Uterine Anomalies

MRI is so over!

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Educational objectives

- **Describe** the 3D US “tools” to complement 2D in imaging uterine malformations
- To emphasize the advantages of “3D US First”
- To encourage those **who perform** Gyn US to use them to shorten their way to the Dx, in spite of problems in reimbursement
- To teach those **who do not** do Gyn US to understand in which cases does 3D really add to making the right diagnosis
GYNECOLOGY

Consider ultrasound first for imaging the female pelvis

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US vs. MRI

“Currently available 3D/4-D volume ultrasound imaging can produce images of the female pelvis of comparable quality and orientation to those of MRI and CT but without radiation and at relatively lower cost”.

3D US vs MRI

• 3D UD has proved just as effective as MRI for the demonstration of Müllerian duct anomalies.
• Like MRI, it can produce simultaneously an image of the uterine contour & the entire endometrial cavity.
• 3D US enables to manipulate uterine volumes in any orientation regardless of its orientation or rotation.

3D US vs MRI

- Multiple studies established the equivalency of 3D US to MRI in diagnostic accuracy of Müllerian anomalies.
- Indeed, accuracy of both 3D US and MRI for the diagnosis of the specific type and extent of Müllerian anomalies typically exceeds 90-95%.

Most will say:

“It is not even reimbursed by payors! Why bother?”

Because it shortens the time to the dx. and it allows you to make more accurate diagnoses.

Thats why!
3D US in Gyn: Hard to ignore!

• Gaining increasing acceptance
  – More 3D machines in use
  – More are familiar with the technique

• Versatile & expanding display modes

• Versatile & expanding clinical use

• More literature

• Laptop software: off-line use easier
The tools
What indeed is 3D US?

- A series of 2 dimensional image slices saved into a volume with possibility to:
  - re-slice, re-study
  - save for future studies, mail, teach
  - make measurements in the volume
  - use different rendering apps
Use specific displays generic to 3D:

- Multiplanar navigation, scrolling
- Thick slice (VCI)
- 3D “Angiography”
- Inversion
- “Sculpting” tools
- Tomography
- SonoAVC
ORTHOGONAL PLANES

Multiplanar navigation (scrolling)

The “bread-and-butter” of 3D

I use it every day every time it enhanced my scans
If you understand the “first slide up” picture, and orientation you are halfway there!!
TV or TA acquisition in the sagittal plane of an anteverted uterus

This is your acquisition plane

This is transverse plane

This is your “never-before-seen” coronal plane
Three more rotations and you have these planes.

Coronal

Sagittal

Axial or transverse section
Orthogonal planes in 3D

Simultaneous & continuous display of the orthogonal planes (which are at right angles to each other)

• Achieve any desired plane
Different machines = different initial display of the orthogonal planes & rendering box.
The orthogonal planes are the basis from which I derive all the other display modalities,

- Thick slice (VCI)
- Tomographic display
- Angiography
- Inversion mode
- Volume analysis
- ....and others
ORTHOGONAL PLANES

‘Thick slice’
‘Volume Contrast Imaging’

These display methods enhance picture quality

I use it daily! It is very helpful!!
Helps outline faint borders
Using the “thick slice” display
3D and the Uterus

If someone asked me to name only one area that 3D US is the most helpful in Gyn: It is in scanning the uterus and its anomalies.
The Uterus

Where does 3D US really help?

- To define a normal uterus
- Find & define uterine malformations
- Look at the uterine cavity (polyps, fibroids etc.)
- Image the cervix
The normal uterus
Three dimensional ultrasound: Normal uterus

In scanning the uterus, the most important feature of 3D is, that we can now see the REAL coronal section of it.
Uterine malformations
Three dimensional ultrasound

- Uterine malformations are a significant problem in reproductive performance.
- The Dx depended upon HSG, MRI & laparoscopy.
- Lately 2D & 3D US became relatively simple, effective and inexpensive diagnostic modalities to allow appropriate clinical management.
Classification of Uterine Anomalies (AFS*)

I. Hypoplasia/Agenesis
   a. vaginal
   b. cervical
   c. fundal
   d. tubal
   e. combined

II. Unicornuate
   a. communicating
   b. non-communicating
   c. no cavity
   d. no horn

III. Didelphic

IV. Bicornuate
   a. complete
   b. partial

V. Septate
   a. complete
   b. partial

VI. Arcuate

VII. DES Related

*Modification after Buttram & Gibbons, AFS 1979;32:40
2D Gray Scale US of the Uterus

- Should still be a valuable SCREENING tool
2D Ultrasound
Sono-clue to uterine malformations

AP/Tx Ratio = <0.6

Width larger than height on axial section

Split endometrial echoes
Hysterosalpingography

- Used mostly by infertility specialists
- Done in the radiology suits
- Delays workup
- No info on uterine contour
- Involves radiation
- Costly

3 D ultrasound
Uterine anomalies: HSG vs. 3D US

Hysterosalpingogram

3D ultrasound

HSG: No information about the contours of the fundus

??

!!!
Uterine anomalies: 3D Ultrasound

The correct diagnosis depends upon imaging the contours of the cavity as well as the fundal contours!

3D US can do the “job” better, cheaper and faster than any imaging method!
What determines the type of uterine malformation?

- The fundal contours
- The shape the uterine cavity
- The cervix
3D US evaluation of the uterus should utilize SIS

Normal uterus
Saline Infusion Sonohysterography
A valuable 3D tool as an adjunct to 3D multiplanar imaging of uterine anomalies:

INVERSION RENDERING
What is 3D Inversion rendering?

Special computer program switching anechoic, fluid filled spaces into echo-filled spaces rendering it...

...a sort of a "cast" appearance.
Incomplete septate uterus

SIS
Incomplete separate uterus:
Sonographic “cast” of the endometrial cavity
Uterine anomalies: 3D Ultrasound
The different ways imaging the uterus

- Un-enhanced exam in the **follicular** phase
- Un-enhanced exam in the **secretory** phase (best using the “**thick slice**” technique)
- Saline infusion sonohysterography with, or w/o inversion
- Tomographic display
NL uterus:
Sonographic “cast” of the uterine cavity by SIS
Arcuate Uterus

- Only a minimal portion of the Müllerian ducts have not undergone resorption.
- There is a smooth fundus and a small indentation of the cavity (<1 cm).
- This is thought to be more likely a variant of normal.
3-D SIS detects the arcuate uterus

2-D scan can NOT supply the coronal plane of the uterus!!
Arcuate uterus
Thick slice
Arcuate uterus:
Sonographic “cast” of the endometrial cavity
Bicornuate Uterus

Incomplete fusion of the 2 ducts so there is an indentation in the uterine cavity as well as the fundus.
Bicornuate uterus

SIS
Bicornuate uterus
Bicornuate uterus SIS

Coronal
Septate Uterus

- Septum: The Müllerian ducts are fused, but there is incomplete resorption of the inside walls.
- The fundus is smooth and there is an indentation of the inside cavity by >1 cm
- It may be **complete** (down to the cervix) or **subseptate** (incomplete or partial septum).
Complete septate uterus
Thick slice
Septate uterus SIS
Incomplete septate uterus
Thick slice
Most common costly mistake

- Confuse septate with bicornuate uterus
- Different treatment, if so chosen
- Septate is easier to surgically correct
Didelphic Uterus

- Two parallel half uteri
- Lack of fusion of the 2 ducts so there are 2 complete ducts
- Two cavities as well as 2 cervices.
SIS Uterus didelphis
SIS Uterus didelphis
Complex anomalies
Hypoplastic rt. horn
Rudimentary horn
Unicornuate uterus

Failure of one Müllerian duct to form.
Unicornuate uterus
Omni view: Curve accommodates the cavities
Omni view: Curve accommodates the cervixes
The Thessaloniki ESHRE/ESGE consensus on diagnosis of female genital anomalies


Congenital Uterine Anomalies (CONUTA) common ESHRE/ESGE Working Group and invited Experts, ESGE Central Office, Diepsteevest 43/0001, 3000 Leuven, Belgium

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Submitted on July 14, 2015; resubmitted on July 14, 2015; accepted on September 14, 2015
What is this Meta analysis all about?

• The aim of the ‘Thessaloniki European Society of Human Reproduction and Embryology (ESHRE)/European Society for Gynaecological Endoscopy (ESGE) consensus’, an initiative of the CONgenital Uterine Anomalies (CONUTA) Working Group, is to provide recommendations for the diagnostic work-up of female genital anomalies; the definitions of the ESHRE/ESGE classification were used as a basis for their development.

• The article is an Executive Summary of the full-length article, which can be found online at http://humrep.oxfordjournals.org
Meta analysis

Total number of citations retrieved from electronic searches \( (n = 1871) \)

Duplicate articles removed \( (n = 206) \)

Articles excluded through title screening \( (n = 1406) \)

Abstracts and/or full text articles assessed for eligibility \( (n = 259) \)

Articles excluded with reasons \( (n = 221) \):
- Comparison not to hysteroscopy-laparoscopy
- And/or incomplete data \( (n = 218) \)
- Full text unavailable \( (n = 3) \)

Primary studies included in systematic review \( (n = 38) \)
Statistical analysis

- Pooled analysis of the included studies showed that the highest degrees of overall diagnostic accuracy were in decreasing order:
  - 3D US: 97.6% (95% CI, 95.6–100)
  - HyCoSy: 96.5% (95% CI, 91.1–100)
  - HSG: 86.9% (95% CI, 74.4–94.9)
  - 2D US: 86.6% (95% CI, 51.0–83.7).

Statistical analysis

• There were no studies found reporting on the use of MRI as a screening tool.

• MRI was shown to be able to correctly subclassify 85.8% of anomalies.

• Overall it appears that 3DUS maybe more accurate than MRI in subclassifying malformations,
  – Although it should be noted that subclassification is hindered due to the subjective nature of the previous classifications adopted.

Figure 2  How to obtain an optimal three-dimensional ultrasound (3D US) coronal plane. Tomographic ultrasound imaging is the representation by a series of parallel slices through the volume and the distance between the slices as well as their number can be configured; the plane is optimal only if the slices or cutting plane is exactly on the coronal view of the endometrium and the junctional zone at the level of tubal ostia and isthmus (plane at the center).
Figure 3 (A–C) How to obtain an optimal 3D US coronal plane. Cutting line is not perfect on the endometrium in plane a and b; thus, if necessary, the dotted line can be curved to follow the endometrium and the tubal ostia, as shown in plane C.
Figure 4: Coronal 3D US views of the uterus. (A) A normal uterus: uterine wall thickness; distance between the line joining tubal ostia (interstitial line) and a parallel line on the top of the fundus. (B) A partial septate uterus; (1) uterine wall thickness; distance between the line joining tubal ostia (interstitial line) and a parallel line on the top of uterine fundus and (2) internal midline indentation; distance between the interstitial line and a parallel line on the top of midline indentation. (C) A complete septate uterus; (1) uterine wall thickness; distance between the line joining tubal ostia (interstitial line) and a parallel line on the top of uterine fundus and, (2) internal midline indentation; distance between the interstitial line and a parallel line on the top of midline indentation (the line reaches the internal cervical os). (D) A bicornoreal septate uterus: uterine wall thickness; distance between the interstitial line and a parallel line joining the external outline of the uterine horns.
Recommended workup of Uterine Anomalies

- **2D US (vaginal)** as presented above, using measurements of 2D US as a potential reference for the evaluation of uterine anatomy deviations in 3D ultrasound,

- **3DUS (vaginal)** where the shape and the deviations from normal cervical and uterine anatomy should be recorded.

- In subgroups of patients with subfertility, recurrent IVF failures or recurrent pregnancy losses additional examinations can be performed:

  Human Reproduction, **published November 4, 2015**.
Recommended workup of Uterine Anomalies

- Additional Examinations:
  - **2D or 3D HyCoSy** offered by an experienced sonographer when available,
  - **HSC** and, in cases of suspected adnexal pathology, hydrolaparoscopy or
  - **LSC** offered by endoscopic reproductive surgeons having also the ability to surgically treat any discovered pathology and
  - **X-Ray HSG**, which should be reserved only for settings where the prementioned diagnostic methods are not available or for national health systems where indicated for other reasons.

Human Reproduction, published November 4, 2015
Recommended diagnostic work-up for complex anomalies

• Subgroups of patients with suspected complex anomalies (defined as anomalies resulting from disturbances in more than one stage of normal embryological development and including deviations in more than one organ of the female genital tract), and those where the application of the previously mentioned methods could not be applied (e.g. obstructing anomalies) should be evaluated as follows:

  • **Abdominal and/or transrectal 3D US** instead of the transvaginal route,
  • **MRI** evaluated by an imaging expert in collaboration with an experienced gynecologist,
  • **HSC and LSC** offered in special centers by experienced surgeons in the diagnosis and treatment of complex anomalies.
Recommended diagnostic work-up for adolescents

- Adolescents with symptoms suggestive for the presence of a female genital anomaly (primary amenorrhea and/or pelvic masses or pathology and/or cyclic pelvic pain) should be evaluated as follows:
  - Gynecological examination as presented
  - Abdominal and/or transrectal 2D US and 3D US
  - MRI is considered as a ‘first line’ diagnostic procedure for those patients
  - HSC and LSC,
  - In patients with female genital anomalies, investigation of the urinary tract is also recommended as mandatory.

Proprietary laptop version of 3D software

- QLab ® (Phillips)
- 4DView ® (GE)
- Sonoviewpro (Medison)
- 3D Volume Viewer (Siemens)

Best way to gain experience in 3D techniques

How easy is it to handle volumes off-line on a laptop?
Summary & Conclusion

- 3D US is the simplest and most effective tool to complement 2D evaluation of uterine anomalies.
- 3D reconstruction, inversion, tomography, 3D navigation are tools for daily use.
- The time investment mastering it is worth while.
- Laptop software is a training & clinical tool.
- ALWAYS consider 3D US before even thinking of MRI.