

Gynekologinen 3/4 D-ultraääni – onko hyötyä? Infertiliteetti ja anomaliat

Ilkka Järvelä

Mitä 3D:llä voi tutkia?

- Munasarja
 - Kasvaimet
 - Reservi (antraalifollikkelit, tilavuus)
- Munatorvi
 - Aukiolo
 - Sakto, hydro
- Kohdun limakalvo
 - Polyypit, myomat
 - Reseptiivisyys
- Kohdun rakenne (anomalia)

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 - **Reseptiivisyys**
- Kohdun rakenne (**anomaliat**)

Visio vuodelta 1995

Ultrasound Obstet. Gynecol. 5 (1995) 219–221

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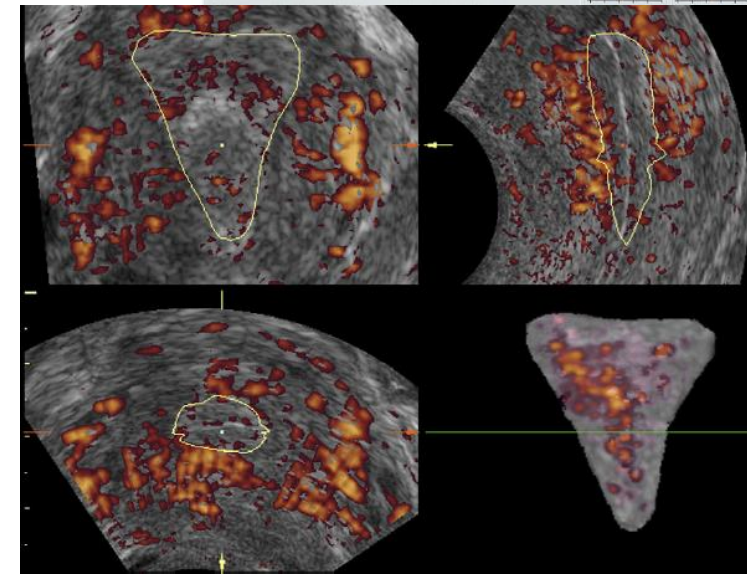
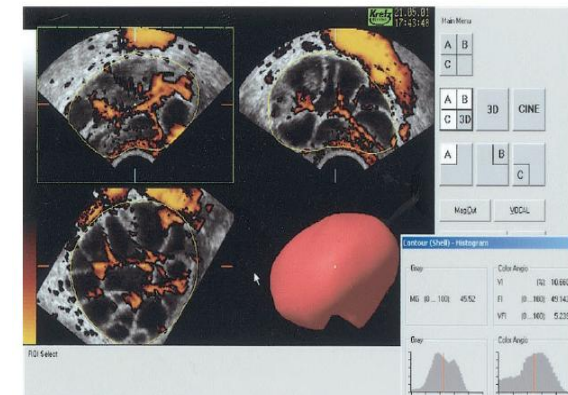
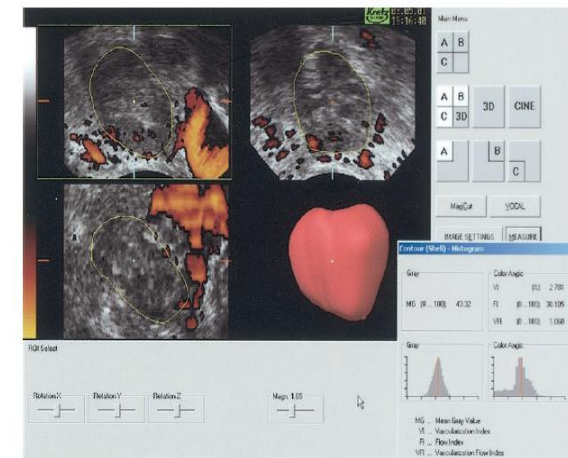
Opinion

Three-dimensional ultrasound

- accurate measurement of organ dimensions and volumes
- improved anatomic and blood flow information
- improved assessment of complex anatomic anomalies
- a better specificity in regard to the confirmation of normality
- standardisation of the sonographic examination procedure
- reduced scanning times with cost-effective use of equipment and sonographer time
- telemedicine and tertiary consultation

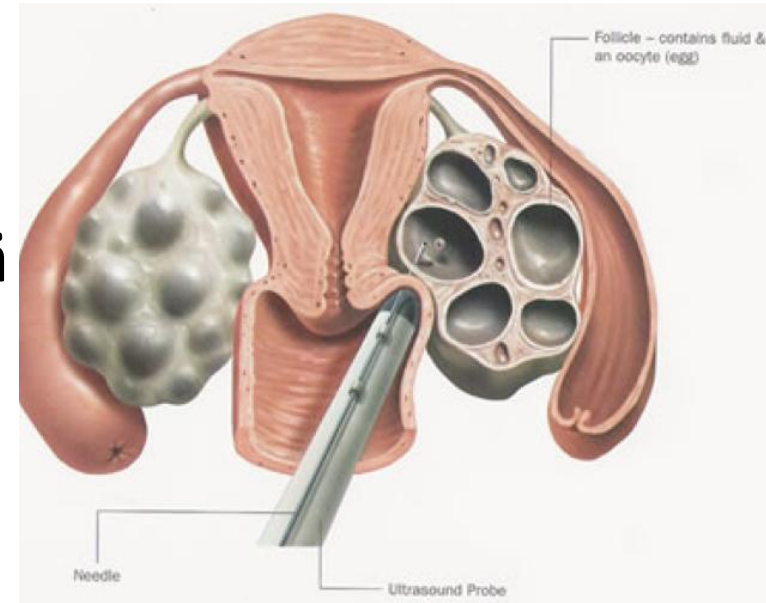
3D:n lisämahdollisuudet

- Tilavuus
- Power Doppler (PD) indeksit
 - Vascularization index VI
 - PD voxels/all the voxels (%)
 - Flow index FI
 - Keskimääräinen PD kirkkaus (0-100)
 - Vascularization flow index VFI
 - $VI \times FI$ (0-100)



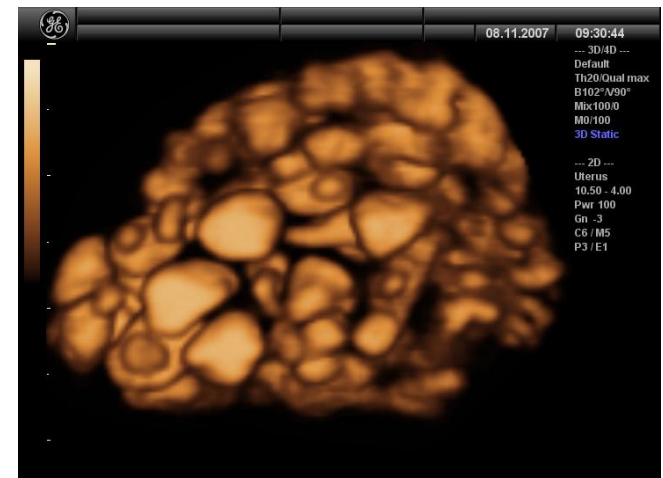
Munasolumäärän ennustaminen ovariostimulaatiossa

- UÄ
 - Munasarjan tilavuus
 - **Antraalifollikkeleiden määrä**
- Hormonit follikkeleista
 - Estradioli
 - Inhibiini B
 - **(anti-Mullerian hormoni AMH)**
- Aivolisäkeperäiset hormonit
 - FSH
 - LH

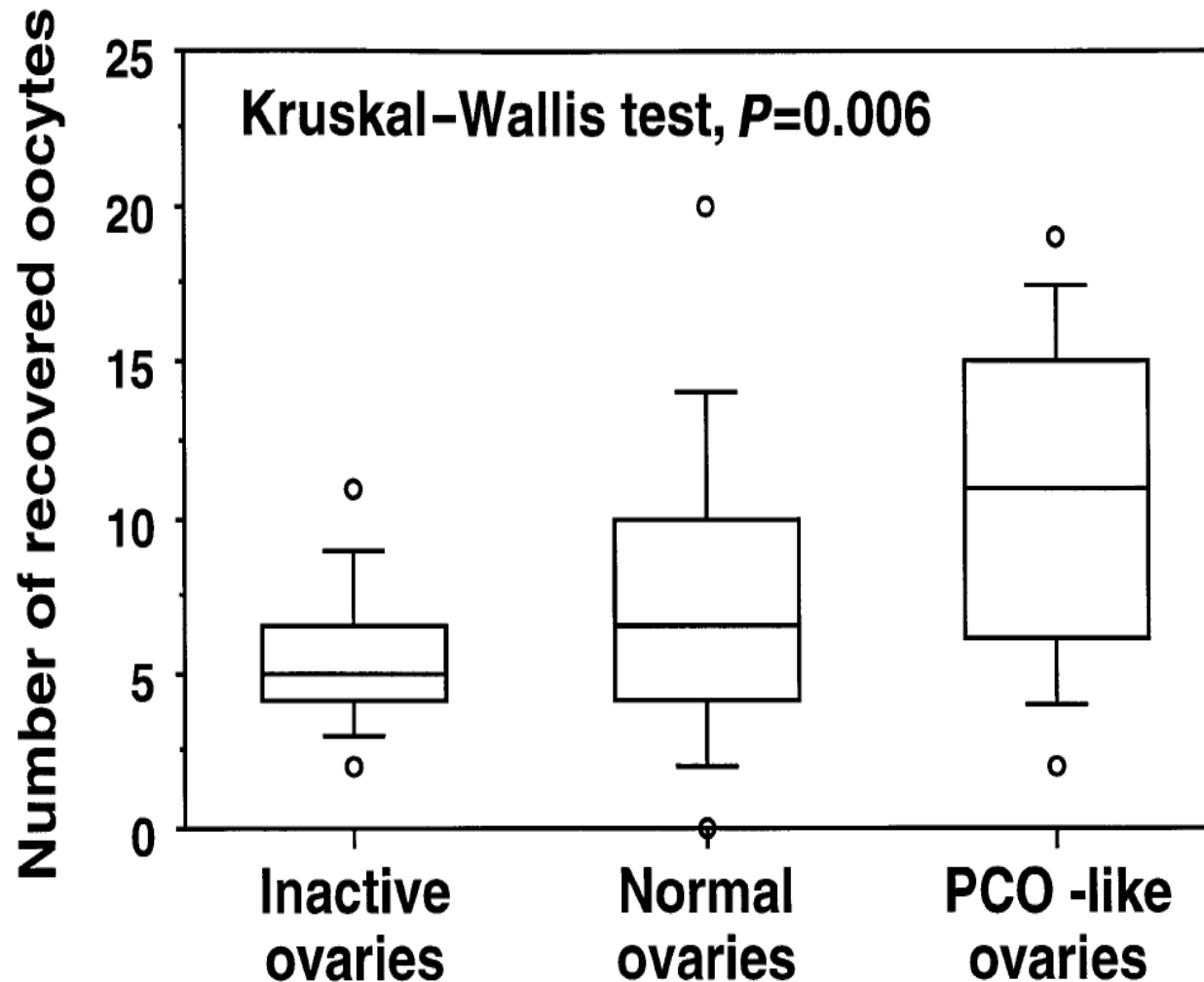


Antraalifollikkelit

- follikulogeneeesin loppuvaihe
 - nesteen täyttämä antrum
- halkaisija 2-5 mm
- FSH-herkkyys
- verisuonitus
 - ovulaation jälkeen kapillaarit teekasolukosta myös granuloosasolukkaan



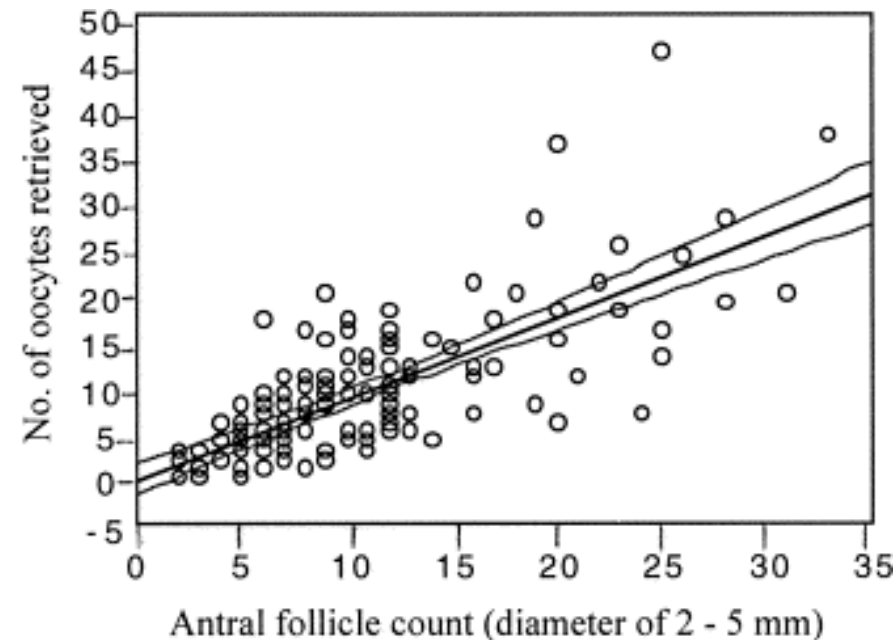
Antral follicle count and number of recovered oocytes



Tomas et al
1997

Antraalifollikkelien ja munasolujen määrän korrelaatio

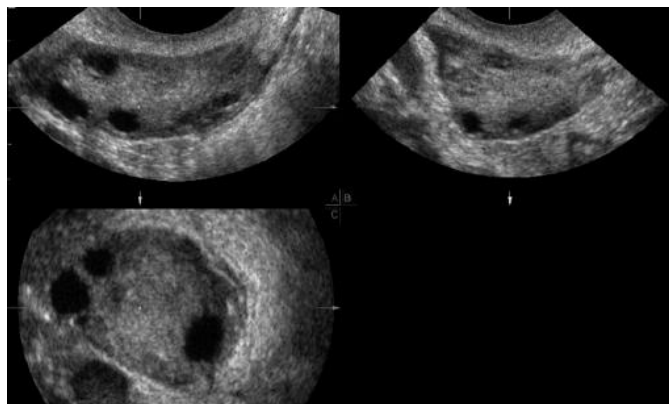
- Chang MY 1998
 - AF < 4:
 - 16/149 cycles
 - cancellation rate 11/16 (69%)
 - no pregnancies



2D vs 3D ja antraalifollikkelimäärä

Antral follicle count (mean $\pm$ SD)

<i>Technique</i>	<i>Observer 1</i>	<i>Observer 2</i>	<i>Observers 1 & 2</i>
2D	16.36 $\pm$ 11.21	16.67 $\pm$ 12.02	16.51 $\pm$ 11.51
3D	16.47 $\pm$ 12.42	16.19 $\pm$ 11.97	16.33 $\pm$ 12.13
<i>P</i>	NS	NS	NS



Ultrasound Obstet Gynecol 2008; 31: 439–444

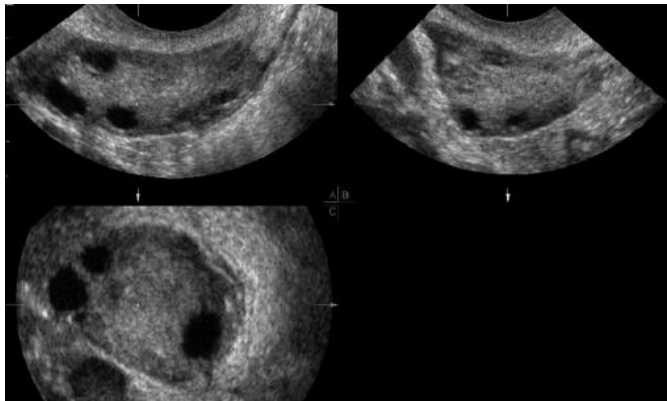
Published online 10 March 2008 in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/uog.5301

Three-dimensional ultrasound improves the interobserver reliability of antral follicle counts and facilitates increased clinical work flow

K. JAYAPRAKASAN, B. K. CAMPBELL, J. S. CLEWES, I. R. JOHNSON and N. J. RAINE-FENNING

Tutkimukseen kulutettu aika

<i>Parameter</i>	<i>Time (s)</i>		
	<i>Mean</i>	<i>SD</i>	<i>Range</i>
2D ultrasound			
Time	103.1	28.6	57–179
3D ultrasound			
Time for acquisition	46.4	7.4	35–70
Time for count	192.9	67.6	86–330
Total time	239.3	71.4	121–400



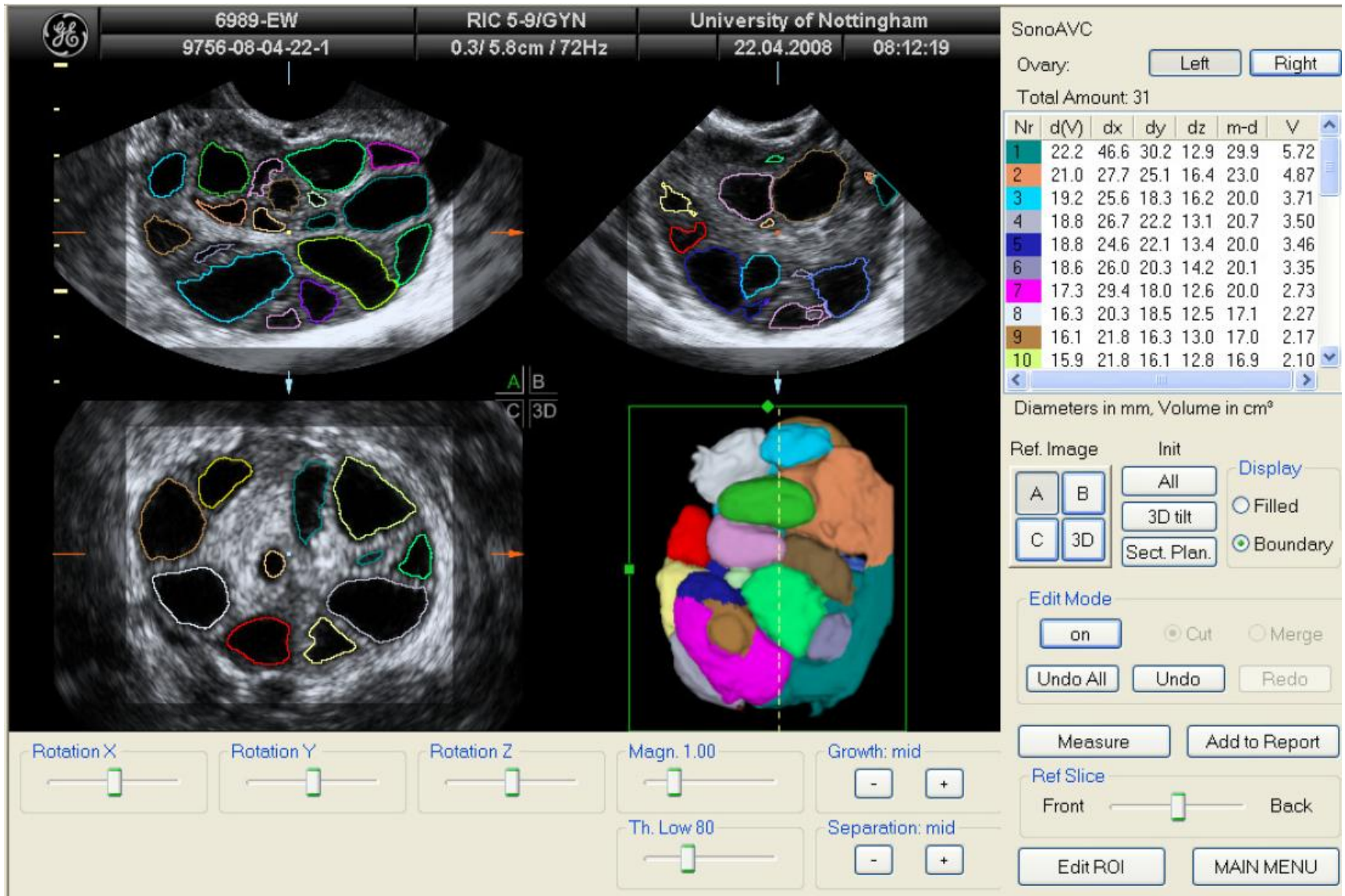
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Follikkelin tilavuus 3D (SonoAVC)



IVF ja munasolun keräys:

SonoAVC vs 2D

TABLE 2

Comparison between SonoAVC and 2D ultrasound in relation to outcome measures of total number of stimulated follicles, oocytes retrieved, size of follicles, maturity of oocytes, fertilization rate, and embryo cleavage.

Outcome variable	2D real-time ultrasound (mean ± SD)	3D automated SonoAVC (mean ± SD)	P value
No. follicles measuring ≥ 10 mm	16.23 ± 8.54	17.53 ± 8.39	.55
No. follicles measuring ≥ 15 mm	7.47 ± 4.17	8.50 ± 3.53	.30
No. follicles measuring ≥ 18 mm	3.83 ± 2.82	4.37 ± 6.08	.40
Day of hCG administration	11.20 ± 1.10	11.73 ± 1.11	.06
Total no. oocytes	13.80 ± 6.95	13.40 ± 5.99	.81
No. mature oocytes	10.70 ± 6.08	11.43 ± 6.17	.64
No. fertilized oocytes	7.27 ± 4.78	7.97 ± 5.25	.59
Fertilization rate (%) (per mature oocyte)	73.86 ± 21.35	68.25 ± 22.76	.33
No. cleavage stage embryos	7.10 ± 4.87	7.47 ± 5.12	.78
Day 2 ET (%)	76.47	82.35	1.00
Day 3 ET (%)	23.53	17.64	.15
Biochemical pregnancy rate (%)	48	52	.85
Clinical pregnancy rate (%)	42	43	.93

Raine-Fenning. Follicular measurement methods and IVF. Fertil Steril 2010.

TABLE 3

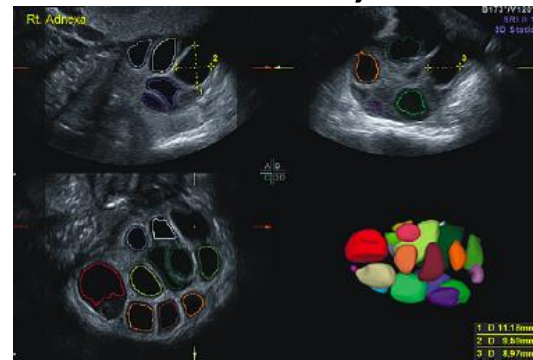
Relationship between the number of mature oocytes and different follicular volumes.

Follicle volume cutoff	Number of mature oocytes/number of follicles in range	Number of follicles in range/number of mature oocytes
≥ 0.8 cc	121.26%	82.47%
≥ 0.7 cc	109.07%	91.69%
≥ 0.6 cc	100.88%	98.60%
≥ 0.5 cc	94.11%	106.26%
≥ 0.4 cc	88.74%	112.69%

Note: When a cutoff of 0.6 cc is chosen, the maximum number of follicles at or above this cutoff is closest to the number of mature oocytes retrieved. Follicular volumes are those measured on the day of hCG.

Rodríguez-Fuentes. Measurement of follicle volume using SonoAVC. Fertil Steril 2010.

- Tilavuus 0.6 cc, $r=0.52$ cm, halkaisija 1.0cm
- Jos follikkelin ka halk hCG-päivänä oli 10 mm, saaliina oli kypsä munasolu



2D color/power Doppler

- perifollicular blood flow correlates with
 - oocyte recovery (Nargund et al 1996)
 - PSV 10 cm/s; before hCG/OPU
 - oocyte development potential (van Blerkom et al 1997)
 - embryos with multinucleated blastomeres are derived predominantly from severely hypoxic follicles
 - embryo quality (Chui et al 1997)
 - power Doppler; implantation potential increased
 - pregnancy rate (Coulam et al 1999, Bhal et al 1999)
 - PSV 10 cm/s, grade of vascularity; before hCG

FSH stimulaatio

Table 2. Three-Dimensional Ultrasonography Measurements of the Ovaries After Pituitary Downregulation and After Gonadotrophin Stimulation

	Low ovarian reserve (<i>n</i> = 12)	Normal ovarian reserve (<i>n</i> = 33)	<i>P</i>
After pituitary suppression			
Volume (cm ³)	6.1 (2.4)	7.5 (3.0)	.136
VI	4.4 (4.1)	6.4 (4.4)	.162
FI	40.0 (7.7)	44.2 (3.9)	.092
VFI	2.1 (2.1)	3.0 (2.3)	.249
MG	51.2 (3.3)	48.8 (4.3)	.089
After ovarian stimulation			
Volume (cm ³)	15.1 (12.5)	31.9 (18.9)	.010
VI	5.7 (5.6)	8.8 (3.1)	.028
FI	44.1 (5.6)	48.7 (2.8)	.024
VFI	2.7 (2.9)	4.3 (1.6)	.032
MG	42.4 (5.0)	41.8 (5.5)	.755

VI = vascularization index; FI = flow index; VFI = vascularization flow index; MG = mean gray value.

Data are presented as mean (standard deviation).

P values for changes induced by ovarian stimulation within the groups: low ovarian reserve: volume increase *P* = .031, MG decrease *P* < .001; normal ovarian reserve: volume increase *P* < .001, VI increase *P* = .017, FI increase *P* < .001, VFI increase *P* = .007, MG decrease *P* < .001.

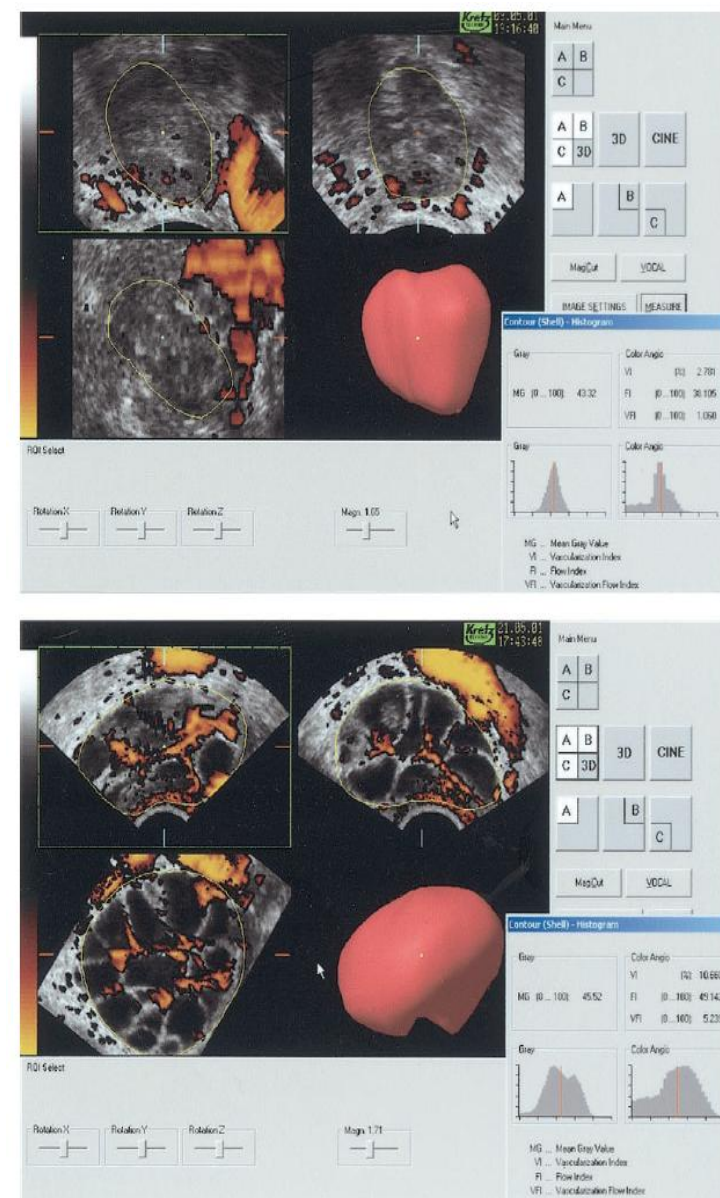


Figure 1. Contour histogram of the same ovary after pituitary downregulation (*top panel*, volume 10.5 cm³) and after gonadotropin stimulation (*bottom panel*, volume 80.4 cm³).

Järvelä. 3-D Power Doppler and Ovarian Reserve. *Obstet Gynecol* 2003.

PCO: AF/ov > 12

- OHSS-riski kohonnut
 - Lisääntynyt verisuonten läpäisevyys → askites, pleuraneste
 - Syynä liiallinen VEGF-eritys
 - angiogeneesi
 - permeabiliteetti
 - Anti-VEGF OHSS:ssa vähentää askitesta 70%
 - Vaatii kehittyäkseen sekä hCG:n että FSH:n annon

hCG:n vaikutus IVF-stimulaatiossa

- ov-tilavuus nousee
 - normaalit 25 ml - 43 ml
 - PCO 63 ml – 103 ml
- VI
 - normaalit 8%
 - PCO 11%
- vaskularisaatio (ml)/foll
 - GnRH-a:n jälkeen: 0.07 vs 0.03 (normaali vs PCO)
 - FSH:n jälkeen: 0.18 vs 0.24
 - hCG:n jälkeen: 0.39 vs 0.35
- vaskularisaation nousu/1 foll/1 FHS IU: 0.04 vs 0.12 (normaali vs PCO)

Munatorvien aukiolo

		Laparoscopy		Total
		Patent	Occluded	
HyCoSy	Patent	25	3	28
	Occluded	0	6	6
	Not able to examine	7	1	8
Total		32	10	42

Acta Obstet Gynecol Scand 2005; 84: 909-913
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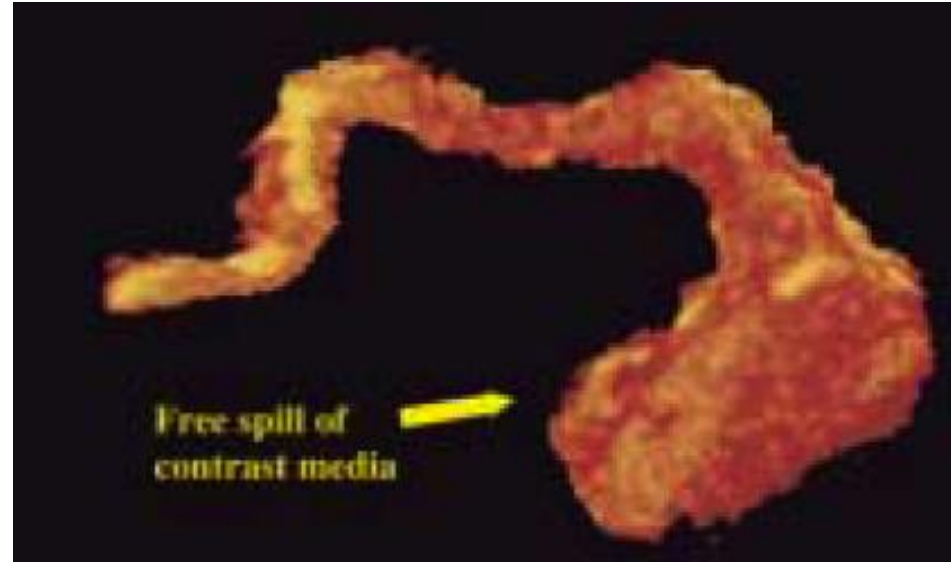
**Acta Obstetrica et
 Gynecologica Scandinavica**

ORIGINAL ARTICLE

Comparison of three-dimensional hysterosalpingo-contrast-sonography and diagnostic laparoscopy with chromopertubation in the assessment of tubal patency for the investigation of subfertility

CARINA C. W. CHAN, ERNEST H. Y. NG, OI-SHAN TANG, KAREN K. L. CHAN AND PAK-CHUNG HO

From the Department of Obstetrics and Gynaecology, Queen Mary Hospital, the University of Hong Kong, Hong Kong, China



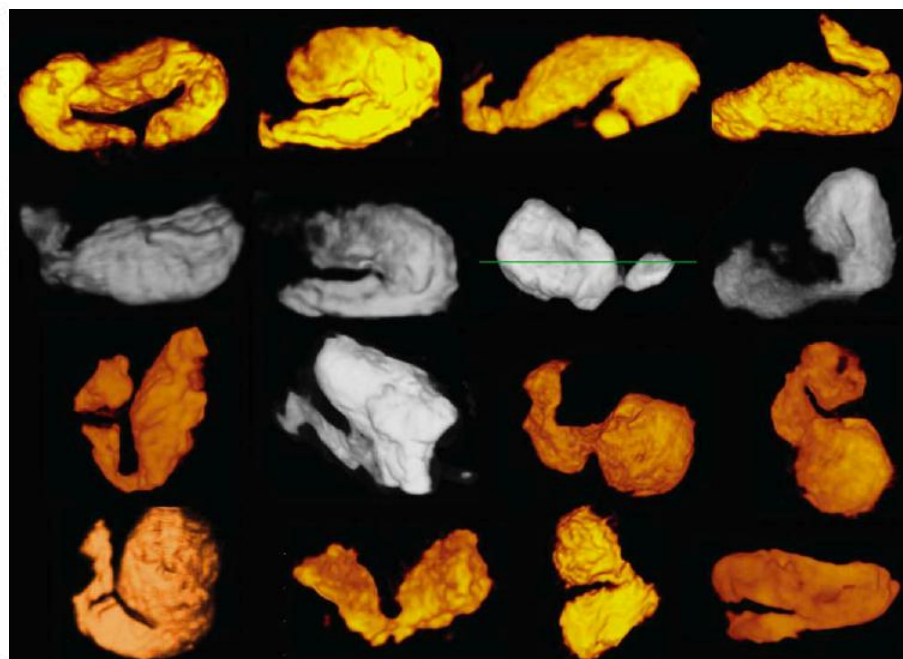
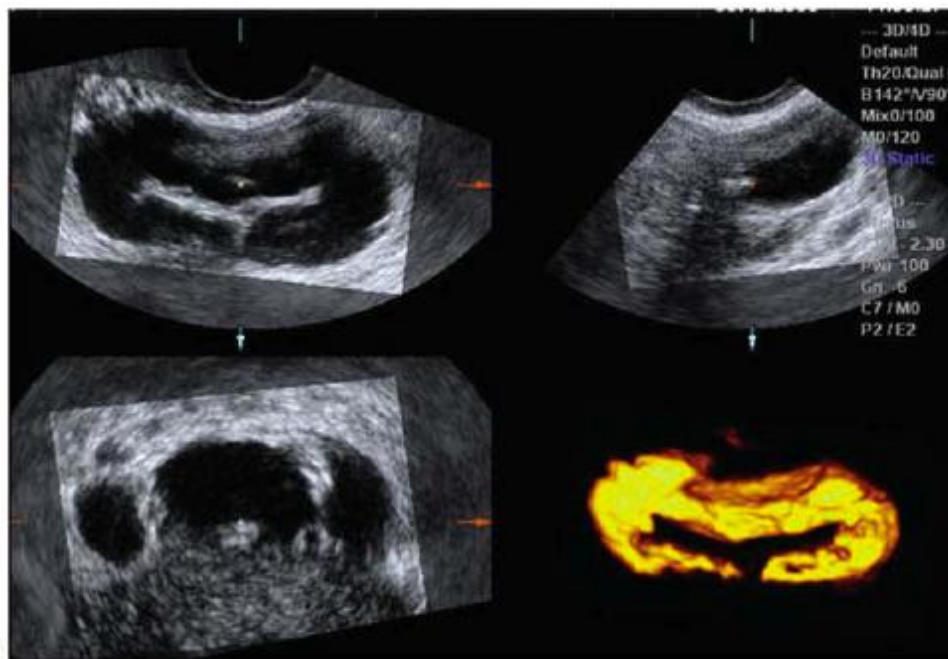
Ultrasound Obstet Gynecol 2000; 16: 644-647.

Three-dimensional power Doppler imaging in the assessment of Fallopian tube patency

P. SLADKEVICIUS, K. OJHA, S. CAMPBELL and G. NARGUND

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Hydrosalpinx



**Three-Dimensional Ultrasound Inversion
Rendering Technique Facilitates the
Diagnosis of Hydrosalpinx**

Inc. J Clin Ultrasound **38:372–376, 2010**

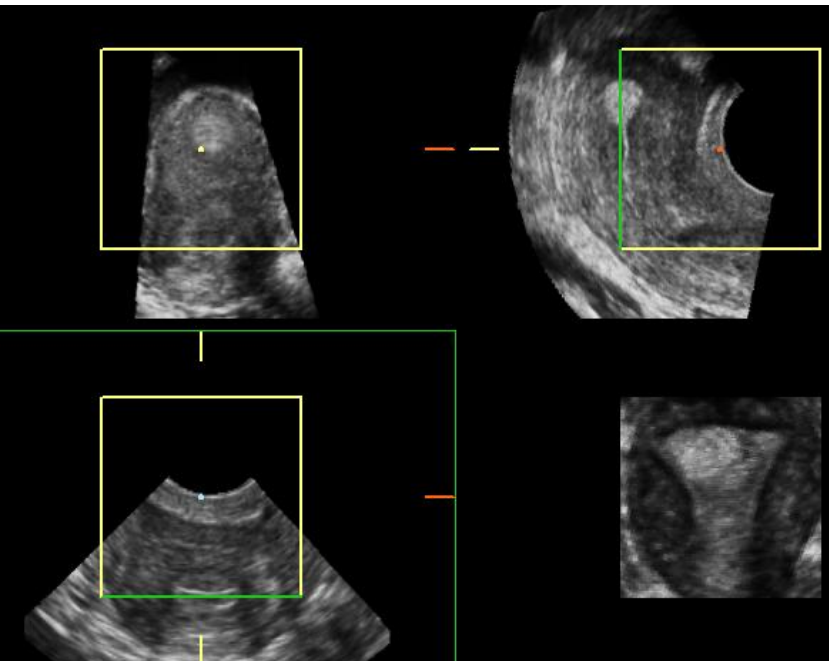
Ilan E. Timor-Tritsch, MD, RDMS, Ana Monteagudo, MD, RDMS, Tanya Tsymbal, RDMS

Muutos kohtuontelossa, 2D HSG vs 3D HSG

- Muutos varmistettiin hysteroskopiaalla:
 - 2D HSG: sensitiivisyys 98%, PPV 95%
 - 3D HSG: sensitiivisyys 100%, PPV 92%



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A prospective study to evaluate the efficacy of two- and three-dimensional sonohysterography in women with intrauterine lesions

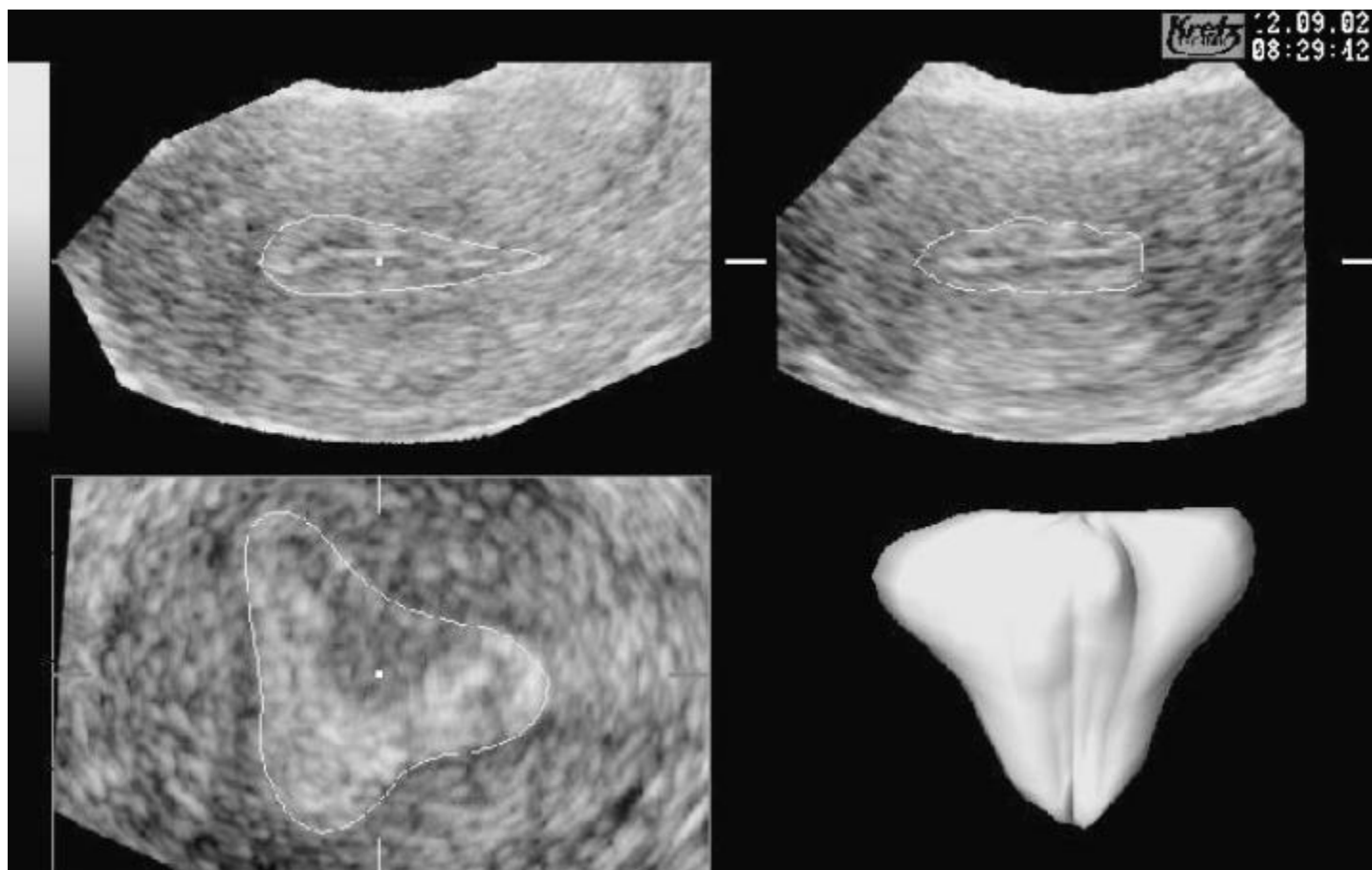
Camille Sylvestre, M.D., Tim J. Child, M.D., Togas Tulandi, M.D., and Seang Lin Tan, M.D.

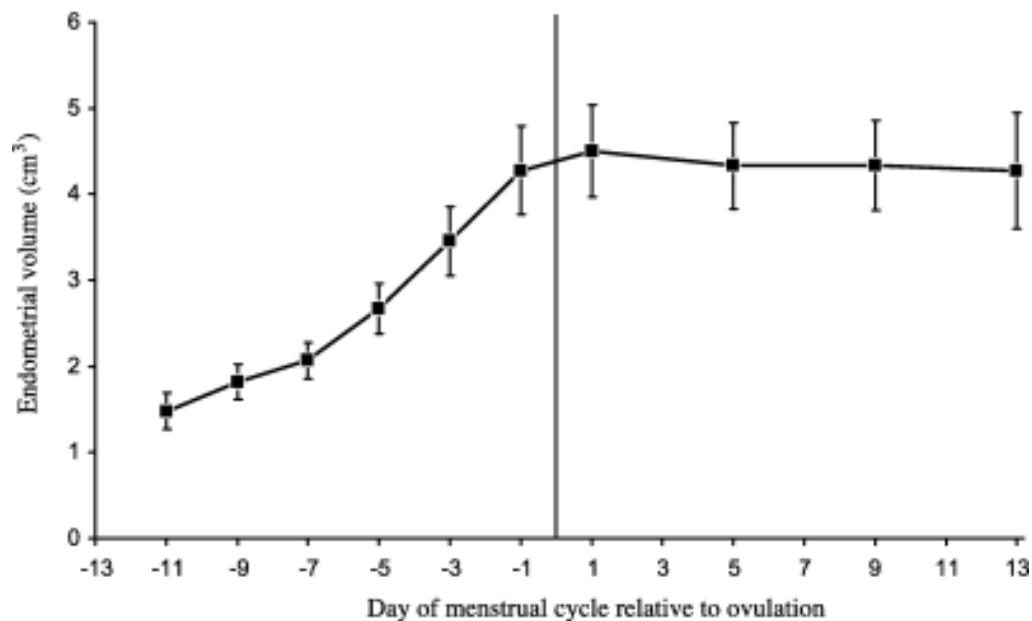
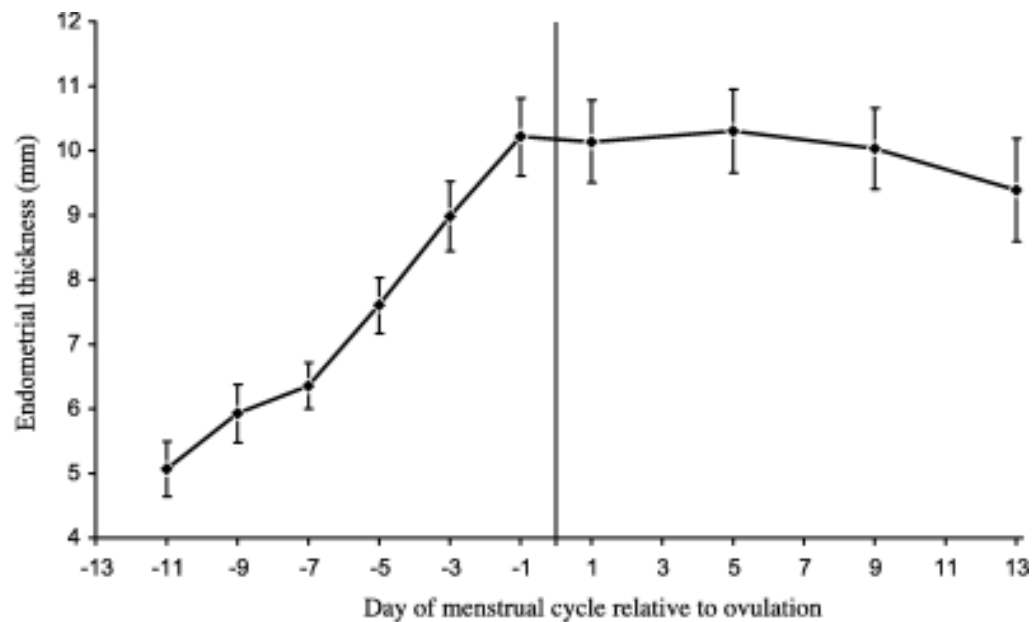
Endometriummin reseptiivisyys

- UÄ-mittarit
 - paksuus (2D) tai tilavuus (3D)
 - rakenne ja kaikuisuus
 - verenvirtaus
 - color Doppler, 2D
 - uterinat
 - power Doppler, 3D
 - endometrium
 - subendometrium

Defining endometrial growth during the menstrual cycle with three-dimensional ultrasound

Nicholas J. Raine-Fenning, Bruce K. Campbell, Jeanette S. Clewes,
Nigel R. Kendall, Ian R. Johnson





Defining endometrial growth during the menstrual cycle with three-dimensional ultrasound

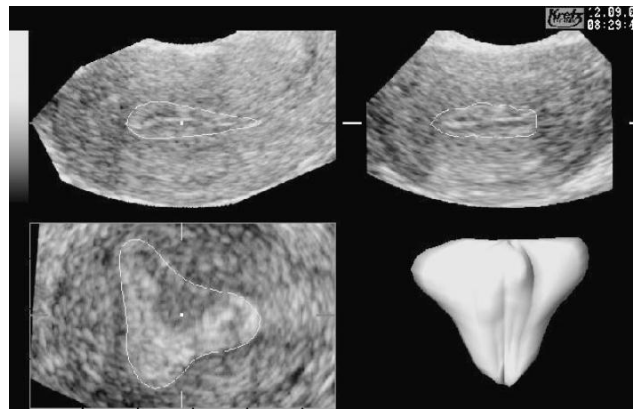
Nicholas J. Raine-Fenning, Bruce K. Campbell, Jeanette S. Clewes,
Nigel R. Kendall, Ian R. Johnson

Endometrium tilavuus, 3D

ei eroa rask. vs ei-rask.

rask. > ei-rask.

- Schild et al 1999
 - n=47
 - OPU
 - PR 31.9%
- Yaman et al 2000
 - n=65
 - ET
 - PR 32.3%
- Kupesic et al 2001
 - n=89
 - ET
 - PR 31.5%
- Järvelä et al 2005
 - n=35
 - before hCG/OPU
 - PR 37.0%
- Ng et al 2006
 - n=451
 - OPU
 - PR 20.8%
- Raga et al 1999
 - n=72
 - ET
 - PR 29.2%
 - no pregnancies < 1ml
- Zollner et al 2003
 - n=125
 - ET
 - PR 27.2%
 - <2.5 ml: 9%
 - >2.5 ml: 35%
- Merce et al 2008
 - n=77
 - hCG day
 - PR 49%



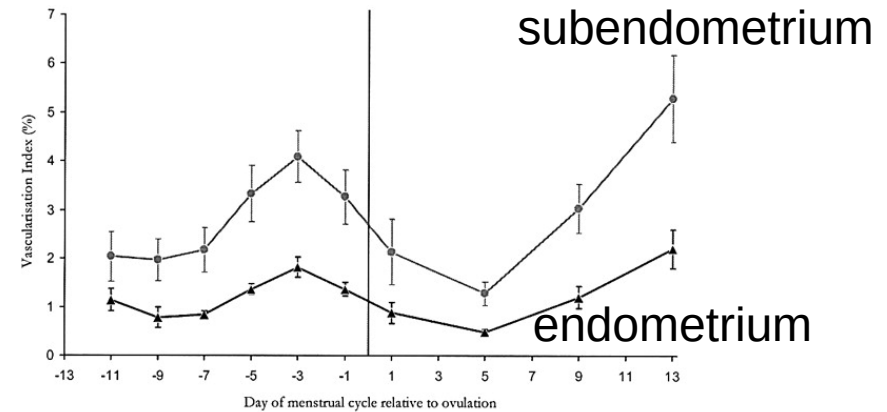
Multilayered endometrium before ovulation/hCG

- Increased PR:
 - Coulam et al 1994
 - 100 FTE
 - 107 IVF
 - **99 HRT/donor embryos**
 - 99 IUI
 - Serafini et al 1994
 - 102 IVF
 - Zaidi et al 1995
 - 99 IVF
 - PR 35% vs 18%
 - Järvelä et al 2005
 - 35 IVF
 - PR 45% vs 0%

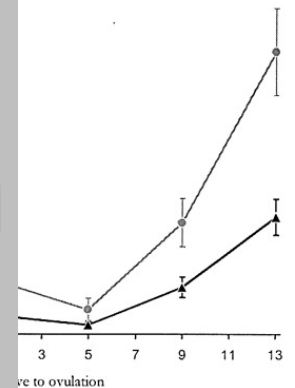
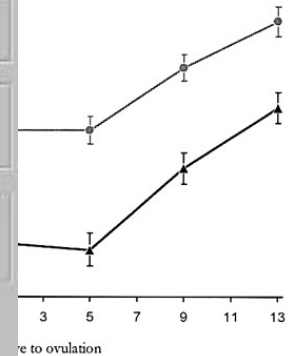
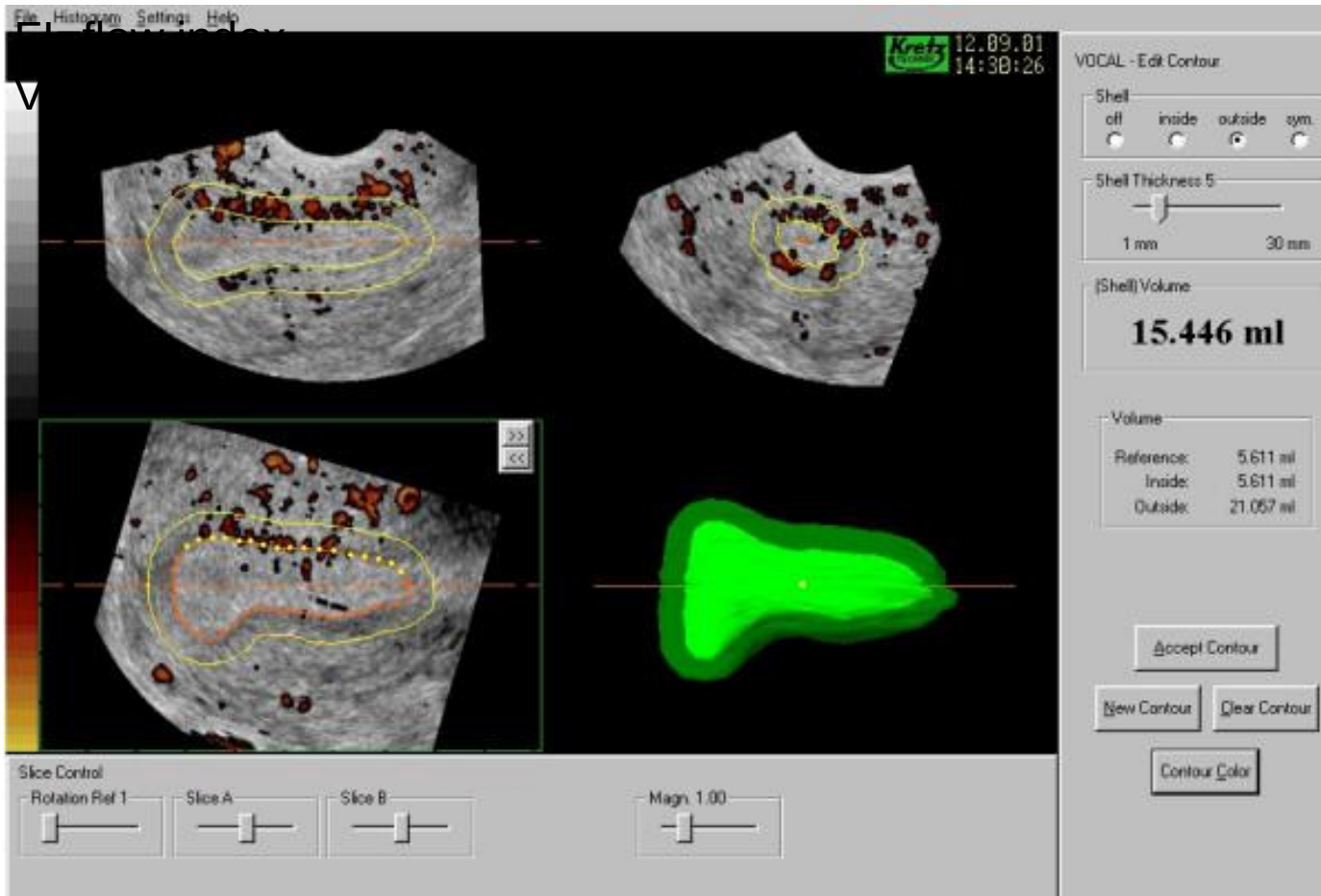


Hum. Reprod. 2004 19:330-338

Raine-Fenning NJ



VI=vasvularization index



Endometrial/subendometrial 3D power Doppler , pregnant vs non-pregnant

- difference
 - Schild et al 2000
 - 96 IVF cycles
 - 1st day of FSH stim
 - PR 20%
 - higher indeces in pregnant
 - Ng et al 2006
 - 451 IVF
 - OPU
 - PR 20.8%
 - endometrial VI and VFI lower in conception cycles
 - Merce et al 2008
 - N=77 IVF
 - hCG day
 - PR 49%
 - Endometrial indeces higher in pregnant women
- no difference
 - Kupesic et al 2001
 - n=89 IVF
 - ET day
 - PR 31.5%
 - No difference in endometrial VI or VFI
 - subend FI higher in pregnant
 - Wu et al 2003
 - n=54
 - hCG day
 - PR 50%
 - No difference in endomtrial indeces
 - subend VFI higher in pregnant
 - Järvelä et al 2005
 - n=35
 - hCG and OPU
 - PR 37%
 - No difference in end and subend

TABLE 2

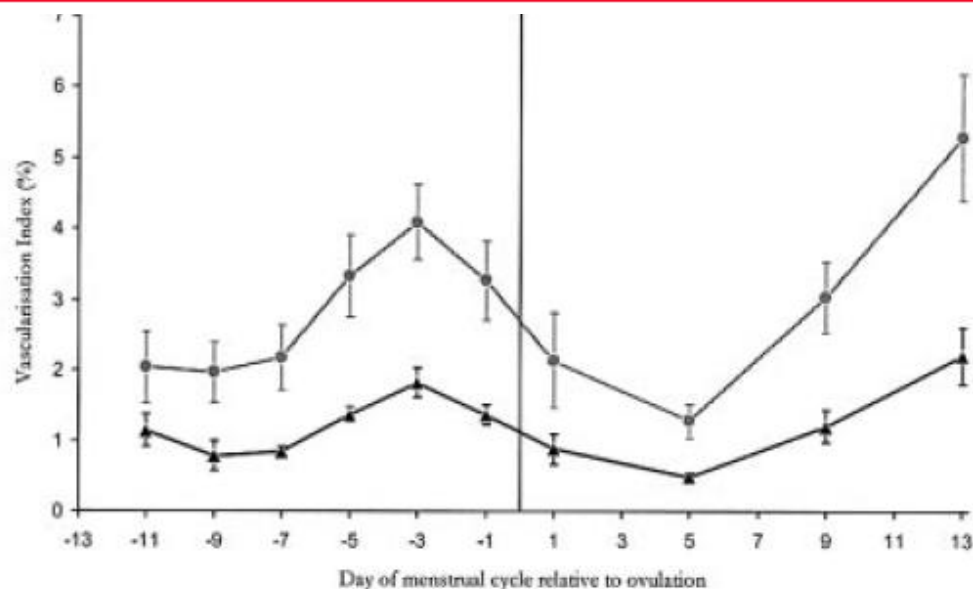
Comparison of endometrial three-dimensional ultrasound and power Doppler angiography parameters on the hCG day between pregnant and nonpregnant groups.

	Pregnant (n = 38)	Nonpregnant (n = 39)	P
Endometrial thickness (mm)	12.29 ± 2.71	12.15 ± 2.31	.810
Endometrial volume (mL) ^a	5.63 (2.67–16.64)	4.82 (2.05–9.24)	.022
Endometrial pattern (n, %)			.259
Triple line	33 (52.4)	30 (47.6)	
Non-triple line	5 (35.7)	9 (64.3)	
Vascularization index (%)	21.19 ± 8.91	16.05 ± 9.84	.019
Flow index (0–100)	28.12 ± 3.90	24.27 ± 3.71	<.001
Vascularization flow index (0–100)	6.30 ± 4.46	3.64 ± 2.75	.014

Note: Data are presented as mean ± standard deviation or n (%).

^a Median (range).

Mercé. Endometrial volume and 3D power Doppler indexes. Fertil Steril 2008.



Ng EH 2006, 451 IVF cycles

Table II. Comparison of uterine pulsatility index (PI) and uterine resistance index (RI), endometrial and subendometrial three-dimensional power Doppler indices between non-pregnant and pregnant patients

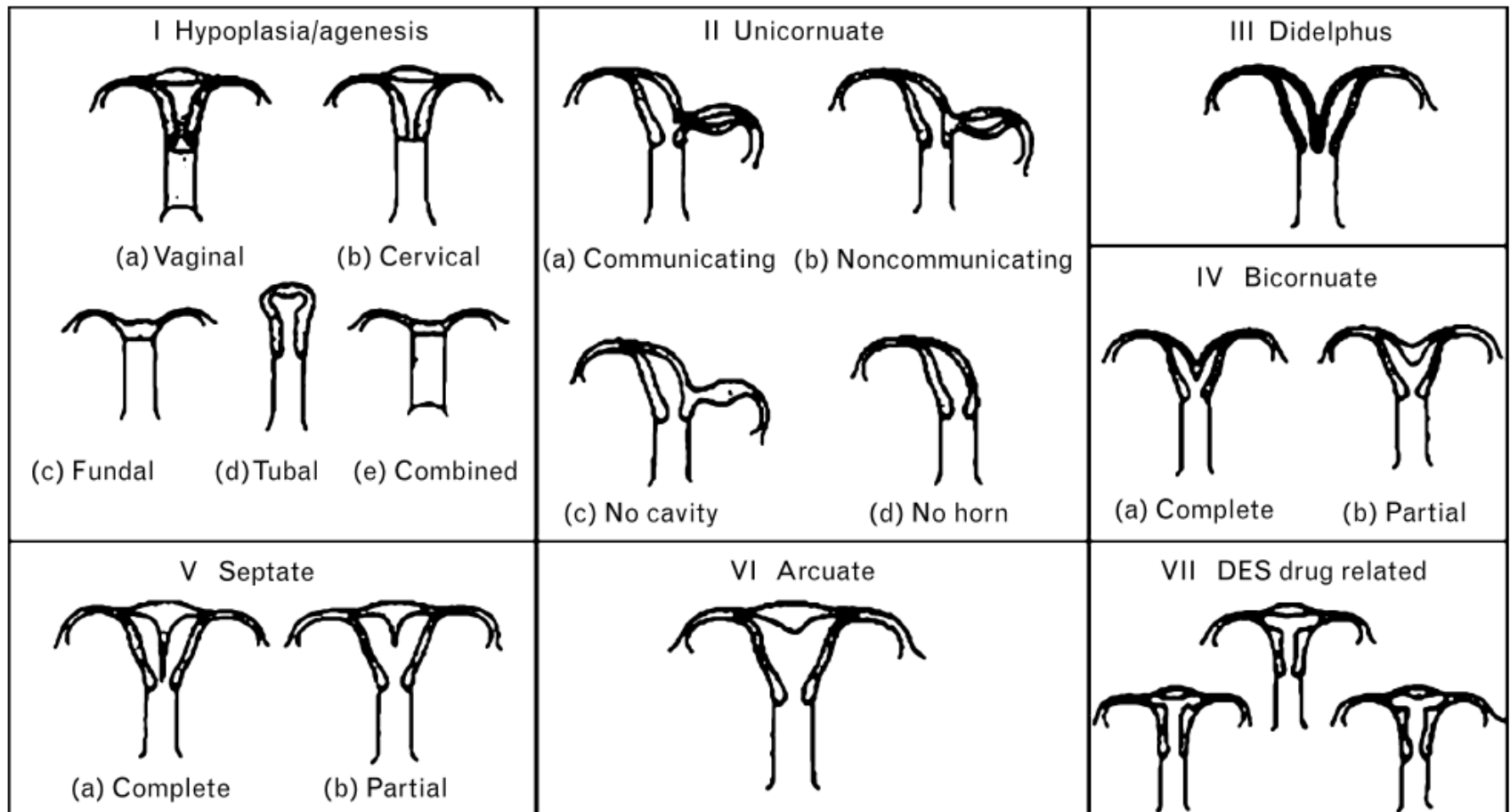
	Non-pregnant (<i>n</i> = 357)	Pregnant (<i>n</i> = 94)	<i>P</i>
Endometrial thickness (mm)	11.8 (9.9–13.5)	11.6 (9.5–13.7)	NS
Endometrial volume (cm ³)	4.93 (3.70–6.45)	4.73 (3.32–6.89)	NS
Endometrial pattern [<i>n</i> (%)]			NS
Multilayered	346 (96.9)	91 (96.8)	
Non-multilayered	11 (3.1)	3 (3.2)	
Uterine PI	2.03 (1.78–2.40)	2.04 (1.70–2.33)	NS
Uterine RI	0.84 (0.80–0.88)	0.82 (0.77–0.87)	0.047
Endometrial VI (%)	1.138 (0.283–2.652)	0.707 (0.300–1.778)	0.039
Endometrial FI (0–100)	22.867 (20.852–25.100)	22.797 (20.952–24.977)	NS
Endometrial VFI (0–100)	0.266 (0.062–0.631)	0.161 (0.063–0.427)	0.047
Subendometrial VI (%)	2.023 (0.617–4.733)	1.738 (0.674–3.569)	NS
Subendometrial FI (0–100)	23.980 (21.783–25.964)	24.118 (21.953–25.929)	NS
Subendometrial VFI (0–100)	0.489 (0.141–1.242)	0.438 (0.140–1.014)	NS

Data given as median (interquartile range) unless otherwise specified.

VI = vascularization index; FI = flow index; VFI = vascularization flow index; NS = not significant.

Kohtuanomaliat

Figure 1 American Society for Reproductive Medicine classification system for müllerian anomalies



Kohtuanomaliat, esiintyvyys

- Fertiili populaatio: 6.7%
- Infertiili populaatio: 7.3%
 - Korkea insidenssi uterusseptoja
- Toistuvat keskenmenot: 16.7%

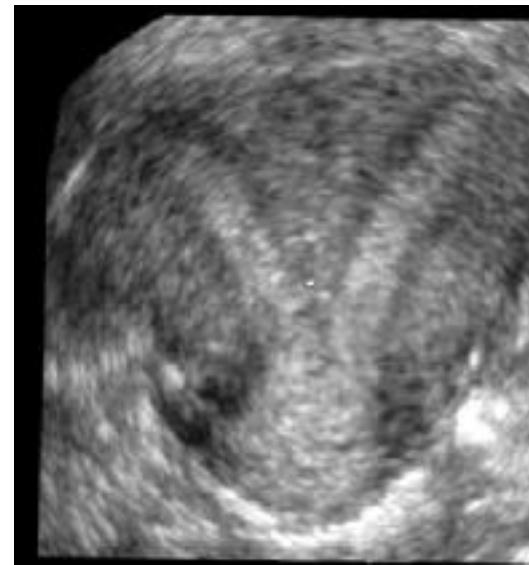
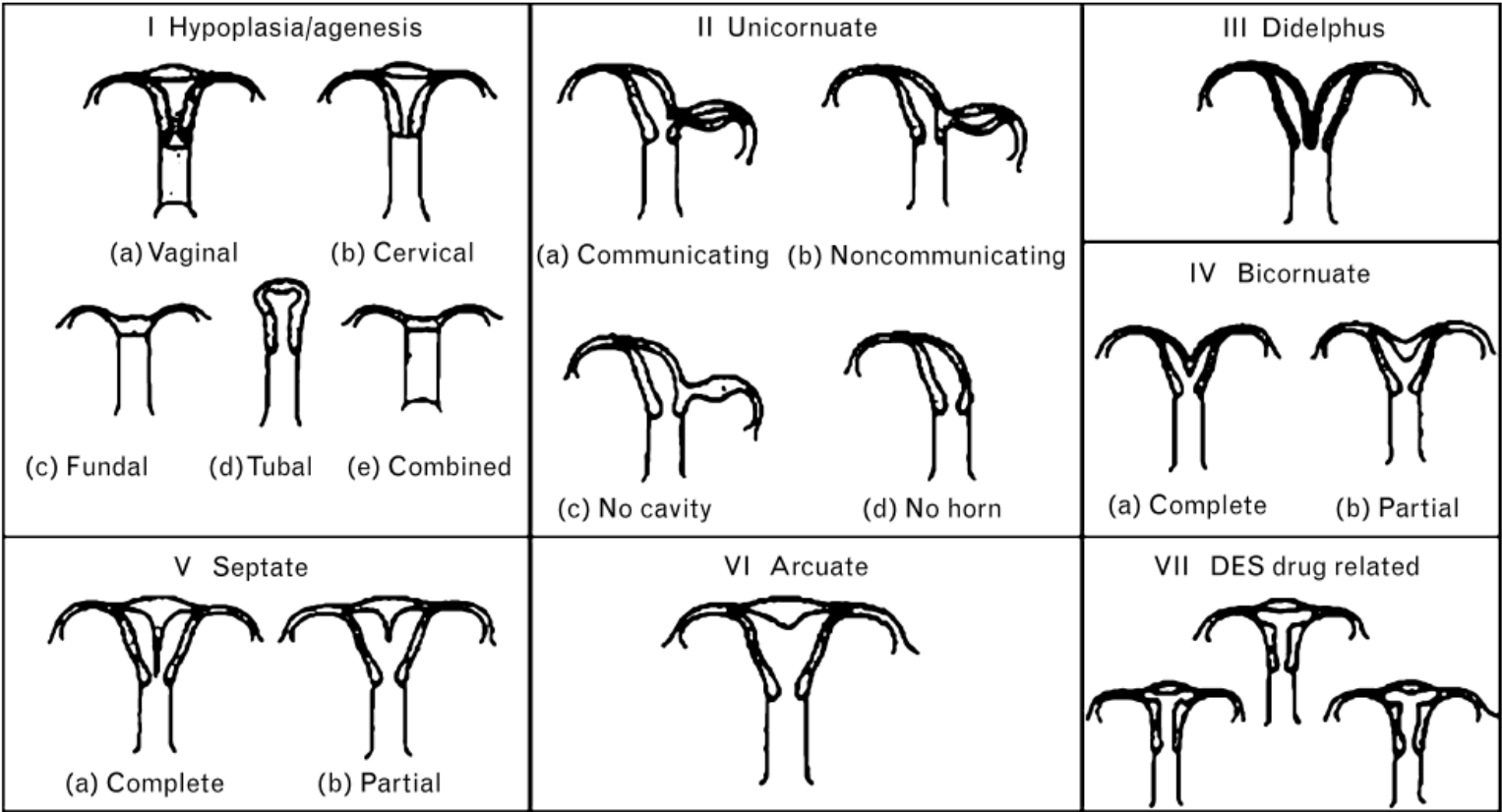


Table 1 Reproductive outcomes in women with congenital uterine anomalies

Uterine anomaly	Number of studies	Number of patients	Number of pregnancies	Abortion rate	Preterm birth rate	Term delivery rate	Live birth rate
Unicornuate	11	151	260	36.5	16.2	44.6	54.2
Didelphys	8	114	152	32.2	28.3	36.2	55.9
Bicornuate	4	261	627	36	23	40.6	55.2
Septate	4	198	499	44.3	22.4	33.1	50.1
Arcuate	3	102	241	25.7	7.5	62.7	66

Rates are averaged and presented as a percentage. Data from Grimbizis *et al.* [4].

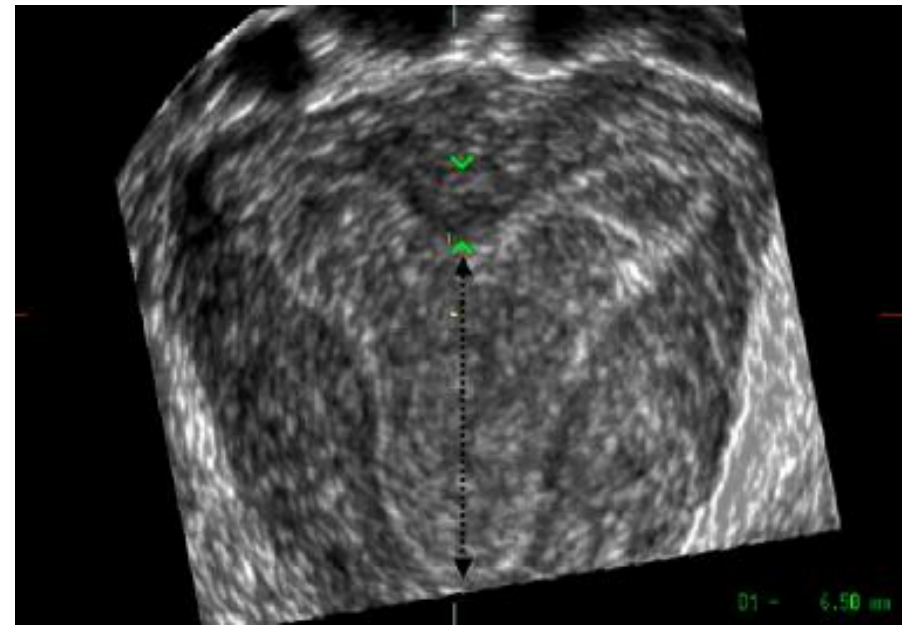
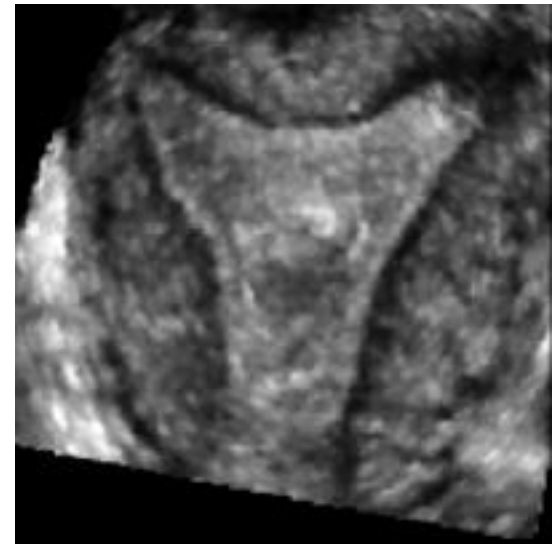
Figure 1 American Society for Reproductive Medicine classification system for müllerian anomalies



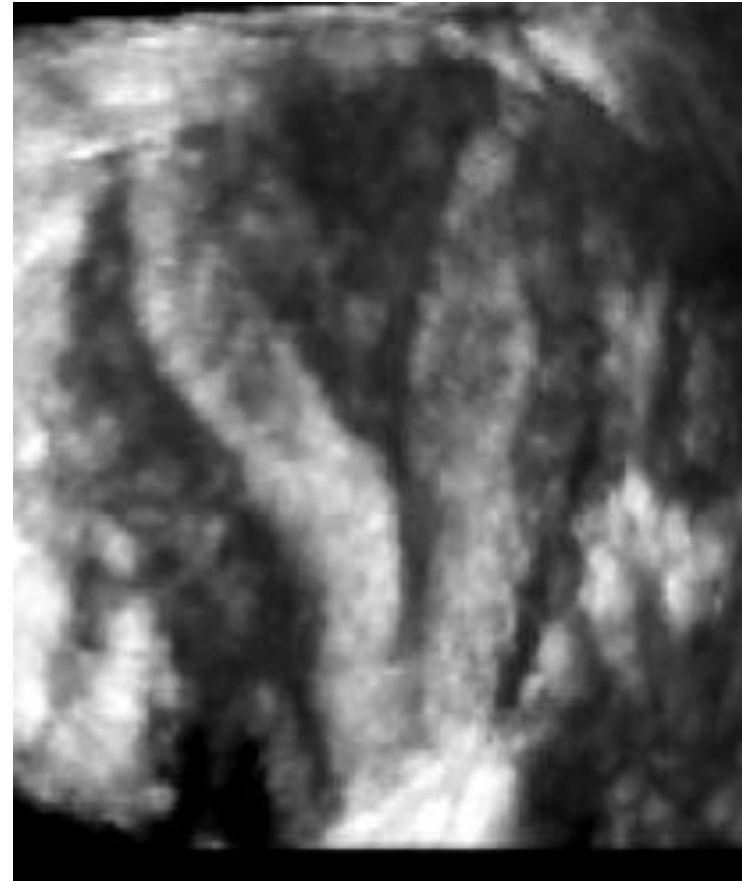
DES, diethylstilbestrol. Reproduced from [9].

Diagnostiikka

- Korpusten määrä
- Funduksen malli
- Kornut
- Väliseinän olemassaolo, pituus
- Portioiden määrä
- Vaginan väliseinä

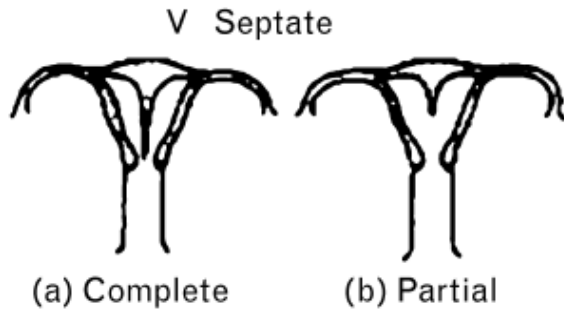


- Erotusdg:
 - bicornuate vs. didelphys vs. septate
 - Septate: Ab 44%, LBR 50%



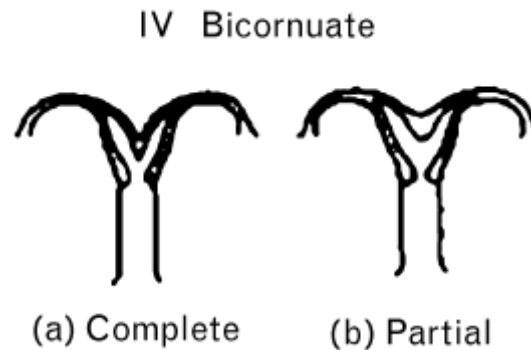
- Septate

- Fundus normaali
- Väliseinä, voi jakaa cx:n kahtia ja ulottua vaginaan



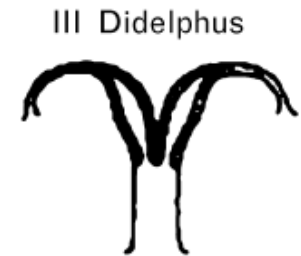
- Bicornuate

- Fundus laskeutuu >1cm
- 2 kaviteettia, 1 cx



- Didelphys

- 2 korpusta, 2 kaviteettia ja 2 cx:ä
- Myös vaginasepta 75%:ssa



Sotirios H. Saravelos^{1,3}, Karen A. Cocksedge¹ and Tin-Chiu Li^{1,2}

Prevalence and diagnosis of congenital uterine anomalies in women with reproductive failure: a critical appraisal

- Laparoscopia ja hysteroscopia
 - Standardi, mahdollistaa toimenpiteet
 - Invasiivinen
- Sonohysterografia ja 3D-UÄ
 - noninvasiivinen
- MRI
 - Tutkimuksia ei vielä riittävästi
- Hysterosalpingografia ja 2D-UÄ
 - Matalin diagnostinen tarkkuus

Table IV. Classification of investigations according to diagnostic accuracy.

Class Ia
Investigations capable of accurately identifying congenital uterine anomalies and classifying them into appropriate subtypes (accuracy >90%):
Hysteroscopy and laparoscopy
SHG
3D US
Class Ib
Investigations capable of accurately identifying congenital uterine anomalies (accuracy >90%) without being able to classify them into appropriate subtypes:
Hysteroscopy alone
Class II
Investigations capable of identifying congenital uterine anomalies with an accuracy <90%:
HSG
2D US
Class III
Investigations of which the accuracy in diagnosing congenital uterine anomalies is uncertain:
MRI
Physical examination during pregnancy or delivery

- 4 tutkimusta
- 130 anomaliaa/679 potilasta
- Vertailu 3D vs hysteroskopia; 100% sens, spes, PPV, NPV

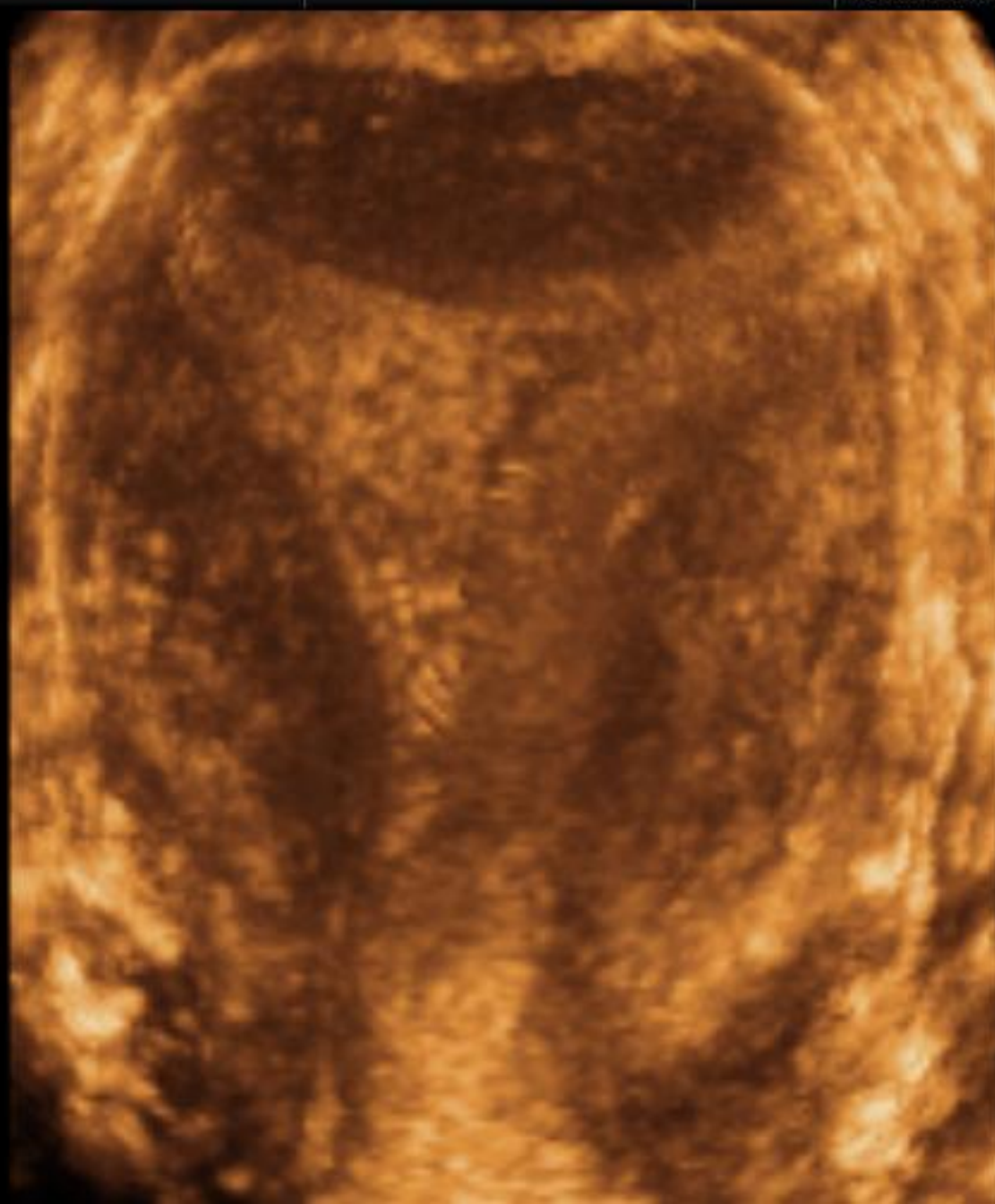
Radoncic E, Funduk-Kurjak B. Three-dimensional ultrasound for routine check-up in in vitro fertilization patients. *Croat Med J* 2000;41:262.

Wu MH, Hsu CC, Huang KE. Detection of congenital Müllerian duct anomalies using three-dimensional ultrasound. *J Clin Ultrasound* 1997;25:487–492.



31.03.2009

12:54:07



--- 3D/4D ---

Default

Th20/Qual max

B142°/V90°

Mix100/0

S.txt/min

M0/100

3D Static

--- 2D ---

Uterus

10.50 - 4.00

Pwr 100

Gn -3

C6 / M5

P3 / E1



08.06.2010

12:05:46

--- 3D/4D ---

Default

Th20/Qual m

B134°/V90°

Mix100/0

S.txt/min

M0/100

3D Static

--- 2D ---

Uterus 1

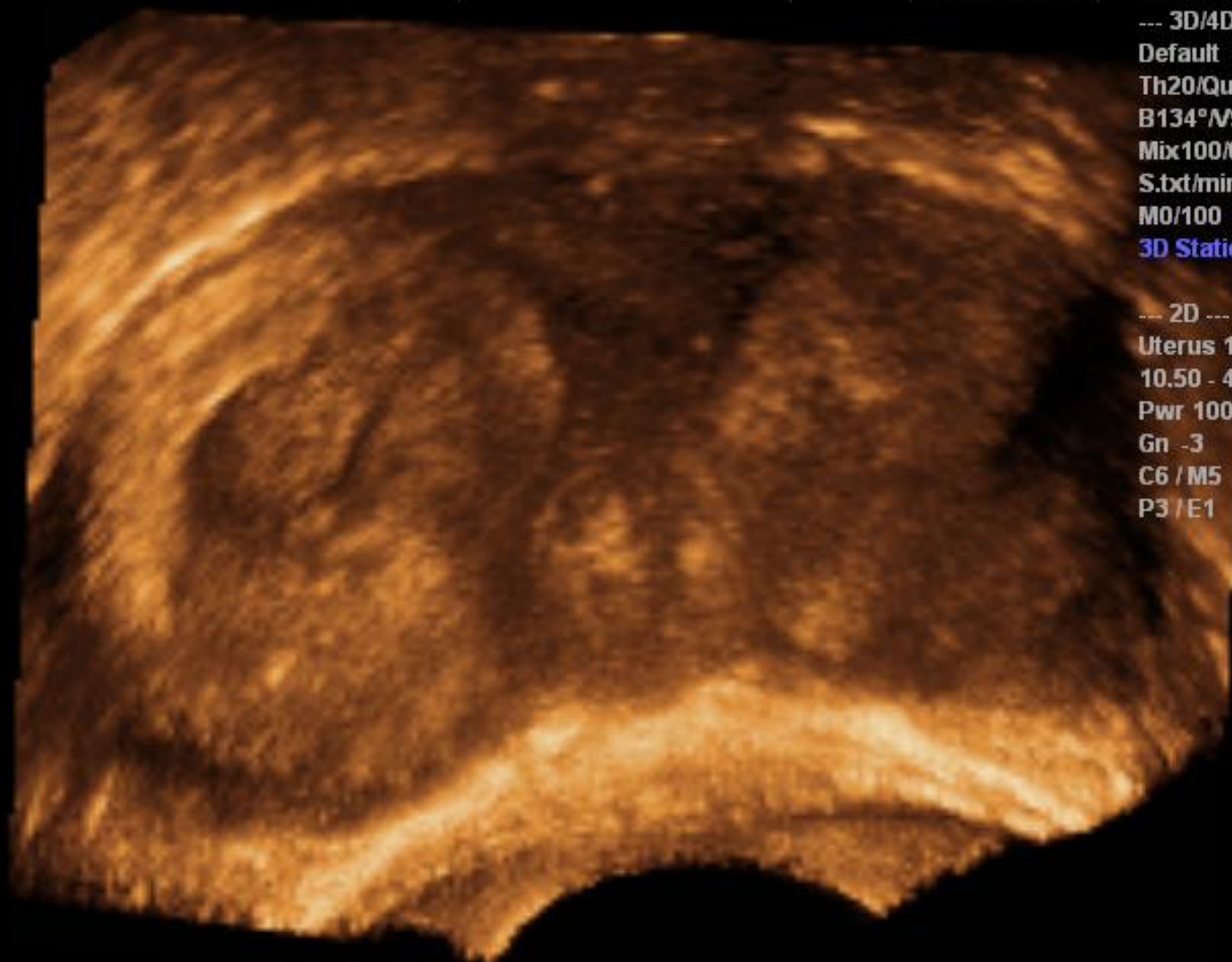
10.50 - 4.00

Pwr 100

Gn -3

C6 / M5

P3 / E1





08.06.2010

12:07:14



--- 3D/4D ---

Default

Th15/Qual max

B55°/V90°

Mix100/0

S.txt/min

M100/93

3D Static

--- 2D ---

Uterus 1

10.50 - 4.00

Pwr 100

Gn -3

C6 / M5

P3 / E1

CRL

CRL 0.77cm
GA 6w5d



26.08.2010

10:46:15

--- 3D/4D ---

Default

Th20/Qual max

B142°/V90°

Mix100/0

S.txt/min

M0/100

3D Static

--- 2D ---

Uterus 1

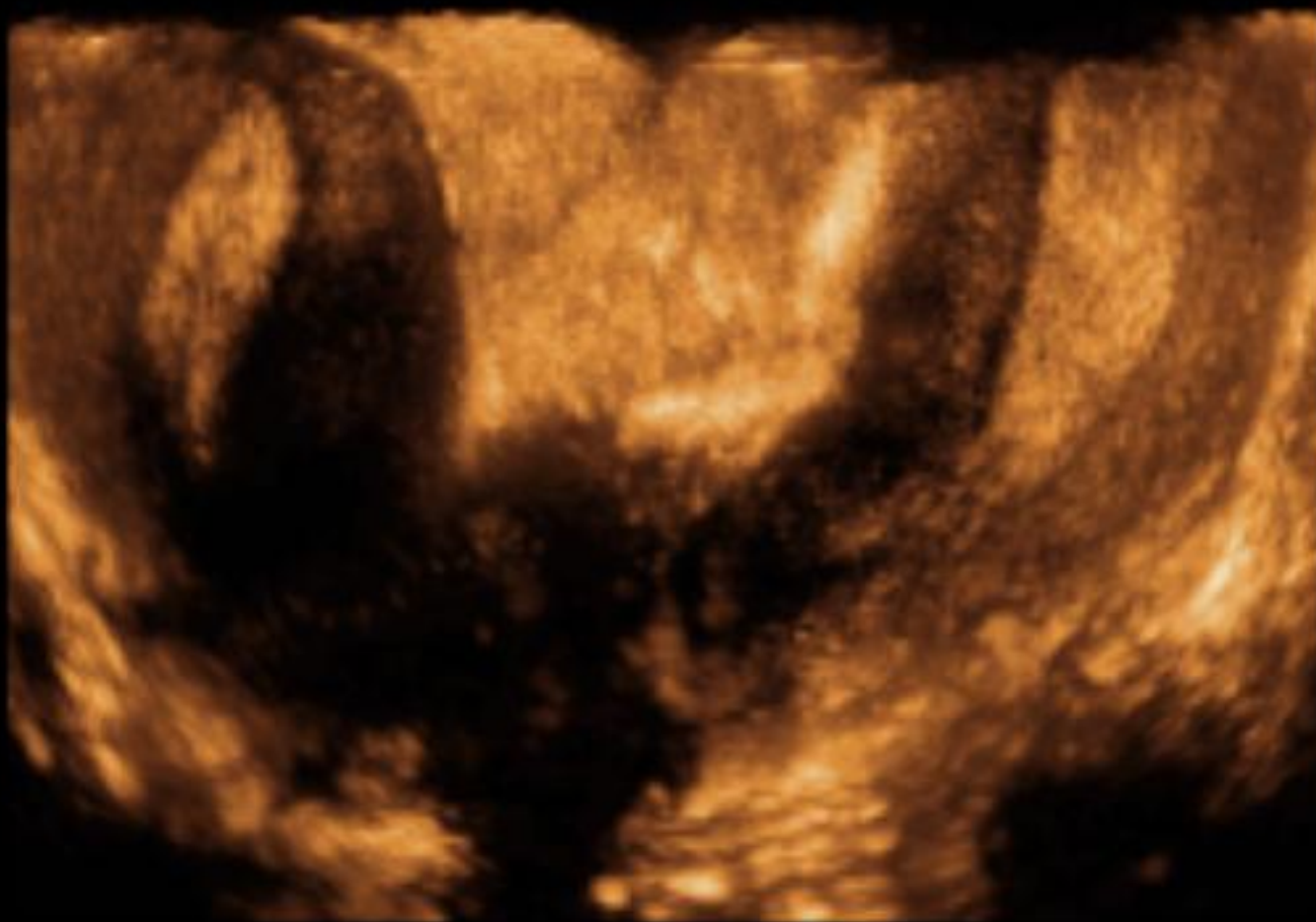
10.50 - 4.00

Pwr 100

Gn -3

C6 / M5

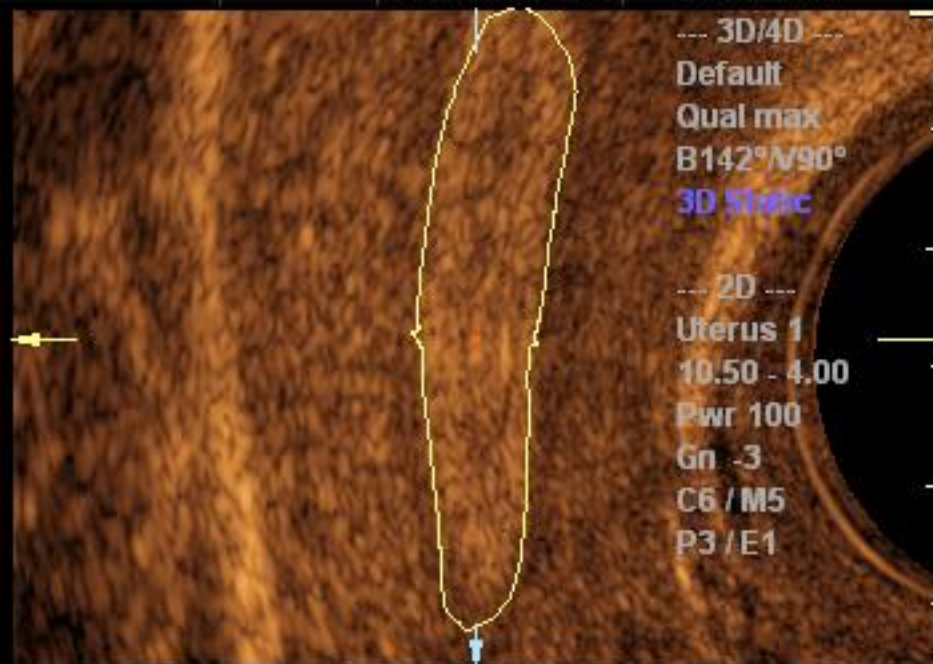
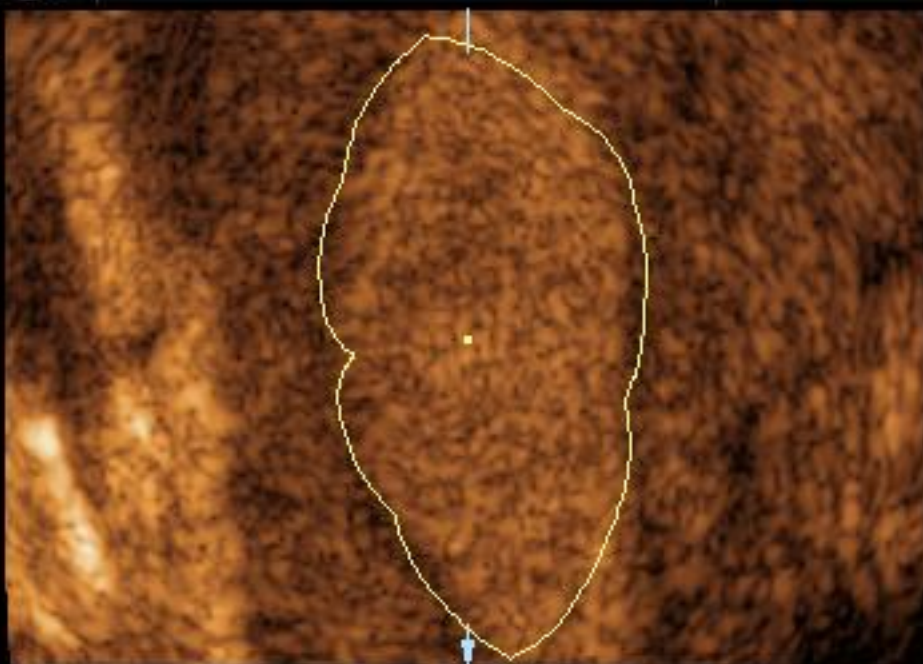
P3 / E1





26.08.2010

10:48:19



tilavuus
1.2 ml,
kp 21





26.08.2010

10:48:19

--- 3D/4D ---

Default

Qual max

B142°/V90°

3D Static

--- 2D ---

Uterus 1

10.50 - 4.00

Pwr 100

Gn -3

C6 / M5

P3 / E1



21.02.2008

09:29:07

--- 3D/4D ---

Default

Th20/Qual mid2

B135°/V90°

Mix100/0

S.txt/min

M0/100

3D Static

--- 2D ---

Uterus

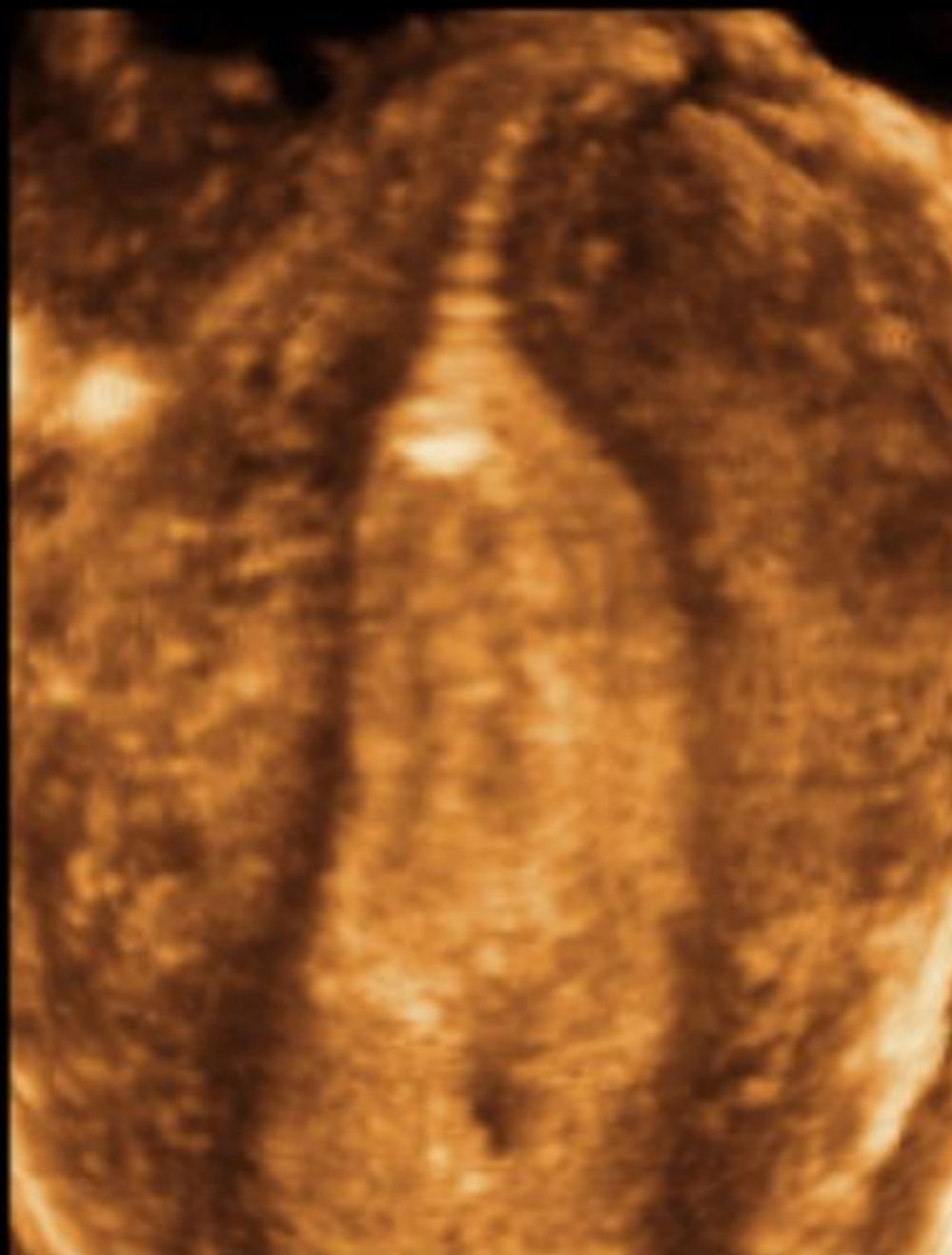
10.50 - 4.00

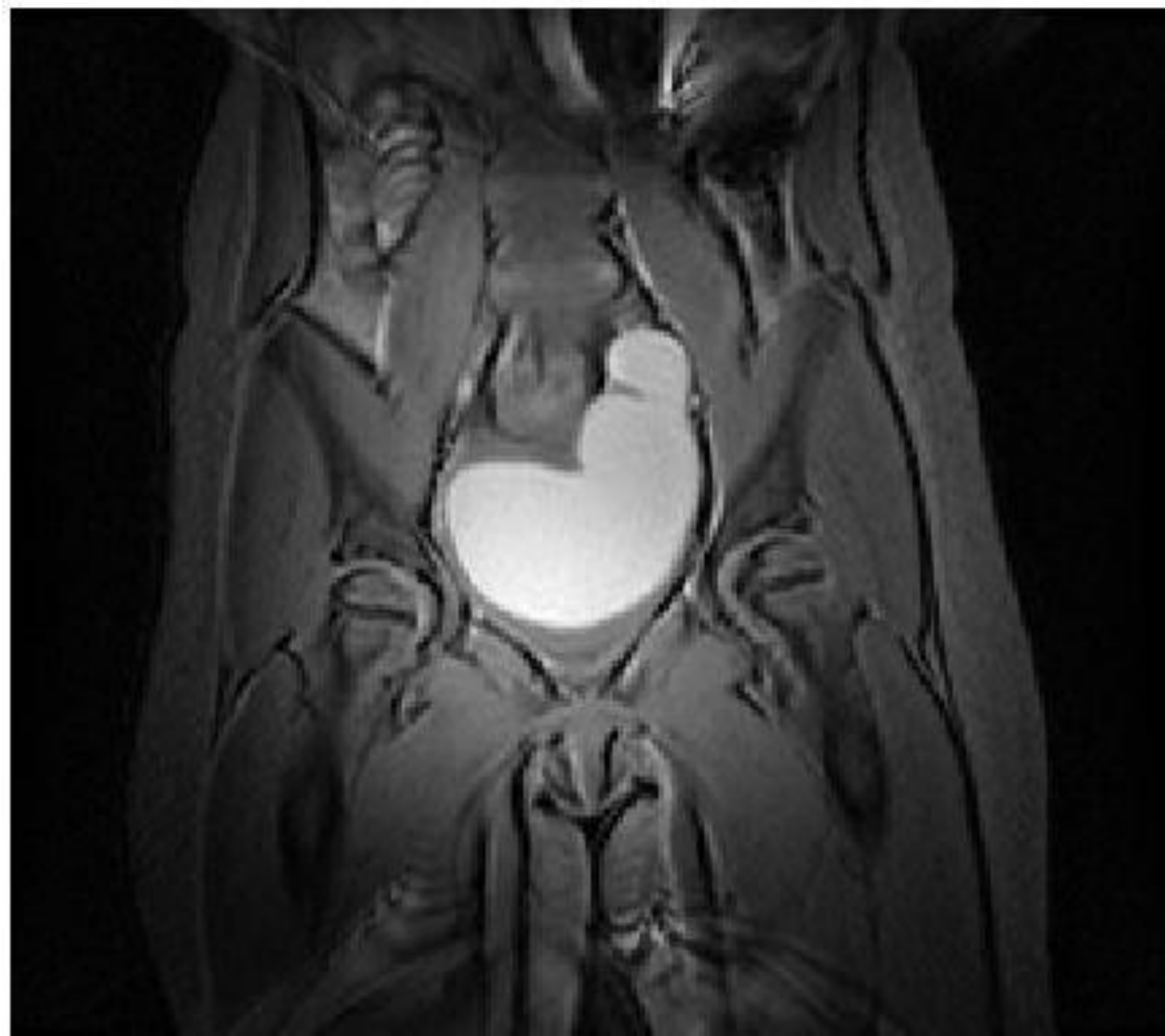
Pwr 100

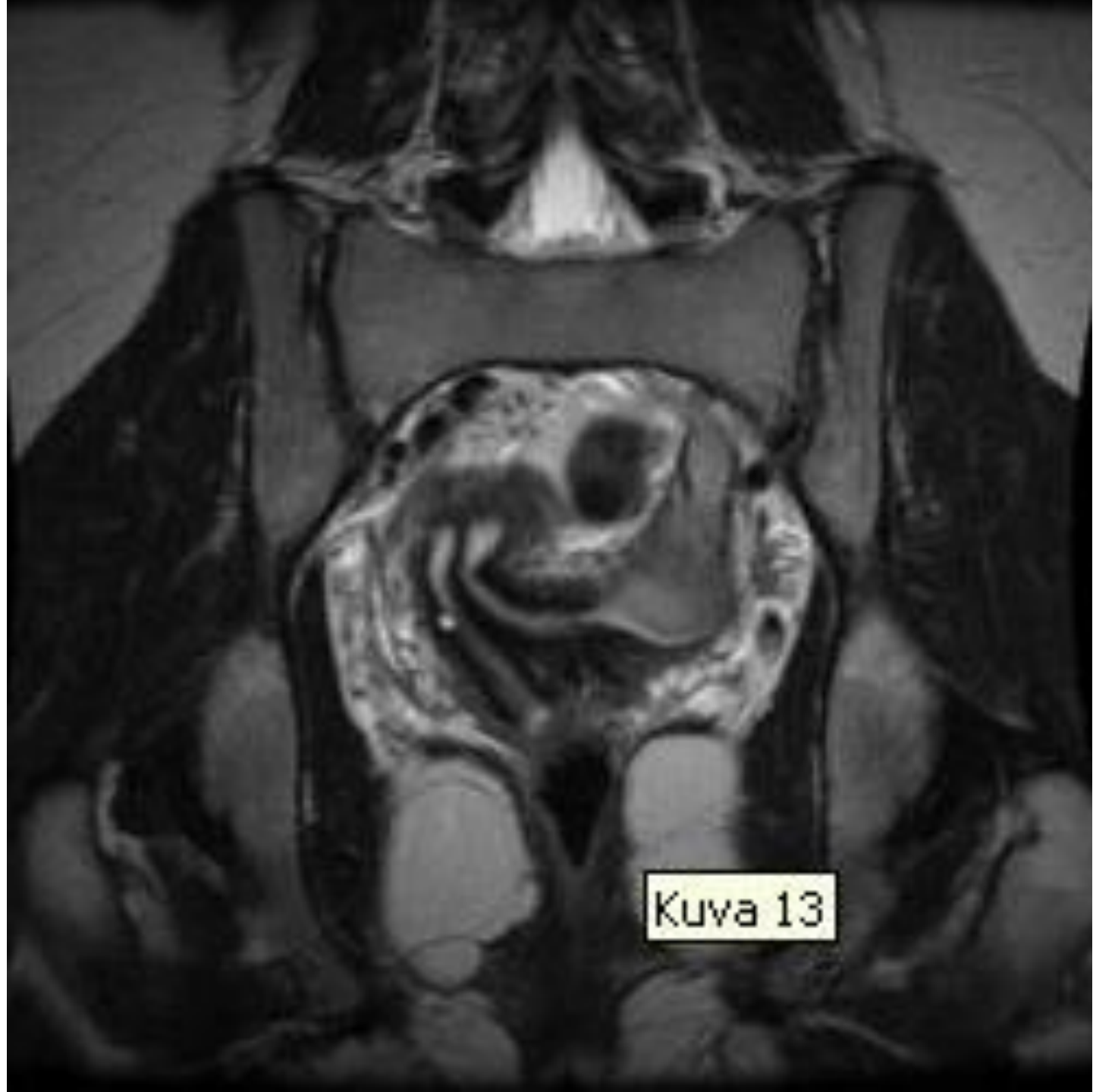
Gn -3

C6 / M5

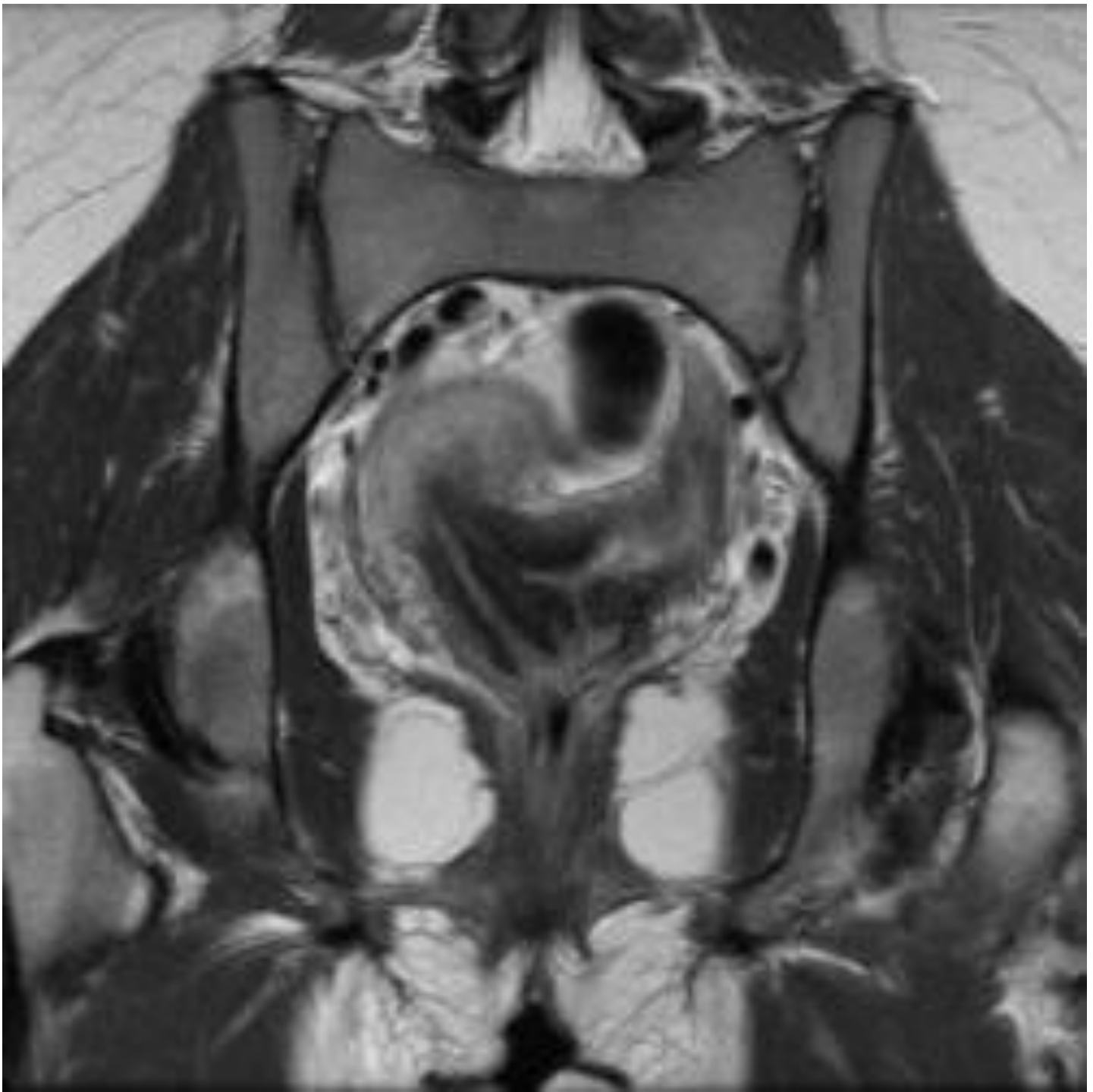
P3 / E1





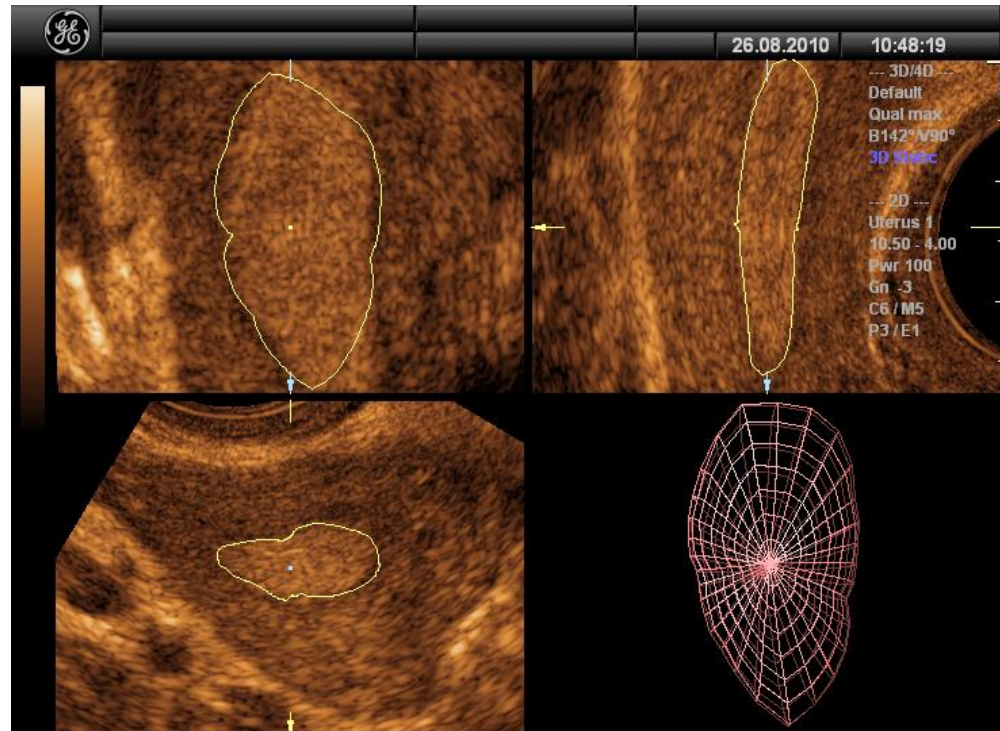
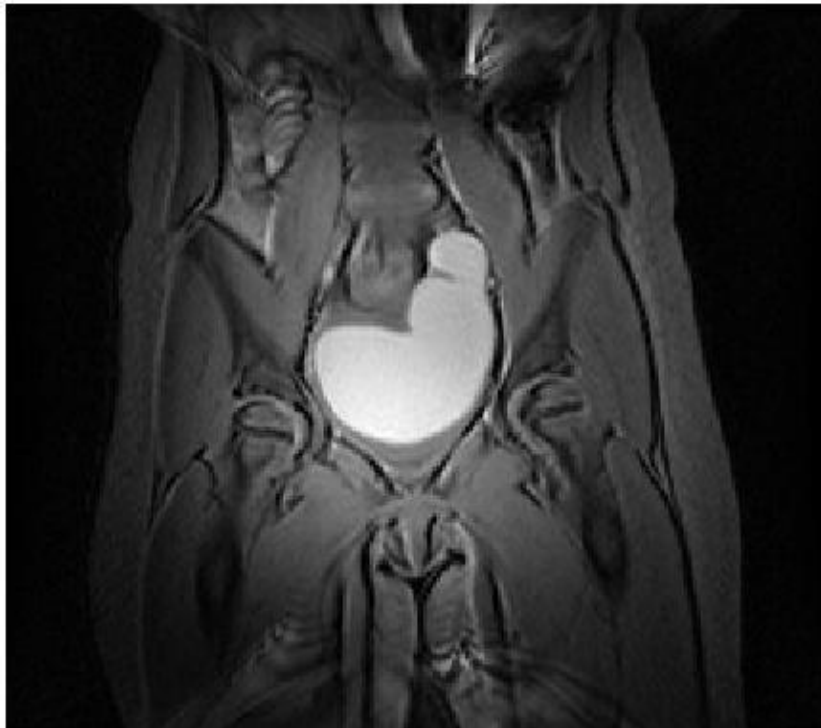


Kuva 13



3D ja anomaliat

- Jos hematometra/hematokolpos, UÄ huono
 - Anatomia vääristynyt, identifiointi vaikeaa
- Kaviteetin tilavuuden arviointi 3D:llä?



Gynekologinen 3 D-ultraääni – onko hyötyä?

- AF
 - SonoAVC voi nopeuttaa follikkelin kartoitusta, tuskin merkitystä raskaustuloksiin
- Endometriumien reseptiivisyys
 - Tulokset ristiriitaisia; vaatii hoitopäätöksen
- Anomaliat
 - Käyttökelpoinen, mahdollistaa funduksen ja kaviteetin visualisoinnin koronaalileikkeessä