3D Ultrasound of the Female Pelvis and Early Pregnancy

Beyond the IUD

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Disclosures

NONE
Objectives

• List indications, technique and limitations of 3D ultrasound (US) of the female pelvis

• Describe the role of 3D US in diagnosis of Müllerian duct anomalies, endometrial abnormalities, submucosal myomas and adenomyosis

• Review role of 3D US in differentiating intrauterine from interstitial and other ectopic pregnancy
3D Ultrasound - Overview

Acquire volume of 2D ultrasound images of area of interest
- Freehand or automatic acquisition
- Volume data manipulated at time of acquisition or offline after patient leaves
- Send coronal 2D/3D images and coronal 2D cine to PACS

Orientation
- Labeling important for localizing lesions accurately, particularly in retroflexed uterus

Time
- 30 seconds to acquire images and send volume data
- 30 seconds to 2 minutes to post-process image
“Z” Technique - Multiplanar Display

- Equipment at our institution: Philips IU22 and EPIQ, Philips Intellispace Portal (ISP)
- Step by step process to obtain midcoronal plane of uterus in volume sonography
- Multiplanar display of a 3D volume – 3 orthogonal planes

Place reference point in mid endometrial stripe (EMS) in sagittal plane

- Use Z rotation to align long axis of EMS with horizontal
- Put reference point in mid EMS in transverse plane

Apply Z rotation on panel C to display uterus in coronal orientation

Abuhamed JUM 2006
Orientation Labels
Important for accurate localization of findings

Retroverted uterus

Transverse image shows left sided gestational sac

Coronal 3D demonstrates sac on right side, but label indicates it is left
3D Ultrasound - Technique

- Quality of 3D depends on quality of 2D acquisition

- Include fundal contour and 1 cm beyond uterine serosa on either side

- Tips to improve quality of 2D
  - Increase gain
  - Constant speed during freehand acquisition

- Coronal reconstruction should include interstitial portion of fallopian tube

Initial coronal 2D reformat - ? small endometrial cavity
Repeat coronal 2D reformat to include interstitial portions of the fallopian tubes
3D volume rendered image
Normal fundal contour
Normal junctional zone
Which patients undergo 3D Ultrasound?

- All female pelvis and first trimester pregnancy ultrasounds regardless of indication

- Sonographer constructs and sends 2D/3D coronal views of uterus and coronal 2D cine loop to PACS

- 3D volume data also sent to portal for offline processing if necessary

Normal coronal 2D cine of uterus
Limitations of 3D Ultrasound

- Sonographer selects/reconstructs images
- Loss of spatial resolution in reconstructed plane
- Inability to measure on freehand acquisition
- Artifacts
- Certain uteri not conducive to 3D reconstruction
  - Markedly enlarged myomatous uteri
  - Thin endometrium may decrease diagnostic ability of coronal 3D image

Andreotti JUM 2006
Benaceraff AJR 2007
3D Adds Value in the Following Gynecologic Conditions

- Müllerian duct anomalies
- Abnormalities of the endometrium and endometrial cavity
- Adenomyosis
- Fibroid mapping
- Intrauterine device type and position
- Assessment of adnexal lesions
- Other

Andreotti JUM 2006
Benacerraf AJR 2007
Müllerian duct anomalies

• Screening of Müllerian duct anomalies important in women with infertility and recurrent miscarriages

• Occurs in 0.4% general population and in 4% infertile women, 3-38% repeated spontaneous miscarriages

• High degree of concordance between 3D ultrasound and MRI in diagnosis of uterine anomalies

Bermejo Ultrasound Obstet Gynecol 2010
Andreotti Radiol Clin N America 2014
Fertility and Sterility 1988
Two endometrial cavities on 2D

Two uterine cavities

Two cervices

Didelphus Uterus

Coronal reformat – shows fundal contour and differentiates between septate uterus and bicornuate / didelphus uterus

Two uterine cavities

Subseptate Uterus
Pitfall: Unicornuate uterus

Uterus interpreted as normal on 2D US (no 3D US performed)

Subsequent MRI demonstrates left unicornuate uterus with rudimentary right horn

Normal uterus?

Coronal 2D shows right unicornuate uterus
Endometrial Polyps

Thickened EMS
Numerous echogenic endometrial nodules

2D sonohysterogram shows carpet of endometrial polyps

3D sonohysterogram image best depicts extent of innumerable polyps

3D US clearly shows fundal location; sonohysterogram not necessary
Recurrent miscarriages

Sag uterus

Trv uterus

Diagnosis: Synechiae
Endometrial Ablation

2 Layers of Endometrium
- Thin basalis Layer
- Variable functional Layer
- Junctional Zone

Normal Coronal 2D Uterus

Ablation Mesh in endometrial cavity
Image from Daub et al AJR 2015
Endometrial ablation

Ill defined endometrium

Normal

Coronal 2D reformat scarred “Y “shaped endometrium
Endometrial Ablation with Pain

Sag US shows thin calcified ill-defined endometrium

Complications related to bleeding from residual endometrium obstructed by endometrial adhesions

US findings:
- Focal fluid collections behind adhesions

Interstitial hydrosalpinges

Normal

Coronal 2D right
Coronal 2D left
39F with severe pelvic pain

Diagnosis: Hematometros and post ablation tubal sterilization syndrome

Daub et al AJR 2015
Adenomyosis

- Migration of endometrial glands from basal layer of endometrium into myometrium associated with smooth muscle hyperplasia
- 2D US can only assess junctional zone one plane at a time
- 3D US can evaluate lateral and fundal junctional zone on coronal view

**2D ultrasound findings**
- Myometrial hypoechoic and/or echogenic striations
- Myometrial cysts
- Myometrial heterogeneity
- Ill defined endometrial-myometrial junction
- Asymmetry of myometrial thickness
- Diffuse vascularity
- Globular uterine configuration
- Echogenic nodules in junctional zone

**3D ultrasound findings**
- Disruption and infiltration of the hypoechoic junctional zone (JZ) by hyperechoic endometrial tissue
- Difference in JZ thickness ≥ 4 mm and JZ infiltration and distortion
Adenomyosis

- Most commonly seen at cornual-fundal-raphe possibly related to increased peristalsis in this region

- Cornual fundal area best appreciated on coronal 2D and 3D view

Exacoustos Ultrasound Obstet Gynecol 2011
Adenomyosis

- Ill defined endometrial myometrial junction
- Subendometrial cyst
- Echogenic striations in junctional zone
- Diffuse adenomyosis and infiltration of JZ
- Normal for comparison
Adenomyosis – 2 patients
Focal echogenic nodule
Adenomyosis and Fibroid

Findings?
Submucosal fibroid

Submucosal fibroid blocking placement of right Essure device
Complex cystic mass in right uterine body: Degenerated submucosal fibroid versus uterine anomaly with hematometros in right uterine horn?

Transabdominal sag uterus

Trv uterus

Sag right uterus

Coronal 2D
Endometrium

Coronal 2D reformat cine clearly shows degenerated submucosal fibroid distorting endometrium
3D Imaging: Malpositioned Intra-Uterine Devices

On 2D US, positioning may be unclear.

3D Imaging clarifies location and orientation of IUD.

- IUD Malpositioned, Rotated Clockwise
- Left Arm Embedded in Myometrium
- IUD in the Cervix with IUP
IUD placed 1 year ago
Another IUD case
Automatic 3D probe
Transabdominal 3D
Left Hydrosalpinx

Sag left adnexa – tubular cystic structure

2D Reformat “waist sign”
Continuous lumen of hydrosalpinx

2D Reformat “beads on a string” (residual endosalpingeal folds)

Reconstruct volume data into any plane that best depicts the findings!
Deep endometriosis

Retroverted uterus with deep infiltrating endometrial implant on uterine and sigmoid serosa

Sag 3D clearly shows deep implant
Pelvic Varices – Pelvic pain

Transverse uterus

Transverse left

Transverse left color Doppler

Coronal 2D
Left pelvic varices

Coronal 2D cine
3D of Pregnancy Implantation

- Angular
- Interstitial
- Cesarean Scar Ectopic
- Cervical Ectopic
- Pregnancy in setting of Müllerian Duct Anomaly
IUP/Angular pregnancy

- Intrauterine pregnancy that implants eccentrically in one of the lateral angles/corners of uterine cavity
- Large, broad based connection with endometrium
- Outer border may be surrounded by myometrium
- 3D ultrasound helpful to exclude interstitial pregnancy

Interstitial pregnancy

- Ectopic pregnancy that implants in the intramural portion of the fallopian tube
- Separated from endometrial cavity by thin band of myometrium
- Difficult 2D diagnosis
- Improved sensitivity with 3D sonography

Tanaka J Ultrasound Med 2014; 33:2031-2035
Intrauterine Pregnancy

Transverse uterus

Coronal 3d confirms intrauterine location of gestational sac

Sag uterus
Cervical ectopic pregnancy

Coronal 2d reformat

Sag view shows sac in cervical canal

Yolk sac

Cesarean scar ectopic pregnancy

Sag uterus

Gestational Sac adjacent to Cesarean scar

Coronal 3D
Uterine contraction distorting endometrium and displacing gestational sac

IUP  
6 weeks 4 days

20 minutes later
Pregnancy and Müllerian duct Anomalies

Location of pregnancy? Interstitial versus intrauterine?

3D image shows intrauterine pregnancy in the left uterine horn of a subseptate uterus
Complete Septate Uterus
50% subchorionic hemorrhage
11 weeks 2 days
3D US of Urethra
Vaginal “Mass”

Axial and sagittal CT

Sagittal reformat

Axial reformat

Coronal reformat
Order 3D Ultrasound!

• CPT codes
  – 76376 (3D without post processing)
  – 76377 (post processing on independent workstation)
• -Infertility indication
• -Uterine anomaly
• -IUD
• -pregnancy / OB studies where the 3D coronal view is important in making the diagnosis (ie, interstitial ectopic pregnancy versus iup in lateral angle of uterus)
• -IUP in setting of two endometrial cavities/ uterine anomaly
Conclusion

- 3D volume ultrasound is cost effective, accurate and fast.
- Proper acquisition, orientation labeling and post-processing of 3D ultrasound of the female pelvis is important for diagnostic accuracy.
- A variety of gynecologic conditions (congenital uterine anomalies, endometrial abnormalities, submucosal fibroids, and adenomyosis) can be evaluated with 3D ultrasound and may obviate need for further imaging.
- Normal and ectopic pregnancy implantation can be accurately characterized with 3D ultrasound, particularly interstitial ectopic pregnancy.
- 3D ultrasound is useful in evaluation of pregnancy implantation in the presence of a uterine anomaly.
References