28 Spin Echo Imaging

Sagittal and axial T1-weighted spin echo images, acquired at 1.5 T, are shown prior to (**Fig. 28.1a,b**) and an axial image following (**Fig. 28.1c**) intravenous gadolinium chelate administration. The scans demonstrate a heterogeneously enhancing hypothalamic mass, by stereotactic biopsy a grade II astrocytoma.

In an MR pulse sequence, either a gradient magnetic field or an RF pulse can be employed to form (refocus) the observed signal (the echo). A sequence that uses a gradient to refocus the echo is referred to as a "gradient echo" pulse sequence (see Chapter 35). If there is an RF pulse prior to the echo (classically a 180° pulse), then the pulse sequence is referred to as a "spin echo" sequence. Spin echo (SE) technique was widely used historically. However, today, its application in MR is limited, largely due to the emergence of fast or turbo spin echo technique. SE technique is still commonly employed at 1.5 T for T1-weighted imaging in the brain, as illustrated in **Fig. 28.1**.

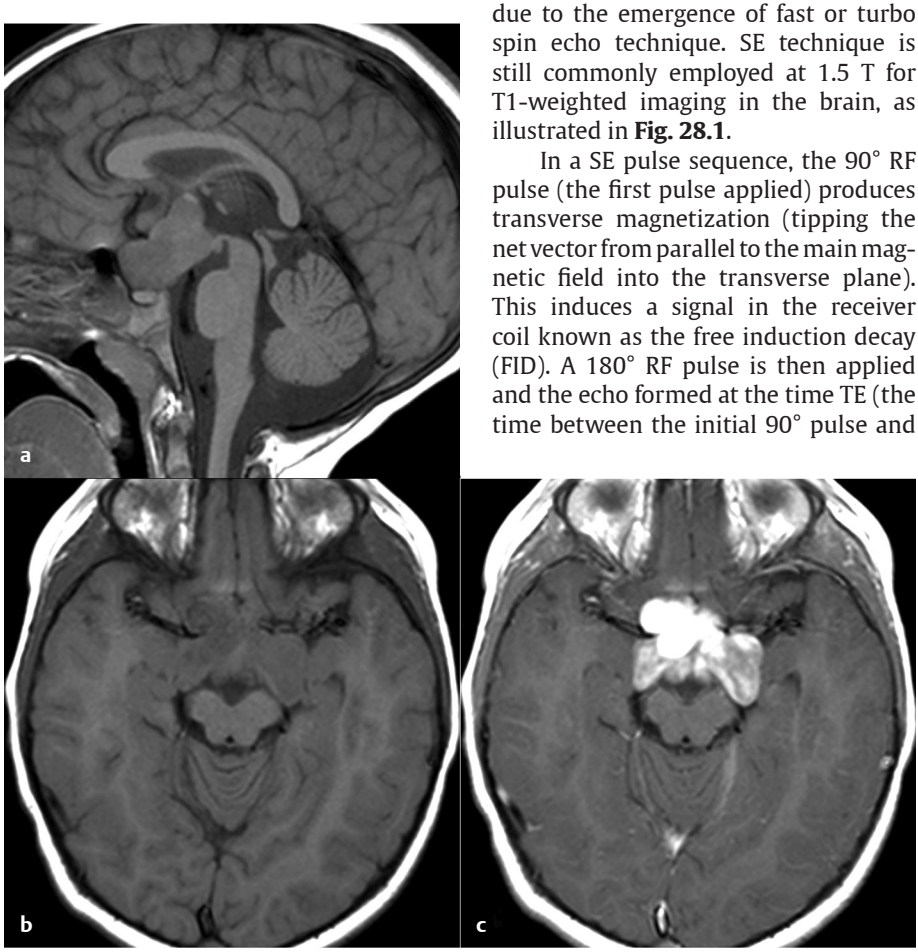

Fig. 28.1

In a SE pulse sequence, the 90° RF pulse (the first pulse applied) produces transverse magnetization (tipping the net vector from parallel to the main magnetic field into the transverse plane). This induces a signal in the receiver coil known as the free induction decay (FID). A 180° RF pulse is then applied and the echo formed at the time TE (the time between the initial 90° pulse and

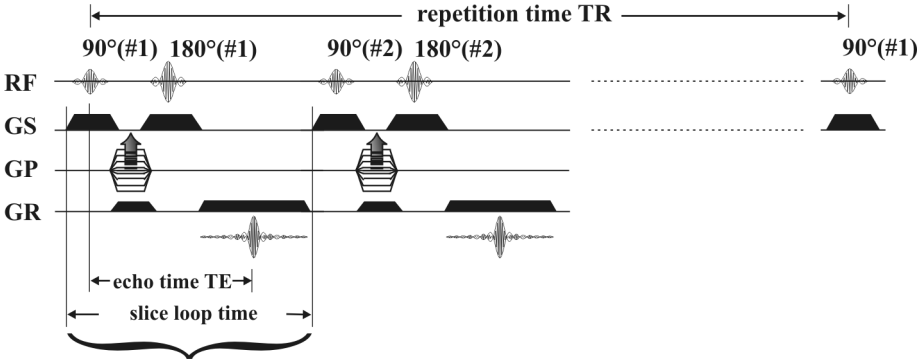

Fig. 28.2

the echo). The 180° RF pulse also corrects for dephasing effects from field and local inhomogeneities (T2* effects), as well as for phase effects that can occur (and lead to loss of signal) when fat and water both occupy a single voxel.

There are two operator-selectable timing parameters, which can be varied to control the contrast of the image when using a SE sequence (**Fig. 28.2**). These parameters are TR (repetition time) and TE (echo time). In general, the TR determines the T1-weighting and the TE determines the T2-weighting. As discussed in Chapter 26, the use of a relatively short TR (i.e., 500 msec or less) and a short TE (i.e., 25 msec or less) produces images in which the tissue contrast is primarily related to differences in T1 relaxation times. For example, in **Fig. 28.1**, TR/TE = 435/14 for the sagittal and 500/12 for the axial acquisition. Tissues with short T1 relaxation times appear bright on T1-weighted images. Gadolinium, employed as an intravenous contrast agent in the form of a chelate, is a paramagnetic metal. When in close proximity to a water molecule, the paramagnetic effect shortens the T1 of the water protons resulting in high signal intensity on T1-weighted images (**Fig. 28.1c**).

Increasing the TR while maintaining a short TE produces images that are primarily proton density–weighted. Using a long TR ($\geq$ 2000 msec) and a long TE ($\geq$ 80 msec) produces images that are T2-weighted. Because increasing TR also increases scan time, proton density– and T2-weighted scans are now acquired using fast SE technique, as opposed to traditional SE technique (see Chapter 29).

Given that TR in a SE sequence is much longer than TE, SE scans are performed in a multislice fashion. During the time following the echo, other slices are excited (the timing for two such slices is illustrated in **Fig. 28.2**). The maximum number of slices one can acquire during a given pulse sequence is dependent primarily on the ratio TR/TE. Reducing the TR or increasing the TE reduces the number of slices one can acquire for a given SE pulse sequence.