ASK-Asymmetric Saddle K-topology for Spinal Cord Imaging

M. B. Snyder[1], P. H. Chan[1], and F. Robb[1]
[1]GE Healthcare, Aurora, OH, United States

Introduction: Surface coil arrays are particularly suitable for spinal cord MR imaging. Demand for higher channel count systems has lead to an increased need for optimized performance of constituent coil elements in order to obtain high SNR, adequate penetration depth, ease of isolation, and uniformity of response. In this study we have analyzed the performance characteristics of 6 different array building block designs for use in a posterior/spinal application. As a result of this analysis we propose a design based upon the Asymmetric Saddle motif that yields the best balance of performance characteristics for a full posterior coverage (44cm) application.

Methods and Materials: The methods consisted of hardware development, modeling and data measurement.

Hardware Development: Fig. 1.2 contains a photographic montage of the various coil array systems that were compared in this work. Again, the QD was used as a standard to judge all other motifs on the basis of SNR at clinically relevant depths (especially those pertinent to spinal imaging). The 3-loop, 4-loop, and single layer surface arrays were used as comparative standards for assessing the performance metric of directivity.

Modeling: Initial prediction of SNR profile for 3 cases, namely i) Single loop; ii) A loop pair and iii) Asymmetric Saddle (AS) having covering the same field of view (FOV) were numerically calculated using the Remcom XFDT package, College Station, PA. Fig.1.1 shows the contour plots. The single loop has best uniformity but worst SNR, whereas the double loop has best SNR but worst uniformity and penetration depth, and AS has optimum SNR and homogeneity.

Data Measurement: Phantom testing for each topology was done using 1.5T GE Exite scanner and a sequence (TR/TE = ms/ms; 256*128; FOV = 44cm) and a SOS reconstruction.

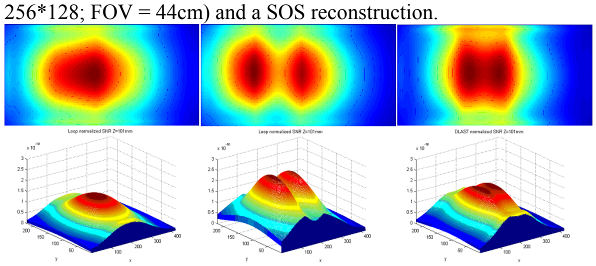

Fig 1.1: A comparison of the sensitivity profiles for the single loop (left), double loop (center), and optimized Double Asymmetric Saddle (DAS) pair.

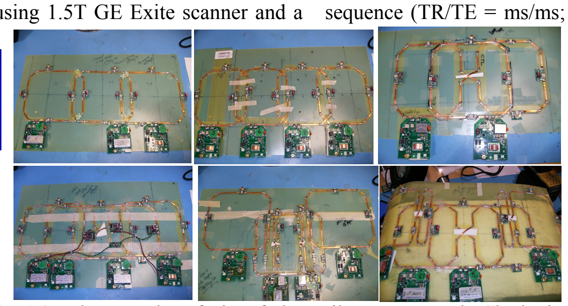

Fig 1.2: Photographs of six of the coil arrays tested. Clockwise from top left: the three loop motif; the four loop motif; the QD motif; the QD (center) plus loops; the DLAS motif; QD (center) plus two asymmetric saddles (left and right) motif.

Results: Fig. 3 shows the SNR profile of the different array topologies. As predicted, higher channel count "rectangular window" arrays have higher SNR at surface. DLAS out-performed the rest at the spine region. Fig.4 shows the relative SNR profile of the DLAS and ASK (scaled 20:1) and also the percentage SNR improvement of the ASK compared to that of DLAS. The relative SNR gain provided by the ASK array compared to the DLAS ranges from 40 % at the periphery to 15% at the center. The ASK system demonstrated a peak SNR (at center) 20% better than the standard (QD).

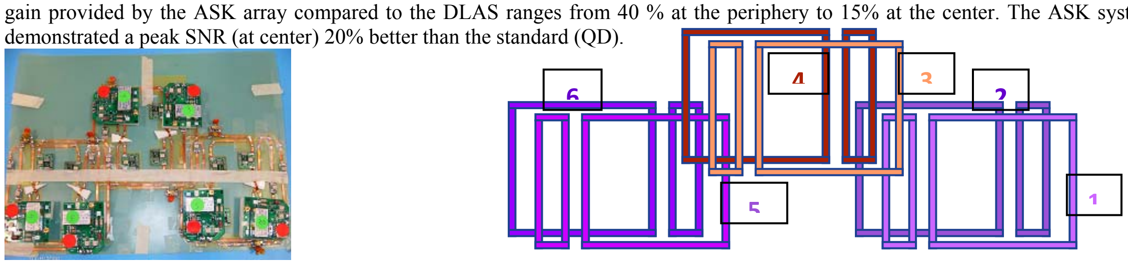

Fig 2: A close up photograph of the ASK motif. The Asymmetric Saddle K-topology (ASK) coil system consists of three pairs of Asymmetric saddles.

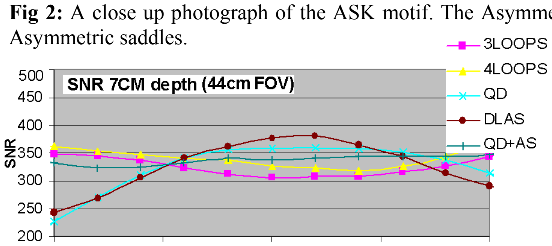

Fig 3: The SNR profile of five of the coil topologies taken along the axial plane at 7cm depth inside the phantom. In the central region, the QD and especially the DLAS offer significantly greater performance.

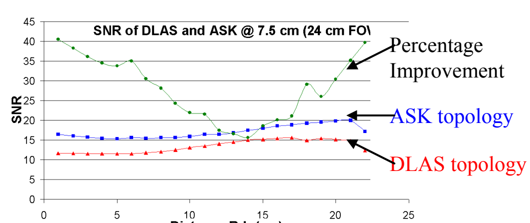

Fig 4: A comparison of the ASK (blue curve) and DLAS (red curve) motifs. The green curve represents the percentage improvement of the ASK over the DLAS.

Conclusions: In this work we have extended a previously published coil array topology for posterior imaging. We have adapted the AS configuration from DLAS and replaced the loops with the AS pairs. This led to higher SNR over a larger FOV. The SNR behavior was compared to the DLAS topology.

Reference: [1]. "Self-Decoupled Asymmetric Saddle Coil Array for SENSE Imaging", Chan, P.H., Proc. ISMRM 14th Annual Meeting, p3529 (2006).