ADVANCED MRI APPLICATIONS

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Abstract. Despite that Magnetic Resonance Imaging (MRI) was introduced as a clinical imaging tool more than 25 years ago, it continues to be characterized by fast-paced technological evolution that has a profound influence on its clinical applicability. This chapter presents a few selected recent technological MRI innovations and new clinical applications.

Keywords: Magnetic Resonance Imaging, Magnetic Resonance Angiography, contrast agent, brain morphometry, high field, gradient echo.

1. Introduction

This chapter will summarize a few of the more advanced clinical MRI applications. The specific topics are 1) Faster and more efficient imaging, 2) MRI contrast agents and 3) Imaging with magnetic field strengths of 3.0 Tesla (T) and higher.

2. Faster and more efficient imaging

The development of such enhanced MRI techniques offer reduced economic costs, lessened sensitivity to physiological motion, a reduced requirement for patients to hold still for extended periods of time and the opportunity to measure more in the fixed amount of time that a patient can hold still.

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In the early 1990’s, Fast Spin Echo (FSE) imaging (also known as Turbo Spin Echo (TSE) imaging), relaxed the one k-space line per TR requirement and thereby significantly enhanced the time efficiency MRI. FSE techniques collect four or more phase encoded spin echoes during a single TR, making the imaging process considerably faster. The acquisition of multiple echoes tends to restrict FSE to the acquisition of T2-weighted images. Figure 1 provides an example of a typical modern day FSE brain image illustrating that FSE techniques can acquire high quality T2-weighted images.

Gradient echo MRI is alternate approach that can be used to acquire image data more quickly than is possible with conventional spin echo imaging. In gradient echo imaging, the echo signal is formed by gradient polarity reversal at relatively short time-to-echo (TE) rather than by a spin echo formed by the action of a refocusing pulse.

Figure 2 shows the generic pulse sequence design used in two-dimensional gradient echo imaging. The concept of gradient echo imaging was introduced in the 1980’s. However, initial applications were relatively limited because gradient hardware systems of the time were not able to reverse gradient polarity without the induction of undesirable spatial and