MR Evaluation of Lung and Abdomen Volume Analysis

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I have no commercial disclosures
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 hypoplasia*

- 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*

Challenges

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

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

![Graph showing average normal FLV vs. gestational age]

Deshmukh et al. AJR 2009
Time used for FLV measurement

Mean time per patient (min)

- Standard Quantitative: 10.6
- PPLV: 19.0
- Subjective: 1.4

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% 
- PPLV less than 15

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
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 2\textsuperscript{nd} Trimester

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

22 weeks
Volume Selection in 3\textsuperscript{rd} 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

\[ y = 0.078e^{0.17x} \]

\[ R^2 = 0.87 \]

Colon Volume
\- min = 1.1 ml
\- max = 36 ml
\- (outlier = 65 ml)
Fetal colon volume vs. A.C.

$y = 7 \times 10^{-5}x^{3.733}$

$R^2 = 0.8712$
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.