Three-dimensional ultrasound and its importance for the assessment of the uterus

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3-D US

- one of the latest developments in 3-D imaging
- a series of adjacent 2-D US tomograms covering a volume of interest

Computer processing:

- acquisition of 3-D data
- construction of 3-D data set
- projection of 3-D data set on 2-D plane and display
Acquisition of 3-D data

- untracked freehand system

- tracked freehand system (acoustic, mechanic, electromagnetic)

- mechanical assemblies

- automatic scanning
Construction of 3-D data set

2-D US tomograms → computer → volume matrix (3-D data set) = parallelepiped

- plane XY corresponds to tomograms
- Z line direction of scanning
LINEAR

2-D Image Storage → 3-D Motorized Scan → 3-D Reconstruction → 3-D Volume Image
Image display technique

1. Multiplanar image analysis
   - allows the acquisition of any arbitrary plane (even C plane)

* the ortogonale planes

* texture mapping
  - a polyhedron painted with tomograms on each face
Image display technique
2. Volume rendering
   - surface rendering
   - transparent mode reconstruction (X-ray mode)
     * maximum intensity projection images
     * minimum intensity projection images
   - colour mode reconstruction
     * frequency (CDI)
     * amplitude (CPA)
3. Surface rendering + multiplanar reformating
Limitations

- skilled and experienced investigator
- like 2-D US depends on physics:
  * optical barrier
  * non favourable scanning conditions
    oligoamnios
    obesity
    absence of tissue borderline
    movements
- size of volume scanning
- great capacity of digital storage
- time between image acquisition and image display
3-D US for the uterus

- frontal uterine plane

* congenital pathology

* acquired pathology: polyps
  leiomyomas
  endometrial carcinoma
  adhesions

- 3-D hysterosonography (contrast medium expands the cavity)

- volume measurements
3D - US
uterine congenital abnormalities

0,1 - 12 %
fertility and pregnancy failure

diagnosis: - external contour of the uterus
  * laparoscopy
  * laparotomy

- contour of the uterine cavity
  * hysteroscopy
  * hysterosalpingography
3D - US

uterine congenital abnormalities

Jurkovic et al. (1995) - 58 miscarriage / infertile women
Raga et al. (1996) - 42 infertile women
Ayida et al. (1996) - 10 patients for IVF
Wu et al. (1997) - 40 miscarriage / infertile women
Jurkovic et al. (1997) - 1046 low risk women

* 5.4%

* failure: - large calcified anterior leiomyoma
  - thin endometrium
  - IUD
  - previous endometrial resection
<table>
<thead>
<tr>
<th></th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Positive predictive value (%)</th>
<th>Negative predictive value (%)</th>
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<tbody>
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<td><strong>Normal uterus</strong></td>
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<td></td>
<td></td>
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<tr>
<td>2-D</td>
<td>88</td>
<td>94</td>
<td>97</td>
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<tr>
<td>3-D</td>
<td>98</td>
<td>100</td>
<td>100</td>
<td>94</td>
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<td><strong>Arcuate uterus</strong></td>
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<td>3-D</td>
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<td><strong>Major anomaly</strong></td>
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Normal uterus
Arcuate uterus + leiomyoma
Septate uterus
Bicornuate uterus
Unicornuate uterus
Leiomyomas
IUD

- 2-D US fails in 10-15% of cases
- Bonilla-Musoles et al. (1997) 184 cases
Extrauterine pregnancy

Rumpen et al (2000) - endometrial asymmetry

Infertility - endometrial receptivity

Raga et al. (2000) - endometrial volume > 3 ml
Schield et al. (2000) - subendometrial blood flow
Baba et al. (2000) - monitoring the site of ET

Postmenopausal bleeding

Gruboeck et al. (1996) - endometrial volume > 13 ml
Conclusions

- adequate knowledge of the advantages and limitations avoids misinterpretation

- improved assessment of congenital and acquired uterine pathology

- endometrial volume measurement offers new opportunities

- further clinical trials are necessary to conclude its value

- the equipment is still expensive and therefore available only in a few specialised centers