AbstractID: 9882 Title: Contrast Agents in MRI

Drugs, known as "**M**agnetic **R**esonance (MR) **C**ontrast **A**gents (CA)" are firmly established in current clinical practice. According to recent data, MR CAs are administered in about 25-30% of all MR Imaging (MRI) procedures; it is estimated that in 2005 about 20 million procedures involving injected CAs were performed worldwide. In standard applications, they are administered intravenously with the intent to modify the **N**uclear **M**agnetic **R**esonance (NMR) characteristics of tissues. Since the extent of contrast agent impact varies with tissue type, the differential effect of drug action on imaged lesions modifies their appearance on MR images. This phenomenon is used to aid the clinical diagnosis.

Physical principles governing the behavior of CAs are discussed first, with emphasis on mechanisms that play a major role in MRI applications. CA's main role is to modify the NMR relaxation properties (longitudinal relaxation time T1, transverse relaxation time T2, or both) of its molecular environment. Since the effect is proportional to CA's concentration in the tissue, the biodistribution of CA has a major impact on the overall efficacy of the drug. Thus, in addition to NMR relaxation processes, fundamentals of compartmental analysis are discussed. The segment is concluded with taxonomy of CAs currently available for clinical use.

The second part of the presentation describes clinical applications of MR CAs. Currently, routine applications explore non-organ targeted relaxation enhancement mechanisms of action. In this method, a bolus of CA is injected intravenously and data collection for MRI begins a few minutes later, after tissue uptake mechanisms have established stationary conditions throughout the patient's body. Abnormalities within organs accumulate higher concentrations of CA, which shortens their T1 relaxation time and makes them appear brighter (relative to their background) on T1-weighted MR images. However, two major off-label areas of use have emerged already: contrast-enhanced **MR A**ngiography (MRA) examinations and **D**ynamic **C**ontrast **E**nhancement (DCE) studies of tissue perfusion. Strengths and weaknesses of these techniques are reviewed. The segment ends up with a discussion of tissue-specific CAs, such as **s**uper**p**aramagnetic **i**ron **o**xides (SPIO) used in imaging of the liver.

The last part of the lecture focuses on the safety issues associated with the use of MR CAs. Despite rigorous pre-market evaluations (MR CAs are considered drugs and are subject to FDA regulations) some side effects emerge only after the drug has been on the market for considerable time, when the large volume of available clinical records reveals patterns that remain hidden within smaller data pools. The recent alarm caused by emergence of the **N**ephrogenic **S**ystemic **F**ibrosis (NSF) syndrome as a serious consequence of using Gadolinium-based CA during MR studies in patients with acute or chronic kidney disease is used to describe and analyze safety issues related to the use of MR CAs.

Educational Objectives:

1. Understand the physical mechanisms governing the action of contrast agents used in MR Imaging.
2. Become acquainted with the taxonomy of contrast agents used in current clinical practice.
3. Learn about safety issues related to the use of contrast agents in MRI practice.