THE EFFECT OF LOAD GEOMETRY ON B1 INHOMOGENEITIES ON A HUMAN BODY RF COIL AT 3 TESLA

R.T. Goldberg (UF/MBI), D.M. Peterson (UF/MBI), B.L. Beck (UF/MBI), J.R. Fitzsimmons (UF/Radiology)

Introduction

Magnetic resonance imaging continues increasing B0 field strength in search of improved signal to noise. However one consequence of the increased frequency of the B1 field is field focusing and wave behavior within the sample, leading to image inhomogeneities that can become very severe at 11.1T [1], leading to signal voids. At lower fields the effect is less severe but never the less impacts image quality, especially as samples get larger, as is the case for imaging the human body at 3 T. The causes of the B1 field inhomogeneity can be fundamentally explained through a quite straight forward theory of multiple wave interaction whereby cylindrical electromagnetic waves emanating from each current carrying element in a volume coil system interact constructively and destructively at the inside region of the volume coil, or load if one is present, yielding a standing wave pattern within these regions. To understand, and potentially correct or alleviate these effects, we have been modeling phantoms and examining the influence of sample geometry on the image inhomogeneities.

Methods

A 16-element high pass body coil (diameter 60cm, length 50cm, f = 128Mhz) was simulated using XFDTD, a finite difference time domain electromagnetic field solving software package from Remcom Inc., State College Pa. The body coil was loaded with an anatomically correct human “body mesh” model, with absorption coefficients and dielectric constants representative of the human body, as well as with both a solid circular and elliptical geometrical phantom with absorption coefficient and dielectric constants comparable to the mean value in the middle part of the human torso. The major axis of the elliptical cylindrical phantom was 35 cm and minor axis was 27 cm, comparable to the human torso dimensions. The diameters of the circular cylindrical phantoms, for comparison, were made the same as the major and minor axis of the solid elliptical phantom, 35 and 27cm. respectively. The length of all the phantoms was 70cm.

Results

The simulation results in the figure show clearly a single bright striped region in the center of the human torso (A), with two dark striped regions on either side of the center stripe. The simulated B1 field for the solid elliptical cylinder in (B) shows a very similar result to that in (A) with nulls on either side of the major axis of the solid ellipse, where (C,D) show a markedly different display of complete circular symmetry of the standing wave pattern.

Conclusion

These data suggest the possibility that these standing wave patterns maybe more a function of radius of curvature of the outside surfaces of each geometry rather than diameter. This suggests that the inclusion severe long wavelength diffraction effects, such as a modified ray tracing, could prove to be useful in analyzing and rectifying these problems. The work has been submitted to the ISMRM (2).

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References