MR Evaluation of Lung and Abdomen Volume Analysis

Erika Rubesova, MD

Lucile Packard Children's Hospital at Stanford

Why do we need to measure?

- To improve the diagnosis
- To improve parental counseling
- To plan postnatal management
- To predict outcome

LUNGS

When do we need to measure?

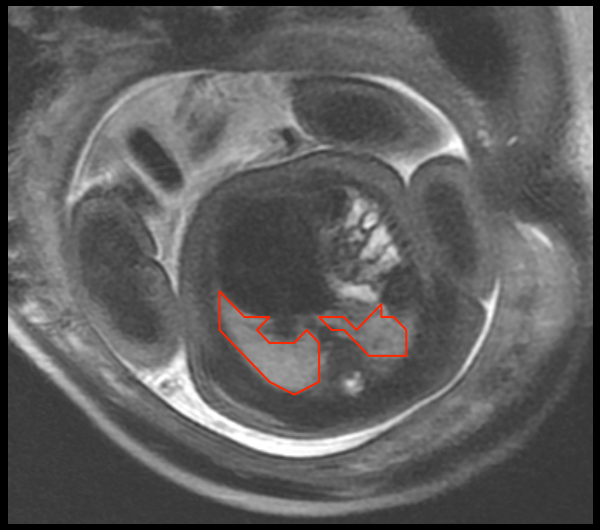
***Lung hypoplas*ia**

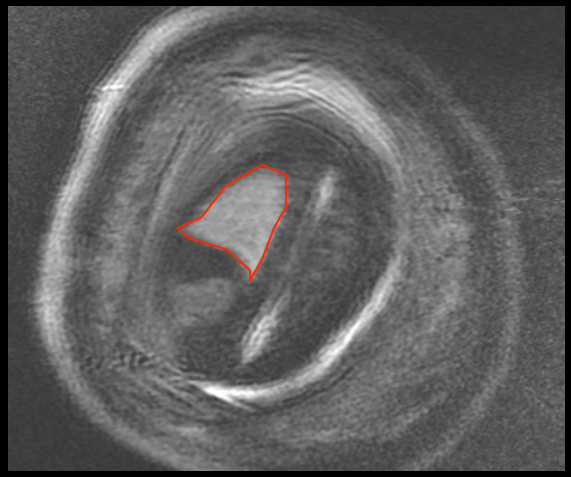
- Diaphragmatic hernia
- Chest masses
- Chest deformity in skeletal dysplasia, neuromuscular disorders
- Chest deformity in abdominal wall defects, oligohydramnios

How do we measure?

- Measuring lung area and multiplying by slice thickness to obtain the fetal lung volume

- Measured fetal lung volume is compared to normative values based on gestational age





32 weeks of GA

Other Approaches to Lung Volumes

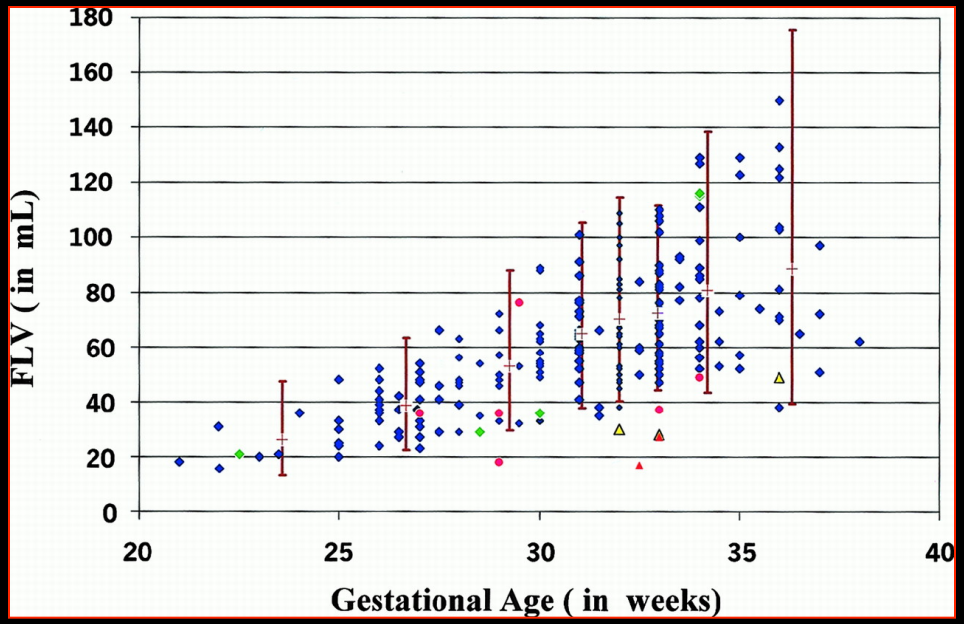
Measured lung volume to fetal biometry

Percent Predicted Lung Volume predicts lung volume as total measured thoracic volume minus measured mediastinal volume*

*Barnewolt et al Journal of Pediatric Surgery. (2007) 42: 193_197

Challenges

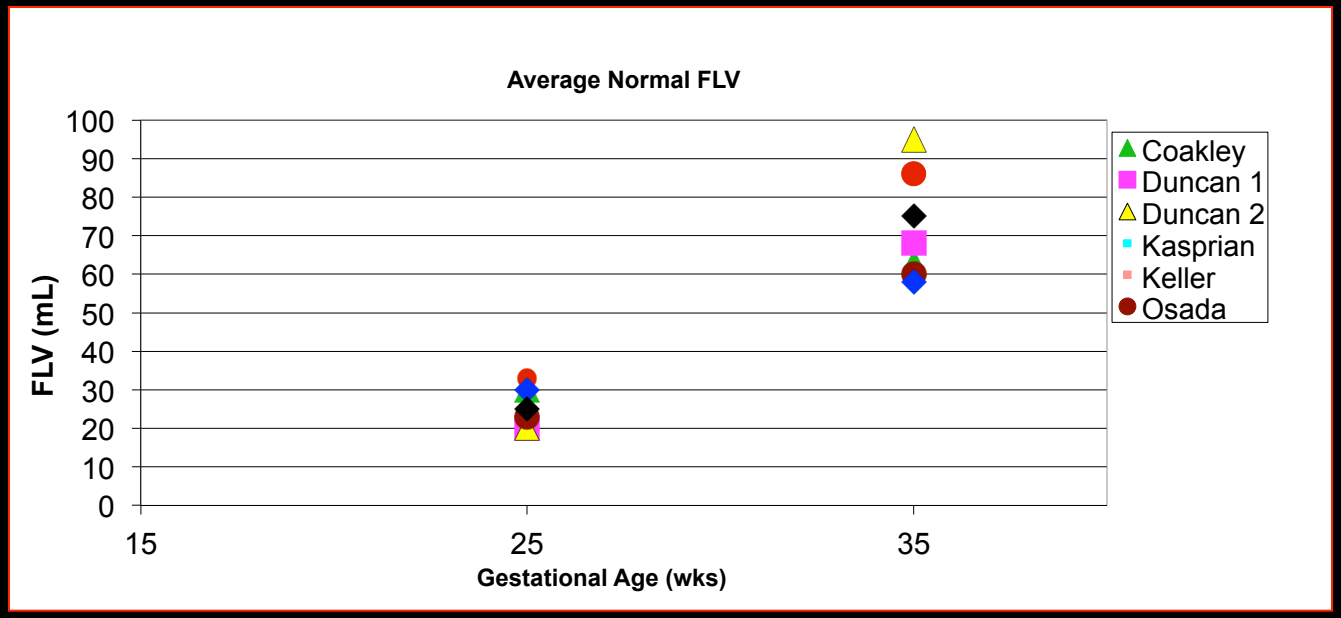
- Large range of values within the normal population
- Higher variability at high GA
- Overlap between normal and hypoplastic lungs



Rypens, F. et al. Radiology 2001;219:236-241

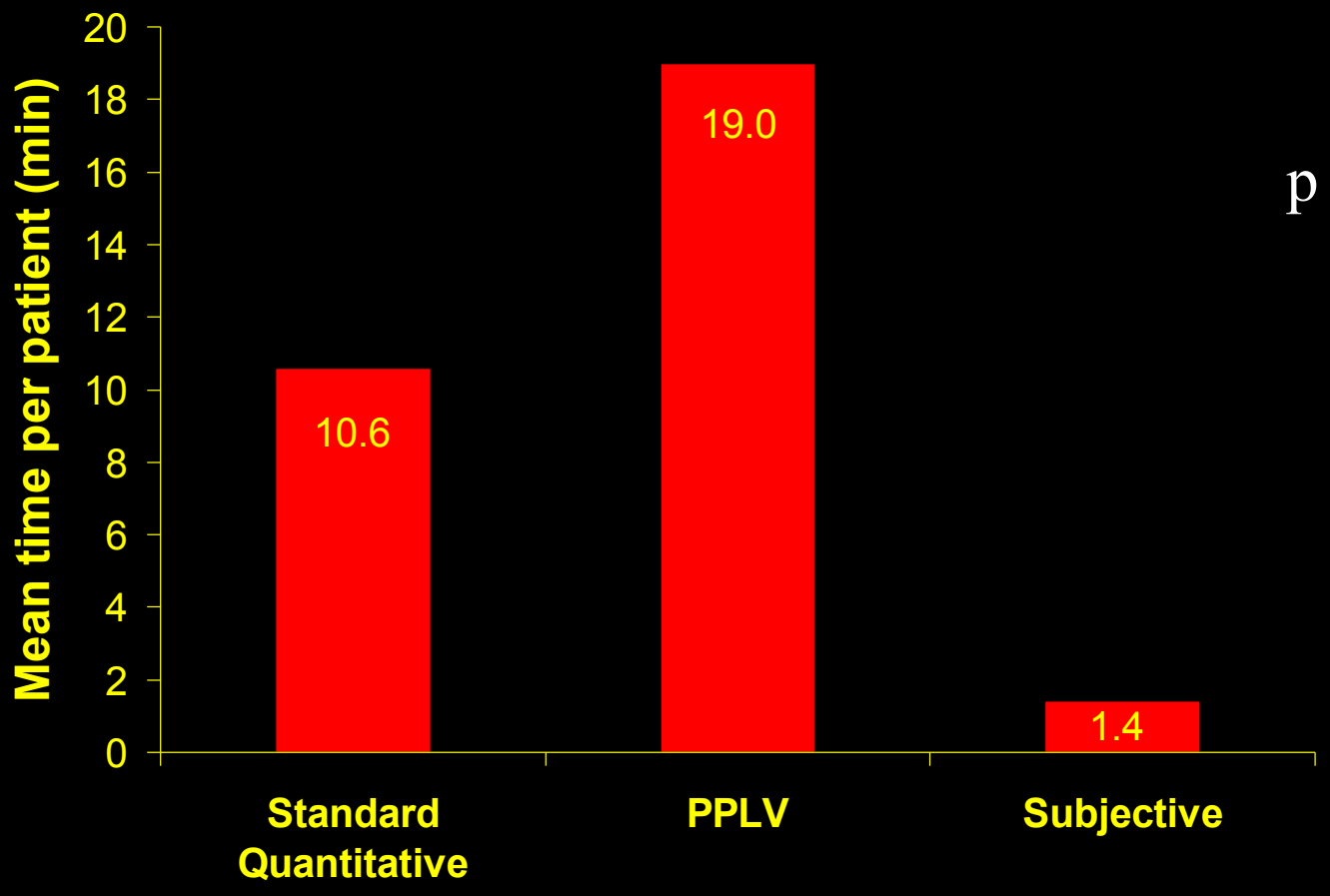
Variability of Lung Volumes

- Multiple studies with lung volumes related to GA or biometric measurements
- Variability in normal values between studies



Deshmukh et al AJR 2009

Time used for FLV measurement



$p < .0001$

Lung Volumes and Outcome

Diaphragmatic Hernia

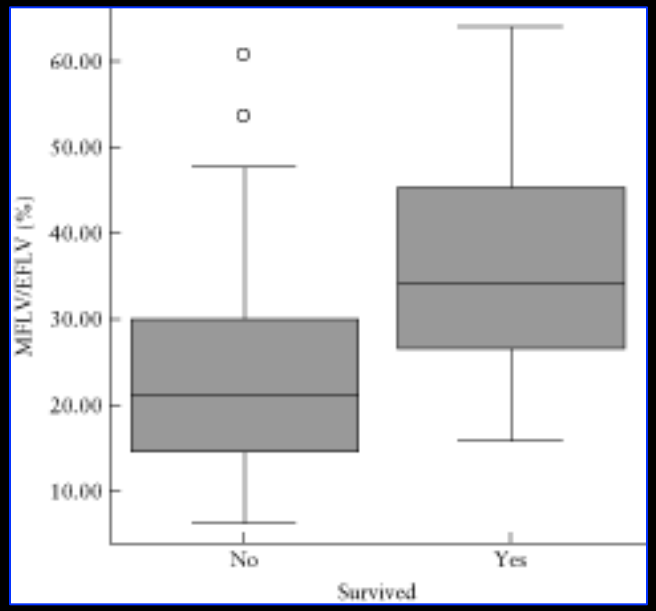
- Fetuses with observed / expected FLV:
  - ~ 40-25% have decreased survival
  - ~ 20% have need for ECMO
  - ~ 5% will develop chronic lung disease

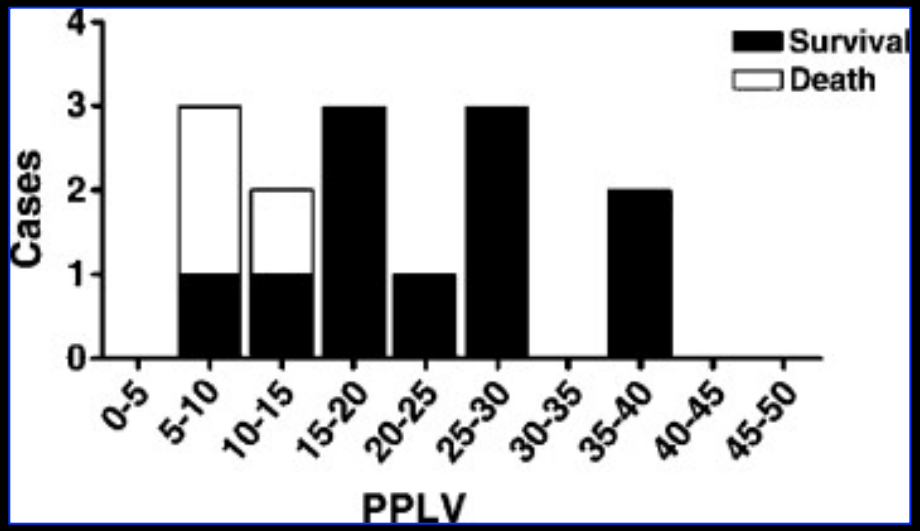
Giant Omphalocele

- Fetuses with FLV < 50% have higher postnatal morbidity

A. Debus et al. Radiology 2012 Dec 13
E. Danzer et al. Fetal Diagn and Therapy 2012(31) 248-353

Markers of Decreased Survival





MFLV/EFLV less than 25% [1]

PPLV less than 15 [2]

[1]Gorincour et al Ultrasound in Obstetrics & Gynecol 2005. (26) 738-44

[2]CE Barnewolt et al. Journal of Pediatric Surgery (42), 2007 193 - 197

Correlation with Outcome

Method	Kappa	Accuracy
Stnd Quantitative	0.48 $p<0.003$	54%
PPLV	0.58 $p<0.0001$	69%
Subjective	0.46 $p<0.0004$	69%

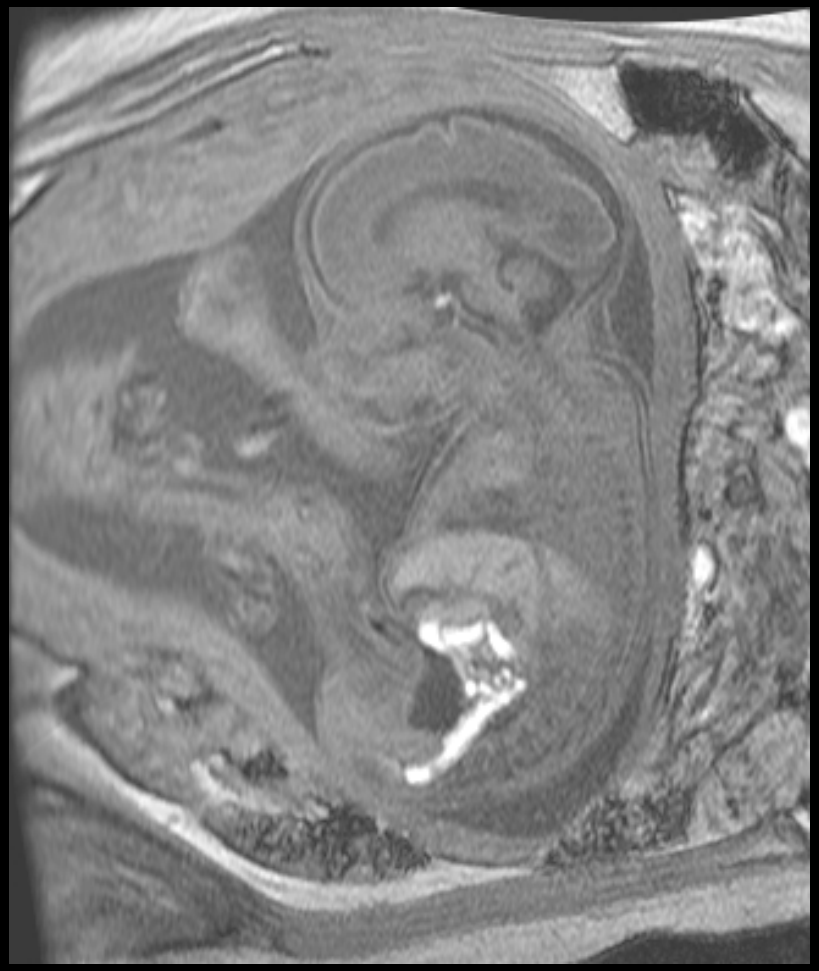
BOWEL

When do we need to measure?

- Evaluation of fetal gastro-intestinal anomalies:
  - Intestinal atresia
  - Colon atresia
  - Hypoplastic left colon
  - Microcolon
  - Imperforate anus…

The “Magic” of Meconium

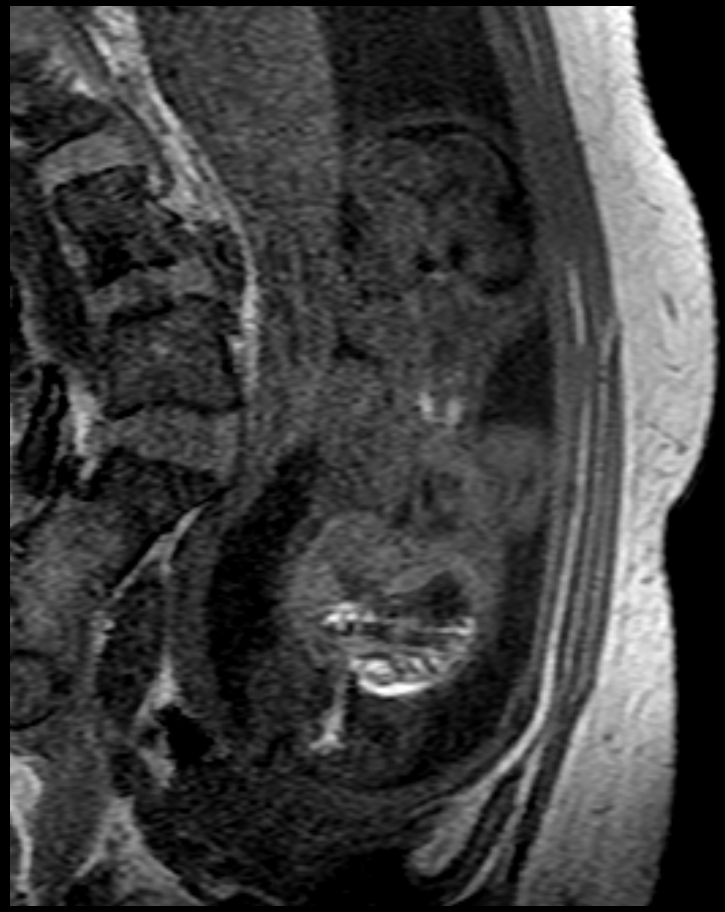
- Allows differentiation of small bowel and colon



- Meconium has a high T1 signal
- Retrograde accumulation from the rectum
- Seen up to 30 weeks in the small bowel but in small amount

Volume Selection in 2nd Trimester

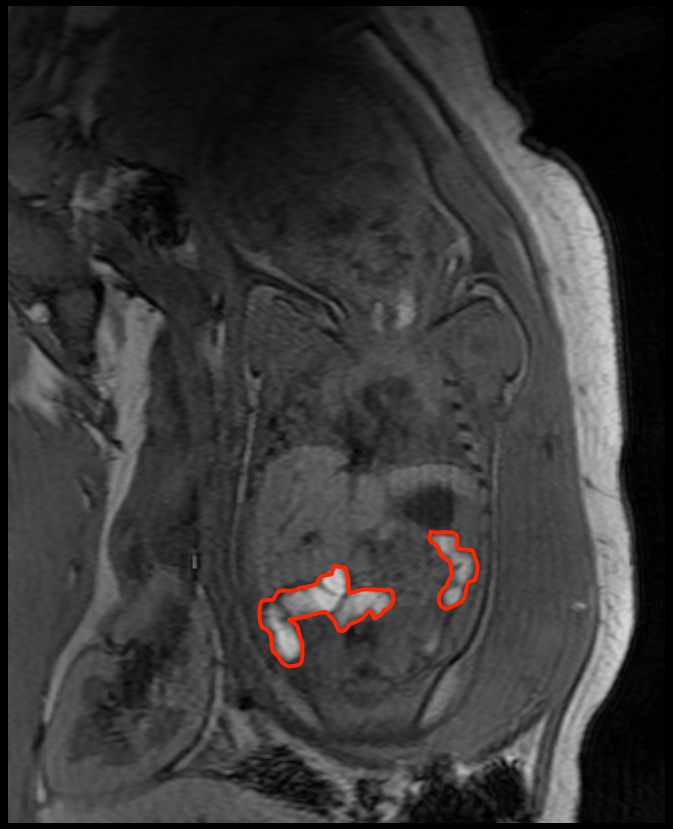
- Presence of hyper-signal in the small bowel during the 2nd trimester
- Limited visualization of the transverse and right colon



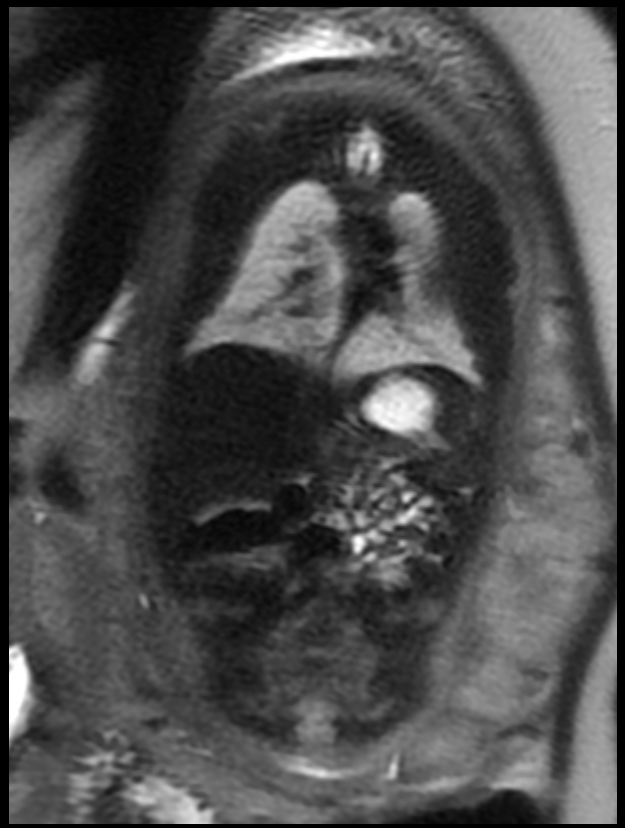
22 weeks

Volume Selection in 3rd Trimester

Good visualization of the transverse and right colon



T1 FGRE



T2 SSFSE

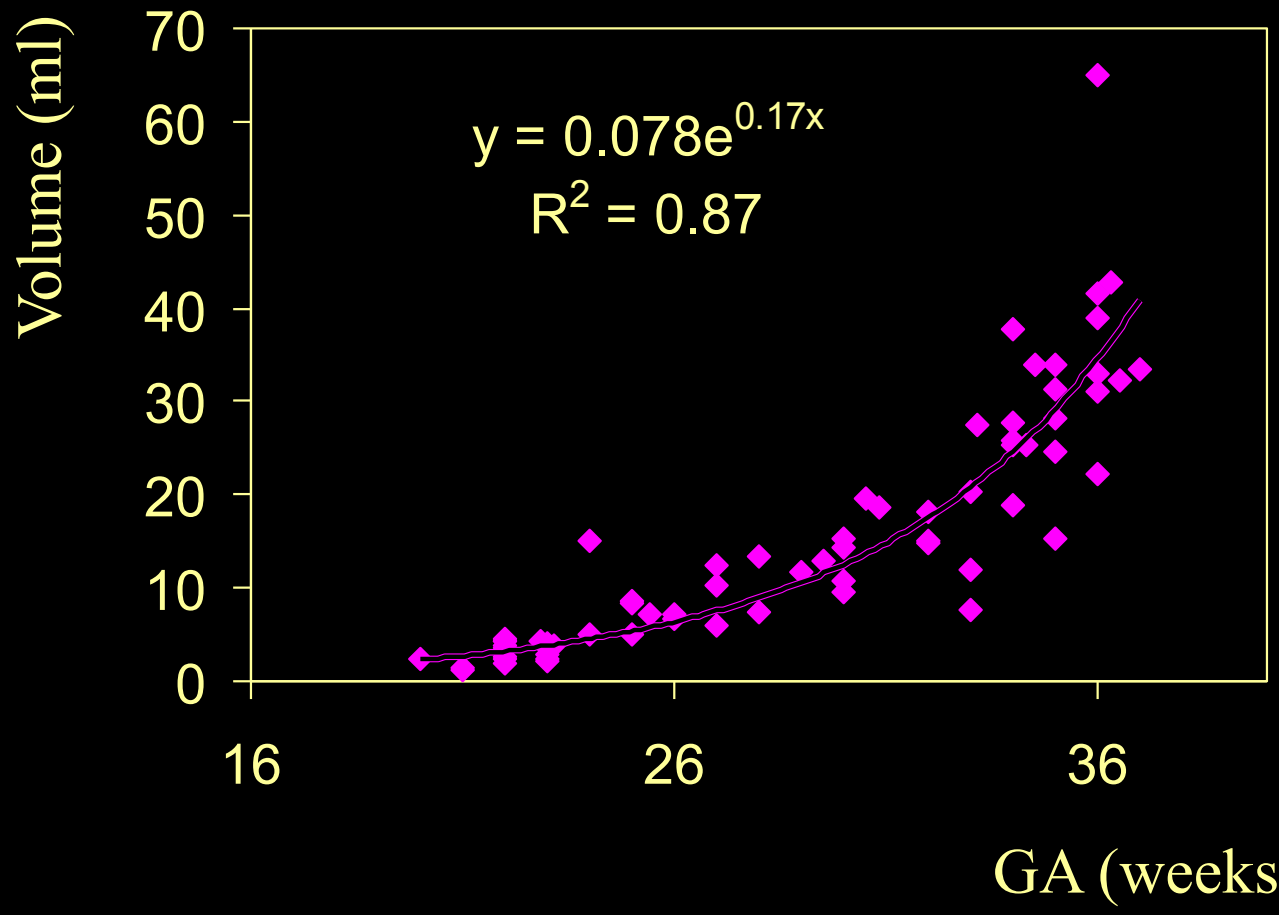
3D Visualization by GA

22 weeks – 4.2 ml

29 weeks – 12 ml

35 weeks – 28 ml

Fetal colon volume by GA



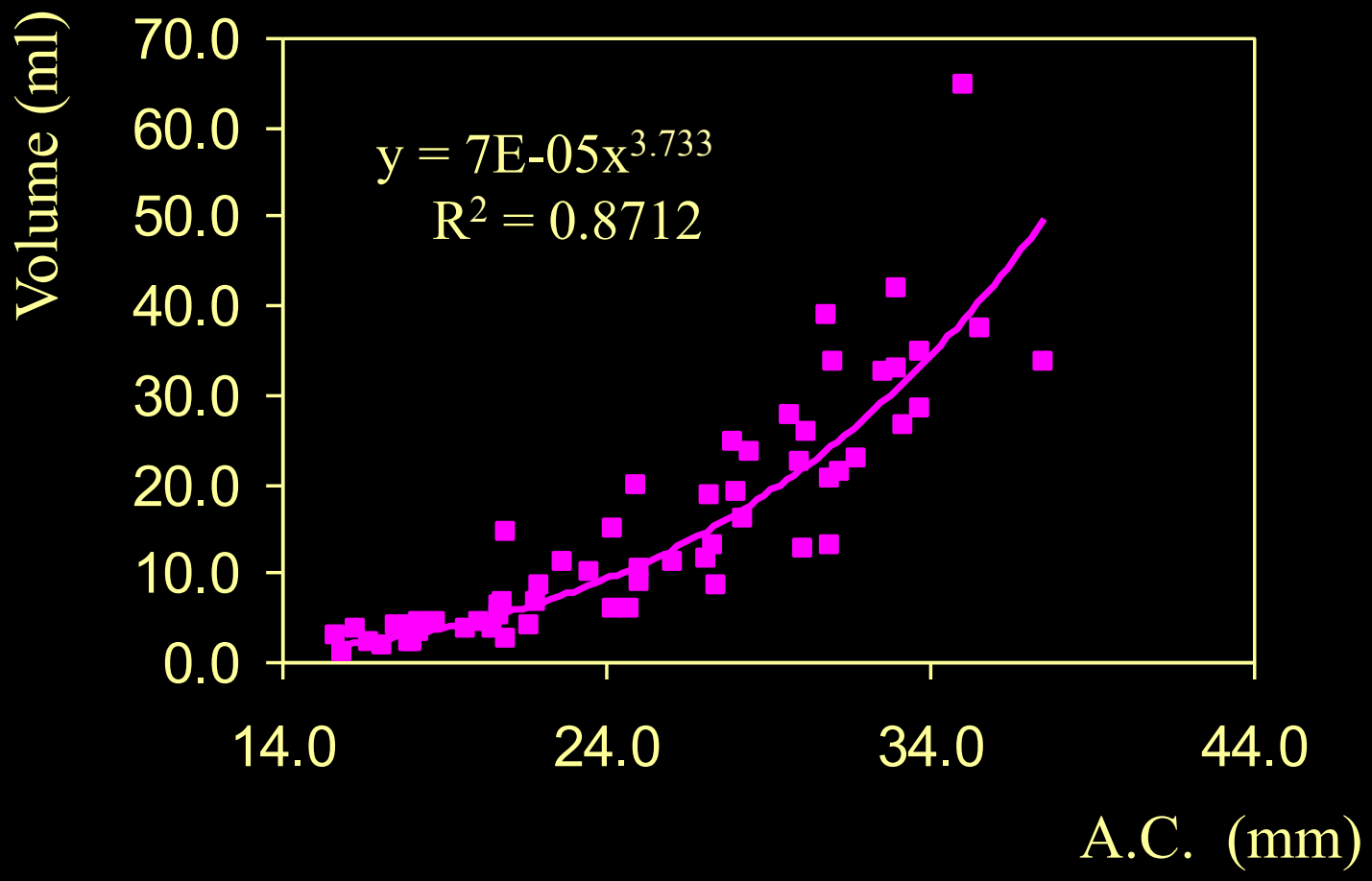
Colon Volume

min = 1.1 ml

max = 36 ml

(outlier = 65 ml)

Fetal colon volume vs. A.C.



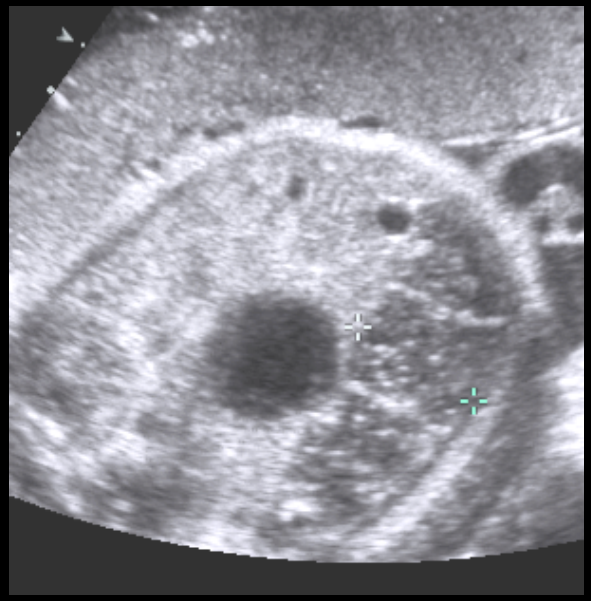
Volumetric Measure of Colon

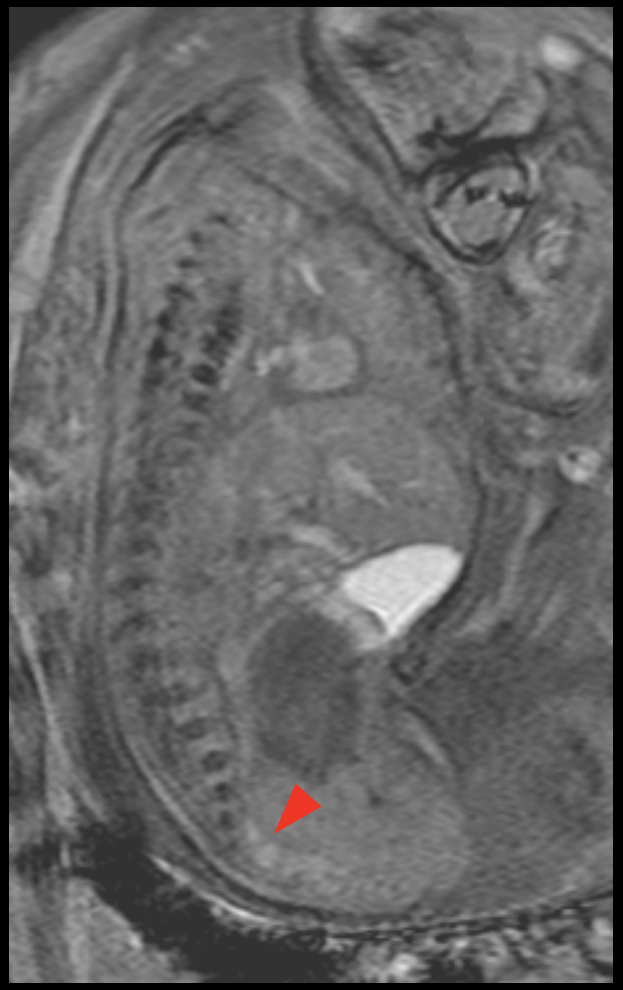
T1 FGRE

35 weeks – 28 ml

Colonic Atresia

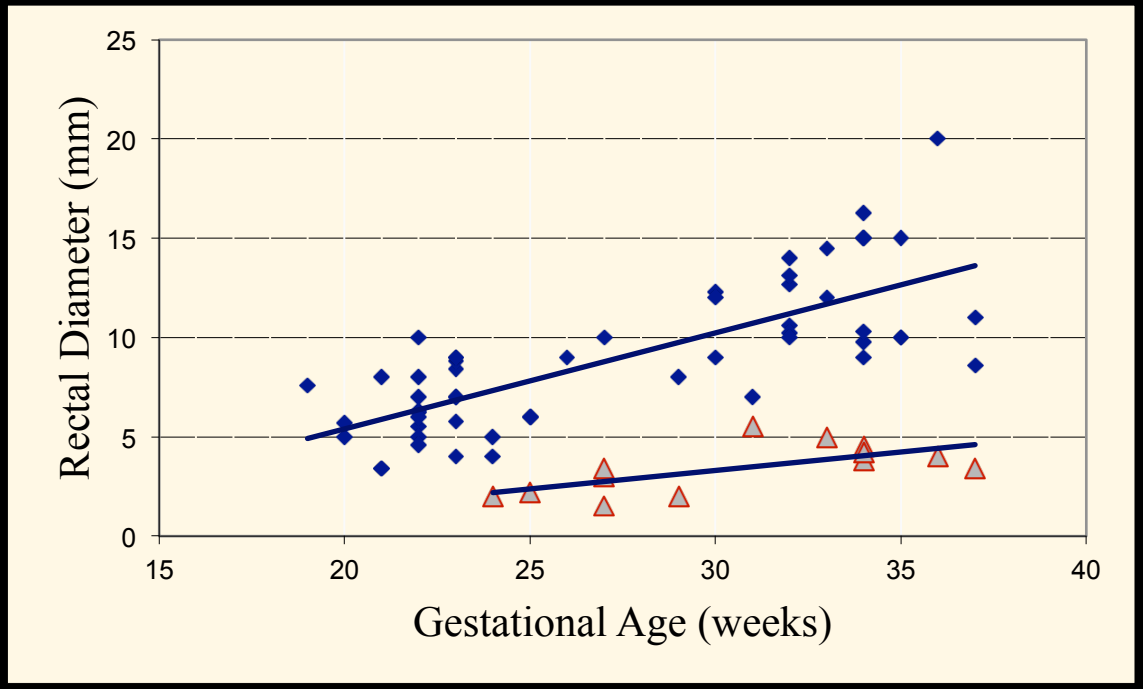
34 weeks



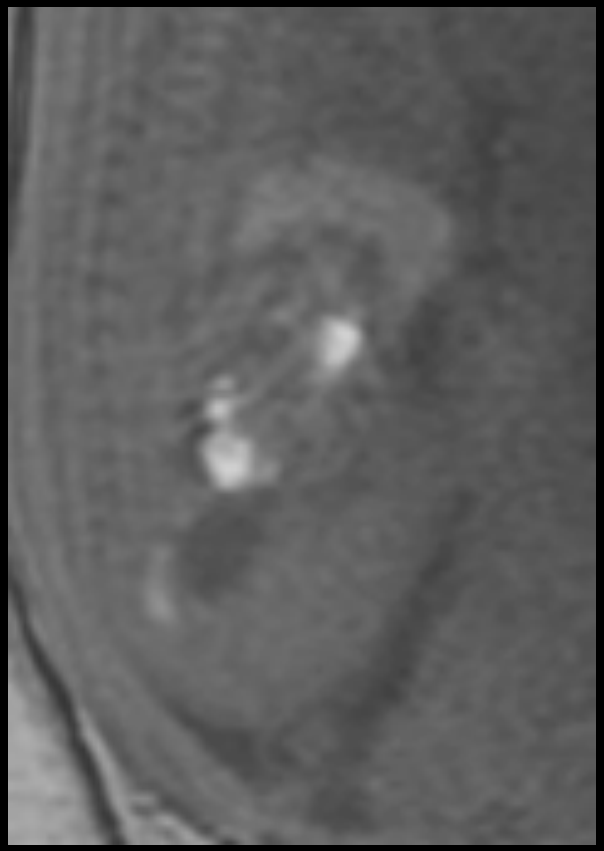


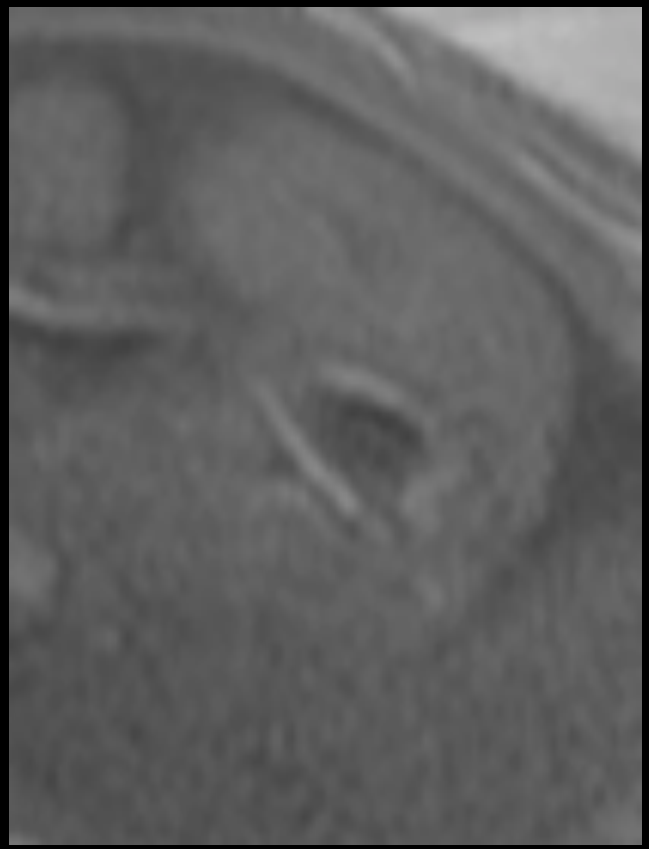
Diameter of the Fetal Rectum by GA

32 weeks GA – 12 mm



Challenges





24 weeks of GA

34 weeks of GA

Conclusions

- MRI volumetric measurements of the lungs and bowel are helpful to predict outcome and improve postnatal management and parental counseling

- Overlap exists between normal and abnormal measurements, especially at advanced gestational ages