Gradient echo

Gradient echo sequences are an alternative technique to spin-echo sequences,differing from it in two principle points :

utilization of gradient fields to generate transverse magnetization

flip angles of less than 90°

Compared to the spin echo and inversion recovery sequences, gradient echo sequences are more versatile. Not only is the basic sequence varied by adding dephasing or rephasing gradients at the end of the sequence, but there is a significant extra variable to specify in addition to the usual TR and TE. This variable is the flip or tip angle of the spins. Flip angle

The flip angle is usually at or close to 90 degrees for a spin echo sequence but commonly varies over a range of about 10 to 80 degrees with gradient echo sequences. For the basic gradient echo sequence FLASH (figure 1) the larger tip angles give more T1 weighting to the image and the smaller tip angle give more T2 or actually T2* weighting to the images. Gradient echo

The gradient echo is generated by the frequency-encode gradient, except that it is used twice in succession, and in opposite directions: it is used in reverse at first to enforce transverse dephasement of spinning protons and then right after, it is used as a readout gradient (like in spin echo MRI) to re-align the dephased protons and hence acquire signal.

Because low flip angles are used, there is some retention of the original longitudinal magnetization as opposed to the 90° pulse used in spin echo, which completely eliminates the longitudinal magnetization. As a result, the build up time for longitudinal magneitzation is significantly reduced for the subsequent pulses , allowing faster image acquisition in GE.

Another important feature of GE is that the dephasement of spinning protons occurs as a result of T2* decay which is more rapid than the T2 decay process underlying Spin Echo sequence (leading to shorter TE) and is susceptible to static field inhomogeneities (leading to compounded influence of degraded blood products, and metal objects on the signal). Image characteristics

Images from other gradient echo sequences such as GRASS and FISP have less intuitive tissue contrast characteristics than FLASH. The FLASH and SPGR sequences show better tissue contrast between white matter and grey matter in the brain and spinal cord than GRASS or FISP and are preferred when the time of acquisition does not have to be very short. GRASS and FISP maintain better SNR than FLASH at short TR times and are therefore preferred with breath-holding techniques, for example.

A vector magnetization diagram of the gradient echo sequence is shown below. Note that the spins are refocused by reversing the direction of the spins rather than flipping them over to the other side of the x-y plane as occurs with the spin echo sequence. Gradient refocusing of the spins takes considerably less time than 180 degree RF pulse refocusing. One big disadvantage of gradient echo sequences is the loss of signal from static magnetic field inhomogeneity. This occurs to a lesser degree with spin echo sequences (and for a different reason). Magnetic susceptibility artifacts are therefore more pronounced on gradient echo sequences that on spin echo sequences [1).

1)
http://radiopaedia.org/articles/gradient-echo-sequences-1