MAGNETIC RESONANCE IMAGING (MRI)

Magnetic resonance imaging technique use RF region of the electromagnetic spectra to provide an image. First a patient is placed in an external magnetic field which causes the magnetization of protons of hydrogen atoms in his body. Due to magnetization, these protons align and process about the external magnetic field. Now a radiofrequency pulse at resonance frequency is transmitted into the patient under controlled and prescriber condition.

Block diagram of MRI system

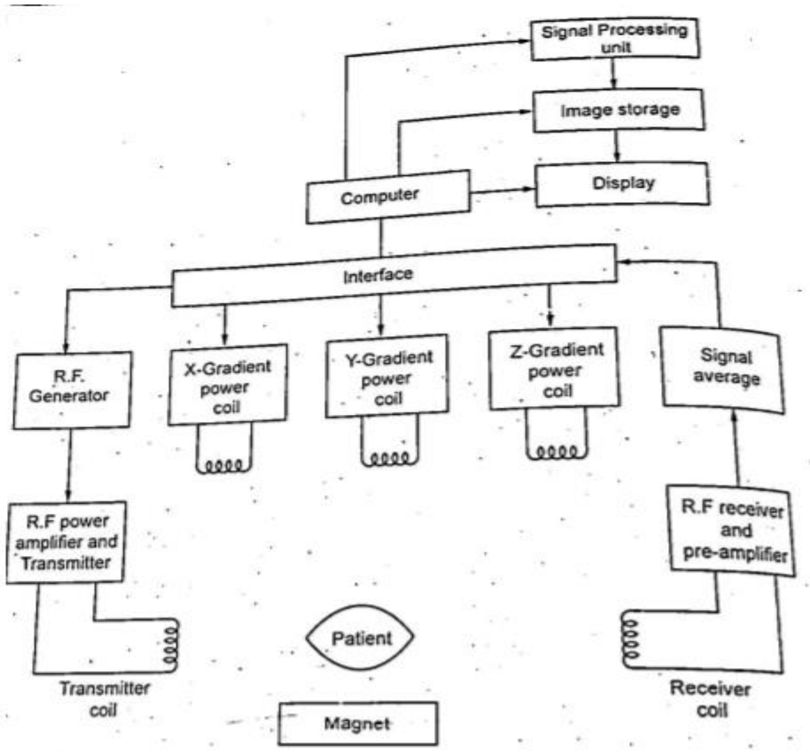

Fig: Block diagram of MRI system

The block diagram consists of super conducting magnetic coil, RF transmitter and receiver coil (X, Y, Z gradient coil), computer and display unit. There is a super conducting magnetic coil which provides a strong, uniform steady magnetic field and the coils are used to cooled to liquid helium temperature and it can produce very high magnetic field.

Different gradient coil systems produce a time varying controlled spatial non uniform magnetic fields in different directions. By taking a series of these projections at different direction a two- or three-dimensional image can be obtained. Now the patient is kept in this gradient field space between the transmitter and receiver RF coils surrounding the site on which the image is to be constructed.

The slice of image depends upon the gradient magnetic field is controlled by computer and that field can be positioned in three-time invariant planes i.e. (X, Y and Z). The transmitter provide the RF signal pulses and the received nuclear magnetic resonance signal is picked up by the receiver coil and is fed into the receiver for signal processing. By using two dimensional fourier transformation, the image is constructed by the computer and displayed on the television screen.

MRI Parameter:

There are three principal MRI parameters they are,

1. Spin density
2. Spin-lattice (Longitudinal) relaxation time, T_1
3. Spin-spin or Transverse relaxation time, T_2

Spin density:

To measure the concentration of mobile hydrogen nuclei available to produce an NMR signal is called the spin density.

Spin-lattice (Longitudinal) relaxation time, T_1:

The time constant that describes the rate at which the Z-component of net magnetization will return to its equilibrium value M_o is the T_1 relaxation time and this happens due to the excited nuclei transforming their energy to the surrounding molecular environment, called the lattice and also called as spin-lattice or longitudinal relaxation.

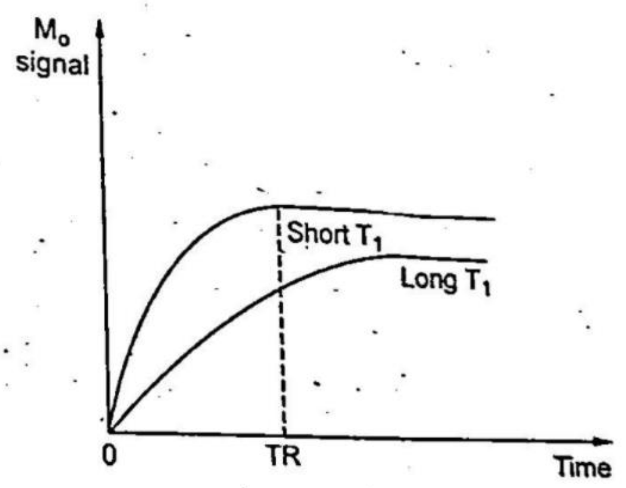

Fig: Spin lattice relaxation time, T_1

Spin-spin or Transverse relaxation time, T_2:

T_2 represents the time constant associated with loss of magnetization M_{xy} in the XY plane. The spin-spin relaxation time is normally measured with a spin-echo pulse sequence involving multiple echoes. The relaxation of peak height of a spin echo at time te to the peak height of an FID is

$$M_{xy}(te) = M_{xy}(0) \exp[-te/T_2]$$

A pulse sequence in MRI is basically a set of instructions to the magnet telling it how to make an image.

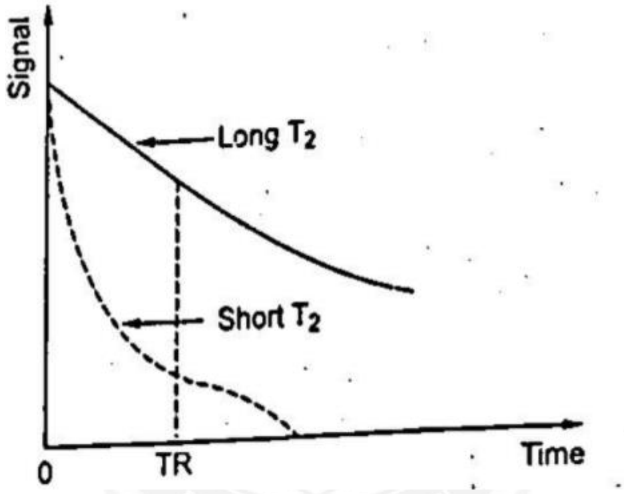

Fig: Spin-spin relaxation time, T_2