Novel Spine and Body Coil Designs Using Matrix Clusters And Mode Combiners

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Introduction:

In this abstract a novel coil architecture for spine and body imaging is presented. These so called “Matrix Coils” allow the use of a scalable number of receivers as a function of desired acceleration factor for parallel imaging and/or desired SNR in peripheral regions [1-7]. SNR comparisons between these novel coils and existing CP array coils were performed. It can be shown that for non-parallel imaging the SNR along the main patient axis is comparable. In addition however, the novel Matrix Coils allow parallel imaging in left-right direction by using extra channels which are not available in standard CP array coil design.

Motivation:

The Spine Matrix consists of 24 independent channels of which a maximum of 12 fit into a 500mm FOV. Up to three 6 channel Body Matrix coils can be combined with the Spine Matrix for whole body coverage. The well known loop-butterfly antenna geometry (e.g. Siemens Magnetom Symphony: CP Spine Array and CP Body Array) was broken into 3 independent loop elements [8]. The signals of these 3 loops were internally combined to 3 new mode signals [9]. One of these mode signals correlates to the circular polarized (CP) signal of the original loop-butterfly geometry. The two additional signals carry the rest of the information needed for parallel imaging or for improving the SNR in the periphery of the object. The dimension of the loops were optimized for maximum SNR at a penetration depth of 10-14 cm.

Methods:

Investigations were carried out using a body phantom in a 1.5 T Siemens Magnetom Symphony scanner (using CP Spine Array and CP Body Array) and in a 1.5 T Siemens Magnetom Avanto scanner (using Spine Matrix and Body Matrix).

A standard spin echo sequence was used for SNR evaluation. Using MatLab™ (The MathWorks, Natick, MA) the SNR maps were calculated by method of sum-of-squares (Fig. 1a, 1b) and maximum-available SNR. In both cases, a full noise correlation matrix was considered.

The parallel imaging performance of the new matrix coils was investigated with a volunteer and adequate sequences in transversal (Fig. 2a) and coronal (Fig. 2b) slice orientations in breathhold technique. Acceleration was done with a factor of 2 and anterior-posterior (Fig. 2a; acquisition time: 2*9.33sec) as well as left-right (Fig. 2b; acquisition time: 3*12.30sec) phase encoding.

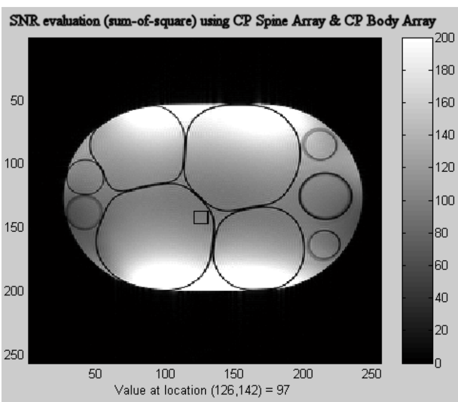

Fig. 1a)

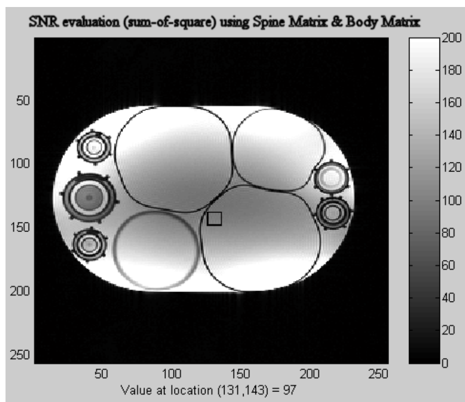

Fig. 1b)

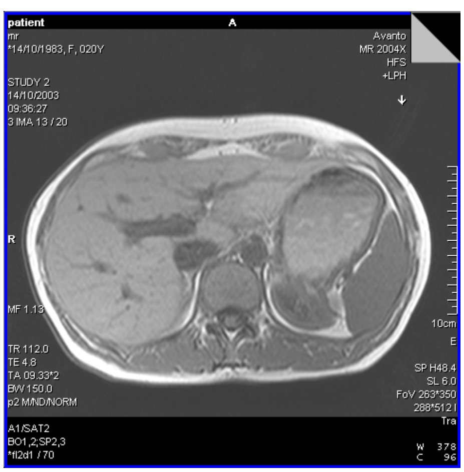

Fig. 2a)

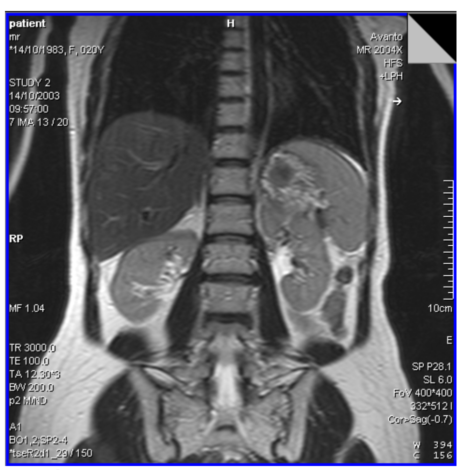

Fig. 2b)

Results:

Figure 1 visualizes the SNR distributions over the body phantom calculated by method of sum-of-squares. Fig. 1a shows the results from the conventional CP Spine Array and CP Body Array and Fig. 1b shows the corresponding measurement with the novel Spine Matrix and Body Matrix obtained with a Siemens Magnetom Avanto system using all three signals (Triple Mode). In the middle of the phantom (evaluation window 10cm from the phantom bottom) the SNR has the same value of 97 in both measurements. In addition, the SNR in the periphery of Figure 1b is significantly increased in comparison with Fig. 1a. The accelerated clinical images in Fig. 2a and 2b are without any visible artifacts. Here too, the periphery is well illuminated.

Conclusion:

The CP signals obtained from the Matrix Coil design achieve SNR values in the object center which are comparable to conventional CP arrays. The “CP Mode” of the Matrix Coils requires also the same number of channels as the conventional CP arrays. If instead of the CP signals, all three independent signals are selected, higher acceleration factors are possible and the SNR in the periphery can be significantly increased.

In comparison with the CP signals the images showed better “robustness”, i.e. better artifact suppression when all three signals were used with anterior-posterior and coronal-caudal phase encoding.

Because of short acquisition times of 9 to 12 seconds the images can be obtained in breathhold technique.

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