Assessment of the ovaries and DD of the pelvic mass

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Overview

- Methodology

- Normal ovary

- Fertility evaluation

- Pelvic masses

- IOTA

- Examples and cases types of masses

- Benign: Endometriomas, Dermoid cysts

- BOT

- Malignant

- Ovarian cancer evaluation, metastases

Start with a transabdominal scan

- Gives an overview of the pelvis (and abdomen)

- Mutual relationship of the pelvic organs

- Best way to measure uterine diameters

- Avoids overlooking masses located in the upper pelvis

- Takes less than 1 minute

- Longitudinal and transverse section

- Allows visualization of abdominal wall and kidneys

- Bladder does not have to be full (Benacerraf JUM 2003: 83.5% TVS only, 15% TAS without full bladder, 1.5% TAS completely full bladder)
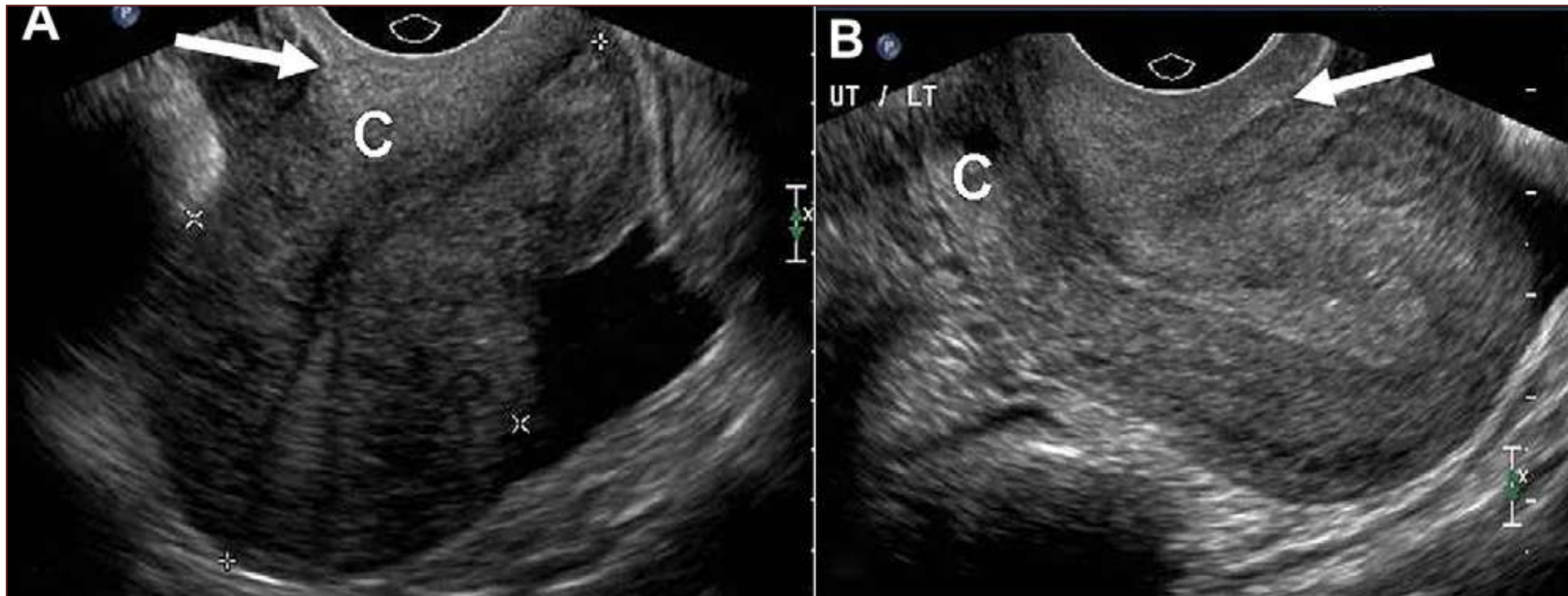
Limitations of only TVS scanning

- High resolution TVS probes have limited penetration: uteri > 8-10 cm are incompletely evaluated
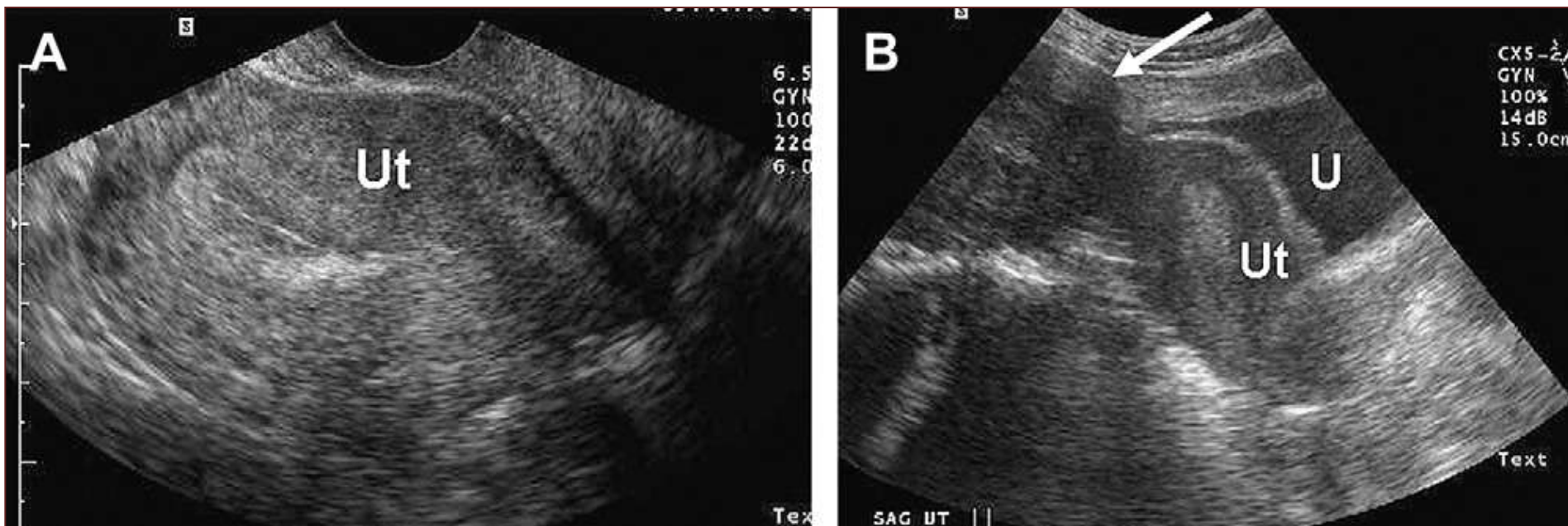
Location of probe

(A) Transvaginal sagittal, transducer in the anterior vaginal fornix (thick arrow): unfavorable, low-resolution image of a retroverted and mildly retroflexed uterus that is almost parallel to the US beam.
(B) Transducer is gently manipulated into the posterior vaginal fornix (thick arrow) and light, steady manual pressure exerted on the uterus. The uterus changes into a more retroverted position and the body, fundus, and endometrium become more perpendicular to the beam.

How to look for the ovaries

- After evaluating the uterus on a transverse section, find the level at which the utero-ovarian ligament lies

- Tilt the probe laterally

- Find out were the pelvic wall is

- Slip up & down until you find the ovary

- Go back to the transverse section of the uterus

- Do the same for the contralateral ovary

Remember – you have 2 hands

- Use the free hand to palpate the pelvis, it can be useful to:
    – Revert the uterus in cases of stretched uterus
    – Push the ovary toward to probe
    – Check for mobility
    – Separate masses in close proximity
    – Movement of internal echoes
    – Differentiating hollow structures

US is dynamic and interactive

- Pressure and retraction of the probe allows to assess mobility and elasticity of the structures, as well as tenderness of a given organ

- Are organs fixed or mobile (sliding)?
- Organ tenderness?
- Elasticity
- Is there any peristalsis?
- Cyst contents (streaming, jelly)

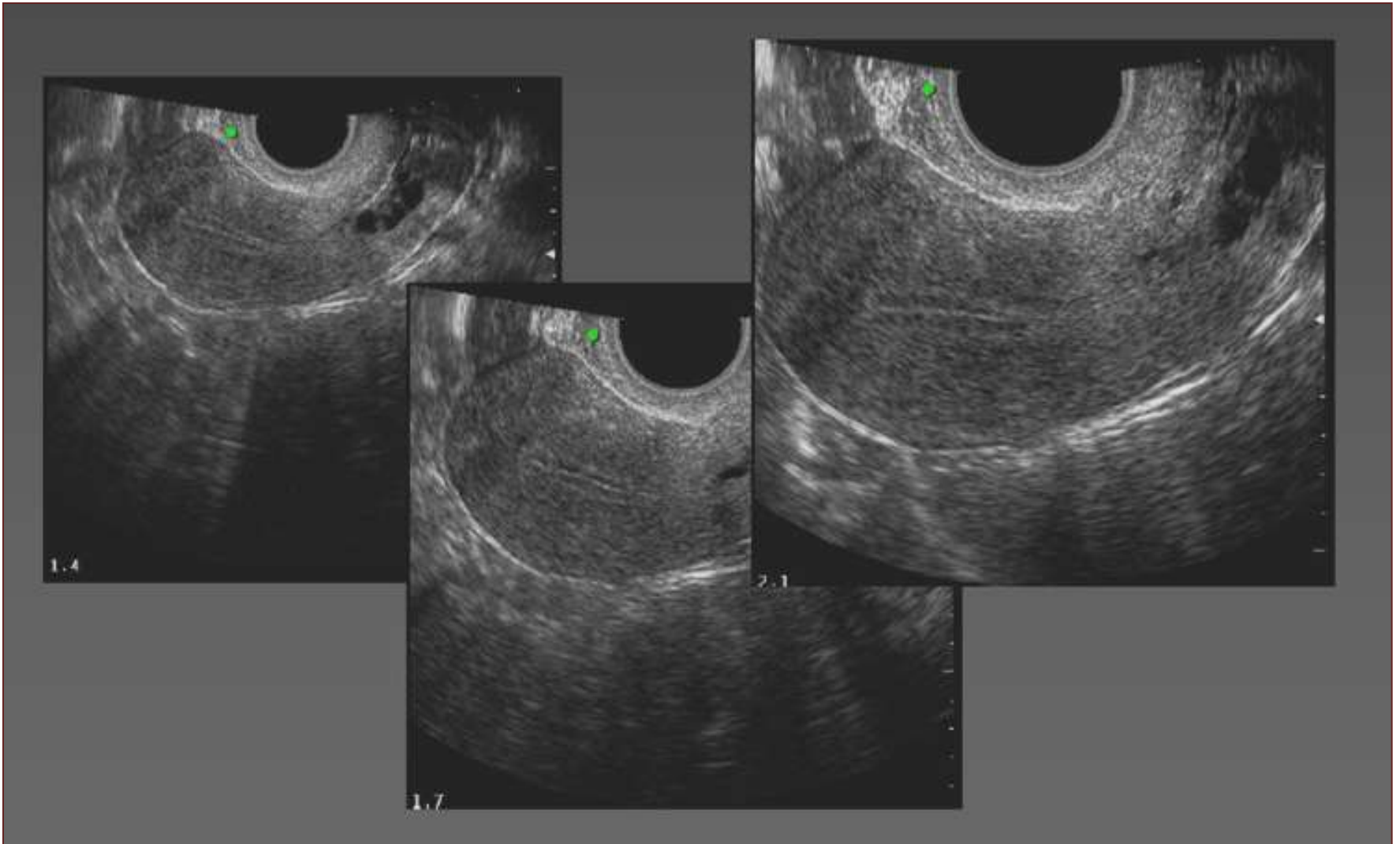# **Optimization of the image**

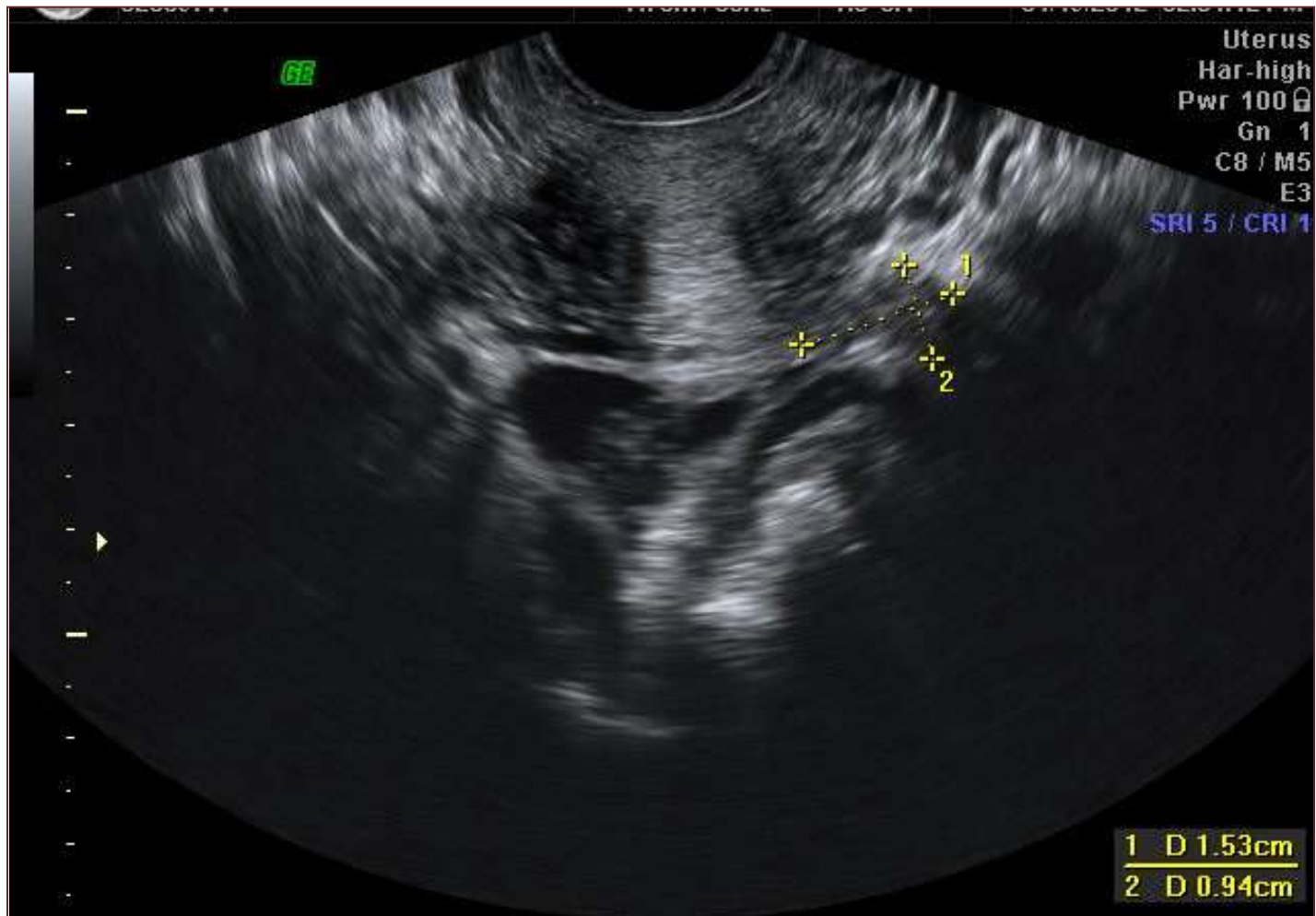# Adjust focal point

- ONE correctly placed

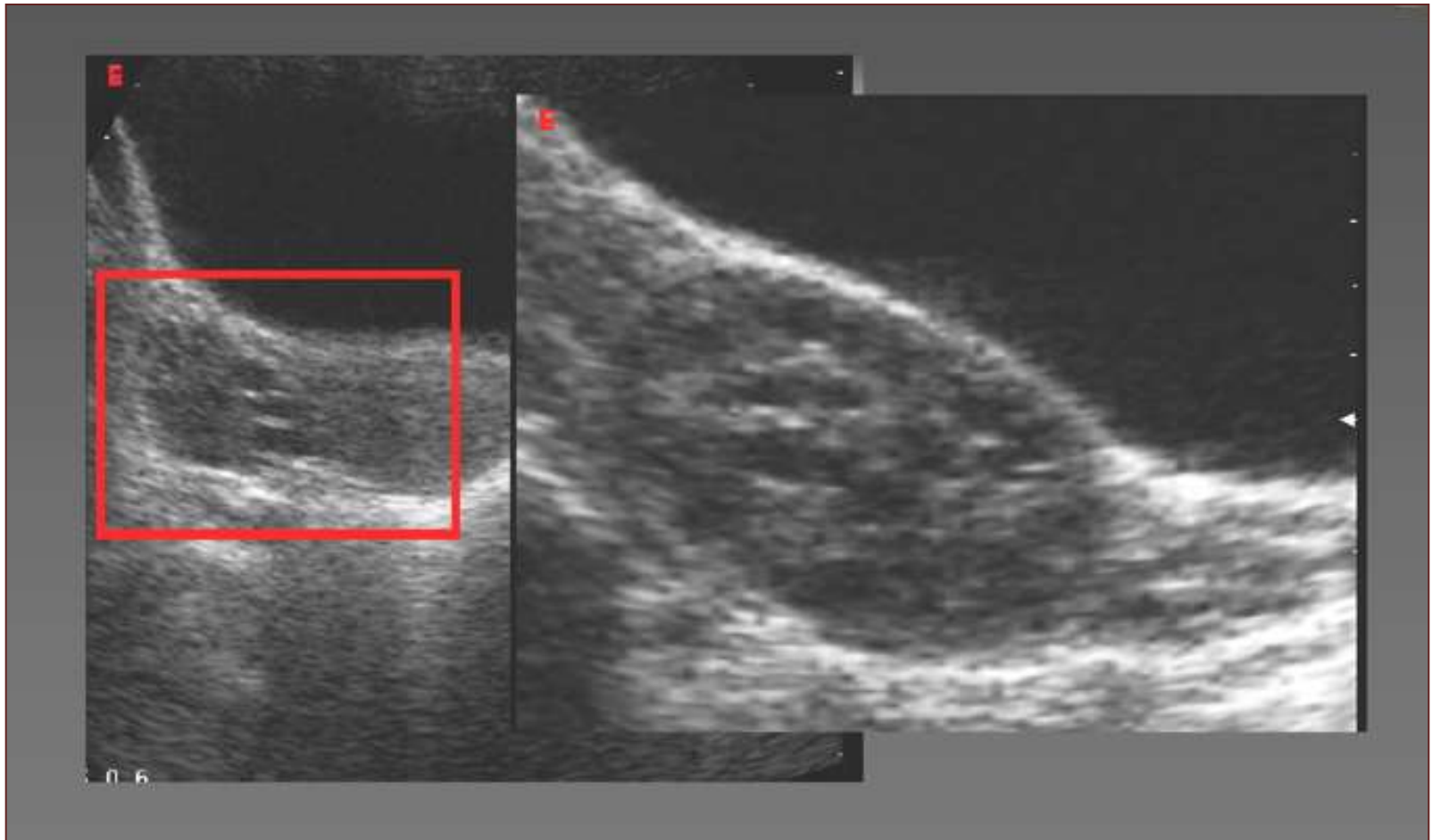# Adjust depth

- Small depth
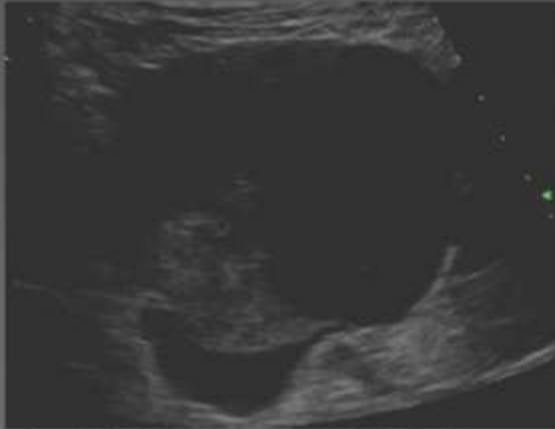
Adjust angle

• Small image angle

Adjust zoom

- True zoom

Adjust gain

Test – lower gain, compare with adjacent fluid structures and increase gain
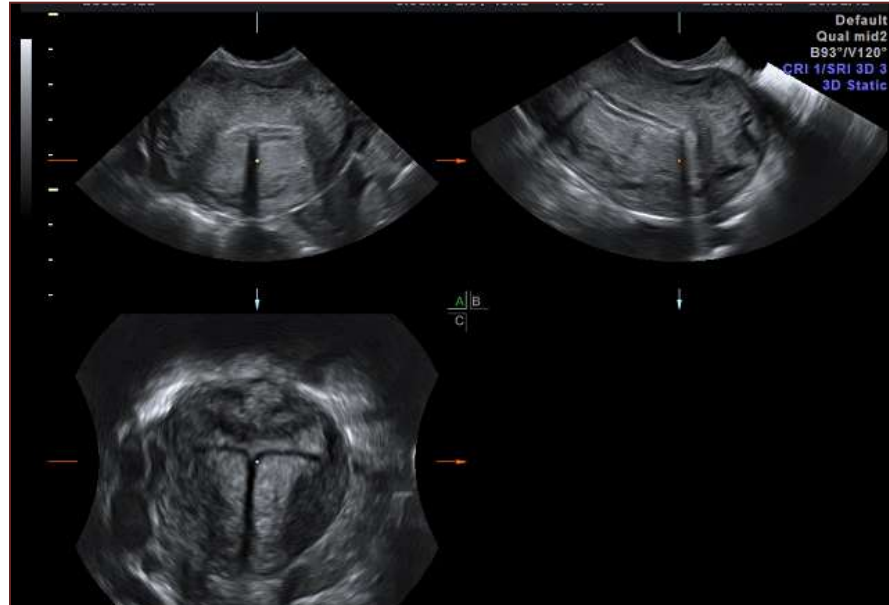
Adjust dynamic range

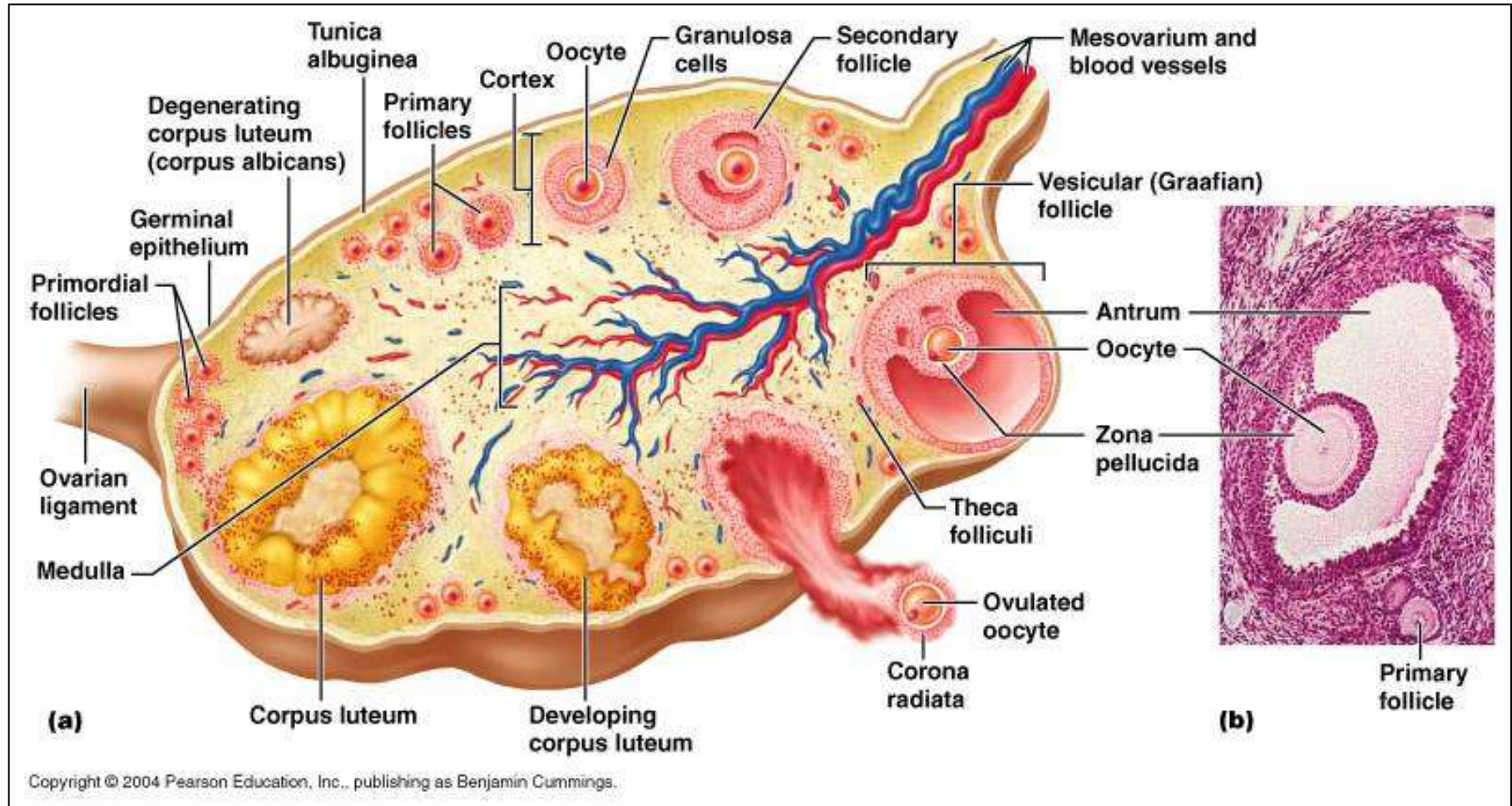# Adjust power level

Acoustic shadow

Blind spots in the pelvis

- Upper pelvis above the uterus
- Laterally along pelvic sidewalls
- Deep in the cul-de-sac
- Markedly anterior to uterus

- Important when searching for ovaries
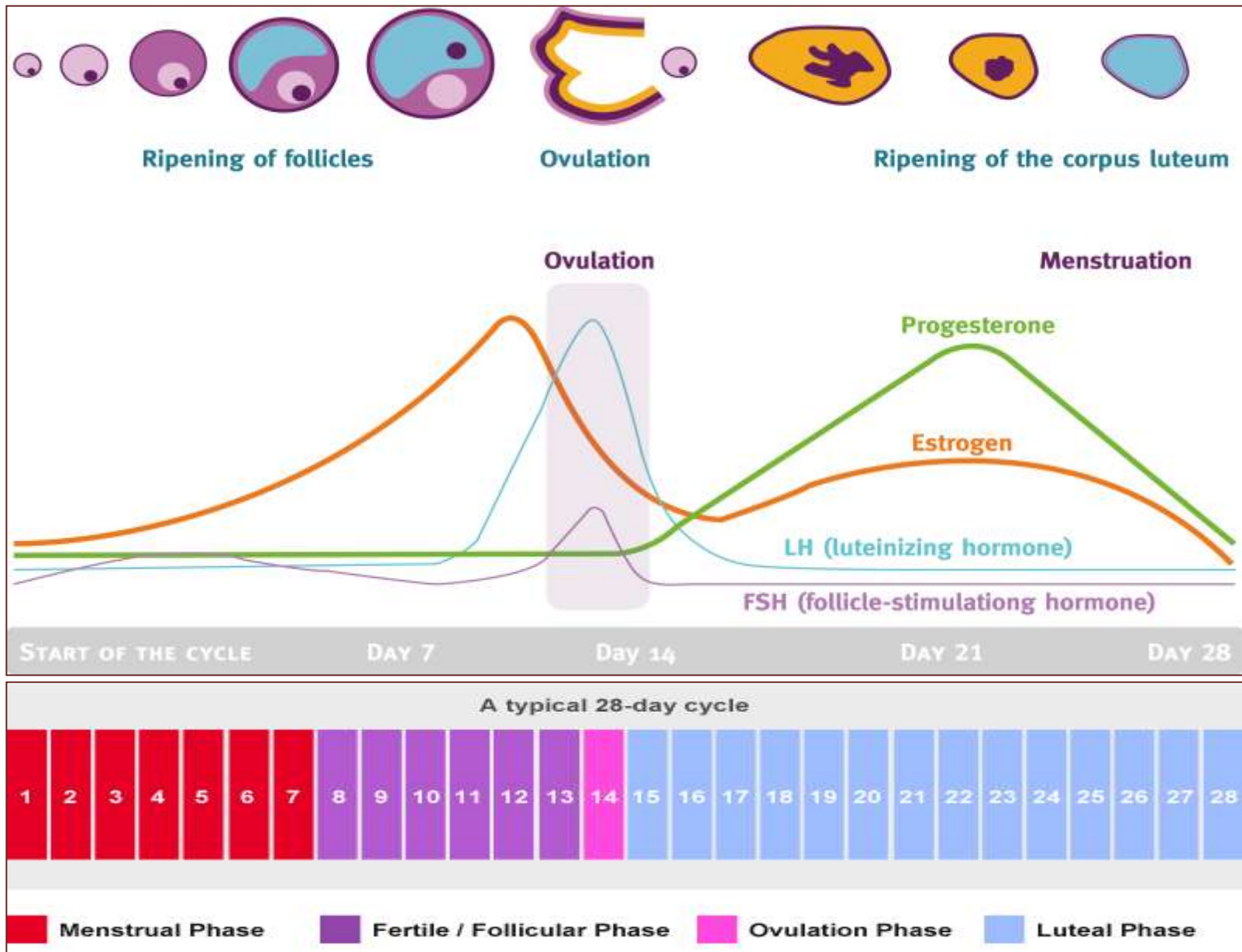- Looking for ectopic pregnancies
- Remember TAS

The normal ovary

Ovarian structure

Copyright © 2004 Pearson Education, Inc., publishing as Benjamin Cummings.

Menstrual cycle

Ripening of follicles **Ovulation** **Ripening of the corpus luteum**

Ovulation **Menstruation**

Progesterone

Estrogen

LH (luteinizing hormone)

FSH (follicle-stimulationg hormone)

START OF THE CYCLE DAY 7 Day 14 DAY 21 DAY 28

A typical 28-day cycle

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

Menstrual Phase Fertile / Follicular Phase Ovulation Phase Luteal Phase

Normal size of the ovaries

| Phase of Life	Mean Volume (cc)	Upper Limit of Normal Volume (cc)
0-3 months	1	4
3 months-2 years	1	3
Premenarchal (3-15 years)	3	9
Menstrual female	10	22
Postmenopausal	6	14
>15 years after menopause	2	4

- Long axis 3 cm

- AP and transverse 2 cm

- Medial to pelvic vessels

- Postmenopausal – if more than twice the volume of their contralateral counterpart === abnormal
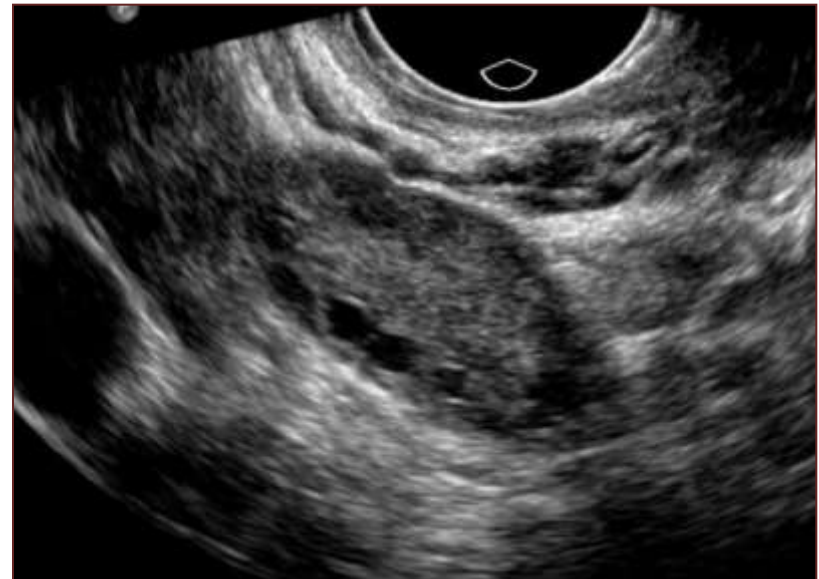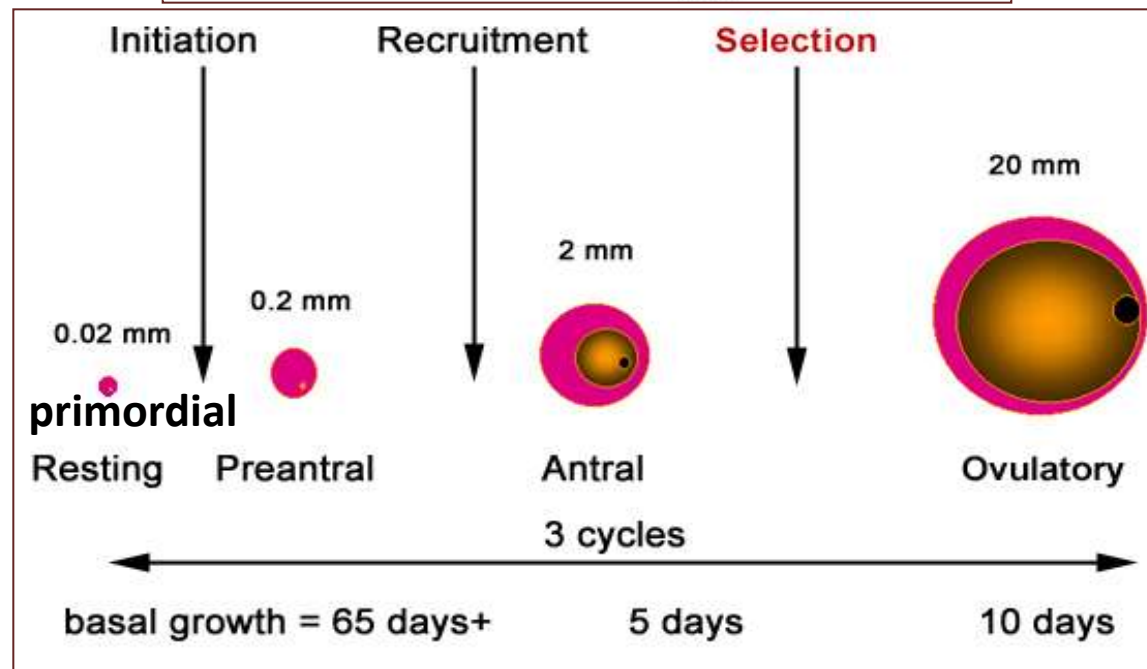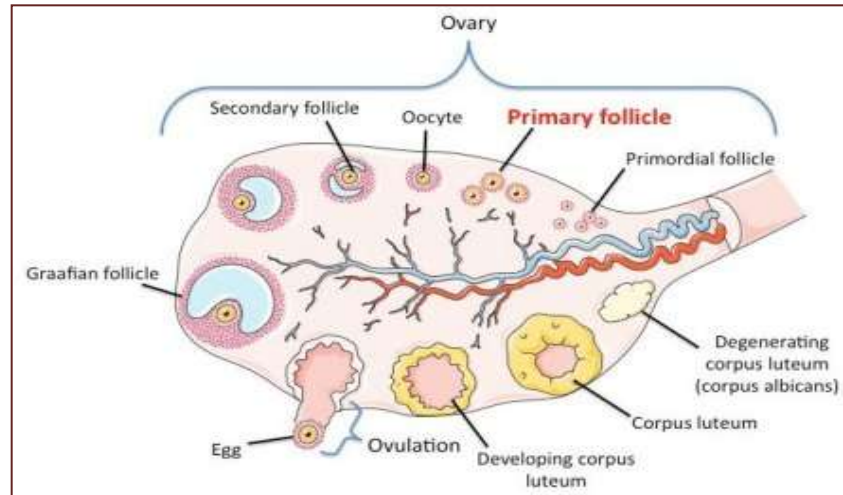
Sonographic evaluation of ovarian reserve

- AFC – Antral Follicular Count

- Ovarian volume

- Ovarian stromal blood flow

- Compared with AMH
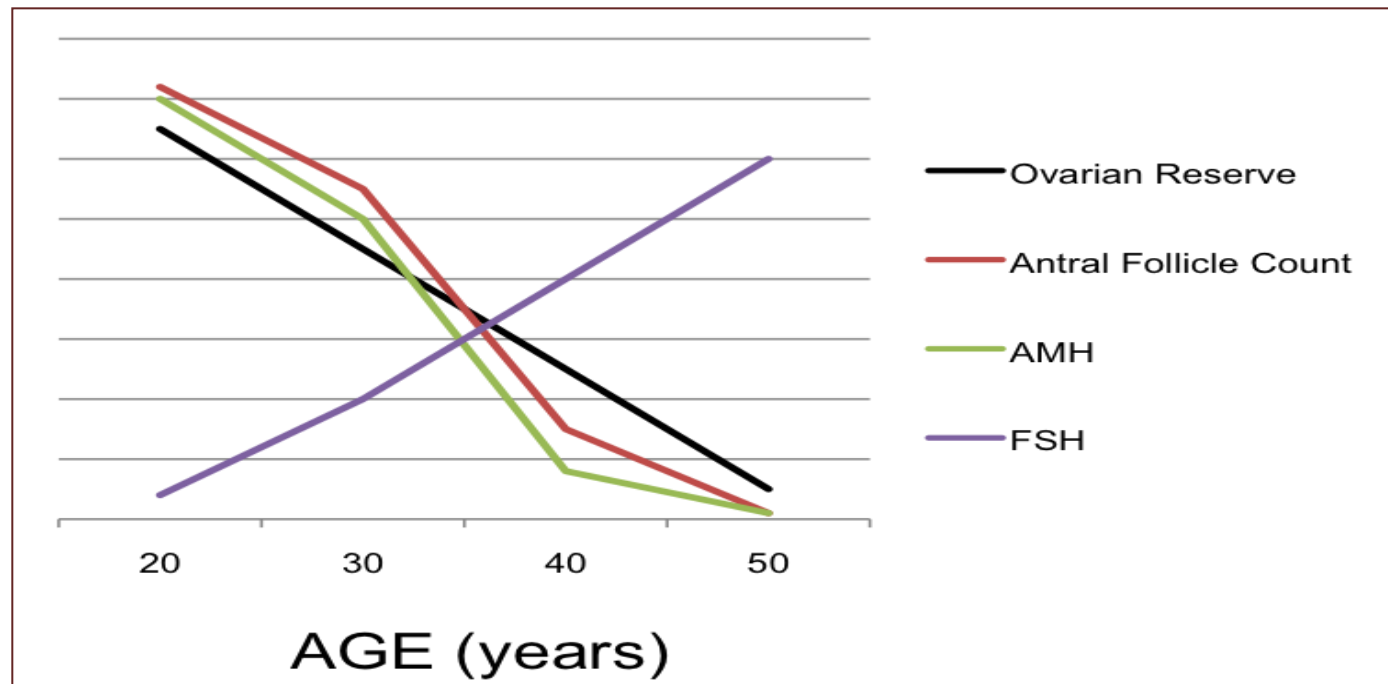
Pool of primordial follicles in the ovary is related to the no. of growing antral follicles

Sonographic evaluation of ovarian reserve

- ## Ovarian reserve
  - Total no. of follicles that can be stimulated to grow under maximal stimulation
  - Antral follicles responsive to gonadotropin stimulation are the ovarian reserve

- ## Antral follicle count - AFC
  - The # of follicles < 10 mm detected by TVS in early follicular phase
  - The number of small follicles (2–6 mm) declines with age; the number of larger follicles (7–10 mm) remains constant!!!!
  - **2–6 mm follicles represent the functional quantitative ovarian reserve**

Antral follicle count

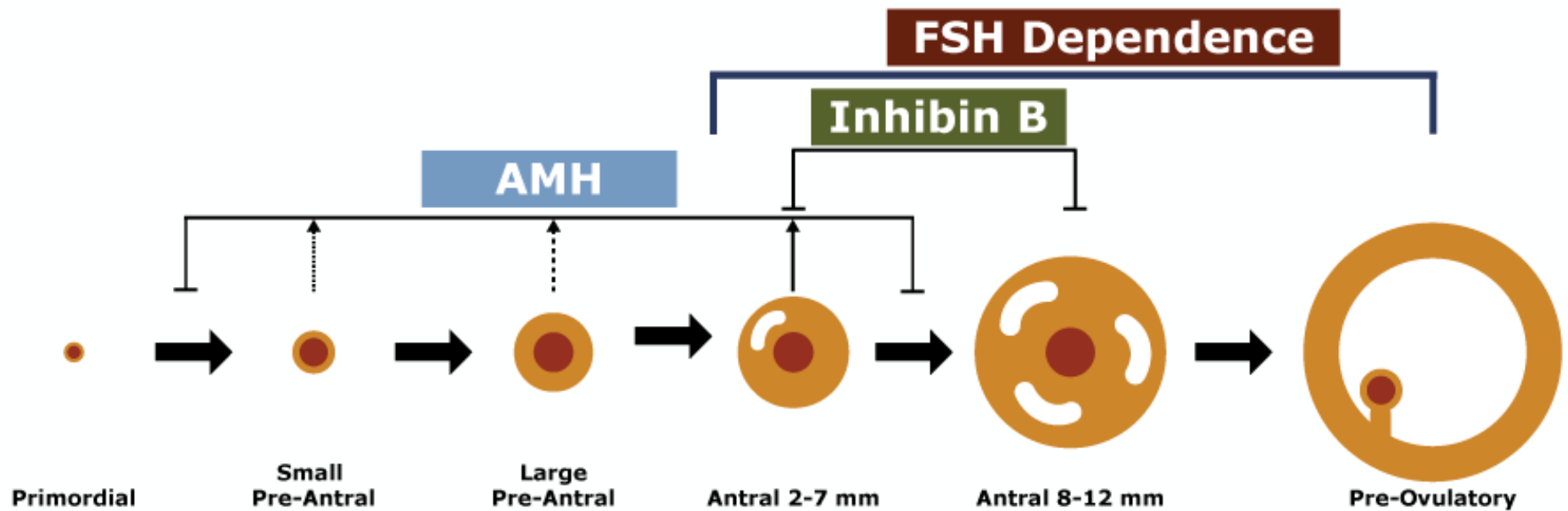- Follicles 2 to 6 mm on Day 1 or 2

- Low Inter-observer variation

- If total AFC < 4- significantly worse outcome- cancellation
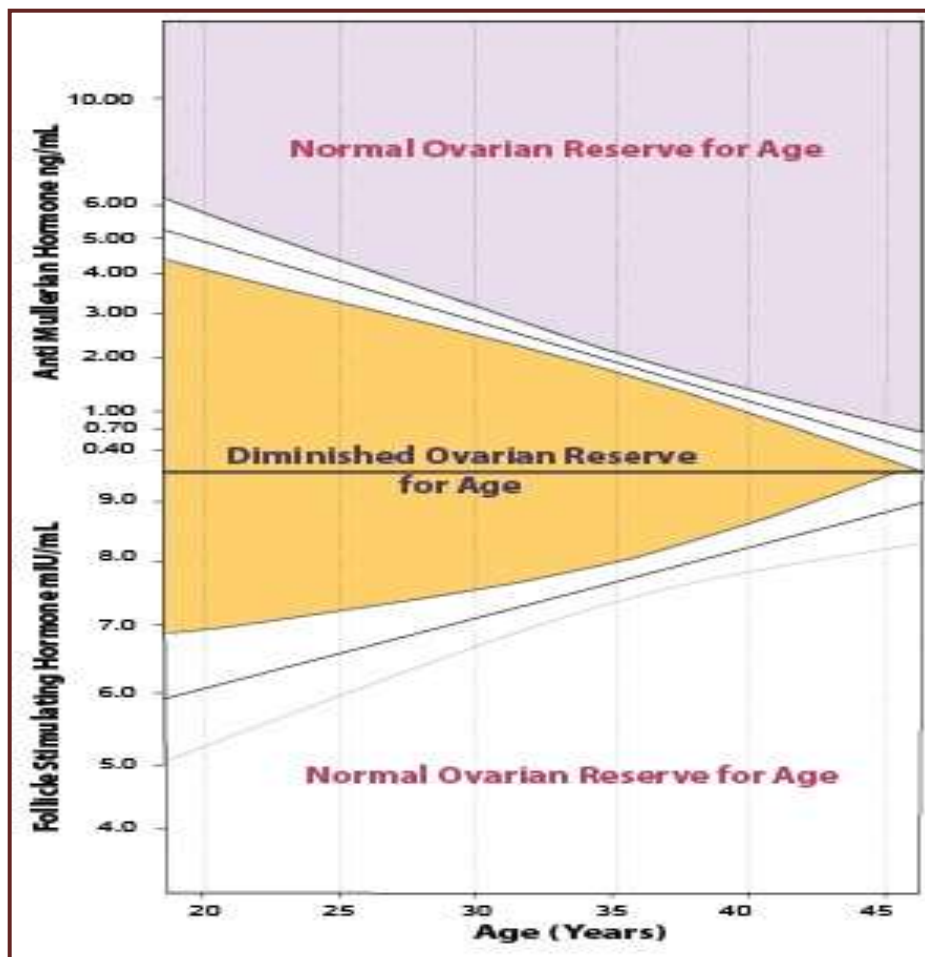
- Total > 14 adjust dose to prevent OHSS
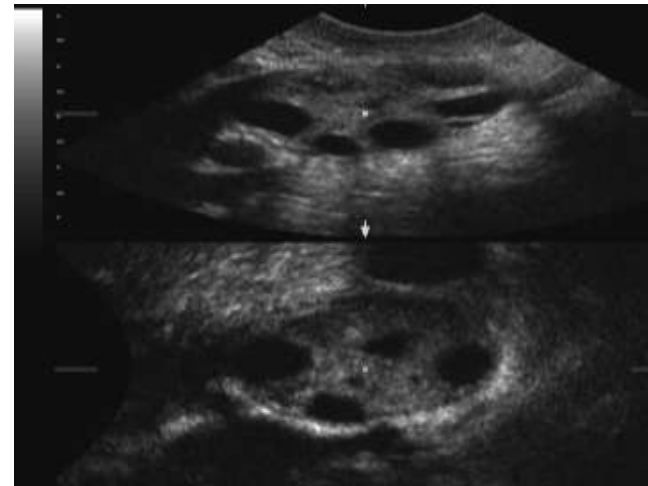
AMH- Anti-Müllerian hormone

Reflects the follicular ovarian pool ⬇ in the number of small growing follicles ➡ ⬇circulating AMH

AMH- Anti-Müllerian hormone

| רמות AMHו- FSHבגילים השונים		
גיל	FSH	AMH
מתחת גיל 33	פחות מ- 7.0 mIU/ml	2.1 ng/ml
בגיל 33-37	פחות מ-7.9 mIU/ml	1.7 ng/ml
בגיל 38-40	פחות מ- 8.4 mIU/ml	1.1 ng/ml
בגיל 41 שנה	פחות מ- 8.5mIU/ml	0.5 ng/ml

Polycystic ovarian syndrome

Revisited Rotterdam Criteria(2 of 3)

- Oligo-ovulation or anovulation

- Clinical or biochemical signs of an ovulation

- Polycystic ovaries and exclusion of other causes

- PCOs- at day 1-3 – $\geq$ 12 follicles 2-9 mm &/or ov. Volume >10ml.Single PCO enough to meet the criteria
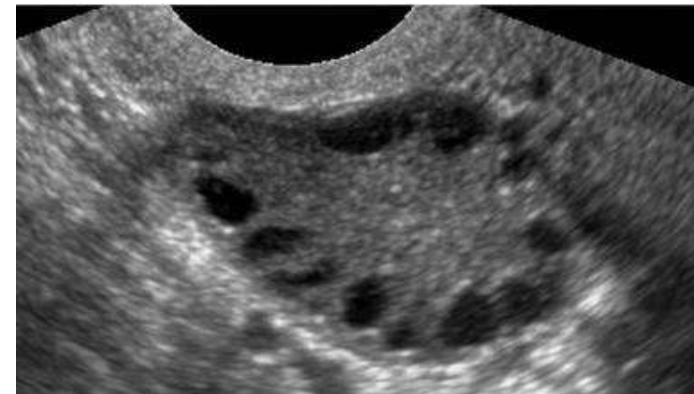
Ultrasonographic classification of OHSS

Mild OHSS ovarian enlargement < 5 cm, small amounts of abdominal fluid and no hemoconcentration

Moderate OHSS ovarian enlargement between 5-10 cm with moderate abdominal fluid and no hemoconcentration
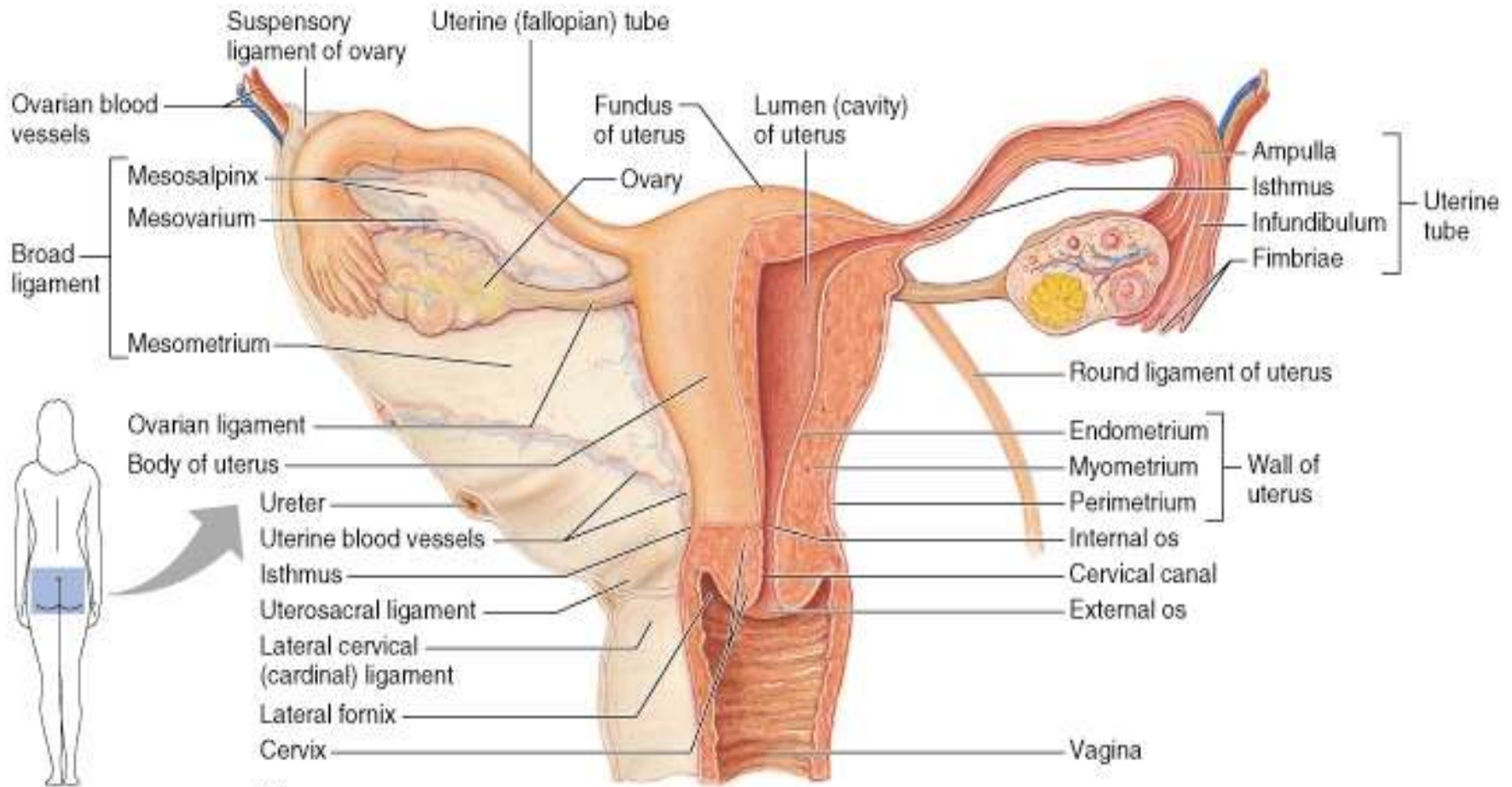
Severe OHSS ovarian enlargement, a large accumulation of fluid in the abdomen (ascites) with hemoconcentration and reduced urine output. Blood electrolytes are often abnormal. Kidney and liver function may be impaired and there is an increased risk for blood clots

Ovarian cancer diagnosis

Adnexae

(a)

Ovarian and pelvic masses

- **Sonography - diagnostic method of choice**
- **Origin** – uterus, ovary, tube etc.
- **Size** – physiologic small, tumor large, torsion fast growth
- **Internal architecture** – cystic, solid or complex, septations, papillary growth
- **Associated lesions** – intraperitoneal fluid (up to 10 ml is normal). Torsion – transudate from obstructed flow, Fibroma – Meig synd.

- **Clinical correlation**

Ovarian cancer

- The most lethal gynecological cancer.

- 1-2% lifetime risk for developing the disease (1/70)

- 60% risk for developing the disease up to the age of 70 in high risk population

- 8th most common cancer death for women worldwide

Theories of ovarian cancer

- Reproductive factors: early menarche, late menopause, low parity, infertility

- Repeated epithelial trauma accompanying ovulations, followed by repair, during which mutations could occur, resulting in malignant transformation

- Gonadotropin theory

- Inflammatory changes (endometriosis)

Theories of ovarian cancer

- Type I:
  - Low-grade serous, low-grade endometrioid, clear cell, mucinous and transitional (Brenner) carcinomas
  - Indolent
  - Confined to the ovary at presentation
  - Genetically stable
  - **Go through borderline step**
- Type II:
  - highly aggressive, evolve rapidly and almost always present in advanced stage
  - include conventional high-grade serous carcinoma, undifferentiated carcinoma and malignant mixed mesodermal tumors

International Ovarian Tumour Analysis (IOTA) Group

- Aims:
- To develop rules and models to characterize ovarian pathology.
- To establish the role of measurements of CA 125 and other serum tumor markers for diagnosis.

- 1999 – 9 centers in 5 countries.
- 2015 - 47 centers in 17 countries.
- 14,500 ovarian tumors were examined.

ULTRASOUND
in Obstetrics & Gynecology

isuog.

Terms, definitions and measurements to describe the sonographic features of adnexal tumors: a consensus opinion from the International Ovarian Tumor Analysis (IOTA) group

D. TIMMERMAN, L. VALENTIN*, T. H. BOURNE†, W. P. COLLINS‡, H. VERRELST§ and I. VERGOTE

Department of Obstetrics and Gynaecology, University Hospitals KU Leuven, Leuven, Belgium, *Department of Obstetrics and Gynaecology, University Hospital, Malmö, Sweden, †Department of Obstetrics and Gynaecology, St. George's Hospital Medical School, University of London, London, UK, ‡King's College, University of London, UK and §Department of Electrical Engineering, ESAT-SISTA, Katholieke Universiteit Leuven, Belgium
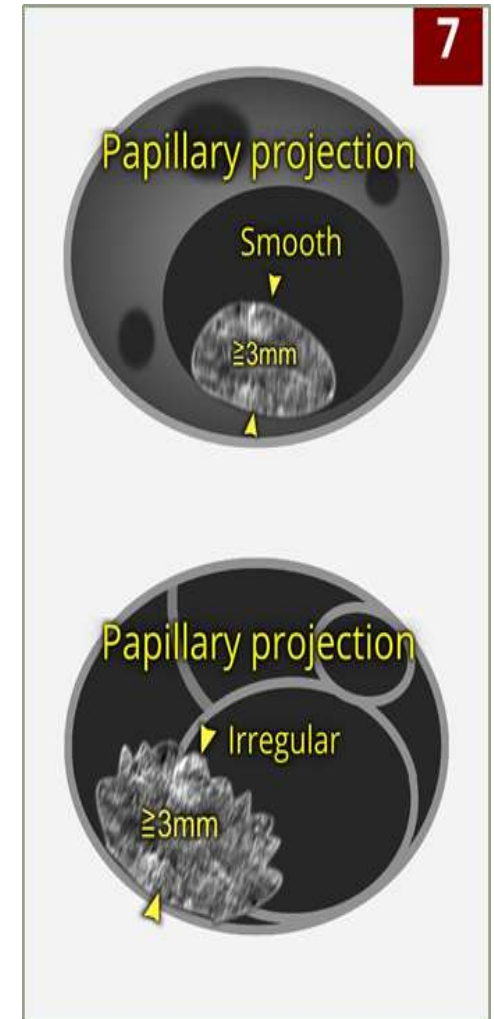
IOTA Terms, Definitions and measurements

- A lesion – Part of the ovary inconsistent with normal physiology.

- A septum – A thin strand of tissue running across the cyst cavity from one internal surface to the contralateral side. Could be complete or incomplete (Incomplete septa are seen in Hydrosalpinx).

IOTA Terms, Definitions and measurements:
Solid Components

- A solid component – a structure that has high echogenicity suggestive of a tissue (myometrium, ovarian stroma).

- Papillary projection – Protrusion of solid tissue into a cyst cavity >3mm (height)

- Protrusions <3mm (height) = irregularities.

- Papillary projection=solid component.
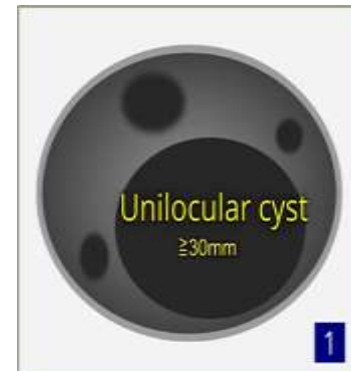
- Papillary projections can be smooth or irregular.

IOTA Terms, Definitions and measurements:
Types of Cysts

- <u>Unilocular cyst</u> – No Septa, No Solid components.

- <u>Multilocular cyst</u> – At least one septum, No Solid components.

- <u>Unilocular Solid cyst</u> - Unilocular cyst with a measurable solid component.

- <u>Multilocular Solid cyst</u> - Multilocular cyst with a measurable solid component.

- <u>Solid tumor</u> – The solid components comprise 80% or more of the tumor.

- <u>Not classifiable</u> - poor visualization, acoustic shadows, calcifications

Cyst's Walls

- The Internal wall is described as being "Smooth" or "Irregular".

- The external wall of a cyst is not taken into account.

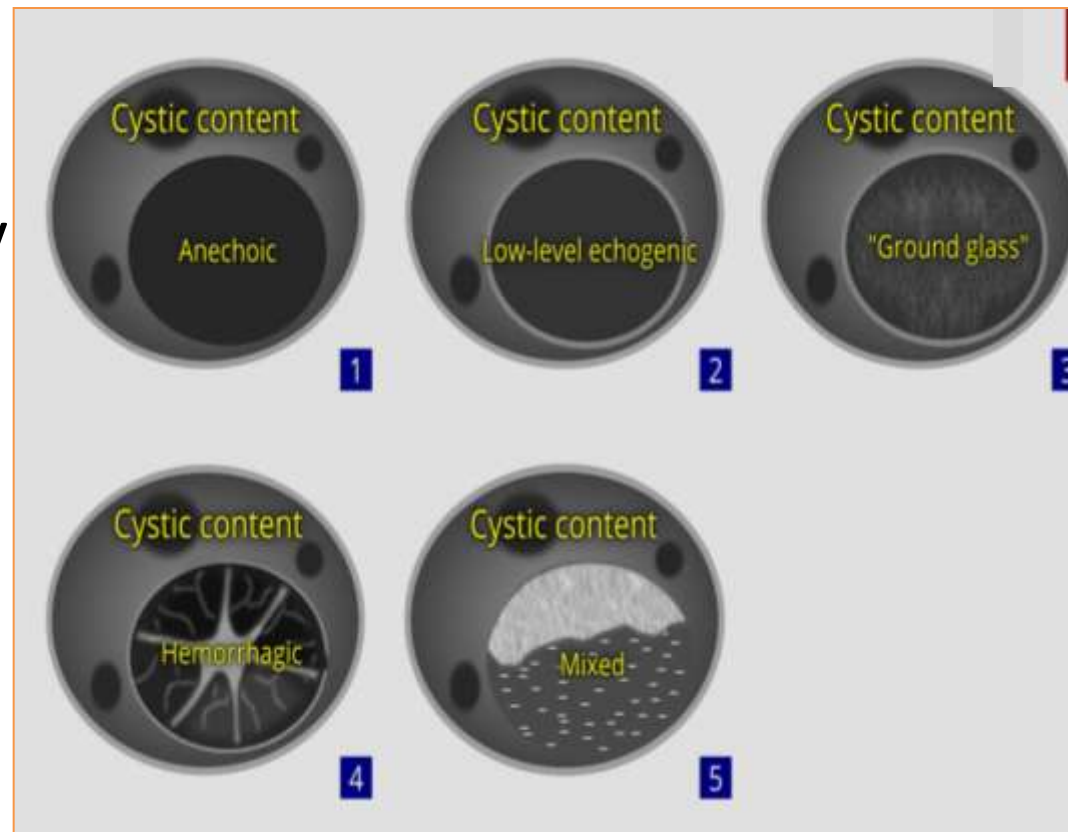- In case of a solid tumor the outline of the tumor is described as "Smooth" or "Irregular".

IOTA Terms, Definitions and measurements:
Cyst's Contents

1. Anechoic
2. Low level echogenicity
3. Ground glass
4. Hemorrhagic
5. Mixed

IOTA Terms, Definitions and measurements

- Acoustic shadow - Loss of acoustic echo behind a sound absorbing structure.

- Fluid in the Pouch of Douglas is measured in sagittal plane.
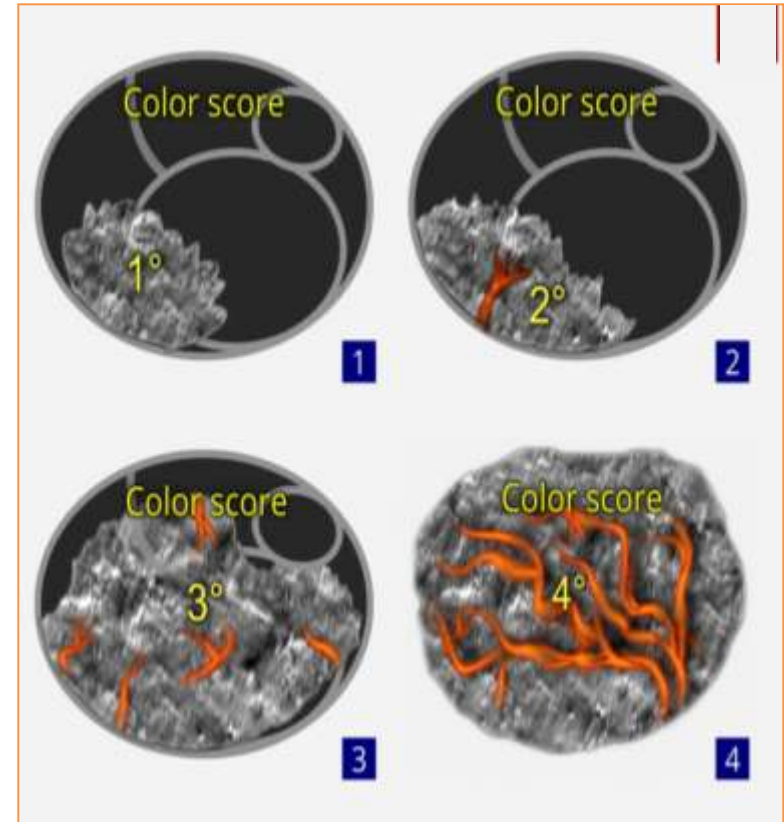
- Ascites – Fluid outside the Pouch of Douglas.

IOTA Terms, Definitions and measurements:
Blood Flow

- PRF 0.3-0.6

- <u>Color score 1</u> – No blood flow.
- <u>Color score 2</u> – Minimal blood flow.
- <u>Color score 3</u> – Intermediate blood flow.
- <u>Color score 4</u> – Marked blood flow.

The Optimal approach to the classification of adnexal pathology is subjective assessment of Ultrasound findings by experienced examiners. Unfortunately, such level III Ultrasonography is not always available
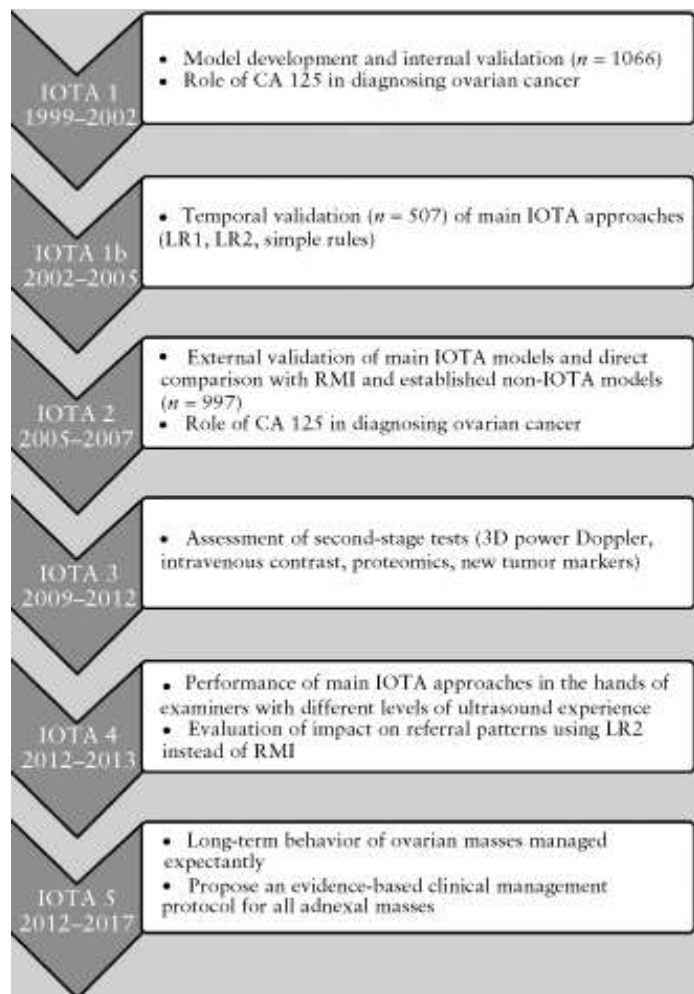
Timmerman et al. Ultrasound Obstet Gynecol 1999; 13: 11-6.

Valentin et al. Ultrasound Obstet Gynecol 2001; 18: 357–365.

Timmerman et al. Best Pract Res Clin Obstet Gynaecol 2004; 18: 91-104.

Valentin et al. Ultrasound Obstet Gynecol 2009; 34: 345-54.

A summary of IOTA studies

IOTA 1 1999–2002	• Model development and internal validation ($n = 1066$) • Role of CA 125 in diagnosing ovarian cancer
IOTA 1b 2002–2005	• Temporal validation ($n = 507$) of main IOTA approaches (LR1, LR2, simple rules)
IOTA 2 2005–2007	• External validation of main IOTA models and direct comparison with RMI and established non-IOTA models ($n = 997$) • Role of CA 125 in diagnosing ovarian cancer
IOTA 3 2009–2012	• Assessment of second-stage tests (3D power Doppler, intravenous contrast, proteomics, new tumor markers)
IOTA 4 2012–2013	• Performance of main IOTA approaches in the hands of examiners with different levels of ultrasound experience • Evaluation of impact on referral patterns using LR2 instead of RMI
IOTA 5 2012–2017	• Long-term behavior of ovarian masses managed expectantly • Propose an evidence-based clinical management protocol for all adnexal masses

- **IOTA 1** — Model development: 1066 women, 9 clinical centers in 5 countries.
- **IOTA** — Temporal validation: 507 new consecutive patients, at 3 centers participating in Phase 1.
- **IOTA** — External validation: 997 patients in 12 new centers+941 patients in 7 centers from Phase 1.
- **IOTA** — Comparison of tests: 2403 patients in 18 centers (3 new).
- **IOTA 4** — Operators with varied experience: 962 patients in 3 centers.
- **IOTA 5** — Long-term behavior of adnexal masses characterized as benign. 8000 patients (4500 cases of follow up).

Simple Rules

- B1 Unilocular cyst
- B2 Presence of solid components with largest diameter < 7mm.
- B3 Presence of acoustic shadows
- B4 Smooth multilocular tumor with largest diameter < 100mm
- B5 No blood flow (color score 1)
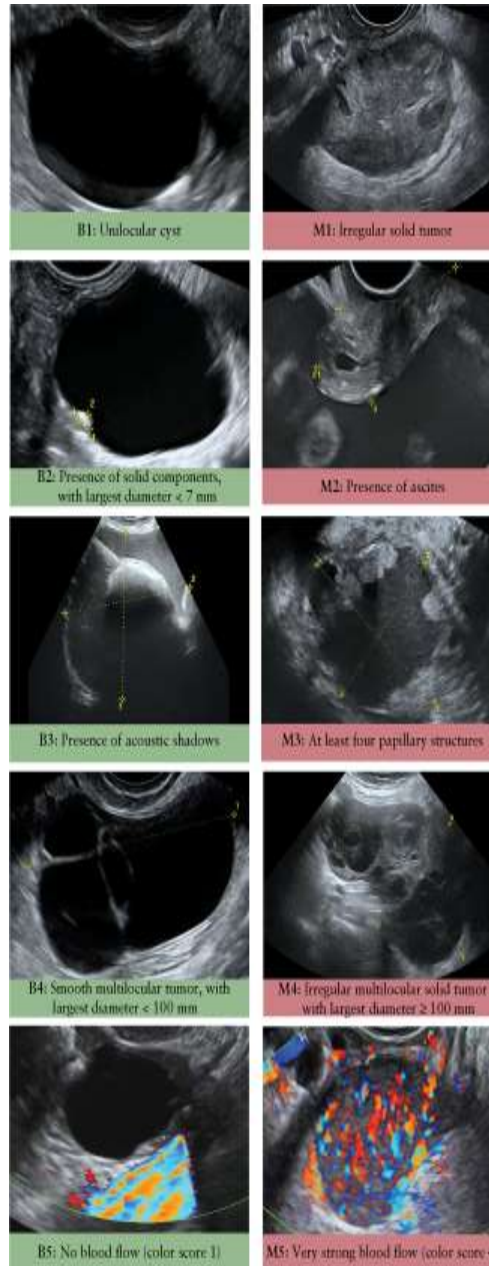
- M1 Irregular solid tumor.
- M2 Prescence of Ascites.
- M3 At least 4 papillary structures.
- M4 Irregular multilocular solid tumor with largest diameter >= 100mm.
- M5 Very strong blood flow (color score 4).

Simple Rules

- Rules could be applied to 77% of ovarian tumors.

- The performance of LR1, LR2 and simple rules are similar.

- A two step strategy was suggested:

    Step 1 – Simple rules.

    Step 2 – "Inconclusive" result → Subjective assessment by an experienced examiner.

- The two-step strategy detected ovarian malignancy with sensitivity of 90% and a specificity of 93%.

Timmerman et al. BMJ 2010; 341: c6839.

The use of 'Instant' Descriptors

– Almost half (43%) of ovarian masses have features that enable them to be characterized relatively easily.

– Typical Dermoid cysts, Typical Endometriomas and late-stage ovarian cancer have very characteristic ultrasound features.

– Six 'easy descriptors' were retrospectively defined.

Ameye et al. Ultrasound Obstet Gynecol 2012; 40: 582–591.

'Instant' Descriptors

- BD1: Unilocular tumor with ground glass echogenicity in premenopausal woman (Endometrioma).

- BD2: Unilocular tumor with mixed echogenicity and acoustic shadows in premenopausal woman (Benign cystic teratoma).

- BD3: Unilocular tumor with regular walls and largest diameter < 10 cm (Simple Cyst or Cystadenoma).

- BD4: All remaining unilocular tumors with regular walls.
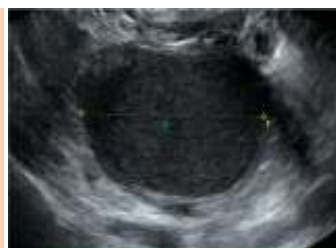
BD1: Unilocular tumor with ground glass echogenicity in premenopausal woman (suggestive of endometrioma)

BD2: Unilocular tumor with mixed echogenicity and acoustic shadows in premenopausal woman (suggestive of benign cystic teratoma)
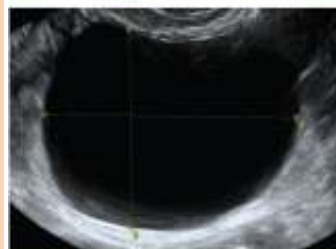
BD3: Unilocular tumor with regular walls and largest diameter < 10 cm (suggestive of simple cyst or cystadenoma)

BD4: Remaining unilocular tumor with regular walls
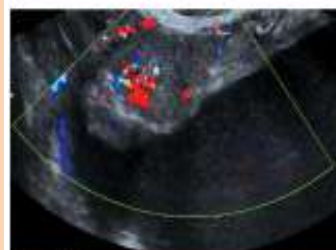
MD1: Tumor with ascites and at least moderate color Doppler blood flow in postmenopausal woman

MD2: Age > 50 years and CA 125 > 100 U/mL.

- MD1: Tumor with ascites and at least moderate color Doppler blood flow in postmenopausal woman.

- MD2: Age > 50 years and CA 125 > 100 U/mL.

Ameye L et al. Ultrasound Obstet Gynecol 2012; 40: 582–591.

Three-step strategy to the assessment of adnexal pathology.

- For the masses to which the descriptors could be applied (50%), they had a sensitivity of 98% and a specificity of 97%.

- For 'non-instant' masses, simple rules can be applied (30%) with subjective assessment by an expert examiner as a third step (20%).

- This protocol gave a sensitivity of 92% and a specificity of 92% when retrospectively applied on all 1938 patients from IOTA Phase 2.

Ameye et al. Ultrasound Obstet Gynecol 2012; 40: 582–591.

The role of CA-125

- Incorporating serum CA 125 measurements into logistic regression models has no significant impact on performance.

- Adding information on the serum CA 125 level to subjective assessment of ultrasound findings does not improve the diagnostic performance of experienced ultrasound examiners.

- CA 125 level can reliably discriminate only between Stage II–IV invasive tumors and benign tumors that are not an abscess or endometrioma.

Timmerman et al. J Clin Oncol 2007; 25: 4194–4200. 41.
Van Calster et al. J Natl Cancer Inst 2007; 99: 1706–1714.
Van Calster et al. Cancer Epidemiol Biomarkers Prev 2011; 20: 2420–2428.
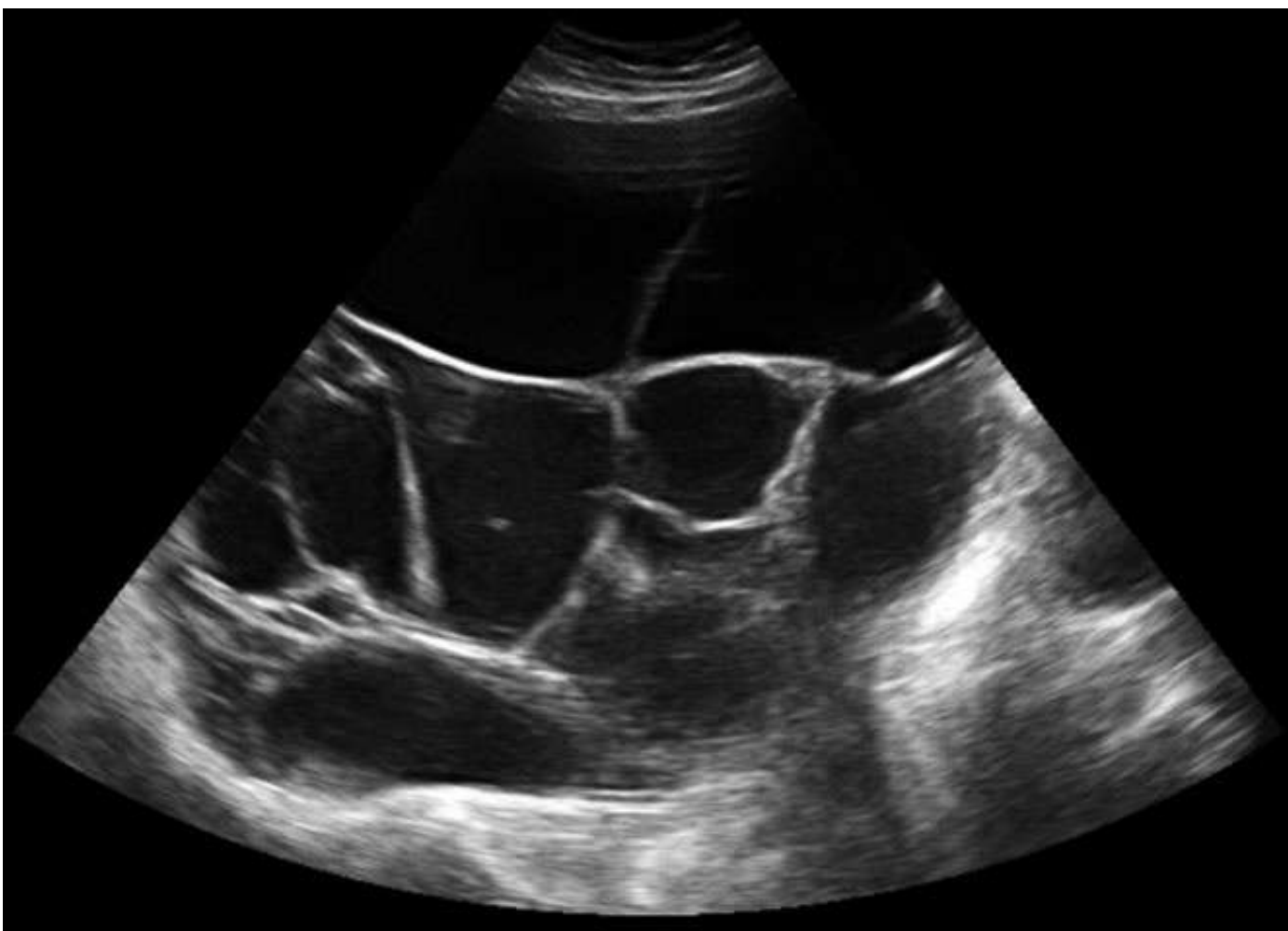
Examples and cases

M1	Irregular solid tumor	☐ B1	Unilocular
M2	Presence of ascites	☐ B2	Presence of solid components where the largest
M3	At least four papillary structures	☐	solid component has a largest diameter < 7 mm
M4	Irregular multilocular solid tumor with largest	☐ B3	Presence of acoustic shadows
	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)

M1 Irregular solid tumor

M2 Presence of ascites

M3 At least four papillary structures

M4 Irregular multilocular solid tumor with largest diameter ≥ 100 mm

M5 Very strong blood flow (color score 4)

☐ B1 Unilocular

☐ B2 Presence of solid components where the largest solid component has a largest diameter < 7 mm

☐ B3 Presence of acoustic shadows

B4 Smooth multilocular tumor with largest diameter < 100 mm
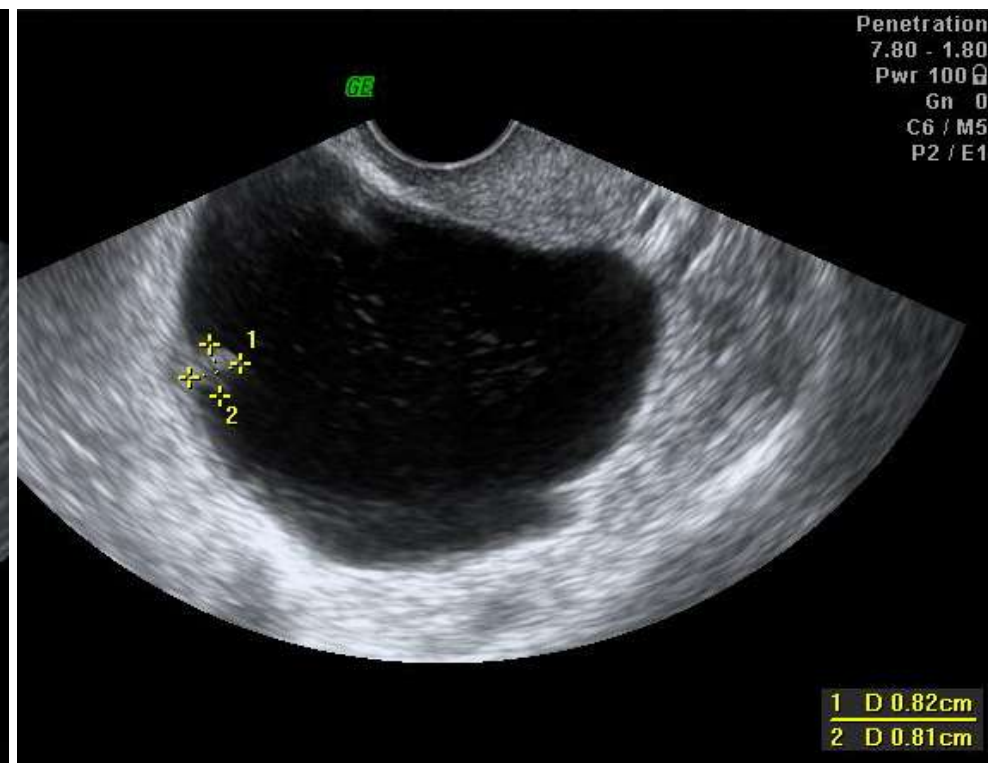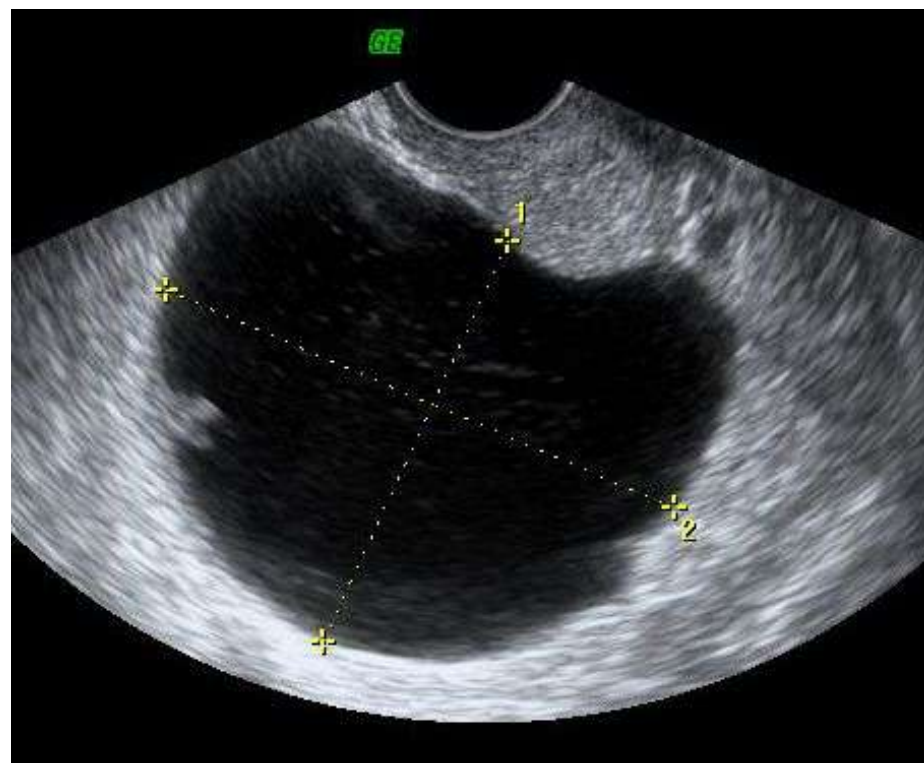
☐ B5 No blood flow (color score 1)

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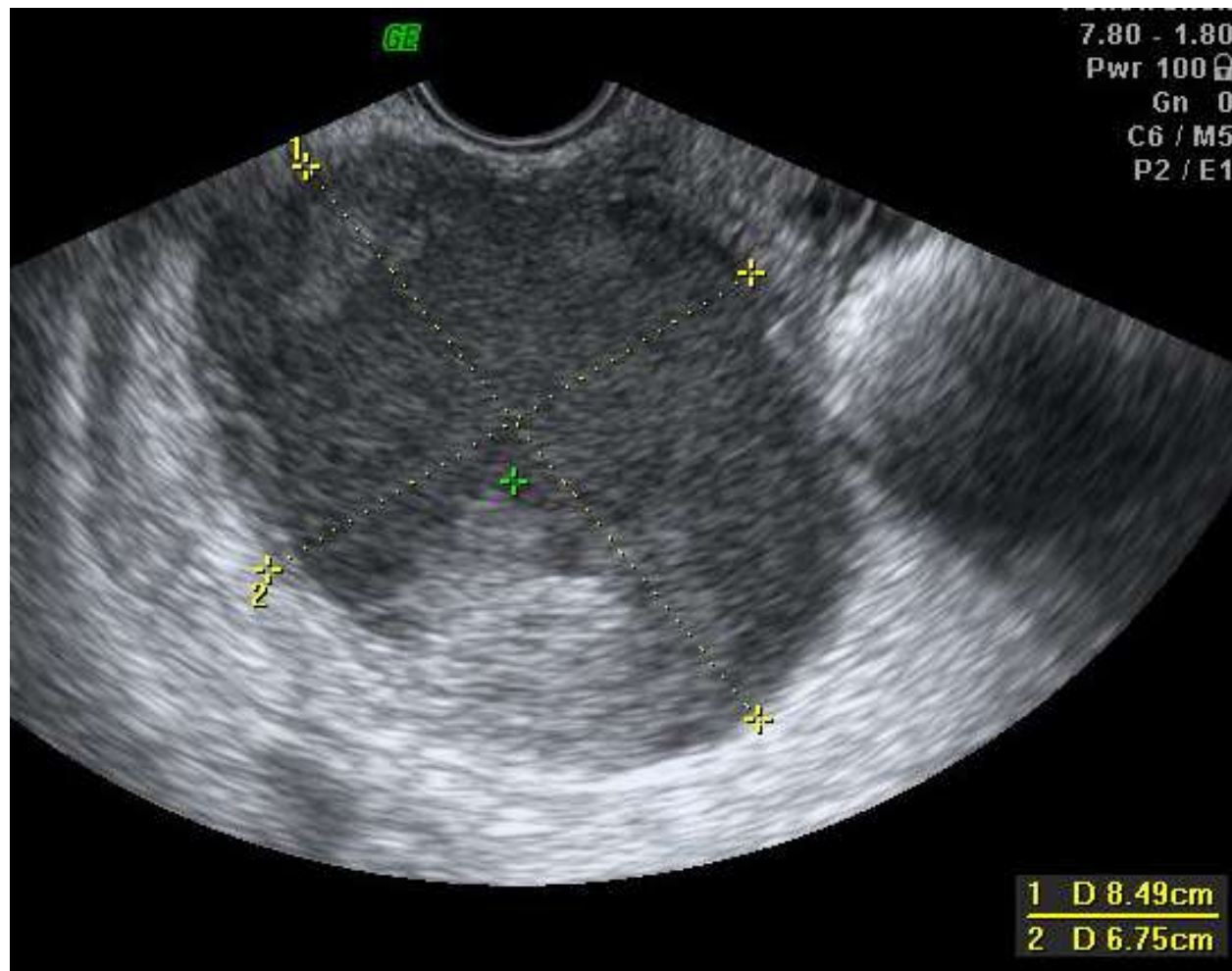| M1	Irregular solid tumor		B1	Unilocular
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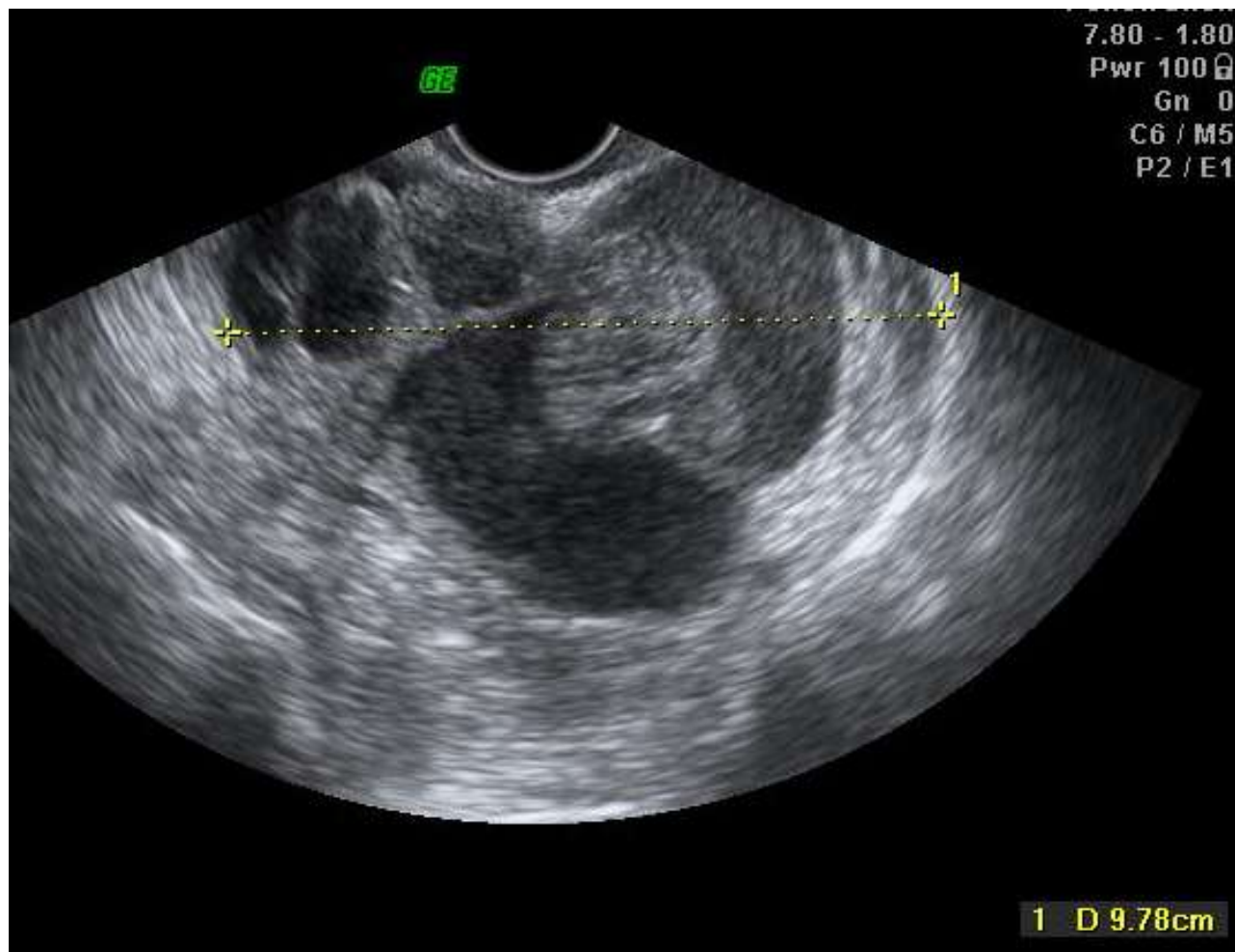|		
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M3	At least four papillary structures	□		solid component has a largest diameter < 7 mm
M4	Irregular multilocular solid tumor with largest	□	B3	Presence of acoustic shadows
	diameter ≥ 100 mm		B4	Smooth multilocular tumor with largest diameter < 100 mm
M5	Very strong blood flow (color score 4)	□	B5	No blood flow (color score 1)

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M2	Presence of ascites	☐	B2	Presence of solid components where the largest solid component has a largest diameter < 7 mm
M3	At least four papillary structures	☐		
M4	Irregular multilocular solid tumor with largest diameter ≥ 100 mm	☐	B3	Presence of acoustic shadows
			B4	Smooth multilocular tumor with largest diameter < 100 mm
M5	Very strong blood flow (color score 4)	☐	B5	No blood flow (color score 1)

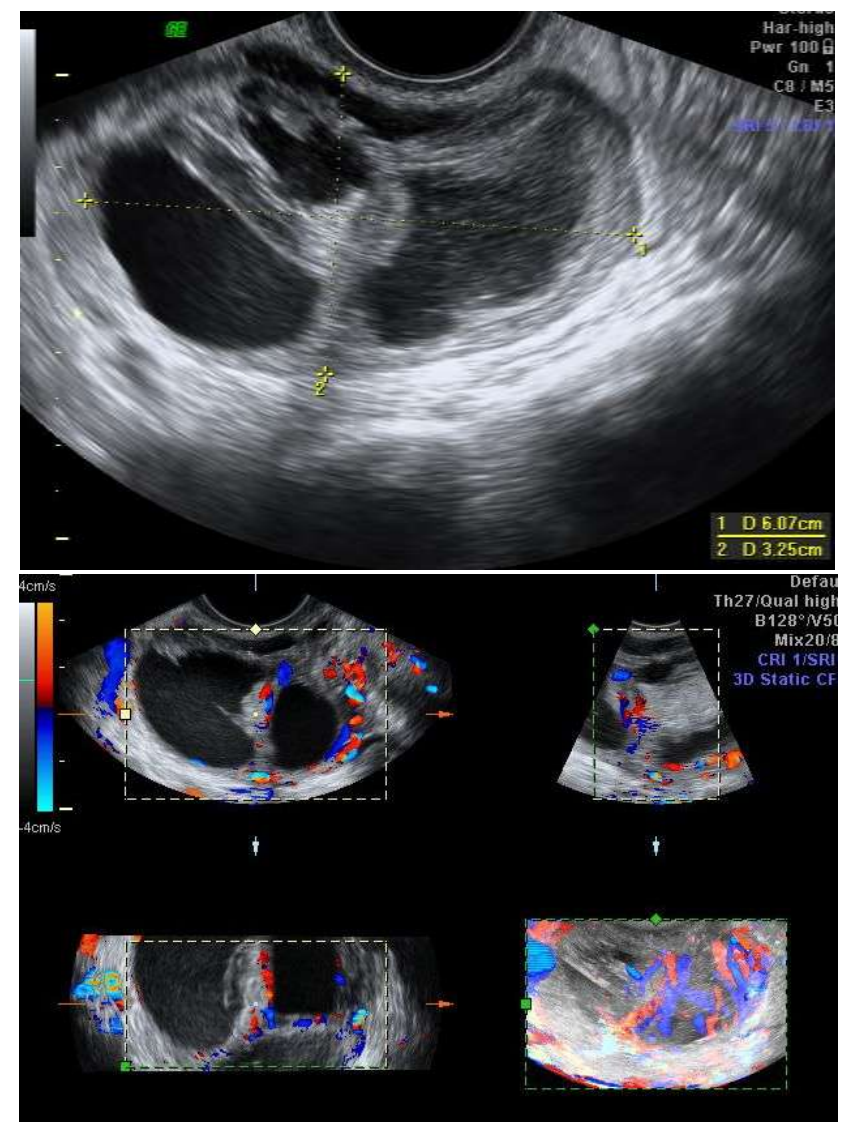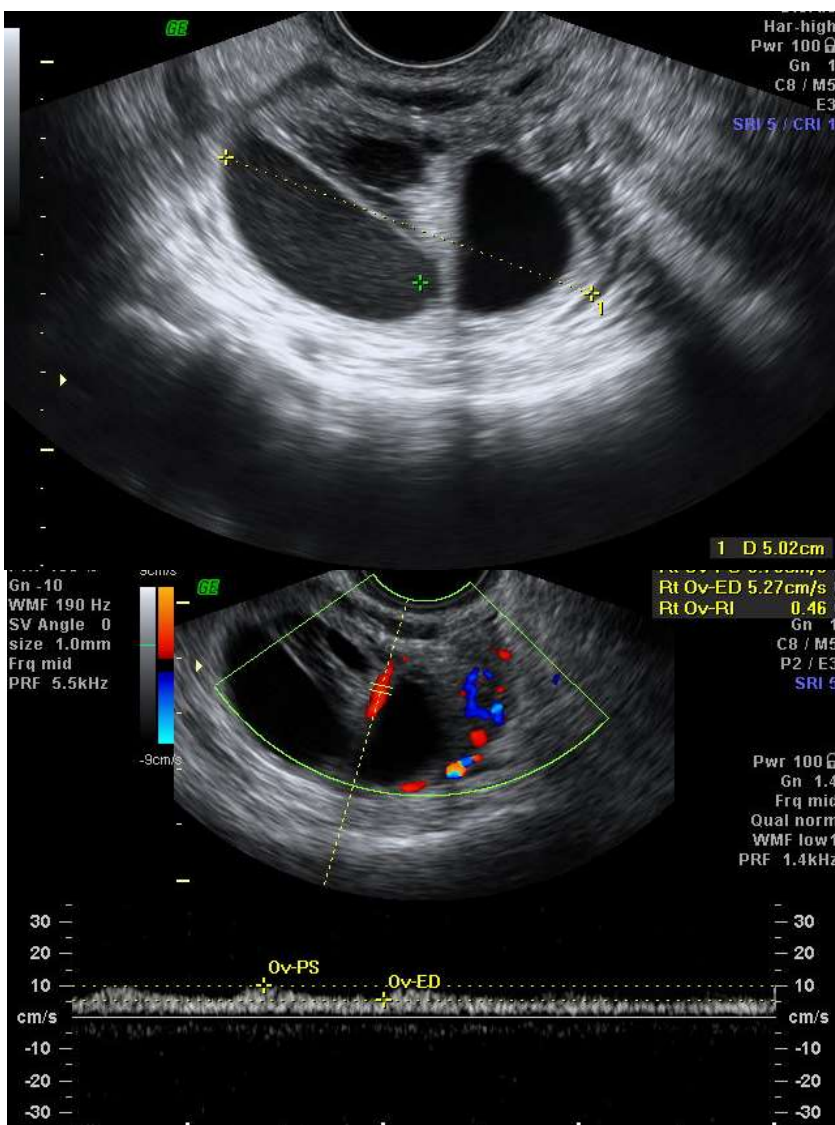|	
M1 Irregular solid tumor	☐ B1 Unilocular
M2 Presence of ascites	☐ B2 Presence of solid components where the largest
M3 At least four papillary structures	☐ solid component has a largest diameter < 7 mm
M4 Irregular multilocular solid tumor with largest	☐ B3 Presence of acoustic shadows
diameter ≥ 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)

M1	Irregular solid tumor	☐ B1 Unilocular
M2	Presence of ascites	☐ B2 Presence of solid components where the largest
M3	At least four papillary structures	☐ solid component has a largest diameter < 7 mm
M4	Irregular multilocular solid tumor with largest	☐ B3 Presence of acoustic shadows
	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)

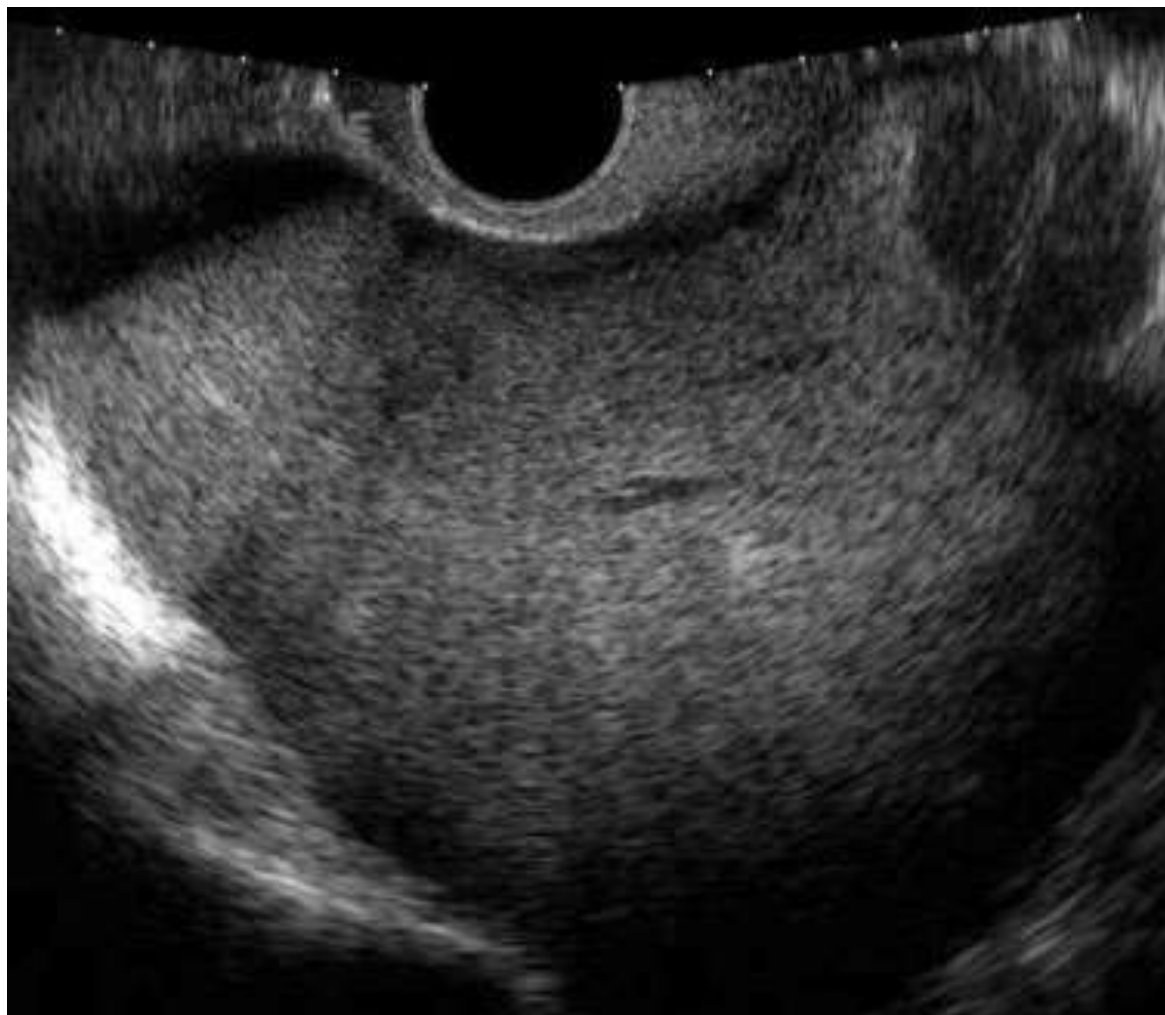| M1	Irregular solid tumor		B1	Unilocular
M2	Presence of ascites		B2	Presence of solid components where the largest
M3	At least four papillary structures			solid component has a largest diameter < 7 mm
M4	Irregular multilocular solid tumor with largest		B3	Presence of acoustic shadows
	diameter ≥ 100 mm		B4	Smooth multilocular tumor with largest diameter < 100 mm
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M1	Irregular solid tumor	☐ B1	Unilocular
M2	Presence of ascites	☐ B2	Presence of solid components where the largest
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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
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M4	Irregular multilocular solid tumor with largest diameter ≥ 100 mm		B3	Presence of acoustic shadows
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|	
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M1 Irregular solid tumor

M2 Presence of ascites

M3 At least four papillary structures

M4 Irregular multilocular solid tumor with largest diameter ≥ 100 mm

M5 Very strong blood flow (color score 4)

☐ B1 Unilocular

☐ B2 Presence of solid components where the largest solid component has a largest diameter < 7 mm

☐ B3 Presence of acoustic shadows

B4 Smooth multilocular tumor with largest diameter < 100 mm

☐ B5 No blood flow (color score 1)

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
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Metastases to the ovary

- 95% solid, multilocular-solid or multilocular

- 93% of those from breast, stomach, lymphoma or uterus were solid

- 73% of those from colon, rectum, appendix, or biliary tract were multilocular or multilocular-solid

- Meta from colon, rectum, appendix, or biliary tract were larger, had irregular external borders, papillary projections, less vascularisation, than those from breast, stomach, lymphoma or uterus
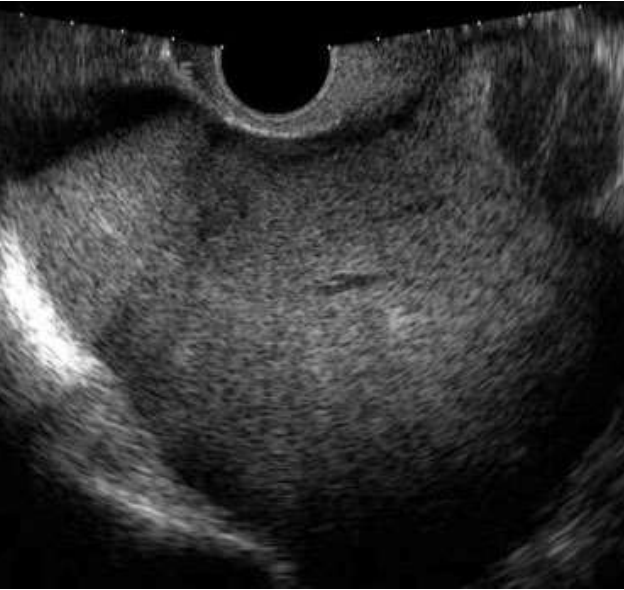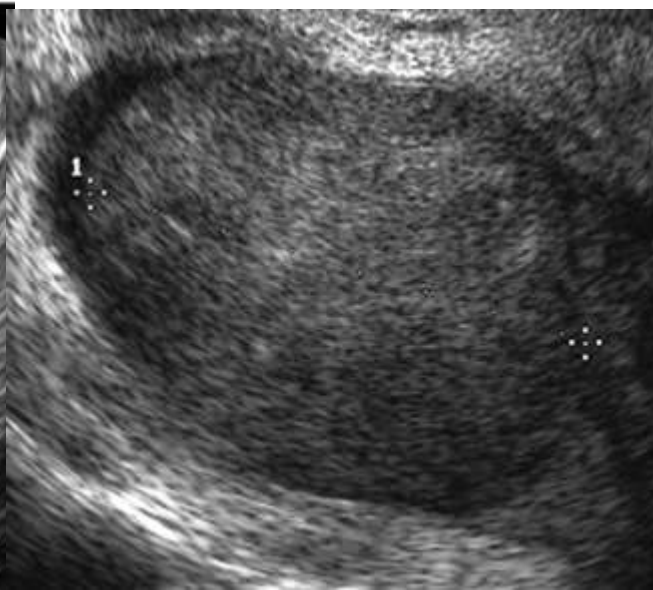
Metastases to the ovary
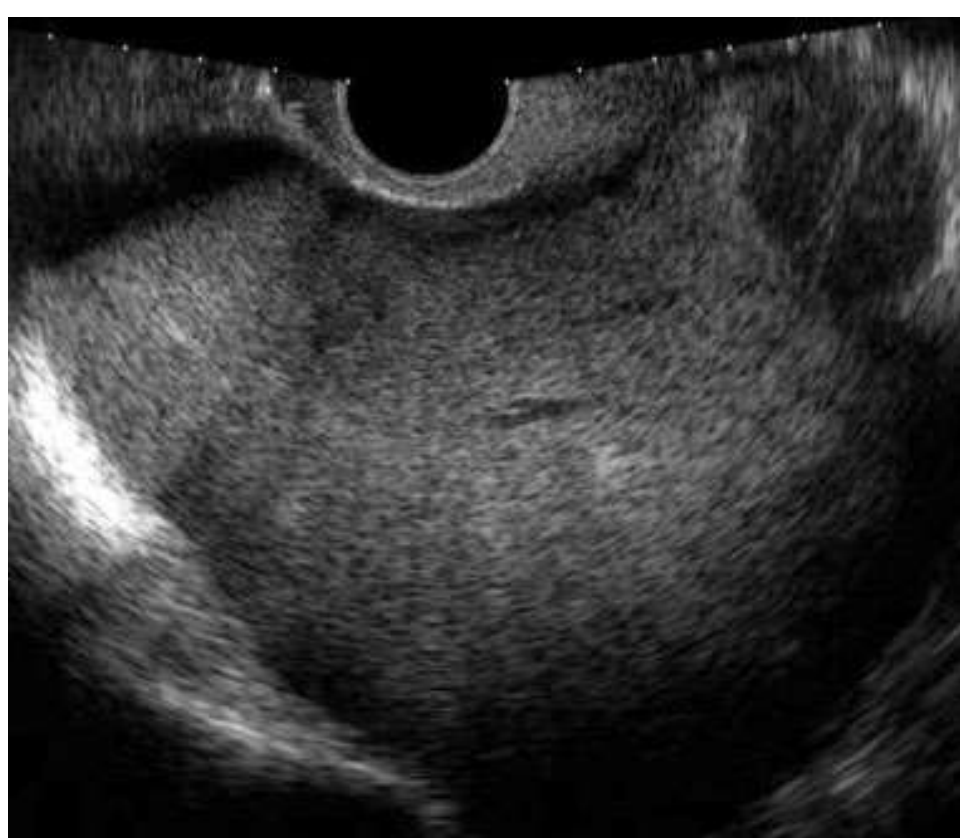
From gastric tumors
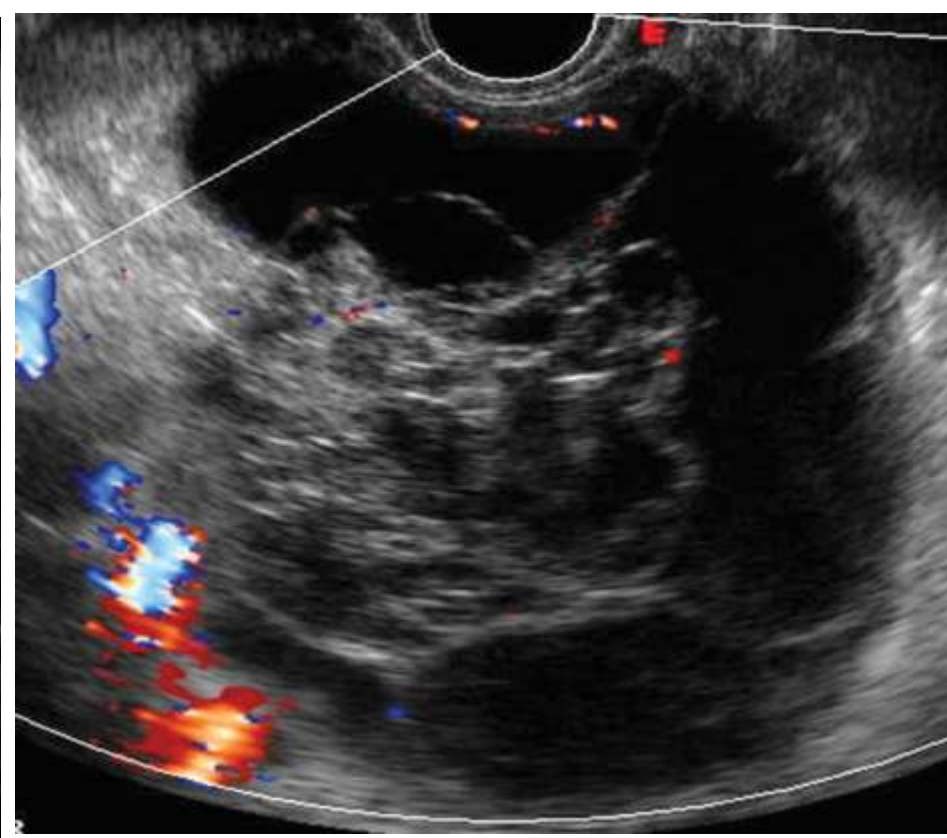
From large intestine

Metastases to the ovary: stomach, breast, lymphomas

From gastric tumors

From breast

From lymphoma

Tubal disease

- Tubal disease in conjunction with peritoneal disease

- Adhesions alter normal tubal course or occlude the tube

- Sactosalpinx - "cogwheel" sign- dilated fallopian tube with thick walls and incomplete septa

- Hydrosalpinx – "beads on a string" sign – hyperechoic mural nodules measuring about 2–3mmand seen on cross-section of the fluid filled distended structure

- TOA complex

Timor–Tritsch, 1998
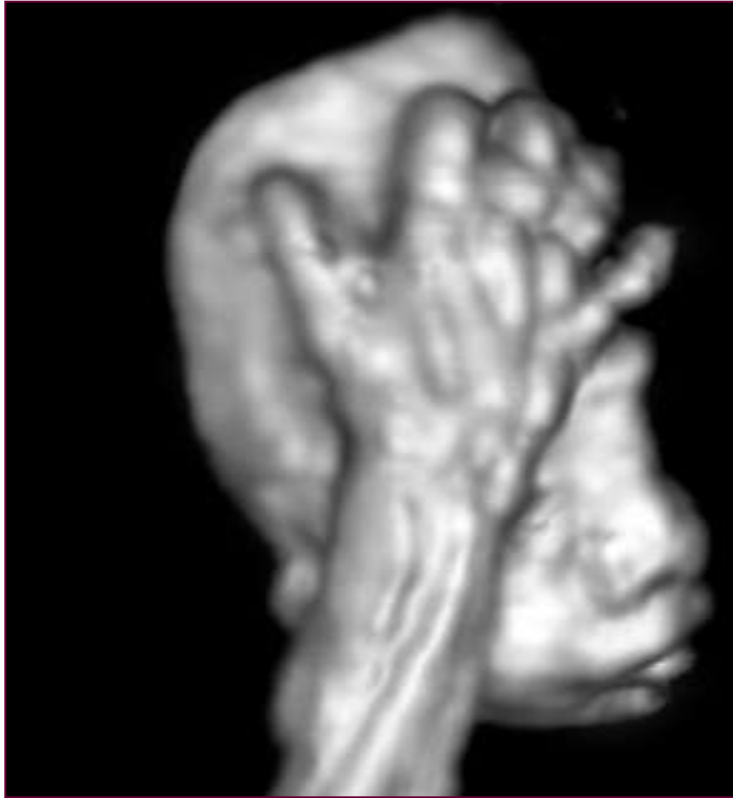
Tubal disease
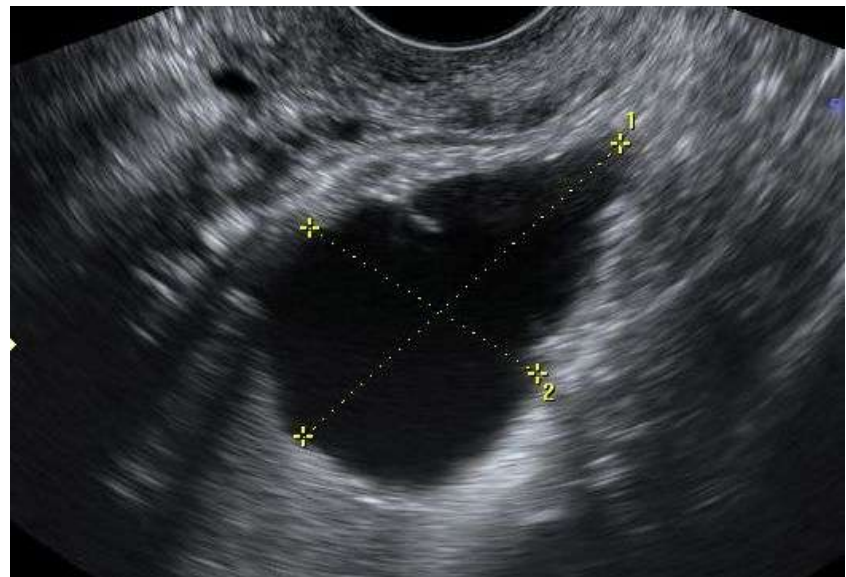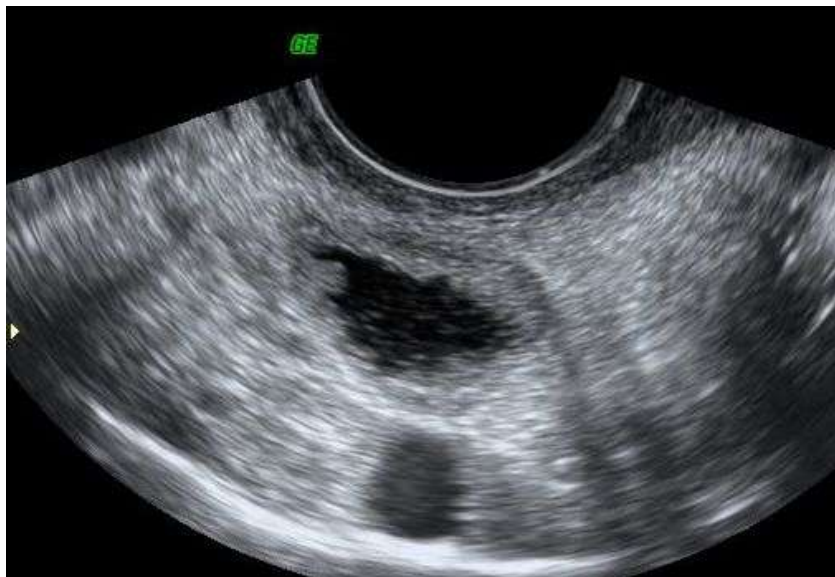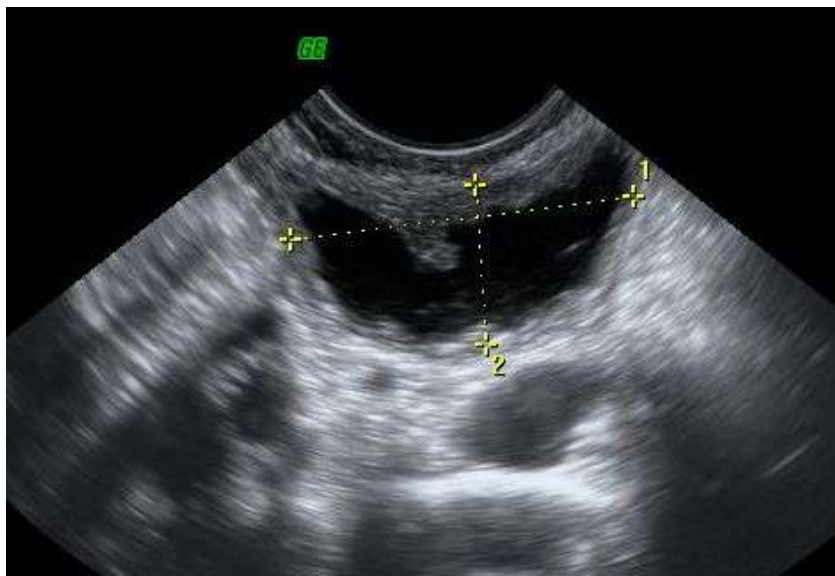
Other pelvic structures
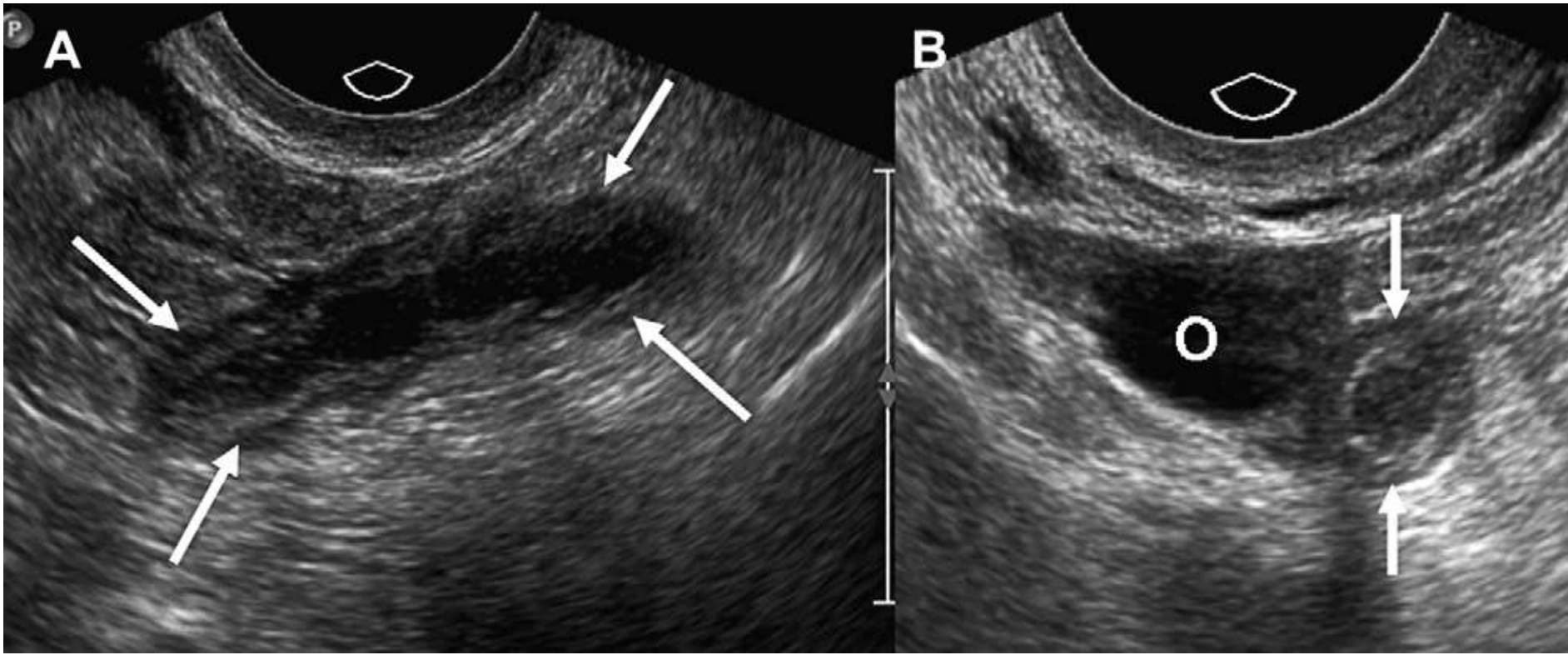
Thank you

veredeis@bezeqint.net