

MR susceptibility imaging of the human placenta in vivo: Preliminary results in healthy pregnancies

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BACKGROUND

Quantitative susceptibility mapping (QSM) is a non-invasive MR imaging technique for measuring magnetic susceptibility of tissue. While QSM is typically used to study iron deposition, myelination, and hemorrhage in the brain, it may also have the potential to identify early evidence of hypoxia, hemorrhage, and calcifications in the placenta. In this study we successfully demonstrated simultaneous acquisition for QSM and T2* mapping of the human placenta with maternal free breathing at 1.5 T and 3 T.

OBJECTIVE

To demonstrate the feasibility of performing QSM in the human placenta in vivo.

METHODS

Six healthy pregnant women were recruited under a protocol approved by our institutional review board. Five women were studied at 1.5 T and two women were studied at 3 T. One woman was studied at both 1.5 T and 3 T on the same day. Image acquisition for QSM and T2* mapping was performed using a 3D multi-echo gradient echo sequence with flow compensation. Imaging parameters include FOV = 36-38 cm, matrix size of 320x128, and 22-30 slices with slice thickness of 3 mm. Prospective respiratory triggering was performed using respiratory bellows, and an acquisition window of 30% was placed at end-expiration. For the outside of acquisition window, dummy acquisitions were performed to minimize perturbation of the transition and steady state of magnetization. Total scan time with SENSE (R=2) was 6-7 min for 1.5 T and 3-4 min for 3 T. Scans were performed on GE MR450 1.5 T and MR750 3 T scanners using an 8-channel cardiac coil. QSM reconstruction was performed using the approach of morphology-enabled dipole inversion (MEDI). T2* was calculated using nonlinear fitting of magnitude data. The placenta was manually segmented on each slice for QSM reconstruction and T2* fitting.

RESULTS

There was a trend for decreasing median T2* with increasing standard deviation (SD) of susceptibilities ($p=0.04$). These results of QSM and T2* mapping corroborate each other because a larger magnitude of susceptibility (either positive or negative) contributes to lower T2*. Median T2* of the placenta also showed a trend toward a decrease with advancing gestational age, demonstrating good agreement with a previous study. Both susceptibility and T2* maps show lobulation on the placenta more pronounced than anatomical images at both 1.5 T and 3 T. Regions inside the lobules show lower susceptibility and higher T2* values, likely reflecting higher oxygenation in these highly vascularized regions.

CONCLUSION

We demonstrated the feasibility of performing QSM and T2* mapping of the human placenta at 1.5 T and 3 T. Placental QSM may provide a new, non-invasive contrast for evaluation of pregnancies at risk for hypoxia-ischemia, hemorrhage, or calcifications in the placenta.