A 3T transmit and 16 channel receive array coil for Hand/Wrist imaging

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Introduction: High resolution MR imaging of hand is useful tool for early diagnosis and understanding of diseases such as Rheumatoid Arthritis and Osteoarthritis of wrist and finger joints. However, current commercially available hand/wrist coils are receive-only coils, which use the whole body coil in the MRI system to transmit RF power into the human tissue. In this case, it is required relatively high RF power and residual signals induced by the outside of the imaging volume might cause degradation of signal to noise ratio (SNR) and wrap-around artifacts. To address this issue, a hand/wrist array coil with local transmitter is desirable. On the receive side, an array of small RF coils needs to be positioned close to the anatomy to optimize SNR performance [1, 2]. For the wrist imaging, the typical S-I coverage of the coil is about 10cm. However, it is often required that the same coil be able to image the entire hand, for which the coverage of the coil has to increase to more than 20 cm. To meet above mentioned requirements, a 3T 16 channel hand/wrist array coil with integrated local transmitter coil is developed and tested.

Materials and Methods : The coil, designed for Siemens 3T MAGNETOM Verio (Erlangen, Germany), consists of a transmit-only quadrature 8 rung elliptical high pass birdcage coil, and an array of 16 independent receive–only loop coils (Fig 1). The transmitter and receiver coils are all tuned and matched at 123.2 MHz. The elliptical birdcage coil is driven at 2 ports (0 degree, 90 degree) and relatively homogeneous B_1 profile can be obtained due to low loss of hand anatomy unlike head at 3T. The receive array layout consists of two rows in the S-I direction which enables whole hand imaging (FOV of S-I direction = 22 cm) while providing high SNR at wrist region. The inner dimension of the coil is contoured to match the shape of the hand and wrist in order to maximize SNR. The adjacent loop elements are appropriately overlapped to minimize the mutual coupling among them, and the coil elements are further isolated using ultra compact, low input impedance preamplifiers. Each size of a loop, approximately on the average 15 cm by 5cm at hand or 10 cm by 4 cm at wrist, is optimized, depending upon its location relative to the hand.

Fig1. Mechanical Design of the coil

Results and Discussion: The coil was tested on both a water phantom and a human subject. Image SNR was measured on the water phantom and compared with a commercially available 8 channel receive only wrist array coil. Figure 2 shows that the transmit receive hand/wrist array coil has about 11 % higher SNR in the phantom center calculated by Kellman method [3]. Figure 3 shows coronal 2D cross sections of the healthy volunteer acquired with T_1 weighted 2D spin echo (TR/TE = 500/17 ms, NEX = 2, slice thickness = 3 mm, FOV = 199 × 117 mm, matrix size = 448 × 231) and fat-suppressed images acquired with STIR (TR/TI/TE = 2750/220/19 ms, ETL = 15, NEX = 2, slice thickness = 3 mm, FOV = 200 × 120 mm, matrix size = 320 × 195). As shown in this figure, detailed anatomical structures and joint fluid are clearly visualized within whole hand FOV. The required transmit voltage for both coils were also compared. The transmit receive hand/wrist array coil has significantly lower transmit voltage than the receive only wrist coil (79V vs. 400V).

Conclusion : A transmit and 16 channel receive hand/wrist array coil was constructed and evaluated at a 3T MRI system. Initial results suggested that the coil showed excellent performance SNR and coverage of FOV, and significantly less transmit power requirement compared with receive-only coils.

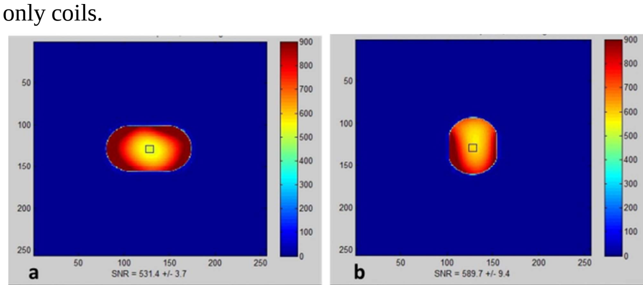

Fig 2. SNR Comparison on the water phantom, right: transmit and 16 channel receive hand/wrist coil; left: 8 channel receive only wrist

Fig 3. The healthy volunteer images acquired with T1W-TSE(left) and STIR (right).

References

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