Whole Body RF Coil for 3 Tesla MRI System

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Introduction

In recent years there has been an increase in usage of MRI systems at field strengths above the typical 1.5 Tesla. Research systems have been built with magnets as high as 8 Tesla. Systems are now commercially available at 3 tesla and 4 tesla. These systems are primarily used for research in fMRI and human head related imaging and spectroscopy studies. The addition of a large volume whole body transmit coil would allow new clinical applications to be developed in other parts of the human body outside the head as well as supporting the use of local receive only surface coils. Several technical issues must be resolved such as the increase in RF power required to produce the B1 field at higher frequencies. The shorter wavelength due to the higher frequency must also be considered. Attempts to retune standard 1.5T body coils are difficult because the capacitor values required become very small and parasitic capacitance of the endring gaps is a significant effect.

Methods

A whole body shielded highpass birdcage coil (1),(2) (Figure 1.) was designed for a whole body 3 tesla magnet. (Magnex Scientific) fitted with short gradient coils capable of 40mT/m.The birdcage coil is built on a 55cm I.D. bore tube. The length of the birdcage was kept relatively short to reduce RF drive power and minimize rung inductance. The rungs were also made very wide to further reduce inductance and yield higher capacitor values. The distance from the coil to the RF shield is very close resulting in higher coil currents but further reducing rung inductance and yielding reasonable capacitor values. The coil has an unloaded Q of 236 and loaded Q of around 47. The coil was connected to a 90 deg. quadrature hybrid power splitter and driven by a 25KW tube type RF amplifier.(Astex Inc.) Pin diode disable circuits were employed in 8 locations for deresonating the coil during headcoil and receive surface coil operation.

Results

The coil produced a B1 field with a uniformity of +-10% over 20cm DSV and +-30% over 35cm DSV as measured in air with a field probe. Load impedance varied between 40 and 80 ohms for various patient weights from 120 to 310 lbs. Images of the abdomen(Figure 1),spine (Figure 2), Heart (Figure 3) wrist, abdomen were acquired with good results. The coil has an inherant efficiency of aproximately 75%.

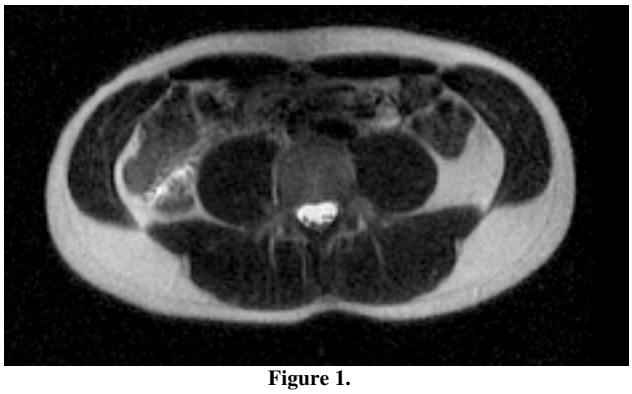

Figure 1.

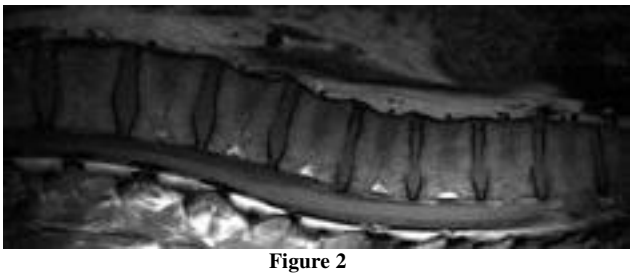

Figure 2

Figure 3

Discussion

The addition of this whole body RF coil in a 3T system will allow the use of virtually all whole body clinical application facilitated by a standard whole body 1.5T system. Despite the aggressively short length of the coil the limitation in FOV was primarily due to the Z gradient coil in the sagittal and coronal images. The peak and average power required to run standard image protocols although higher than 1.5T systems is very reasonable and within current limits set by the FDA. 3 tesla whole body systems provide a potential to have significant increase in image quality and resolution in high resolution applications such as cardiac, spine and extremity imaging.

References

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