

8 Channel Multi-coil to Image Both Hands and Both Wrists Symmetrically for RA Diagnosis

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Introduction

The demand of early diagnosis for Rheumatoid Arthritis (RA) is increasing by the development of new drugs like anti-TNF-drugs for RA treatment. There is also the demand of use of medical imaging as a Drug Development Tool, including RA treatment drug [1]. MRI is one of the imaging equipments expected to be used for these purposes. RA has a feature of symmetric arthritis that typically occurs in joints on both sides of the body (such as hands, wrists or knees). It is preferable for the RF coil for RA diagnosis to have the capability of imaging both sides in a symmetric way at the same time. The holding fixture that keeps the patient's posture in such a way comfortably is one of the important keys. An eight channel multi-coil with stable and comfortable holding fixture for imaging both hands and both wrists in a symmetric way was designed and developed.

Material and Methods

At first the posture of the patient was considered under the requirement that both hands should be put symmetrically in the same plane in comfortable manner. Several ideas for the posture were tested with some healthy volunteers and their opinions were gathered. Based on their opinion it was determined that both hands were put symmetrically in the same plane before abdomen under the condition that a patient was on patient's back. Then the holding fixture was designed to keep such posture. The holding fixture was constructed of the upper and the lower components that were hinged together so the upper component can be lifted when the hands were placed between them. Each component had fallen part on the surface to make space for the hands when the upper component was closed. The lower component had the tilting mechanism that enabled to change the tilting angle of the plane, where both hands were in, between 0 and 10 degree from the horizontal plane. The lower component also had the mechanism for change of its height to adjust space under itself for the patient's body. Low-rebound cushion was put between hands and the component's surface so that hands were kept immobile comfortably. The tapered sponge was put under the patient's back. This sponge tilted the patient's upper body up so the patient could keep the posture comfortably. Trapezoidal sponges were put under both elbows as an armrest. (Fig.1) At last coil elements were designed so that the multi-coil's sensitivity could cover both hands and both wrists as homogeneously as possible. The number of channels was determined as eight that was almost all current MRI systems support. Both upper and lower components of the holding fixture had four round coils inside. The coil elements were etched from 0.2mm thickness FR-4 plate with 0.035mm thickness copper on. The trace width was 6mm. The round coil had 125mm diameter (copper foil center to center). This coil size was determined for the B1 sensitivity of the four coils to cover both hands and both wrists. The multi-coil was tuned to 127.7MHz for 3T scanner. Each coil element had two active decoupling circuits in the coil loop to reduce temperature increase on the fixture surface. BALUNs were put between each coil feeding port and the coil interface of the system. (Fig2) Image quality of the coil was checked in volunteer scans. Imaging was performed on 3.0T GE MRI scanner (Signa HDx, GE Healthcare, WI, USA).

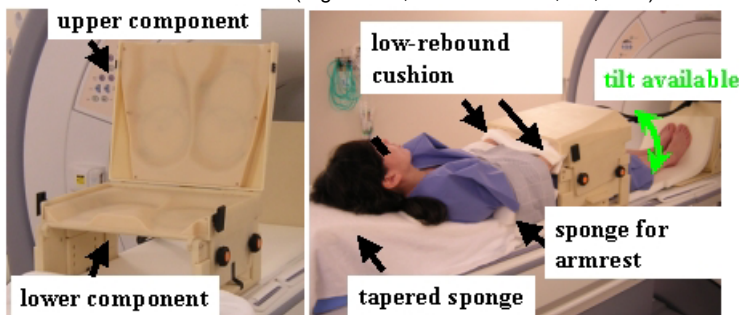


Fig.1 Pictures of the holding fixture (left) and the situation of a volunteer setup (right)



Fig.2 Layout of the coil elements inside the upper and the lower components

Results and Discussion

The four coils inside the upper or the lower component was decoupled enough by the geometrical layout under load condition. Volunteer images showed that the coil had enough coverage for both hands and both wrists imaging and that the homogeneity was good enough for RA diagnosis. (Fig.3) The holding fixture could hold both hands and both wrists comfortably enough so that there was no apparent motion artifact in the images.

Conclusion

Developed multi-coil with stable holding fixture could hold both hands symmetrically in stable and comfortable manner so that it made it possible that both hands and both wrists were imaged symmetrically

at the same time. This feature serves for RA diagnosis.

Reference [1] Presentations from the FDA/DIA/BIO Meeting: Use of Medical Imaging as a Drug Development Tool, May 5-6, 2005. <http://www.fda.gov/cder/regulatory/medImaging/default.htm>

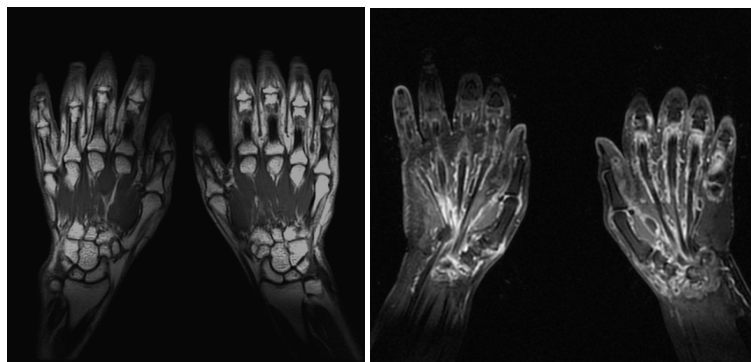


Fig.3 A volunteer image (left); 2D T1W SE:TR/TE=400/9, 0.5mmx0.5mm resolution with 3mm slice. A RA patient image (right); Contrast-enhanced IR prepared 3D Fast SPGR:TR/TE=3.9/1.8, 0.59mmx0.59mmx0.5mm resolution.