213 Novel 3D morphologic analysis of the early placenta using deformable medial modeling

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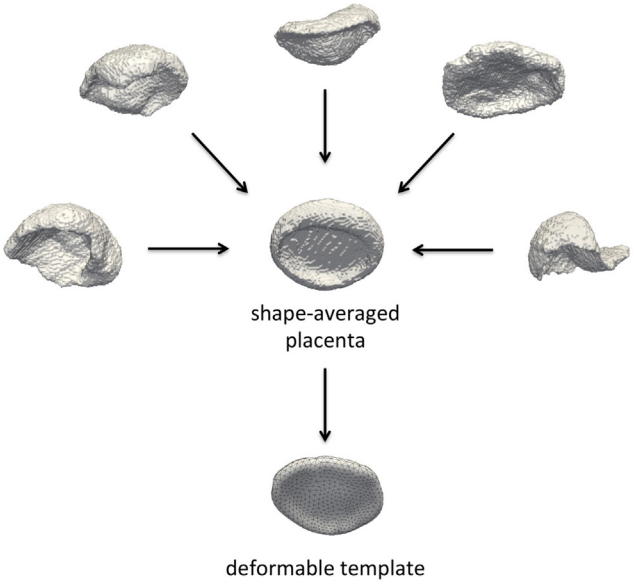
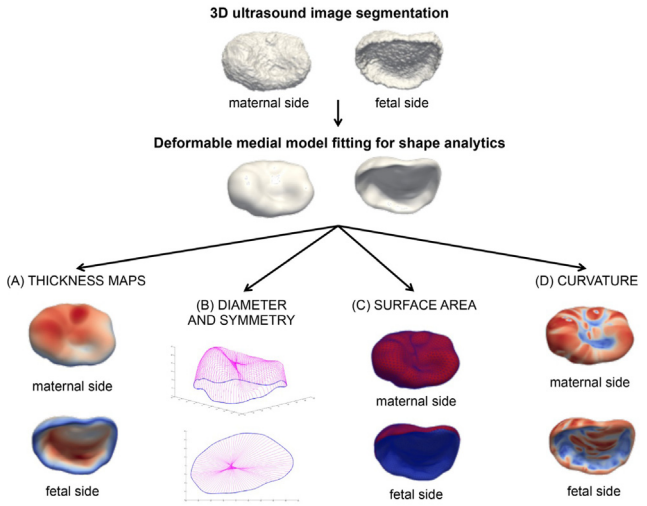
OBJECTIVE: Advances in 3D ultrasound (3D-US) technology have revealed a clear association between early placental volume and fetal growth outcomes. However, a more detailed evaluation of placental shape remains elusive and could potentially lead to new quantitative metrics for fetal growth and outcome prediction. We introduce deformable medial modeling as a new paradigm for comprehensive characterization of the 3D morphology of the early placenta in vivo.

STUDY DESIGN: 3D-US placental images acquired at 11-14 weeks were analyzed. The placental mass was manually delineated in each image, and a shape-averaged deformable medial template of the placenta was generated from the collection of segmentations (**Figure 1**). Deforming the template to a target segmentation provides a *medial axis representation* of the individual placental morphology, from which shape metrics are automatically generated. We first evaluated how accurately the deformable template captures patient-specific placental shape. We then determined whether quantitative metrics of 3D placental morphology could be extracted to potentially serve as novel investigational parameters of early placental development.

RESULTS: Twenty six 3D-US images were manually segmented (placental volume: mean 84.4 cc, range 45.7 to 216.0 cc) and were used to create the deformable medial model (**Figure 1**). The Dice overlap between each image segmentation and its fitted medial model was 0.92 ± 0.04. Model fitting allows quantification of individual placental thickness maps to locally measure and display thickness variations (**Figure 2a**). It also enables quantitative analysis of the placental disc area (**2b**), maternal and fetal surface area (**2c**), and novel metrics for describing placental curvature (**2d**).

CONCLUSION: Deformable medial modeling allows for a new frontier of accurate and detailed shape analytics to be applied to the in vivo human placenta. Further refinement and automation of these techniques will maximize the ability to characterize gross placental development in an entirely novel and robust manner.





214 Cpr 2 as a new doppler parameter for assessment of wellbeing in fetal growth restricted fetuses

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OBJECTIVE: Cerebro-placental ratio (CPR), the ratio between pulsatility index (PI) of middle cerebral artery (MCA) and PI of umbilical artery (UA), appears to reflect acute changes in fetal P02. This ratio has been considered superior to the middle cerebral artery pulsatility index (PI) in predicting fetal outcomes among growth restricted fetuses (FGR).Previous studies assessing vascular redistribution resulting from brain sparing in FGR fetuses suggested that the anterior cerebral artery (ACA) showed pathologic vasodilatation before it was seen in the MCA. Furthermore, tissue perfusion studies in FGR suggested that increased frontal perfusion is the earliest response to brain hypoxia. The aim of the study was to define a new Doppler parameter, the CPR2, for monitoring the well-being of the FGR.

STUDY DESIGN: This is the pilot study in which we defined the CPR2 as the ratio between the PI of the ACA and the PI of the umbelical artery. We measured CPR and CPR2 in 26 FGR and 171 appropriate-for-gestational age (AGA) fetuses between 24 and 36 weeks of gestation.

RESULTS: The values of the CPR (for both AGA and FGR fetuses) were consistent with the expected values reported in the literature. The graph representing the values of the CPR2 by gestational age among the AGA fetuses was a linear-like curve compared to the CPR curve. Among AGA fetuses, the correlation between the CPR2 and the CPR reported a high R2 value. This result suggests that CPR2 could be considered as a clinically significant alternative. The same correlation amnong FGR was also a linear-like curve, but the R2 is lower because of the limited number of measurements collected.

CONCLUSION: This study suggests that CPR2 may be considerd a clinically useful parameter in the evaluation of fetal well-being among FGR. More data are required to validate this parameter.

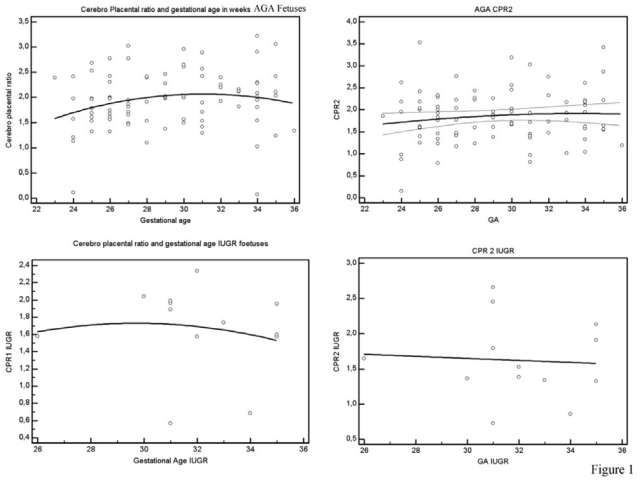
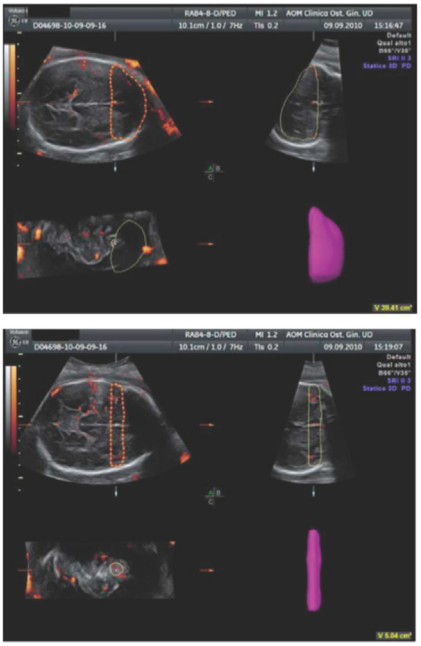


Figure 1



215 Assessment of fetal brain vascularization in fetal growth restriction comparing 3-dimensional power angiography to bi-dimensional velocimetry

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OBJECTIVE: To assess perfusion of different cerebral regions in normal fetuses and in those affected by fetal growth restriction (FGR) using 3D power Doppler angiography (3DPDA) comparing to Bi-Dimensional (2D) Velocimetry.

STUDY DESIGN: 3D-PDA examinations were performed on 70 FGR pregnancies and 183 appropriate-for-gestational age (AGA) fetuses between 24 and 36 weeks of gestation. Three FGR groups were considered: Group 1: Late-onset FGR (GA>34 weeks) with normal 2D Doppler flow measurements; Group 2: Early-onset FGR (GA<34 weeks) with abnormal umbilical artery (UA) pulsatility index (PI), normal middle cerebral artery (MCA) PI; Group 3: Early-onset FGR with abnormal 2D flow measurements in UA and MCA. Plane of section traverses the third ventricle and thalami in the central portion of the brain. After displaying three simultaneous perpendicular planes of fetal head on the monitor the size of the region of interest (ROI) was adapted manually to create the 2 zones : the Frontal Zone (zone 1), perfused mainly by ACA, obtained tracing a contour passing through the anterior side of CSP surrounding part of temporal and frontal bone and the Temporal Zone (zone 2), perfused by MCA, defined by a rectangle obtained tracing a contour from temporal bones of the width of CSP included. The blood flow indices considered were Flow Index, Vascularization Index and Vascularization and Flow Index.

RESULTS: Results In early-onset FGR, 3D PDA showed increase of perfusion in temporal zone compared to AGA fetuses in both groups with and without abnormal MCA 2D findings.

In late-onset FGR vascularization assessed by 3D-PDA was increased in the frontal region, while vascularity in the temporal one was decreased in according with 2D findings.

CONCLUSION: We can define the **Frontal Brain Sparing** as VASCULAR REDISTRIBUTION with preferential increment in bloody supply to the frontal region to protect general cognitive function. 3D Power Doppler angiography can be considered as new tool to study additional vascular parameters of the fetal brain.

216 Prenatal prediction of extracorporeal membrane oxygenation requirement in patients with congenital diaphragmatic hernia

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OBJECTIVE: The prenatal diagnosis of congenital diaphragmatic hernia (CDH) can portend significant neonatal respiratory morbidity for the affected fetus. At the most severe end of the spectrum is the need for extracorporeal membrane oxygenation (ECMO) treatment after birth, which is independently associated with lower survival rates. The severity of anticipated neonatal respiratory morbidity is related to the degree of prenatal lung compression. Lung compression can be estimated by various ultrasound methods (lung-to-head ratio (LHR) based on dimensions of the contralateral lung, observed to expected (O/E) LHR, liver position, side of the hernia). We sought to determine the best ultrasound predictors of neonatal ECMO requirement in patients with CDH.

STUDY DESIGN: This is a retrospective study of a contemporaneous cohort (2010-2015) of prenatally diagnosed CDH managed at a single institution. Multiple ultrasound variables including the LHR, O/E LHR, liver position, side of the hernia, birthweight, and gestational age at delivery were ascertained. Logistic regression related these to the need for ECMO. Receiver operator curve (ROC) analysis was performed to determine the optimal prediction cutoff for ECMO.

RESULTS: 29 CDH cases were studied. Two patients had fetal demise. One neonate died before ECMO was attempted. Of the 26 remaining cases, 12 (46.2%) required ECMO. The median O/E LHR was 39.7% (19.5-81.7%), LHR 1.2 (0.9-2.7), birthweight 3000 grams (200-4400 grams), and gestational age at delivery was 39 weeks (19.1-40.4 weeks). Logistic regression identified only the O/E LHR and birthweight as independent predictors of ECMO (r^2=0.56, p=0.03). ROC