Assessment of vascularity in the placenta on 3D US and B-flow

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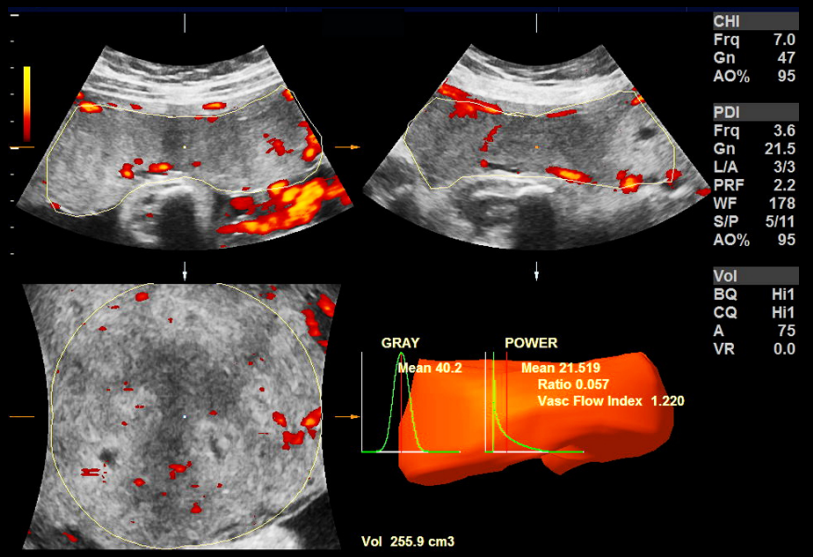
Introduction

- Ischemic placental disease (IPD) - uteroplacental under perfusion, chronic hypoxia, and placental ischemia.
- Histopathology in preeclampsia - ↓ maternal blood vessel proliferation in the placenta.
- IUGR is diagnosed
  - disproportionate asymmetric growth
  - reduction in amniotic fluid volume and
  - abnormal Doppler waveforms in the umbilical artery (UmA), ductus venosus (DV) and middle cerebral artery (MCA).
- Doppler of UA and UmA - wide variability and poor predictive accuracy
- Indirect measures of placenta function.

3D Color Doppler

- 3D Color Doppler US measures the blood flow through an organ
- Animal studies
- Small studies in pregnant women.
- Lai et al in their study in 20 pts - significant variability in all the three readings
- Noguchi et al “sonobiopsy”
  - found reduced perfusion in IUGR compared to normal pregnancies



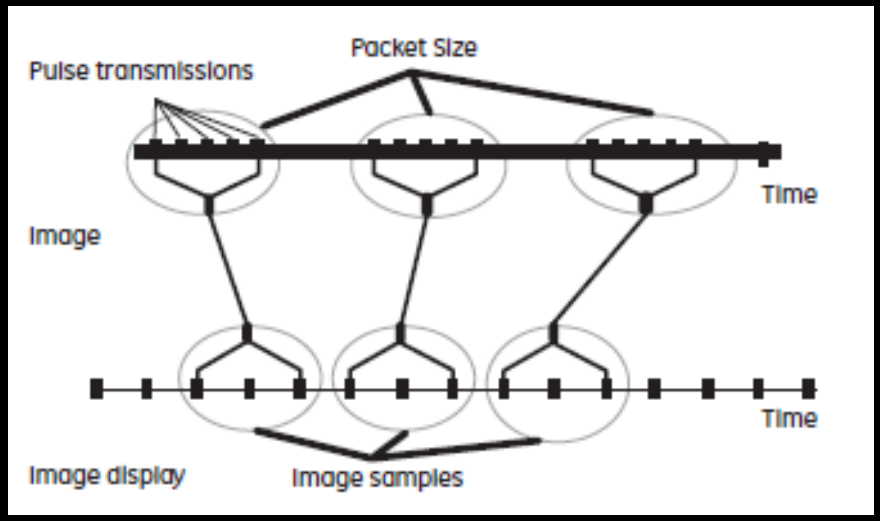
Vascularization index (VI) - ratio of color-coded voxels to all voxels within the volume and is expressed as a percentage

Flow index (FI) - mean power Doppler signal intensity from all color-coded voxels

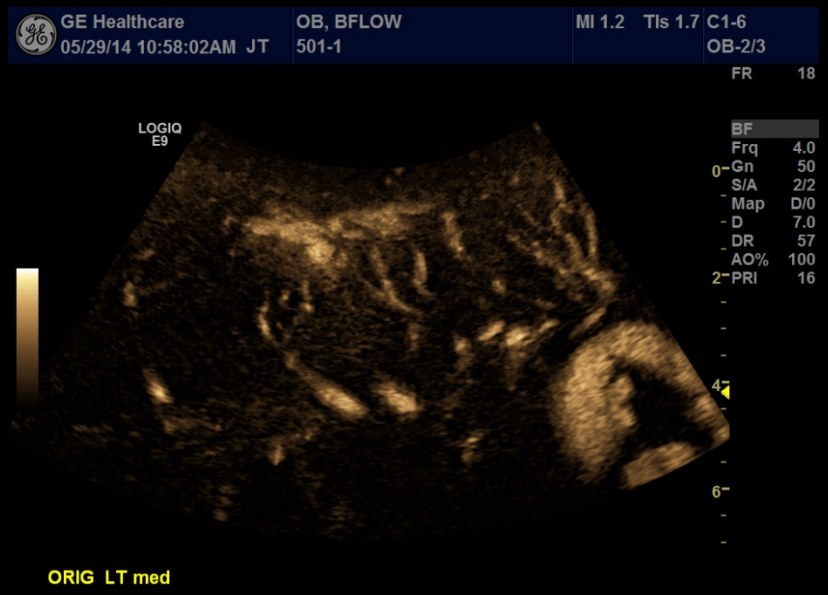
Vascularization flow index (VFI) - multiplying VI by FI and dividing the result by 100

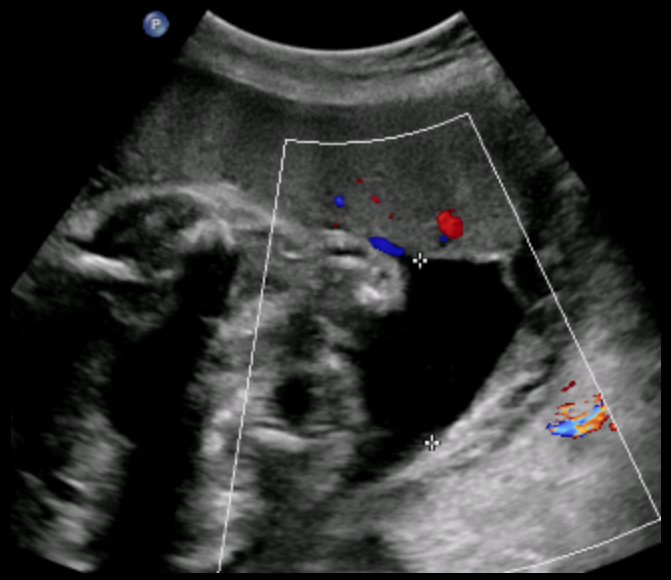
Bflow

- Digital encoding techniques to suppress tissue clutter and improve sensitivity for direct visualization of blood reflectors
- Improved sensitivity

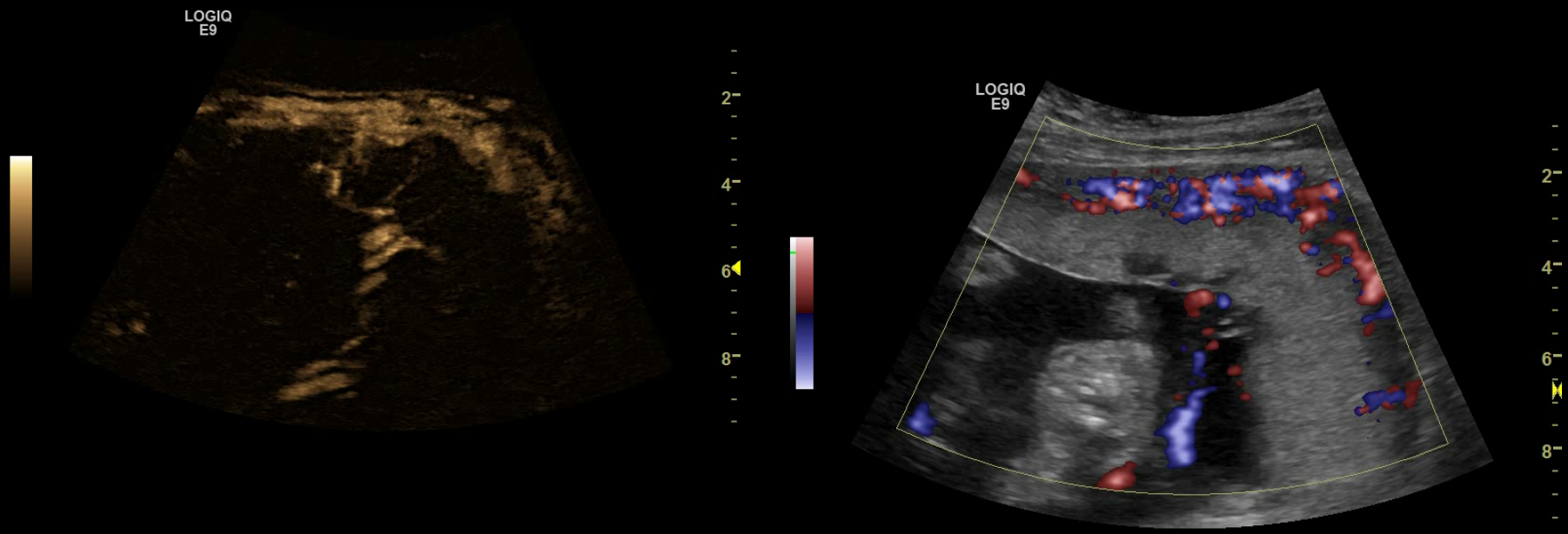


Sound scatterers → Speckle pattern → Produce image of spatial distribution of RBCs





B-Flow placenta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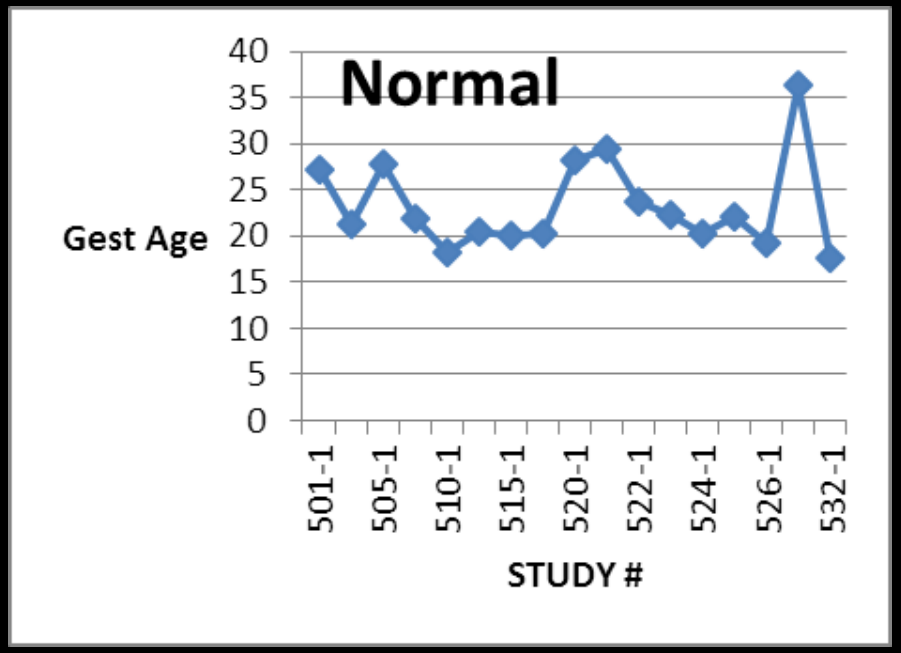
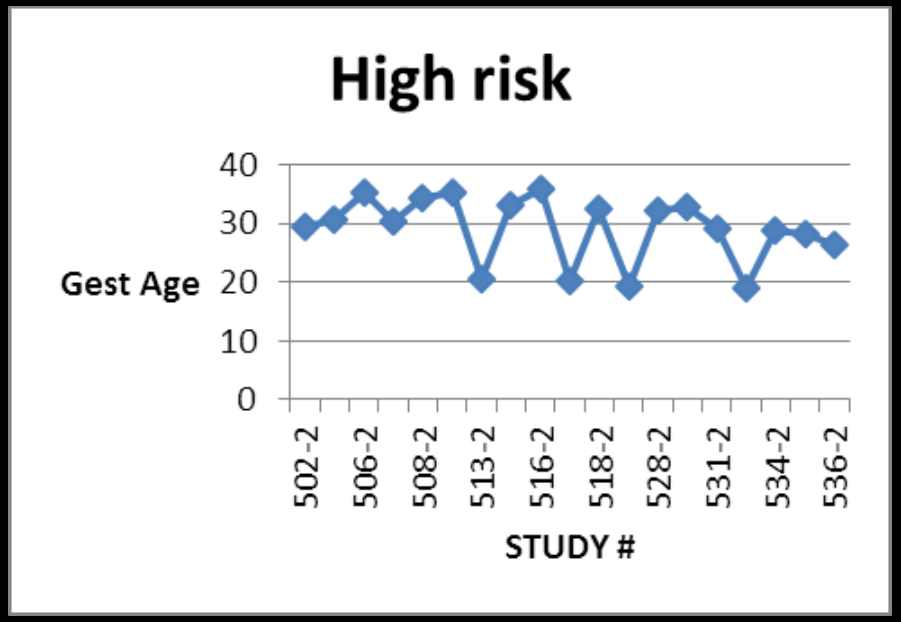
36 patients
17 normal patients and 19 high risk patients.
Age range -19 years to 43 years
Average age - 31.7yrs.

3 were referred for intrauterine growth restriction (IUGR),
7 had Diabetes and
11 had hypertension or pre-eclampsia.

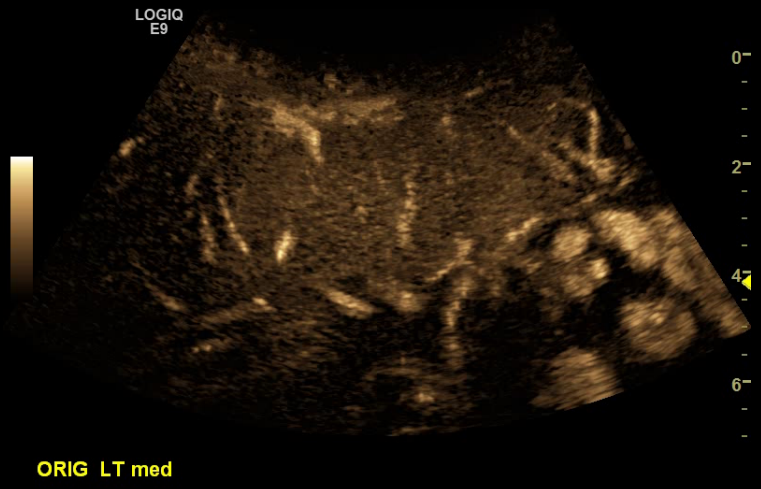
Gestational age varied from 17 weeks 5 days to 36 weeks 3 days with an average of 26 weeks, 3 days.

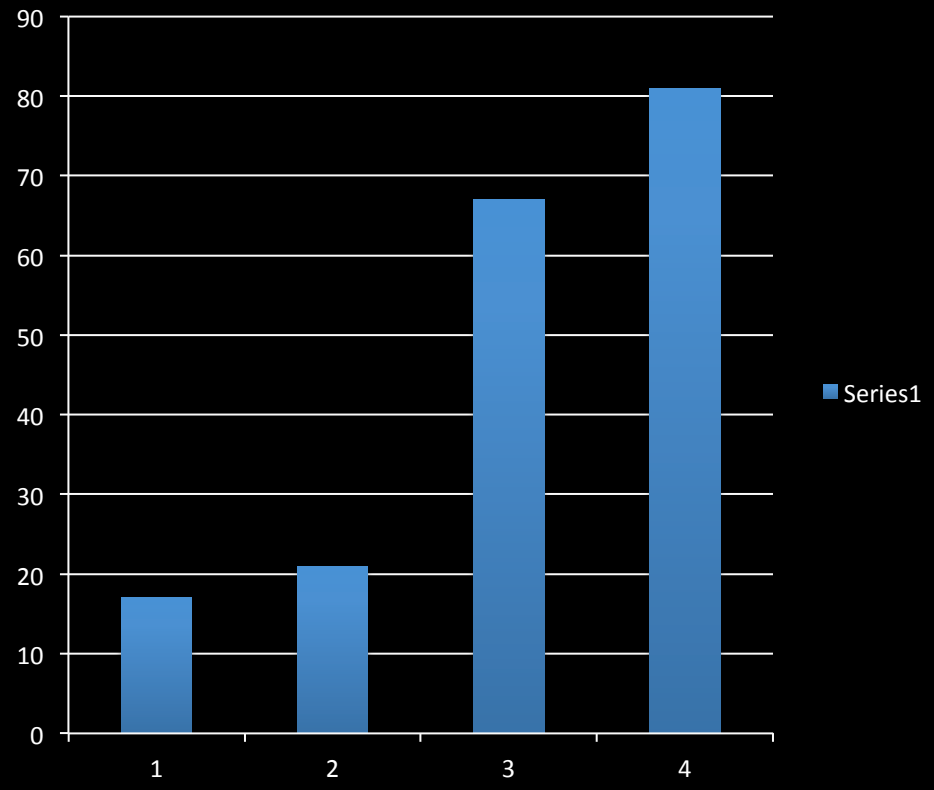




Bflow: 161 Bflow images and 138 cine capture images

3D Perfusion Doppler: 93 datasets were acquired, minimum of 1 dataset per patient to a maximum of 4 datasets per patient





1 = Color Doppler - Number of vessels seen on fetal side
2 = Color Doppler - No of vessels on maternal side
3= Bflow – no of vessels seen on fetal side
4 = Bflow – no of vessels seen on maternal side.

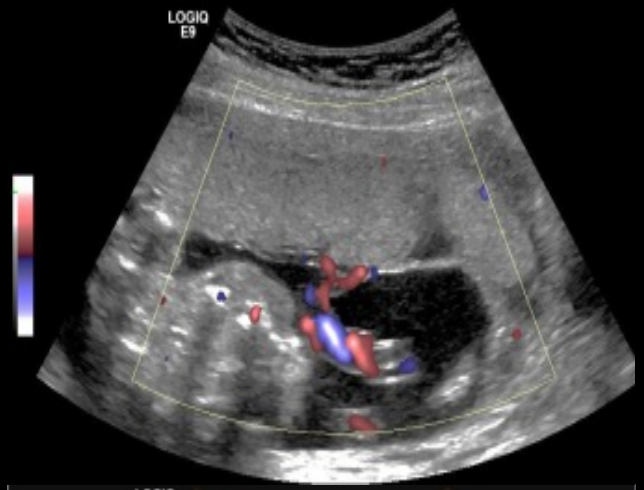
		Imaging		
Variable		Doppler	B-Flow	P-value*
Horizontal Vessels				
Small	0	17 (23.6)	6 (8.3)	0.046
	1-5	39 (54.2)	40 (55.6)	
	6-10	11 (15.3)	21 (29.2)	
	>10	5 (6.9)	5 (6.9)	
Medium	0	6 (8.3)	6 (8.3)	0.49
	1-5	50 (69.4)	39 (54.2)	
	6-10	13 (18.1)	24 (33.3)	
	>10	3 (4.2)	3 (4.2)	
Large	0	38 (52.8)	43 (59.7)	0.68
	1-5	31 (43.1)	28 (38.9)	
	6-10	3 (4.2)	1 (1.4)	
	>10	0 (0.0)	0 (0.0)	
Vertical Vessels				
Small	0	35 (48.6)	10 (13.9)	<0.001
	1-5	36 (50.0)	51 (70.8)	
	6-10	1 (1.4)	8 (11.1)	
	>10	0 (0.0)	3 (4.2)	
Medium	0	15 (20.8)	6 (8.3)	0.90
	1-5	52 (72.2)	61 (84.7)	
	6-10	5 (6.9)	4 (5.6)	
	>10	0 (0.0)	1 (1.4)	
Large	0	43 (59.7)	49 (68.1)	0.68
	1-5	29 (40.3)	23 (31.9)	
	6-10	0 (0.0)	0 (0.0)	
	>10	0 (0.0)	0 (0.0)	

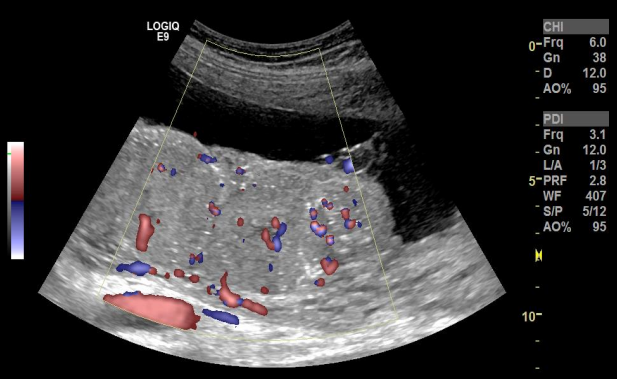
Bflow – 15 images were good with no evidence of artifact. Rest of the images had some artifact in them

PRF/Scale	Flash	Resp Motion	Arterial motion	Fetal motion	Over gain	Under gain	Dark ray lines	Poor penetration	Too zoomed image
2	89	27	24	67	3	50	7	51	17

Cine capture images – 22 images were good with no evidence of artifact. Rest of the images had some artifact in them.

PRF/Scale	Flash	Resp Motion	Arterial motion	Fetal motion	Over gain	Under gain	Dark ray lines	Poor penetration	Too zoomed image
4	48	37	5	20	3	9	7	49	10





hypertensive with normal blood pressure

thalassemia and developed pre-eclampsia

Placenta

	Normal	High risk
VI	5.4	4.69
FI	20.56	20.79
VFI	1.16	1.05

	Sensitivity	Specificity
VI (4.2)	50	66.7
FI (18.5)	87.5	66.7
VFI (0.54)	62.5	100

Conclusion

Bflow is capable of showing a larger number of blood vessels in the placenta compared to color Doppler.

The pattern of blood vessels in the placenta may be different in early compared to late gestational age placentas. In addition, the vessels may have a different pattern in pre-eclampsia compared to normal patients, however we had only a small number of patients to evaluate this. In addition, the evaluation of the pattern of blood vessels would work better if 3D capability was present in Bflow.

The VI, FI and VFI in normal patients was different from the VI, FI and VFI in high risk patients. However the number of patients in this study were too low to be able to have any statistical significance.