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

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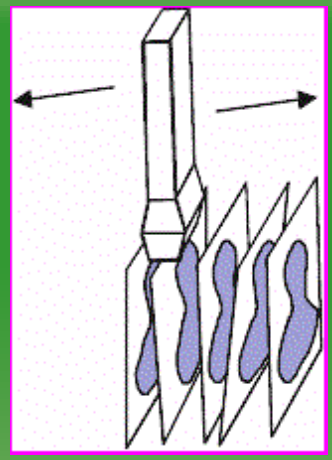
3-D US

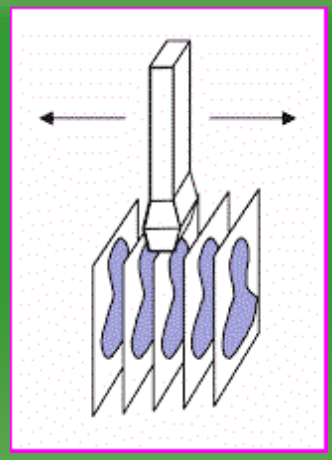
- one of the latest developments in 3-D imaging
- a series of adjacent 2-D US tomograms
  covering a volume of interest

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

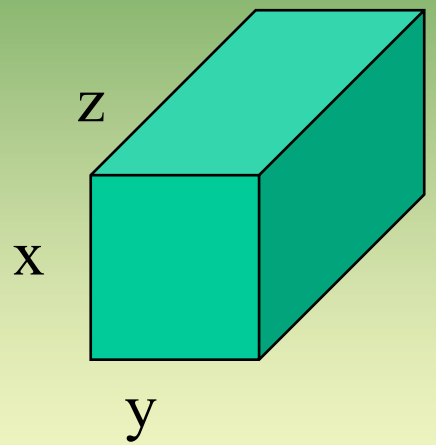
- tracked freehand system (acoustic, mechanic, electromagnetic)

- mechanical assemblies

- automatic scanning

Construction of 3-D data set

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



- plane XY coresponds to tomograms
- Z line direction of scanning

LINEAR

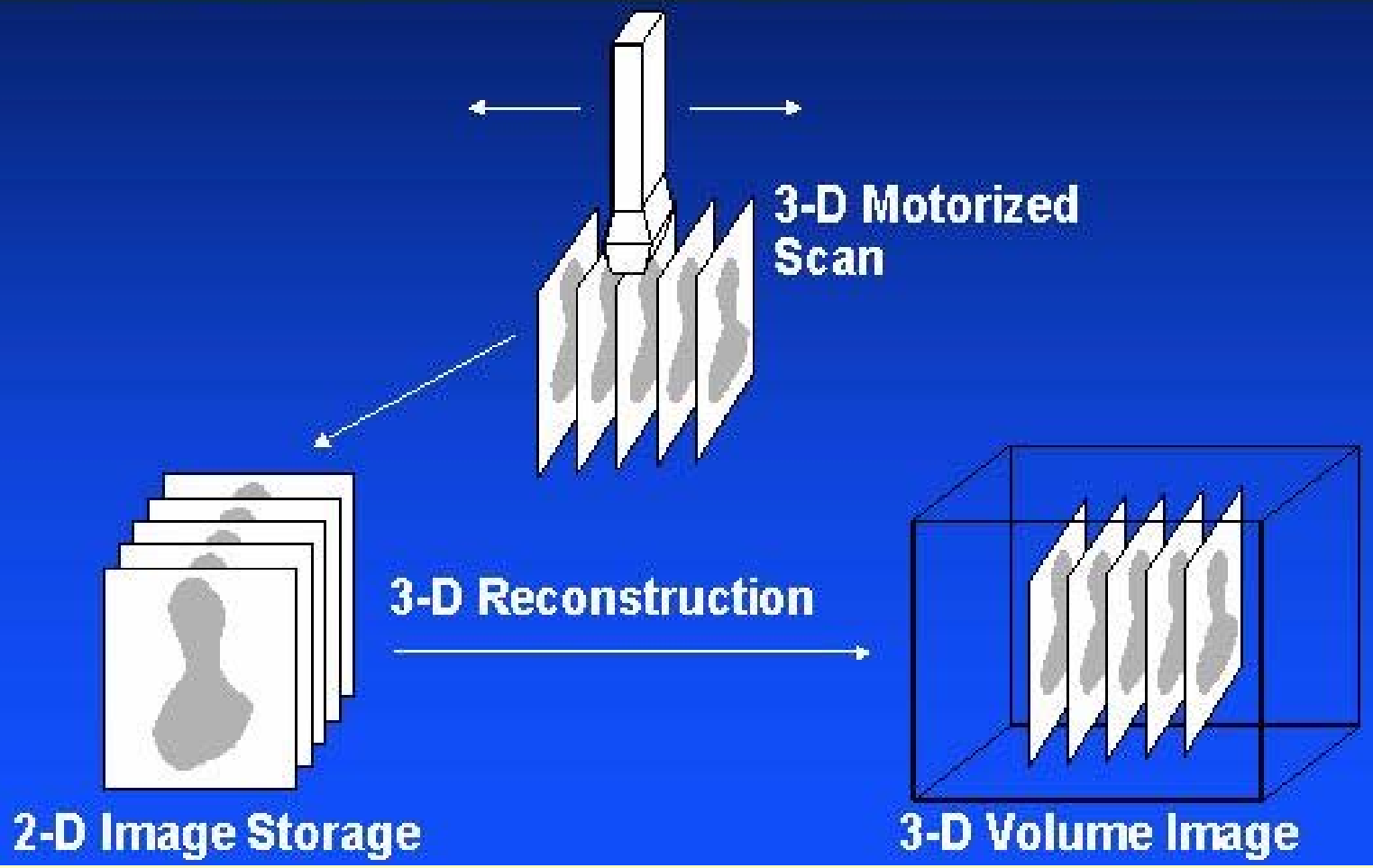
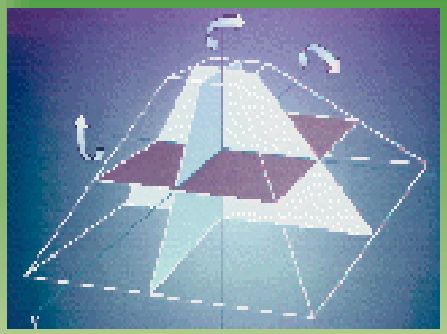
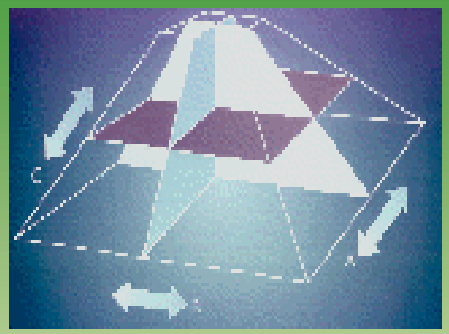

3-D Motorized
Scan
3-D Reconstruction
2-D Image Storage
3-D Volume Image

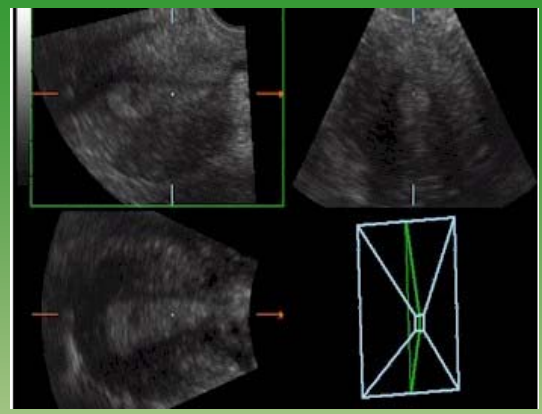
Image display technique

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

* the ortogonale planes







* texture mapping
  - a polihedron painted
  with tomograms on each face

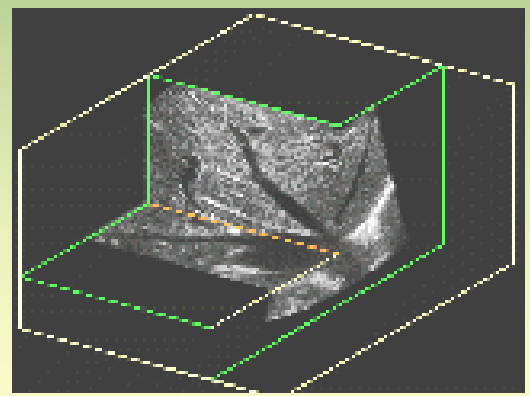
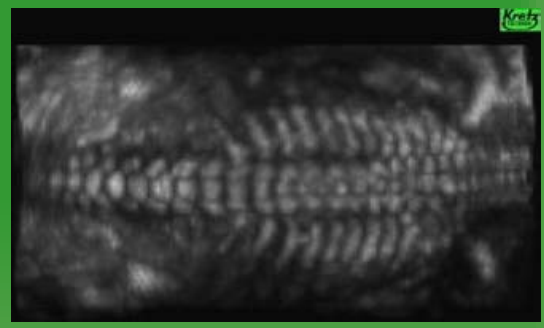


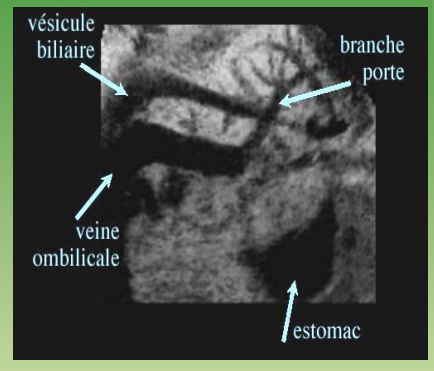
Image display technique

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

    * aquired patology: 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

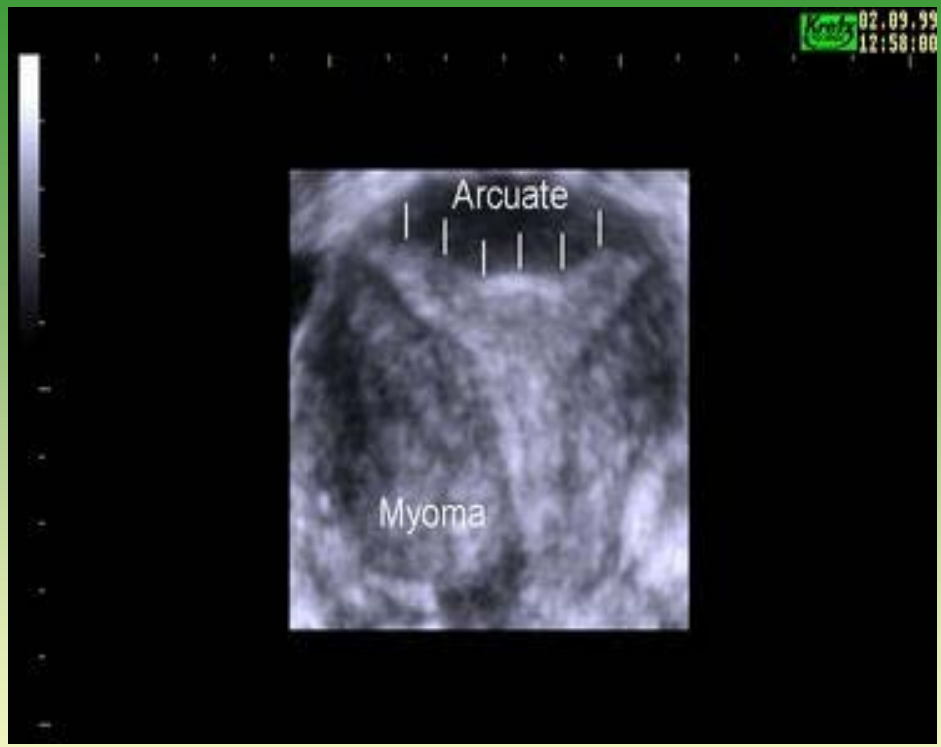
* 5,4 %
* failure: - large calcified anterior leiomyoma
  - thin endometrium
  - IUD
  - previous endometrial resection

Jurkovic et al. (1995)

	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)
Normal uterus				
2-D	88	94	97	75
3-D	98	100	100	94
Arcuate uterus				
2-D	67	94	55	88
3-D	100	100	100	100
Major anomaly				
2-D	100	95	50	100
3-D	100	100	100	100

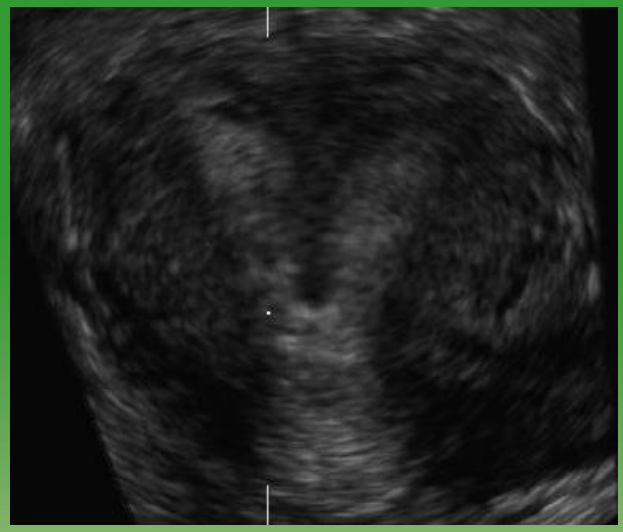
Normal uterus

Arcuate uterus + leiomyoma



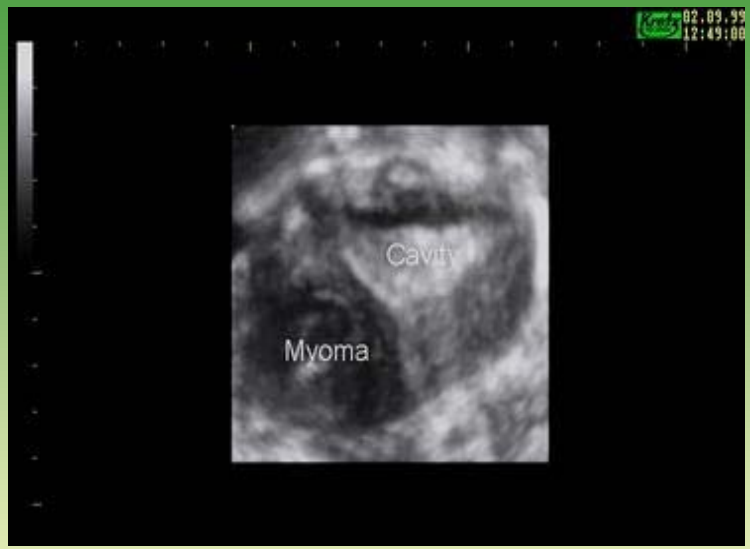
Septate uterus

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