1.5-Tesla Integrated Dual Mode Hand/Wrist Array Coil for Imaging

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Introduction

For wrist imaging, a coil that provides high signal-to-noise ratio (SNR) is critical because of the very challenging imaging criteria which requires high spatial resolution to image thin slices within a very small field of view (FOV) to obtain the fine structure of the anatomy. To optimize SNR performance, an array of small RF coils needs to be positioned close to the anatomy[(1,2)]. For the wrist only imaging, the typical S/I coverage of the coil is about 10cm. However, sometimes it is also required that the same coil be able to image the entire hand, for which the coverage of the coil has to increase to 20cm (as shown in Fig.1). In this case, one can use two sets of RF coils to cover the entire anatomy, and subsequently, the coil design will be more challenging because of extra matching and amplification circuits and also additional coupling arising from more coil elements. The integrated dual-mode hand/wrist coil offers a high resolution mode for the wrist-only imaging, in addition to the full coverage mode for the whole-hand imaging. Furthermore, to realize this elaborate circuit design within a very small physical space, we have also designed a micro-size non-magnetic low input impedance preamplifier (approximately 1cm^3).

Method

Figs. 2 and 3 show an electrical circuit representation of the dual-mode 6-channel array hand/wrist coil. The coil consists of two identical shell-shaped pieces with no electrical connection in between as shown in Fig.6. Each half has three switch-able FOV loop coil elements, the width of the coil element is 6-8cm, and the lengths of the wrist only loop and the full hand loop are 10cm and 20cm, respectively. The wrist only and full hand loops can be activated separately using DC bias current to create two different imaging modes. When the outer loop is activated, the coil can be used for normal hand imaging with typical FOV of 20cm, and the inner loop can be used for small 10cm FOV high resolution imaging, targeting the fine structures of wrist. The required isolation between adjacent loop elements is achieved by either critical overlap or inductive coupling, and the coil-elements coupling is further reduced with the use of micro-sized low input impedance preamplifiers. The inner diameter of the hand/wrist coil is contoured to match the shape of the hand and wrist (Fig. 6).

Fig. 1
Imaging volume for the full hand mode and wrist only mode

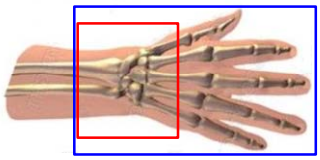
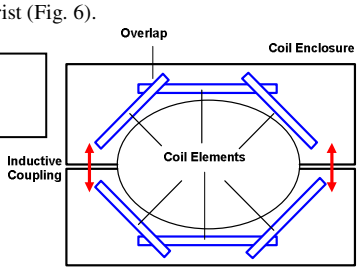


Fig. 2
Element layout of the dual-mode hand/wrist coil



Results

The integrated dual-mode 6-channel array hand/wrist coil was tested on the Toshiba Vantage Atlas 1.5 Tesla system. Fig.4 (a) and (b) show the comparison of coronal images in a human subject with a commercially available standard QD wrist coil (a) and the full mode of the hand/wrist coil (b). Fig. 4 (c) and (d) show the comparison between the standard QD wrist coil (c) and the high resolution mode of the hand/wrist coil (d), all using the same imaging protocol. The first comparison shows that the SNR of the full hand mode is lower than the QD wrist coil which has a smaller inner diameter, however the coverage of the array in S-I is much larger. The second comparison shows that the high resolution mode of the hand/wrist coil has significantly higher SNR than the QD wrist coil.

Fig. 3
Overview of the dual-mode hand/wrist coil

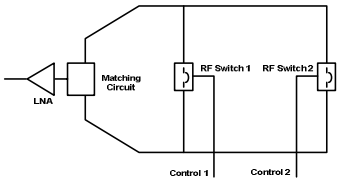


Fig. 4
Comparison of the dual-mode hand/wrist coil against a QD wrist coil

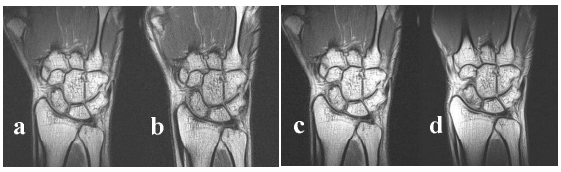


Fig. 5
Images obtained by parallel imaging techniques (R=2; FOV 7cm by 7cm; spatial resolution of 0.3mm by 0.3mm; slice resolution 0.5mm; acquisition time 14min. 5s) with the dual-mode wrist coil

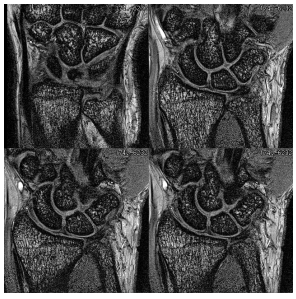


Fig. 6
Mechanical design of the wrist coil

Conclusion

An integrated dual-mode 6-channel array hand/wrist coil was constructed and evaluated on the 1.5 Tesla MR system. The results suggest by using different modes of the coil, both large FOV for full hand imaging and small FOV with high resolution and thereby high SNR wrist imaging can be achieved.

References

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Acknowledgements

The authors thank Kazuya Okamoto and Takahiro Ishihara at Toshiba Medical Systems Corporation (Tochigi, Japan) for their support and invaluable discussions in this study.
This work was also supported in part by the National Institutes of Health (grant 1 R43 EB007094-01A2).