BASIC MRI PHYSICS – "SPIN GYMNASTICS"

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The physics of MRI will be reviewed with the goal of presenting an intuitive and graphically centered conceptual framework. The lecture is given in two components; the physics of NMR followed by the principles of MR imaging.

The first component deals with the basic concepts in nuclear magnetic resonance dealing with proton spin, angular momentum, resonance, bulk magnetization, RF excitation and signal detection. These concepts are used to illustrate the mechanisms responsible for signal loss from spin dephasing arising from T2* and T2 relaxation. The spin-echo is reviewed to illustrate how T2 is measured separately from T2* relaxation mechanisms. T1 is reviewed and signal contrast influences by TI and T2 are illustrated.

The second lecture component illustrates how imaging by NMR is achieved. Slice selection via selective RF excitation in the presence of magnetic field gradient is demonstrated. The use of magnetic gradients for frequency and phase encoding is then illustrated by a graphical approach of spin phase accumulation. Presented in this manner, the two processes can be viewed in a common manner. Finally, all these concepts are united to illustrate how actual MRI pulse sequences operate. Throughout the lecture, unique 3D animations are used to illustrate complex concepts in a graphically intuitive manner. The overall goal is to provide a working knowledge of the basic physics of MRI in a way that is both intuitive and true to the physics of MRI.

References:

1) Plewes DB, Kucharczyk W**.** Physics of MRI: a primer.
J Magn Reson Imaging. 2012 May;35(5):1038-54.