Real-time virtual sonography using MRI and ultrasound fusion imaging in the evaluation of CNS anomalies

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Objective

Over the last years prenatal ultrasound has experienced the benefits of high resolution probes and the use of transvaginal ultrasound to facilitate the difficult diagnosis of central nervous system anomalies. In addition fetal MRI has become a part of a complementary tool in establishing and fine tuning the diagnosis and prognosis. Both techniques deliver their maximal potential in the hands of clinical experts. Unfortunately the experts for fetal ultrasound and fetal MRI are most of the time not the same person. Combination of ultrasound and MRI could provide the benefits from both techniques. The MRI and ultrasound fusion technology has been introduced into medicine and has been successful to diagnose and treat tumors. The technology provides synchronization of MRI and ultrasound images. Only one paper addressed the potential of this technique in prenatal diagnosis. AIM The aim of this study is to evaluate the additional value of real-time virtual sonography in central nervous system anomalies and to look for the gestational age on the feasibility. Does the fusion imaging technique performed by a fetal medicine specialist provide more information than the fetal ultrasound only and is the additional information gained by the fusion technique superior to that found by the fetal MRI specialists?

Methods

In our Fetal Medicine Unit, we performed during a 4 month period (april 2014- august 2014) 14 MRI-US fusions to evaluate the fetal brain in cases of suspected central nervous system malformation. 14 patients with a CNS anomaly were offered to undergo a fusion imaging. The patients had a tentative ultrasound diagnosis and were scheduled for fetal MRI. All MRI were performed on a 1, 5 Tesla MRI machine under maternal sedation with flunitrazepam. After the acquisition of the dataset, the fetal MRI was loaded into the DICOM (Digital Imaging Communications in Medicine) system and combined scanning was started within 30/60 minutes after the MRI. The images were synchronized in the same plane using 3 anatomical reference points. The feasibility of real-time fusion was evaluated compared to B-Mode Ultrasound and MRI.

Results

5 patients were referred for CMV seroconversion in the first trimester of pregnancy. 2 patients were referred for ventriculomegaly and one for discordant ventricles. 2 patients with spina bifida and one patient with meningomyelocele were included. One patient had a subdural bleeding while another patient had IVH grade 1. In the last patient a subependymal cyst was diagnosed. Real time virtual sonography was technically possible in all patients. Data registration, matching and fusion imaging were performed in less than 30 minutes after the MRI and was possible from 26 weeks onwards. In the ability to identify and to assess CMV related abnormalities we did not find additional information due to the fusion technique. In one patient polymicrogyria was not depicted on ultrasound but seen on fetal MRI. Fusion was not conclusive in this case. In another CMV patient a cyst was suspected in the posterior horn and picked up by MRI. Fusion only confirmed the presence of this cyst. In the 2 cases of intraventricular hemorrhage the fetal MRI confirmed the ultrasound report. Fusion did not demonstrate parenchymal compression or cortical lesions missed by US/MRI. In the patient with the subependymal cyst, ultrasound was able to visualize the septa in the cyst while MRI/fusion was less accurate to identify these small septa. In the cases of spina bifida, meningomyelocele and ventriculomegaly the images of the prenatal ultrasound and MRI could be matched but no additional information was given by the real time sonography. Fetal MRI confirmed the exact location and size of the spinal lesion previously diagnosed by ultrasound. In the 3 cases of ventriculomegaly the US and MRI images could be merged but no additional information of the fetal brain was found.

Conclusion

Fusion imaging is feasible in the assessment of CNS affected fetuses from 26 weeks onwards. Fusion of ultrasound and MRI images does not show anatomical details that would not be seen by US or MRI alone. However data integration of both modalities could improve the multidisciplinary prognostic appraisal as well as the prenatal counseling.