An Inductively-Coupled Coil Designed for Clinical Use with a Limb-Positioning Platform

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Introduction

Remote limb-positioning has been proposed [1] for improved imaging of ligaments and tendons by making use of T2 relaxation time variations due to the dipolar coupling of structured tissues, known the 'Magic Angle' effect [2,3]. Here we report on the development of a novel inductively-coupled surface coil for use with an MR-compatible limb-positioning platform [4] in a closed-bore scanner.

Methods

A single element RF coil was designed for use with the 3DOF lower limb positioning platform in a Siemens 1.5T Avanto MR system. The coil was designed to attach to the platform with the element centred over the position of the knee or ankle and remain fixed orthogonally to the static field through movements of the two linear and single rotational DOF. To increase the signal penetration depth an inductively-coupled second coil element was added on the opposite side of the leg, held in place by a plastic mount. The coil is shown in Figure 1. The coil elements were tuned following the methods described in [5], individually tuning each coil to a higher frequency before coupling the coils to split the resonance, then adjusting the variable capacitors to centre the out-of-phase response at the Larmor frequency.

Phantom measurements were made to compare the coil SNR of the double- and single-coil configurations and to assess the effect of orientation on image SNR and uniformity. The coil was also used to image the Achilles tendon of a volunteer at orientations of 0^{o} and 55^{o}.

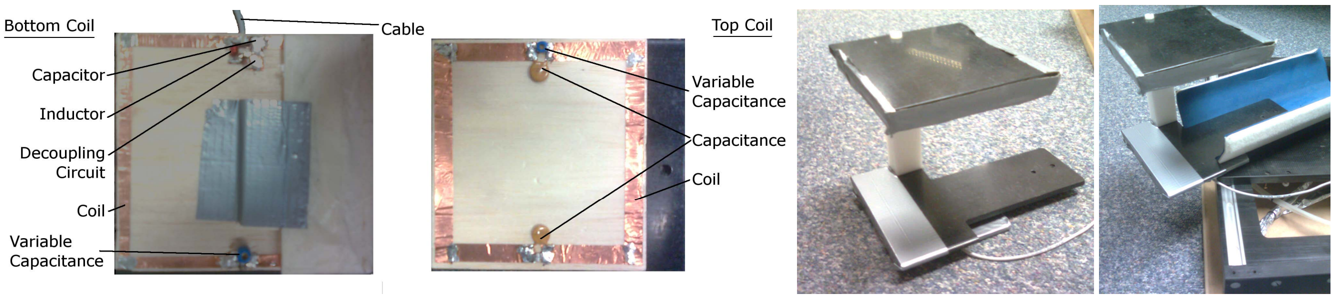

Figure 1. (Left) The two coil elements. (Right) The coil and the limb-positioning platform. The bottom coil is fixed underneath a plastic base which slides into the gutter attachment of the moveable platform, and is connected to the scanner by a single cable. The top coil is fixed in position by the plastic mount.

Results

With the double coil configuration, SNR on the far side of the phantom increased 425% over that of the single coil. For rotations of up to 90^{o} inside the scanner, images showed a maximum variation in SNR of 4.6% for compared with 81.9% for a standard flex coil. Uniformity was also greatly increased. It was found that there were variations of signal intensity of up to 24% when different size loads ranging from 100ml to 1 litre were used as phantoms.

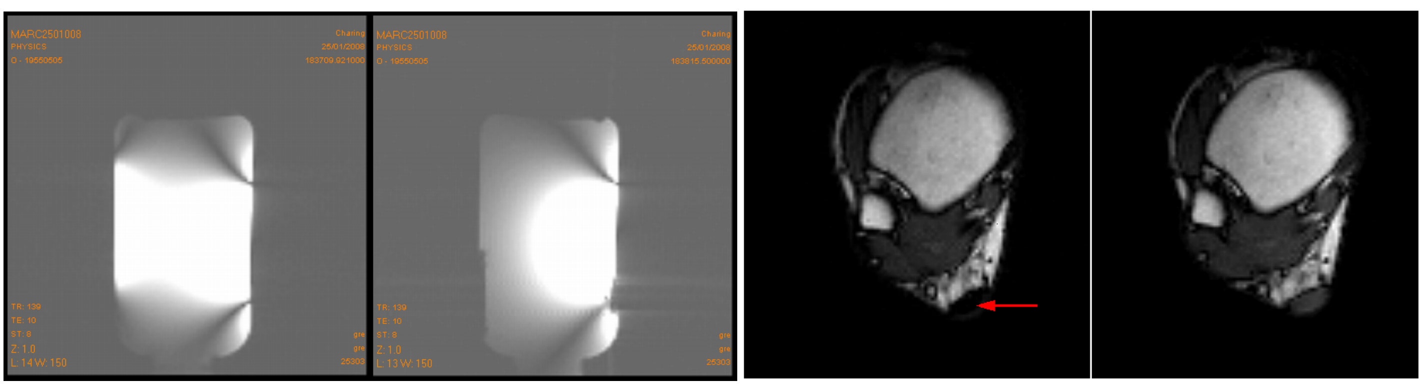

Figure 2. Left: Phantom images showing the signal boost on the far side of the phantom when the IC second element is used. Right: Ankle images taken of a volunteer with the leg orientated at (Left) 0^{o} and (Right) 55^{o} degrees to the static field. The red arrow marks the Achilles tendon.

Discussion

The MA coil has made practical use of fixed-coil inductive coupling principles for the purpose of limb positioning for MA studies. The coil shows excellent uniformity and an almost constant SNR through rotations compared with a standard flex surface coil. This technique may be applied to any surface coil to increase the active volume without the need for extra receive channels. Due to the sensitivity of the split resonance profile to variations in the coil loading, the coil should preferably be finely tuned using a phantom similar in size to the intended anatomy.

References

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