Development of TEM Coil for Animal Experiments at 3T MRI System

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ABSTRACT

A novel TEM resonator coil was developed for the imaging of small animals. The functional elements of the TEM resonator were 8 inner conductors, distributed in a cylindrical pattern and connected at the ends with capacitors to the cylindrical outer shield. The TEM resonator coil with cavity elements was robust to the surrounding influences due to the self-shielding structure. The TEM resonator coil with high Q factor could provide high quality MR images at 3.0T MRI system. Also, the TEM resonator coil has an advantage for a fine tune with length adjustment of each cavity elements. Thus, The TEM resonator coil at 3.0T, even higher field could be used in the research studies.

1. INTRODUCTION

To extend the inherent signal-to-noise ratio (SNR) advantage of high field MRI to human imaging and spectroscopy, a distributed circuit approach to designing RF volume coils is required. As coils approach wavelength dimensions, conventional lumped element designs shows nonuniform current distributions resulting in decreased homogeneity, decreased filling factor, and increased electric field losses and decreased conductor skin depths resulting in increased ohmic losses. At high frequencies the phase change due to the finite propagation velocity of transmit and receive signals on coil conductors is no longer negligible. To preserve coil performance above 100MHz, coil circuits must be distributed, and the distributed nature of the patient loaded coil must be considered. More specifically, lumped elements should be replaced by transmission line and cavity elements. Lumped element circuit theory should be replaced by transmission line or transverse electromagnetic (TEM) coil and the human (or animal) load. The inherent SNR advantage of high field MRI is realized in clinical images and spectra. The purpose of this study is to describe a distributed circuit approach to high frequency volume coil design illustrated with specific coils built accordingly and results obtained from animal studies at 3.0 tesla.

2. MATERAILS AND METHODS

All experiments were conducted on 3T MRI system (Medinus Co., Ltd. Korea). The tuned TEM resonator measures 15cm outer diameter. by 10cm inside diameter. by 30cm in length. The inside diameter and length were determined by animals' body or head size (eg. rats or small dogs, etc.) while the outer diameter was chosen for compactness with some sacrifice of the optimal coil Q predicted for a larger cavity. A spin echo sequence with a TR/TE/flip angle=500/12.4ms/75°was used to check image qualities with phantom. The breed of rat which used for animal images was Sprague-dawley(SD) and was anesthetic using ketamin hydrochloride 75mg/kg.

3. RESULTS

The TEM resonator coil was employed to collect anatomical data of a coronal rat brain. High SNR rat brain images was acquired.

4. CONCLUSIONT

A TEM resonator coil was developed that is suitable for small animal studies. Because of high SNR, the coil will apply to functional magnetic resonance imaging (fMRI) or magnetic resonance spectroscopy (MRS) for animals

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