

Comparison of uterine artery pulsatility and resistivity indices using magnetic resonance imaging and Doppler ultrasound

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Target Audience: Clinicians, scientists & radiologists developing obstetric MRI.

Purpose:

Doppler ultrasound is widely used in obstetrics to predict conditions such as pre-eclampsia and intrauterine growth restriction (IUGR). These are related to abnormal placentation and are often associated with high resistance utero-placental blood flow<sup>1</sup>. The uterine artery pulsatility index (PI) and resistivity index (RI) are used routinely as markers of increased resistance to blood flow in the placenta<sup>2</sup>. MRI is now routinely used in obstetrics for fetal neurological assessment and increasingly for abnormalities of the fetal body and placenta. Although established for evaluating placental localisation and abnormalities, such as placenta accrete, there is limited research regarding placental blood flow. Early studies found that identification of the uterine arteries was difficult making further evaluation of flow impractical<sup>3</sup>. The aim of this work was to evaluate in a cohort of healthy women whether the uterine arteries could be identified at MR examination. Also if an RI and PI could be measured using phase contrast methods, and to compare these markers with those obtained at same day routine sonographic Doppler assessment.

Methods and materials:

The study was ethically approved. 35 normal singleton pregnancies at 28-32 weeks gestation were recruited, and underwent routine Doppler examination, followed by MRI examination. Doppler US was performed using a GE Voluson E8 (GEHC, Waukesha, WI) machine and, using inbuilt software, the RI and PI of both the left and right uterine arteries were measured, just superior to the point at which they cross the external iliac artery. MRI was performed using an 8 channel cardiac array and a 1.5T MRI system (DV450 GEHC, Waukesha, WI). Following sagittal FIESTA breath-hold imaging, an oblique coronal image plane was positioned immediately superior to, and parallel with, the external iliac arteries. A cardiac gated cine phase contrast study was performed using the following parameters: TR/TE 6.45/3.1msec, slice thickness 7mm, FOV 36cm, matrix 192x256, flip angle 30, 60 phases, Venc 80-90cm/sec. Using both the magnitude and phase images, vessels in the uterine wall that passed orthogonally to the image plane, and with flow in the superior direction, were identified as likely uterine arteries. It was decided to exclude patients if an artery could not be identified, if severe flow aliasing occurred, or if there was more than one artery identified on either side - owing to difficulty correlating with ultrasound. An in-house flow analysis program was used to delineate the vessel margin, provide background correction, calculate the flow profile, and measure RI and PI for each artery. These were then compared with the US results using Bland Altman statistics.

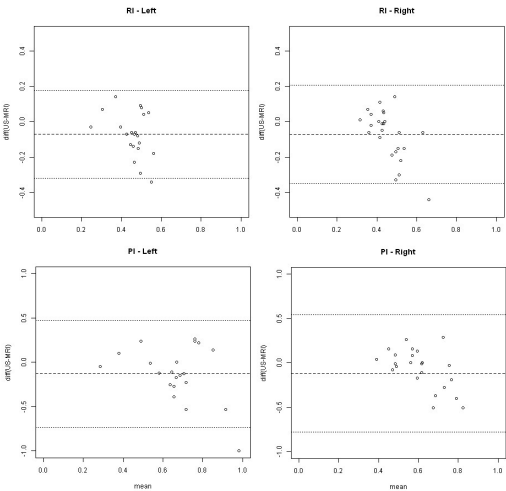


Figure 3: Bland-Altman plots for the comparison of RI and PI for the left and right uterine arteries.

References:

1. Albaiges G, Missfelder-Lobos H, et al (2003) "Comparison indices in a population at high risk for adverse outcome at 24 in Obstetrics and Gynaecology 2003; 21: 170-173  
2. Stampalija T, Gyte G. M and Alfirevic Z "Utero-placental pregnancy outcome" Cochrane Database Systematic Review  
3. Pates J. A, Hatab M. R, et al. "Determining uterine blood resonance imaging" Magnetic Resonance Imaging 2010; 28 :

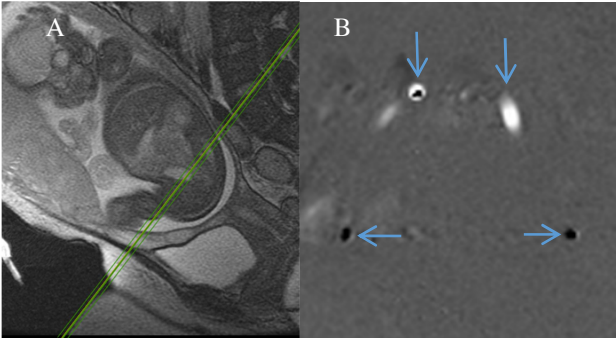


Figure 1: (A) Line indicates the position of the oblique coronal phase contrast acquisition (B) which demonstrates the iliac vessels (vertical arrows) and the uterine arteries (horizontal arrows)

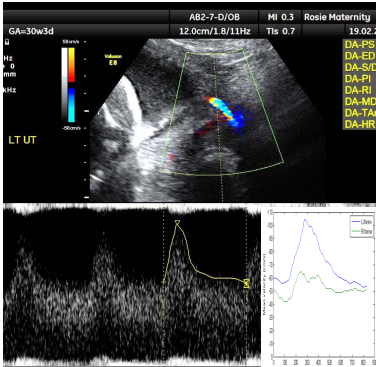


Figure 2: Example duplex Doppler US exam of a uterine artery with matching MRI flow profile superimposed in the bottom right hand corner.

Results: At US one uterine artery could not be identified. At MRI 13 multiple uterine arteries on one side were identified, 4 arteries had severe aliasing and 3 vessels could not be confidently identified, leaving 47 vessels in 28 patients for analysis. The Bland-Altman analysis is demonstrated in Figures 3 & 4 demonstrating a relatively small bias for the results in these healthy patients.

Discussion:

Using a carefully selected imaging plane corresponding to the location used for ultrasound, it proved possible to identify uterine arteries in the majority (80%) of patients. Despite the examinations taking place within 90 minutes of each other, the correlation is only moderate for RI/PI. An issue with MRI based flow measurements is accurate background correction selection of an optimal Venc. MR phase contrast techniques also allow for absolute flow quantification, and with improved spatial resolution and a correspondingly longer acquisition time, total uterine blood flow may be obtained using this approach - a measurement that is currently considered unreliable using Doppler US.

Conclusion:

This study demonstrates that the uterine arteries can be identified at MRI in a majority of healthy pregnancies in the early third trimester, with a relatively small measurement bias when compared with same day Doppler US measurements. This MRI technique has potential when ultrasound measurements are considered unreliable or impossible to obtain. Future studies involving patients with abnormal Doppler findings are needed to further validate this MR based technique.

	US	MRI	bias	95% LOA
PI				
Right	0.59[0.53-0.67]	0.62[0.51-0.87]	-0.12	-0.78 to 0.54
Left	0.59[0.52-0.64]	0.75[0.64-0.79]	-0.13	-0.74 to 0.47
RI				
Right	0.43[0.39-0.46]	0.45[0.40-0.60]	-0.07	-0.35 to 0.21
Left	0.42[0.38-0.44]	0.50[0.46-0.55]	-0.07	-0.32 to 0.18
Median [inter-quartile range]				

Figure 4: Bland-Altman Comparison Analysis

of colour Doppler uterine artery weeks' gestation" 2003 Ultrasound  
Doppler ultrasound for improving 2010;8 (9) CD008363  
flow in pregnancy with magnetic 507-510