Use of a 32-channel coil to improve resolution in assessing brain perfusion of newborn infants with 3T MRI

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INTRODUCTION.

Studies of brain perfusion in newborns based on arterial spin labeling (ASL) perfusion weighted imaging (PWI) magnetic resonance imaging (MRI) have been limited by a low signal-to-noise ratio (SNR) [1]. Several solutions have been proposed to solve this problem, including use of an ultrafast echo planar imaging (EPI) acquisition, or use of 3 Tesla (T) MRI. We sought to utilize a multichannel coil that offers increased signal-to-noise ratio to determine if this enables higher spatial resolution imaging. Our study assesses the brain perfusion of a normal term newborn infant using a 32-channel 3T head coil.

PATIENTS AND METHODS.

Data from a normal term newborn (study patient) were acquired on a 3T Siemens MAGNETOM Trio, a TIM System (Siemens HealthCare, Erlangen, Germany), using a commercially available 32-channel head coil. The newborn underwent a complete MRI study, including conventional imaging and ASL-PWI MRI, sleeping naturally after having been fed and wrapped in blankets and a vacuum pillow. Data from a different normal term newborn (control patient) previously scanned on the standard 12-channel head coil using the typical clinical protocol were used for comparison. Parental consent was obtained for all the scans.

A 32-channel head coil (Siemens HealthCare, Erlangen, Germany) developed for human brain imaging and previously described [2] was used. The performance of this array has been previously evaluated in adults showing SNR gains of up to 3.5-fold in the cortex and 1.4-fold in the corpus callosum compared to the standard 12-channel matrix head coil. The experimentally measured g-factor performance of the helmet array has shown significant improvement compared to the 12-channel matrix head coil (peak g-factor 59% and 26% of the twelve-channel values for four- and fivefold acceleration). The performance of the coil has been demonstrated in high-resolution and highly accelerated brain images. However, it has not been used clinically on pediatric imaging.

In addition to conventional anatomical imaging, we used a pulsed ASL sequence to measure perfusion (PICORE Q2TIPS) [3] with an EPI readout including prospective motion correction (3D PACE). Images were acquired with 2 different slice thicknesses:

(1) Typical ASL-PWI parameters for newborns: 18 slices were acquired with a slice thickness of 6 mm. The imaging parameters were TI1 (time between inversion recovery pulse for labeling the blood and periodic saturation pulse) = 700 ms, TI1s (time between inversion recovery pulse for labeling the blood and end of the saturation pulse on the labeling plane) = 1400 ms, and TI2 (time between inversion recovery pulse for labeling the blood and beginning of the imaging data acquisition by an EPI sequence) = 1500 ms, and, TE (echo time) / TR (repetition time) = 13/2400 ms, FOV (field of view) = 192 mm, 64 x 64 matrix EPI readout, giving an image resolution of 3 x 3 x 6 mm.

and (2) Optimized parameters for the ASL-PWI MR 32-channel acquisition: 29 slices were acquired with a slice thickness of 3 mm giving an image resolution of 3 x 3 x 3 mm. All other parameters were as in (1).

RESULTS.

Figure 1 shows perfusion maps obtained with the standard 12-channel 3T matrix head coil in the control patient. **Figure 2** shows perfusion maps obtained with the same typical imaging parameters but utilizing the 32-channel 3T head coil in the study patient. **Figure 3** shows perfusion maps obtained with optimized parameters and the 32-channel 3T head coil in the study patient.

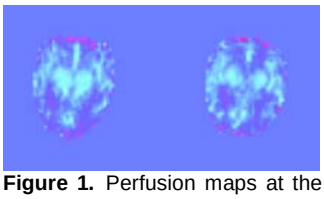

Figure 1. Perfusion maps at the level of basal ganglia, obtained with the typical parameters and the standard 12-channel 3T head coil.

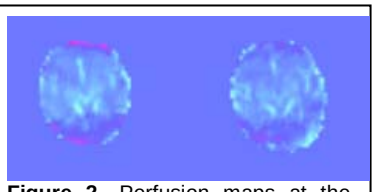

Figure 2. Perfusion maps at the level of basal ganglia, obtained with the typical parameters and the 32-channel 3T head coil.

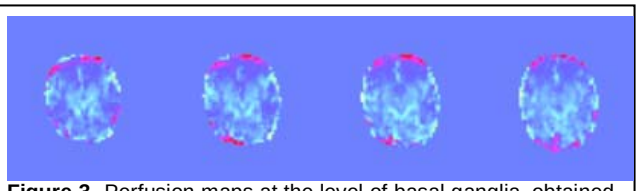

Figure 3. Perfusion maps at the level of basal ganglia, obtained with the optimized parameters and the 32-channel 3T head coil.

First, perfusion maps obtained with the standard 12-channel 3T head coil or with the 32-channel 3T head coil were compared. The perfusion maps obtained with the 32-channel 3T head coil showed improved spatial resolution and better differentiation of cortex, white matter, and basal ganglia.

Second, perfusion maps obtained were compared using the 32-channel 3T head coil. The perfusion maps obtained with the 32-channel 3T head coil and higher spatial resolution permitted acquisition of more slices of smaller thickness. This further improved the differentiation of cortex, white matter, and basal ganglia, reducing measurement error for regional cerebral blood flow by reducing partial volume artifact.

DISCUSSION.

This study demonstrates that the use of a 32-channel 3T head coil permits the acquisition of perfusion maps of improved signal in a term newborn infant, which improved differentiation of cortex, white matter, and basal ganglia. Furthermore, the increase in SNR obtained using the 32 channel coil enables reduction in slice thickness to obtain more slices in which the important brain structures are better perceived.

In conclusion, the 32-channel 3T head coil has been shown to improve spatial resolution and signal-to-noise ratio in measuring brain perfusion with 3T magnetic resonance imaging. This should increase the accuracy of the measurements of brain perfusion in newborn infants, and enable measurements in premature newborn infants who have even a smaller brain.

REFERENCES: [1] Wang J, et al., Magn Reson Imaging 24, 249, 2006; [2] Wiggins GC, et al., Magn Reson Med 56, 216, 2006; [3] Luh WM, et al., Magn Reson Med 41, 1246, 1999.