: 2.1cm³ and**
- **>=70 years: 1.8³**
- **Polycystic ovaries >10-11cm³**
- Mean ovarian volume: 4.9cm³ in premenopausal and 2.2cm³ in postmenopausal women (P < 0.001).
- Ovarian volume was unrelated to patient weight but was greater in tall women (>68 in.) than in short women (<58")

. Pavlik EJ et al ¹, Ovarian volume related to age. Gynecol Oncol. 2000 Jun;77(3):410-2.

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5. Ovarian Pathology: What to look for?

--Sassone AM², Timor-Tritsch IE, Arner A, Westhoff C, Warren WB Transvaginal sonographic characterization of ovarian disease: evaluation of a new scoring system to predict ovarian malignancy. *Obstet Gynecol.* 1991 Jul;78(1):70-8.
 --Timor-Tritsch IE, Goldstein SR: The simplicity of a simple cyst and the complexity of a complex mass. *JUM Editorial* 2005
 --Timmerman D, Testa AC, Bourne T, et al. Simple ultrasound-based rules for the diagnosis of ovarian cancer. *Ultrasound Obstet Gynecol* 2008;31(6):681-690
 --Testa AC et al. Ovarian cancer arising in endometrioid cysts: ultrasound findings. *UOG* 2011; 38: 9
 --John R van Nagell Jr & John T Hoff: Transvaginal sonography in ovarian screening: current perspectives. *International journal of woman's health* 2013

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Ovarian lesions (findings) What do you look for?

- **Internal echo structure ("echogenicity"):**
 - Anechoic (fluid component)
 - Echogenic (solid component)
 - Low-level echoes (ground glass appearance)
 - Mixed echogenicity, reticular etc
 - **Wall structure:**
 - Thickness
 - Internal and/or external papillae
- (the moment you see papillae, apply **power Doppler** [not color!]) and set it to the highest sensitivity to rule-in or-out blood flow). Blood vessels in a papilla is highly predictive of malignancy
- Septae**

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Ovarian lesions (findings) What do you look for?

- **Appearance:**
 - "Bizarre shapes"
 - Mixed components
- Size
- Is it bilateral?
- Ascites
- Motion tenderness
- Vessels
- **Sliding of the ovary**

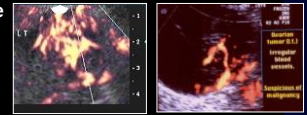


When these are documented, the next step is: LOOK AT THE VASCULARITY.

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Ovarian lesions (findings) What do you look for?

- **Vascularity**
 - CAN ANY VESSELS BE SEEN AT ALL?
 - If seen: **Look for their qualitative appearance:**
 - Location (central/peripheral)
 - Amount of vascularity
 - Tortuous appearance
 - Caliber changes
 - Anastomoses
 - "Lakes"
 - If seen: **Measurements can be done (less used lately, however a low RI & PI is common in cancer):**



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Ovarian lesions: What do you look for?

• General appearance

- Solid →
- Cystic:
 - without solid component →
 - With solid component →
- Unilocular, Multilocular, →

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Ovarian lesions: What do you look for?

Internal echo structure:

- Anechoic/hypoechoic →
- Echogenic (solid) →
- Low-level echoes (ground glass appearance) →
- Mixed echogenicity →
- Reticular, etc →

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Ovarian lesions (findings) What do you look for?

• Wall structure:

– Thickness



– Inner, mural papillae

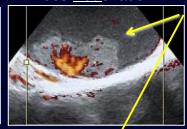
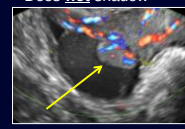
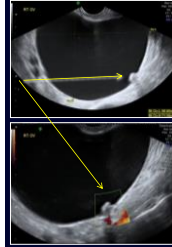


(The moment you detect papilla/e, **apply power** [not color!] **Doppler** and set it to the highest sensitivity to rule in, or rule out blood flow).

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Three kinds of papillae

- Hyperechoic papilla/e
- No vessels in papilla
- Papilla **does** shadow
- Hypoechoic papilla/e
- Smooth, rounded borders
- No vessels in papilla
- Does **not** shadow
- Hypoechoic papilla/e!
- Irregular borders
- Vessels in papilla
- Does **not** shadow



Usually benign (cystadeno-fibroma)

In pregnancy c. appropriate history: Decidualized endometrioma

Usually borderline ovarian tumor or frank epithelial Ca.

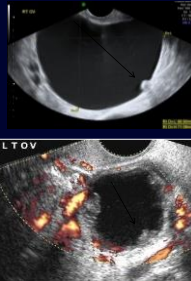
Goldstein & Timor-Tritsch JUM 2010
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Masclini F. et al, UOG 2014;

Timmerman et al, UOG 2008;

The significance of papillary formations in ovarian masses

- Agreement on both shores of the Atlantic :
 - “Small “, hyperechoic papillae **without** blood vessels can be followed by periodic imaging

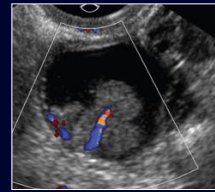
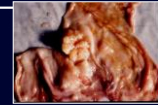


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Radiology: Volume 256: September 2010 n radiology.rsna.org

The significance of papillary formations in ovarian masses

- Agreement on both shores of the Atlantic :
 - Papillae **with** blood flow are suspicious for malignancy and should be removed



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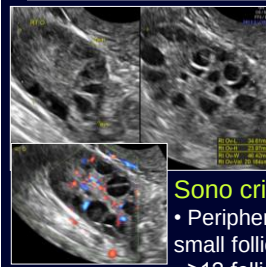
Radiology: Volume 256: September 2010 n radiology.rsna.org

The Ovary

5-1. PCO

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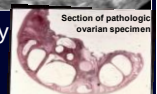
Polycystic ovaries



Sono criteria:

- Peripherally crowded, small follicles
- ≥ 12 follicles of < 10 mm
- Size $\times 1.5$ – 3 of NL ovary
- Hyperechoic hilus
- Rich hilar blood supply

Ovaries are usually larger than 12 mL in volume



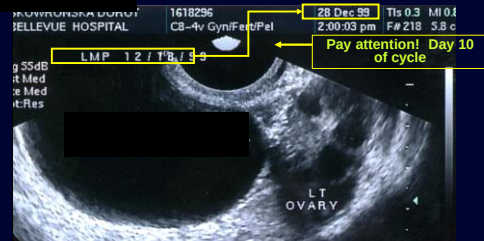
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True PCO or only “sonographic PCO,” aka multicystic ovary?

- Not every ovary that fulfills the **sono criteria** is a PCO syndrome!
- An ovary can have a PCO appearance in the following clinical situations:
 - Hyperthyroid state (36%)
 - Hyperprolactinemia (50%)
 - Hypothalamic hypogonadism (24%)
 - Or without any known reason

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Paraovarian/paratubal cyst

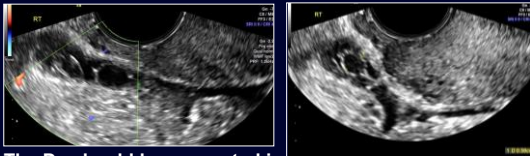


Frequently seen, benign appearing cysts with the following sono markers:

1. Very thin,
2. smooth wall.
3. Anechoic
4. Unilocular
5. Ipsilateral ovary HAS TO BE SEEN!!!

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Postoperative peritoneal inclusion cysts in loculated pelvic fluid



- The Dx should be suspected in the **right clinical setting**.
- Dx depends on the presence of **normal ipsilateral ovary** with surrounding loculated fluid conforming to the peritoneal space.

Sahaey R, Gardiner TL, Woodward PJ, Peterson CM. Sonographic diagnosis of peritoneal inclusion cysts. *J Ultrasound Med* 1995; 14:913-917

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5-2. Non neoplastic ovarian cysts

Non-neoplastic ovarian cysts

These are by far the most common cystic structures.

FUNCTIONAL

- Follicular “cysts” (E)
- Corpus luteum (P)
- Theca-lutein cyst (E)

NONFUNCTIONAL

- Serous cyst
- Corpus albicans
- Endometrioma

E: estrogen secreting; P: progesteron secreting

Except the endometrioma: most resolve and do not need surgical treatment, provided they do not twist. If Dx. in doubt, scan the patient in the next cycle (days 5-9).

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Non-neoplastic ovarian cysts

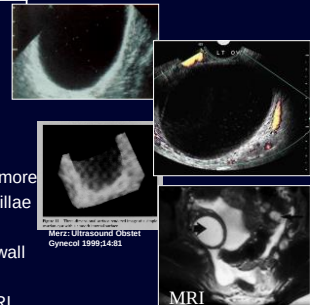
These are by far the most common cysts.

FUNCTIONAL

- Follicular “cysts” (E)
- aka **SIMPLE CYSTS**

- The corpus luteum (P)
- Theca-lutein cyst (E)

- Size: up to 4-5 cm, sometimes more
- Smooth wall, unilocular, no papillae
- Lined with flat granulosa cells
- Circular blood flow around the wall
- Almost never malignant (<1/2%)
- No additional information by MRI



These resolve and no surgery (Sx) needed, provided no rupture or torsion exists.

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Non-neoplastic ovarian cysts

These are by far the most common cysts.

Simple cysts

Ovarian tumors with cystic or septate morphology are at minimal risk of malignancy and can be followed with serial ultrasonography evaluations, thereby avoiding the morbidity and cost of surgery

--Alcázar JL et al Is expectant management of sonographically benign adnexal cysts an option in selected asymptomatic premenopausal women? Hum Reprod. 2005;20(11):3231-4.
--Castillo G, Alcázar JL, Jurado M. Natural history of sonographically detected simple unilocular adnexal cysts in asymptomatic postmenopausal women.
--van Nagell JR Jr., Miller, RW Management of Asymptomatic Ovarian Tumors Obstet Gynecol 2016;127:848-58

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Risk of malignancy in cystic & septated ovarian tumors <10cm in diameter

Evaluation and Management of Ultrasonographically Detected Ovarian Tumors in Asymptomatic Women

(Obstet Gynecol 2016;127:848-58)

John R. Bressler, van Nagell Jr, MD, and Rachel Wise Miller, MD

Table 1. Risk of Malignancy in Cystic and Septated Ovarian Tumors Less Than 10 cm in Diameter

Author	Morphology	n	Spontaneous Resolution	Surgery	Malignancy	Follow-up (mo)
Bailey et al ¹⁶	Unilocular	256	125 (49)	45	0	18 (1-75)
Modesitt et al ²	Unilocular	3,259	2,261 (69)	133	0	76 (1-96)
Saunders et al ¹⁸	Septated	2,870	1,114 (39)	128	0*	77 (4-252)

Values are n, n (%), or mean (range).

* One case of stage IB epithelial ovarian tumor of borderline malignancy.

¹⁶ Bailey CL, et al. The malignant potential of small cystic ovarian tumors in women over 50 years of age. Gynecol Oncol 1998;69:3-7.

² Modesitt SC, et al. Risk of malignancy in unilocular ovarian cystic tumors less than 10 cm in diameter. Obstet Gynecol 2003;102:594-600.

¹⁸ Saunders BA, et al. Risk of malignancy in sonographically confirmed septated cystic ovarian tumors. Gynecol Oncol 2010;118:278-82.

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Risk of malignancy in cystic & septated ovarian tumors <10cm in diameter

- **Unilocular cystic ovarian tumors occur in 5-14% of postmenopausal women & essentially all are benign**
- Bailey et al,* evaluated 7,705 asymptomatic postmenopausal women by annual TVS over 8 years
- 256 developed unilocular ovarian cysts.
- 125 (49%) cysts resolved spontaneously in 60 days
- 131 (51%) cysts persisted.
- 45 persistent cysts removed: none were malignant.
- The remaining 86 patients followed at 3- to 6-month intervals by TVS and none developed cancer.

* Bailey CL, et al. The malignant potential of small cystic ovarian tumors in women over 50 years of age. Gynecol Oncol 1998;69:3-7.

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Non-neoplastic ovarian "cysts"

These are by far the most common cystic structures.

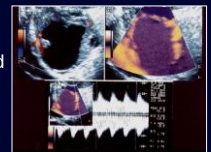
FUNCTIONAL

- Follicular "cysts" (E)

- **The corpus luteum (P)**

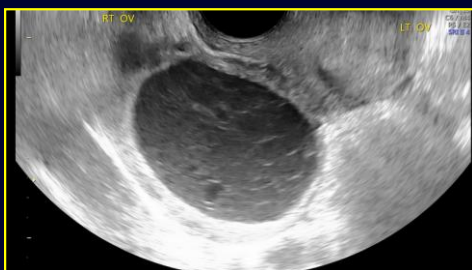
- Theca-lutein cyst (P)

- Size: ≥2.5-3 cm, sometimes more
- Thick wall, unilocular, no papillae
- Filled with interphases, mesh-like texture, bizarre forms and shapes created by the clot as it shrinks, lyses, etc
- Abundant blood flow in wall and around them also called: "ring of fire"
- They regress!!!



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The "jiggling" blood clot in a hemorrhagic CL



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Cyst vs follicles vs corpora lutea

"Before embarking upon descriptions and definitions of ovarian physiology and pathology, please remember that uttering the word 'cyst' or including it in a US report, for most, if not all obstetric and gynecologic (Ob/Gyn) practitioners, implies: **pathology**.

Therefore do not use the word 'cyst'. When describing a follicle or a CL: simply call them **follicles** and **corpora lutea**".

Timor-Tritsch IE, Goldstein SR: The simplicity of a simple cyst and the complexity of a complex mass. JUM Editorial 2005

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Physiologic "cysts" of the ovary

- After ovulation, a CORPUS LUTEUM appears. → 
- A mesh of blood vessels are in the wall which bleed at ovulation. 
- The CL may reach a size of 2.5 cm. Sometimes more! 
- In hyperstimulated ovaries may be more than 1 CL. → 
- Color or power Doppler helps in identifying them. → 

DON'T CALL THEM CYSTS! THEY ARE CORPORA LUTEA !*

In the secretory phase of the cycle, avoid drawing conclusions in cases of adnexal mass workup!!
Rescan on days 5-10 of a subsequent cycle.

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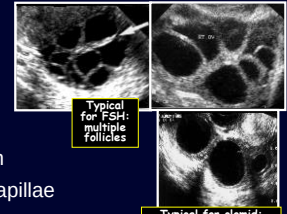
* Timor-Tritsch & Goldstein, JUM Editorial 2005

Non-neoplastic ovarian cysts

These are by far the most common cysts.

FUNCTIONAL

- Follicular "cysts" (E)
- The corpus luteum (P)
- Theca-lutein cyst
- Size may achieve: $\geq 5-10$ cm
- Thick wall, multilocular, no papillae
- In fact: they are hyperstimulated ovaries

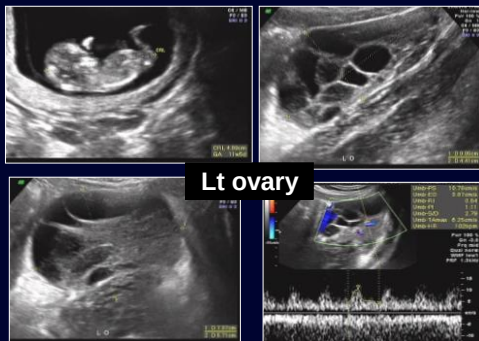


May occur in diabetes, molar pregnancy, pregnancies with hydrops fetalis, hormones

These resolve and no Sx needed, if no rupture or torsion

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Bilateral theca-lutein cysts in an early pregnancy



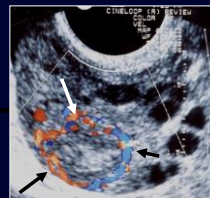
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Non-neoplastic ovarian cysts

These are by far the most common cysts.

NONFUNCTIONAL

- Serous cyst
- Corpus albicans
- Endometrioma



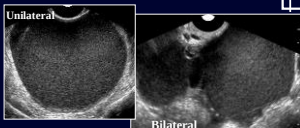
- Size: up to 2-4 cm, hyper- or anechoic (not really a cyst)
- Occur mostly in the late secretory phase, may "roll over" to next cycle/s and persist for a long time
- Should be noted, since its differential Dx is: intra-ovarian benign teratoma

These resolve and do not need surgical treatment.

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Non-neoplastic ovarian cysts

These are by far the most common cysts.



NONFUNCTIONAL

- Serous cyst
- Corpus albicans
- Endometrioma

- Rarely septated, thick walled
- Homogeneous, low-level echo filled
- Rarely vessels run through it
- May be large (10+ cm)

- MRI can help detecting blood
- Rarely can become malignant will show papillae with blood vessels.

The result is **endometrioid carcinoma**

Test for adhesions:
push to see if
organs slide

DOES NOT
resolve, and most
need surgical
treatment.



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Endometrioma



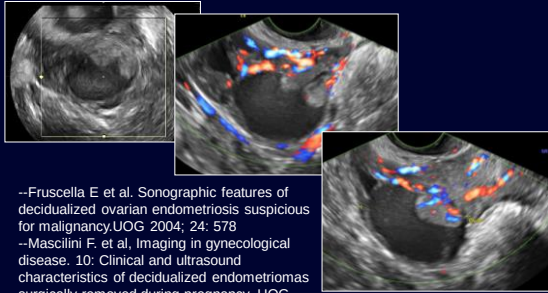
If blood vessels and papillae are seen in, or close to the wall, think of **clear cell carcinoma**, aka **endometrioid carcinoma**.

Testa AC et al. Ovarian cancer arising in endometrioid cysts: ultrasound findings. UOG 2011; 38: 99-106.

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Decidualized endometrioma

A subset of endometrioma seen in pregnancy



--Fruscella E et al. Sonographic features of decidualized ovarian endometriosis suspicious for malignancy. UOG 2004; 24: 578
--Mascilini F. et al. Imaging in gynecological disease. 10: Clinical and ultrasound characteristics of decidualized endometriomas surgically removed during pregnancy. UOG 2014;44:354-60.

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Decidualization

- A morphological and biochemical transformation of endometrial stromal fibroblast into differentiated decidual cells, which is critical for correct trophoblast invasion and formation.
- An ectopic decidual reaction may be encountered within the ovarian stroma as a response of the indigenous cells to the hormonal milieu of pregnancy

Testa AC et al. Ovarian cancer arising in endometrioid cysts: ultrasound findings. UOG 2011; 38: 99-106.

Timor & Monteagudo

Diagnostic "pointers"

- Often pre-existing endometrioma/endometriosis
- Most characteristics of endometrioma are preserved:
 - low-level echogenic (ground-glass) appearing fluid
 - uni- or sometimes bilocular
 - no or thin septum

Mascilini F. et UOG 2014;44:354-60.

Make everything possible to obtain reliable history, previous US images, laparoscopy results etc. A proven diagnosis of endometriosis by the above saves surgery during pregnancy!!

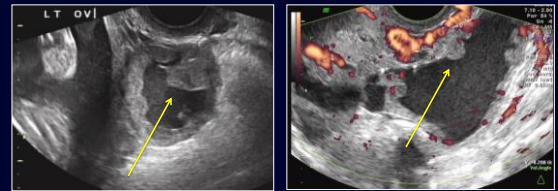
Shallow, mostly smooth, rounded papillae protruding from a thick inner surface "lining"

- Moderate amount of vessels in papillae
- As pregnancy progresses picture returns to the basic character of the preexisting EOMA

Timor & Monteagudo

The point of the matter

- With decidualization the sonographic appearance of endometriomas can become more heterogeneous with **papillary excrescences** and **increased vascularization**
- A richly vascularized ovarian lesion is considered **malignant** unless proven otherwise. Correct diagnosis IMPERATIVE!
- The proof is usually surgical exploration that may lead to **pregnancy loss or premature labor**



Timor & Monteagudo

Machida S, 2008; Sammour RN, 2005

Non-neoplastic ovarian cysts

These are by far the most common cysts.

Ovarian fibroma

Benign ovarian tumor

Cystic



Solid

Timor & Monteagudo

Non-neoplastic ovarian cysts

These are by far the most common cysts.

Ovarian fibroma

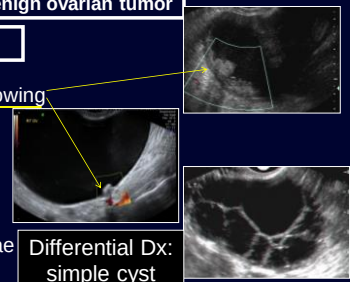
Benign ovarian tumor

Cystic

Sono markers:

- Hyperechoic, shadowing mural papilla/e
- Avascular papillae
- Anechoic fluid
- Mostly unilocular
- 30% multilocular
- Thin wall, thin septae
- Slow rate of growth

Differential Dx: simple cyst



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Goldstein, Timor & Monteagudo JCU 2009

Non-neoplastic ovarian cysts

These are by far the most common cysts.

Ovarian fibroma

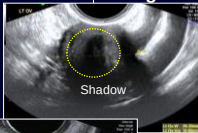
Benign ovarian tumor

Solid

Sono markers:

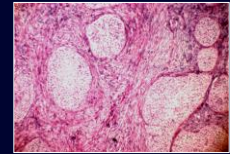
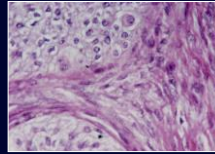
- Myometrium-like texture
- Anechoic/hypoechoic
- Few/no vessels in stroma
- Very slow rate of growth

Differential Dx: Brenner tumor, Krukenberg tumor



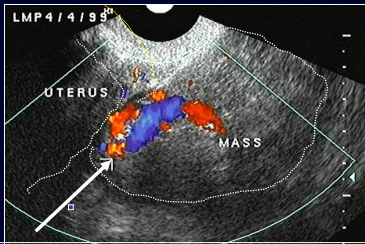
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Solid fibromas: Macro' & micro' of Benner tumor



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Differential diagnosis : intraligamentar myoma or myoma on a pedicle



Search for vascular connection between the uterus and the mass

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5-3. Ovarian neoplasms

- 75% of all neoplasms occur in premenopause (of these, only 13% are malignant).
- 75% of malignant neoplasms are diagnosed in menopause.

Timor & Monteagudo

Ovarian neoplasms: several facts

- Thin, unilocular, anechoic cysts without papillae, without solid component, without thick septae, <6 cm, without significant and prominent blood vessels, (i.e. "simple cysts") are virtually never malignant.
(Some* believe in no follow-up of them at all.)
- Caveat: Before calling them "simple cysts" scrutinize them for the above sono characteristics, possibly using gray scale and color Doppler transvaginal ultrasound

--Valentin L. Timmerman D

--van Nagell JR Jr., Miller, RW. Management of Asymptomatic Ovarian Tumors Obstet Gynecol 2016;127:848-58

Timor & Monteagudo

Ovarian neoplasms

- Most prevalent: dermoid cysts (cystic teratoma) and serous cystadenomas.
- Size matters: malignant neoplasms are larger than benign.

Tumor size	Total	Malignancies
<5cm	32	1
5 - 10 cm	55	6
> 10 cm	63	40

Rulin & Preston. Obstet Gynecol 1987; 70:578

Timor & Monteagudo

Cystic teratoma (dermoid cysts)

A grayscale ultrasound image of a cystic teratoma. The image shows a large, complex mass with internal echoes and a label 'Fat globes' pointing to a specific area. Technical details like '12.5cm' and '1.0' are visible on the right side of the image.

A photograph of a gross specimen of a cystic teratoma. The specimen is a large, multi-lobed, reddish-brown mass with a complex, irregular shape, resting on a blue surgical drape.

Sono markers:

1. Variable, sometimes bizarre appearance
2. Shadowing!!!
3. Rarely has blood vessels (if so: think struma ovarii!)
4. There is ALMOST no typical or UNIFORM appearance

Tumor & Montecarlo



Cystic teratoma (dermoid cysts)

Top left: Ultrasound image showing a complex, heterogeneous mass.

Top middle: Another ultrasound image of a similar mass.

Top right: Ultrasound image with a 'fried egg sign' annotation, indicating a characteristic finding in dermoid cysts.

Middle left: MRI scan showing a large, well-defined mass with internal signal heterogeneity, consistent with the presence of fatty tissue.

Middle right: Text box stating "3D not particularly useful".

Bottom left: Clinical photograph of a large, protruding dermoid cyst on a patient's back.

Bottom right: Axial CT scan showing a large, well-defined mass with internal heterogeneity, consistent with the presence of fatty tissue.

Magnetic resonance imaging (MRI) shows fatty tissue well, however US is less expensive.

3D not particularly useful

Figure 12 Surface-reconstructed image of a dermoid cyst with a small calcification focus at the base of the cyst (arrow).

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Benign cystadenoma
mucinous or serous

Characteristic features:

- Septae fanning from one point
- No shadowing solid component
- Sonolucent (serous) or low-level echogenic (mucinous) fluid
- Paucity of blood vessels
- RI >0.46, PI >0.62, PSV <12 cm/s



Hormone-secreting tumors

- Usually vascular
- Have general clinical symptoms
- Watch out for effect on target organs.

Steroid cell tumors

Sono characteristics:

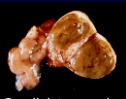
- Small size, homogeneous echogenicity
- Rich vascular ring around its periphery

Male hairline

Small, intra-ovarian, yellowish tumor

Found usually by its clinical presentation & laboratory tests

Monteagudo A et al. Ovarian steroid cell tumors: sonographic characteristics. UOG 1997;10:28



Granulosa cell tumor

In this case blood flow with: Low RI and PI

Best clue to the correct Dx is NOT the ovary!
Look at the next slide.

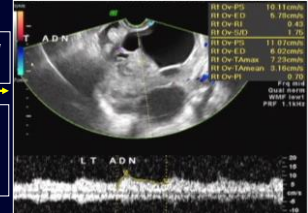
Sono markers:

- Ovary with multiseptated, multilocular structures
- Solid hyperechoic areas
- Usually vascular
- Usually in patients with high BMI

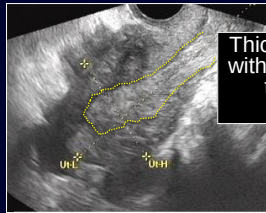
RI	0w-PI	10.11 mm/s
RI	0w-R1	6.78 mm/s
RI	0w-R1	0.43
RI	0w-PI	1.20
RI	0w-PI	11.07 mm/s
RI	0w-R1	6.52 mm/s
RI	0w-R1	7.86 mm/s
RI	0w-R1	3.16 mm/s
RI	0w-PI	2.00
RI	0w-PI	4.64 mm/s
RI	0w-PI	4.64 mm/s
RI	0w-PI	1.1402

LT ADN

Tumor & Metastases



Granulosa cell tumor



The clue:

Thick, hyperechoic endometrium with microcystic changes similar to cases with endometrial hyperplasia

As a matter of fact: **IT IS endometrial hyperplasia** as a result of estrogen production of the tumor



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Granulosa cell tumor

16 patients with surgically proven ovarian GCTs. Ages ranged from 10 to 64 years (mean, 37.7 years).

- Diameters were 2.0 to 15.4 cm (mean, 8.2cm).
- The morphologic appearances classified into 3 patterns;
 - Solid and cystic** (n=10), with macrofollicular and microfollicular patterns with trabecular pattern without cystic changes or hemorrhagic foci.
 - Solid with a sponge form appearance** (n=4) had prominent hemorrhagic necrosis and diffuse proliferation of granulosa
 - Entirely solid** (n=2). The measured resistive index and pulsatility index of the solid portions were 0.23 to 0.5 and 0.26 to 0.62, respectively.

Jeong-Ah Kim et al. High-Resolution Sonographic Findings of Ovarian Granulosa Cell Tumors JUM 2010; 29:187-193

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The Ovary

5-4. Malignant Neoplasms



Timor & Monteagudo

Ovarian neoplasms: several facts

- Thin, unilocular, anechoic cysts without papillae, without solid component, without thick septae, <6 cm, without significant and prominent blood vessels, (i.e. "simple cysts") are virtually never malignant.
(Some* believe in no follow-up of them at all.)
- Caveat: Before calling them "simple cysts" scrutinize them for the above sono characteristics, possibly using gray scale and color Doppler transvaginal ultrasound

--Valentin L. Timmerman D

--van Nagell JR Jr., Miller, RW. Management of Asymptomatic Ovarian Tumors Obstet Gynecol 2016;127:848-58

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It is worth to recapitulate the building blocks of ovarian pathology

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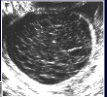
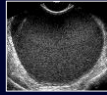
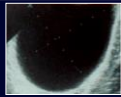
Morphologic building blocks for adnexal mass characterization by gray scale US

- Wall thickness:** thin or thick →
- Loculations:** unilocular or multilocular →
- Papillations:** yes or no →
- Echogenicity:** sonolucent, low level echoes, highly echogenic, solid →
- Shadowing:** yes or no →
- Complex or bizarre appearance** →

Timor & Monteagudo

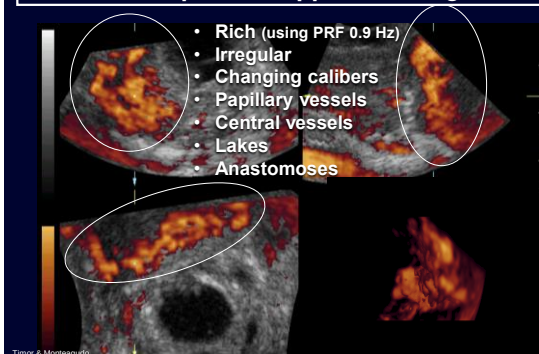
Echogenicity/"texture" of tissues (gray scale)

- Clear, anechoic fluid: serous fluid
- Low level echoes: cellular debris ? "Old" blood?
- Echogenic or reticular: ? Blood clots 1st 72 hrs?
- Highly echo: Bone, dense tissue



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Blood vessels in an ovarian cancer using color and power Doppler interrogation



Timor & Monteagudo

6. Scoring systems to differentiate between benign and malignant ovarian masses

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Before using scoring systems I want you to understand that subjective evaluation based upon understanding and using the sono definitions of ovarian pathology there is a realistic possibility to assess an adnexal mass/es by the practicing gynecologist

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I base it on a scientifically proven set of articles suggesting that subjective evaluation of adnexal masses is almost as good as the evaluation based upon strict scoring systems

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US-based scoring systems

- Translate macroscopic, clinical, and pathologic features and appearances to sonographically recognizable features.
- All or most sono-scoring systems are based upon the same building blocks:
 - Wall thickness
 - Septations
 - Echogenicity
 - Papillary formations
 - Solid components
 - Blood supply (vascularity)
- Some systems add: size, ascites, age, etc...

Timor & Monteagudo

You may use Morphology Scoring Systems: they are out there.

- Sassone M, Timor-Tritsch et al, AJOG 1991
- Kentucky. DePriest et al, Gynecol Oncol 1997
- 1993; Osmer, AJOG 1994
- Bromley et al, Obstet Gynecol 1994
- Lerner JP, Timor-Tritsch al, AJOG 1994
- Kurjak, UOG 1994
- Ferazzi, UOG 1998
- IOT A. Timmerman, UOG 1999 (Neural Network analysis)

However, you do not have to apply them to the letter. Just understand their basic idea to differentiate benign tumor & from suspicious or malignant

Timor & Monteagudo

The first sonographic scoring system published

Chen H, Cernito
doi: 10.1016/j.ajog.2004.04.004
Transvaginal Sonographic Characterization of Ovarian Disease: Evaluation of a New Scoring System to Predict Ovarian Malignancy

J. MARCHESITA SASSONE, MD, ILAN E. TIMOR-TRITSCH, MD, ATTILA ARTHUR, MD, CAROLYN WESTHOFF, MD, AND WENDY B. WARREN, MD

VARIABLE	VARIABLES			
	INNER WALL STRUCTURE	WALL THICKNESS(mm)	SEPTA(mm)	ECHOTEXTURE
1	smooth	thin < 3 mm	No septa	Benign
2	irregular < 2 mm	thin < 3 mm	thin < 3 mm	low echogenicity
3	papillary > 2mm	not applicable, mostly solid	thick > 3 mm	Low echogenicity with echogenic area
4	not applicable, mostly solid			mixed echogenicity
				high echogenicity

The scoring system devised was useful in distinguishing benign from malignant masses, with a specificity of 83%, sensitivity of 100%, and positive and negative predictive values of 37 and 100%, respectively.

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6-1. The Kentucky scoring system

Sonographic images of benign and malignant ovarian morphology. Numeric representation of increasing morphologic complexity is noted in the first column.

0	Benign simple cyst		
1	Benign hemorrhagic cyst		
2	Benign cyst with septation(s)		
3	Malignancy with papillary projections		
4	Malignancy with solid components		
5	Solid malignancy with ascites		

John R van Nagell Jr & John T Hoff: Transvaginal sonography in ovarian screening: current perspectives, International journal of women's health 2013

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6-2. The IOTA scoring systems

The **simple rules** by the IOTA group

But first : What is the IOTA group?

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The IOTA group

- The International Ovarian Tumor Analysis (IOTA) group was founded in 1999 by Dirk Timmerman, Lil Valentin and Tom Bourne.
- Its first aim was to develop standardized terminology.
- In 2000, IOTA published a consensus statement on terms, definitions and measurements to describe the sonographic features of adnexal masses, which is now widely used.
- IOTA now covers a multitude of studies examining many aspects of gynecological ultrasonography within a network of contributing centers throughout the world that are coordinated from KU Leuven.

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Risk assessment of adnexal masses based on the IOTA **Simple Rules**

Dirk TIMMERMAN, MD, PhD^{1,2,*}, Ben VAN CALSTER, MSc, PhD^{1,*}, Antonia TESTA, MD, PhD³, Luca SAVELLI, MD, PhD⁴, Daniela FISCHEROVA, MD, PhD⁵, Wouter FROYMAN, MD^{1,2}, Laure WYNANTS, MSc^{5,7}, Caroline VAN HOLSBEKE, MD, PhD^{2,8}, Elisabeth EPSTEIN, MD, PhD⁹, Dorella FRANCHI, MD¹⁰, Jeroen KAUJER, MD, PhD^{2,11}, Artur CZEKIERDOWSKI, MD, PhD¹², Stefano GUERRIERO, MD, PhD¹³, Robert FRUSCIO, MD, PhD¹⁴, Francesco PG LEONE, MD¹⁵, Alberto ROSSI, MD¹⁶, Chiara LANDOLFO, MD^{1,2}, Ignace VERGOTE, MD, PhD^{2,17}, Tom BOURNE, MD, PhD^{12,18}, Lil VALENTIN, MD, PhD¹⁹ AJOG 2016

* Joint first author

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Background

- Accurate methods to preoperatively characterize adnexal tumors are pivotal for optimal patient management.
- A recent meta-analysis* concluded that the International Ovarian Tumor Analysis (IOTA) algorithms such as the Simple Rules are the best approaches to preoperatively classify adnexal masses as benign or malignant.

(* Kujser J, Sayasneh A, Van Hoorde K, et al. Presurgical diagnosis of adnexal tumours using mathematical models and scoring systems: A systematic review and meta-analysis. Hum Reprod Update 2014;20(3):449-462.

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IOTA Simple Rules

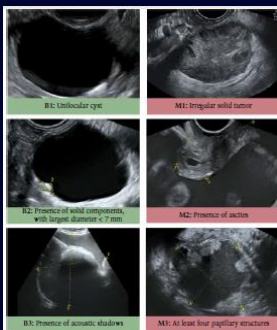
Ultrasound features predictive for a malignant tumor (M-features)	Features predictive for a benign tumor (B-features)
M1 Irregular solid tumor	B1 Unilocular
M2 Presence of ascites	B2 Presence of solid components where the largest solid component has a largest diameter < 7 mm
M3 At least 4 papillary structures	B3 Presence of acoustic shadows
M4 Irregular multilocular-solid tumor with largest diameter ≥ 100 mm	B4 Smooth multilocular tumor with largest diameter < 100 mm
M5 Very strong blood flow (color score 4)	B5 No blood flow (color score 1)

Timmerman D, Testa AC, Bourne T, et al. Simple ultrasound-based rules for the diagnosis of ovarian cancer. Ultrasound Obstet Gynecol 2008;31(6):681-690.

Timor & Monteagudo

IOTA Simple Rules

Ultrasound features used in the International Ovarian Tumor Analysis (IOTA) simple rules, illustrated by ultrasound images. B1–B5, benign features; M1–M5, malignant features.

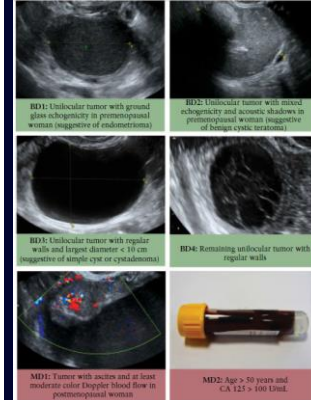


Timmerman D, Testa AC, Bourne T, et al. Simple ultrasound-based rules for the diagnosis of ovarian cancer. Ultrasound Obstet Gynecol 2008;31(6):681-690.

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IOTA Simple Rules

International Ovarian Tumor Analysis (IOTA) 'easy descriptors' illustrated by ultrasound images. BD1–BD4, benign descriptors; MD1–MD2, malignant descriptors.



Timmerman D, Testa AC, Bourne T, et al. Simple ultrasound-based rules for the diagnosis of ovarian cancer. Ultrasound Obstet Gynecol 2008;31(6):681-690.

Timor & Monteagudo

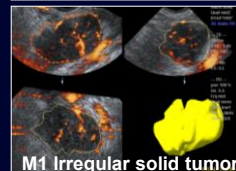
IOTA Simple Rules

- If one or more M-features apply in the absence of a B-feature, the mass is classified as malignant.
- If one or more B-features apply in the absence of an M-feature, the mass is classified as benign.
- If both M-features and B-features apply, the mass cannot be classified. If no feature applies, the mass cannot be classified.
- Correct application of the Simple Rules requires the knowledge and proper use of the ultrasound features, as published by the IOTA group.*

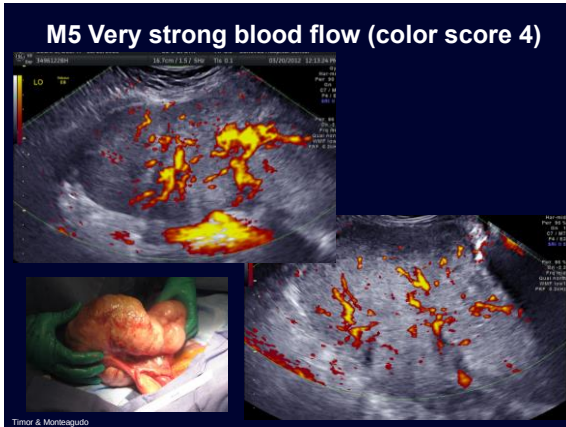
Timmerman D, Testa AC, Bourne T, et al. Simple ultrasound-based rules for the diagnosis of ovarian cancer. Ultrasound Obstet Gynecol 2008;31(6):681-690.

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Malignant US features (M)



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IOTA color score

Subjective assessment of blood flow

- 1 Color score of 1 is given when no blood flow within the septa, cyst walls, or solid tumor areas.
- 2 Color score of 2 is given when only minimal flow can be detected.
- 3 Color score of 3 is given when moderate flow is present.
- 4 Color score of 4 is given when the adnexal mass appears highly vascular with marked blood flow.

Courtesy of D. Fischerova

D. Timmerman, B. Van Calster, A. Testa, L. Savelli, D. Fischerova, W. Croymen, L. Wynants, C. Van Houben, E. Epstein, D. Franchi, J. Kallier, A. Casanueva, B. Goffin, R. Prentice, A. Ezzou, A. Rossi, C. Candio, L. Vergone, T. Bourne, L. Valentin. Risk assessment of adnexal masses based on the IOTA Simple Rules. AJOG 2016.

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Benign US features (B)

Addition: I call them shadowing, hyperechoic papillae devoid of blood vessels (clinical diagnosis: benign cystadenofibroma)

B1 Unilocular cyst

B2 Presence of solid components: largest solid component < 7 mm

B3 Presence of acoustic shadows

B4 Smooth multilocular tumor with largest diameter < 100 mm

B5 No blood flow (color score 1)

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IOTA 2013

Timor & Monteagudo

So.....

Don't be scared by the ultrasound image !!

Based upon your gynecologic knowledge base, your clinical experience.....and some of what you will hear today....

YOU CAN differentiate benign from malignant masses in most patients!

The following 4 slides attest to the importance and validity of subjectively assessing adnexal masses.

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Sensitivity and specificity of simple rules, subjective assessment, logistic regression models 1 & 2, & "risk-of-malignancy" index

All cases

Total (n=1501):	Sensitivity (95% CI)	Specificity (95% CI)
Simple rules	92 (89 to 94)	96 (94 to 97)
Subjective assessment	91 (88 to 94)	96 (94 to 97)
Logistic regression model 1	94 (91 to 96)	92 (91 to 94)
Logistic regression model 2	95 (92 to 97)	91 (89 to 92)

Timmerman D et al The IOTA group 2010

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Sensitivity and specificity of simple rules, subjective assessment, logistic regression models 1 & 2, & “risk-of-malignancy” index

Premenopausal

Total (n=969):	Sensitivity (95% CI)	Specificity (95% CI)
Simple rules	91 (84 to 95)	97 (95 to 98)
Subjective assessment	90 (83 to 94)	97 (96 to 98)
Logistic regression model 1	90 (83 to 94)	96 (94 to 97)
Logistic regression model 2	92 (85 to 96)	95 (93 to 96)

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Timmerman D et al The IOTA group 2010

Sensitivity and specificity of simple rules, subjective assessment, logistic regression models 1 & 2, & “risk-of-malignancy” index

Postmenopausal

(n=532):	Sensitivity (95% CI)	Specificity (95% CI)
Simple rules	93 (89 to 95)	92 (89 to 95)
Subjective assessment	91 (87 to 94)	90 (86 to 93)
Logistic regression model 1	96 (93 to 98)	83 (78 to 87)
Logistic regression model 2	97 (93 to 98)	77 (72 to 82)

Timor & Monteagudo

Timmerman D et al The IOTA group 2010

Sensitivity and specificity of simple rules, subjective assessment, logistic regression models 1 and 2, and risk of malignancy index

Cases with CA 125 available

Total (n=1147):	Sensitivity (95% CI)	Specificity (95% CI)
Simple rules	92 (89 to 95)	95 (93 to 96)
Subjective assessment	91 (87 to 93)	95 (93 to 96)
Logistic regression model 1	94 (91 to 96)	91 (89 to 93)
Logistic regression model 2	95 (93 to 97)	89 (87 to 91)
Risk of malignancy index	75 (71 to 80)	95 (93 to 96)

Timor & Monteagudo

Timmerman D et al The IOTA group 2010

7. The Fallopian tube

The normal Fallopian tube

- A normal Fallopian tube is almost impossible to detect sonographically, unless it is surrounded by pelvic fluid, or, fluid is injected in it (hydrosonography)
- However, tubal pathologies can be detected and diagnosed by gray scale and color Doppler transvaginal US

Timor & Monteagudo

Tubal carcinoma

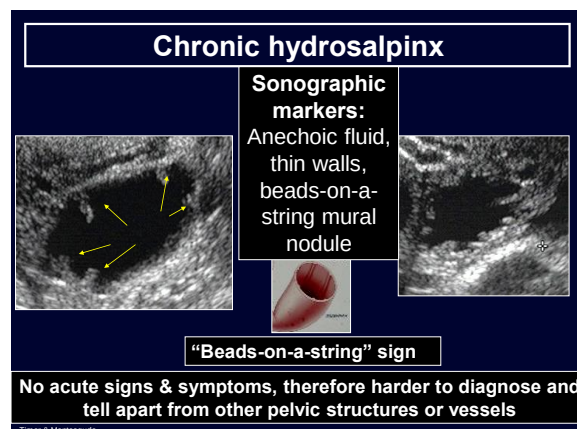
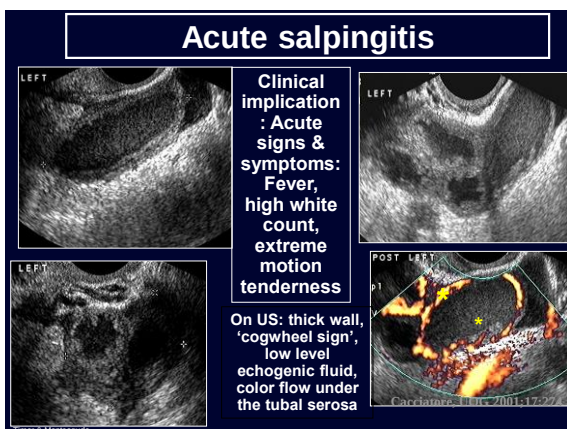
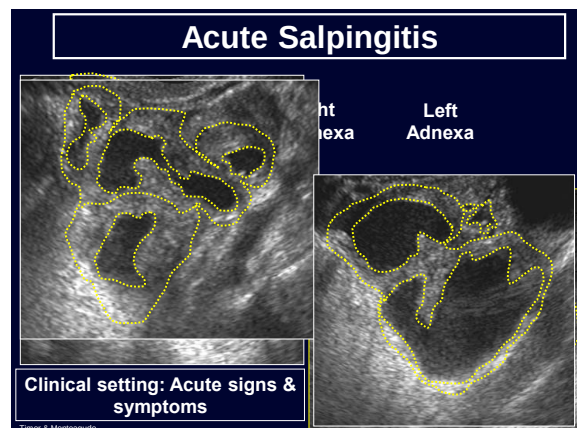
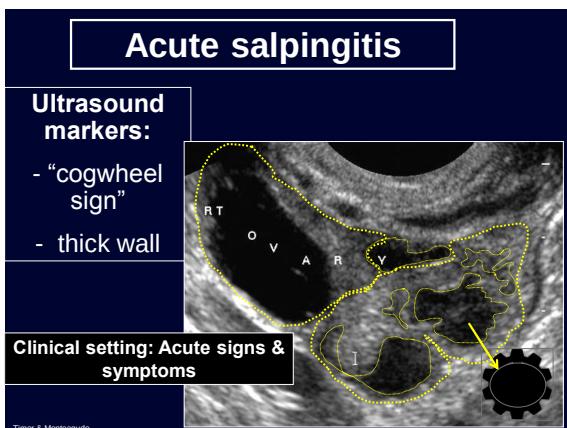
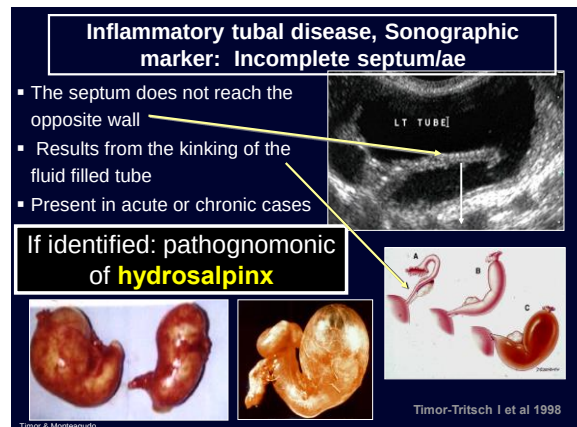
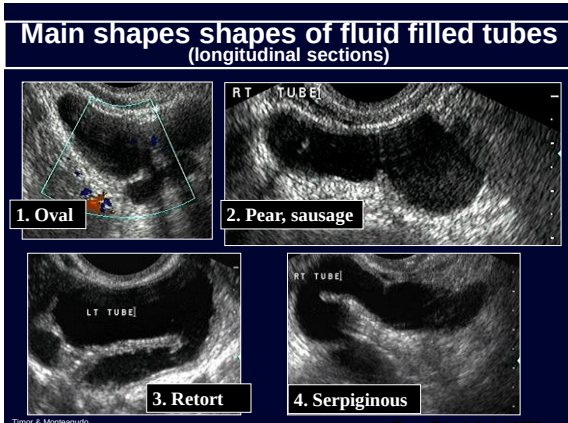
- Primary fallopian tube cancer is the rarest among female genital tract cancers.
- It accounts for 0.3% to 1.8% of these cancers.
- Papillary serous adeno-carcinoma represents more than 90% of these cancers [2, 3].
- Other less common types include clear cell carcinoma, endometroid cancer, germ cell cancers, and sarcoma .

Timor & Monteagudo

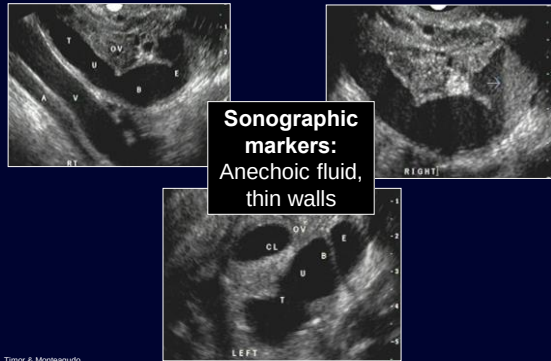
7-1. Inflammatory tubal disease

Transvaginal sonographic markers of tubal inflammatory disease.
Timor-Tritsch IE, Lerner JP, Monteagudo A, Murphy KE, Heller DS.
Ultrasound Obstet Gynecol. 1998 Jul;12(1):56-66.

Timor & Monteagudo



Chronic bilateral hydrosalpinges



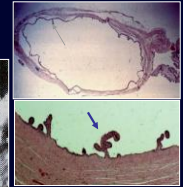
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Sonographic Assessment of chronic hydrosalpinx

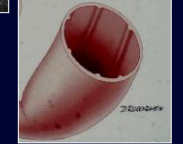


Definition: "Beads-on-a-string"

- ☐ Thin, distended wall
- ☐ Anechoic fluid
- ☐ Fibrosed endosalpingeal folds

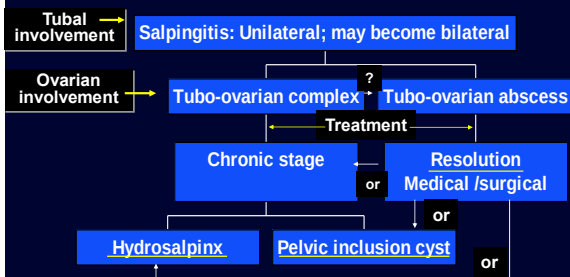


Together they render the tubal wall the appearance of a rosary



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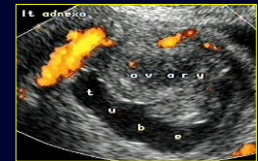
Clinical picture & natural history of PID



1st step in a pelvic inflammatory process: Tubo-ovarian-complex (TOC)

- Clinically: Acute disease, tenderness reversible
- Sonographically: Ovary/tube recognizable

- Thick walls, tubal fluid
- Acute attributes present
- Ovary/tube recognizable
- Thick walls, tubal fluid & incomplete septa
- "Cogwheel sign" (After S. Rottem)



This is not a TOA (yet) !

2nd step in a pelvic inflammatory process: Tubo-ovarian-complex (TOC)

- Clinically: Acute disease, tenderness usually requires surgical treatment
- Sonographically: Ovary/tube un-recognizable
- Confluent fluid loculations
- Speckled fluid
- Usually bilateral
- Located in the cul-de-sac



This, now IS aTOA or an abscess!!

7-2. Tubal cancer

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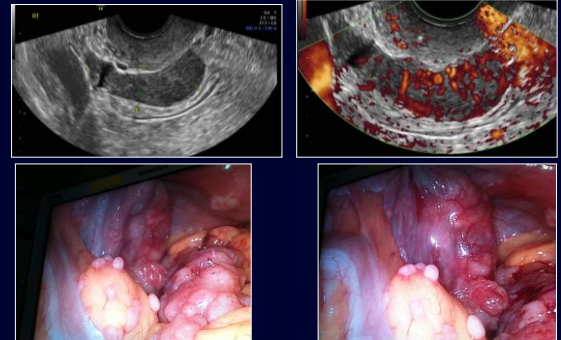
Tubal carcinoma : ultrasound

- Combine c. clinical impression
 - Very rare (1% of all Gyn Ca.)
 - Look for a primary site
- Sono characteristics usually:
 - Adnexal mass, as in ovarian Ca.
 - If sausage shaped, thick wall, cystic area seen, suspect it
 - Finding low RI and PI helps
- If "mistaken" for ovarian Ca., you made a good call!



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Tubal carcinoma

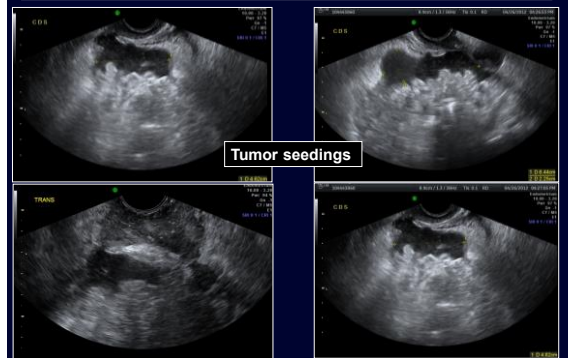


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8. Additional sites to check

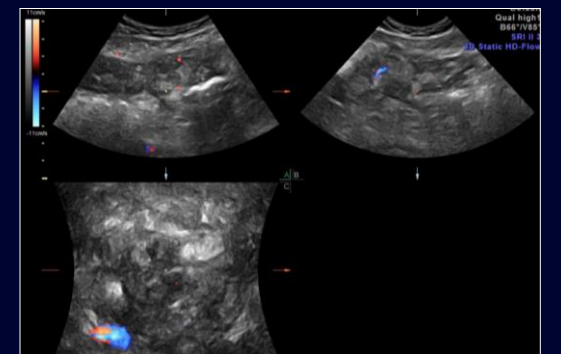
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Cul-de-sac/pelvic peritoneum



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Omentum



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9. Summary and conclusions

Summary and conclusions

- Most of the time adnexal masses carry defined sono characteristics and pathognomonic features (markers)
- The main sono markers of the commonly seen adnexal masses were described to enable a better recognition of their possible histology
- Where relevant, clinical features helping the diagnosis were mentioned
- Where applicable, relevant articles from the contemporary literature were quoted

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Conclusions

- Most adnexal masses can be assessed subjectively using:
 - A transvaginal US probe (TAS if large mass)
 - An enhanced basic US knowledge (Reading REVIEWS)
 - Liberal use of power Doppler
 - Recognizing benign and malignant sono markers
- If you like to use the term : “complex mass”, describe the mass in terms of their sonographic characteristics (possibly the IOTA descriptors)

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Conclusions

- Avoid the word “cyst” referring to follicles or corpora lutea
- Be attuned to the issues of papillae in a cyst (size, number, blood vessels in it)
- Avoid the sentence: “...malignancy can not be ruled out”, use it when really needed
- Use the sentence: “My suspicion of the structure to be malignant is: high, moderate, low, none or can not classify”
- Ask for the help of a GO when in real need

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