**SSA10-01**

**Gadolinium Chelate Contrast in Pregnancy: Fetal Biodistribution in the Nonhuman Primate**

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**PURPOSE**

To determine whether gadolinium chelate is found in the nonhuman primate fetal tissues and amniotic fluid after maternal injection of intravenous gadoteridol.

**METHOD AND MATERIALS**

Gravid macaques (n=12) were maintained on a control diet (14% calories from fat, n=4) or a high fat diet (36% calories from fat, n = 8). On gestational day 129, the macaques were injected with ProHance gadolinium contrast for placental imaging (equivalent to the third trimester). Gadolinium dose was varied based on maternal weight, using 0.1 mmol/kg dosing. Fetuses were delivered via cesarean section within 24 hours of maternal injection (range 19-21 hours). Gadolinium concentration in the placenta, fetal tissues (bone, liver, brain, kidney) and amniotic fluid was obtained by inductively coupled plasma mass spectrometry.

**RESULTS**

Gadolinium chelate crosses the placenta from the maternal circulation. The levels of residual ProHance in fetal tissue after 19-21 hours following maternal injection expressed as percent dose per gram (%ID/g) or percent dose per organ (%ID/organ). Highest concentrations are present in the amniotic fluid and placenta (0.126 and 0.087 %ID/organ respectively). Per gram of tissue, highest concentrations were found in the fetal kidneys (0.0151 %ID/g). Overall amounts of gadolinium were minimal compared to the injected maternal dose. No difference in concentrations was found between those primates fed the high fat or Western diet (n=8) and the control diet (n=4).

**CONCLUSION**

Minimal residual gadoteridol gadolinium chelate is found in primate fetal tissues and amniotic fluid by 24 hours following maternal injection of weight-based clinical doses of gadolinium in the third trimester. Given the similarities between human and nonhuman primate placentas, we suggest there is relatively little deposition in human fetal tissues following maternal ProHance injection. While there will likely be continued debate whether gadolinium administration during pregnancy is justified, our study provides information that may alleviate some uncertainty regarding the potential for gadolinium free ion toxicity to the fetus following maternal dosing.

**CLINICAL RELEVANCE/APPLICATION**

After injection of gadoteridol in the gravid primate, minimal amounts of this gadolinium chelate is found in fetal tissues and amniotic fluid within 24 hours after injection. Our results may have implications for the safety of contrast-enhanced magnetic resonance imaging in pregnancy.
SSA10-03

Assessing Accuracy of Detecting Post-traumatic Placental Abruption on Contrast-enhanced CT in Pregnant Women and Strategies for Optimizing Imaging of the Placenta


PURPOSE
To determine whether the analysis of the apparent diffusion coefficient (ADC) maps of the subglandular area of the cervical canal helps to predict a forthcoming delivery when dealing with an asymptomatic patient presenting with a sonographic short cervix (SCX) below 15mm and with positive fetal fibronectin (FN) at 22-26 weeks of gestation.

METHOD AND MATERIALS
The institutional review board approved this prospective, hypotheses-generating study and waived the informed consent requirement. Our study population comprised 30 pregnant women (mean age: 29 (20-39) with a mean gestational age at the diagnosis of 24 weeks (22-26) who underwent underwent pelvic MR on a 1.5-T scanner. Sagittal diffusion-weighted were obtained by using a single-shot spin-echo type echo-planar imaging sequence with fat suppression using two b values: 0, 800 s/mm². ADC map was calculated for each patient. ADC subglandular, ADC stromal and Δ ADCs (ADC subglandular - ADC stromal) were calculated. Student t test for both unpaired and paired data and Bravais-Pearson linear correlation, as well as ROC curve analysis were performed using the MedCalc software.

RESULTS

8/30 patients ultimately delivered within 7 days after admission (impeding delivery group) while 22 patients delivered after at least 7 days after admission (between 7-63 days; mean 32 days) and entered the late delivery group. The subglandular ADC and Δ ADCs were significantly higher in patients with impending delivery than in patients with late delivery (p <0.0001 for both parameters). The ROC curve analysis classified the subglandular ADC as an extremely accurate parameter to predict impending delivery (AUC = 1.000, p <0.0001), with an overall sensitivity (95% CI: 63.1% - 100%) and a specificity (95% CI: 63.1% - 100%) of 100%. The ADCs of cervical stromal did not help to differentiate the two groups.

CONCLUSION

When considering a diagnosis of impending preterm delivery, ADC maps targeted to the subglandular area of the uterine cervix greatly increase the PPV granted by the combined findings of a short cervix and positive cervico-vaginal fibronectin.

CLINICAL RELEVANCE/APPLICATION

The ADC maps of the subglandular area of the uterine cervix can predict impending preterm delivery. This result cannot be obtained with other techniques and can be particularly useful in the acute management of patients presenting with SCX and positive FN in the late second trimester of pregnancy.
SSA10-04  
Chorionic Bump in Pregnant Patients and Associated Live Birth Rate: A Systematic Review and Meta-Analysis

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PURPOSE

Chorionic bump, a convex bulge from the choriodecidual surface into the gestational sac on first trimester ultrasound, has been considered a risk factor for non-viability in pregnant patients with this rare finding, though the strength of this association has recently been questioned. We performed a systematic review and meta-analysis to summarize the association between chorionic bump and non-viability.

METHOD AND MATERIALS

A comprehensive literature search was performed. We included all studies except case reports. A meta-analysis was performed using a random-effects model.

RESULTS

After screening five studies, two studies with a total of 67 patients met inclusion criteria. This was combined with one study (N=52) from our institution (submitted for publication to JUM) of 52 patients, for a total of 119 unique patients. Overall, the live birth rate (LBR) was 62% (74/119). 51 chorionic bump pregnancies were otherwise normal (i.e., pregnancies in which a gestational sac, yolk sac and embryo with heartbeat was seen at some point), and in this subset, LBR was 83% (42/51). There was no significant relationship found between vaginal bleeding and live birth (p=0.857); no significant difference in bump volume between live birth and no live birth (p=0.19); and for subset analysis of pooled odds ratio for the relationship between live birth and history of infertility, there was no significant relationship found (p=0.186).

CONCLUSION

Chorionic bump remains a risk factor for non-viability in pregnancy, however if the pregnancy is otherwise normal, then the majority result in live birth.

CLINICAL RELEVANCE/APPLICATION

If a first-trimester ultrasound demonstrates a chorionic bump, then the results of this meta-analysis suggest that if the pregnancy is otherwise normal, the majority will result in live birth.

SSA10-05  
Amniotic Fluid Volume Estimation by MR Hydrography

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PURPOSE

Hypothesis:
Hydrographic MR imaging can provide a rapid non-invasive in-vivo estimate of amniotic fluid volume (AFV).

Background:
Current ultrasound based methods, such as amniotic fluid index and single deepest vertical pocket, are indirect measures of AFV and are known to have limitations, making their use in routine management and research controversial.

METHOD AND MATERIALS

23 women with healthy singleton pregnancies between 28 and 32 weeks gestation were consented for MR examinations of the gravid uterus using a 1.5T MRI system. Two breath-hold techniques were used: (1) 2D 5mm thick section FIESTA, surface array coil (2) 2D 200mm thick section PSE TE 800ms, integrated volume body coil
A reference fluid volume of 50mls normal saline was positioned anterior to the abdominal wall and within the field of view of (2). Manual planimetry was used to outline all of the amniotic fluid demonstrated on each 5 mm section of (1), which were summed to provide the reference standard for AFV. Manual regions of interest were used to outline the reference volume and amniotic fluid sac on (2). Using the signal area product, the volume of the amniotic fluid was estimated. The maximum values from the 5 acquisitions were compared with the reference planimetry results using a non-parametric Spearman's rank correlation.

RESULTS

Fluid volumes between 146 and 884 mls were found on planimetry. High inter-rater agreement was noted for both the methods (ICC=0.961 and 0.997). The rank order correlation between the planimetry and the hydrographic method was highly significant (r=0.864, p<0.001). A linear fit equation of y=0.6081 + 163.05mls was obtained, with planimetry defined as the independent variable. This relationship suggests that the inclusion of fetal fluid structures is likely to bias the results positively at lower AFV, and the inhomogeneity of B1 excitation is likely to bias the results negatively at larger AFV.

CONCLUSION

This initial study indicates that it is possible to estimate AFV with MRI using a rapid hydrographic technique, SSA10-04 SSA10-05
This initial study indicates that it is possible to estimate AFV with MRI using a rapid hydrographic technique, based on single thick slab acquisitions. Further optimisation for fetal fluid structures, RF inhomogeneity, as well as data at different gestational ages will be required.

**CLINICAL RELEVANCE/APPLICATION**

A rapid MR hydrographic based estimate of amniotic fluid volume may allow for improved pregnancy management, and new research into fetal outcomes.

**The Ups and Downs of CT Utilization in Pregnancy**

**PURPOSE**

To review CT utilization in pregnant women from 2006-2013 and to evaluate for an interval decrease as concerns over radiation exposure from medical imaging have increased.

**METHOD AND MATERIALS**

This IRB approved, HIPAA compliant retrospective review of the radiology database at a large academic women's hospital was conducted to identify all CT examinations performed in pregnant females from January 1, 2006 - December 31, 2013. Patient age, gestational age at the time of CT, indications for the study, final impression, radiation dose and additional imaging exams performed within one week for the same complaint were recorded.

**RESULTS**

There were a total of 440 CT examinations performed in pregnant patients during the study period. There were 69,508 deliveries during the study period. 24 patients had 2 CT exams during the same pregnancy. Average patient age was 27 (range 15-40 yrs). Average gestational age at time of CT was 27 weeks (range 5 to 40 weeks). The majority of CTs were performed in the third trimester, 56% (246/440). The most common CT examination performed over the 8 year span was a CT Pulmonary Embolus 44% (194/440) followed by a CT of the abdomen and pelvis 33% (144/440). The most common indication for a CT exam was shortness of breath 33% (144/440). Positive, acute findings were identified in 21% (91/440) of exams. There were a total of 301 additional imaging studies performed on this patient cohort, with chest X-ray being the most common 35% (106/301). CT utilization per 1000 deliveries in 2006/2007 was 6.1, increasing 33% to 8.1 in 2008/2009. Utilization decreased 50% from peak utilization in 2008/2009 to 4.1 in 2012/2013. The average overall CT acquired radiation dose for all patients was 27.63 mGy.

**CONCLUSION**

CT utilization in pregnant patients has declined 50% over the past 4 years.

**CLINICAL RELEVANCE/APPLICATION**

CT utilization in pregnancy has declined over the past 4 years as awareness of radiation related to medical imaging has increased among both patients and providers.

**Three-dimensional Visualization of the Placental Arterial and Venous Vasculatures ex vivo by 64-spiral CT**

**PURPOSE**

The purpose of this study is for the first time to investigate the three-dimensional visualization of the placental arterial and venous vasculatures ex vivo on 64 spiral CT angiography by injecting two different concentrations of contrast agent into arteries and veins.

**METHOD AND MATERIALS**

The placentas from 25 healthy singleton pregnancies were injected with two different concentrations of color dyed non-ionic iodinated contrast medium in umbilical arteries and veins (red solution with 150 mg of iodine per milliliter for chorionic arteries paired with blue solution with 30mg of iodine per milliliter for chorionic veins in each placenta, respectively). Computed tomography angiography was employed by 64 spiral CT and reconstructed using Vital Images' Vitrea® medical imaging software, allowing for the three-dimensional configuration of placental tree with chorionic arteries and veins in different densities or colors. The branches of the intraplacental villous vascular trees were observed, and the diameters of each branches of arteries and veins were measured on digital photograph.

**RESULTS**

The 3D visualization of placental vascular tree was delineated with arteries and veins in different densities or colors. The CT angiography showed the vessels starting with the chorionic vessels branching off into 5-6th generation blood vessels in arteries and 4-5 generation blood vessels in vein, of which some in the placental
CONCLUSION

Placental arteries and veins could be differentiated in one CT angiography by injecting different concentrations of contrast agent. The deep blood vessels in the placental parenchyma could be delineated.

CLINICAL RELEVANCE/APPLICATION

Ex vivo CT angiography of the placental arteries and veins can demonstrate deep blood vessels in the parenchyma and is recommended in the investigation of deep arterio-venous anastomoses within twin or triplets placentas.

Automatic Differentiation of Functional Placental Compartments for Perfusion Analysis in the Mouse Using the Time-to-peak Model at 7T

PURPOSE

DCE MRI is a commonly applied imaging technique for perfusion quantification and is frequently used in experimental setups for perfusion analysis in the mouse placenta. To date, placental perfusion analysis is commonly performed by determining the average perfusion value for the entire placenta without taking the different functional placental compartments into account. The purpose of this work was to develop an automatic differentiation of the two functional placenta zones in a mouse model based on bolus arrival times for a detailed and reproducible perfusion assessment.

METHOD AND MATERIALS

Ten pregnant BALB/c mice at gestation day 16.5 were examined at 7T. Coronal dual-echo 3D T1-weighted gradient-echo sequences were acquired after application of contrast agent for dynamic MR-imaging. An adapted gamma variate function was fitted to the concentration time curves to evaluate the effect of noise on perfusion and segmentation results. Maps of the bolus arrival time were calculated based on discrete and fitted curves and used to classify each voxel into a high-flow and low-flow compartment based on k-mean clustering. Segmentation results were evaluated based on the DICE coefficient with manually delineated compartments from two independent observers. Perfusion analysis was performed on discrete and fitted curves using the steepest slope model.

RESULTS

Manually delineated high-flow and low-flow compartments agreed with automatic segmented compartments for discrete (D=0.76/0.75; D=0.76/0.79) and fitted (D=0.80/0.80; D=0.81/0.82) concentration time curves. Mean perfusion values of discrete and fitted curves ranged in the high flow compartment from 134 to 142 ml/min/100ml (discrete) vs. 138 to 143 ml/min/100ml (fitted) and in the low-flow compartment from 91 to 94 ml/min/100ml (discrete) vs. 74 to 82 ml/min/100ml (fitted).

CONCLUSION

Functional perfusion compartments can be automatically differentiated using bolus arrival times with a high agreement to manual differentiations. Fitting of the gamma variate function improves segmentation results. The proposed method may overcome reported limitations in perfusion analyses by eliminating the subjective choice of regions of interest.

CLINICAL RELEVANCE/APPLICATION

The heterogeneity within the placenta with its two functional compartments generates the need for separate compartment analysis to enable a more detailed and reproducible understanding of placenta perfusion.

DCE MRI of the Placenta Reveals Alterations of Placenta Perfusion after a Stress Challenge during Pregnancy in Mice

PURPOSE

Stress during pregnancy is known to have a negative effect on fetal outcome, possibly via placenta mediated pathways. The purpose of this study was to examine alterations in placental perfusion upon a stress challenge during pregnancy in mice.

METHOD AND MATERIALS
MRI was performed on a 7Tesla scanner (ClinScan, Bruker, Germany) on 20 pregnant Balb/c mice on gestation day (gd) 16.5. 10 damns were exposed to an established model of acoustic stress challenge, 10 damns served as controls. For DCE-MRI, a contrast enhanced 3D T1-weighted gradient-echo sequence was used. Placental perfusion was calculated based on the steepest slope model in 2 placentas per dam. The two functional placental compartments, the highly vascularized labyrinth and the endocrine junctional zone, were assessed separately. Immunohistochemistry, including staining for neoangiogenesis, was performed on placentas after imaging.

RESULTS

Perfusion increased significantly upon a stress challenge, compared to the control group (192 + 51 ml/ml/min vs. 141+ 28ml/ml/min ) (p< 0.001) in the highly vascularized labyrinth - the zone of oxygen and nutrition exchange of the placenta. This observation was supported by immunohistochemistry of the placentas, demonstrating an increased expression of the angiogenesis biomarker CD31 (p ≤ 0.01) and an increased count of small and medium vessels in the placental labyrinth of the stress challenged group (p ≤ 0.01).

CONCLUSION

Placental perfusion increases upon a stress challenge during pregnancy, possibly by neoangiogenesis of small and medium size vessels.

CLINICAL RELEVANCE/APPLICATION

Stress has a profound impact on fetal outcome and health conditioning, yet the underlying mechanisms remain unknown. Studying placental vascular alteration may help to understand these pathways.