An Optimized "QD-like" 6-Channel Flexible and Ergonomic Shoulder Array Coil at 1.5T

X. Yang[1], S. Walk[1], P. Taylor[1], T. Zheng[1], and H. Fujita[1,2]

[1]Quality Electrodynamics, Mayfield Village, OH, United States, [2]Physics and Radiology, Case Western Reserve University, Cleveland, OH, United States

Introduction

Shoulder anatomy size varies significantly when human weight changes from 120lb to more than 400 lb. This rather a huge "shoulder geometry" variation presents a technical challenge to shoulder coil design with respect to coverage and SNR, yielding a conventional approach where a large shoulder coil and a small shoulder coil are offered. Previous studies show that hinged surface coil gave a higher SNR than armpit loop shoulder coil for a large population [1]. We herein report a novel shoulder coil which covers a very broad range patient population and still provides high SNR, uniformity, and depth coverage. This goal can be realized though the optimized ergonomics fitting between coil and shoulder anatomy which maximizes the MRI signal, bigger coil elements which allow good signal coverage in depth, and quadrature configuration which provides improved SNR and uniformity. With these considerations we propose an ergonomically-designed shoulder coil with 3 rows of loop and saddle pairs whose sizes are large enough to cover the practically and realistically largest shoulder size.

Methods

Fig 1 shows the coil photo. Fig 2 shows the channel diagram of the coil layout with the dimension of the loop and the saddle. All three rows dimensions are similar but optimized for better fitting of the corresponding shoulder anatomy. The loop size of each row is about 10.5cm wide in the middle and 25.5 cm long. Both sides of the loop width are tapered to conform the shoulder shape. The saddle is about 35.5 cm long and has similar width as the loop in the middle. The neighboring saddles and loops overlap each other for array isolation consideration [2]. The overall size of coil is chosen to cover a 400 lb human. Other array coil techniques are also used to optimize the coil, such as decoupling by using a low impedance preamplifier [2].

Results and Discussions

Fig 3 shows the comparison of a typical T1 image on a 400lb volunteer between the proposed flexible coil and the rigid shape 4-channel coil. The proposed coil shows clear improvements on depth coverage, uniformity and SNR. Fig 4 shows the image comparison between 160lb and 360lb volunteers using the proposed flexible shoulder coil. As seen in Fig. 4, there is no visible image quality degradation observed when human size changes from 160 lb to 360 lb regarding depth coverage and uniformity. The SNR, depth coverage and uniformity are affected by several factors in this shoulder coil design. The first one is isolation S_{12} because SNR is roughly proportional to $1/\sqrt{1+S_{12}^2}$ assuming patient loss unchanged for different shoulder size. In this design the isolation is optimized and lower than -15dB for an approximate 250 lb human volunteer. For smaller and larger size human the isolation becomes worse due to the overlap change from the optimized positions. The second factor is the depth coverage which improves naturally as the shoulder size becomes smaller. The third factor is the size of the coil and the quadrature configuration of the elements. With larger and more closely contoured elements, each pair of loop and saddle coils at its quadrature configuration, provides improved uniformity and depth coverage. Considering all these factors and the test results above, the proposed ergonomically designed QD-like shoulder array coil is an improved and balanced coil solution to be offered in today's wider MRI systems for shoulder imaging.

Fig 1 (a) Coil Photo (outside)

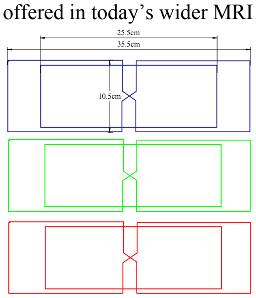

Fig 2 coil layout

Fig 3 T1W image on a 400lb volunteer. T
left is the proposed coil and the right is t
rigid shape 4-channel shoulder coil.

Fig 4 FSE-T1 image on 160 lb and 360 lb volunteers. The left is 160 lb and the right is 360 lb.

References

[1]Y. Hamamura, et al., Proc. Intl. Soc. Mag. Reson. Med. 14 (2006)

[2] P.B. Roemer, W.A. Edelsten, C.E. Hayes, S.P. Souza and O.M. Mueller, Mag. Reson. Med. 16, P192 (1990)

Acknowledgements The authors thank Kazuya Okamoto, Junichi Makita and Ernie Zepeda at Toshiba Medical Systems Corporation and Toshiba Medical Research USA, Inc. for their support and invaluable discussions in this study. This work was in part supported by the National Institutes of Health and National Institute of Biomedical Imaging and Bioengineering, Grant Award 2R44EB007094-2.