Comparison of US and MR measurement of amniotic fluid volume at 28-32 weeks

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Target audience

This abstract is relevant to those with an interest in obstetric imaging with MRI.

Purpose

Third trimester amniotic fluid volume (AFV) estimation is part of routine antenatal care, with poly or oligohydramnios considered an indirect sign of fetal stress or abnormal development, leading to management changes. Ultrasound estimation of AFV is well established with standards using two semi-quantitative techniques; single deepest vertical pocket (SDVP) and amniotic fluid index (AFI). In recent years, fetal MRI has become increasingly used to evaluate suspected fetal abnormalities but there have been only limited studies[1, 2] of AFV. These have used manual planimetry (MP) techniques based on quantification of multiple regions of interest (ROI) on multi-section imaging, which are laborious and not practical for routine clinical use. Rapid MRI assessment of other fluid volumes (stomach, bladder, pancreas secretion) has been previously demonstrated using projection hydrography (PH) techniques based on thick section heavily T2w SSFSE imaging. This work evaluates this approach applied to in vivo AFV assessment using a reference fluid volume and compares the results with MR based planimetry techniques and established US measurements.

Methods

Participants with a normal single pregnancy (28 to 32 weeks gestation) undergoing routine antenatal care were recruited for the study. MR examinations were performed using a 1.5 T MRI system (DV 450, GEHC, Wisconsin) the integrated body coil and left decubitus positioning. A 50 ml bag of normal saline was included as a reference in the field of view. Breath-hold PH was performed in axial and sagittal planes with 20cm thick-slab SSFSE sequences (TE 800msec, TR 10seconds, matrix 384x256, FOV 32cm). Five one second long acquisitions were obtained in each location to allow for fetal motion causing signal loss through spin dephasing. In addition breath-hold 5mm thick multisection FIESTA sequences for MP were obtained in axial and sagittal planes (TE, 1.4msec TR 4.3msec, matrix 384x256, FOV 36cm) through the whole uterus. Same day routine US examination was performed with SDVP and AFI measurements. Two independent observers (blinded to US results) analysed the MRI on a workstation (Osirix, CH). MP was performed on amniotic fluid regions on the FIESTA imaging. On the PH separate ROIs were drawn around the entire amniotic sac and the reference volume. By extrapolation from the 50ml reference volume (signal mean x area product) the AFV was estimated and the maximum value from the 5 acquisitions used as the final AFV.

Results

11 completed studies were obtained with one incomplete dataset owing to an operator error. There was good inter-observer agreement for MRI measurements (sagittal MP ICC = 0.984, sagittal PH ICC = 0.996) and PH and MP measurements correlated strongly, particularly in the sagittal plane (Sagittal R^2= 0.899), see figure 1. Moderate correlation was achieved for AFI vs Sag PH (R^2 = 0.440), see figure 2.

Fig 1

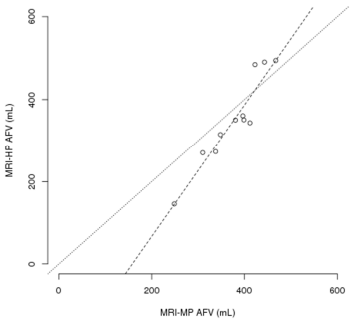
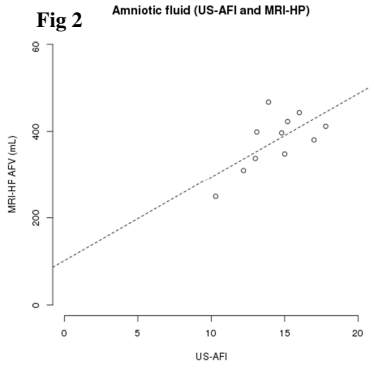


Fig 2



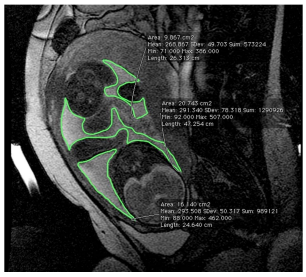


Fig 3: MP measurement of sagittal fluid volume (single slice)

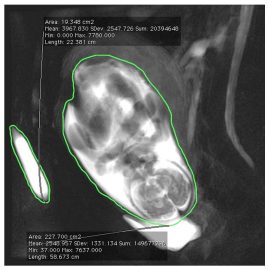


Fig 4: PH measurement of sagittal fluid volume (total volume)

Discussion

The PH method presented here has several limitations, e.g. amniotic fluid assumed similar T2 to normal saline, incorporation of fetal CSF, bladder ,stomach and maternal bladder signal, as well as motion related and other signal losses. However the established US method has similar limitations[3] and it can be argued that MP using multi-section MRI is likely to be more accurate than US AFI or SDVP and in this study the PH and MP MR methods correlated strongly. Future work will investigate a larger number of patients and adjustments to account for actual T2 fluid values and contaminating fluid volumes (CSF, bladder etc).

Conclusion

Further development of this novel rapid estimation of amniotic fluid volume to compensate for incorporated bladder and CSF volumes may lead to a technique that is appropriate for routine clinical use. This would allow a more comprehensive fetal assessment when using MRI and could provide similar or better information than US for antenatal care.

References

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