

QASCI-Quadruple Asymmetric Saddles for Cardiac Imaging

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Introduction: The existing cardiac coil in the market is an 8-channel coil with 4 anterior loops and four posterior loops with a field-of-view coverage of 30 cm by 30 cm. One finds that the clinical demand for cardiac coils is split into two segments: one is those coils which are solely for cardiac imaging with a field-of-view requirement of 30 cm by 30 cm to cover the heart only; the other segment is for cardiovascular imaging with a field-of-view requirement of 48 cm by 48 cm in order to be capable of performing vascular imaging. In order to increase channel count, element size must be restricted, which limits the coil's penetration depth, and thus sensitivity to deep tissues. In addition, most high channel cardiac imaging coil systems are both heavy and bulky, making them difficult for the technician/operator to use, and cause the patient discomfort.

Therefore a need exists to create a cardiac/cardiovascular imaging coil system that is lightweight, simple to use, and which offers excellent imaging performance throughout the thoracic region. In this study we have constructed a 32-channel phased array MRI coil system designed specifically for cardiac and thoracic vascular imaging. What makes the coil unique and unlike prior art is the specific combination of geometric elements within the design. A new array motif design, the QASCI (Quadruple Asymmetric Saddle for Cardiac Imaging), is used to generate those elements closest to the cardiac region, where they comprise a total of 16 channels (or half of the total channels) of the overall design (Fig 1). To aid patient comfort, the eight rectangular loops can be detached from the QASCI core when cardiac-only imaging is needed, thus decreasing the weight of the system. Thus, an integrated design approach is taken to realize a user-friendly system that is highly optimized for clinical cardiac imaging use.

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

Hardware Development: When two groups of QASCI elements are combined with eight rectangular-loop elements, the overall design of the present coil is realized (Fig 1). The peripheral loops provide the depth-of-penetration needed to view deep vasculature, while the four QASCI elements provide a relatively shallow but very high SNR/resolution image of the heart itself. With this combination of elements, it is possible to view the entirety of the thorax, but the FOV has been optimized specifically to meet the needs of cardiac and vascular imaging.

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

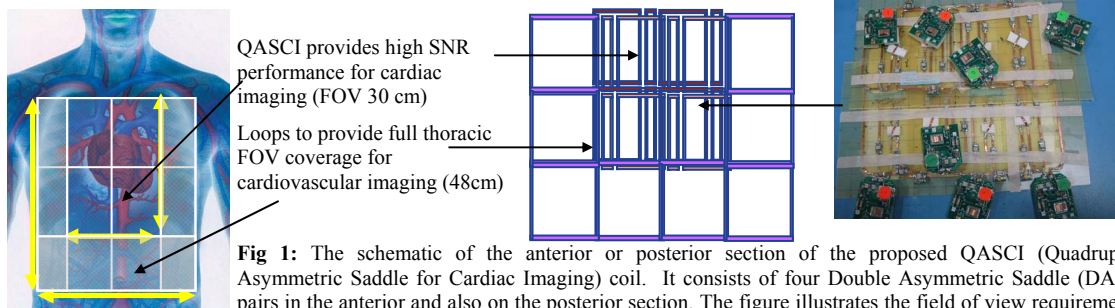


Fig 1: The schematic of the anterior or posterior section of the proposed QASCI (Quadruple Asymmetric Saddle for Cardiac Imaging) coil. It consists of four Double Asymmetric Saddle (DAS) pairs in the anterior and also on the posterior section. The figure illustrates the field of view requirement for cardiac and cardiovascular imagings are 30 cm by 30 cm and 48 cm by 48 cm respectively.

Results: Fig. 2 is a comparison of the SNR performance of four channels of the eight channel GE cardiac coil (top) and four channels of the QASCI coil (bottom). In Figure 2 the SNR performance was evaluated along three directions, which are : axial (left to right); axial (top to bottom); and coronal (left to right). The topmost curve in each subfigure shown in Figure 2 is the overall SNR; the other curves represent the individual elements. Figure 3 illustrates the overall SNR performance for the QASCI (cyan) and 8-channel coil (blue) along axial (left to right) and coronal (left to right) directions. The QASCI clearly outperforms this venerable design, offering a nominal 50% SNR performance increase.

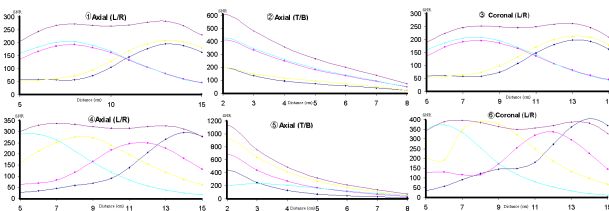


Fig 2: A comparison of the overall and individual-element SNR for four channels of the 8 channel cardiac coil (top) and four channels of the QASCI (bottom) as evaluated in three slice orientations (from left: axial left-to-right, axial top-to-bottom, and coronal left-to-right). Both arrays were used to image the anterior thoracic region of a phantom.

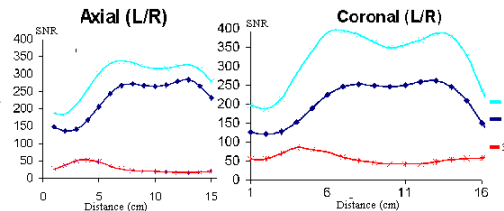


Fig 3: An SNR comparison of the QASCI (cyan) and 4 channel loop (blue) motifs as evaluated in axial (left) and coronal (right) slices. The red curve represents the percentage improvement of the 4 channel QASCI over the 4 loop array.

Conclusions: In this work we have created a flexible, modular 32-channel array for cardio-thoracic imaging that is based on traditional loop elements and Double Asymmetric Saddle pairs. This unique design demonstrates a significantly higher SNR over a larger FOV than the 8 channel cardiac coil, even when evaluated on an element-by-element basis.

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