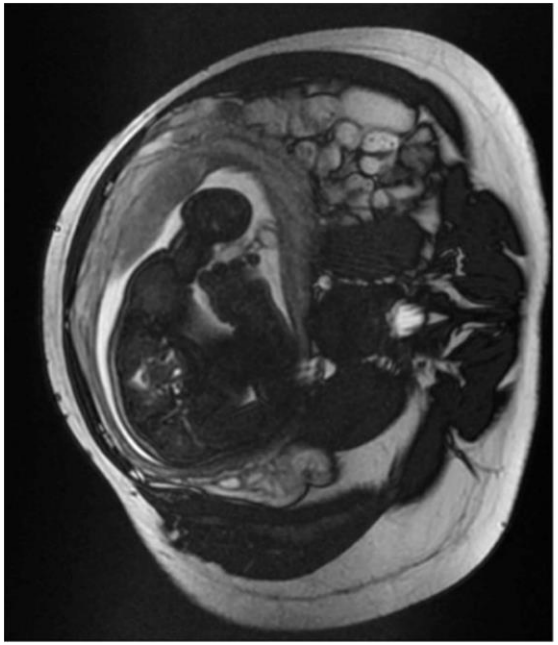
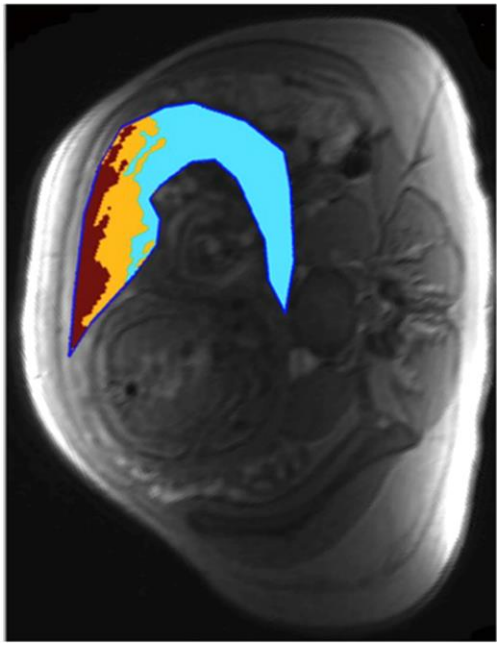




Fetal Oksijenasyon ve MRI

KOÇ ÜNİVERSİTESİ

TABLE 2

Results of human placental functional magnetic resonance imaging studies

Magnetic resonance imaging technique	Normal pregnancy	Intrauterine growth restriction	Preeclampsia
Dynamic contrast-enhanced (DCE)	N/A	N/A	N/A
Arterial spin labeling (ASL)	F = 176 ± 91 mL × min^{-1}100 g^{-1}[136]		
	Presence of low perfusion regions of the placenta[38]	Increased number of low perfusion regions[38]	
	Perfusion = 923 arbitrary units[77]	Perfusion = 2359 arbitrary units[77]	
Blood oxygen level–dependent (BOLD)	Increased signal intensity in the chorionic plate of the placenta during maternal oxygenation[31]		
	Decrease in R2 across gestational age[42]		
	R2 = 149 $msec^{-1}$ at 24-29 wk gestation[43]	R2 = 88 $msec^{-1}$[43]	
Diffusion weighted imaging (DWI)	Apparent diffusion coefficient (ADC) = 1.77 ± 0.19 10^{-3} mm^2 × s^{-1}[133]	Decreased ADC	
		ADC = 1.46 ± 0.1 10^{-3} $mm^2.s^{-1}$[133]	
Intravoxel incoherent motion (IVIM)			
Perfusion fraction f	Estimated 26 ± 6%[34] to 35.1%[77]	Decreased in total placenta 24-28%[77]	Decreased in early preeclampsia 26%[45]
	Decreases 0.6% per week of gestation[34]	Decreased in basal plate 37.8%[77]	Increased in late preeclampsia 35%[45]
	Early pregnancy: 36%[45]	Higher in the chorionic plate than in the basal plate[34]	Decreased in the basal plate: 27 ± 5%[101]
	Late pregnancy: 28%[45]		
	In the basal plate: 36 ± 5%[101] to 40.7%[77]		
	Higher in the basal plate than in the chorionic plate[34]		
Pseudo diffusion coefficient	D* = 57 ± 41 10^{-3} mm^2 × s^{-1}[34]		
Diffusion coefficient	D = 1.7 ± 0.5$10^{-3}$ mm^2 × s^{-1}[34]		
Magnetic resonance spectroscopy	Phosphodiesters (PDE) = 28%[103]		Early preeclampsia[103]
	Phosphomonoesters (PME) = 13%[103] and 24%[105]		PDE = 32.9%
	PDE/PME = 1.1[103]		PDE/PME = 1.4

N/A, not applicable.

Siauve. Functional MRI (fMRI) of the human placenta. Am J Obstet Gynecol 2015.

Fetal oksijenasyon ve MRI

TABLE 3

Advantages and pitfalls of functional magnetic resonance imaging techniques

Magnetic resonance imaging technique	Advantages	Pitfalls
Dynamic contrast–enhanced (DCE)	Quantify placental perfusion ± permeability	Computationally demanding quantitative methods
	Reliable and reproducible estimation	Uses contrast agent that may pass into the fetus
	Gold standard to study organ perfusion	
Arterial spin labeling (ASL)	Quantify placental perfusion	Low signal-to-noise ratio (SNR)
	Endogenous contrast agent	Motion and transit artifacts
Blood oxygen level–dependent (BOLD)	Endogenous contrast agent	Does not measure physiological parameters but rather tissue oxygenation
		Multiple confounding factors
Diffusion weighted imaging (DWI) intravoxel incoherent motion (IVIM)	No contrast agent	Exact nature of what is measured with placental MIM remains controversial
	No specific experimental protocol	
	Easy to implement	
Magnetic resonance spectroscopy	No contrast agent	Long acquisition time
	Multiple types of metabolic data	Limited spatial and temporal resolution
		Sensitivity to motion artifacts

Siauve. Functional MRI (fMRI) of the human placenta. Am J Obstet Gynecol 2015.

Fetal oksijenasyon ve MRI

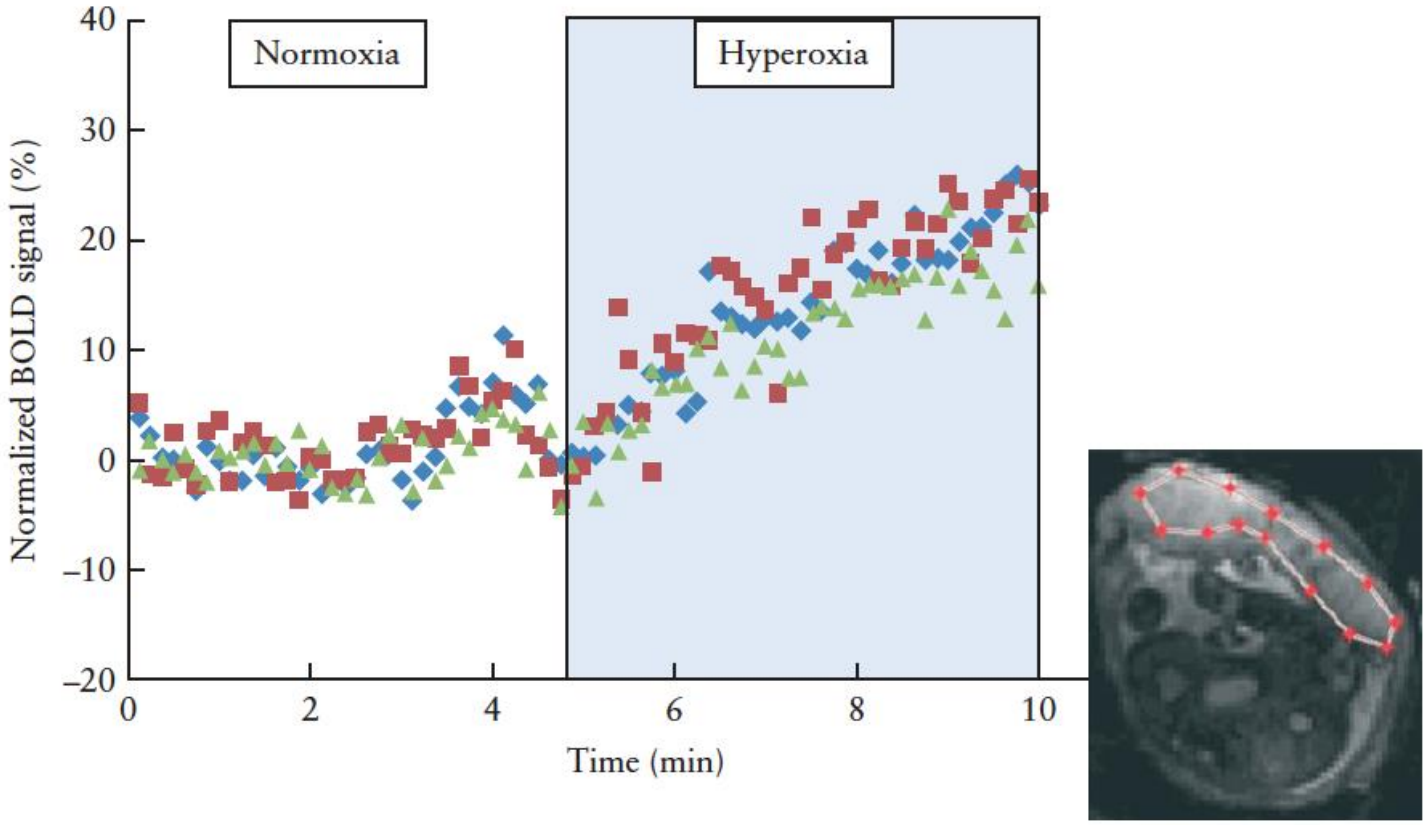
- MRI:
  - ‘**B**lood **O**xygen **L**evel **D**ependent (BOLD)’ MR
    - Serebral metabolik oranın quantative değerlendirilmesi
  - **‘Oksijen enhanced’** MR
    - Venöz oksijen seviyesinin ölçülmesi

Fetal oksijenasyon ve MRI

- **BOLD**: Kandaki oksijen seviyesine bağlı sinyal değişiklikleridir (deoksihemoglobinin paramagnetik kontrast tutulumu
- **SWI**
  - rezolüsyonu daha yüksek teknik
  - Venleri arterden daha iyi ayırt etmektedir
  - Venöz oksijen seviyesini gösterir

Changes in human placental oxygenation during maternal hyperoxia estimated by blood oxygen level-dependent magnetic resonance imaging (BOLD MRI)

A. SØRENSEN*, D. PETERS†, E. FRÜND*, G. LINGMAN‡, O. CHRISTIANSEN* and N. ULDBJERG§



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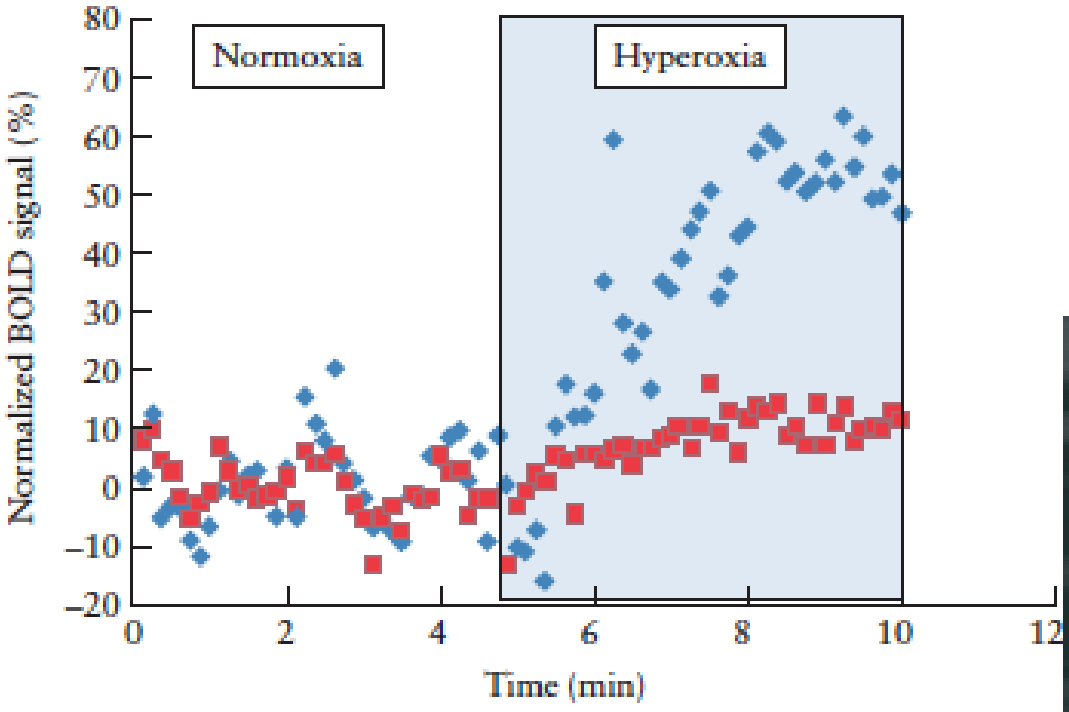
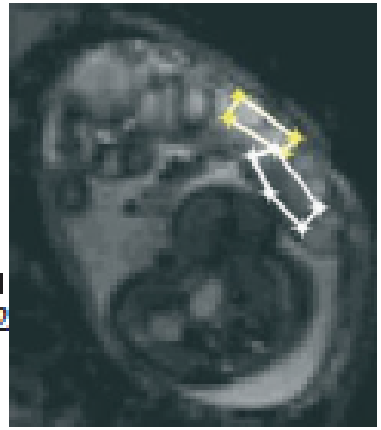
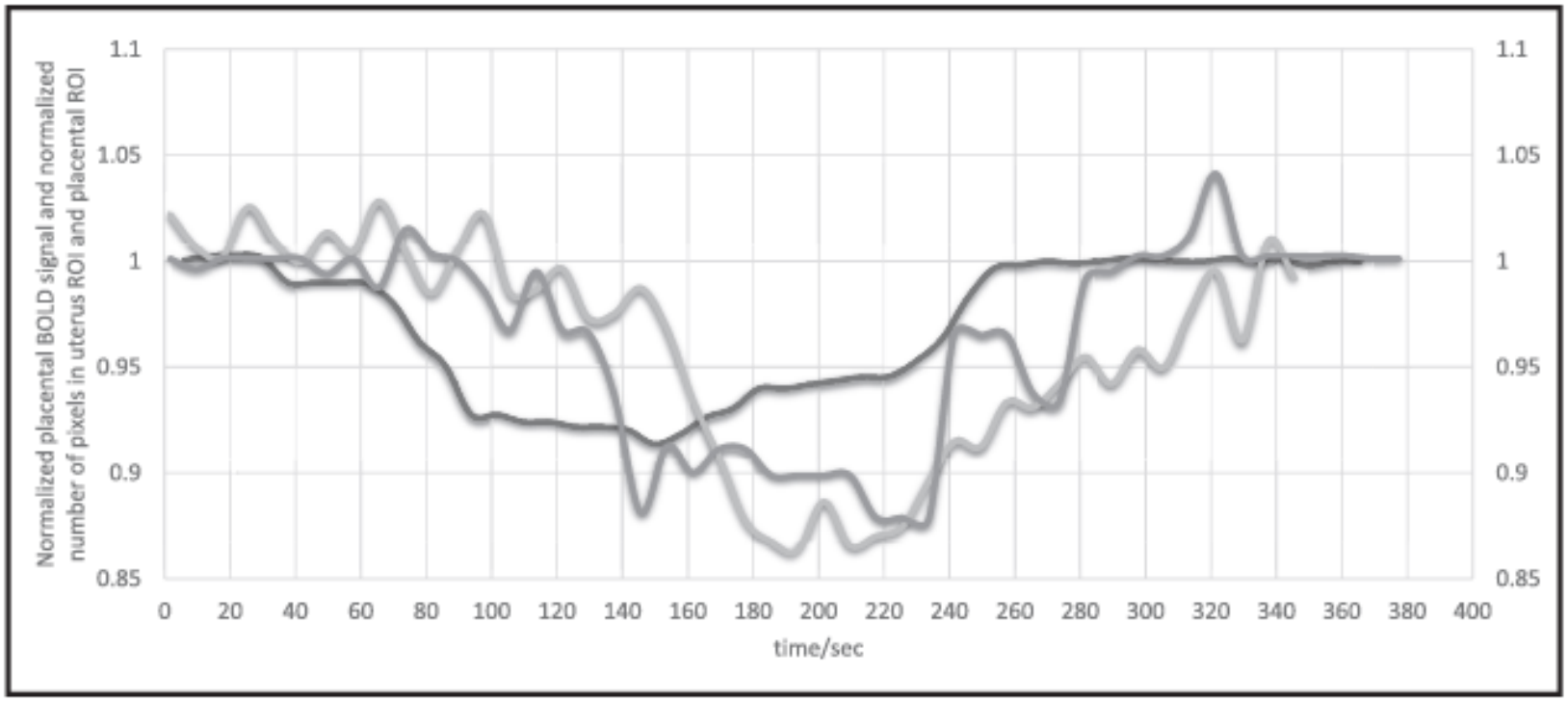


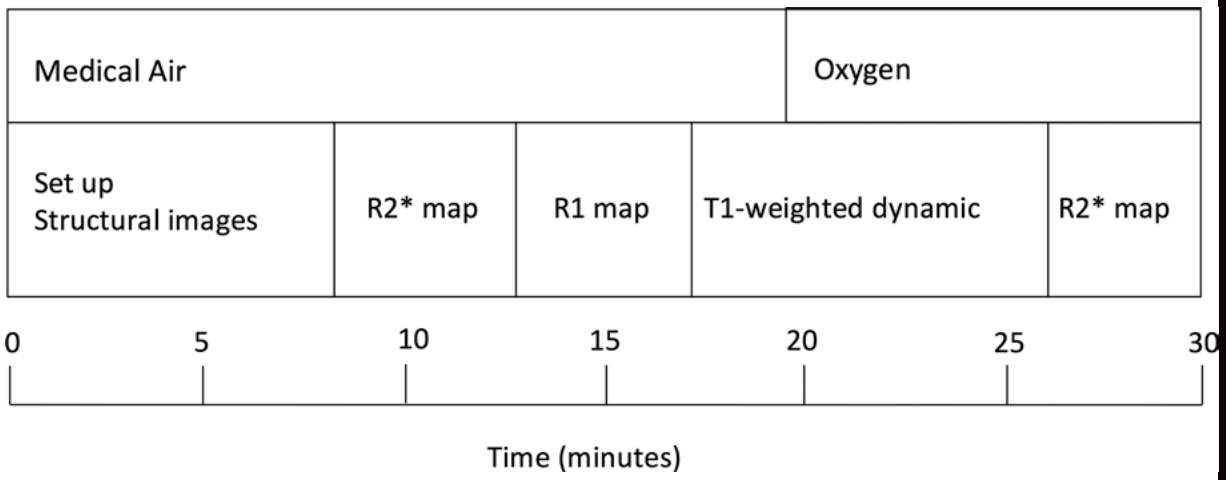


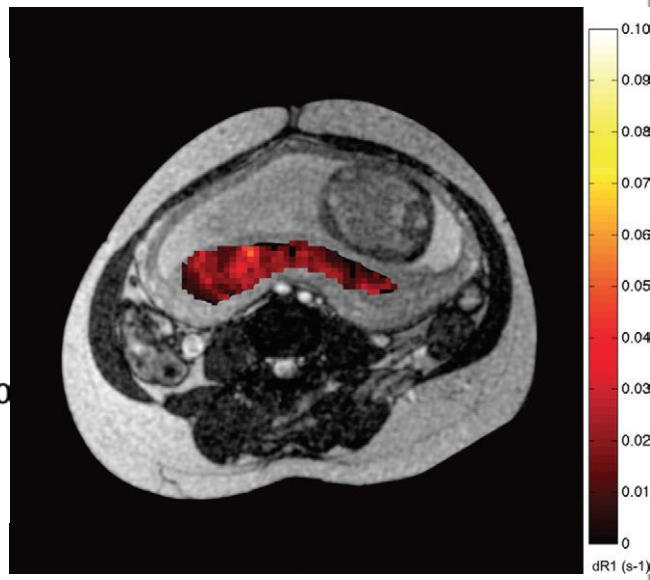
Reduced placental oxygenation during subclinical uterine contractions as assessed by BOLD MRI

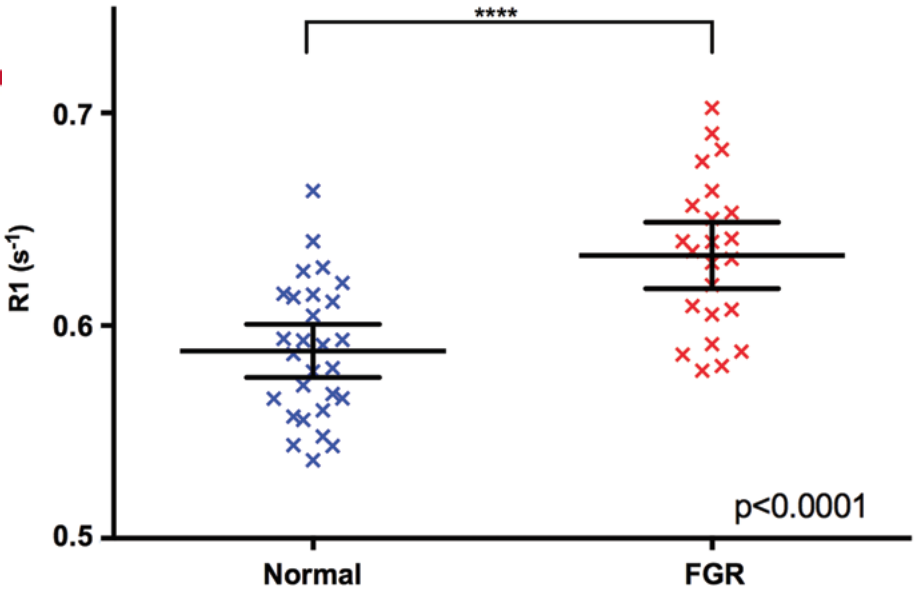
Marianne Sinding [a, *], David A. Peters [b], Jens B. Frøkjær [c, d], Ole B. Christiansen [a, d], Niels Uldbjerg [e], Anne Sørensen [a, d]

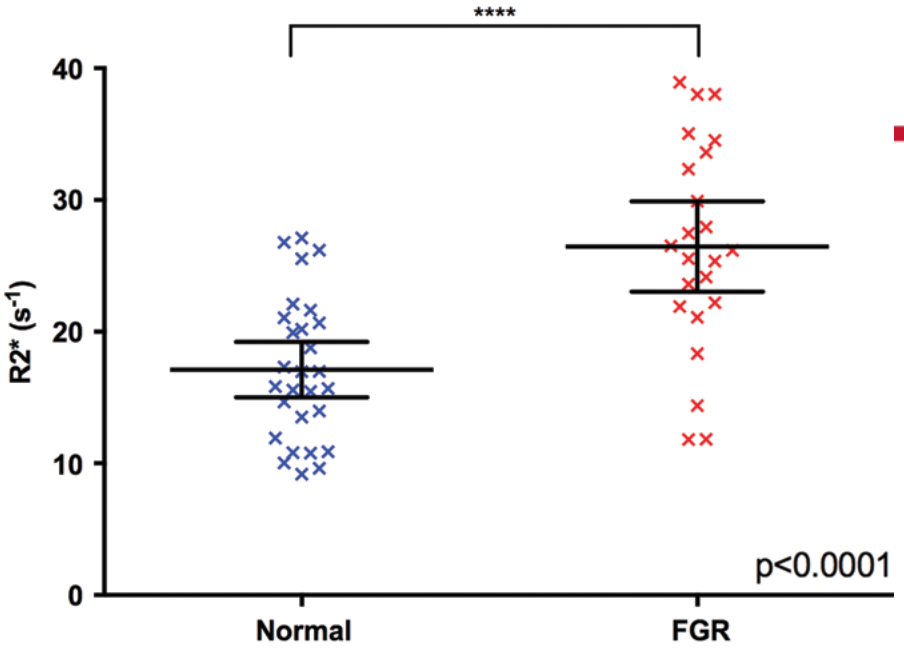


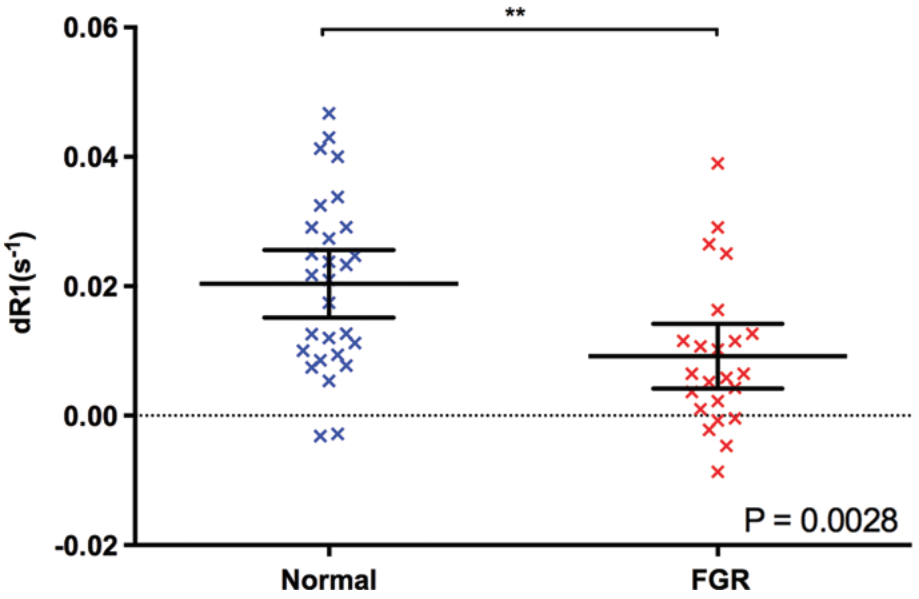
MR Imaging Measurements of Altered Placental Oxygenation in Pregnancies Complicated by Fetal Growth Restriction[1]

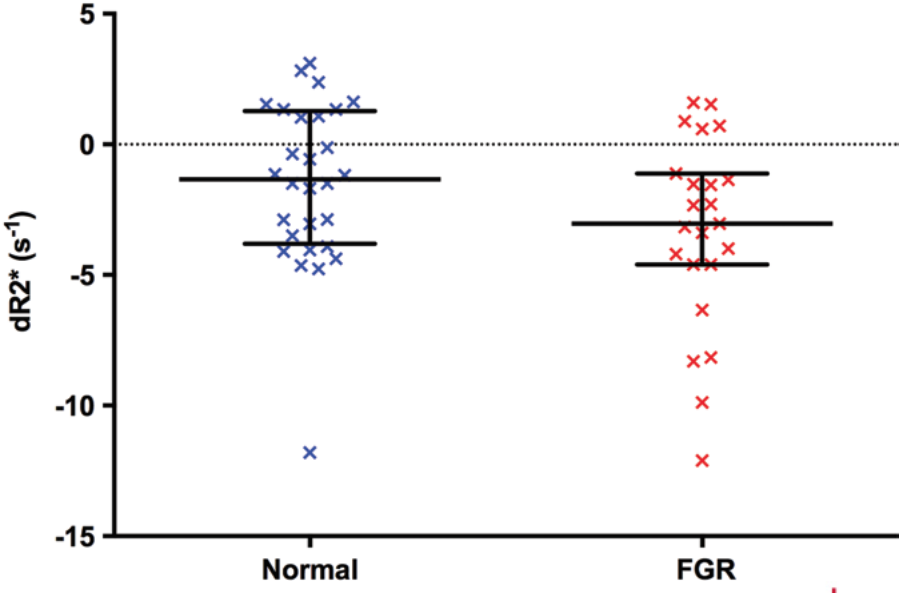




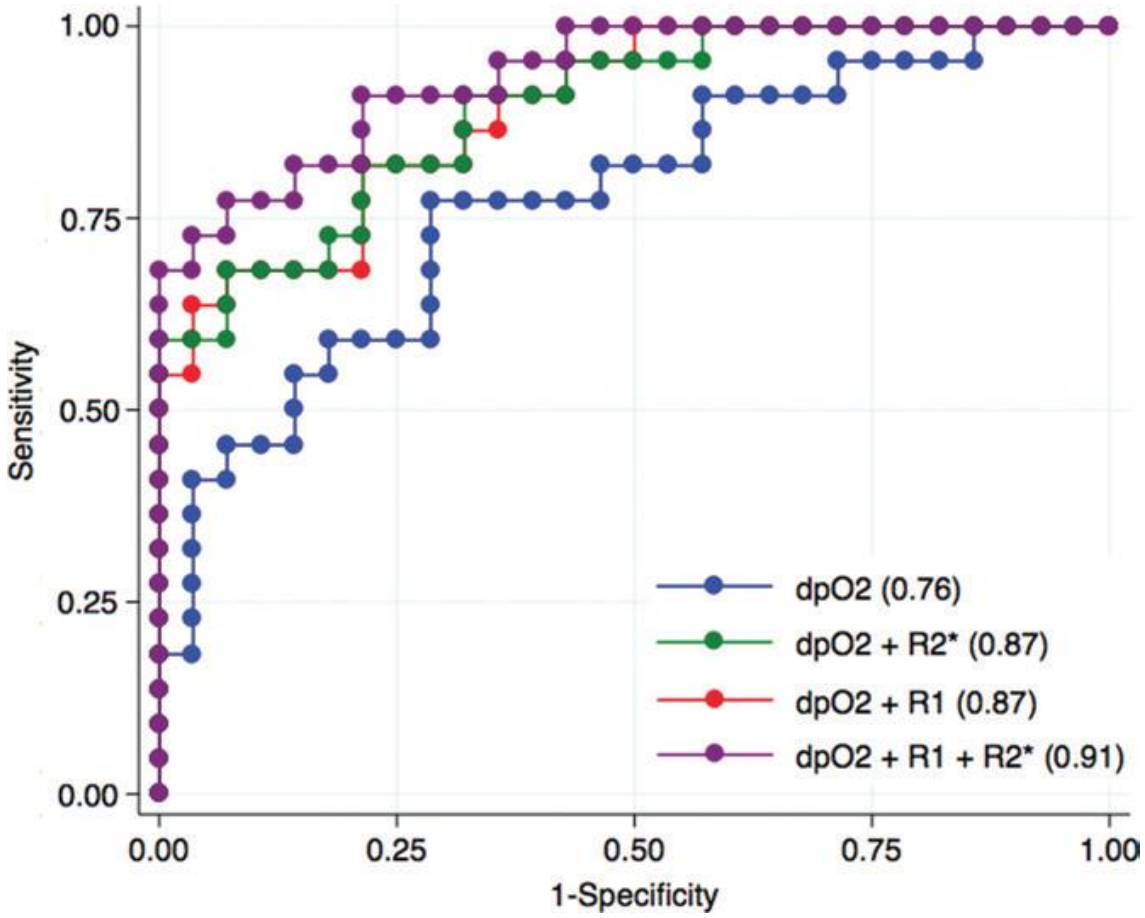

****
0.7
0.6
0.5
R1 (s-1)
p<0.0001
Normal
FGR


****
40
30
20
10
0
R2* (s-1)
p<0.0001
Normal
FGR

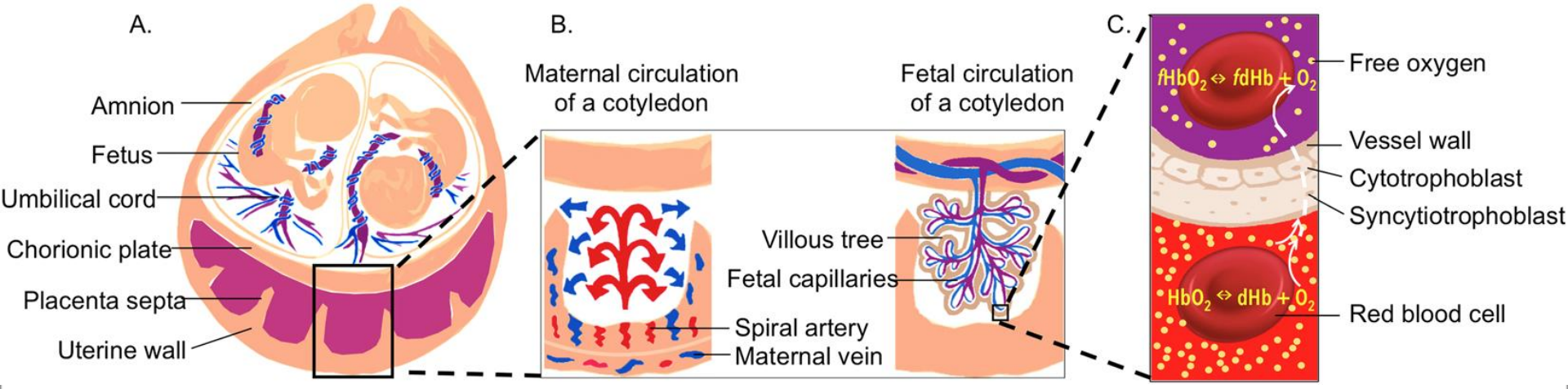

**
0.06
0.04
0.02
0.00
-0.02
dR1(s-1)
P = 0.0028
Normal
FGR


5
0
-5
-10
-15
dR2* (s-1)
Normal
FGR

MR Imaging Measurements of Altered Placental Oxygenation in Pregnancies Complicated by Fetal Growth Restriction[1]



In Vivo Quantification of Placental Insufficiency by BOLD MRI: A Human Study



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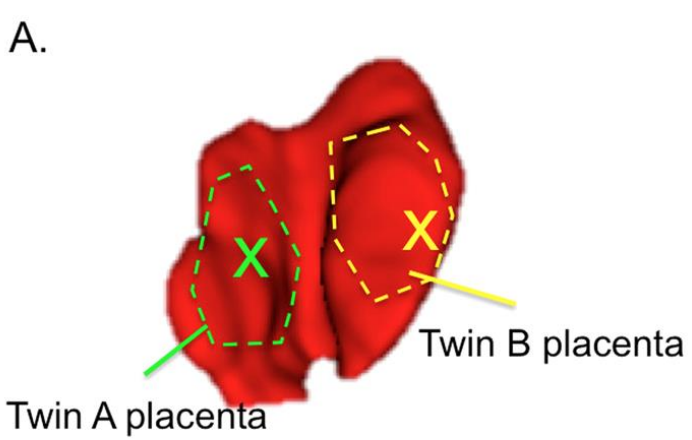
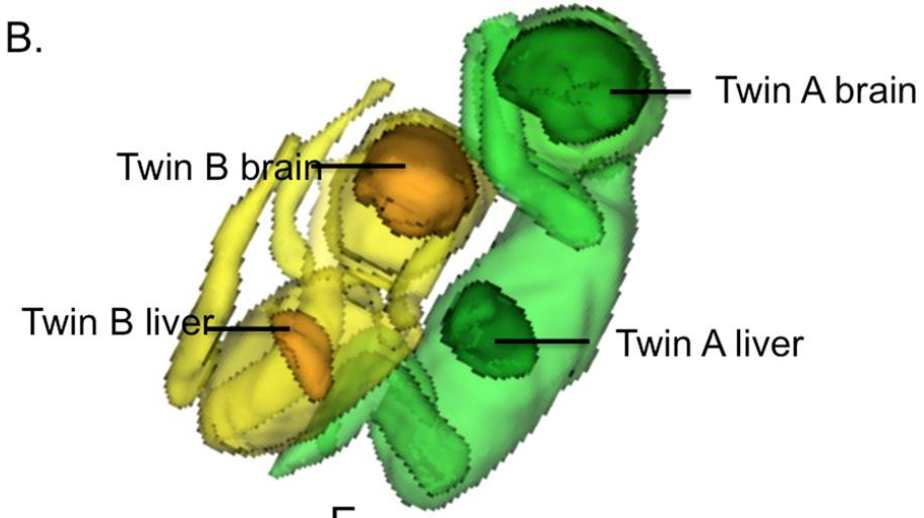
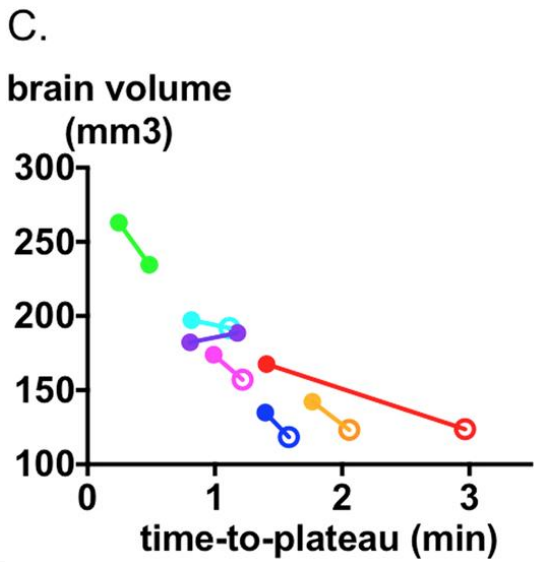
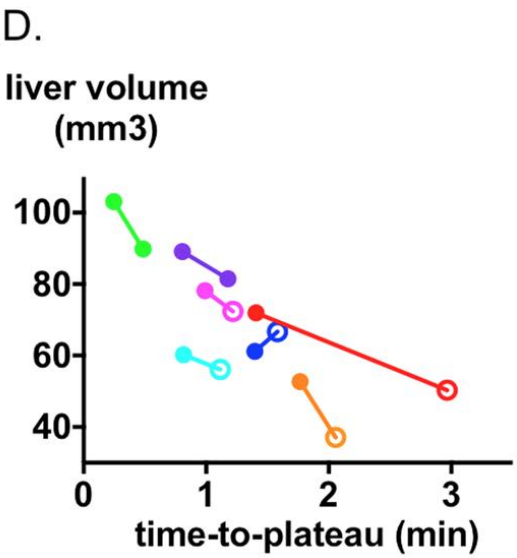
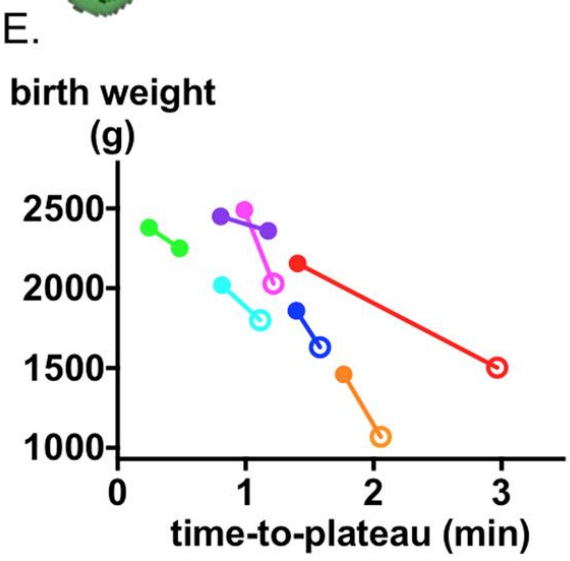




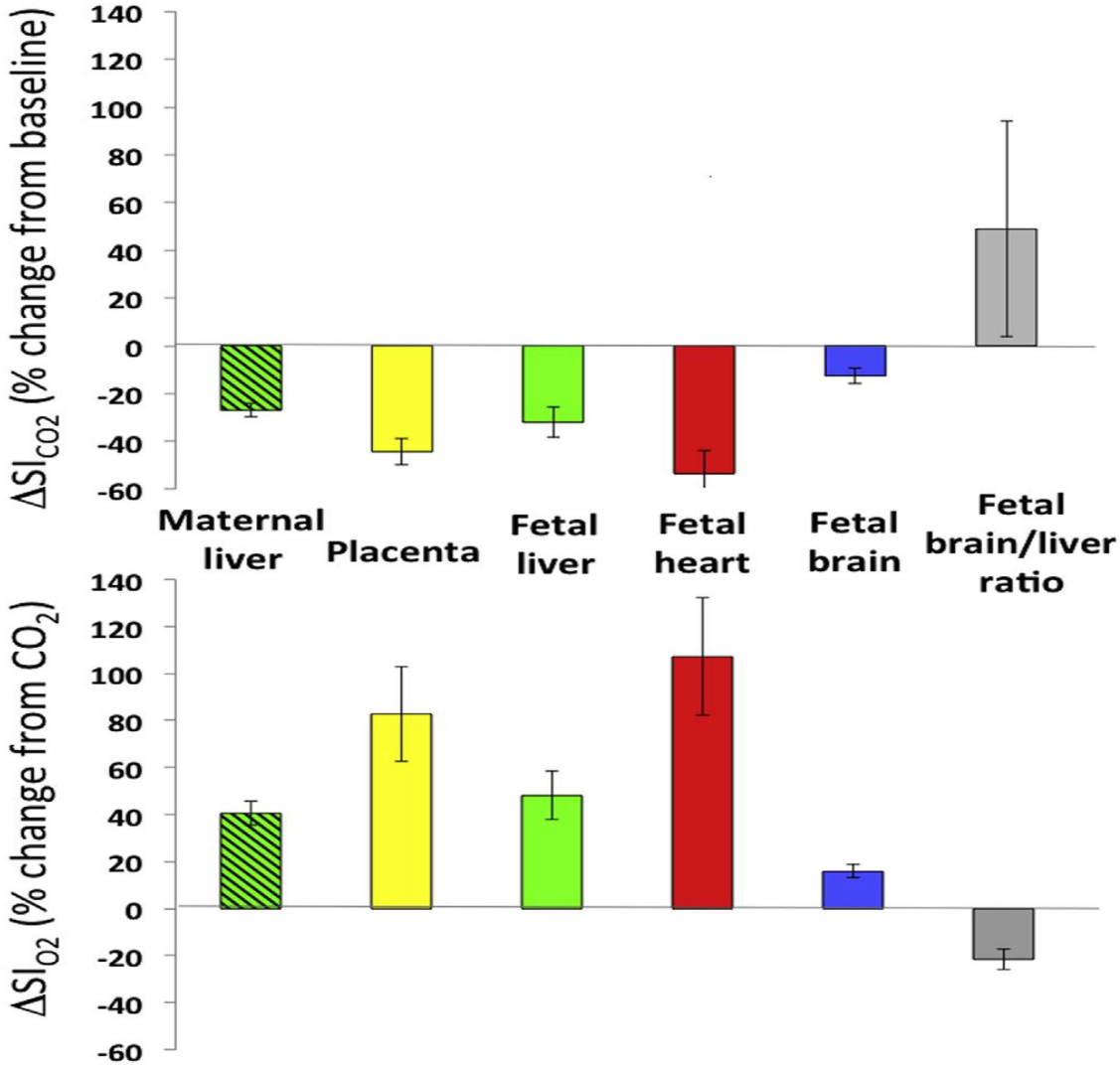






BOLD-MRI demonstrates acute placental and fetal organ hypoperfusion with fetal brain sparing during hypercapnia

Yehuda Ginosar [a, b, *], Yuval Gielchinsky [c], Nathalie Nachmansson [d], Lital Hagai [e], Joel Shapiro [f], Uriel Elchalal [c], Rinat Abramovitch [d]



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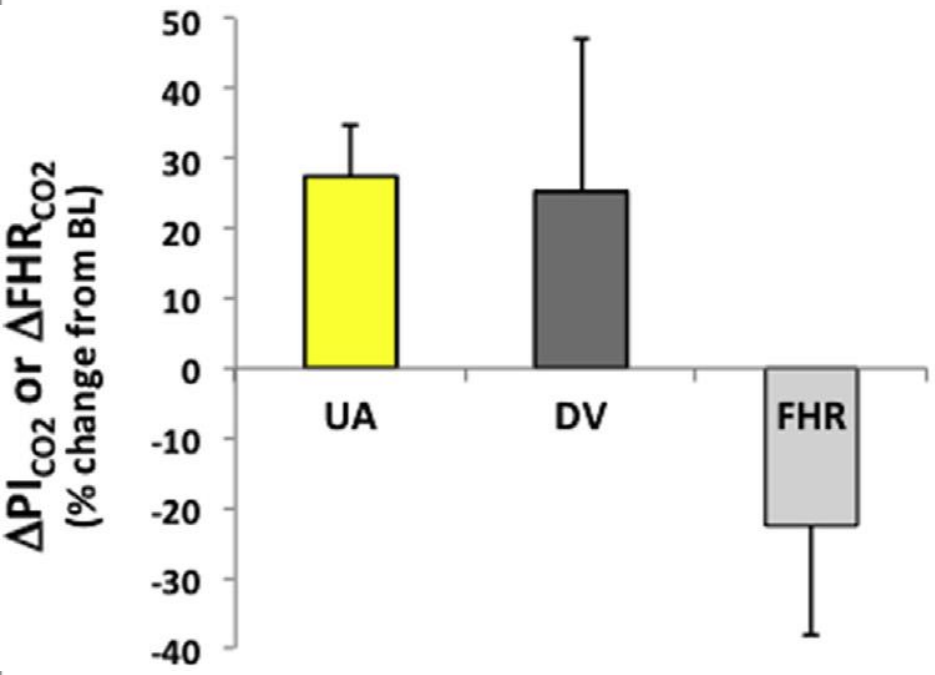
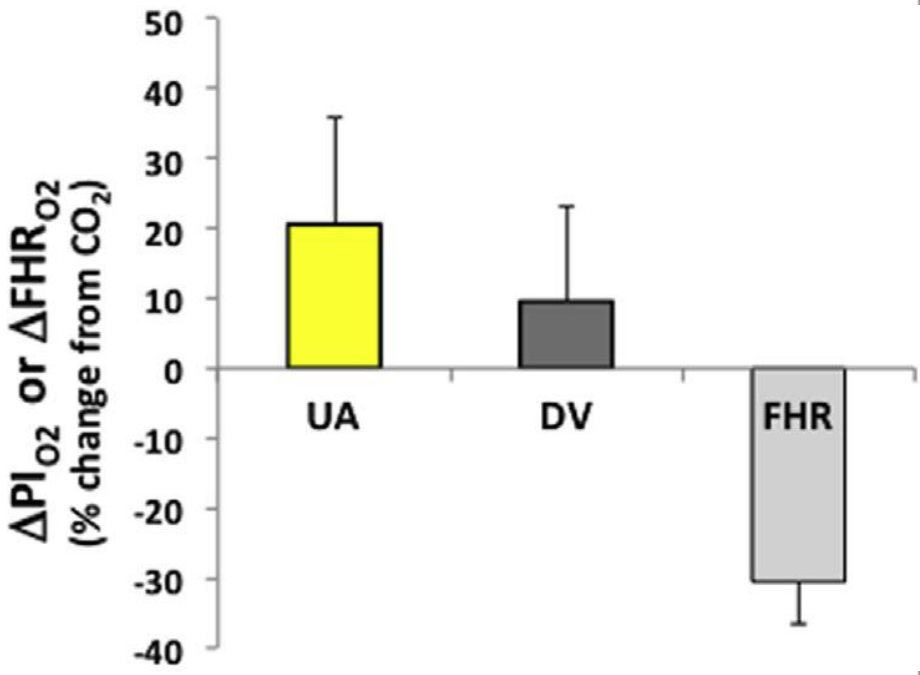
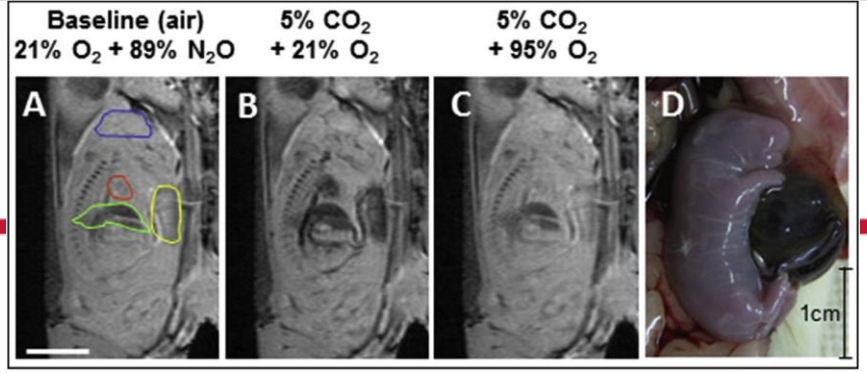
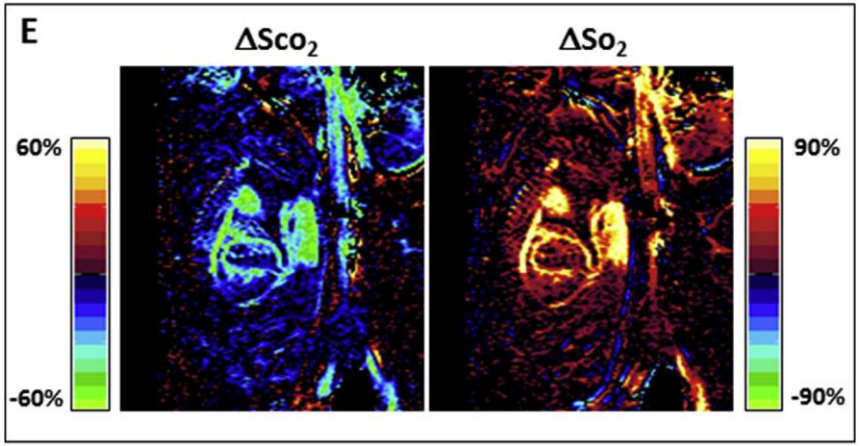
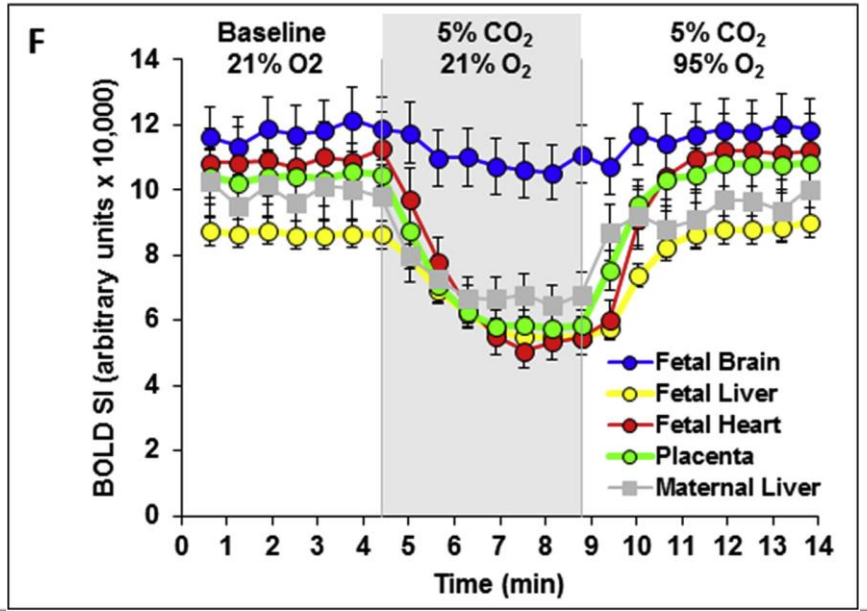




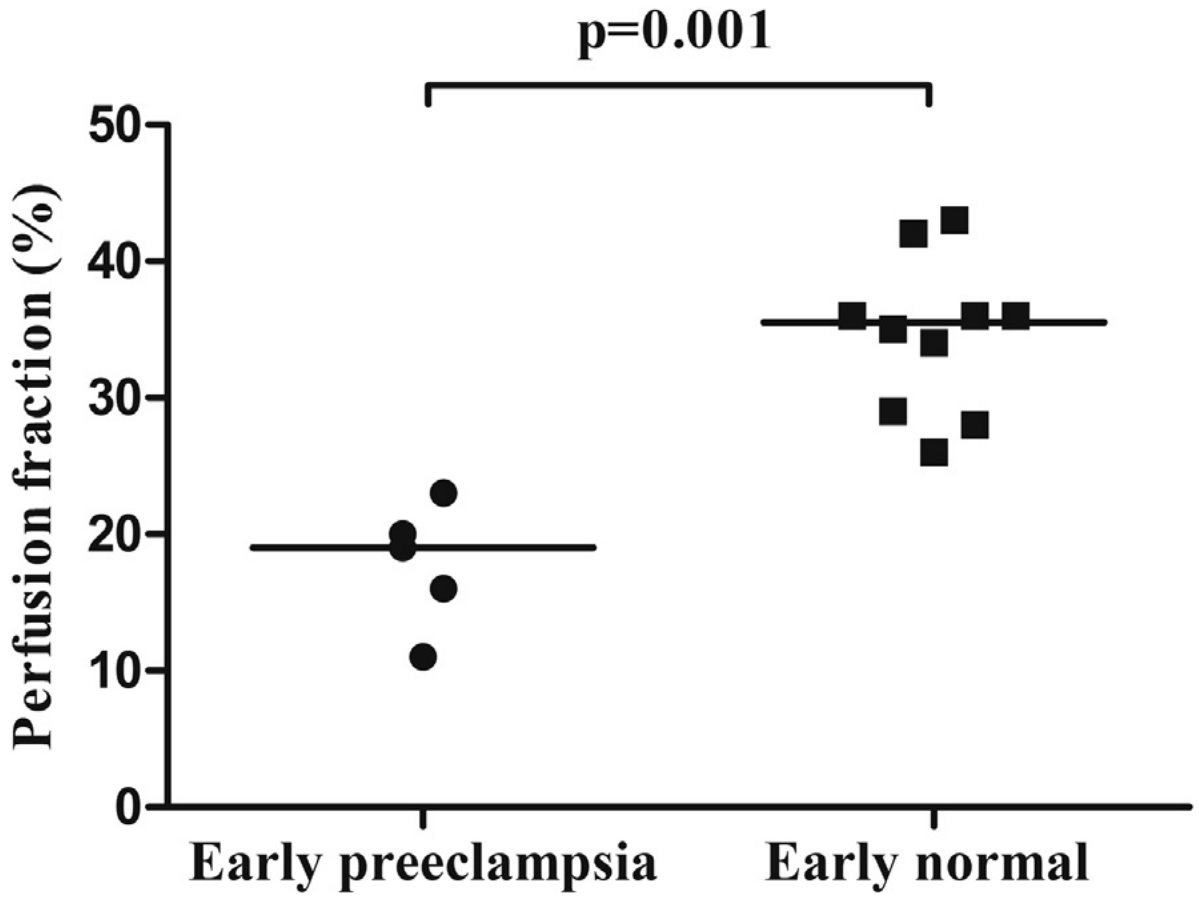

Baseline (air)
21% O2 + 89% N2O
5% CO2
+ 21% O2
5% CO2
+ 95% O2
A
B
C
D
1cm


E
ΔSco2
ΔSo2
60%
-60%
90%
-90%


F
Baseline
21% O2
5% CO2
21% O2
5% CO2
95% O2
BOLD SI (arbitrary units x 10,000)
Time (min)
Fetal Brain
Fetal Liver
Fetal Heart
Placenta
Maternal Liver

Placental perfusion in normal pregnancy and early and late preeclampsia: A magnetic resonance imaging study

S. Sohlberg [a,*], A. Mulic-Lutvica [a], P. Lindgren [a], F. Ortiz-Nieto [b], A.-K. Wikström [a], I. Wikström [b]



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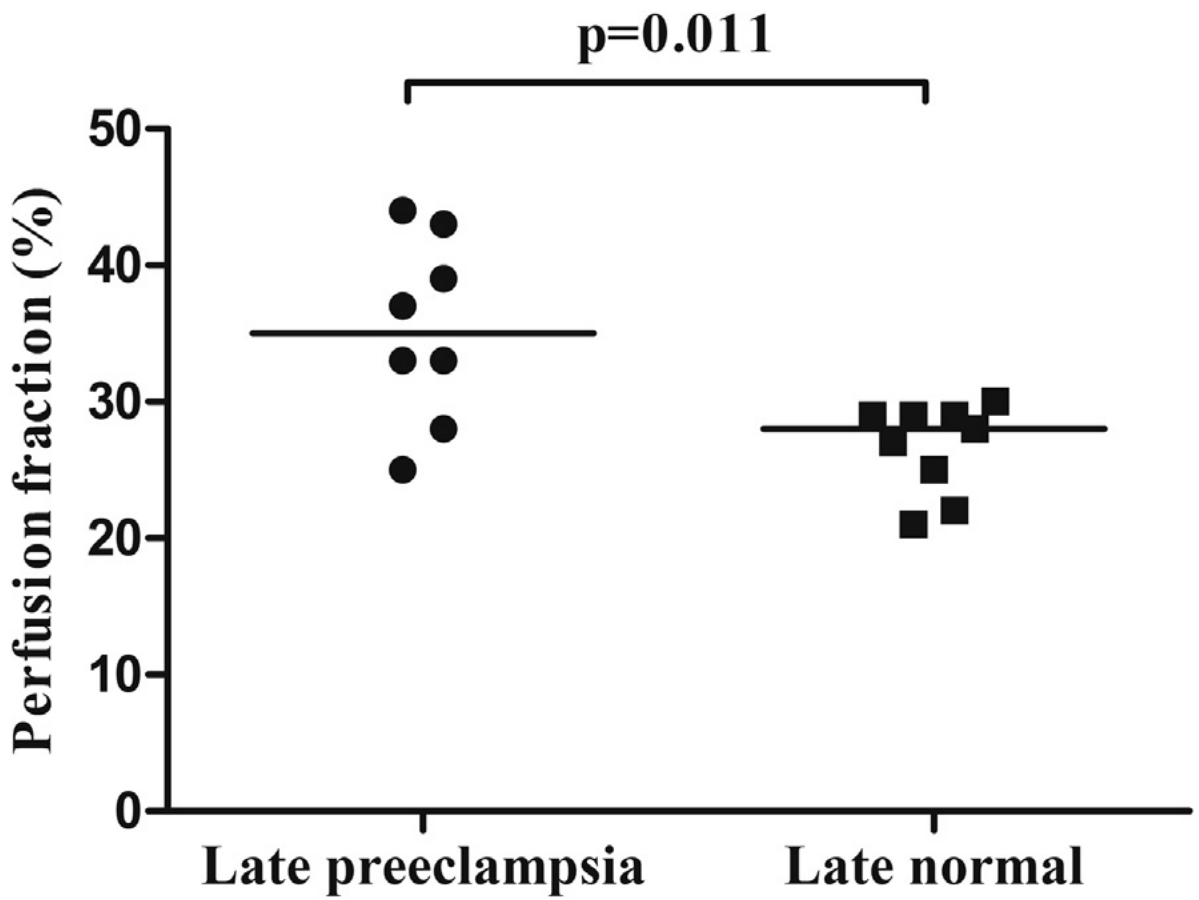
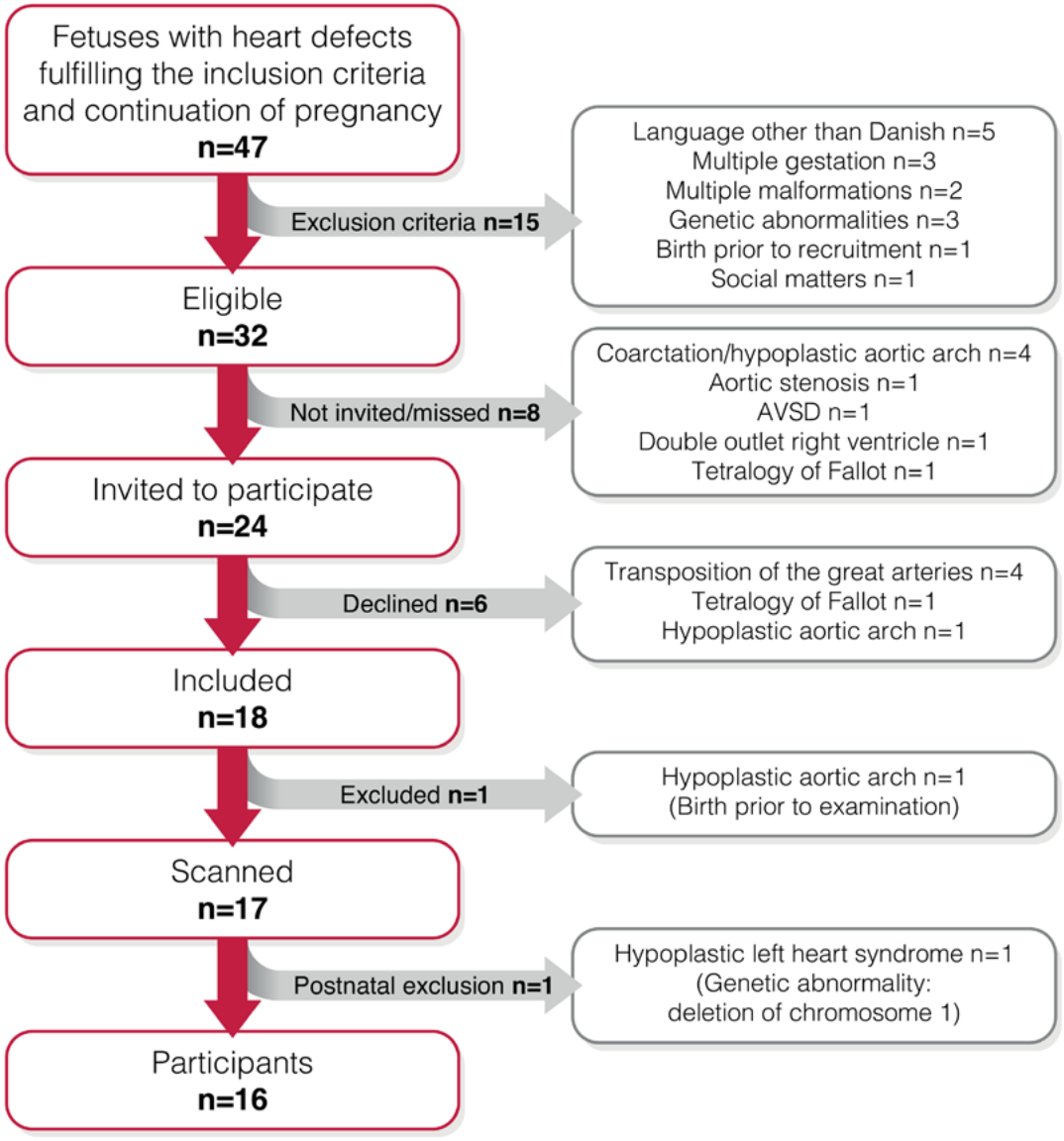
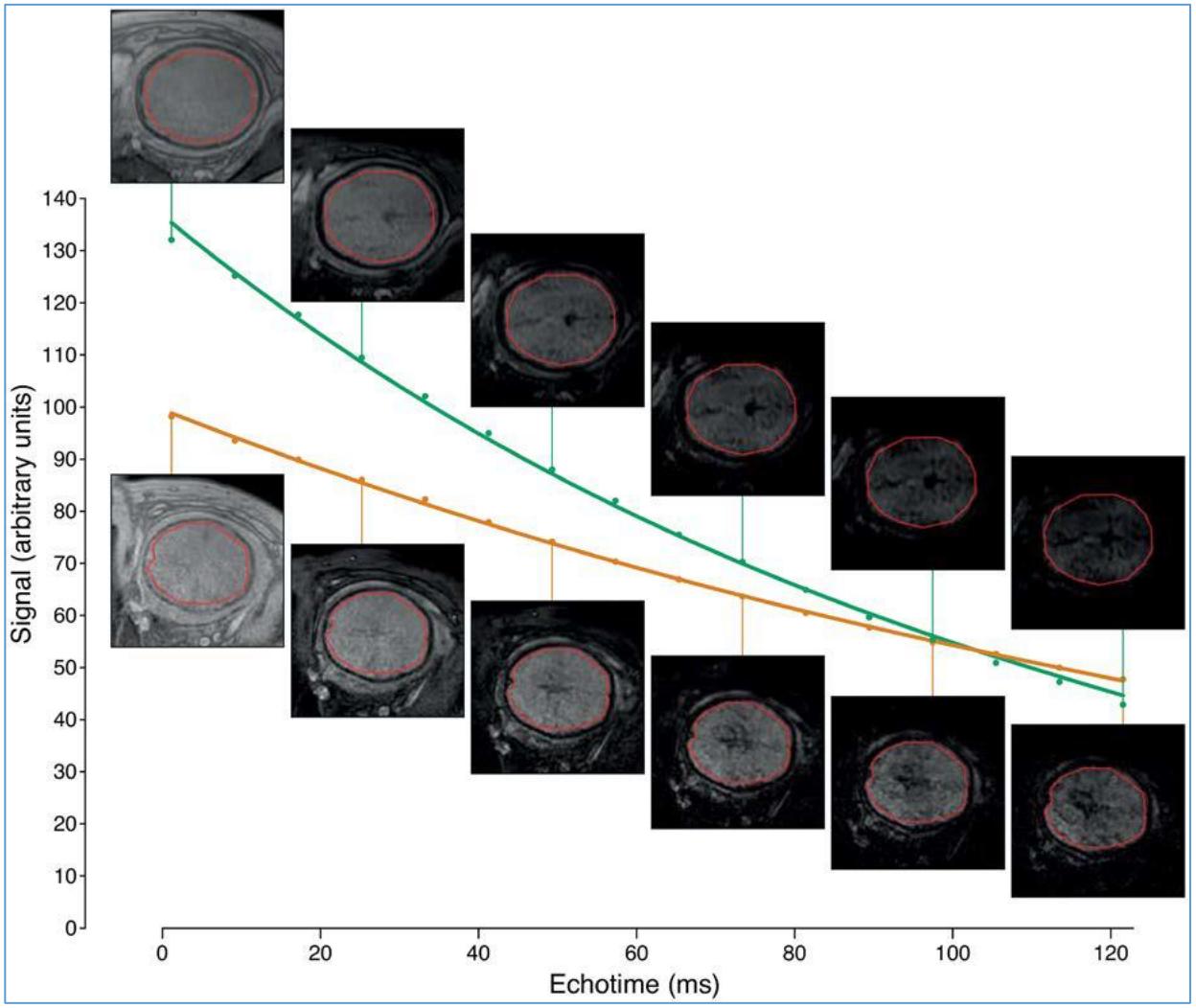
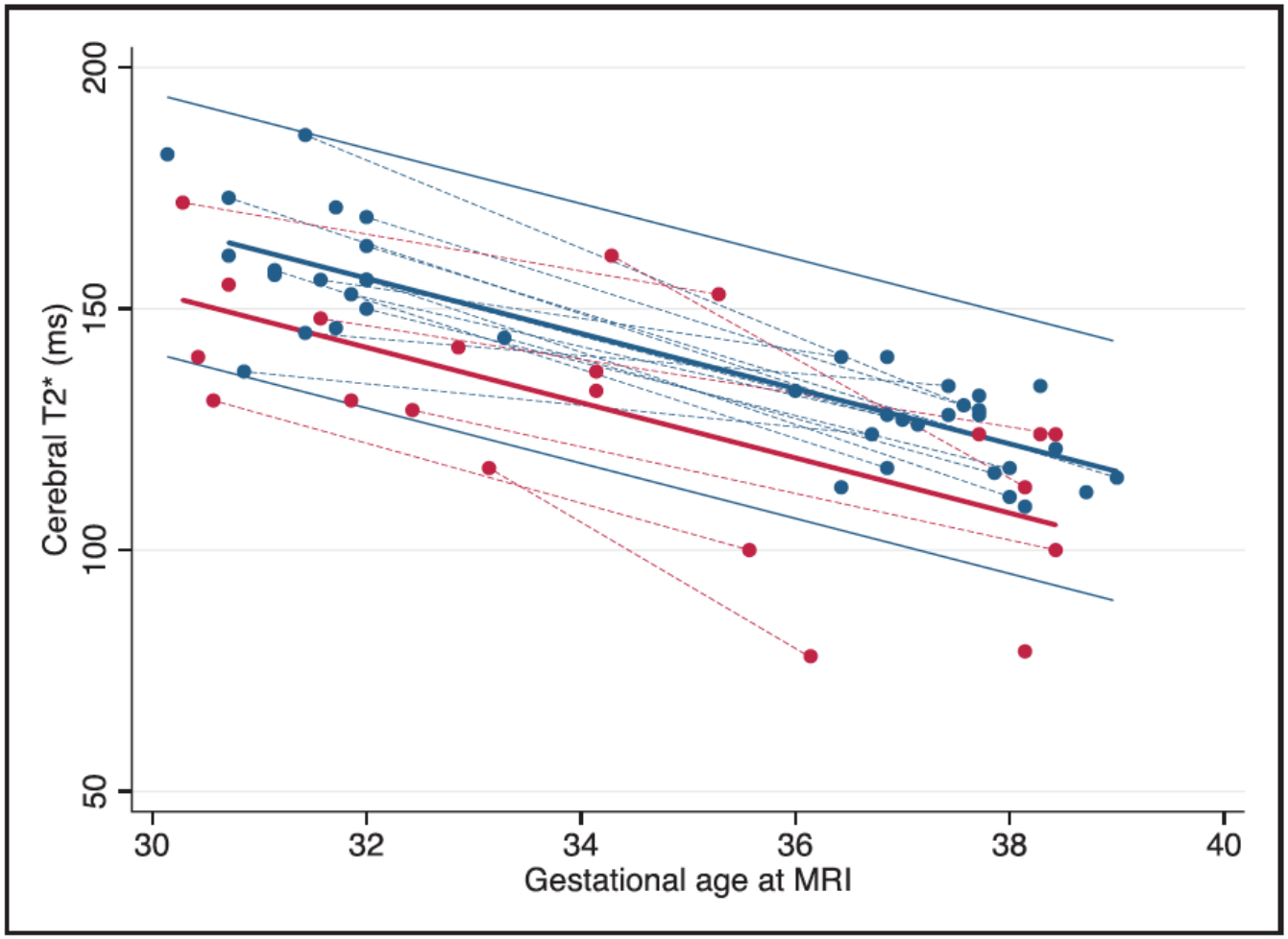


Cerebral Oxygenation Measurements by Magnetic Resonance Imaging in Fetuses With and Without Heart Defects

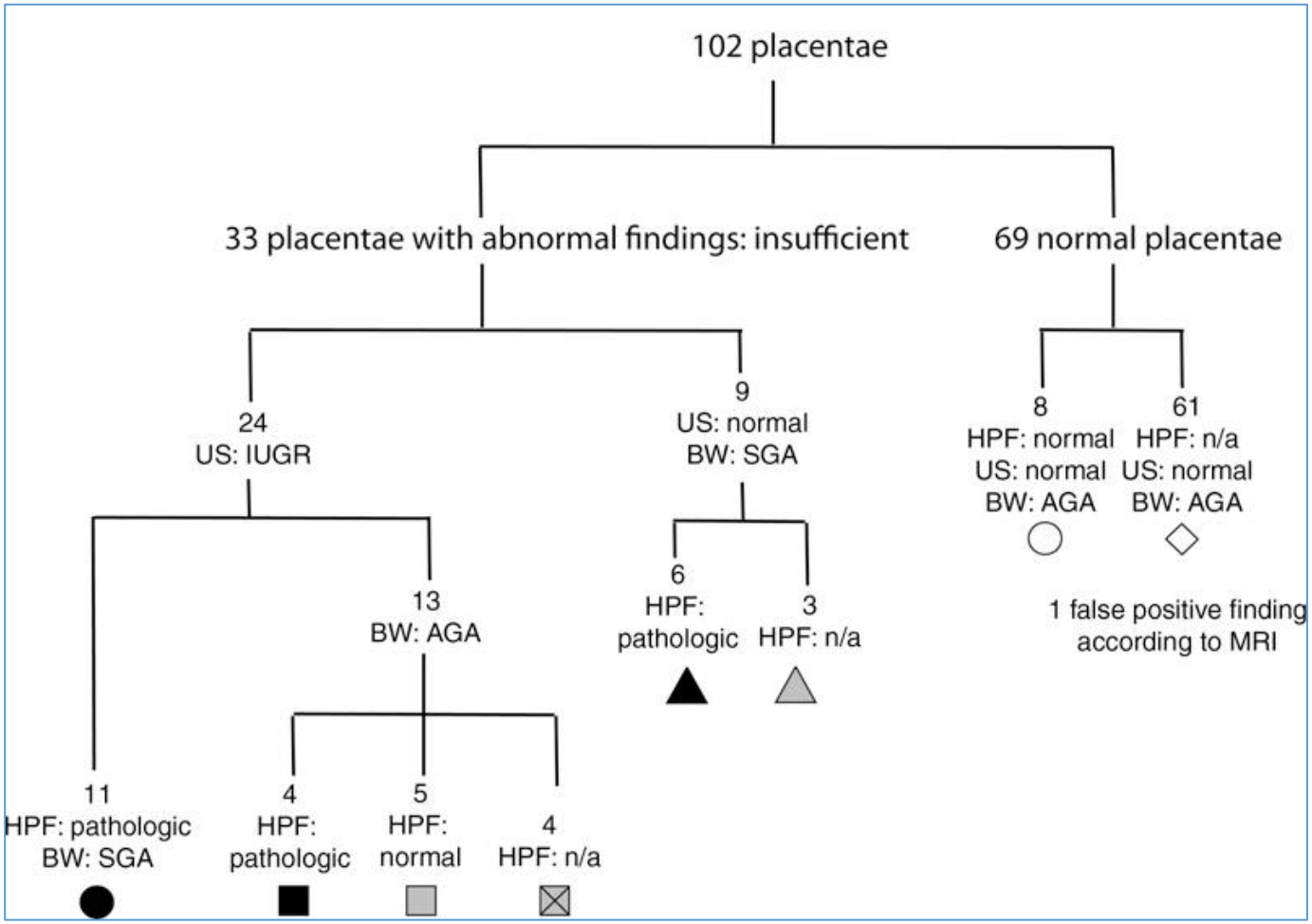


Cerebral Oxygenation Measurements by Magnetic Resonance Imaging in Fetuses With and Without Heart Defects

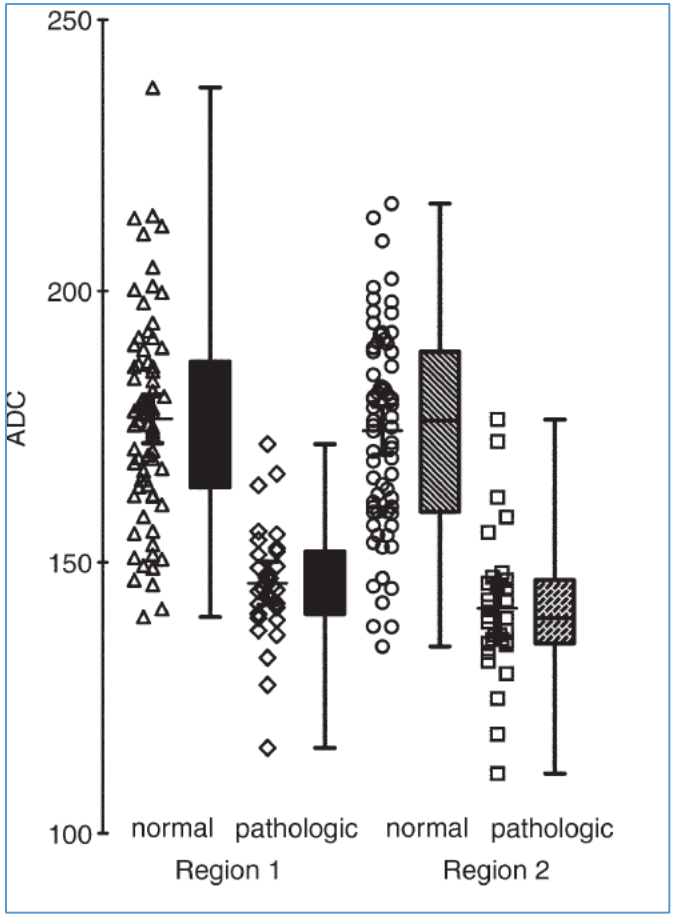



Cerebral T2* (ms)
200
150
100
50
30
32
34
36
38
40
Gestational age at MRI

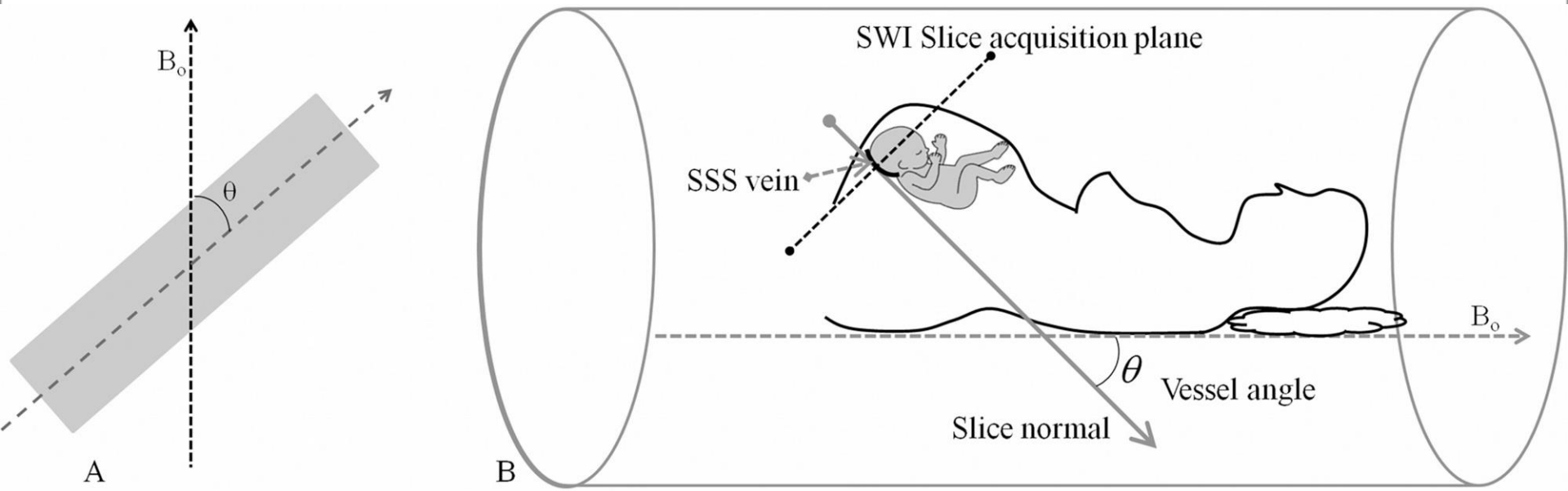
Diffusion-weighted MR Imaging of the Placenta in Fetuses with Placental Insufficiency[1]



Diffusion-weighted MR Imaging of the Placenta in Fetuses with Placental Insufficiency[1]



MR Venography of the Fetal Brain Using Susceptibility Weighted Imaging



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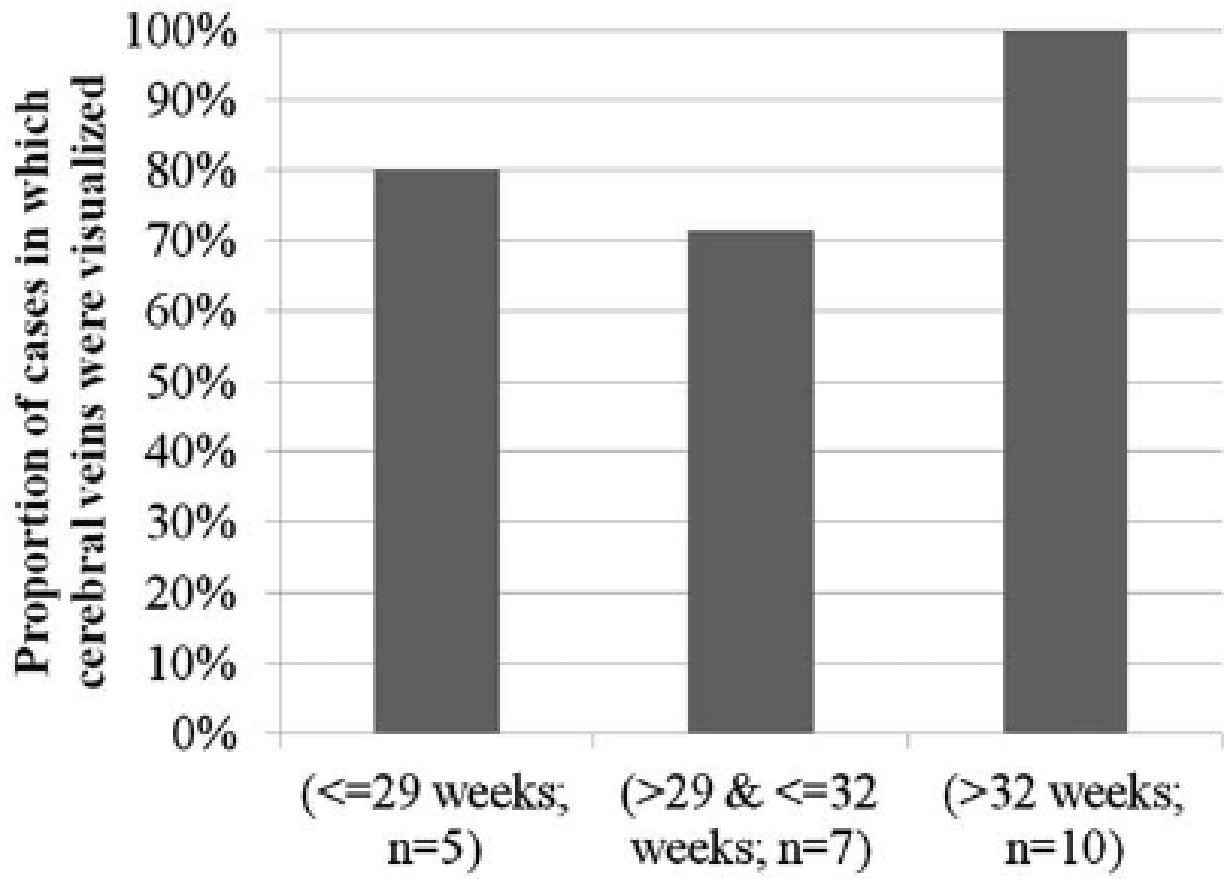

Figure 3. Proportion of cases with visible cerebral venous vasculature by gestational age at image assessment.