Anthropomorphic head phantom for use in performance testing of proton in vivo magnetic resonance spectroscopy

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In vivo Magnetic Resonance Spectroscopy (MRS) is currently the only completely non-invasive method of determining the presence or absence of magnetically detectable metabolites in the human body.

In this work, an anthropomorphic phantom of the human head has been developed. The phantom contains solid gel materials which mimic the magnetic resonance properties of various regions of the human brain and has compartments of metabolite-containing gel materials. The metabolites used are those which are known to be detectable in vivo in clinical MRS units. Other compartments of the phantom contain simulated brain tumors in various stages of advancement. All compartments within the phantom mimic the T$\sb1$ and T$\sb2$ of water in the human brain. The phantom also contains regions of water T$\sb1$ and T$\sb2$ inhomogeneity, as found in the brain near the cerebral ventricles. There are regions of magnetic susceptibility inhomogeneity due to tissue-air boundaries as one finds in the human head near the sinuses. These magnetic susceptibility inhomogeneities induce magnetic field inhomogeneities which make production of a uniform field through shimming difficult. The phantom thus simulates the difficulty of obtaining a high resolution spectrum near magnetic field inhomogeneities.

The heights of all peaks in in vivo MRS spectra of the human brain are weighted by the T$\sb1$'s and T$\sb2$'s of the $\sp1$H nuclei responsible for those peaks. The simulated brain material in the phantom mimics these T$\sb1$'s and T$\sb2$'s better than other known phantom materials.

$\sp1$H NMR spectra of fresh adult pig brain have been obtained at 1.9 Tesla at room temperature and at body temperature (37$\sp\circ$C). These spectra are almost indistinguishable from the spectra of the brain-mimicking materials. The T$\sb1$'s and T$\sb2$'s of $\sp1$H nuclei corresponding to various peaks in the pig brain spectra are much closer to the values in the head phantom brain-mimicking material than any other previously developed brain-phantom material. (Abstract shortened by UMI.)