CHAPTER B5
Sequences

INTRODUCTION

This chapter introduces the reader to the signal response associated with different types of sequences. The first two units discuss short T_R gradient echo sequences. Second only to spin-echo methods, these powerful gradient-echo techniques are used for rapid conventional and dynamic 2- and 3-D imaging, most often for 3-D imaging of the brain and MR angiography. A proper understanding of the imaging parameters such as T_R, T_E, and flip angle are critical to their proper use.

UNIT B5.1 addresses imaging methods commonly known as FLASH (fast, low angle shot) or spoiled GRASS (gradient-refocused acquisition in the steady-state), but here are referred to as steady state incoherent (SSI) methods. They force the transverse magnetization to be zero prior to any RF pulse. This is usually accomplished by RF and gradient spoiling. The resulting signal exhibits the same types of contrast mechanisms as spin echo except with T_2 replaced by T_2^*. For very short echo times, the difference between spin density and T_1-weighted imaging depends on the flip angle. For flip angles smaller than the Ernst angle, the MR signal is spin-density weighted. For flip angles larger than the Ernst angle, the MR signal is T_1-weighted. The sequence can still be run with very short T_R's with good spoiling, at least down to 20 msec and is often used for breath-hold abdominal scanning as well. These issues and the sequence design are carefully derived and discussed in this unit.

UNIT B5.2 addresses imaging methods commonly known as SSFP (steady-state free precession), FISP (fast imaging with steady-state free precession), true FISP, or GRASS, but here referred to as SSC methods. They do not force the transverse magnetization to be zero prior to the RF pulses. Rather, they ensure that both components, longitudinal and transverse, reach equilibrium. Hence, it is no surprise that the signal now develops a T_2 dependence. Unfortunately, the signal dependence tends to be more T_1/T_2 weighted and so it performs best when imaging fluids and, as is being discovered, the blood as well. Since it can be run very quickly and does not require spoiling, it is being used with contrast agents for MR angiographic studies. These issues and the sequence design are carefully derived and discussed in this unit.

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