MR Imaging Within the Neonatal Intensive Care Unit: Initial Experience

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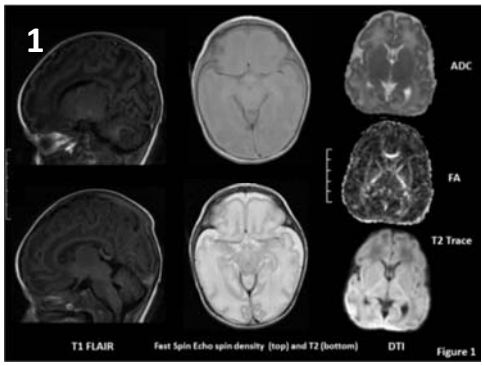
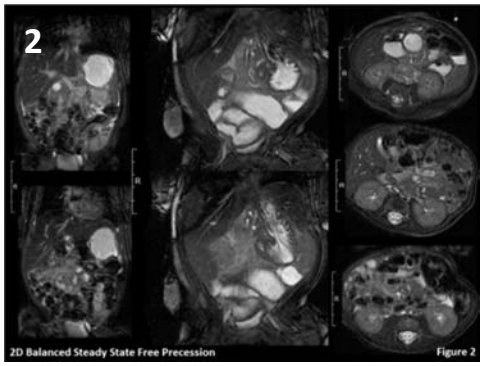
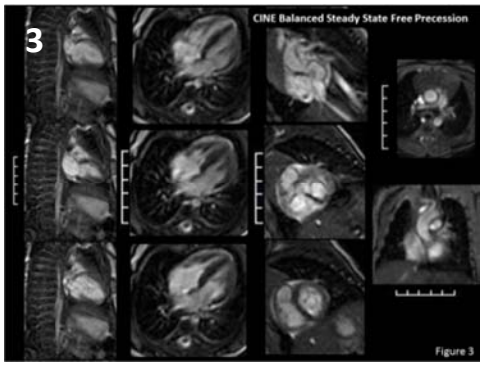
Purpose: The most significant obstacles preventing routine clinical MRI in neonatal medicine are the logistics and medical risk associated with transporting the infant from the Neonatal Intensive Care Unit (NICU) to the Radiology Department for the exam. To address these impediments, we have developed a small footprint 1.5T MRI system for neonatal imaging and easy installation in the NICU. The purpose of this study was to evaluate the safety and image quality of this novel NICU MRI system in 15 neonates.

Methods: A 1.5T MR system designed for orthopedic use was adapted for neonatal imaging. The magnet is superconducting and has a bore diameter of 21.8cm without an RF coil. Modifications included raising and leveling the magnet, construction of a patient table and integration of imaging electronics of a high performance adult-sized scanner. The end result is a small footprint 1.5T system with all of the advanced imaging capabilities of a high-end conventional MRI unit. 15 medically and thermally stable neonates (post menstrual age (PMA) at scan: (31wk + 4d – 46wk + 3d; weight at scan: 1.6 – 3.36 kg) were recruited into the study. In accordance with our Institutional Review Board, written informed consent was obtained from the parents of each baby prior to imaging. 18cm or 16cm single channel volume coils were used to obtain MR exams of the brain, abdomen and chest without sedation ("feed and swaddle" method employed) using standard clinical protocols. ECG, heart rate, oxygen saturation and temperature were monitored continuously throughout the exam. Axillary temperature at the start and end of the exam was also noted. The images were evaluated by two pediatric radiologists and one MR experienced pediatric cardiologist for overall study quality, motion artifact, spatial resolution, signal-to-noise and contrast.

Results: All 15 exams were successfully completed without sedation. No adverse MR related events were noted. The total imaging time (limited to 60 minutes by the IRB protocol) for each subject was 59 ± 1.13 minutes; range 58 – 60 minutes. The average time between infant arrival and departure from the MRI Control Room was 1 hour 18 min 30 sec ± 520 sec (range: 1 hour 10 min – 1 hour 36 min). High quality diagnostic images were obtained at each anatomic location using standard sequences (e.g. conventional and fast SE, FLAIR, DTI, balanced SSFP, 3D IR prepared SPGR and TOF MRA, SWI and phase contrast). Gross (versus physiologic) subject motion proved to be the most influential factor in determining overall study and image quality. 15 MR exams of the brain were performed (Figure 1). Five of the preterm infants showed no brain abnormalities, consistent with earlier ultrasound and clinical findings. The remainder of the brain MRI exams demonstrated intracranial pathology such as cerebellar hemorrhage and white matter injury, the majority of which had been seen on prior ultrasounds. Seven MR exams of the abdomen were performed. In two infants, the bellows used for respiratory motion compensation proved to be insufficiently sensitive and provided only marginal benefit. When gross infant motion was negligible, high quality T1 and T2 weighted images (Figure 2) were obtained suggesting the clinical potential of this imaging platform for MRI of the neonatal abdomen. ECG triggered cardiac studies were performed on two of the infants. The images were assessed to be of good and diagnostic quality by the MR experienced pediatric cardiologist (Figure 3).







Conclusion: Our preliminary experience using the neonatal MRI system demonstrates its feasibility, safety and potential benefit to neonatal medicine, providing state of the art MRI capabilities within the NICU.