Fetal MRI lung-to-muscle signal intensity ratio in congenital diaphragmatic hernia: Establishing a novel technique

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I have no disclosures.

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- HaiThuy Nguyen, MD
- Wei Zhang, Ph.D

Outline

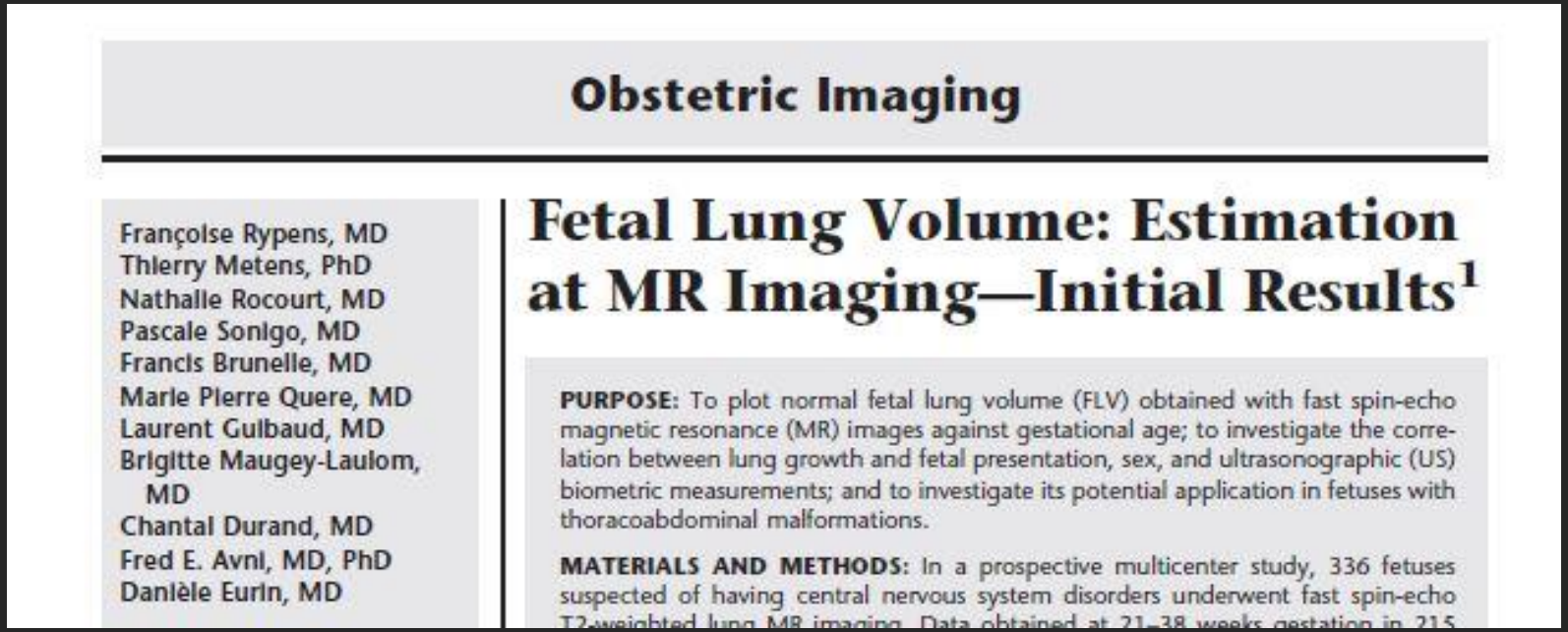
- Background
- Study aim
- Methods
- Results
- Conclusions
- Future directions

Background

- Congenital diaphragmatic hernia (CDH) affects 1 in 3,000 live births
- Neonatal mortality rate in CDH can approach 50%
- In isolated CDH pulmonary complications, including severe pulmonary hypoplasia, account for >30% of neonatal deaths

Balassy C, Kasprian G, Brugger PC et al. Eur Radiol 2010;20:829-837.

Background



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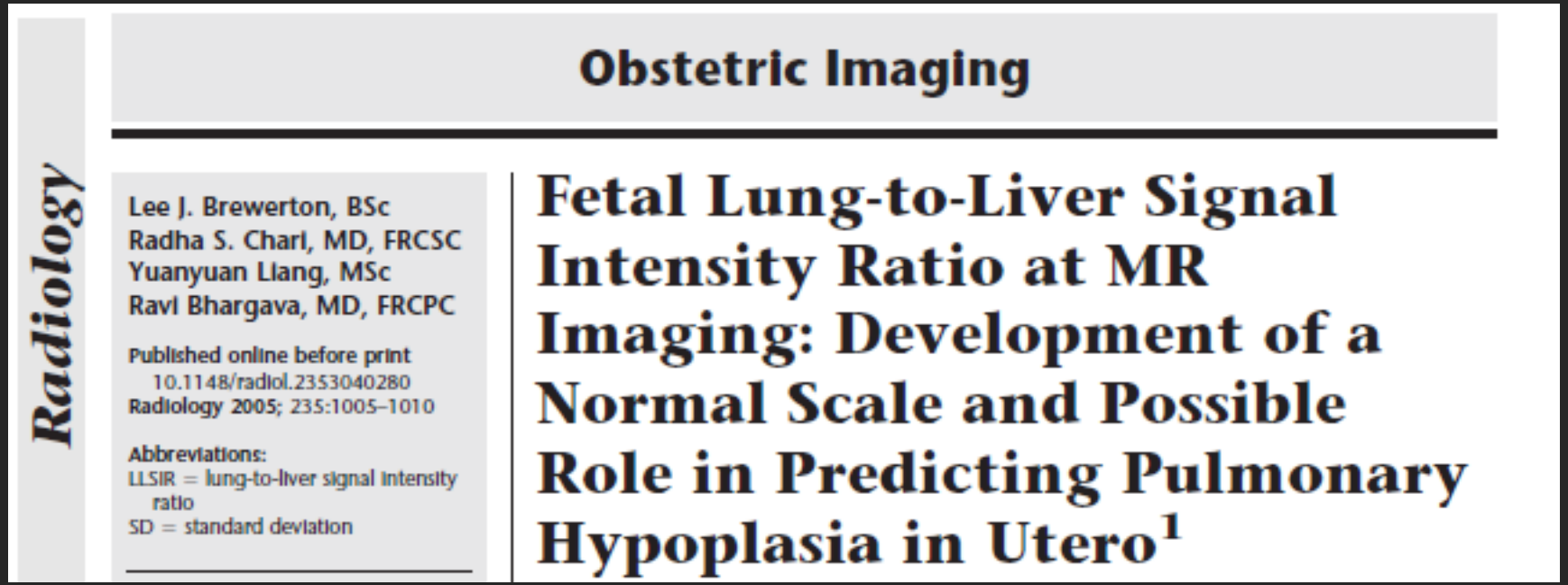
Fetal Lung Volume: Estimation at MR Imaging—Initial Results[1]

PURPOSE: To plot normal fetal lung volume (FLV) obtained with fast spin-echo magnetic resonance (MR) images against gestational age; to investigate the correlation between lung growth and fetal presentation, sex, and ultrasonographic (US) biometric measurements; and to investigate its potential application in fetuses with thoracoabdominal malformations.

MATERIALS AND METHODS: In a prospective multicenter study, 336 fetuses suspected of having central nervous system disorders underwent fast spin-echo T2-weighted lung MR imaging. Data obtained at 21–38 weeks gestation in 215

Background



Radiology

Obstetric Imaging

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Radiology 2005; 235:1005–1010

Abbreviations:
LLSIR = lung-to-liver signal intensity ratio
SD = standard deviation

Fetal Lung-to-Liver Signal Intensity Ratio at MR Imaging: Development of a Normal Scale and Possible Role in Predicting Pulmonary Hypoplasia in Utero[1]

Background

Eur Radiol (2010) 20: 829–837
DOI 10.1007/s00330-009-1633-x

PEDIATRIC

Csilla Balassy
Gregor Kasprian
Peter C. Brugger
Michael Weber
Bence Csapo
Christian Herold
Daniela Prayer

Assessment of lung development in isolated congenital diaphragmatic hernia using signal intensity ratios on fetal MR imaging

Background

Pediatr Surg Int (2018) 34:161–168
DOI 10.1007/s00383-017-4184-2

ORIGINAL ARTICLE

The fetal lung-to-liver signal intensity ratio on magnetic resonance imaging as a predictor of outcomes from isolated congenital diaphragmatic hernia

Masaya Yamoto[1] · Teruo Iwazaki[2] · Kasumi Takeuchi[2] · Kyouhei Sano[2] · Koji Fukumoto[1] · Toshiaki Takahashi[1] · Akiyoshi Nomura[1] · Kei Ooyama[1] · Akinori Sekioka[1] · Yutaka Yamada[1] · Naoto Urushihara[1]

Study Aim

- To establish a novel fetal lung signal intensity ratio, comparing T2 signal in the fetal lung to that of chest wall musculature.

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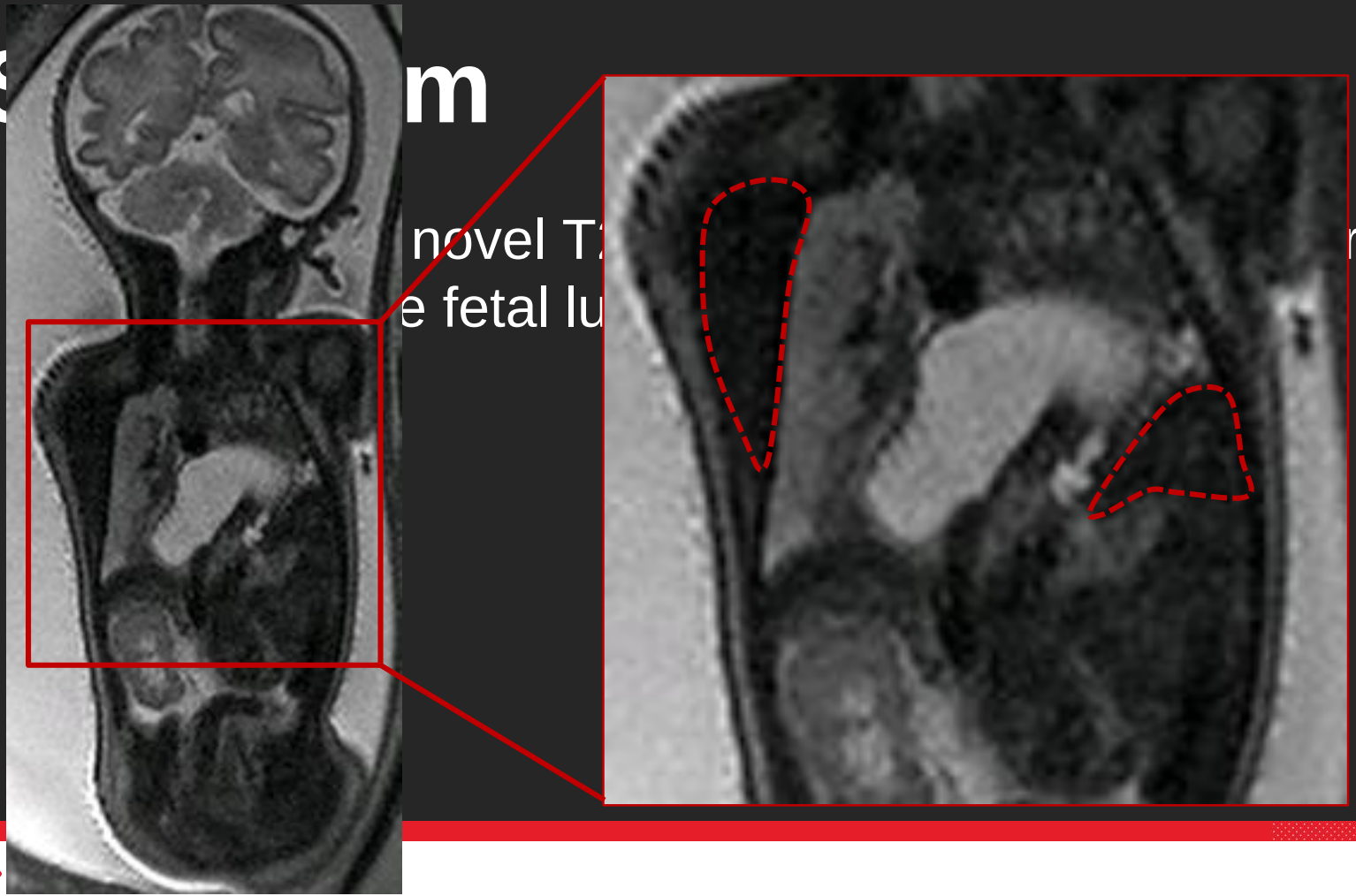

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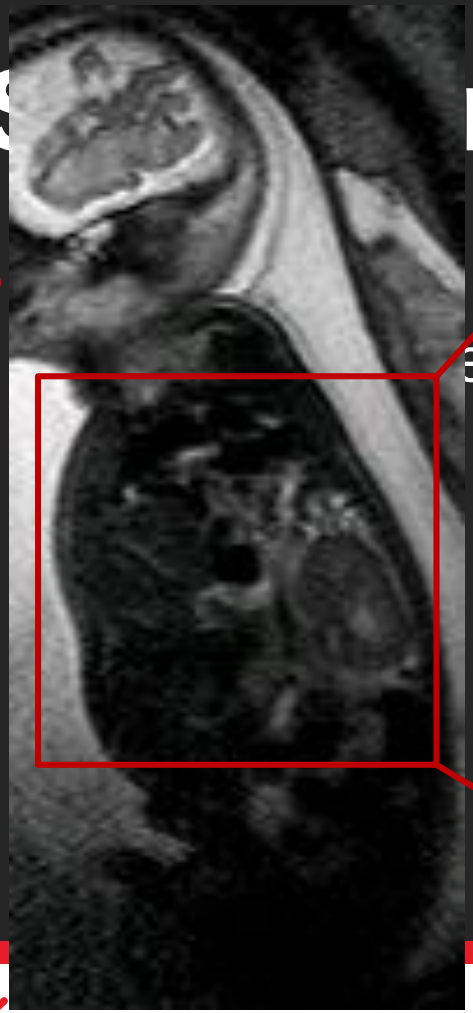

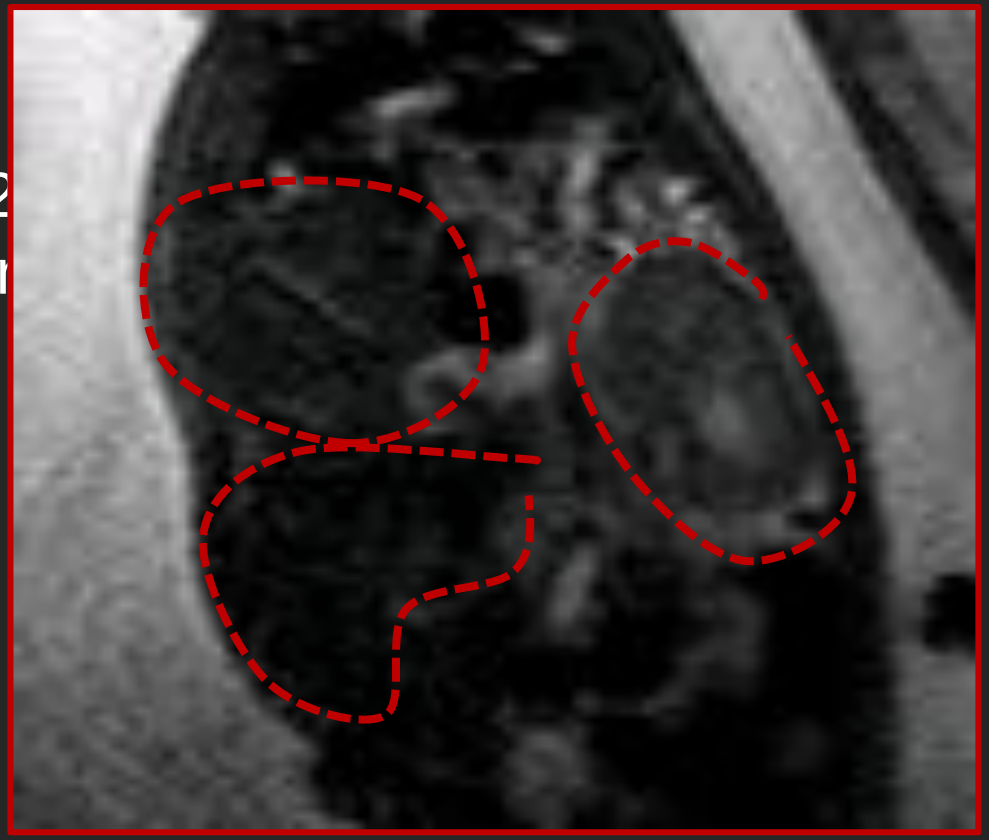

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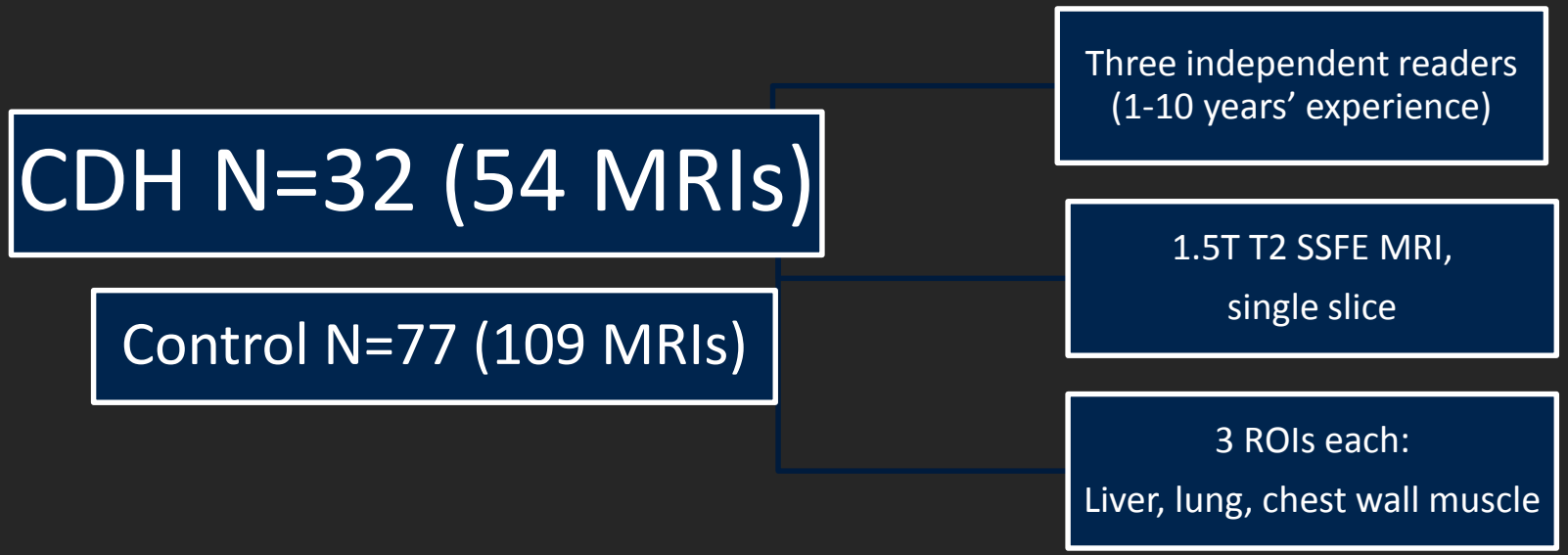
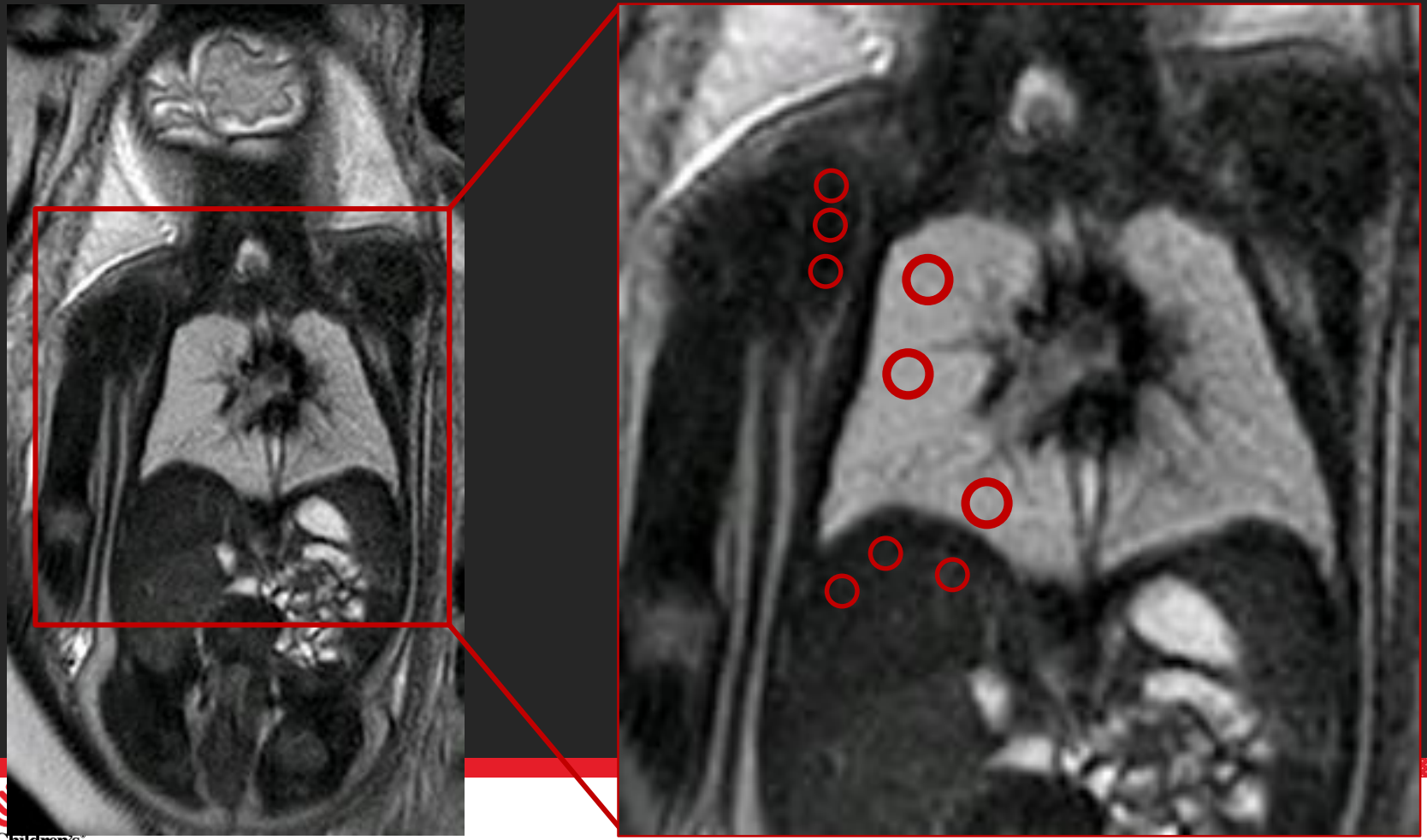
Methods


CDH N=32 (54 MRIs)
Control N=77 (109 MRIs)
Three independent readers
(1-10 years' experience)
1.5T T2 SSFE MRI,
single slice
3 ROIs each:
Liver, lung, chest wall muscle



Methods, pt 1

- Lung-to-muscle signal intensity ratio (LMSIR) and lung-to-liver signal intensity ratio (LLSIR) calculated for each reader individually.
- $LMSIR^{10.A} =$

$$\frac{[(LungROI^{10.A.1} + LungROI^{10.A.2} + LungROI^{10.A.3}) / 3]}{[(MuscleROI^{10.A.1} + MuscleROI^{10.A.2} + MuscleROI^{10.A.3}) / 3]}$$

Results, pt 1

- Inter-rater reliability was assessed via intraclass correlation (ICC).
- **ICC 0.59-0.86**

Methods, pt 2

- Adequate inter-rater reliability allowed further analysis with an average of the calculated LLSIR and LMSIR across readers
- $LMSIR\_AVG^{10} =$

$$[(LMSIR^{10.A} + LMSIR^{10.B} + LMSIR^{10.C}) / 3]$$

- Variation of LLSIR and LMSIR compared via Wilcoxon rank test

Results, pt 2

	Control			CDH			
Label	N	Mean ± SD	15/50/85 Percentile	N	Mean ± SD	15/50/85 Percentile	P
GA	109	25 ± 4.58	20.4/23.3/31.4	54	29.5 ± 5.22	22.6/31.8/34.8	<.0001
LLSIR_AVG	109	2.05 ± 0.48	1.67/1.91/2.48	54	2.37 ± 0.67	1.69/2.25/3.05	.0012
LMSIR_AVG	109	2.09 ± 0.66	1.57/1.82/2.83	54	2.68 ± 0.84	1.71/2.58/3.58	<.0001

Results

LLSIR	AVG		
Variable	Estimate	Standard Error	Pr > |t|
Rate of change wrt GA (control)	0.05	0.01	<.0001
CDH vs. Control	-0.65	0.44	0.1445
Rate of change wrt GA (CDH minus control)	0.03	0.02	0.1096

LMSIR	AVG		
Variable	Estimate	Standard Error	Pr > |t|
Rate of change wrt GA (control)	0.12	0.009	<.0001
CDH vs. Control	0.12	0.43	0.7759
Rate of change wrt GA (CDH minus control)	-0.002	0.02	0.8907

Conclusions

- LMSIR is a reproducible measurement
- LMSIR increases with gestational age both in isolated left-sided CDH and in controls
- LMSIR is non-inferior to the existing LLSIR

Future Direction

- Is LMSIR valuable as a predictor of postnatal pulmonary function?

Future Direction

	ECMO (n=17)	No ECMO (n=14)	p-value
Average LLSIR (1) (n=31)	2.08 ± 0.5 (n=17)	2.23 ± 0.7 (n=17)	0.472
Average LMSIR (1) (n=31)	2.11 ± 0.6 (n=17)	2.59 ± 0.9 (n=17)	**0.076**
Average LLSIR (2) (n=21)	2.69 ± 0.6 (n=14)	2.41 ± 0.4 (n=7)	0.328
Average LMSIR (2) (n=21)	3.01 ± 0.8 (n=14)	3.32 ± 0.5 (n=7)	0.358
Delta LLSIR (median, IQR) (n=21)	0.06 [0.03, 0.11] (n=14)	0.05 [0.08, 0.1] (n=7)	0.709
Delta LMSIR (median, IQR) (n=21)	0.11 [0.03, 0.15] (n=14)	0.14 [0.11, 0.16] (n=7)	0.412

Future Direction

	Supplemental O2 @ 30 days (n=17)	NO Supplemental O2 @ 30 days (n=9)	p-value
Average LLSIR (1) (n=27)	2.02 ± 0.5 (n-17)	2.36 ± 0.76 (n=9)	0.18
Average LMSIR (1) (n=27)	2.13 ± 0.55 (n=17)	2.69 ± 0.97 (n=9)	**0.07**
Average LLSIR (2) (n=17)	2.41 ± 0.42 (n=13)	2.56 ± 0.43 (n=4)	0.55
Average LMSIR (2) (n=17)	2.92 ± 0.61 (n=13)	3.27 ± 0.44 (n=4)	0.304
Delta LLSIR (n=17)	0.05 [0.03, 0.097] (n=13)	0.05 [-0.01, 0.97] (n=4)	0.284
Delta LMSIR (n=17)	0.11 [0.03, 0.17] (n=13)	0.13 [0.02, 0.15] (n=4)	0.874

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Thank you!

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