

Sodium MRI on Human Brain at 7T with 15-channel Array Coil

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INTRODUCTION

Phased array coils have the ability to significantly increase signal-to-noise ratio (SNR) in proton (¹H) MR imaging as compared with volume coils (1-2). This SNR advantage has, however, not been fully demonstrated in sodium (²³Na) imaging yet. This study is intended to present the SNR advantage of a customer-built 15-channel array coil for sodium imaging on human brain at 7T.

METHODS AND EXPERIMENTS

MRI scans. Sodium imaging was performed on a whole-body 7T MRI scanner of max gradient amplitude 40 mT/m and max slew rate 170 mT/m/ms (Magnetom 7T MRI, Siemens Medical Solutions, Erlangen, Germany). Five adult healthy human subjects (aged 19-30 years) were scanned under an approved Institutional Review Board (IRB) protocol. A customer-built 15-channel head array coil of volume (birdcage for transmit/receive) and array (15-channel insert for receive-only) modes was used for data collection. The B₀-field shimming was implemented with an 8-channel head array proton coil (Rapid Biomedical GmbH, Rimpar, Germany). Acquisition parameters were: TPI sequence (3), rectangular RF pulse (0.8ms), TR/TE=126/0.44ms, flip angle=90°, FOV= 220mm, matrix size=128, 3D isotropic nominal resolution Δx=1.72mm (actual resolution ~3.5mm), rings=41, p=0.3, averages=3, and total acquisition time TA = 16.2 min. Noise-only images were acquired separately using blank RF. **Noise de-correlation.** De-correlation of noise across the 15 receiving channels was implemented on the raw data before image reconstruction. The de-correlation process follows exactly the procedures described in the SENSE parallel image reconstruction (4). **SNR calculation.** Signal-to-noise ratio was measured on the SOS-combined signal and noise-only images using a method proposed by Constantinides *et al* for multi-channel array coils (5).

RESULTS AND DISCUSSION

Compared with the volume coil (Figs. 1a-c), the 15-channel array coil significantly increased overall SNR across entire brain and improved visualization of anatomical details inside the brain (Figs. 1d-f). The de-correlation of noise across channels showed further significant improvement in SNR (Figs. 1g-i). The measured SNR of cerebrospinal fluid (CSF) in the region of a lateral ventricle (Fig. 1i), for example, was increased 25% by the array coil (Fig. 1f) over the volume coil (Fig. 1c) and extra 88% by additional noise de-correlation (Fig. 1i). The improvement of SNR by the 15-channel array coil is varying spatially as expected; more improvement in the peripheral than at central regions over the volume coil (Fig. 2). The profiles across the brain in Fig. 2j demonstrated the details of the spatial variation. More than 3/4 of FOV region has SNR increased. **In conclusion**, it has been demonstrated that the customer-built 15-channel array sodium coil significantly increased SNR in human brain imaging in comparison with the volume coil. Noise de-correlation was helpful in extending SNR improvement into deep region of the brain.

REFERENCES: [1] Roemer PB *et al.* MRM 1990; 16: 192-225. [2] Lee RF *et al.* MRM 2002; 48:203-213. [3] Boada FE, *et al.* MRM 1997; 37:717-725. [4] Pruessmann KP *et al.* MRM 2001; 46:638-651. [5] Constantinides CD *et al.* MRM 1997; 38:852-857.

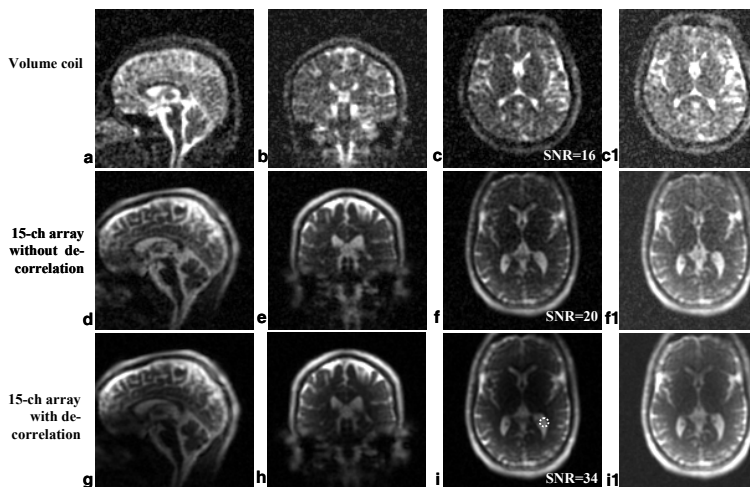


Fig. 1. Sodium images (a-i) of healthy human brains at 7T, showing SNR improvement by using the 15-channel array coil and the noise de-correlation. SNR was measured on CSF at the dashed circular region in (i). The most right column (c1, f1 and i1) shows noise reduction at the same window/level.

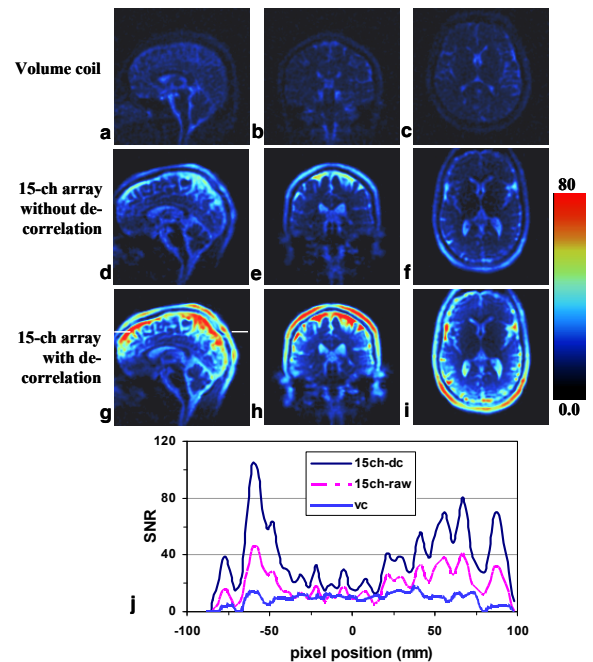


Fig. 2. SNR images (a-i) and profiles (j) of healthy human brains. The profiles were taken from the sagittal slices (a, d, g) through the line as shown in (g). SNR was significantly improved by the 15-channel array coil (d-f) over the volume coil (a-c), and further improved by additional noise de-correlation (g-i).