

Shortened Quarter Lambda antenna for traveling wave excitation in high field MRI

H. Kroeze^{1,2}, A. Andreychenko³, C. A. van den Berg³, D. W. Klomp¹, and P. R. Luijten¹

¹Radiology, UMC Utrecht, Utrecht, Netherlands, ²Medical Technology, UMC Utrecht, Utrecht, Netherlands, ³Radiotherapy, UMC Utrecht, Utrecht, Netherlands

Introduction

Recently the concept of traveling wave excitation was demonstrated for high field MRI (1). In these experiments RF excitation and reception was done by using a patch antenna, suited for this task. The disadvantage of this antenna, however, is its size. A proper patch antenna for 7 T MRI is almost as large as the diameter of the bore. This limits the location of the antenna to the edge of the bore, relatively far from anatomical structures to be imaged in, for instance, the abdominal area. In the latter case, tissue between the object to be imaged and the actual antenna will act as an attenuator, reducing image quality and SNR ratio. Moreover, a large patch antenna will block any access to the patient at the backend of the magnet, which may jeopardize access to visual stimuli as well. We therefore propose the use of a mechanically less constrained Shortened Quarter Lambda (SQL) antenna for setting up travelling waves, and demonstrate 8 fold improved efficiency in the abdomen compared to a patch antenna

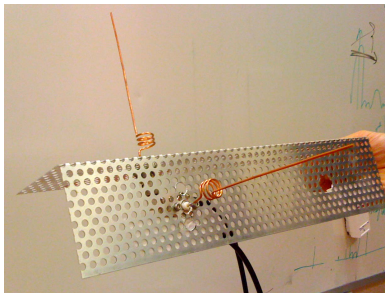


figure 2 SQL antenna

Methods

A quarter lambda antenna mounted on a ground plane is a good and efficient radiator (2). At 298.2 MHz such an antenna has a length of 250 mm. To further reduce the length of the antenna, an inductor is introduced at the base of the antenna. The inductor consists of 3 turns of the antenna wire (1.8 mm) with an inner diameter of 12 mm. A groundplane of 160*360 mm² was employed. By varying the length of the antenna wire and the length of the inductor, the SQL antenna can easily be tuned and matched. To enable quadrature excitation, two SQL antennas were placed on a 90° folded groundplane (figure 1). To compare the performance of the SQL antenna to a circular quadrature patch antenna, FFE images were

obtained from a cylindrical phantom and a healthy male volunteer with both antennas at equal RF power settings.

Results

With a length of 154 mm an impedance of 53+3j ohm was measured with the SQL antenna located in a (dummy) bore close to a waterfilled phantom, resulting in a VSWR of 1.1. The matching is varying with the distance to the phantom, indicating good coupling with the load. Figure 2a and b show the transversal FFE images of the cylindrical phantom positioned at equal distance from the antennas, in which the average SNR with the patch antenna is slightly higher.

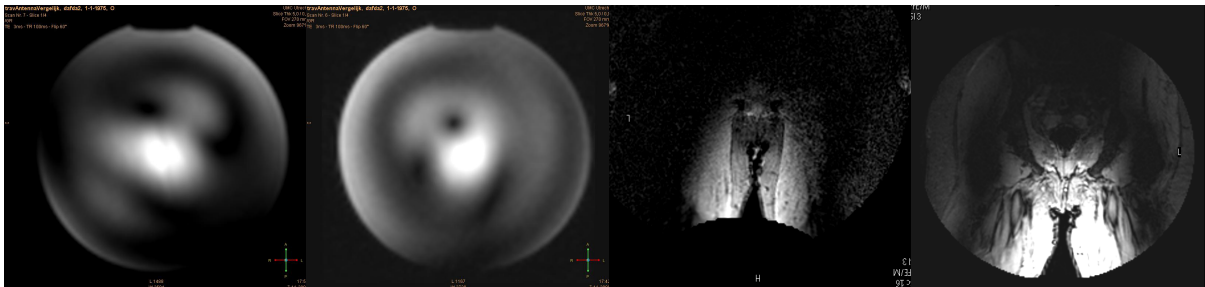
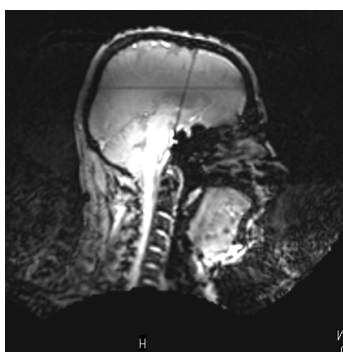


Figure 2a Patch antenna Figure 2b SQL antenna Figure 3a Patch antenna Figure 3b SQL antenna

Figure 3a is a coronal image of the prostate region, imaged using the patch antenna located at the feet of the volunteer, whereas figure 3b is obtained using the SQL antenna, placed between the legs of the volunteer. An improvement of a factor 8.2 was obtained in SNR. An example of a saggital image obtained with the SQL antenna placed super cranial is shown in figure 4.



Conclusion

Although the patch antenna shows a slightly higher efficiency when positioned equally far from the tissue of interest, the SQL antenna can be positioned between the legs of the patient, thereby substantially improving efficiency in sensitivity in the human prostate. In addition, images of the head can be obtained without blocking the path for visual stimuli, enabling fMRI experiments in combination with such antenna

References 1) Brunner O, et al, Nature 457, 2009. 2) Kraus and Marhefka, Antennas for all applications, McGrawHill 2002.

Figure 4