



# How to utilize ultrasound in infertile patients ?

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Dep of Reprod Med and IVF

# INFERTILITY



- Approximately 15- 20 %



# Diagnostic Tools

- **TVUSG -2D -3D -4D**
- **Saline infusion sonohysterosalpingography**
- **Ultrasound with contrast**
- **Hysterosalpingography**
- **Hysteroscopy**
- **Laparoscopy**



# Tagging, Planes , Localization, Terms

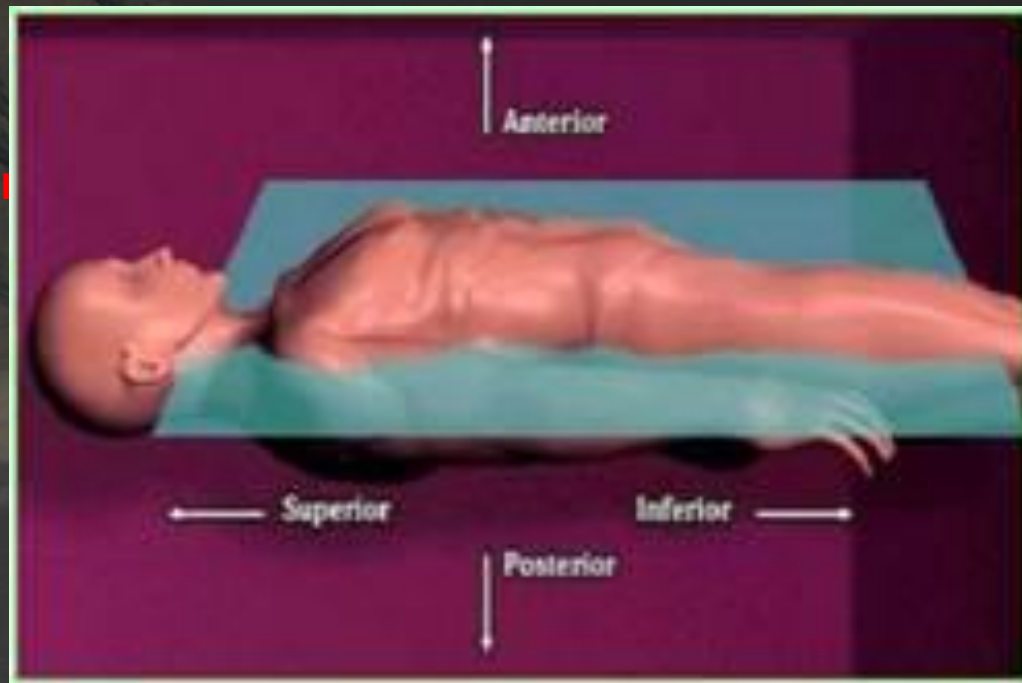




## Terms defining localization

**Proximal** : close to the origin

**Anterior or ventral**: organs close to the front of the patient



**Superior, cranial or cephalad** : organs close to the head of the patient

**Inferior or caudal**: organs close to the feet of the patient

**Distal** : far from the origin

**Posterior or dorsal**: organs close to the back of the patient

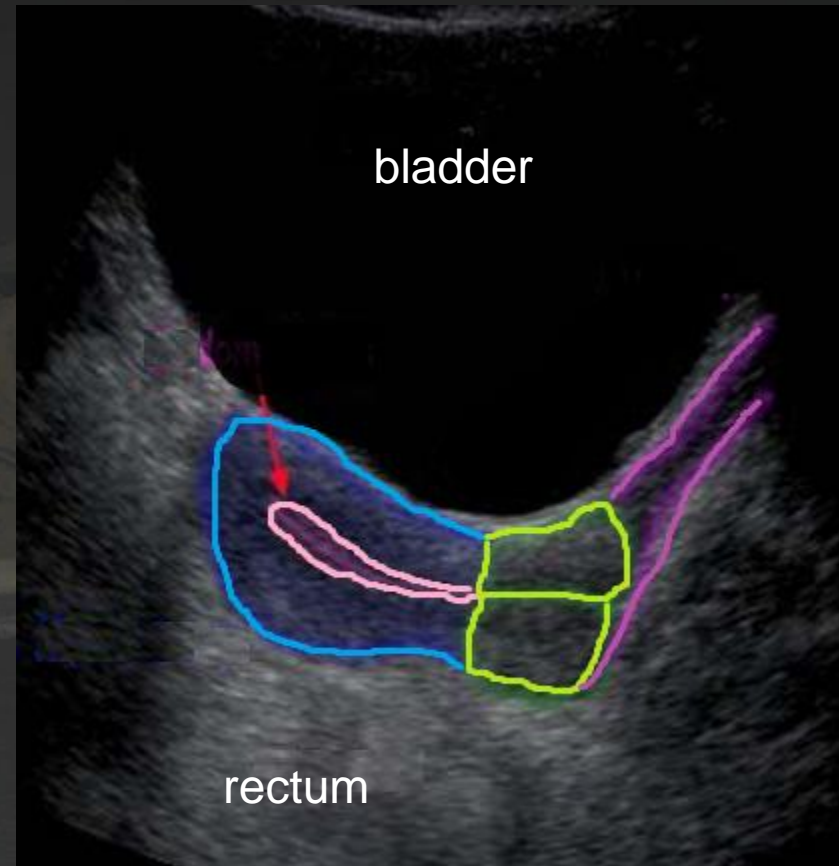


# Longitudinal scanning (Sagittal scanning)

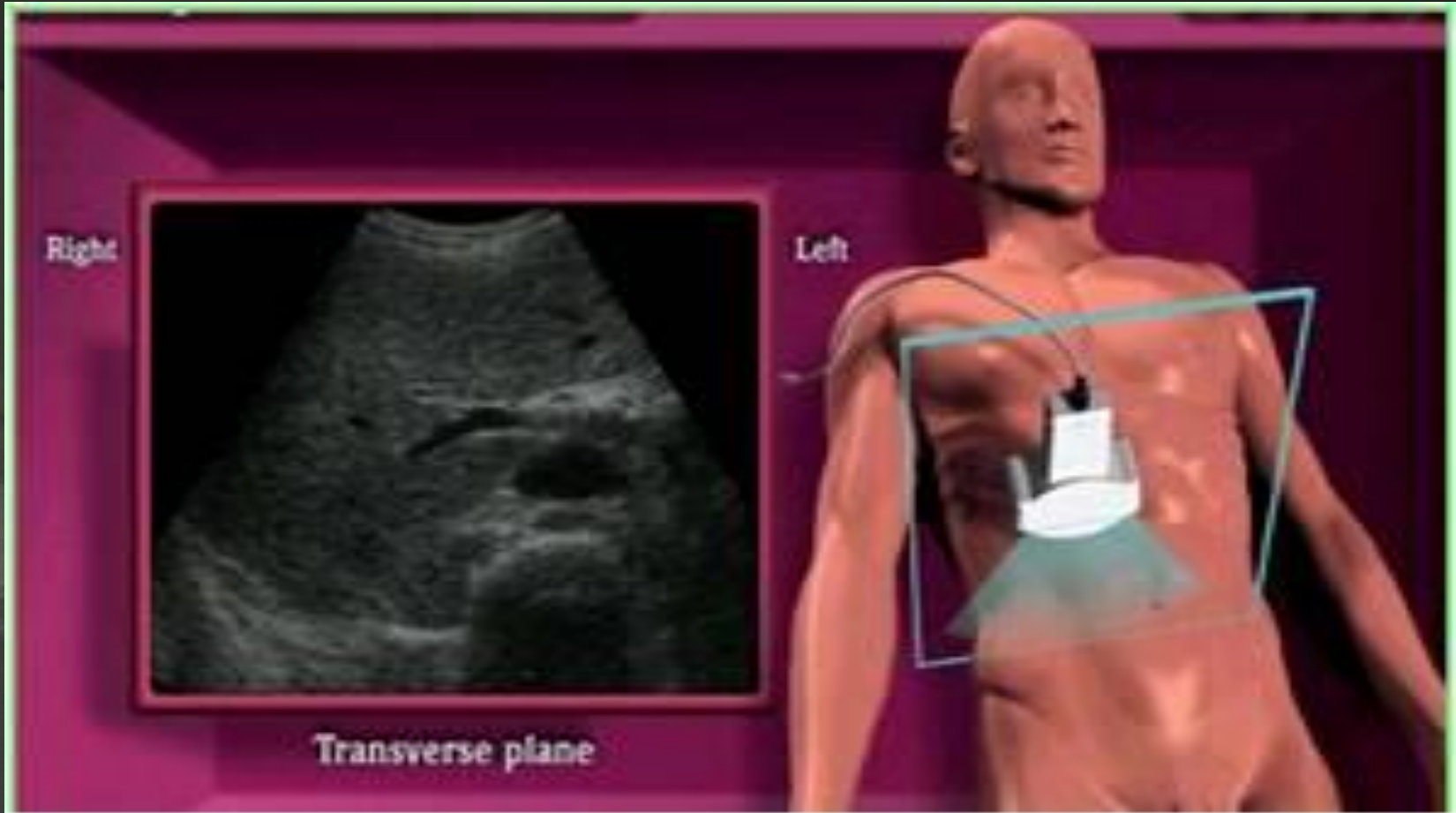




# Longitudinal scanning (Sagittal scanning)



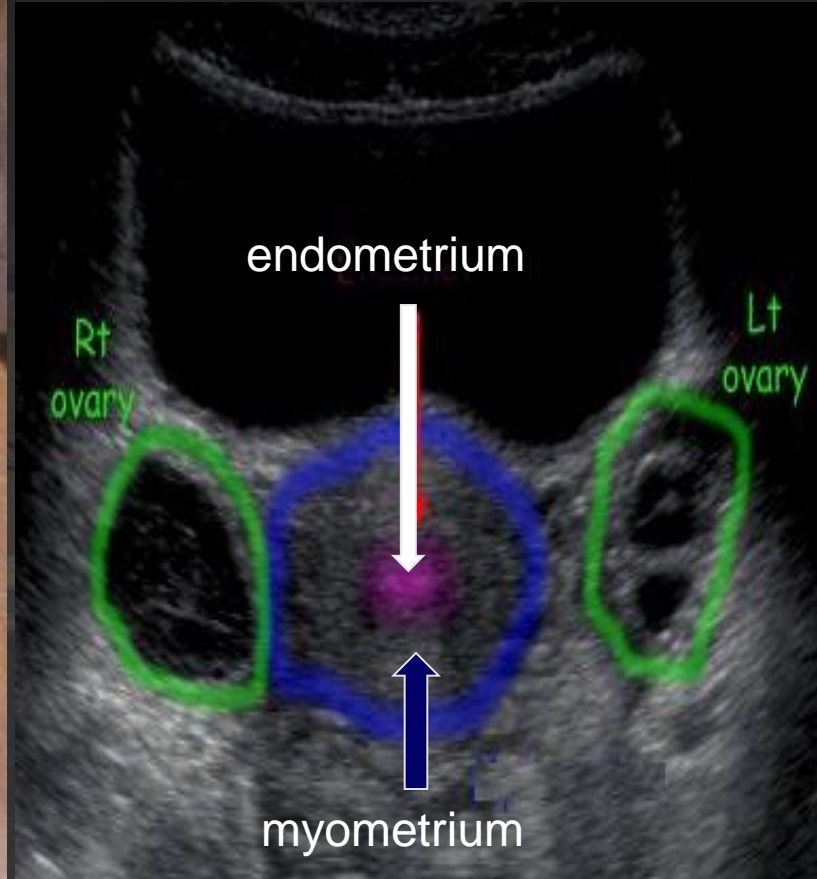
# Transverse Scanning





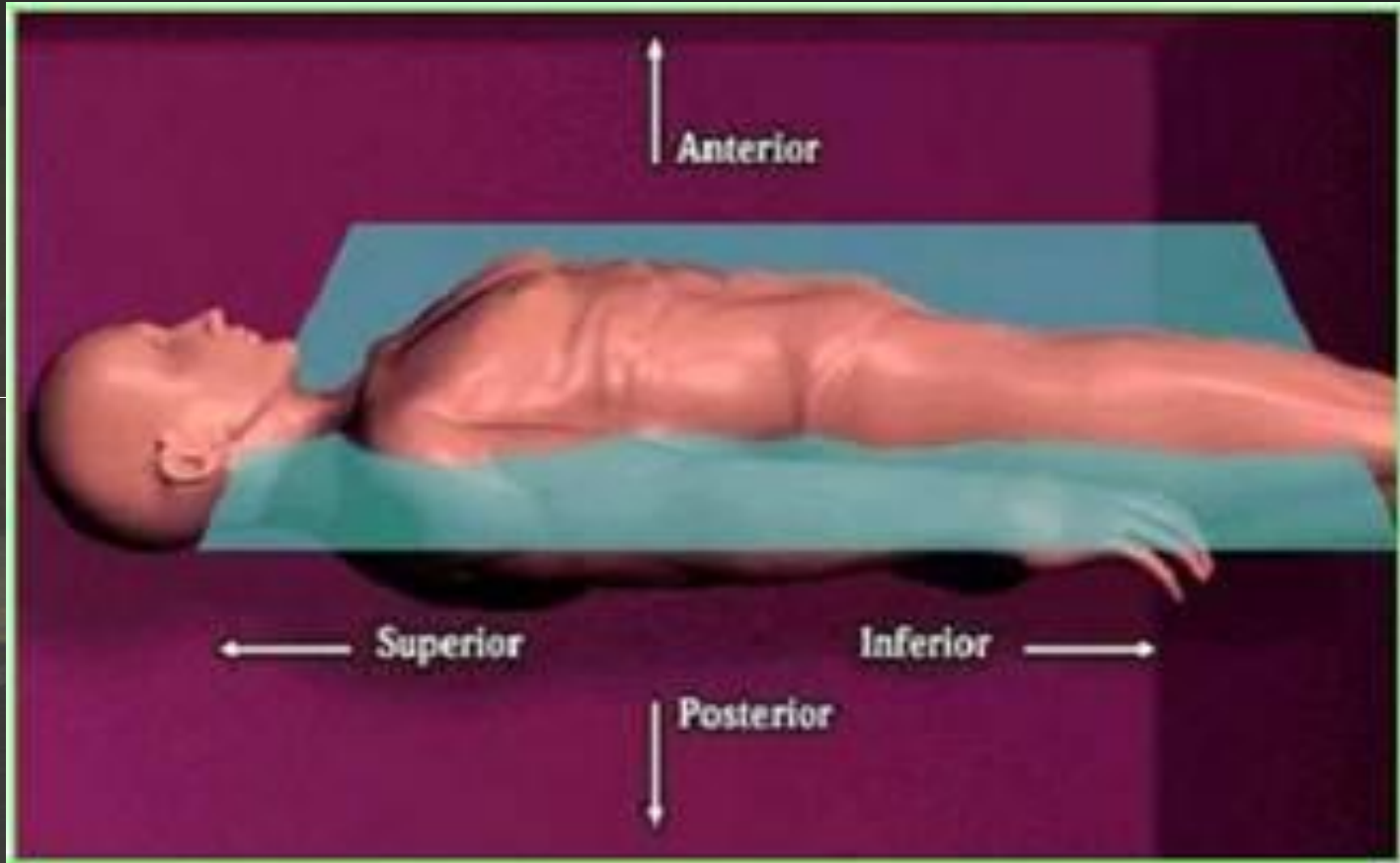


# Transverse Scanning



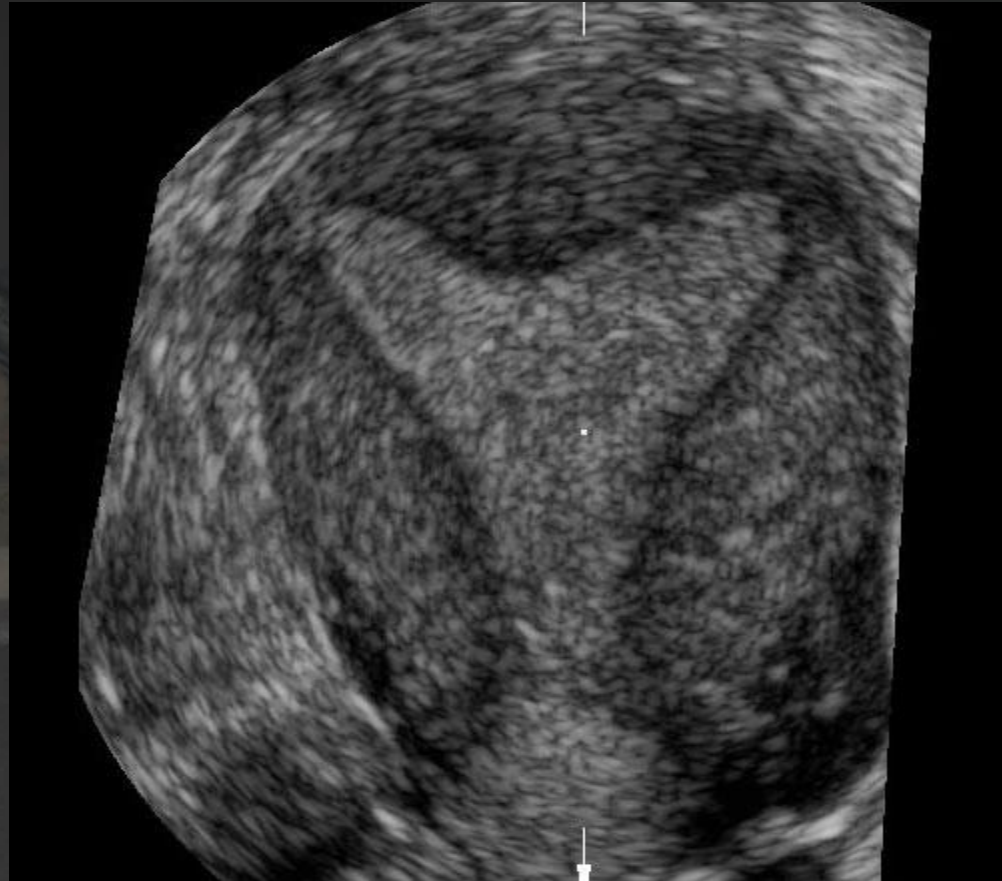


# Coronal scanning



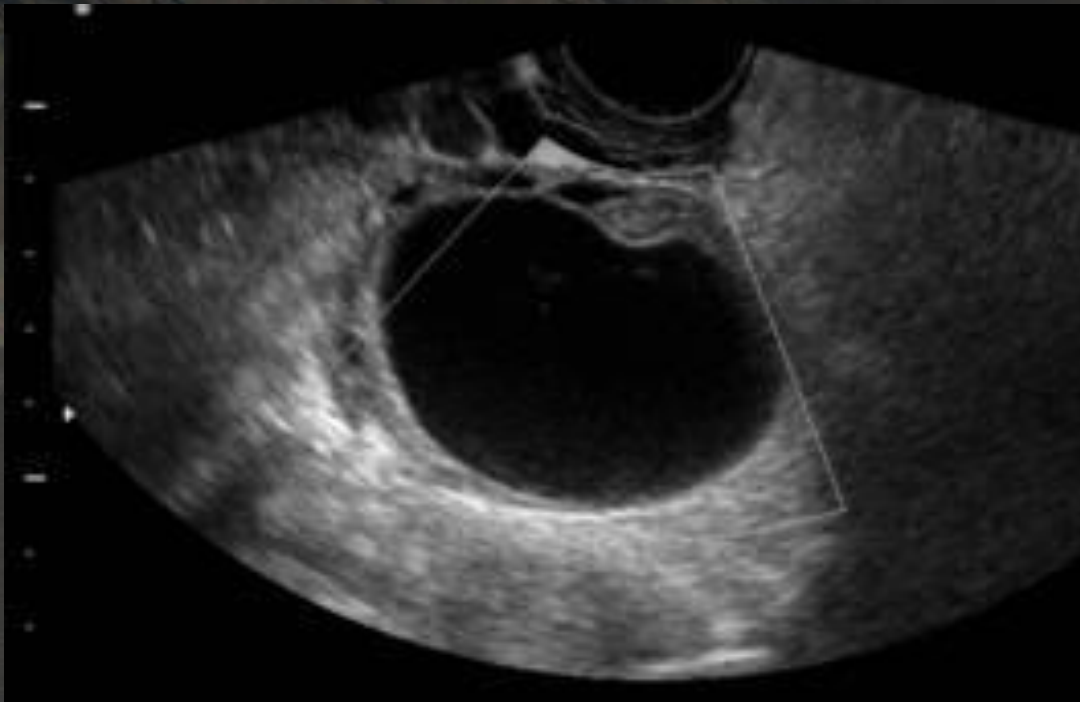


# Uterus in coronal plane



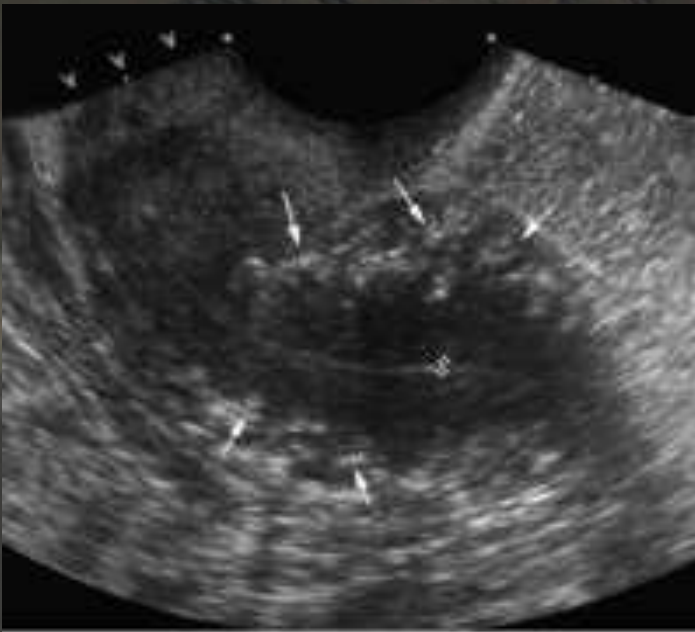


- **Anechogenic or sonolucent – (appears black), is filled with fluid, ultrasound penetrates easily (opposite of echogenic)**





- **Echogenic or hyperechogenic- (opposite of anechoic) creates an ultrasound echo:**
- **Appears in bright density on ultrasound**



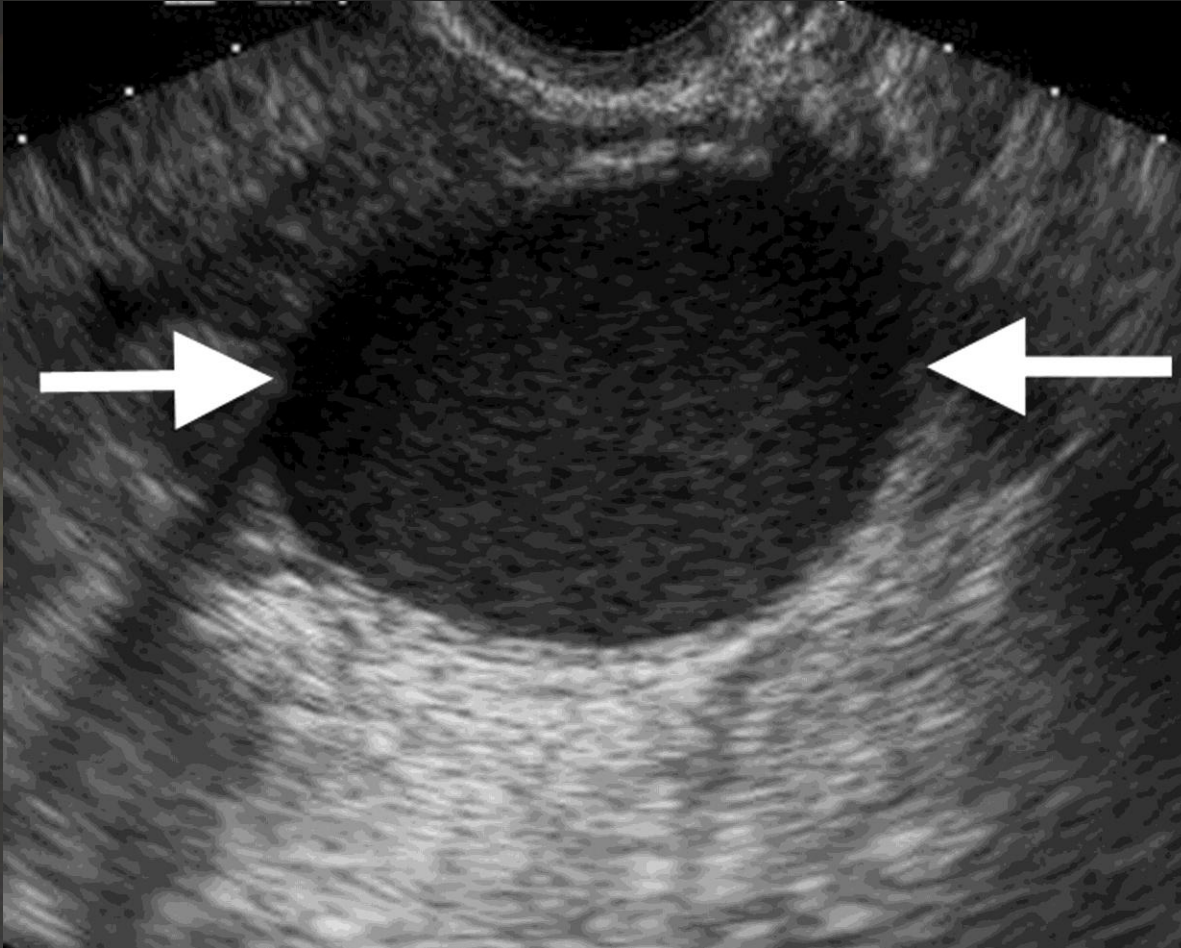


- **Hypoechoogenic: lower echogenicity as the normal parenchyma**
- **isoechogenic: if the echogenicity is the same as the normal parenchyma**



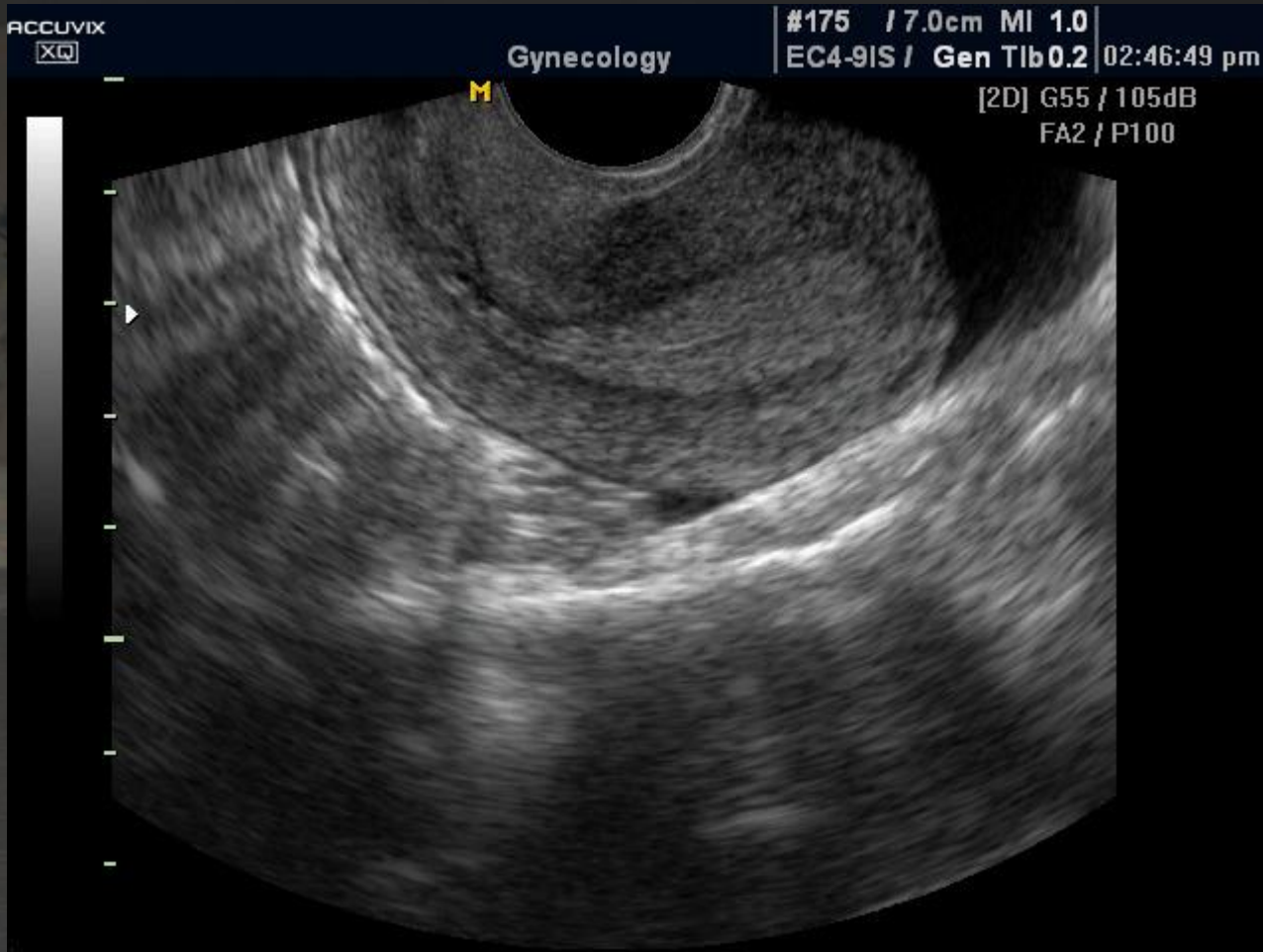


**Hypoechoogenic:** ovarian cyst with low echogenic content, endometrioma





- **Homogeneous-** (opposite of heterogeneous) whole tissue has the same echogenicity; myometrium, endometrium

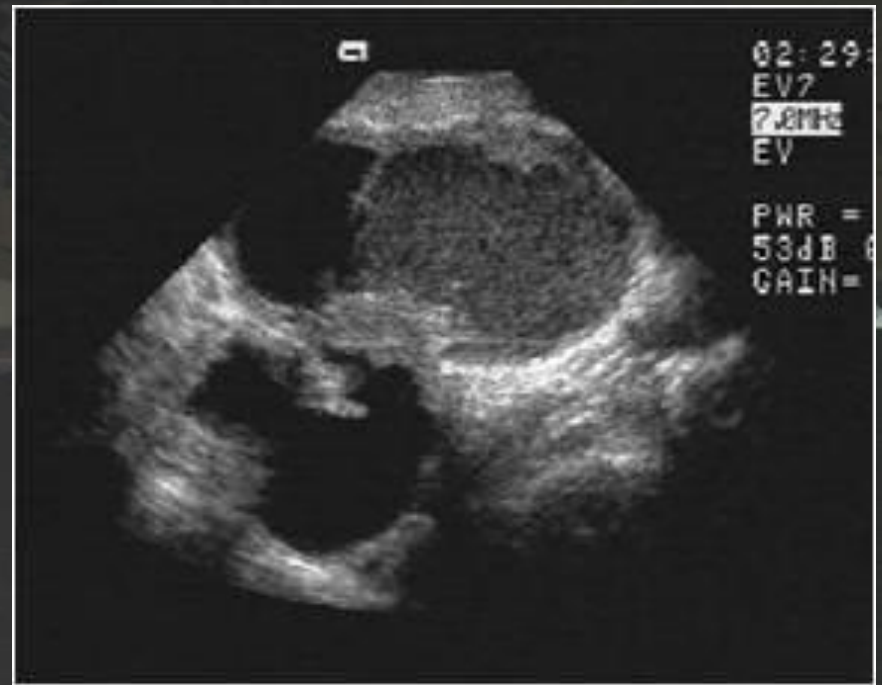






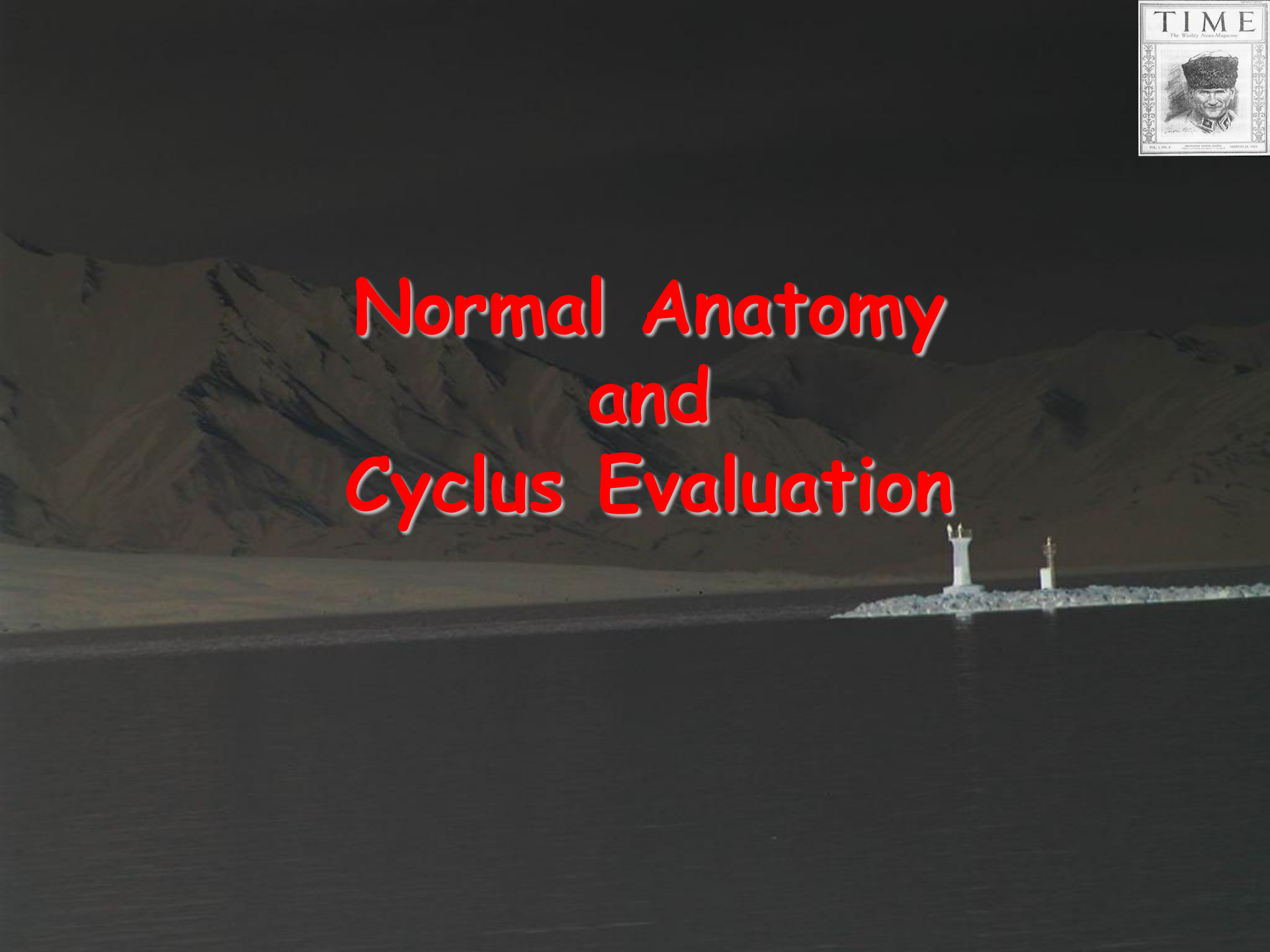
**Heterogeneous-** tissue containing areas with different echogenities

**Complex-** containing cystic and solid compartments  
smooth thin wall x irregular thick wall



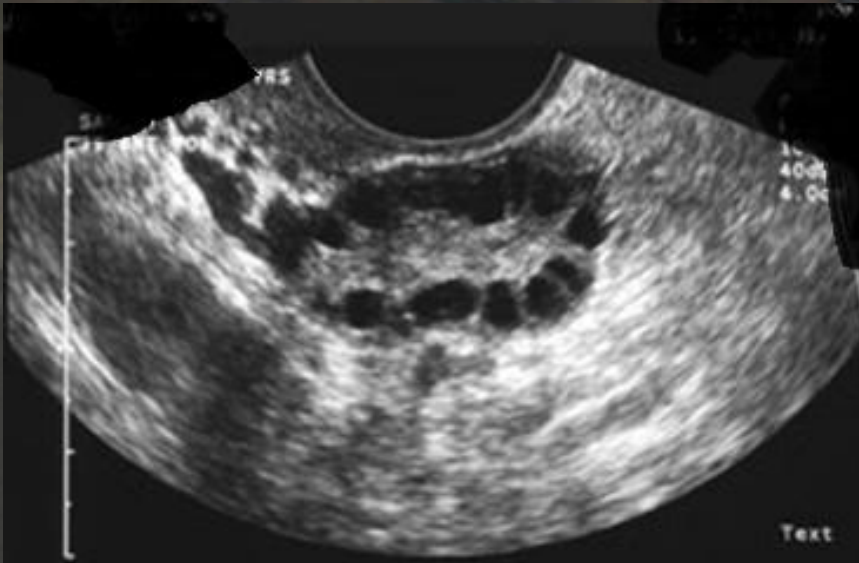
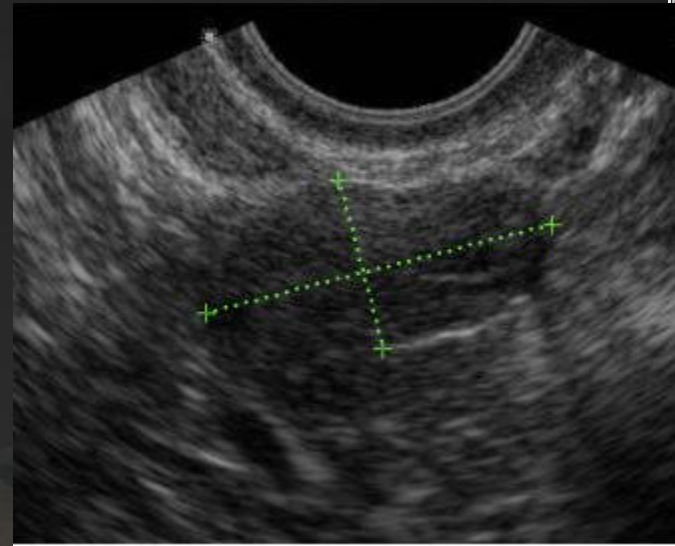


# Normal Anatomy and Cyclus Evaluation





- 2-4 th day of cycle
- 2-10 mm sized follicles
- If total antral follicle count  $< 4$  low ovarian reserve
- If total antral follicle count  $> 24$  risk of OHSS increases







ADVANCED FERTILITY CTR OF CHICAGO

ATO

11/12/01 11:28:53

3C6  
GYN

R9

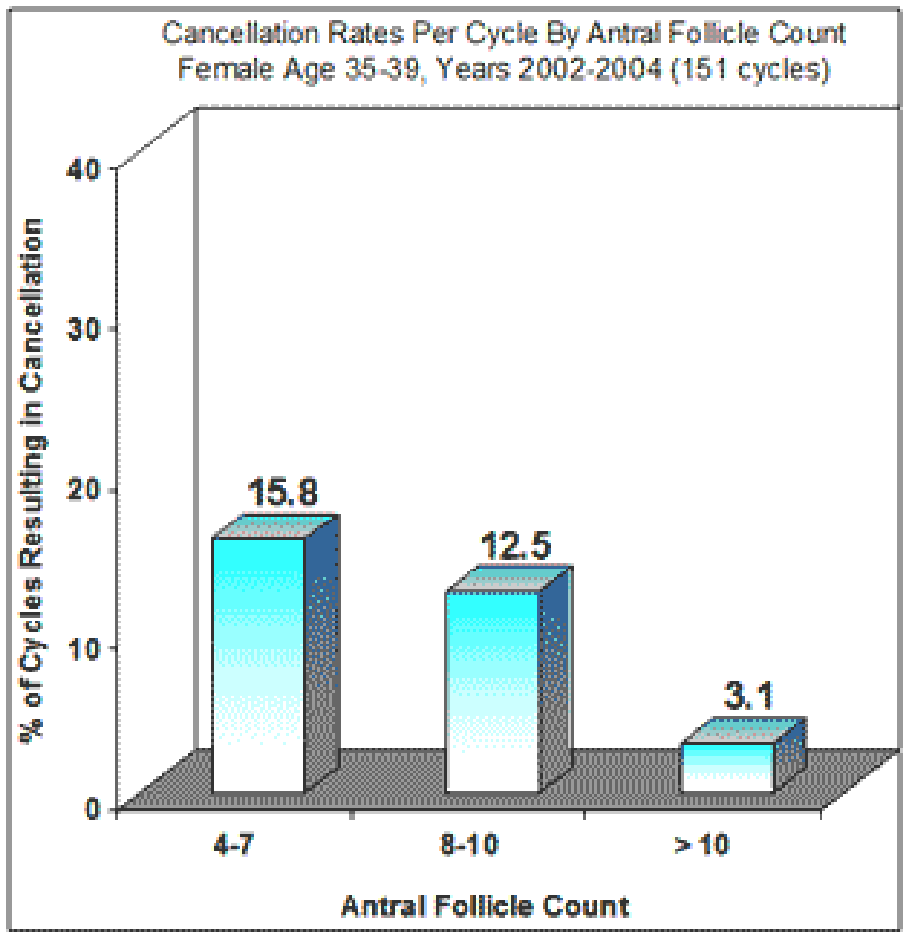
5.5MHz  
FA:M  
EE:L  
CN64  
6cm  
DR66  
G70

+ 30.0mm

17.8mm

GE







# Ovarian Volume ( $d_1 \times d_2 \times d_3 \times 0.5$ )



OV: 4.5 mL  
AFC: 9



OV: 1.0 mL  
AFC: 1

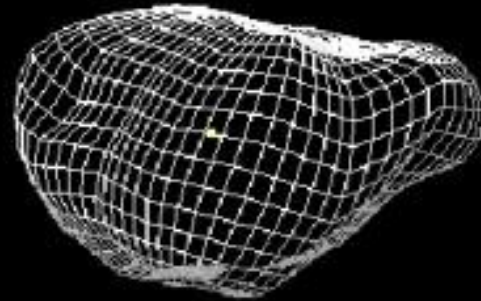
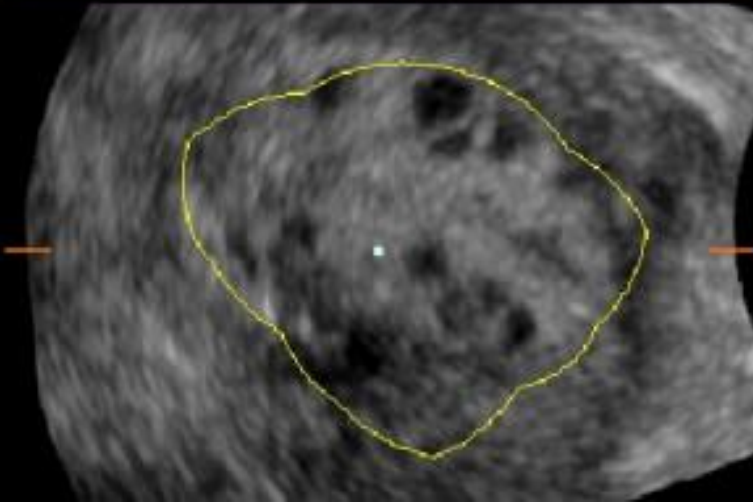
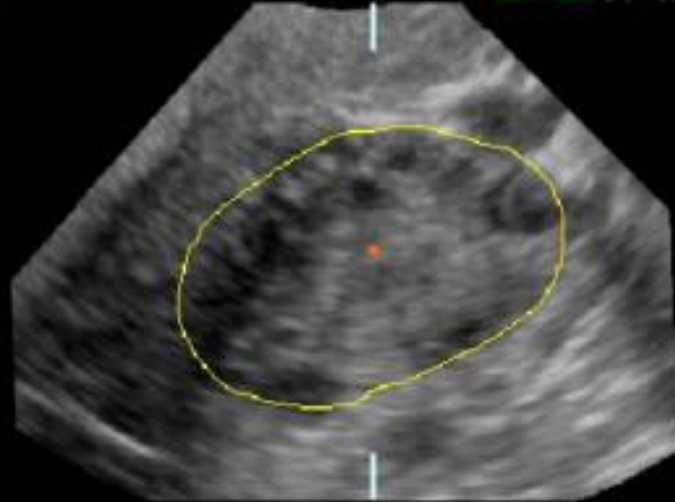


OV: 1.5 mL  
AFC: 2





Kent 06.01.01  
14:48:34





## Relation between rise of OHSS and Antral Follicle Count-Ovarian Volume (AFC - OV)

<b>AFC # (2-6 mm)</b>	< 5: low 5-15: normal <b>&gt; 15: increased</b>
<b>Ovarian volume (OV) (<math>d_1 \times d_2 \times d_3 \times 0.5</math>)</b>	< 3 mL low 3-9 ml : normal <b>&gt; 9 mL: increased</b>



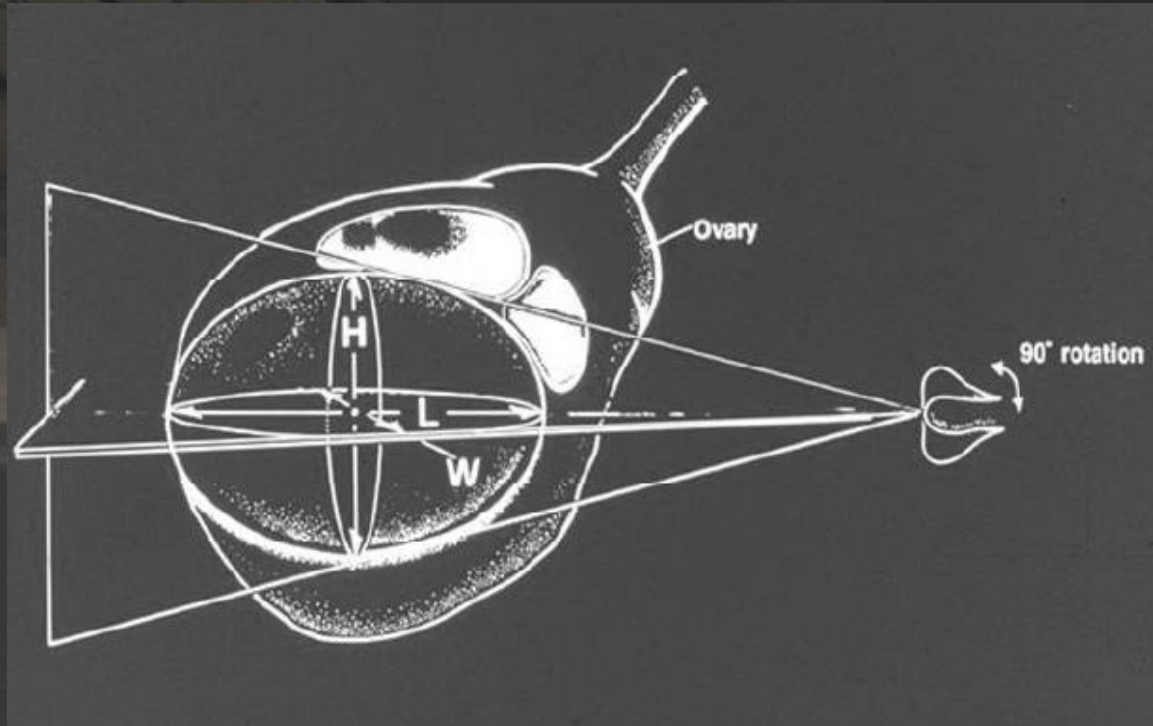
Low-dose ovarian stimulation regimen



# Folliculometry



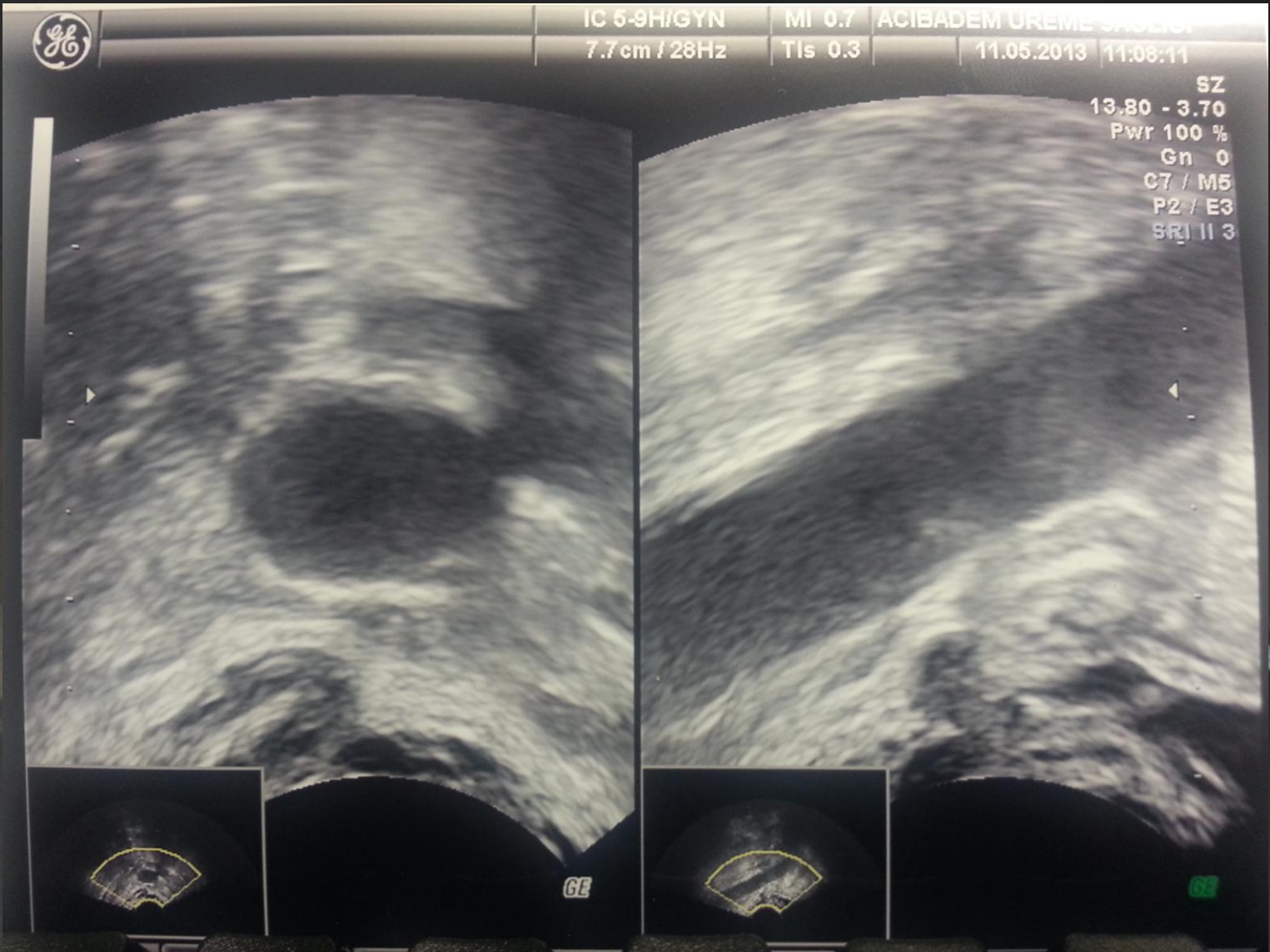
- **Maximum diameter**
- **Two diameter (dimension)**
- **Three diameter (dimension)**





# Differential Diagnosis

- **Internal iliac artery / vein**
- **Bowel**
- **Hydrosalpinx**
- **Ovarian cyst**
- **Paratubal cyst**





# Follicular Growth

- **approximately 1.5- 2 mm/day**
- **Diameter of Follicule**  
**14 – 24 mm**
- **> 24 mm the chance of retrieving follicles and fertilization decreases**



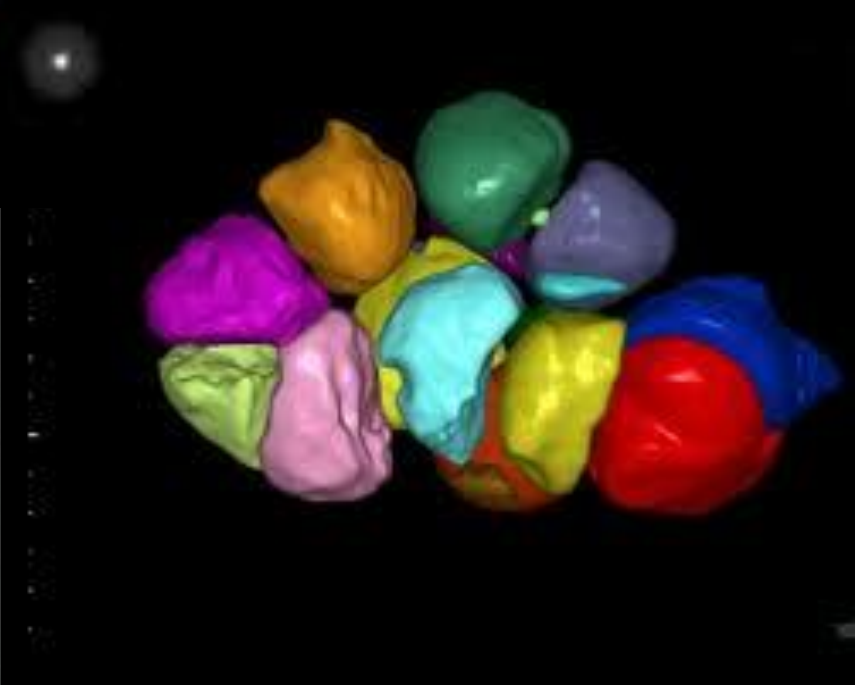
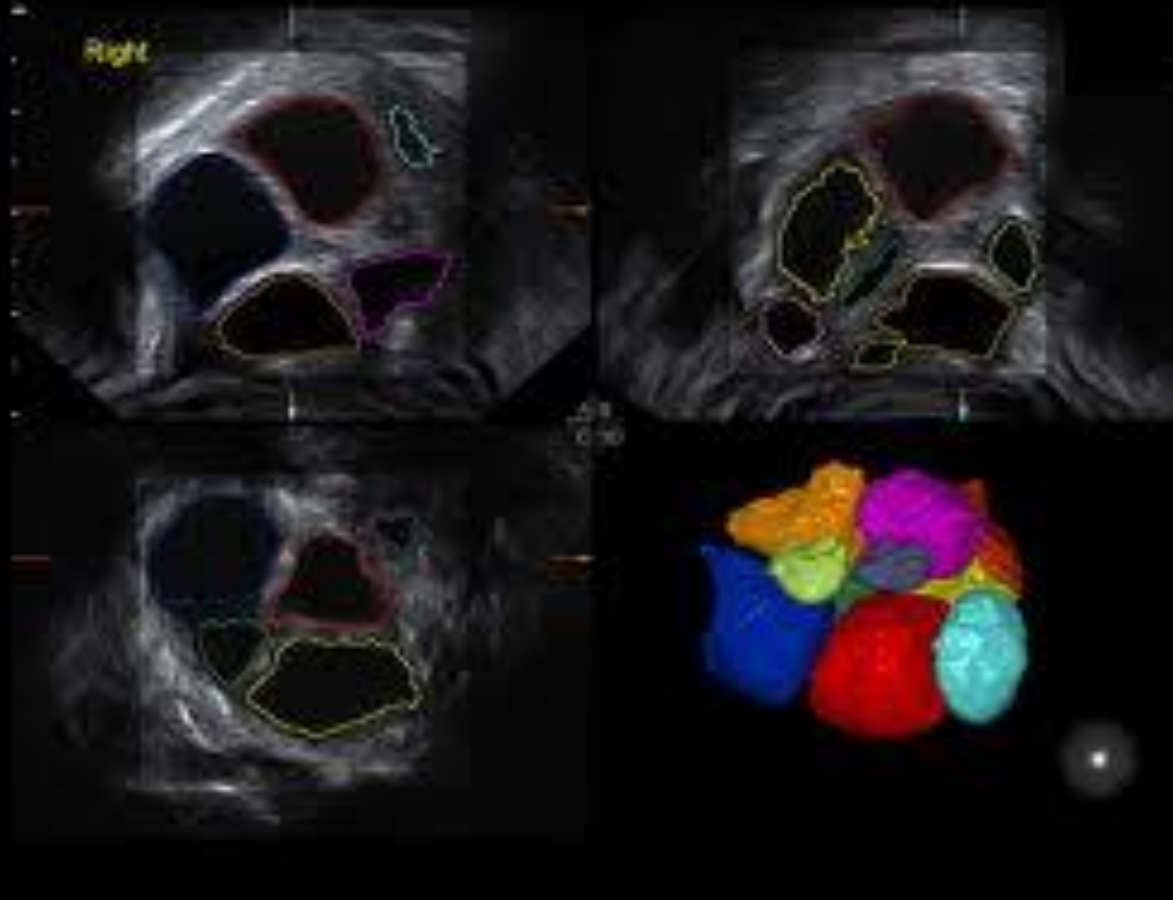
## Sono - AVC

Sono-AVC has been used to automatically calculate the mean relaxed sphere diameter (dV) and the mean diameter (m-d) calculated from the maximal dimensions (dx, dy, dz) of the follicles.

Nr	d(V)	dx	dy	dz	m-d	V
1	26.3	33.9	28.4	19.8	27.4	9.52
2	21.9	31.8	20.6	17.8	23.4	5.48
3	16.5	25.9	16.1	12.2	18.1	2.37

Rotation X: [Slider]    Rotation Y: [Slider]    Rotation Z: [Slider]    Magn: 1.00    Growth: mid [-] [+]    Th. Low 80    Separation: mid [-] [+]    Measure    Add to Report    Edit ROI    MAIN MENU







# Endometrial Thickness

**1-4 mm menstruel phase,**

**4-8 mm midproliferative**

**8-14 mm late follikuler**

**7-14 mm sekretuar phase**

**At the day of hCG endometrium > 7 mm**

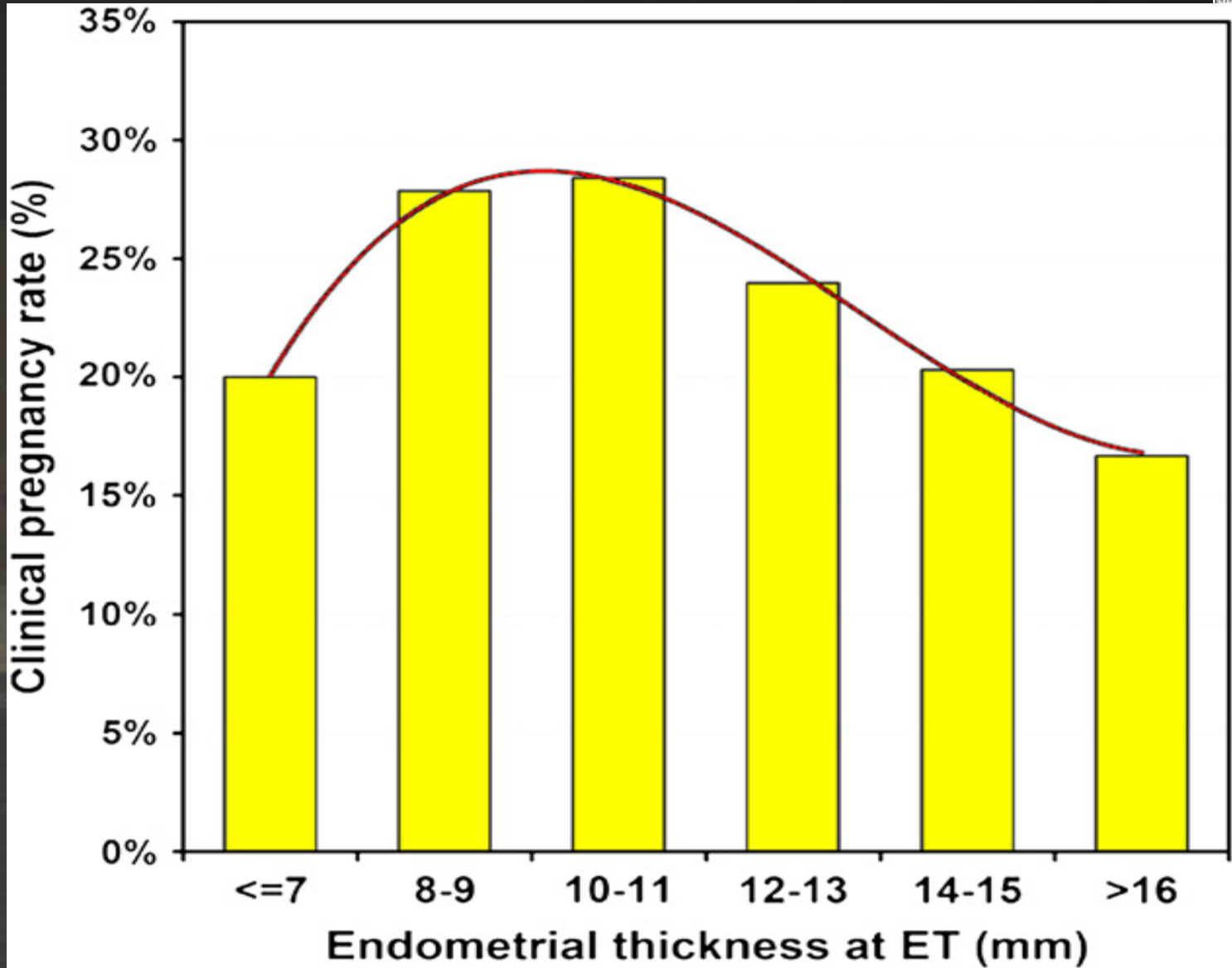
❖ Oliveira JB, et al. Endometrial ultrasonography as a predictor of pregnancy in an in-vitro fertilization programme after ovarian stimulation and gonadotrophin-releasing hormone and gonadotrophins. Hum Reprod 1997

❖ Schild RL, et al. Endometrial receptivity in an in vitro fertilization program as assessed by spiral artery blood flow, endometrial thickness, endometrial volume, and uterine artery blood flow. Fertil Steril 2001



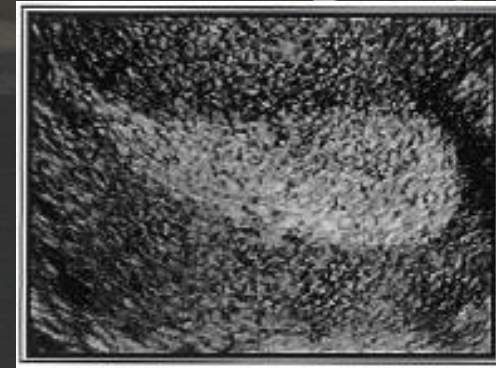
# Endometrial Thickness

- **Decrease in pregnancy rate – increase in spontaneous abortion rate**
  - $< 5$  mm
  - $< 6$  mm
  - $> 13$  mm
  - $> 14$  mm
  - $> 18$  mm
  - Upper limit ??



# Endometrium

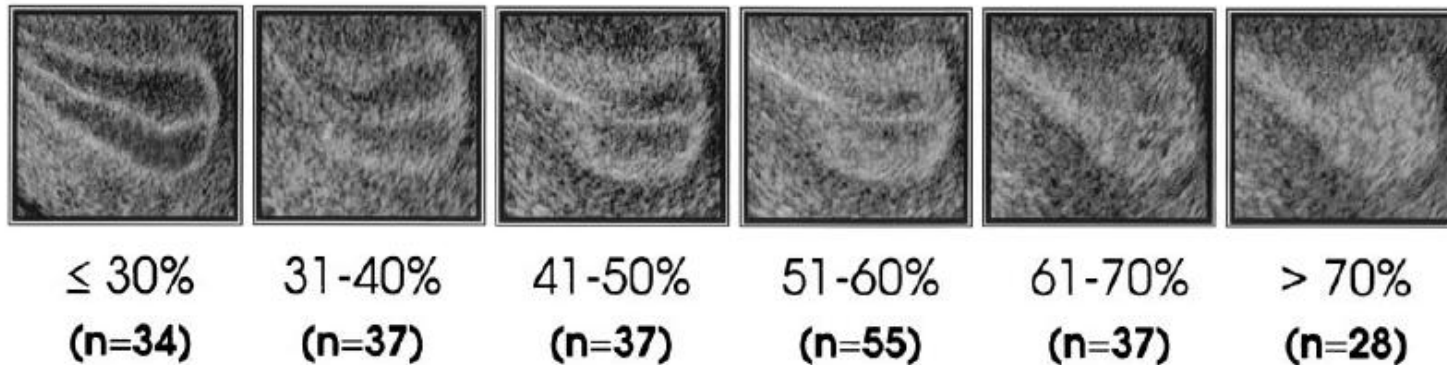
- Hypoechoic:  
Proliferative phase;  
midline echogenic line
- Hyperechogenic:  
Sekretuar phase; No  
midline echogenic line



## FIGURE 2

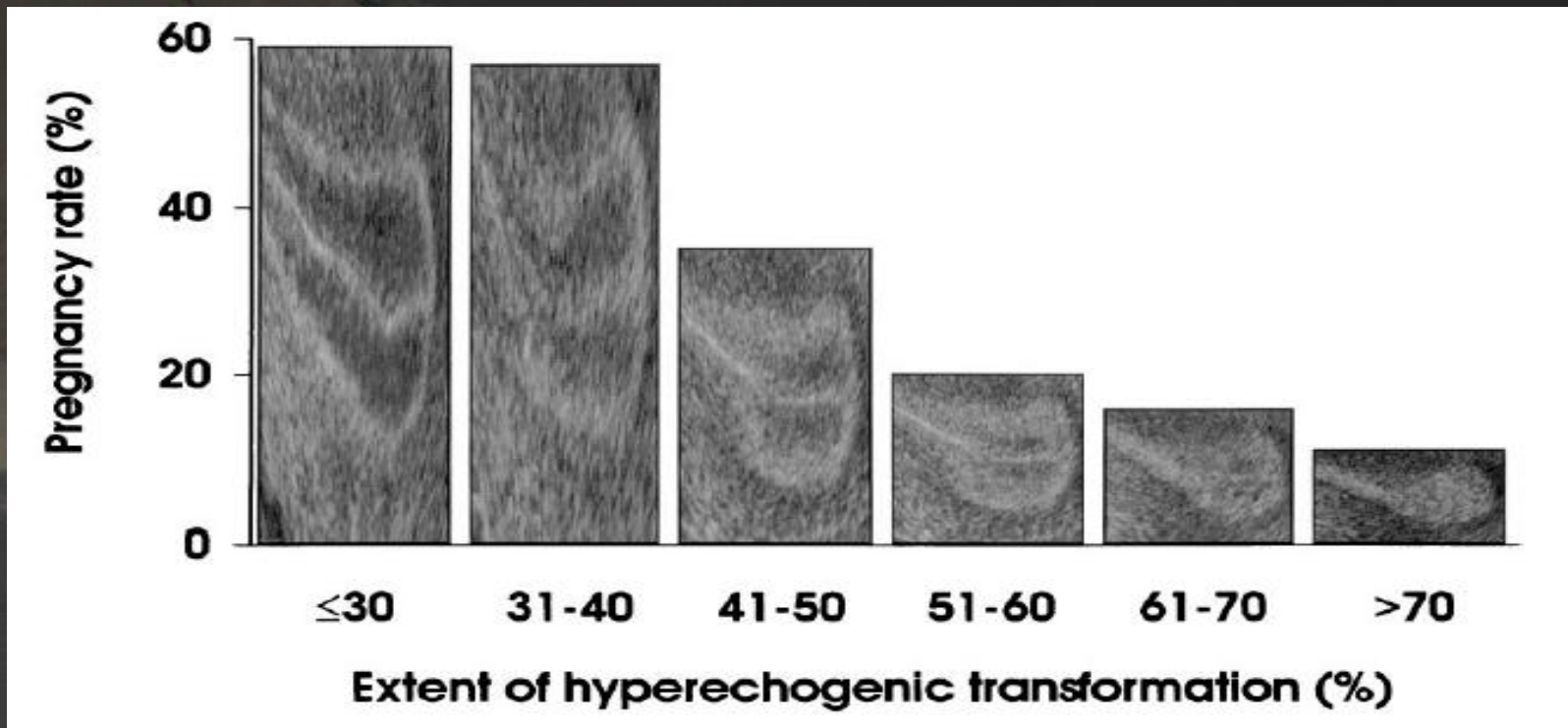
The cycles were sorted into six groups according to the extent of the upward hyperechogenic transformation of the endometrium.

6 echogenicity groups: **Extent of hyperechogenic transformation**  
**Endometrial thickness**





# Relation between extent of hyperechogenic transformation on day of BhCG injection and pregnancy rate ( $p < 0.001$ )





## Doppler ve Endometrial Receptivity

- **Evaluation of endometrial and subendometrial blood flow with Power doppler ;**
  - Increases in follicular phase,
  - Decreases with age,
  - Low diagnostic predictor for implantation,

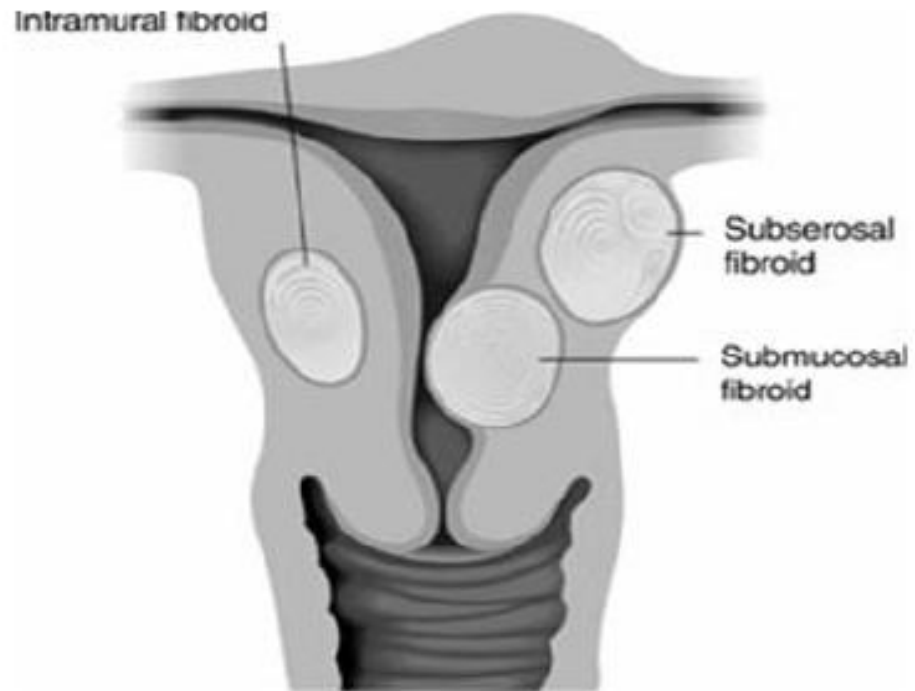


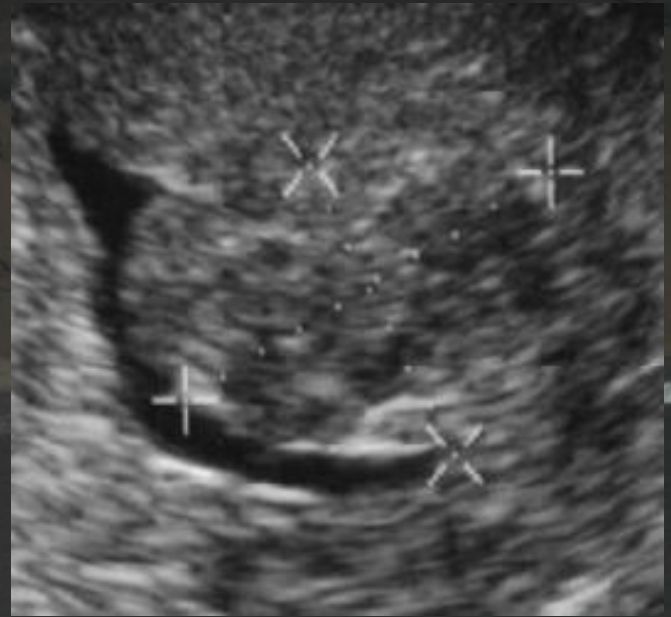
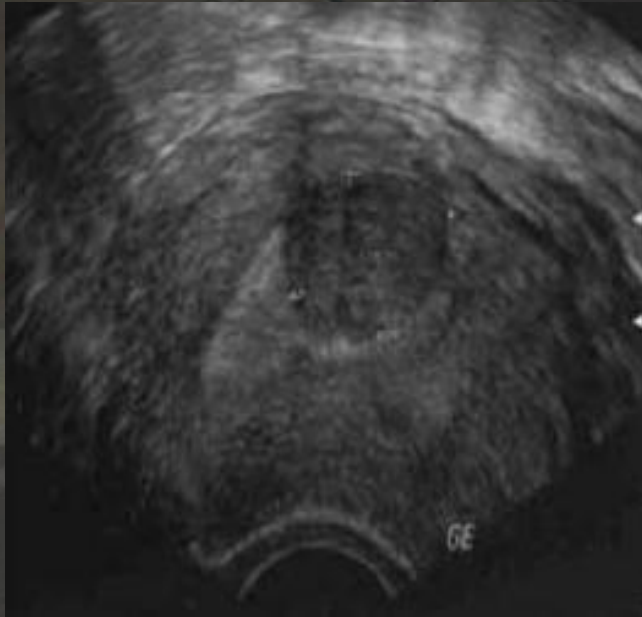


# Ultrasonographic diagnosis and classification of gynecologic pathologies

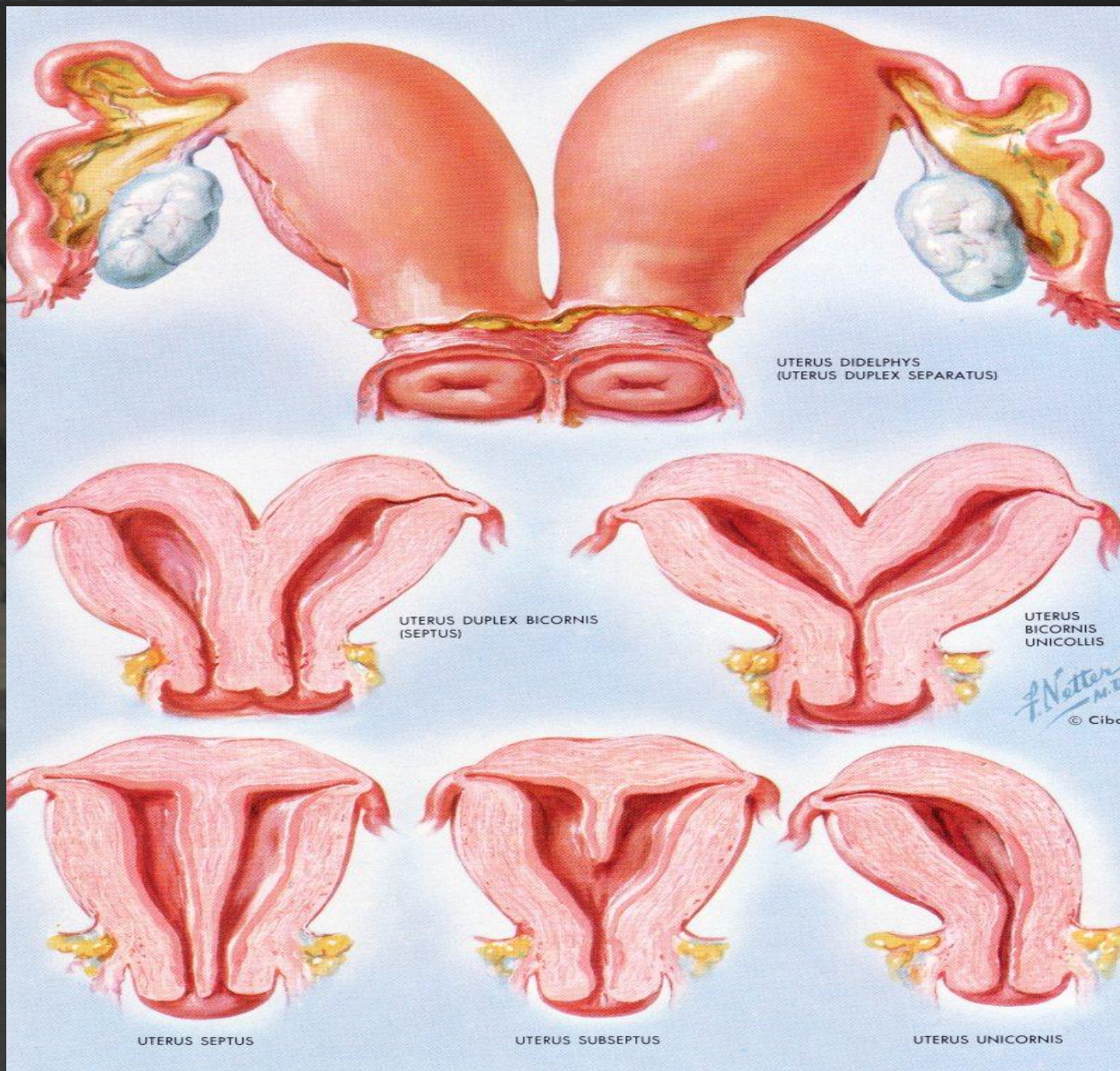


# Classification of Uterine Fibroids





# Congenital Anomalies





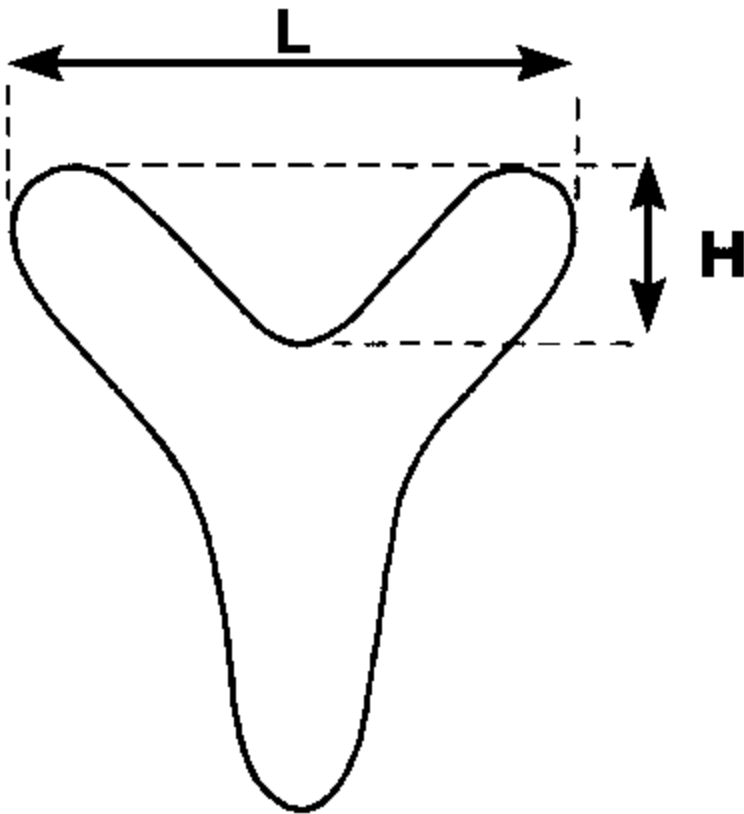
# Suspicion of Uterine Anomaly

- **Using ultrasound for diagnosis of uterine anomalies**
  - 2D sensitivity %88 specificity %94
  - 3D sensitivity and specificity %98-100
- **Sensitivity and specificity of MRI %100**
- **Diagnostic Laparoscopy:**
  - Accompany hysteroscopy
  - Diagnosis and treatment of symptomatic patients



Diagram of arcuate uterus ratio. When ratio of height ( $H$ ) to length ( $L$ ) is less than 10%, an adverse reproductive outcome is not expected. (Reprinted, with permission, from reference)

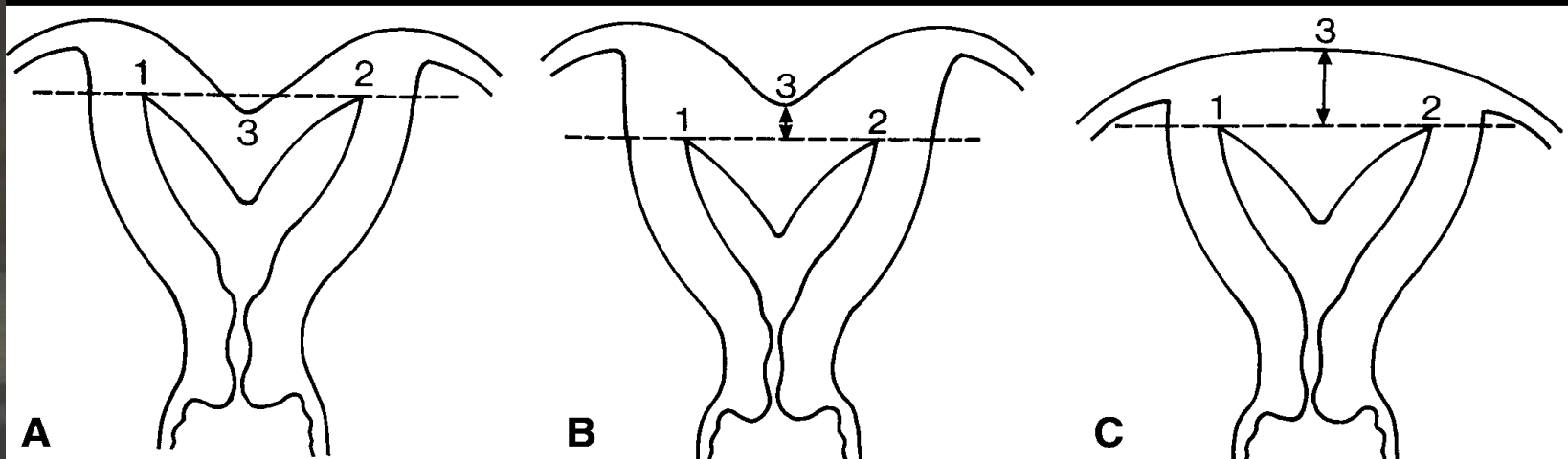
Arcuate uterus. Transverse fastspin-echo T2-weighted MR image (6166/130) demonstrates nonspecific low signal intensity of fundal myometrium (arrow)



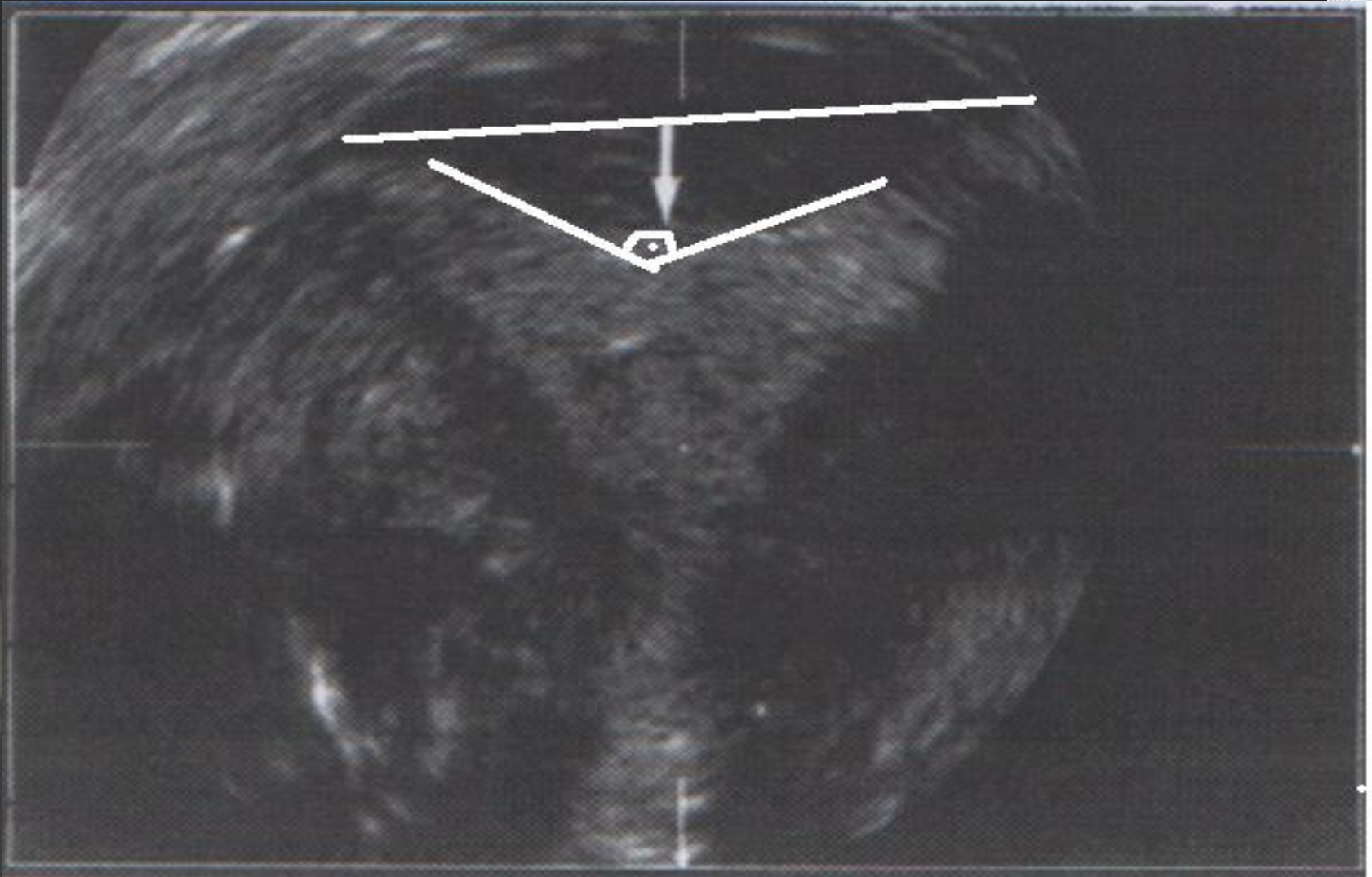
Robert N. Troiano, MD Shirley M. McCarthy, MD, PhD : Mullerian Duct Anomalies: Imaging and Clinical Issues 1 Radiology 2004; 233:19-34



**F Classification criteria for US differentiation of septate from bicornuate uteri. A, When apex (3) of the fundal external contour occurs below a straight line between the tubal ostia (1, 2) or, B, 5 mm (arrow) above it, the uterus is bicornuate. C, When apex is more than 5 mm (arrow) above the line, uterus is septate.**

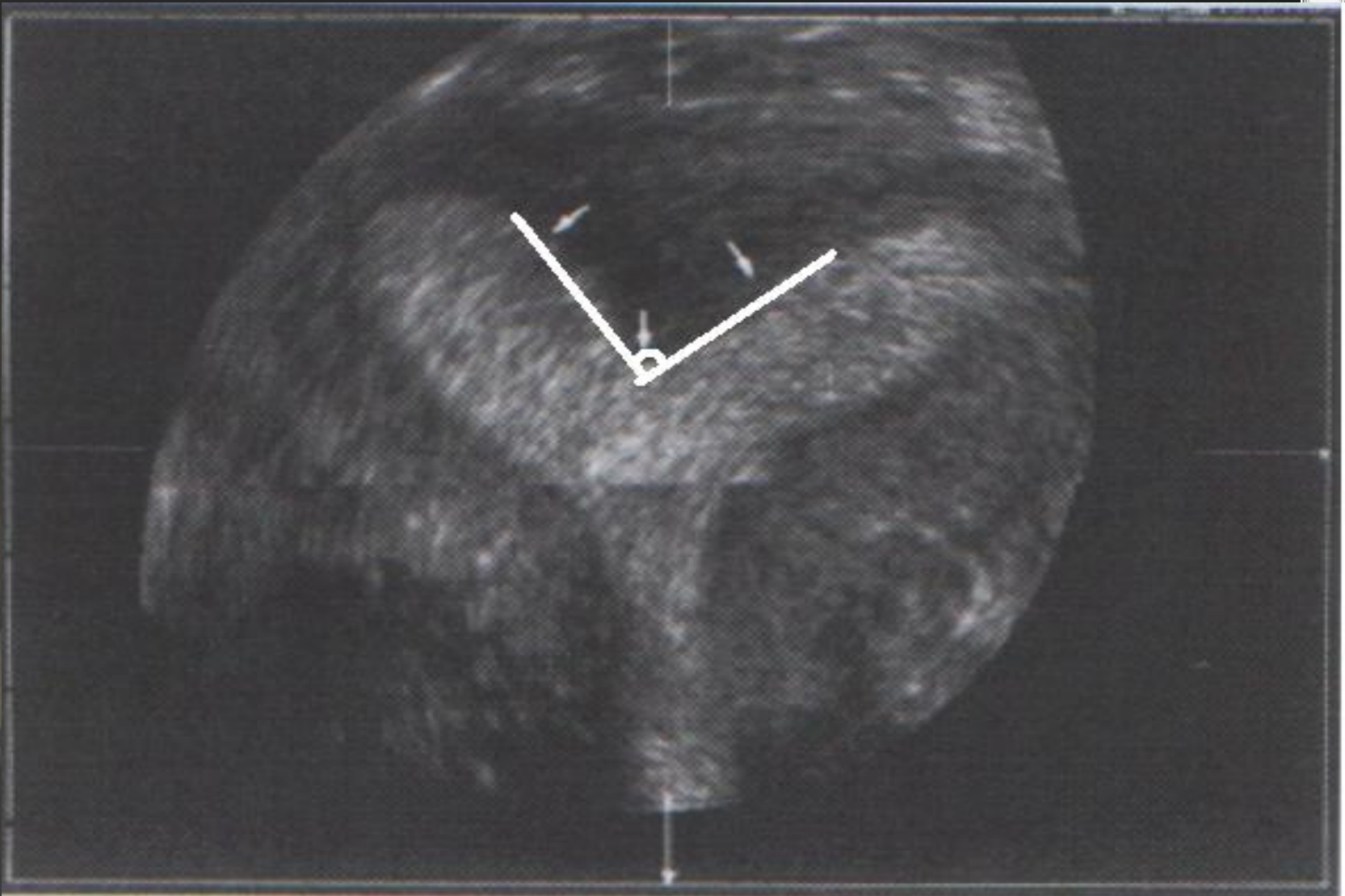


Robert N. Troiano, MD Shirley M. McCarthy, MD, PhD : Mullerian Duct Anomalies: Imaging and Clinical Issues *1 Radiology* 2004; 233:19–34



Wu et al, J Clin Ultrasound, 1997



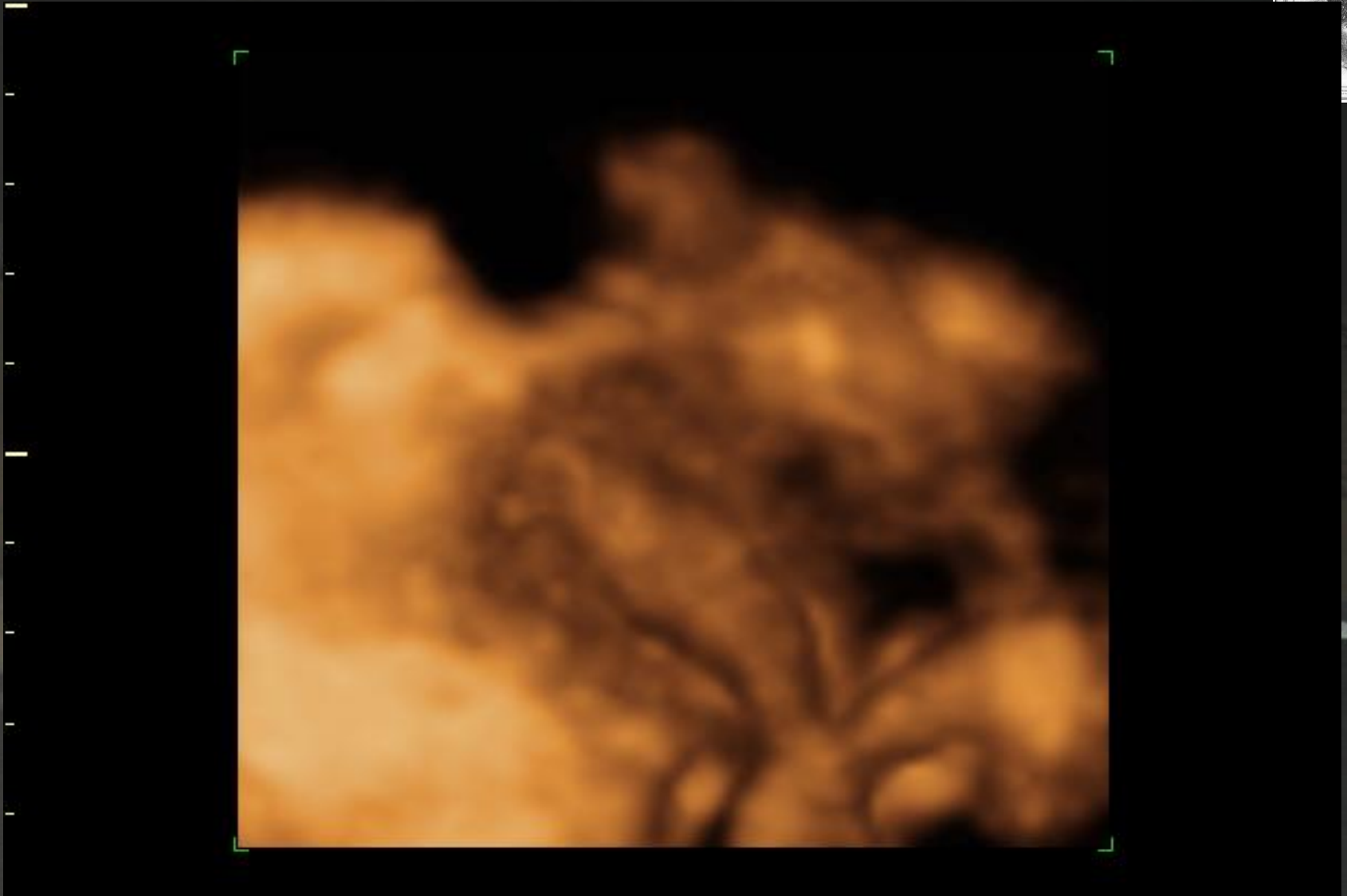


Wu et al, J Clin Ultrasound, 1997

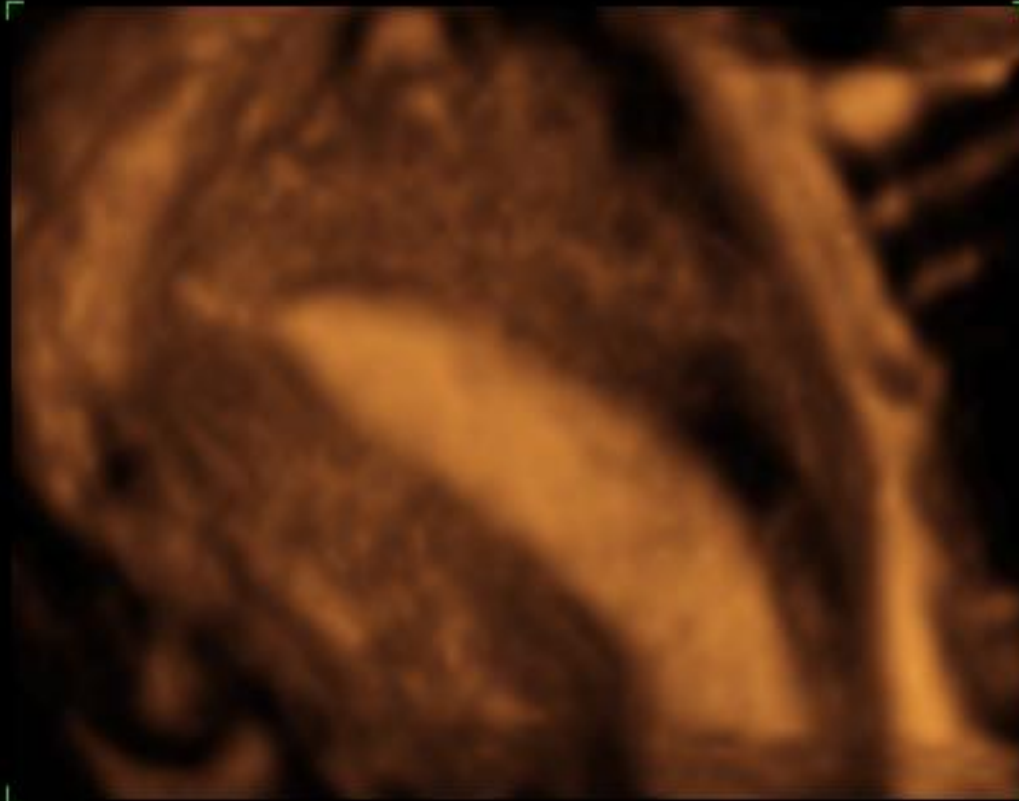


## Tips for 3D-4D Ultrasound

- **Transvaginal 3D is better than transabdominal 3D**
- **Perform the ultrasound exam in the luteal phase when the endometrium is thick**
- **The bladder should be half full for a transabdominal ultrasound exam**
- **Try to obtain transverse or coronal planes**
- **Use video options and obstetric modes**



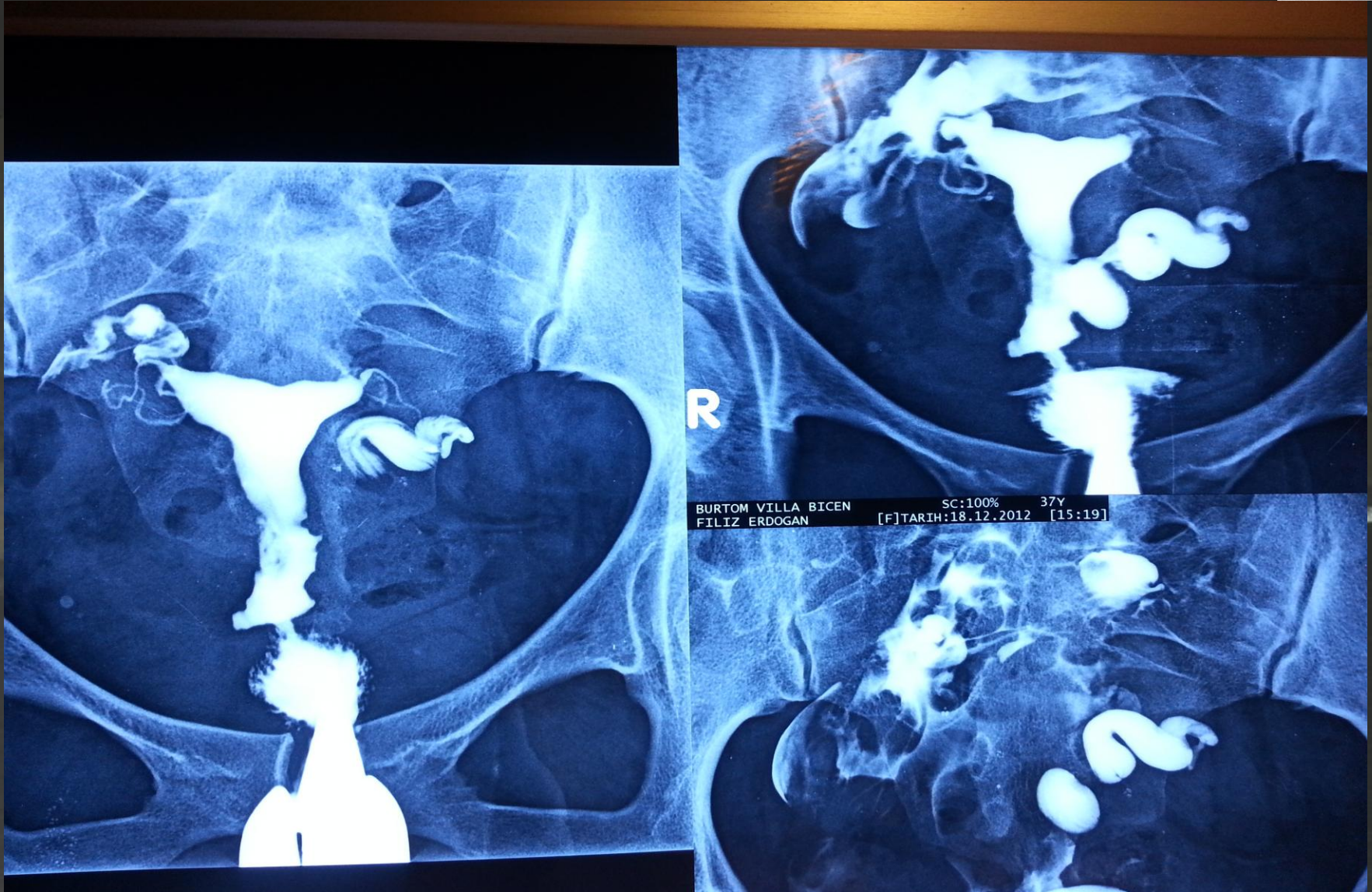
Caliskan E et al, J Clin Ultrasound, 2010



Caliskan E et al, J Clin Ultrasound, 2010

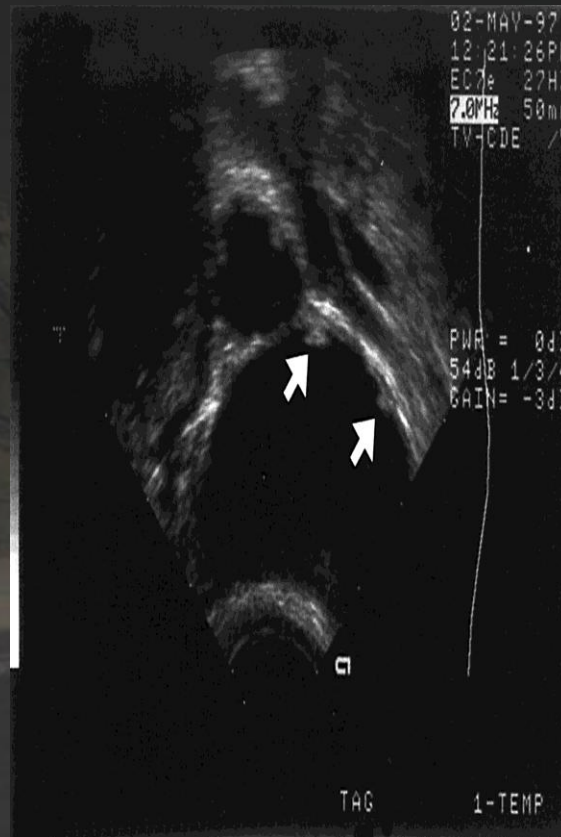


# Hydrosalpinx





## Hidrosalpinx



Incomplete septation  
Elongated dilatation

Beads-on-a-string

Poor vascularisation

(Guerriero, S. et al. Hum. Reprod. 2000 15:1568-1572)



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A





01-15-5

1.0/ 4.8cm / 55Hz

TIs 0.4

15.07.2013

13:38:13

S  
13.80 - 3.7  
Pwr 100  
Gn  
C7 / M  
P2 / E  
SRI II









## IMPLANTATION RATES AFTER LS SALPINGECTOMY VS NO INTERVENTION BEFORE IVF

Table VI. Mean implantation rates (IR) (of each individual's mean implantation rate) in all transfer cycles in the total study population and in subgroups of patients with bilateral and ultrasound-visible hydrosalpinges in the two treatment groups

Study group	Laparoscopic salpingectomy <sup>a</sup>			No intervention before IVF			<i>P</i>	Bonferroni-Holm adjusted <i>P</i>
	<i>n</i>	Mean IR	(SD)	<i>n</i>	Mean IR	(SD)		
Total study population	104	27.2	(29.1)	82	20.2	(28.6)	0.030	0.030
Bilateral hydrosalpinges	63	29.4	(31.5)	34	13.4	(23.4)	0.004	0.008
Ultrasound-visible hydrosalpinx	51	30.3	(29.4)	42	17.1	(30.4)	0.003	0.009
Bilateral and ultrasound-visible	33	34.2	(32.0)	19	10.5	(26.8)	0.001	0.004

Cycles after non-randomized surgery are excluded.

*n* denotes the number of included patients.

<sup>a</sup>104 patients in the salpingectomy group is the sum of 103 patients with salpingectomy before any transfer + one patient with salpingectomy after oocyte retrieval but before transfer.

From Strandell et al 2001



## Approach to hydrosalpenx before ART ?

- **Transvaginal needle aspiration**

- Aboulghar M, et al. Fertil Steril 1990;53:311–4.
- Sowter MC, et al. Hum Reprod 1997;12:2147–50.
- Van Voorhis BJ, et al. Hum Reprod 1998;13:736–9



# Asherman's Syndrome





# Intrauterine Synechiae





postoperative



7.7cm / 40Hz

Tis 0.3

14.12.2012 12:46:51

SZ  
13.80 - 3.70  
Pwr 100 %  
Gn 0  
C7 / M5  
P2 / E3  
SRI II 3

576

Cine/pos

14 sec

GE

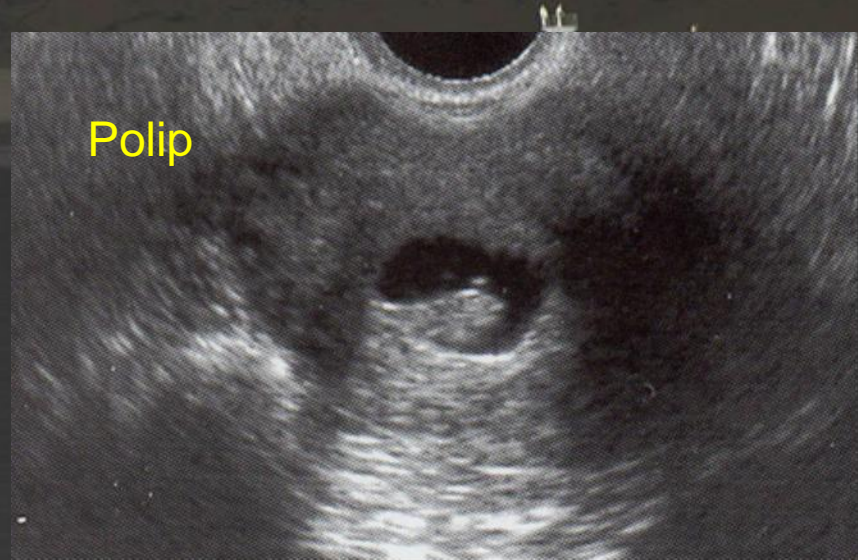
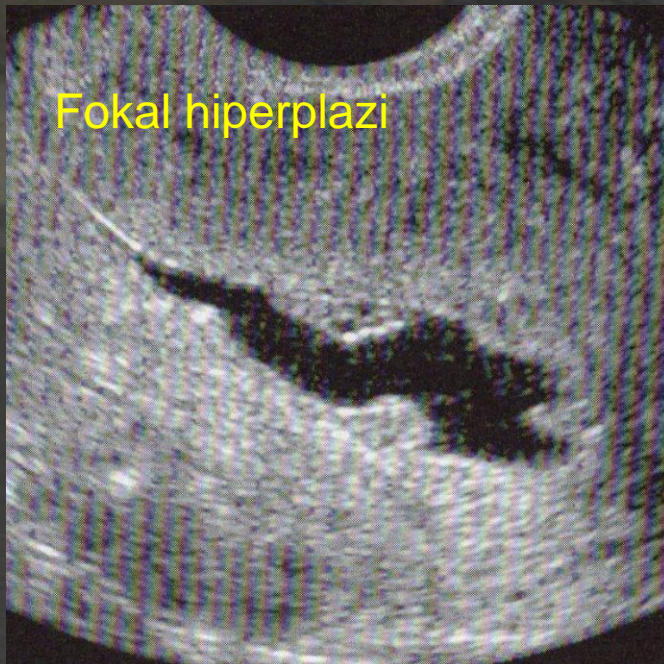
# Endometrial polyps –

## Differential diagnosis

- ✓ Focal hyperplasia

*Usually you don't see the endometrial border*

*Often confused with small and sessile polyps*





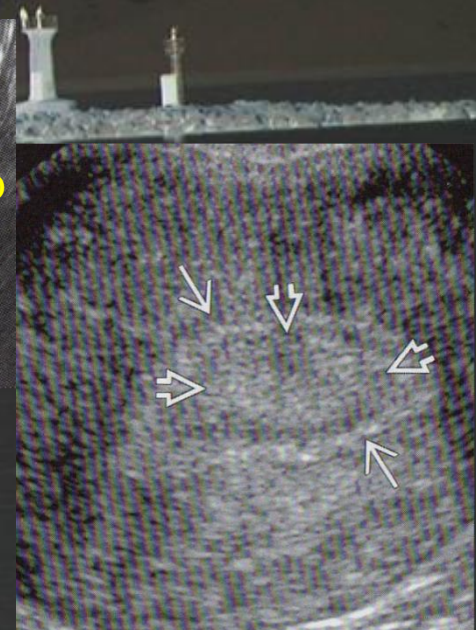
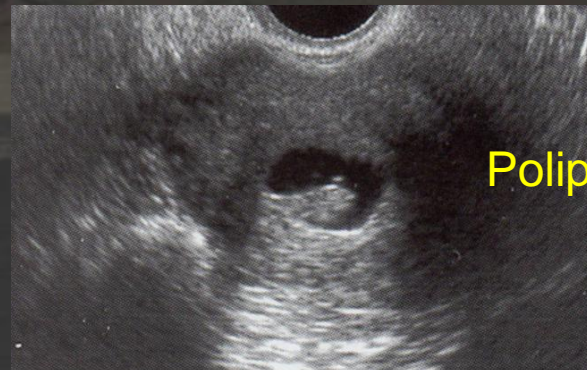
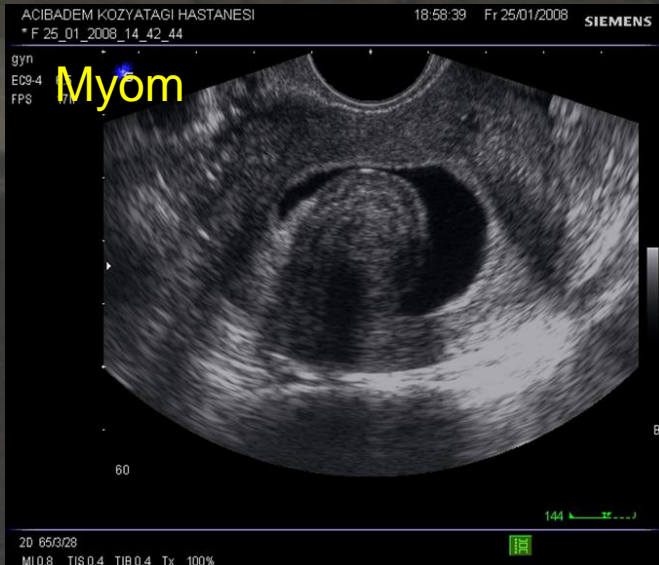


# Endometrial polyps – Differential diagnosis

- ✓ Submucosal fibroid

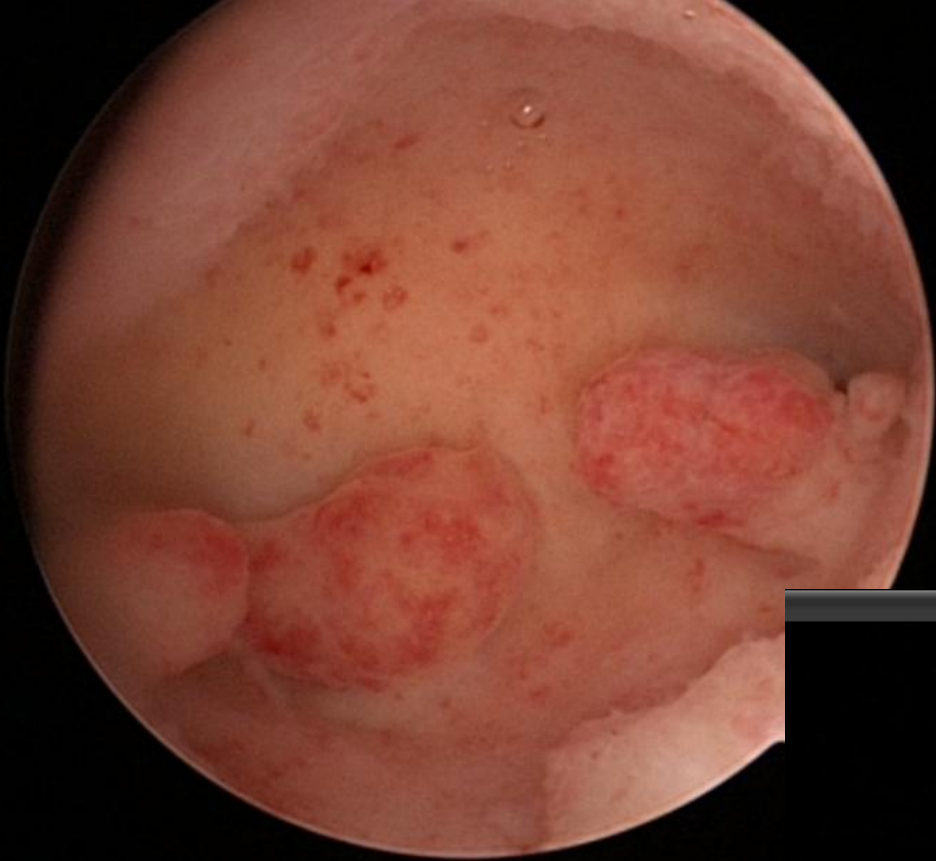
*Fibroids are more hypoechogenic*

*Endometrial echogenicity covers the mass*









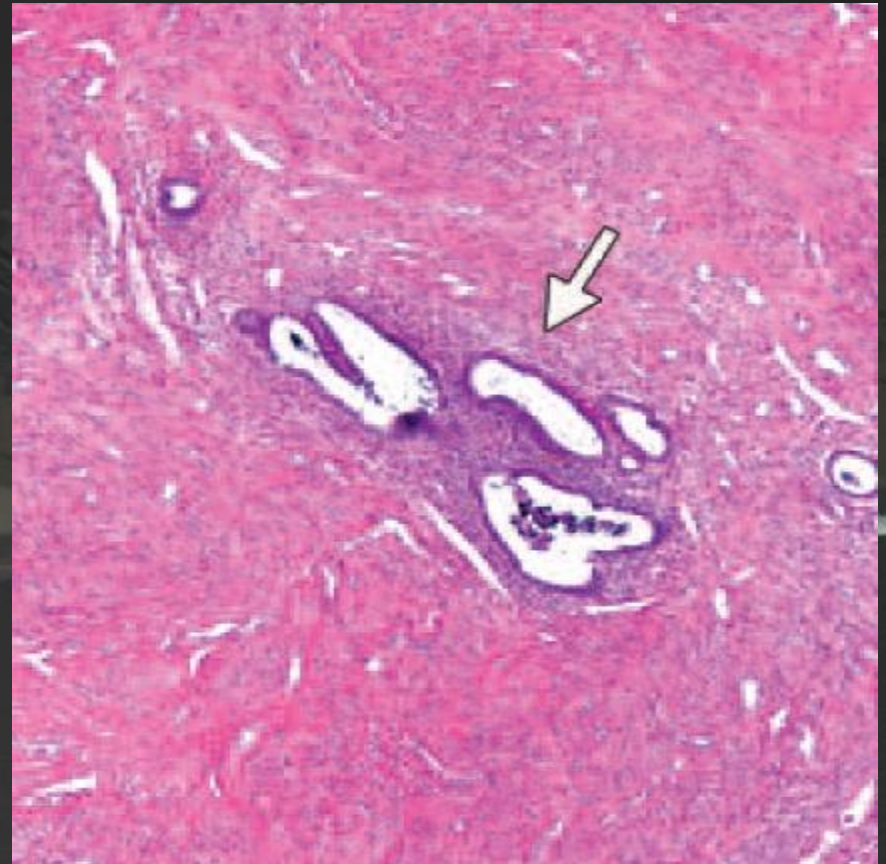
Video\_001.mpg [1/2]





# Adenomyosis

- **The presence of ectopic endometrial glandular and stromal tissue in the myometrium**





# Adenomyosis Epidemiology

- **% 20 of women**  
(J Minim Invasive Gynecol 2009; 16:622–625)
- **More common in women with endometriosis**
- **More common in women with low BMI**  
(Hum Reprod 2010; 25:1325–1334)



Adenomyozis

## Diagnosis- Ultrasound Findings

- Enlarged uterus (no fibroid)
- Unclear endometrial lining edge
- Myometrial cysts
- Variable echogenicity
- No defined mass image
- Difficult to determine borders of the lesion
- Penetrating blood flow on Doppler US

# Adenomyosis







16266-13-03-27-6

IC 5-9H/GYN

MI 0.7

ACIBADEM UREME SAGLIGI

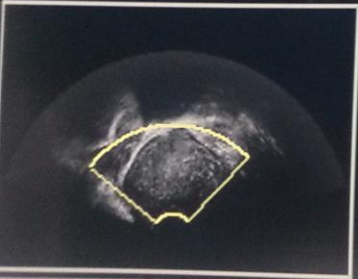
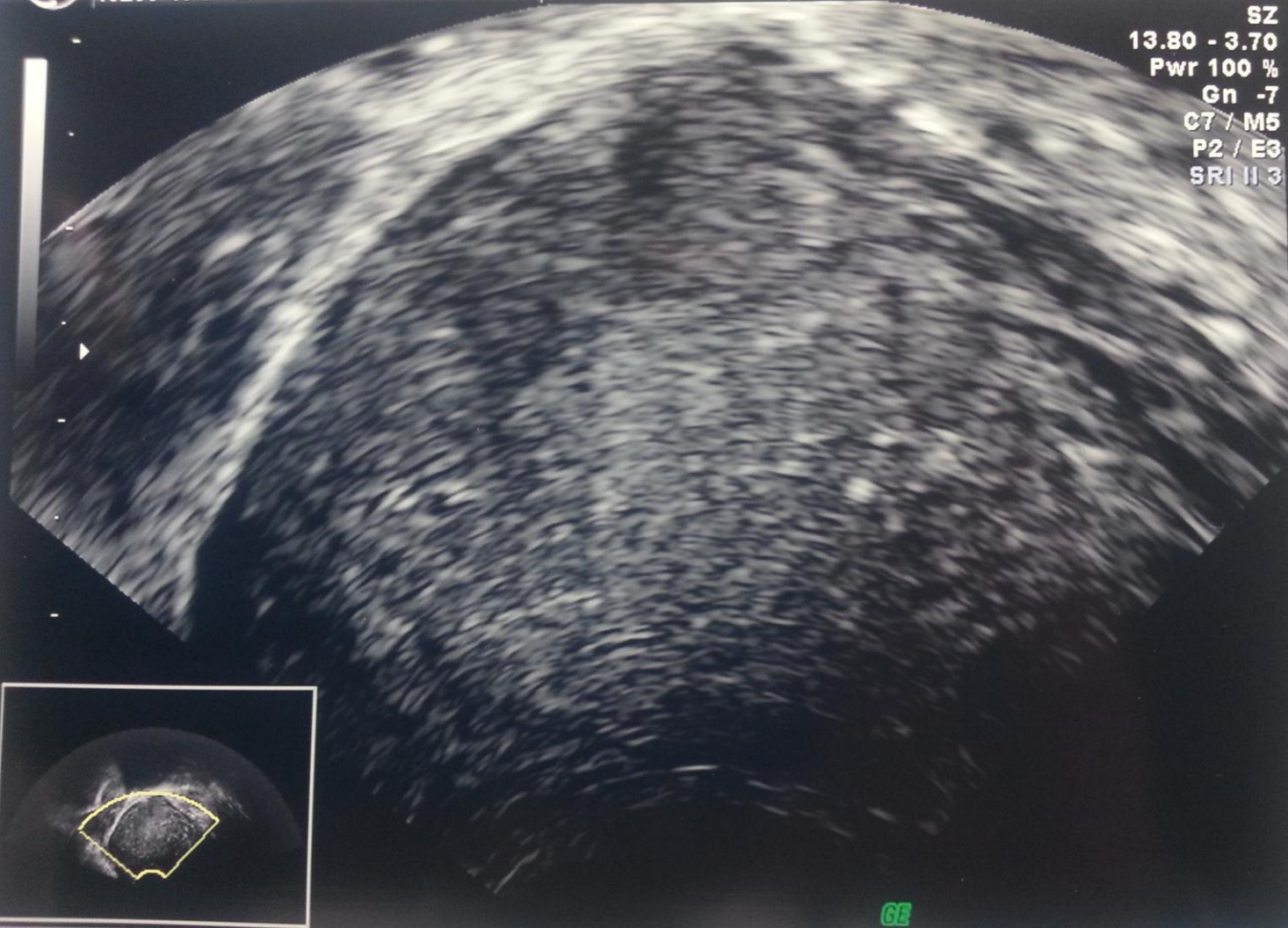
0.1/4.3cm / 66Hz

TIs 0.4

27.03.2013

15:19:25

SZ  
13.80 - 3.70  
Pwr 100 %  
Gn -7  
C7 / M5  
P2 / E3  
SRI II 3

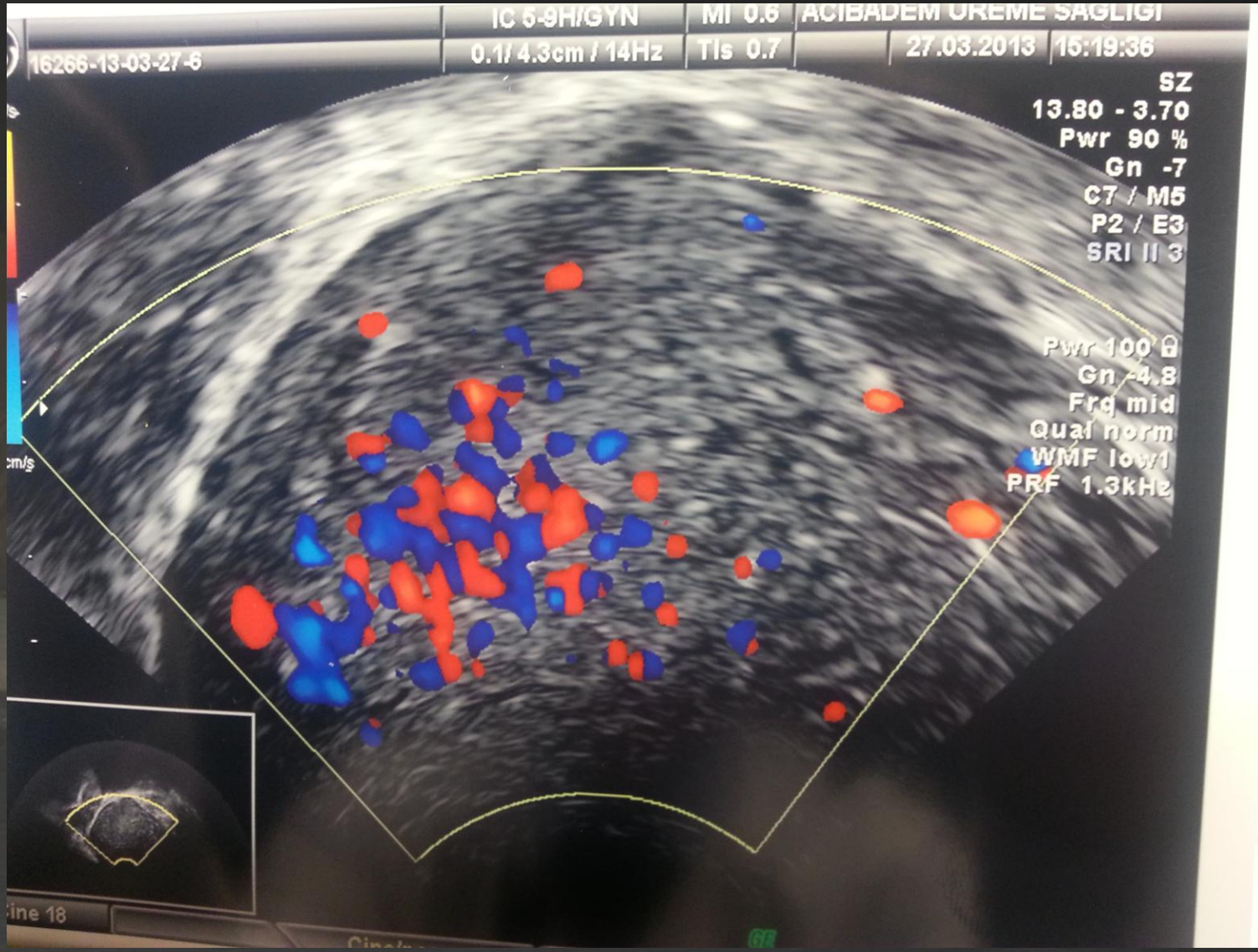


GE

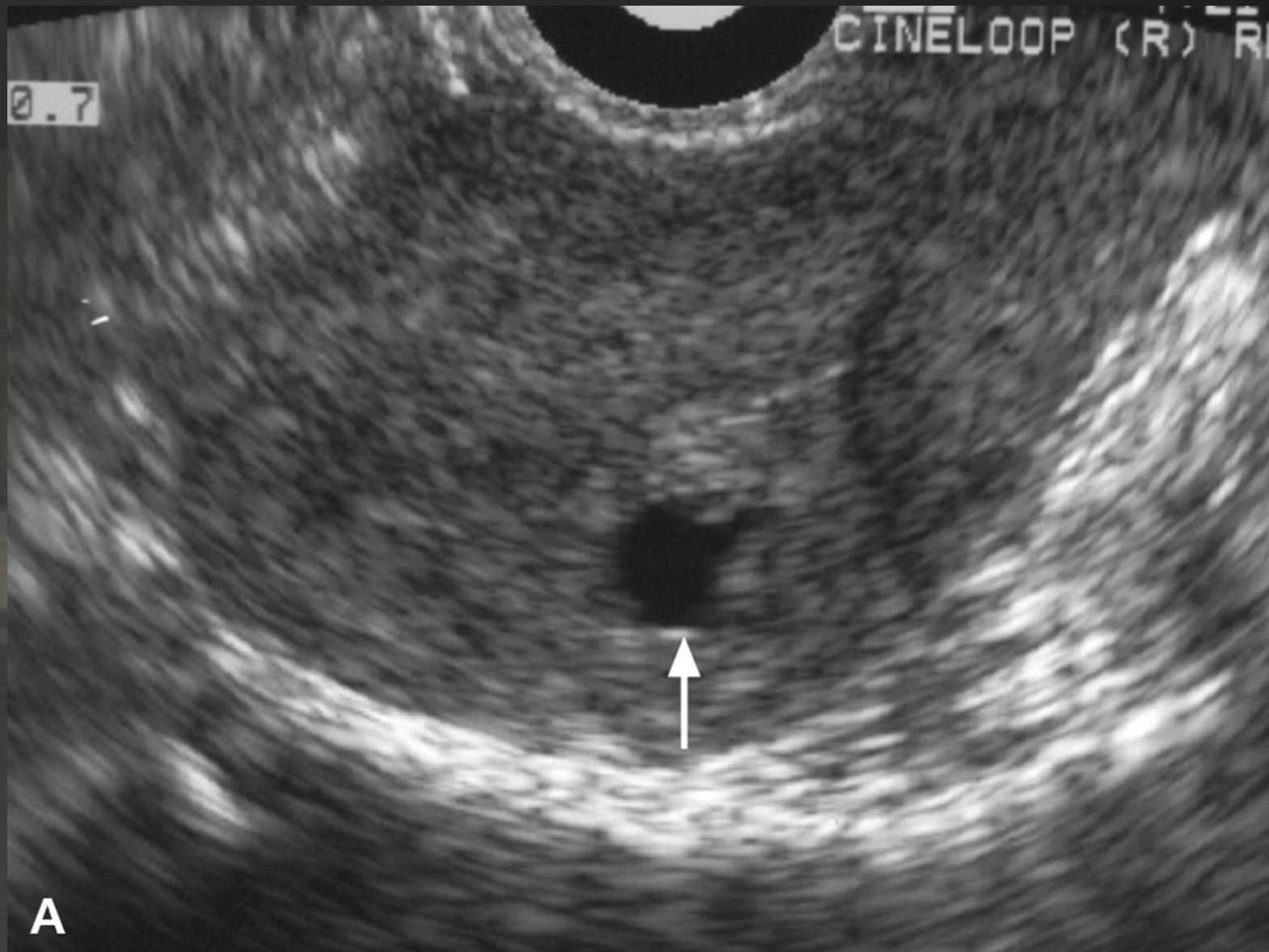
D-pos

Cine/pos

47 sec



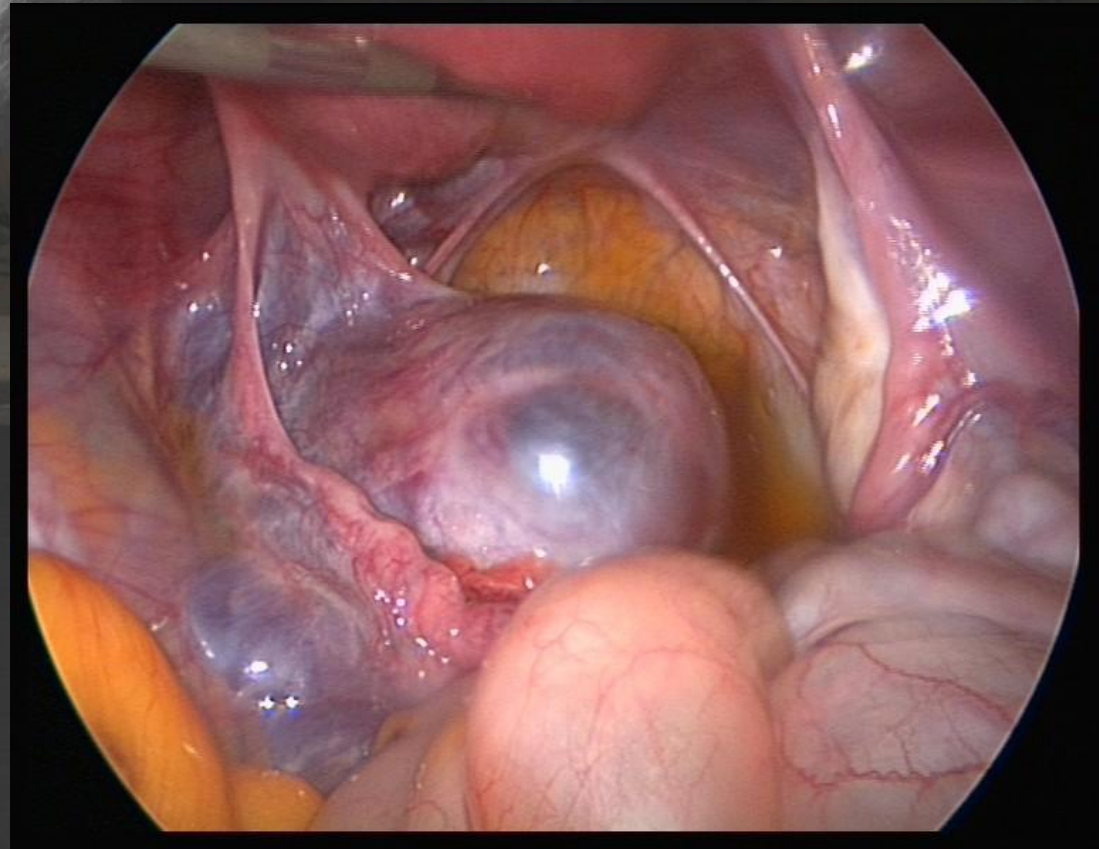
# Adenomyosis



Uniloküler Over Kistleri



# Hemorrhagic cyst



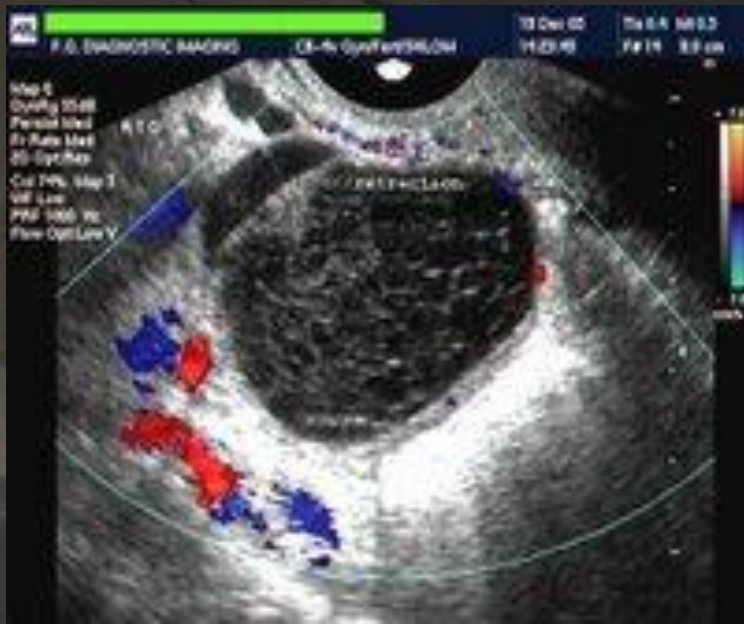


# Endometrioma vs Hemorrhagic Cyst

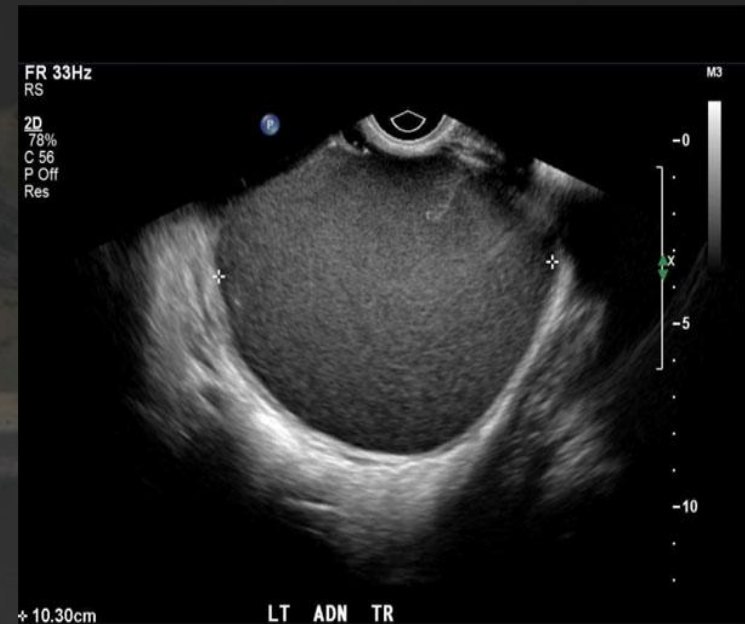
Hemorrhagic Cyst

Cyst

Endometrioma



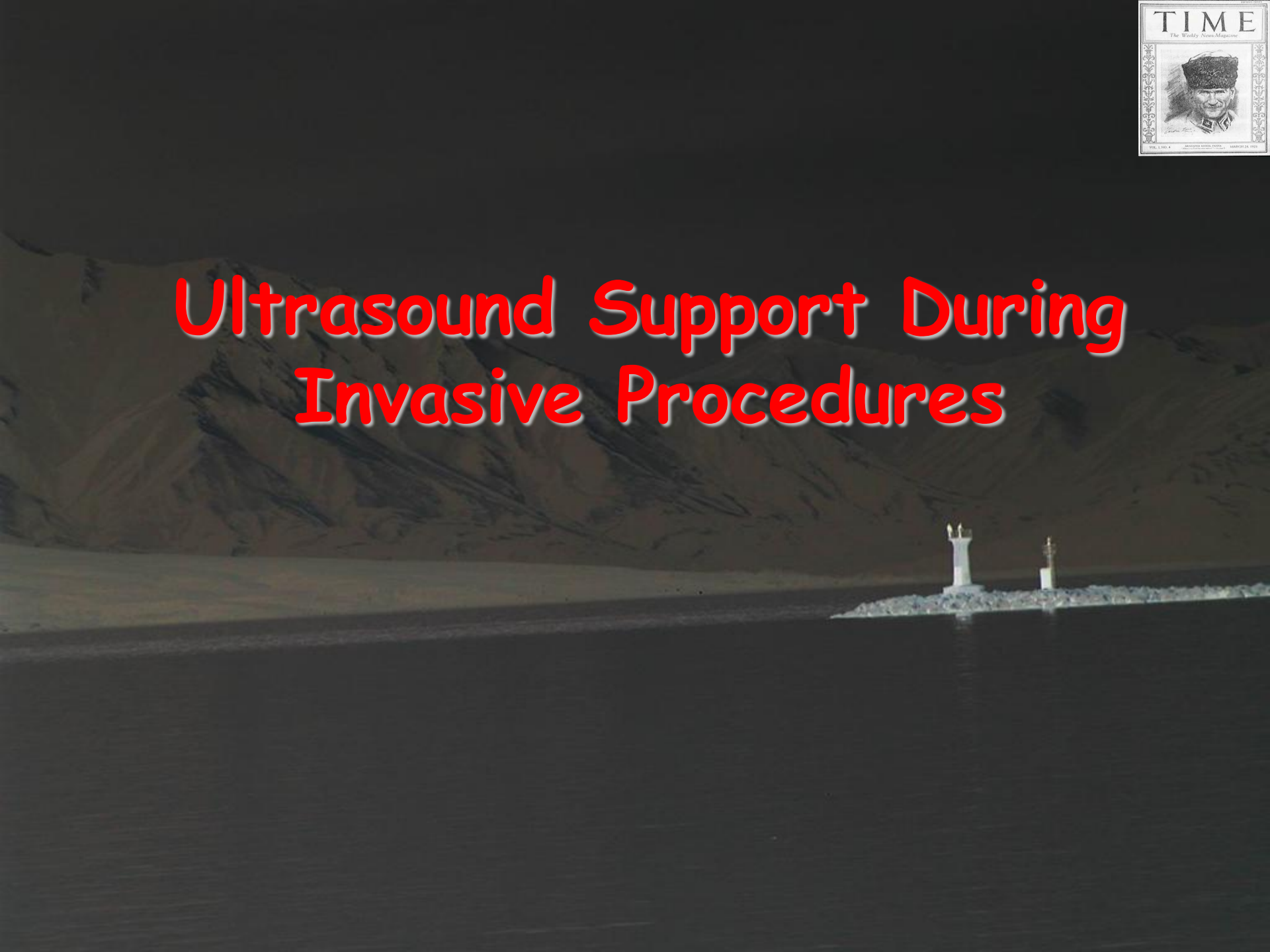
Retraction  
Organization



Homogenous increased concentration

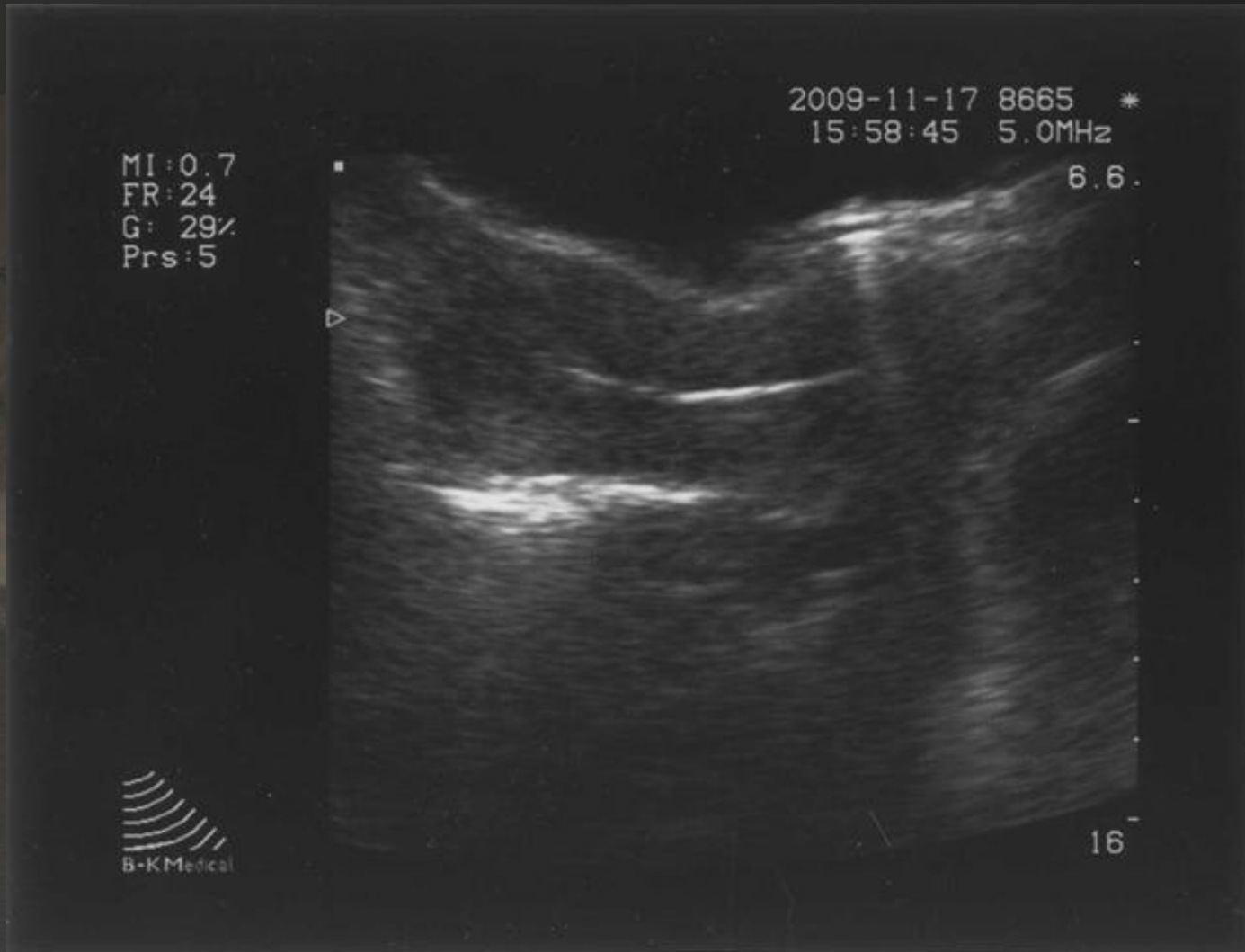


# Ultrasound Support During Invasive Procedures





# Intrauterine Insemination



# Oocyte Pick up



ACIBADEM BURSA IVF UNIT

08:51:25 Tu 26/03/2013

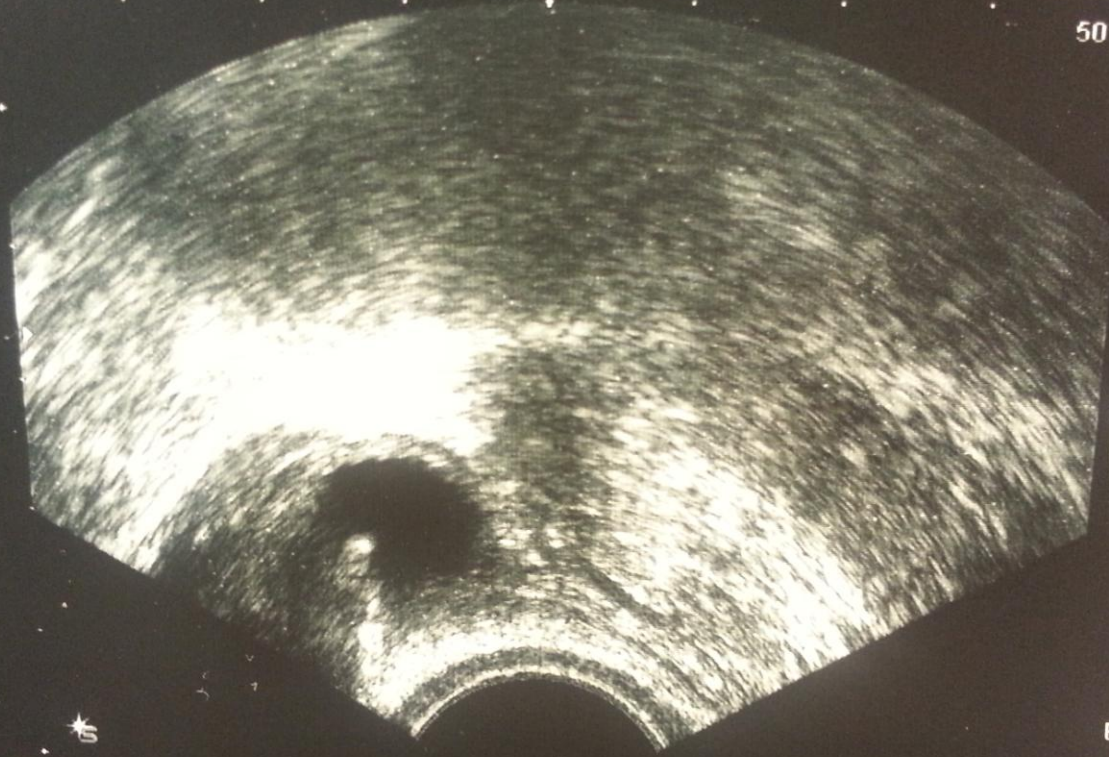
SIEMENS

SZ GYN

EC9-4 6.5

FPS 21h

50



2D 65/3/28

MI 0.8 TIS 0.4 TIB 0.4 Tx 0dB



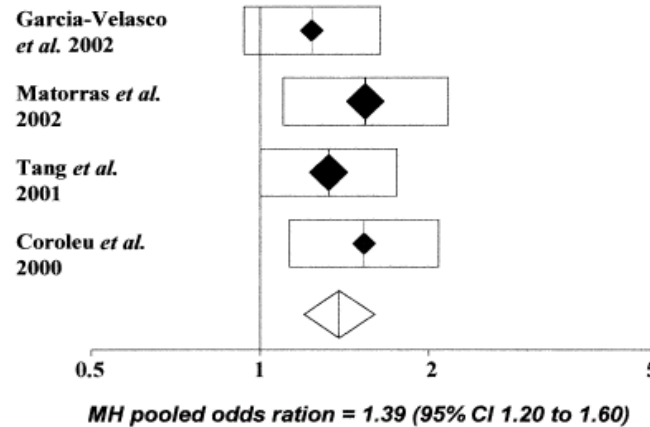




# Embryo Transfer

## 1. Ultrasound guided vs. clinical touch ET

Odds ratio for embryo implantation in all prospective randomized controlled trials of ultrasound-guided embryo transfer.



Buckett. *Meta-analysis of ultrasound-guided ET. Fertil Steril* 2003.

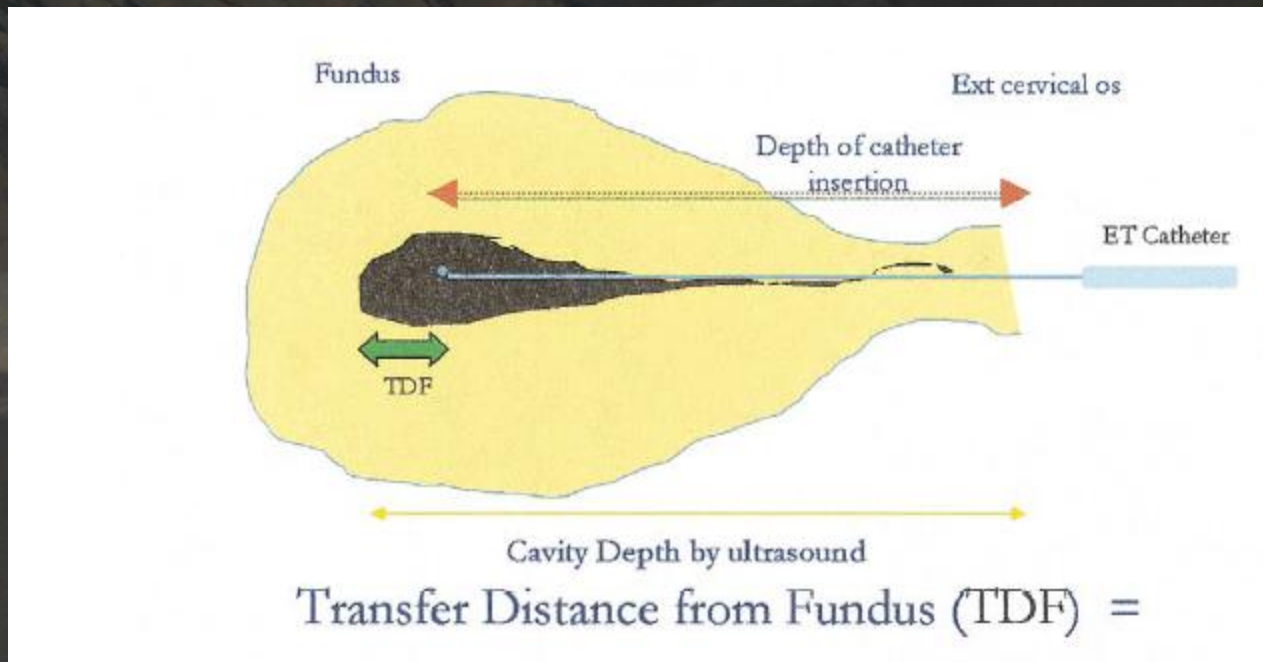
**Ultrasound guided ET increases clinic PR and IR**

**(Buckett 2003 ,meta-analysis)**



## Embryo Transfer

### 2. Drop off point of Embryos:





ACIBADEM BURSA IVF UNIT

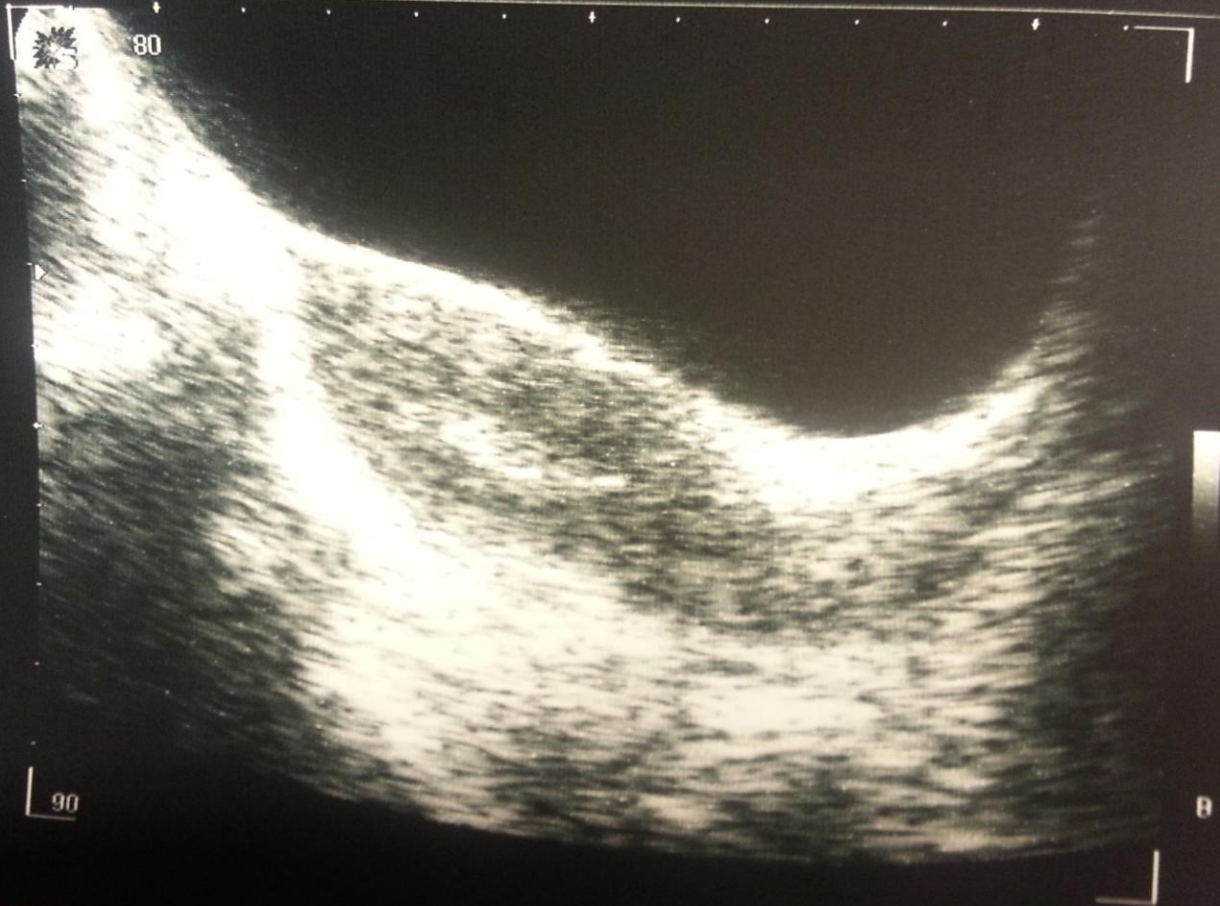
09:38:41 Tu 26/03/2013

SIEMENS

SZ ET

CG-2 3.5

FPS 12h



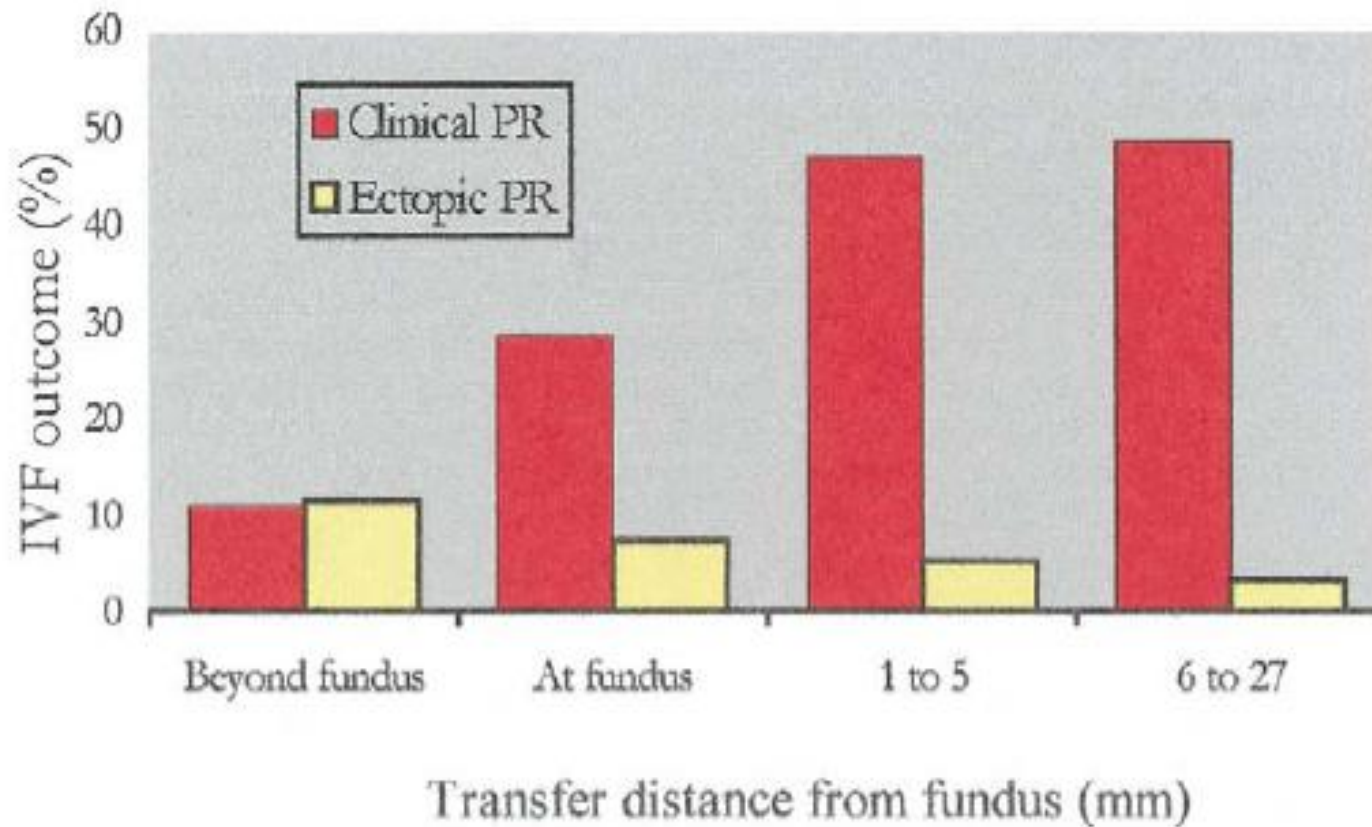
2D 60/2/ 0

MIO.8 TIS.0.6 TIS.0.0

177



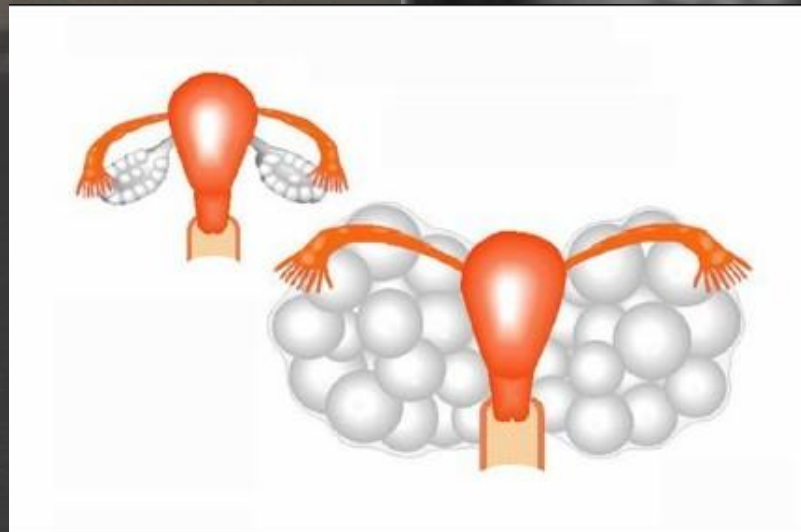
## IVF-ET outcome by embryo transfer distance from fundus using ultrasound guidance.



*Pope. Fundal transfer decreases pregnancy rate. Fertil Steril 2004.*

# OHSS (Ovarian Hyperstimulation Syndrome)

- **Enlarged ovaries**
- **Ascites**
- **Hemoconcentration**
- **Oliguria – kidney failure**
- **Shortness of breath**
- **Thrombosis**



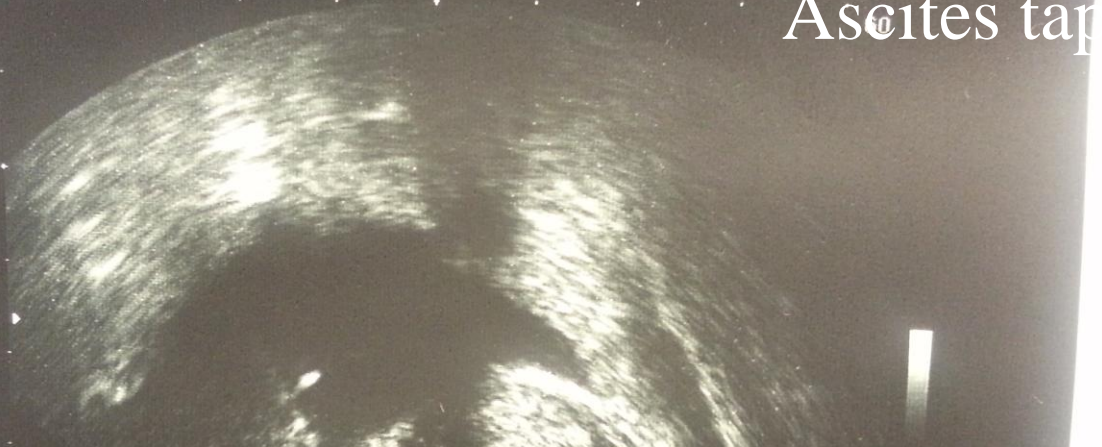
ACIBADEM BURSA IVF UNIT

16:01:13 Tu 26/03/2013 SIEMENS

SZ GYN

EC9.4 6.5

FPS 21h



# Ascites tapping in OHSS



2D 65/3/20  
MI 0.8 TIS 0.4 TIB 0.4 Tx 0dB

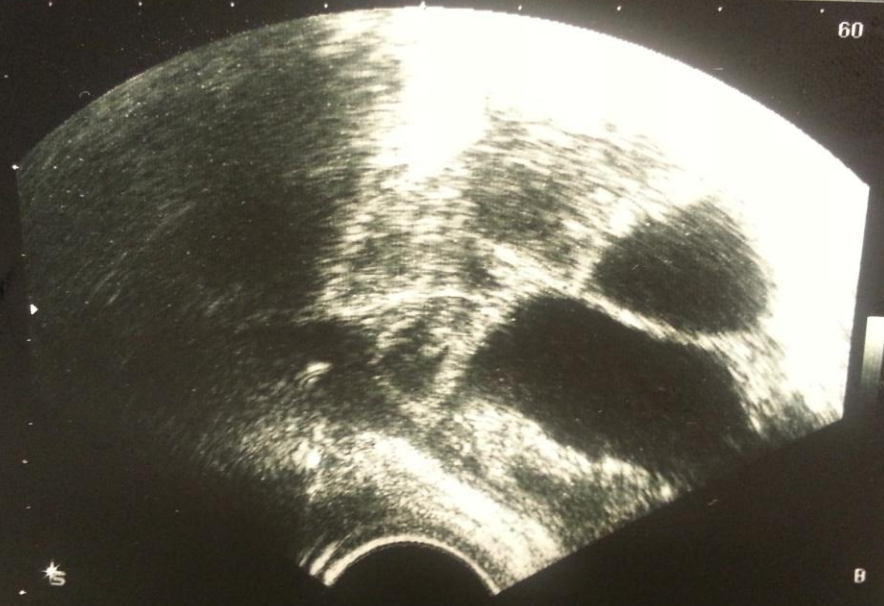
ACIBADEM BURSA IVF UNIT

16:32:28 Tu 26/03/2013 SIEMENS

SZ GYN

EC9.4 6.5

FPS 21h



2D 65/3/33  
MI 0.8 TIS 0.4 TIB 0.4 Tx 0dB



**Thank you...**