Purpose:
To demonstrate the feasibility of performing natural abundance 17-oxygen (17-O) MRI imaging of the human brain at 9.4T and illustrate that a constrained reconstruction approach using 23-sodium (23-Na) data provides improved image quality for natural abundance 17-O data.

Materials & Methods:
Natural abundance 17-oxygen and 23-sodium MR imaging was performed on a healthy volunteer using the 9.4T 80 cm MR scanner described in [1]. Data were acquired using a modified version of the previously reported twisted projection imaging [2] and custom-built, single-tuned quadrature birdcage RF coils. These RF coils can be rapidly exchanged without disturbing the subject, enabling the co-registered acquisitions from different nuclei. Data co-registration is required for constrained reconstruction.

After shimming at the sodium frequency to a whole-head linewidth of less than 25 Hz, sodium imaging was performed with an isotropic resolution of 3.125 mm in 6 minutes and 36 seconds. Natural abundance 17-O imaging was then performed with an isotropic spatial resolution of 7 mm in 7 minutes and 50 seconds. The specific absorption rate (SAR) was monitored in real-time during all acquisition and remained within FDA guidelines.

Image reconstruction was performed using a conventional 3D gridding approach with a Kaiser-Bessel interpolation kernel. Constrained reconstruction of the 17-O data was performed using the high-resolution sodium data as the constraint [3].

Results:
The reconstructed sodium and oxygen images are shown in Figure 1, where it can be seen that natural abundance 17-O imaging of the human brain in less than 8 minutes is possible at 9.4T. The constrained reconstruction illustrates that the intrinsic data quality can be improved upon by incorporating information that can be readily obtained from other nuclei (23-Na in this case). Using an acquisition optimized for time (rather than SNR), whole-brain 17-O imaging can be performed as rapidly as 26 seconds. When combined with constrained reconstruction techniques, this potentially enables near real-time 17-O imaging to be performed in humans.

Conclusion:
Human 17-O imaging can be achieved at 9.4T and enhanced by constrained reconstruction.

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References: