A Novel Body and Spine Array for Parallel Imaging

K. Okamoto[1], M. Ishii[2], H. Motohashi[1], K. Nakabayashi[1]

[1]TOSHIBA Medical Systems Corporation, Otawara, Tochigi, Japan, [2]TOSHIBA Medical Systems Engineering Co. Ltd., Otawara, Tochigi, Japan

Introduction

Array coil technology plays an important role in parallel imaging (PI) and helps to achieve higher throughput in clinical MRI examinations. Currently, large array coils to cover a large FOV without changing array coils, such as various neurovascular array coils[1)] and a body and spine array[2)], have been developed to improve overall throughput. In this paper, we propose a novel body and spine array consisting of rectangular loop coils and a twisted coil.

Methods

Conventional spine arrays are generally constructed by aligning QD surface coils in the Z-direction to obtain a high SNR in the area from the center to posterior regions of the body. The basic concept of a body array coil is to surround the body with more than four element coils[2)-4)] to obtain a high-SNR image over the entire axial plane. The proposed body and spine array consists of an anterior array with three loop coils and a posterior array with three loop coils and one triple-twisted coil, similar to a saddle train coil[5)] (figure 1). In the twisted coil, each crossing is positioned near the center of each loop coil, which produces a quadrature effect between each loop coil and the twisted coil. Coil-to-coil decoupling can be performed by adjusting the degree of overlap between the coils. The wide coverage required for body and spine imaging is obtained by aligning this array in the Z-direction.

Computer simulation and various experiments were performed to evaluate the features of this array. In computer simulation, the SNR of this array was compared with that of 6-loop and 8-loop array coils. Each array was divided into an upper array and a lower array. The width was 46 cm and the depth was 16 cm (figure 2). Both coil resistance and eddy current noise[6)] were considered. An elliptic cylinder phantom (H*W*D: 200*300*400 mm) was positioned at the center of these arrays as the eddy current noise source. Phantom experiments were made on 1.5T EXCELART™ system using a prototype of this array, a 6-loop array, and a conventional QD surface coil for SNR comparison. The phantom was the same elliptic cylinder phantom as used in the simulation model, which contained $CuSO_4$-doped water. Finally, phantom and volunteer images were also obtained by parallel imaging.

Results and discussion

Figure 3 shows the SNR distribution in the axial plane of the phantom for each array obtained by computer simulation. This array had almost the same SNR as the other two arrays at the center and the highest SNR in posterior regions. Figure 4 shows the SNR profiles along the Y-axis of the axial images obtained in phantom experiments. The SNR profile of this array was superior to that of the 6-loop array in posterior regions and equal in other regions. Moreover, the SNR in posterior regions was almost equal to that of the QD surface coil. The features of this array were excellent for use as a spine array. The PI capability was confirmed as shown in figure 5. Good axial images of the phantom and the volunteer were obtained for acceleration factor 3 in X-encoding and factor 2 in Y-encoding.

Conclusion

We have confirmed that this novel body and spine array, which consists of a loop coil array and a twisted coil, has excellent SNR and PI capabilities. This 7-channel body and spine array has a practical number of channels and outstanding features as an element array for a body and spine array. Employing this array in combination with a neurovascular array makes it possible to construct a new large array coil system, which is useful for improving overall throughput.

References

[1] P. Chan , et al., Proc. of ISMRM, p. 2385 (2004), [2] V. Matschl , et al., Proc. of ISMRM, p. 1586 (2004), [3] K. Okamoto , et al., Proc. of ISMRM, p. 859 (2002), [4] Y. Zhu , et al., MRM, 52, p. 869 (2004), [5] H. Fujita , et al., Proc. of ISMRM, p. 858 (2002), [6] P. Roemer , et al., MRM, 16, p. 192 (1990)

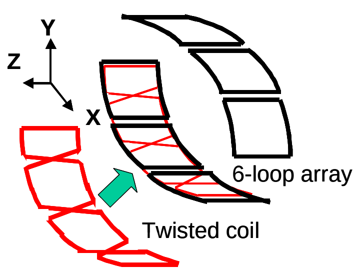

Fig. 1 Proposed new body and spine array

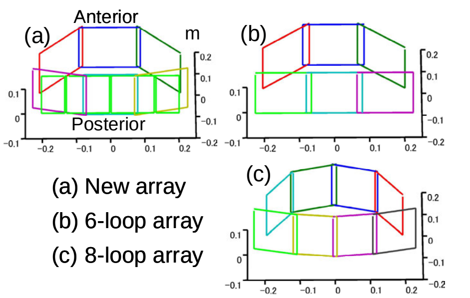

Fig. 2 Simulation models for three array types

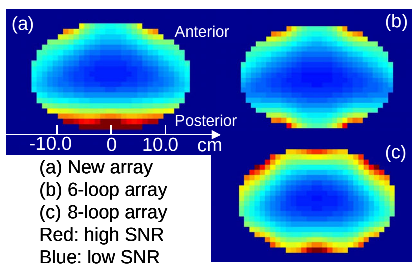

Fig. 3 Simulation results

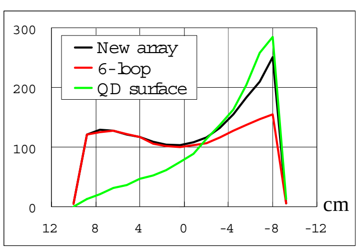

Fig. 4 SNR profiles along the Y-axis

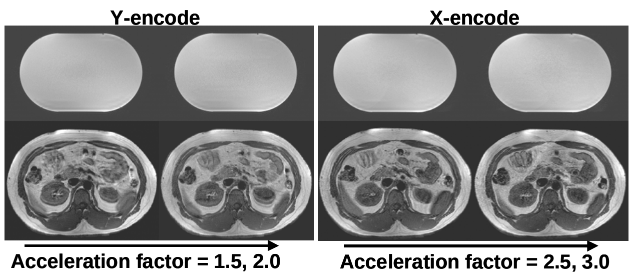

Fig. 5 PI for acceleration factor 1.5 to 3 using this new array

Upper : phantom
Lower : volunteer