Experimental Comparison of Signal-to-Noise Between 16 and 8 Element Receive-Only Brain Gapped Array Coils and Birdcage Head Coil at 3 Tesla.

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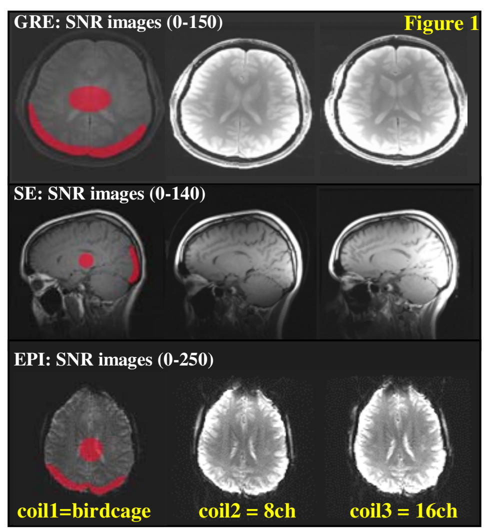
Introduction: The signal-to-noise ratio (SNR) and noise amplification factor (g-factor) performance of a 16-element gapped receive-only brain array coil have been evaluated at 3 Tesla (1) with a custom built MRI receiver (2). However, the SNR performance between arrays with different number of elements was compared with set of hypothetical coils created by software combination of individual channels (1). Here we present an experimental comparison of the SNR of 16,8 element receive-only gapped arrays and the birdcage head coil using a commercially available MRI scanner.

Material and Methods: Imaging hardware: 3T General Electric Excite3 MRI scanner (3T/90cm, a whole body gradient inset 40mT/m, slew rate 150 T/m/s, a whole body T/R RF coil) equipped with 16 channel high bandwidth receivers; standard T/R birdcage head coil (coil1), 8-element (coil2) and 16-element (coil3) receive-only arrays (Nova Medical Inc.) (1). Coils imaging volumes were: V1>V3>V2. For SNR comparison 3 imaging sequences were used: a) gradient echo (GRE) with matrix size 192x144, TR/TE=2s/6.5ms, flip angle=30^o, bandwidth 31.25kHz, FOV=24cm, slice=3mm, gap=2mm, 27 axial slices; c) spin echo (SE) with matrix size 352x192, TR/TE=750ms/15ms, bandwidth 31.25kHz, FOV=24cm, slice=4mm,gap=0.5, 20 sagittal slices; c) single shot full k-space gradient echo EPI with matrix size 128x128, TR/TE=3s/40ms, flip angle 90^o, bandwidth 250kHz, FOV=24, slice=4mm, gap=1mm, 16 axial slices; Data are from 3 subjects. During a single subject session, all coils were used in random order and images were acquired using all three sequences for each coil. SNR were determined using NEMA method (3) as well as from raw data (1) – both methods provided very similar results. Region-of-interest (ROI) type analysis were performed. Three multi-slice ROI were defined: a) the whole brain without skull (bROI); b) periphery (pcROI); c) brain center (cROI).

Table1	GRE		SE		EPI		GRE+SE+EPI	
(N=3)	R2=coil2/coil1	R3=coil3/coil1	R2	R3	R2	R3	R2	R3
bROI	2.7 +/- 0.2	2.8 +/- 0.1	2.0 +/- 0.3	2.4 +/- 0.1	2.8 +/- 0.3	3.0 +/- 0.2	2.5 +/- 0.4	2.7 +/- 0.3
cROI	1.5 +/- 0.1	1.6 +/- 0.1	1.5 +/- 0.2	1.7 +/- 0.1	1.7 +/- 0.2	2.0 +/- 0.1	1.6 +/- 0.1	1.8 +/- 0.2
pcROI	5.2 +/- 0.2	5.7 +/- 0.6	4.9 +/- 0.7	5.8 +/- 0.3	4.4 +/- 0.3	5.6 +/- 0.4	4.8 +/- 0.4	5.7 +/- 0.1

Results: Figure 1 top row shows a single slice and single subject SNR maps from the GRE experiment for all 3 coils. Figure 1 middle row shows similar SNR maps from the SE experiment. Figure 1 bottom row shows the EPI data. On all of birdcage coil SNR images pcROI and cROI masks are also shown. An example of SNR values from GRE sequence and the whole brain bROI analysis are: coil1: 34 (#223510), coil2: 88 (#227096), coil3: 96 (#273834), where number in brackets indicates number of voxels within bROI. Table 1 shows SNR ratios (R2=coil2/coil1 and R3=coil3/coil1, group data from 3 subjects) as mean value +/- stdev.



Discussion:. In this study we have observed that 16 element close fitting array can provide a 2.7-fold SNR increase over the whole brain, 5.7–fold increase in the brain periphery and 1.8-fold increase in the brain center compared to the standard birdcage coil. Increasing the number of array elements from 8 to 16 provides SNR gains of 10%,13% and 18% in the whole brain, brain center and periphery respectively. This experimental data agrees with SNR improvement predicted previously using software combination of individual channels obtained with home built MR receiver (1,2). Multi-element receive-only brain gapped arrays provide substantial SNR improvements over standard birdcage coils on commercially available MRI scanner. For this type of coil design, an increase in the number of elements beyond 16 is expected to provide diminishing SNR improvements.

References: 1) de Zwart et al. MRM 51:22 (2004); 2) Bodurka et al. MRM 51:165 (2004); 3) National Electrical Manufactures Association (NEMA) In Determination of SNR in diagnostic MRI (MS I-2001). p. 16, (1988), Washington DC, USA