SENSE Optimized Sixteen Element Receive Array for Cervical Spinal Cord Imaging at 3T

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Introduction: High quality and high resolution anatomical and functional imaging of the human spinal cord remains a significant challenge in MRI [1,2]. The benefits of parallel imaging with surface coil arrays have been clearly shown particularly in the brain imaging for both anatomical and fMRI studies [3,4]. Here we demonstrate a custom design and build of a sixteen element receive-only surface coil array for spinal cord MRI imaging at 3 Tesla.

Material and Methods: The spinal array has been develop and built with help of Nova Medical Inc. (Wakefield, MA USA). The array consisted of a 4x4 arrangement of coils placed upon a rigid curved former (Fig 1a). Each of the four columns comprised four elements overlapped in z. In order to improve axial Sensitivity Encoding (SENSE) g factors, gaps were placed between adjacent columns with a gap to element width ratio of 30%. Each coil element comprised an oval 8x6cm copper trace on flexible PC board and was tuned to 127.8 MHz with distributed capacitors. A lumped element balun matched the coil impedance to 50 ohm coaxial cable and in conjunction with a PIN diode functioned as an active detuning trap. Each element also had one passive detuning trap. The cables from each coil were routed to ultra low impedance preamplifiers (input impedance <1.2 ohm) through two sets of baluns to minimize any common mode cable currents. The preamplifier outputs were then fed to the 3Tesla General Electric HDx system connectors through two shielded cable bundles with integral triaxial baluns. MRI Imaging: Phantom: Gradient Echo with FOV/sl=300/4mm, matrix 256x256, TR/TE=34/1.2ms, flip=20deg, BW=31.25kHz. Human: Fast Spin Echo Sequence with flow compensation and fat suppression was used with: FOV/sl/gap=300/2/0.5 mm, matrix 512x512, TR/TE=2800/90ms, NEX=4, etl=16, BW=50kHz, 16 sagittal slices. Single shot EPI with SENSE (reduction factor=2 in the phase direction) was used with: FOV/sl/gap=120/4/0.5 mm, matrix 192x144, TR/TE=2000/30 ms, BW=250kHz, 10 axial slices.

Figure 1

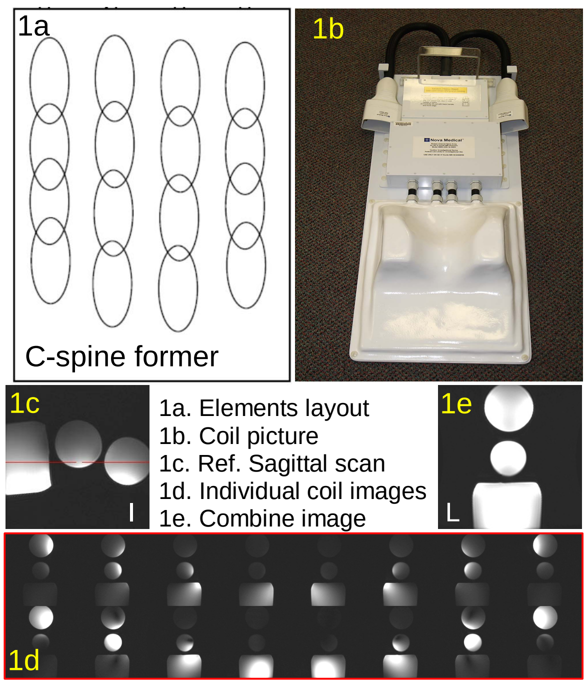
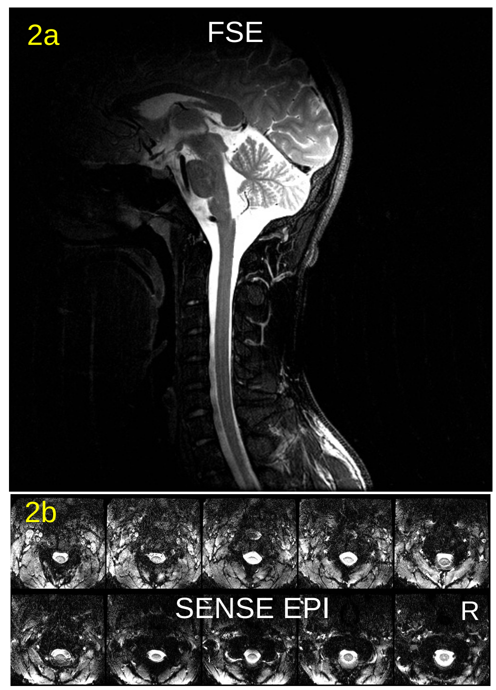


Figure 2



Results: Phantom results are shown on Figures 1c-1e. The sagittal reference image (Fig 1c, display level displev=0-1000) shows coronal imaging plane (red line) used for the array evaluation as well as individual coronal coils images (Fig 1d, displev=0-300) and resulting the combine image (Fig 1e, square root of sum of squares, displev=0-500) are shown. Individual images show an excellent isolation between coils. An example of T2-weighted FSE anatomical image (SNR image: displev=0-70) and of high-resolution SENSE EPI axial images (displev=0-2000) are shown on Figures 2a and 2b respectively.

Discussion and Conclusion: The new 16-element spinal array offers excellent image quality for both anatomical and functional studies. The imaging coverage spans from brain visual cortex down to about the tenth cervical vertebra. The coil optimized parallel imaging design allowing high resolution SENSE EPI for functional studies – which may be critical for more meaningful fMRI results to be obtained from the spinal cord. With regard to anatomical imaging, the good SNR over a large range of the spine can open up a wide array of potential clinical applications.

References: 1) Stroman Clin Med Res. 3;146, 2005; 2)Maieron et al. J. Neurosci. 27:4182, 2007; 3) Heidemann Neuroimaging Clin N Am. 16:311, 2006; 4) Bodurka et al. MRM, 51:165, 2004.