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Poster 6

Multiple-Loop Single-Turn-Solenoid Surface Coil for MR Imaging

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Introduction

Surface coil technology in MR imaging has greatly improved the local visibility of tissues near the surface. It is to detect the signal from the spins of specific ROI (Region of Interest), suppressing the thermal noise from rest of the body far from the coil, resulting the improvement of SNR. In general, the effective imaging depth is proportional to the size of the coil, so that for imaging of large region like spine, the coil is split to multi-segments surface coils (phased-array) for less depth.[1]. The phased-array coil requires the multiple receivers. In this study, the single-phase surface coil with multi-loop (MLSTS Surface coil: Multi-Loop Single-Turn-Solenoid) was developed for receiving NMR signal, resembling the tilted single-turn-solenoid coil by Jeong, et.al.[2]

Methods

Multi-loop single turn surface coil was a 90° tilted version of STS (Single-Turn-Solenoid).[2] Three MLSTS surface coils were constructed for the comparison, with the number of loops 1, 4, and 10. The size of the coils were 25cm long and 8cm wide. Figure 1(d) is the schematic diagram for the construction of 4-loop MLSTS. The passive transmit/receive decoupling circuit with cross-diodes was attached at the other end of the coil.[3] Each multi-loop STS coil was consist of multi circular rings with diamrters of 8 cm.

MLSTS surface coils were tested on a clinical MRI system (Signa Horizon, GE Medical Systems). Volume neck coil phantom (4l H_2O with cupric sulfate($CuSO_4$) dissolved) was imaged with spin-echo pulse sequence, TR/TE = 400.0/11.0 msec, 256x256 matrix, FOV 20 cm.

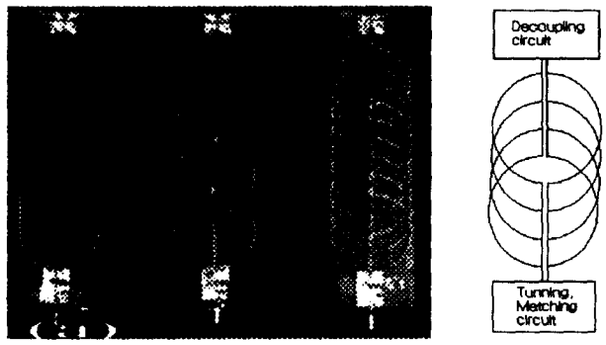

Figure 1. Picture of MLSTS surface coils with (a) single-loop, (b) 4-loop, and (c) 10 loops, and (d) the schmatic diagram of 4-loop MLSTS.

Results

Table 1 is the configuration of the MLSTS surface coils for this study. As in the reference [2], the tuning capacitance C_T was much larger for 10-loop MLSTS, than for less loop MLSTS. Figure 2 is the plots of signal intensities along the direction

Table 1. Inductances of the coil and tuning capacitance C_T of 3 imaging coils.

	Single-loop	4-loop	10-loop
Inductance(μ H)	0.89	0.12	0.095
Capacitance(ρ F)	7	52	65
Q(un-/load)	-	66/55	55/48

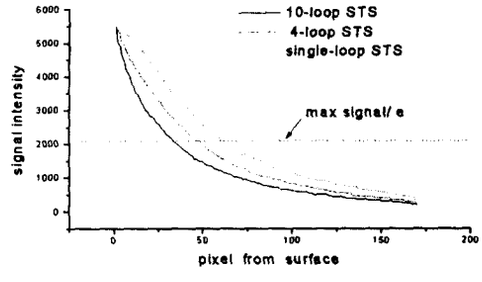

Figure 2. Signal intensity plots along the areal vector of MLSTS coils.

Table 2. Skin depths and SNRs of three MLSTS coils

	Single-loop	4-loop	10-loop
Skin depth(㎜)	48.4	38.3	27.3
SNR	232	252	292

perpendicular the center of the surface coil. The skin depth, defined by the distance from the coil to where the signal drops by 1/e, was measured from the signal plots in Figure 1. Table 2 is the list of the skin depths and SNR for the coils. The result proved that 10-loop MLTST surface coil's signal rapidly decreased as the depth increased. Axial T1 weighted images using 3 coils are in Figure 3.

(a) (b) (c)

Figure 3. Axial images of human wrist with coils, (a) single-loop, (b) 4-loop, (c) 10-loop MLSTS surface coil

Discussion

Multi-loop STS surface coil has smaller skin-depth, measured from the signal decay curve as in the Figure 2 and Table 2. This suggested that the multi-loop STS surface coil acted like a phased-array coil assembly, without using multi channel receivers. The self-inductance of the coil assembly decreasing with more loop may be advantageous for tuning a large size coil, which typically requires small value of tuning capacitance. Even though more thorough study is necessary for the direct comparison with a phased-array coil with the same physical size, the preliminary results showed this method is somewhat promising.

References

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