

Lecture 2

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Magnetic resonance imaging

The basic principle of MRI depend on the fact that the nuclei of certain elements align with the magnetic force when placed in a strong magnetic field

MRI is noninvasive method of mapping the internal structure and certain aspects of function within the body.

It uses nonionizing electromagnetic radiation and appears to be without exposure-related hazard

At the field strengths currently used in medical imaging ,hydrogen nuclei (protons) in water molecules and lipids are responsible for producing anatomical imaging .If radiofrequency of hydrogen is applied ,aproportion of the protons change alignment ,flipping through a preset angle ,and rotate in phase with one another. following this radiofrequency pulse ,the protons return (realign)to their original position .

As the protons realign (relax) they induce a radio signal which ,although very weak ,can be detected and localized by antenna coils placed around the patient .

An image represent the distribution of the hydrogen protons can be built up .

The strength of signal depends not only on proton density but also on two relaxation times .T1 and T2

T1-depend on the time the proton s takes to return to the axis of magnetic fields;T2- depend on the time the protons take to diphas e .

AT1-weighted images is one in which the contrast between tissue is due mainly to their T1 relaxation propereties ,while in a T2-weighted image the contrast between tissue is due mainly to their T2 relaxation propereties .

Most pathological processes show increase T1 and T2 relaxation times and these processes therefore appear lower in signal (blaker)on a T1 – weighted scan and higher in signal (whiter) on a T2 –weighted scan than the normal sarounding tissue .the T1 and T2 weighting of an image can be selected by appropriatly altering the timing and sequences of radiofrequency pulses .

Atypical MRI scanner consist of large circular magnet.Inside the magnet are the radiofrequency transmitter and receiver coils as well as gradient coils to allow spatial localization of the MRI signal .Ancillary equipment converts the radiosignal into adigital form which the computer can manipulate to create image.

T1 is called longitudinal relaxation time , also called spin- lattice relaxation

T_2 is called transverse relaxation time, .Also called spin-spin relaxation time, T2 is much smaller than T1

– For tissue in body, T2: 25-250ms, T1: 250-2500 ms

DVANTAGES OF MRI

Information can directly imaged in any plane .

No ionizaing radiation

No adverse biological effects from diagnostic MRI

DISADVANTAGE

Require longer scanning time compare to CT scan ,so the patient keep still during scanning procedure .

An avoidable movement from breathing mcardiac pulsation and peristalsis often degrade the image .

Strong magnetic field used mean that it is at present contraindicated in patient with cardiac pacemakers, intraocular metallic foreign bodies and certain types of aneurysm clip .

Sequence of MRI :

1-T1 : longitudinal relaxation

2-T2: transverse relaxation

3-proton density

4-fat suppression sequence:

a-stir: short T1 inversion recovery

b-spir: spectral inversion recovery

c-spair: spectral attenuation inversion recovery

5-Flair : fluid attenuation inversion recovery

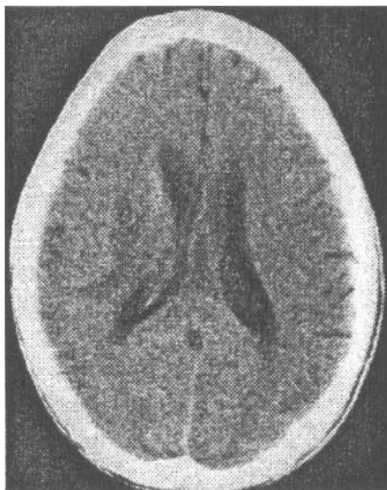
CONTRAST AGENT FOR MRI

Contrast agent providing useful diagnostic information with MRI .the most widely used agents are gadolinium compounds which only cross the B.B.B. when it is damaged by disease and which concentrate in tissue and diseases processes with high blood supply .

Tissue which concentrate the agent show very high signal intensity (they appear white) on T1 –IMAGES .

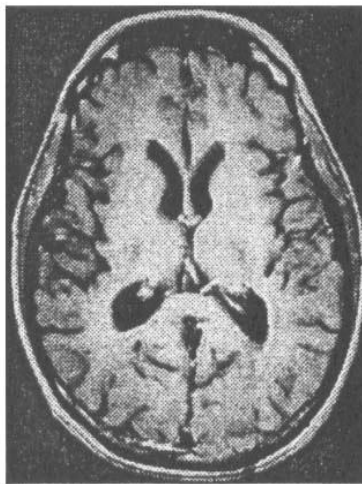
Tissue specific media ,such as iron oxide agents for reticuloendothelial cells imaging

CT SCAN



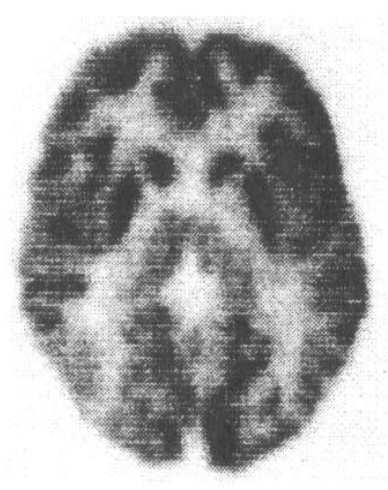
(a)

MRI



(b)

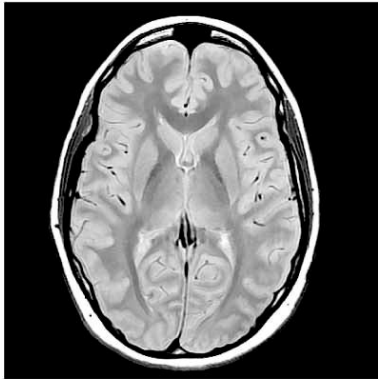
PET



(c)

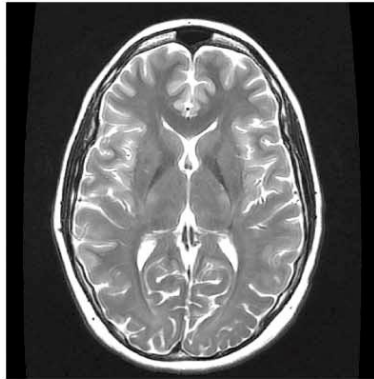
Figure I.4

PD weighted



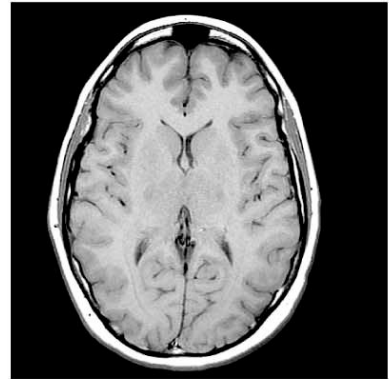
(a)

T2- weighted



(b)

T1- weighted



(c)

Source of MR Contrast :

Different tissues vary in T1, T2 and PD (proton density)

- The pulse sequence parameters can be designed so that the captured signal magnitude is mainly influenced by one of these parameters
- Pulse sequence parameters
 - Tip angle α
 - Echo time T_E
 - Pulse repetition time T_R