Placental Elasticity Imaging Demonstrates Feasibility of an Ultrasound-Based Method for Generation of a Placental Biomarker

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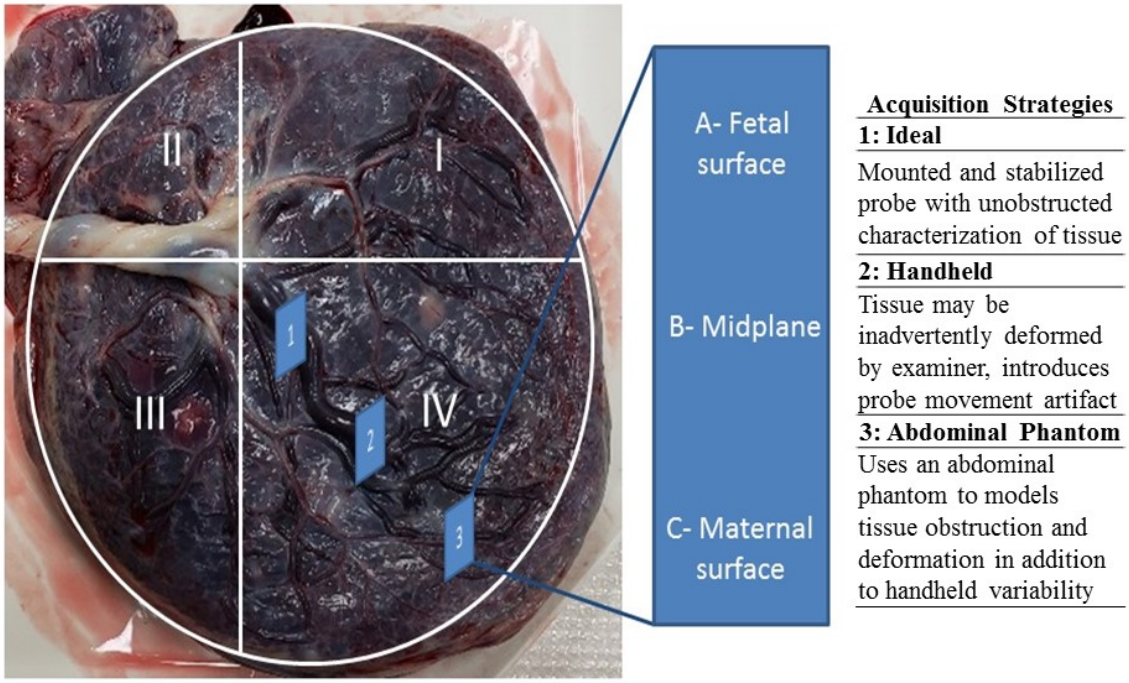
Objective: To demonstrate the validity of elasticity imaging as a novel method of interrogating structural characteristics of human placentae. Our goal is to identify easily reproducible, direct, and non-invasive placental biomarkers based on elasticity imaging to detect and predict placenta-related disease.

Study Design: A prospective, descriptive cohort of unselected women presenting for obstetric care at a tertiary medical center were enrolled antenatally for post-delivery placental collection. Sheer wave speeds (SWS) of the *ex vivo* placenta were measured using ultrasound elasticity techniques based on Acoustic Radiation Force Impulse (ARFI) technology on a Siemens S3000 research platform. SWS data were acquired in triplicate with the placenta in a water bath at physiologic temperature over a variety of acquisition conditions (Figure 1). SWS were compiled to describe the range of measurements within and between placentae.

Results: 10 term were patients enrolled for *ex vivo* placental ultrasound with 1433 regions analyzed in triplicate across 4 arbitrarily assigned quadrants in 3 acquisition conditions representing a total of 4299 elastography measurements. Consistent precision and interplacental variability in SWS were demonstrated with SEM <0.5 in >99% of all measurements across acquisition conditions. SWS were evaluated at different depths and radial circumferences with ratios between depths within the same plane also reported (Figure 2).

Conclusion: Elasticity imaging of placental tissue demonstrates high precision with serial sampling of the same region of interest across a variety of acquisition strategies including when introducing artifacts that would be encountered in antenatal assessment. While intra-placental variability was similar in magnitude to inter-placental variability, SWS ratios calculated in a single plane can provide within-tissue correction and are dimensionless, thus representing an opportunity to standardize assessment across ultrasound platforms. Both high precision and the opportunity for standardization support the feasibility of elastography use for a placental biomarker.

Figure 1: Systematic Acquisition Strategies to Generate SWS Precision, Intra-Placental Variation, and Population Tissue Speeds



Acquisition Strategies
1: Ideal
Mounted and stabilized probe with unobstructed characterization of tissue
2: Handheld
Tissue may be inadvertently deformed by examiner, introduces probe movement artifact
3: Abdominal Phantom
Uses an abdominal phantom to models tissue obstruction and deformation in addition to handheld variability

Figure 2: Sheer Wave Speeds* Across the Surfaces and Depths of the Human Placenta Under Ideal Acquisition Conditions