Clinical Applications of Magnetic Resonance Imaging /RAD465

1st Mid-term Exam 1st semester 1437-2015 (Good Luck)

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Student Name: ***Number:***

Q1) Essay Questions:

(A) Answer the following questions related to Specific Absorption Rate (SAR):

i. What is SAR? 1 mark

Thermoregulatory stress placed on an individual is dependant on the amount of energy deposited per unit of tissue mass. The dosimetric term used to describe this load is the Specific Absorption Rate or SAR. The units of SAR are Watts per kg and can be viewed as a whole body averaged figure or peak values for 1 gm of tissue.

ii. How do you calculate it? 1 mark

Calculation of SAR for each case can be quite complex as the deposited rf depends on: the type of pulse (90°, 180°, hard, soft), *TR*, coil type (resonator or surface coil), tissue properties (conductivity, dielectric constant).

iii. When you should consider the SAR level carefully? 2 marks

Disorders, which impair cardiac output such as cardiac failure of all types, myocardial infarction, and valvular disorders must be observed carefully when SAR limits are approached. Peripheral neuropathies and spinal cord lesions can also impair thermoregulation. Diabetes mellitus is a common disease, which may impair neurovascular control and cause vessel disease. Such patients also require careful observation.

(B) Answer the following questions related to Peripheral Nerve Stimulation (PNS):

i. What is PNS? 1 mark

Peripheral nerve stimulation (PNS) is accepted as the most sensitive indicator of possible physiological effects from time-varying magnetic fields. This is primarily due to the length of peripheral nerves, and thus the projected area into which a gradient field may induce a current.

ii. How do you observe PNS in your patients during MRI examination? 1 mark

Tissue	Effect	Threshold ($\mu A/cm^2$)
Muscle	twitching/contraction	15-100
Myocardium	fibrillation	0.2-1.0
Neurones	seizures	3

(C) Answer the following questions related to MRI instrumentation and equipment

i. List the major components of the MRI scanner (start from the parts closer to the patient) 2 marks

A radio frequency source – for RF excitation (RF Coils)

A magnetic field gradient system – for spatial encoding (Gradient coils)

A shimming system (shim coils)

Shielding system (shield coils)

A magnet – for nuclear alignment (Magnet coils)

A computer system – for the image formation process and the user interface an image processor – to convert ' signals ' into images.

ii. Describe briefly the function of each component? 4 marks

A radio frequency (RF) source perturbs or excites nuclei. The RF system requires a transmitter and a receiver. To achieve resonance the frequency of the RF excitation pulse must be similar to the precessional frequency of the magnetic moments of the nuclei in the slice.

Magnetic field gradients determine spatial location of RF signals. The MR signal is changed to an understandable format from a FID into a spectrum by a series of mathematical equations known as Fourier transformations. This process occurs via the array processor.

The magnet aligns the nuclei into low - energy (parallel) and high - energy (anti-parallel) states. The stronger the magnet, the more spins in the low - energy state. The more low – energy spins the greater the spin excess, the higher the signal and hence the better the image quality.

To maintain magnetic evenness or homogeneity, a shim system is necessary. The more homogeneous the magnetic field, the better the image quality.

(D) List at least four potential risks or hazards your patients may experience during MRI examination and where they come from? 2 marks

1. Ballistic risks posed by static magnetic fields

2. Torsional and tractional injury from ferromagnetic implants (source static magnetic field)

3. Thermal effects and source is Radiofrequency pulses.

4. Acoustic noise and source is gradient system

5. Peripheral nerve stimulation (PNS) and source is gradient system

Q2) True or False Questions, Which of the following statements are True or False? 6 marks

(A) MRI has been classified within the low Frequencies and high wavelength in electromagnetic radiation spectrum and still can produce ionizing radiation (F)

(B) A common example of paramagnetic material is gadolinium contrast agent, which is frequently used for MRI examination (T)

(C) A coarse matrix is one with a low number of frequency encodings and/or phase encodings therefore it would lead to boost both spatial resolution and signal to noise ratio (F)

(D) To boost signal to noise ratio, it is better either image your subject at high magnetic field or increase voxel size of your images (T)

(E) Increasing the number of phase encodings steps would result in both augment the spatial resolution and lengthening the experiment time (T)

(F) The operator controls the geometry of a voxel by selecting the FOV dimensions, the image matrix and the slice thickness, which they are predominately affect spatial resolution and signal to noise ratio (T)

Q3) Fill the blank Questions; write down the appropriate words within the dashed lines

(A) To assess the safety of device or medical implants in the static magnetic field, several technical considerations, which they include 2 marks

i. Size of the device

ii. Location

iii. Field strength

iv. Device function

(B) When MR imaging a patient who has a cardiac pacemaker, two major problems might arise:

i. Induction of heating currents within the lead wire 1 mark

ii. Disabling of the pacemaker by reed switch or inductive telemetry switching

(C) Superparamagnetic materials have an intermediate positive magnetic susceptibility that is greater than that exhibited by paramagnetic materials (low positive) and less than that of ferromagnetic materials (high positive) 1 mark

Q4) Multiple Choice Question (MCQ), choose the most appropriate answer in the following:

6 marks

(A) Example of superparamagnetic material is:

i. lead
ii. copper
iii. water
iv. iron oxide particles

(B) Which of the following is considered a ferromagnetic material?

i. Stethoscope
ii. MRI compatible pulse oximeter
iii. i and ii
iv. None of the above

(C) Which of the following magnet used in MRI environment can be switched on and off:

i. Permanent magnets
ii. Resistive magnets
iii. Superconducting magnets
iv. Hybrid magnets

(D) To boost the magnetic field strength, which of the following magnet you should use:

i. Permanent magnets
ii. Resistive magnets
iii. Superconducting magnets
iv. Hybrid magnets

(E) Increasing TR would result in:

i. In acquiring heavy T2 weighted
ii. In boosting SNR
iii. In boosting spatial resolution
iv. i and ii

(F) From a practical point of view the CNR is increased in the following ways:

i. By acquiring T2 weighted images
ii. By administrating contrast agent
iii. By lengthening TR and TE
iv. All of the above
v. i and ii