

MRI Principles

Presented by Frank R. Korosec, Ph.D.
Noon – 1 PM Daily
Room 1335 HSLC

Date: Monday, July 10, 2017

Introduction and Overview: Summary of Capabilities and Clinical Examples (Sounds of various sequences; T1, T2, and density-weighted spin echo imaging of the brain and spine; gradient echo imaging for surgical planning, vascular, and cardiac imaging; advanced sequences such as echo planar imaging, functional imaging, spectroscopy, hyperpolarized helium imaging, and high field imaging).

Date: Tuesday, July 11, 2017

Basic Physics I: The Magnetic Resonance Phenomenon (criteria for generating magnetization, alignment of nuclear magnetic moments and formation of bulk magnetization, precession, signal generation and detection, the Larmor equation, the rotating frame of reference, spin tipping).

Date: Wednesday, July 12, 2017

Basic Physics II: T2 & T1 Relaxation (mechanisms responsible for spin dephasing, spin-spin interactions, signal decay, spin flips, regrowth of longitudinal magnetization, spin-lattice interactions, relaxation properties of various states of matter, effects of field strength on T1 and T2 relaxation).

Date: Thursday, July 13, 2017

Basic Physics III: The Spin Echo Phenomenon (spin dephasing, 180 degree refocusing, spin rephasing, the spin echo rf sequence, TE and TR sequence parameters and their effects on T1, T2, and density weighting).

Date: Friday, July 14, 2017

Image Formation: Slice Selection (slice selective rf pulse and slice selection gradient), Frequency Encoding (encoding position using different frequencies during signal readout), Phase Encoding (encoding position using different phases) and Pulse Sequence Timing Diagrams.

Date: Monday, July 17, 2017

Imaging Sequences: *Spin Echo Imaging* (scan time determination, data acquisition for single slice imaging, interleaved data acquisition order for multi-slice imaging, dual echo spin echo imaging for simultaneously acquiring density- and T2-weighted images, effect of imaging parameters on CNR, SNR, scan time), and *Fast Spin Echo Imaging* (echo train length, scan time determination, data acquisition, and image weighting), *Inversion Recovery Imaging* (inversion pulse, signal differences based on different T1 regrowth rates, signal nulling). *Gradient Echo Imaging* (eliminating the 180 degree pulse and its effects on data acquisition and image quality, properties of gradient echo sequences, small tip angle imaging, the gradient echo, examples of gradient echo imaging), and *Echo Planar Imaging* (the pulse sequence, example of reduced motion sensitivity, examples including functional and diffusion-weighted imaging).

Date: Tuesday, July 18, 2017

Imaging Options: Review of factors influencing the SNR of the image, Fractional NEX, Fractional Echo, Fractional FOV, No Phase Wrap, Chemical Saturation, Spatial Saturation, Magnetization Transfer, IR Prep, DE Prep, Slice ZIP, Read ZIP, Tailored RF, Variable Bandwidth, SPECIAL, Flow Compensation, Cardiac Triggering, etc.

Date: Wednesday, July 19, 2017

Artifacts and Remedies: RF noise, motion, pulsatility, phase wrap (aliasing), signal over-range, susceptibility, chemical shift, saturation, intravoxel dephasing, etc.

Date: Thursday, July 20, 2017

Safety and Screening: Static Fields (biological effects, mechanical effects), Varying Fields (induced currents, auditory damage, RF power deposition), and other issues (cryogenics, claustrophobia, contrast agents).

Date: Friday, July 21, 2017

Questions and Answers: Summary of series presented using Raphex Exam Questions and Answers.

Date: Monday, July 24, 2017

Fast Spin Echo Imaging and Variants: The echo train, phase encoding arrangement for T1, T2, and density weighting, edge enhancement in T2-weighted imaging, edge blur in T1-weighted imaging Dual Echo – split the echo train to get density-weighted information early and T2-weighted information late in the train, pros and cons; FRFSE – fast recovery fast spin echo – use an additional -90 degree rf pulse to tip the residual transverse magnetization longitudinal so you don't have to wait for regrowth of longitudinal magnetization, shorter TR, heavier T2 weighting; IRFSE – inversion recovery FSE – used to add T1 weighting; FLAIR – fluid attenuated inversion recovery – inversion recovery sequence with long TI to null the signal from CSF; SSFSE – single shot fast spin echo – long, compact echo train to sample all the information for an image in a single echo train; MRCP – MR Cholangiopancreatography – fast spin echo sequence with a very long TE to null signal from all tissues having T2s shorter than that those of fluids.)

Date: Tuesday, July 25, 2017

Advanced Gradient Echo Imaging: Sequence design, elimination of refocusing pulse, shorter TE, shorter TR, reduced tip angle, sensitive to signal loss caused by magnetic field inhomogeneities/susceptibility, susceptible to signal saturation, spoiled versus non-spoiled methods, fat and water in and out of phase, chemical shift artifact of the second kind, modified contrast using fat saturation, magnetization transfer, inversion recovery, and driven equilibrium, applications include fast scanning of dynamic processes, cardiac imaging, vascular imaging, etc.

Date: Tuesday, July 26, 2017

k-space: An introduction to the meaning of k-space will be presented. The relationship between imaging gradients and k-space will be described. Some common artifacts that arise from the misrepresentation of k-space will be reviewed and explained.