**Phased-Array Coils for MR Microscopy of the Skin in vivo**

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**100 WORD ABSTRACT**

An RF receive-only phased-array coil for high-resolution in vivo imaging of human skin was developed. Simulations of signal-to-noise ratio (SNR) for various coil geometries—single loops and 2 and 3-element phased-arrays—were performed with respect to the special noise characteristics of small coils. The 2-element phased-array coil was implemented. SNR measurements in a phantom verified the simulations. In vivo measurements of healthy skin were performed.

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**INTRODUCTION**

Noninvasive imaging and characterization of healthy skin, inflammatory skin diseases, and differentiation of skin tumors is of high dermatological interest. A high resolution of about 40-100 μm in-plane is required for imaging microscopic structures within the skin. To achieve high SNR in such tiny voxels (ΔV ≤ 10³ μm³), the use of surface receive-coils is mandatory. In previous work [1], very low noise linear 2-turn, 15mm-diameter loop and circularly-polarized surface coils were implemented. To further enhance the SNR, phased-arrays can be used. Phased-arrays consist of several individual elements, which are arranged with an optimized overlap [2]. Phased-arrays achieve a higher SNR than single coils with the same surface coverage. In this work, various phased-arrays were simulated and implemented. They were found to offer a significant increase in SNR, while covering the same surface area as the single 15mm-diameter loop.

**METHODS**

A simulation tool was developed to determine homogeneity, sensitivity and SNR per measured voxel over space in all three dimensions. The SNR is calculated taking into account the noise generated by the coil itself. Different designs, each with 2 turns, were compared: a 15 mm-diameter single loop, a 2-element phased-array, and a 3-element phased-array (both phased-arrays with 10mm element diameter). These designs were implemented for a Siemens Sonata 1.5 Tesla. Comparative SNR measurements were performed on a thin walled plastic bottle phantom filled with 0.5 % 0.9% NaCl solution. The pulse sequence was a 2D fast spin echo (TE = 12 ms, T2, TR = 2 s, FOV = 45mm², matrix 256 x 256, slice thickness 1.5 mm). Additionally, in vivo measurements of healthy skin were performed with the 2-element phased-array in a volunteer.

**RESULTS**

Figure 1 shows the calculated SNR distribution of the 15 mm-diameter single loop (a) and the 2- and 3-element phased-arrays (b, c) in a plane through a middle layer of the skin (y = 1.5 mm). Figure 2 shows the simulated (a) and measured (d) SNR profiles in y at the center of each coil. For easy comparison, the original simulated data were multiplied by a factor of 0.8. The simulations match the measurements very well. In the middle of the skin, the phased-arrays achieve a 2-2.6 fold higher SNR than the single loop, while maintaining the same coverage area. The high-resolution in vivo MRI of healthy skin over the shin (Figure 3) shows details of the dermis and the subcutaneous fat.

**CONCLUSIONS AND FUTURE WORK**

The simulations demonstrate how the 3-element phased-array improves the SNR for the same coverage area versus the single loop. The 2-element phased-array achieves nearly the same SNR, but it has limited coverage for sagittal (yz) planes. The achieved high SNR of the 2-element phased array coil enabled high-resolution in vivo imaging of healthy skin in human volunteers with microscopic resolution. The 3-element phased-array will be implemented soon, with the expectation of SNR approximately equivalent to the 2-element phased array while maintaining full coverage.

**REFERENCES**