# Real-time SSFSE Imaging of the Fetus

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**Introduction:** The SSFSE imaging sequence can provide excellent high contrast images of the fetus. However, due to the necessity of obtaining imaging rapidly enough to freeze fetal motion, these images tend to be limited in spatial resolution and signal-to-noise ratio (SNR). Due to fetal motion, it is often difficult to obtain slice orientation in planes that are completely orthogonal to the fetus. The purpose of this work was to evaluate the utility of Real-time Single Shot Fast Spin Echo (RT-SSFSE) in clinical imaging of the fetus.

**Methods**: Standard and RT- SSFSE imaging was performed in 30 examinations of 27 patients referred for MRI of the fetus. Twenty examinations in 17 patients were for clinical indications (posterior fossa abnormality N=3; extremity abnormality N=3; interventricular hemorrhage N=2; at risk for cleft soft palate N=2; and one case each of agenesis of the corpus callosum, lymphatic malformation, monochorionic twins with one demise, unexplained polyhydramnios, congenital diaphragmatic hernia, hypoplastic nose, and possible renal agenesis). Ten examinations were part of a research study on ventriculomegaly. The Beth Israel Deaconess Medical Center Institutional Committee on Clinical Investigations approved the research protocol and written informed consent was obtained from all subjects. We performed all scans on a General Electric Signa Excite 1.5T TwinSpeed MR imaging system (GE Medical Systems, Waukesha, WI, USA) using a flexible eight element body array (W.L. Gore and Associates, Newark, DE, USA). Gestational age ranged from 15-36 weeks, with a mean ± standard deviation of 25.6 ± 6.3 weeks.

In each patient, we obtained standard SSFSE images sets (TR single shot, TE 90 ms, 360-420 mm FOV, 3-4 mm slice thickness) in fetal sagittal, coronal and axial orientation. Enough slices were acquired to cover the region of interest in 3 planes and the entire fetus in at least one plane. Sequences were repeated as needed if obliquity or fetal motion limited the study.

We then proceeded to use RT-SSFSE (1) to visualize a specific region of the pertinent anatomy. For fetuses with ventriculomegaly, question of cleft soft palate, and posterior fossa abnormality, this was the midline sagittal view of the face and brain. For fetuses with cleft lip and question of cleft soft palate these were coronal and sagittal views of the face and oropharynx. Other real-time views were obtained for fetuses with extremity and genitourinary abnormalities. During realtime imaging, scan parameters including, FOV, slice thickness, plane orientation, delay between obtaining slices, and TE were adjusted interactively to give optimal image quality. The matrix size was fixed at 256 x 256 for all RT-SSFSE images. Prospective data was recorded by the radiologist proscribing the imaging parameters was a comment on the utility and ease of use (or lack thereof) of RT-SSFSE. For each patient, the limitations of the standard SSFSE images were recorded (obliquity was recorded on a four point scale (0-3) with 0 indicating no obliquity limitation and 3 indicating severe limitation). Motion and SNR were recorded as degrading or not degrading image quality.

For 23 patients with 25 examinations where sagittal midline face and brain were the pertinent anatomy, a radiologist with expertise in fetal imaging chose the best single midline view from standard imaging and RT imaging. These were presented to 3 reviewers for blinded review. Images were compared with respect to SNR, resolution, motion, and overall image quality to demonstrate midline anatomy.

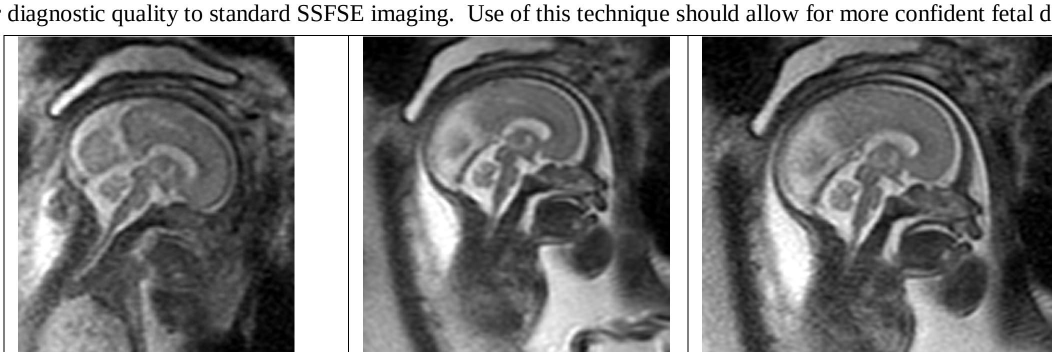
**Results:** Three to six (mean of 3.8) multi-slice acquisitions with standard SSFSE were obtained in each patient. Obliquity limited image quality of the first acquisition of each patient in 22/30 cases with an obliquity mean score of 1.43. Obliquity limited image quality of the second and third acquisition of each patient in 20/30 cases with obliquity mean scores of 1.03 and 1.00 respectively. The first three acquisitions in the standard studies were felt to be limited by motion in 25/90 cases and SNR in 3/90 cases.

Figure 1 shows examples of SSFSE and RT-SSFSE images obtained in this study. Fig. 1A shows a typical SSFSE image from a patient and Fig. 1B shows the corresponding RT-SSFSE image. In 5 cases the interactive image optimization with dynamic changes in slice thickness and FOV were felt prospectively to have aided in performing the study. In all cases RT-SSFSE was judged easy to use.

In blinded retrospective review RT-SSFSE was judged to have provided a better sagittal midline view for assessment of anatomy in 23/25 cases and an equivalent midline sagittal view in the remaining 2 cases. SNR was judged better on the sagittal midline view in 24/25 cases.

**Discussion:** RT-SSFSE allows for interactive optimization of imaging parameters. Since fetal motion frequently leads to oblique image planes, use of RT-SSFSE allows for obtaining improved anatomic slices orthogonal to fetal anatomy. Another benefit of RT imaging is that since a single image can be obtained, there is often better SNR since there is no cross talk between consecutive slices.

**Conclusion:** RT- SSFSE imaging of the fetus allows for interactive optimization of imaging parameters and slice orientation. This results in images of superior diagnostic quality to standard SSFSE imaging. Use of this technique should allow for more confident fetal diagnosis.



| Best midline view from Standard SSFSE imaging In 27 week gestational age fetus | Midline view from RT-SSFSE | Repeat midline view from RT-SSFSE imaging |
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**References:** 1. Busse RF, Riederer SJ, Fletcher JG, et al. Interactive fast spin echo imaging. Magnetic Resonance in Medicine. 2000;44:339-348.