3D in Gyn Ultrasound: The Basics and Applications

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Conflict of Interest Disclosure
Consultant—Philips Ultrasound

Learning Objectives
- Behavioral objective:
  - Incorporate 3-dimensional pelvic ultrasound into practice where there are clear benefits to the technology
- Content:
  - The “Z-technique” and the mid-coronal plane of the uterus
  - Formatting – MPR, rendered, inversion and tomographic views
  - Technical tips to expand practice

3-D Ultrasound in GYN
- Areas of clear benefit
  - Uterus and endometrium
    - Müllerian uterine anomalies (CUA)
    - IUD location/management
    - Sub-mucous myomas
    - 3D sonohysterography (SIS)
    - Essure micro-inserts
    - Intrauterine adhesions (Asherman’s)
- Fallopian tube
  - Cornual/interstitial pregnancy
  - Hydrosalpinx
2-Dimensional Imaging

- Limitations
  - Scanning planes – two
    - Sagittal
    - Horizontal
  - Bony structures of the pelvis reduce vaginal probe mobility

3-D Imaging

Orthogonal Planes

- The volume of data is displayed as three orthogonal planes at 90° to each other

3-D Display

What does it mean?

- Acquisition view
- 90° to both Planes 1 & 2
- 90° to Plane 1

3-D Imaging

Multi-planar (MPR) Views

- Three MPR views displayed
- Ability to
  - Slice through the planes sequentially or rotate any plane
  - Reconstruct the MPR views in different planes

3-D Imaging

Rendered Volume

3-Dimensional Imaging

Uterus
**“Volume Data Set” Manipulation**
Multi-Planar Reconstruction, Rendering

**3-D Ultrasound in GYN**
Uterus and Endometrium

- Z-Technique\(^1\) for mid-coronal view
  - Board certified physicians already practicing 2-D TVS
  - No prior exposure to post-processing 3-D volume data sets
  - Mean time required to display the C-plane was 47.7 seconds
  - *Easy to learn!*

*Abuhamad A. JUM 2006;25:607*

**Congenital Uterine Anomalies**

**Congenital Uterine Anomalies**

**Accuracy**

- 3-D ultrasound as effective as MRI, but less costly and faster
    - 42 patients, infertility, LS and HS confirmation
    - 11/12 correct anomaly diagnosis
    - 41/42 correct external configuration of the uterus
  - Kupesic S. *J Ultrasound Med* 1998;17:631
    - 420 patients, infertility or RPL, 278 septate uterus
    - LS and HS confirmation
    - Sensitivity 98.4%, specificity 100%

**Congenital Uterine Anomalies**

**Congenital Uterine Anomalies**

- **Septate**
**Congenital Uterine Anomalies**

**Technical Tips**

- With TVS, consider late luteal phase timing
- Sonohysterography (SIS) helpful, not mandatory
- Uterine size/architecture may require more than one automated sweep or a handheld sweep
  - Alternative: horizontal plane of acquisition
- Separate 3D imaging of the cervix

**IUD**
**IUD**

- Improved accuracy for IUD identification and positioning
    - 2D vs. 3D assessment of IUD location
    - 2D: 10/66 either misidentified location/position or not seen
    - 3D: all IUDs accurately identified—confirmed by hysteroscopy (HS)

- Ideal means to image myometrial side arm penetration
  - Benacerraf B. *Ultrasound Obstet Gynecol* 2009;34:110-115
    - 16.8% of 167 pts showed side arm penetration into the myometrium and this finding only detected on 3-D coronal view of the uterus
    - Higher proportion (75%) of pts with abnormal IUD location had pain or bleeding than those with normal IUD location (34.5%)
    - 20/21 symptomatic pts with abnormal IUD location improved after removal

- Benacerraf B. *Obstet Gynecol* 2010;116:305-10

- Shipp T. *J Ultrasound Med* 2010;29:1453-6

- *Mirena®* 32 mm
- *Paraguard®* 36 mm
- *Skyla®*
**IUD Technical Tips**

- Consider 3D sweep on all patients with IUD in-situ presenting for ultrasound
- Rendered/slab/thick slice view may improve contrast and detection of myometrial penetration
- Should ‘best practice’ mean a 3D ultrasound before/after IUD insertion?
3D SIS vs. 2D SIS

3D SIS vs. 2D SIS (Compared to Hysteroscopy)

<table>
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<th>Abnormal</th>
<th>Normal</th>
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<td>Normal</td>
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</tbody>
</table>

de Kroon et al. J Ultrasound Med 2004; 23: 1433-1440

3D SIS vs. 2D SIS

- Procedure time and patient comfort
  - Shortens procedure time and improves patient satisfaction/comfort

Weinraub Z. Ultrasound Obstet Gynecol 1996;8:277-282

Essure

Adhesions

Fallopian Tube
Fallopian Tube Interstitial Ectopic

Fallopian Tube Hydrosalpinx

Fallopian Tube Inversion Rendering

Research Infertility/ART
- Infertility/ART
- Cancer
  - Uterine
  - Cervix
  - Ovarian
- Incontinence/pelvic floor
  - Vaginal, transperineal, endoanal

3D Ultrasound Limitations
- “What you see is what you get”
- Technology cost
- Sonographer and physician learning curve
- Decreased spatial resolution, especially outside of the plane of acquisition
- Entire organ may not be in view with a single sweep and may require 2-3 volumes
- Work flow changes in the ultrasound unit

Summary
- Short acquisition time for the test
- Images may be manipulated in any plane
- Multiple formats can be customized according to preference and structure under evaluation (e.g., MPR, rendered, thick slice/slab, tomographic display, etc)
- Increase efficiency and patient satisfaction (3-D SIS)
Summary

- “Doable” learning curve for data manipulation
- Several areas within Gynecology where this technology has moved from the research bench into clinical practice
- The ongoing areas of research predict further expanded clinical uses for this imaging modality in the future

Case Examples

Case #1

- 24 y/o, G0
  - LMP ~ 6 weeks prior; no contraception
  - 2 day hx of moderately severe pelvic cramping and light vaginal bleeding
  - PMH, PSH – unremarkable
  - Physical exam
    - 36° F, HR 84, RR 16, 134/83
    - Abdomen: non-tender, soft
  - Laboratory
    - WBC 8.4, Hct 45%, A positive
    - UPT +, hCG 3183
Case #1

- Ultrasound dx: Left cornual pregnancy

Case #1

- Ultrasound dx: eccentrically located “angular” IUP
  - Interstitial pregnancy
Case #2

- 17 y/o, G0
  - LMP ~ 2 weeks prior
  - Sudden, progressive, severe pain mostly L-sided; seen 1 day prior at another hospital
  - Nausea, emesis, intolerant of oral analgesics
  - Menarche age 13 x 28 days x 4 days
  - PMH, PSH, ROS negative

Physical exam
- VSS; Abd – non-surgical; Pelvic – tender, no mass
- Laboratory
  - WBC 8.7, Hct 34%, UPT negative

Hospital course
- Report of outside ultrasound: possible bicornuate uterus with normal right horn and a left horn “full of blood and debris”. Plan was for uterine evacuation if necessary.
- Treatment: IV anti-emetics and narcotic analgesics, non-steroidal analgesics, IV fluid hydration
- Imaging performed
Case #2

- Hospital course
  - Relapsing 10/10 pain, nausea, vomiting
  - Surgery: laparoscopy with resection of left non-communicating functional uterine horn and left salpingectomy

Case #3

- 31 y/o presented to PCP for annual exam. Only complaint = daily, mild, non-lateralizing pelvic discomfort.
- IUD of unknown type placed elsewhere 3 years prior. Strings not visible on pelvic examination.
- Patient desired IUD removal and fertility.
Case #3


Case #4

- 29 y/o, G5 P4, desiring sterilization
  - Essure tubal micro-inserts placed bilaterally
    - "scar tissue at left ostea"
  - HSG performed 3.5 mos later
    - Patient c/o chronic LLQ pain since procedure and admitted significant discomfort during the procedure with placement of the left device only