Original Article

Estimation Of Sar Value Of Brain Using Common Brain Sequences

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Abstract

Background: SAR is radiofrequency power sent to tissue during Magnetic Resonance Imaging examination. RF power accumulation outcomes in increased warming of patient muscles. In our study aim is to estimation of SAR value of brain using common brain sequences in western UP population using Siemens MAGNETOM Avanto 1.5 Tesla MRI scanner.

Objective: (i) To estimate the SAR value in common sequences used in brain (ii) To compare the SAR value among common brain sequences

Methods and material: In this prospective cross-sectional study on 42 female patients and 58 male patients referring to the department of radio-diagnosis and imaging, Teerthanker Mahaveer hospital and research center, Moradabad UP west India were evaluated. SAR value of common brain sequences were measured by using SAR measuring tool. Correlation is done between sequences.

Result: A total of 100 patients were evaluated. Mean age was 41.89 years ± 13.14, mean height was 159.96 cm ± 14.98, and mean weight was 66.31 kg ± 9.43. Mean of SAR values of spin echo was 1.54 w/kg ± 0.41, fast spin echo was 1.79 w/kg ± 0.53, FLAIR 1.74 w/kg ± 0.48, Diffusion 1.96 w/kg ± 0.74, and GRE 1.65 w/kg ± 0.46.

Conclusion: SE images showed frequently higher SAR in all patients compared to FSE, FLAIR, DWI and GRE.

Keywords: DWI- DIFFUSION WEIGHTED IMAGE, FSE- FAST SPIN ECHO, FLAIR- FLUID ATTUNATED INVERSION RECOVERY, GRE- GRADIANT RACALLED ECHO, MRI- MAGNETIC RESONANCE IMAGING, RF- RADIO FREQUENCY, SAR- SPECIFIC ABSORPTION RATE, SE- SPIN ECHO

INTRODUCTION

MRI scans are used since 1984 in Denmark for diagnostic imaging. MRI scans were based on hydrogen nuclei present in the patient's body, which are found in water and fat. MRI scans were used for soft tissue imaging. MRI scans are free from ionizing radiation. A complete MRI scans comprise diverse sequences that take 20-60 minute. (1) MRI is non-invasive technique that can provide complete multi parameter details about the anatomy, function, and metabolism of the brain. (2) Previously MRI and magnetic resonance angiography give invaluable details in the assessment of the patient with all phages and grades of TBI. Details acquired along MRI scans layout, more proper estimation of the patient brain trauma and probable long-term sequence. (3) A guideline has been provided to reduce potential patient concerns from (a) mechanical acceleration of ferromagnetic objects like torque and static fields in metal implants, and (b) nerves, guidelines have been devised. Stimulation with gradient fields and (c) radiofrequency fields for localized heating of tissues and entire body. (4)

There have been several injuries and even fires related with revelation to the Radiofrequency arenas in MRI. A number of tattoos have been reported to demonstration heating which has caused in burns in patients who have undertaken MRI. However, many of the second and third-degree injuries were reported to have been associated with the cables from the coils and contact with patient skin. In addition, some localized thermal injuries to patients have been noted after imaging where there was no wire near the wound. Newly, the FDA released a public health consultative about the hazard of burns related with drug skin patches (metal drug transfer patches). FDA report on MRI-interconnected injuries. Some patients were reported to have created sparks and flames at their feet using metal plates. (5)

SAR is radiofrequency power sent to tissue during a Magnetic Resonance Imaging (MRI) examination, demonstrate in watts per kg (W/kg). RF power accumulation outcomes in increased warming of patient muscles; thus, the use of MRI has to be controlled to ensure patient safety. (6) Maximum Local Absorption Rate (SAR) is a limiting factor for many

high- and ultra-high-frequency MRI applications. (7) Heating the patient with radio frequency (RF) energy on MRI is an important safety issue. Specific Absorption Rate (SAR) estimates that do not depend on the value displayed on the MRI scanner are desirable. (8)

The biological effect of RF absorption is tissue heating. So you need to control the absorption of time. Us food and drug administration (FDA) RF revelation limit is dignified as an upturn in physique hotness or SAR. This established in muscle healing and the patient's capacity to disintegrate extra heat. Body temperature maximum set by the ministry of food and drug safety is 1.0°c. In the surrounding space, the head rises to 38°c, the torso rises to 39°c, and the upper body rises to 40°c limbs allowed. There is a better way to measure RF absorption as measuring the patient's body temperature, especially body temperature, involves practical considerations (ie measuring the patient's body temperature during imaging). (5)

AIM:

To measure specific absorption rate during MRI scanning using common brain sequence from Siemens magnetom Avanto 1.5 Tesla MRI system.

OBJECTIVE

(i)To estimate the SAR value in common sequences used in brain, (ii) to compare the SAR value among common brain sequences.

MATERIALS AND METHODS

In this study 100 patient were analyzes prospectively during routine MRI brain scanning. This study was done on Siemens MAGNETOM Avanto 1.5 Tesla MRI scanner using head coil with patient position supine head first. Before starting the scan patient's weight were measured and entered in MRI scan protocol. For all the 100 patients all the sequence acquisition were kept same. The default brain sequences used for all the patients are shown in (Table 1 & Figure 1). The sequence acquisition were taken in order of i) Localization, ii) SE, iii) FSE, iv) FLAIR, v) DWI, vi) GRE. The SAR value of each sequences are recorded on Microsoft office Excel 2013 and processed on SPSS software.

PARAMETER	FLAIR	DWI	GRE	SPIN ECHO	FAST SPIN ECHO
Number of images	20	22	22	20	20
Averages	1	1	1	1	1
Field of view (mm)	100	230	230	100	100
Slice thickness (mm)	5	5	5	5	5
Time of acquisition (mm:sec)	2:26	2:12	1:59	1:30	1:47
Repetition time (ms)	6000	4100	700	6000	6000
Echo time (ms)	99	69	26	99	99
Inversion time (ms)	2500	-	-	-	-
Turbo factor	17	-	-	36	36
Echo train per slice	13	20	-	13	13
Band width (Hz/px)	362	892	200	144	172

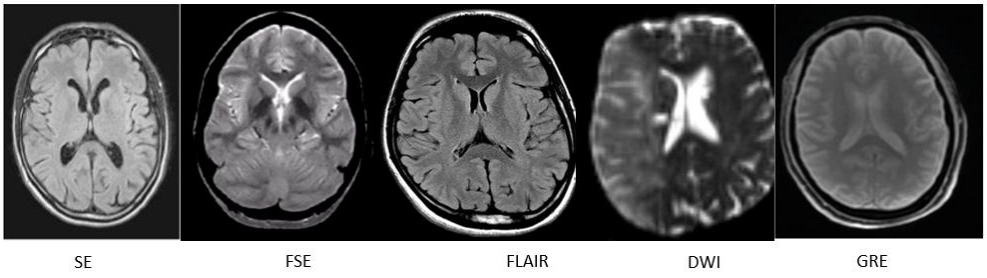
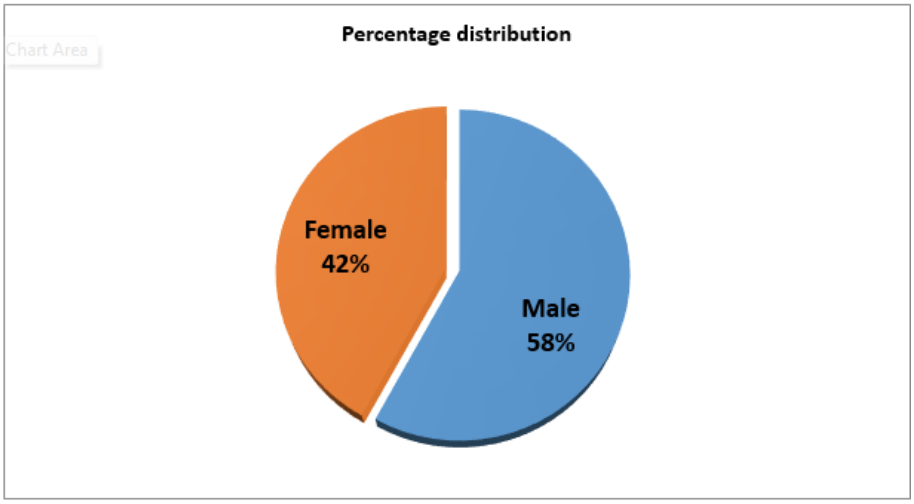


Fig: Acquired images

RESULTS

Study Population

This study was done in between 08 March 2021 to 08 March 2022, at Teerthanker Mahaveer Hospital and research center, Moradabad, Uttar Pradesh (India). A total 100 patents were taken for MRI examination in our hospital. Out of 100 patients 58 male and 42 female were present (Graph). In this study we had included those patients who were referred for MRI brain scanning and excluded patient with any kind of brain implant.



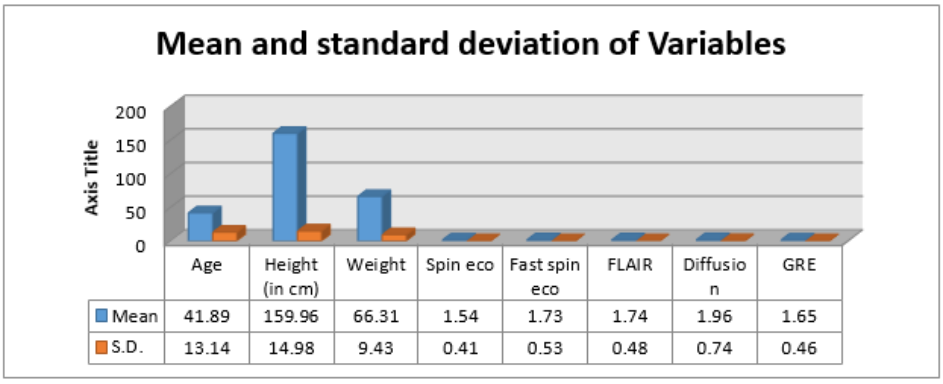
Graph: Frequency distribution of age groups

SEQUENCE EVALUATION

In this study 100 patients were taken, in which mean age of patients were 41.89±13.14 years, mean height of patients were 159.96±14.98 cm, mean weight of patients were 66.31±9.43 kg. In our study total 5 sequences were taken that were i) localizer, ii) SE, iii) FSE, iv) FLAIR, v) DWI, vi) GRE. Mean of each sequences were calculated using SPSS software. The mean of SE was 1.54±0.41 w/kg, mean of FSE 1.73±0.53 w/kg, mean of FLAIR 1.74±0.48, mean of DWI 1.96±0.74, mean of GRE 1.65±0.46 (Table).

(n = 100)	Mean	S.D.
Age	41.89	13.14
Height (in cm)	159.96	14.98
Weight (kg)	66.31	9.43
Spin echo (W/kg)	1.54	0.41
Fast spin echo (W/kg)	1.73	0.53
FLAIR (W/kg)	1.74	0.48
Diffusion (W/kg)	1.96	0.74
GRE (W/kg)	1.65	0.46

Table: Mean and standard deviation of variables



Graph: Mean and SD of variables

Above graph demonstrates the mean and SD of variables between different variables. In which show the mean of age is 41.89±13.14 years, mean of height in cm is 159.96±14.98, mean of weight in kg is 66.31±9.43, mean of spin echo sequence is 1.54±0.41 W/kg, mean of fast spin echo sequence is 1.73±0.53 W/kg, mean of Flair sequence is 1.74±0.48 W/kg, mean of diffusion sequence is 1.96±0.74 W/kg, mean of gradient echo sequence is 1.65±0.46 W/kg.

DISCUSSION

SAR is an important parameter regarding the amount of RF that accumulates in a patient during an MRI scan. On the basis of result he concluded that, SE, especially FSE, provided more RF power, resulting in higher SAR and more tissue heating, while the gradient echo method resulted in lower SAR and less tissue heating.(9)
In our study mean of SAR value of 5 sequences are listed in decreasing order 1. Diffusion 1.96±0.74 W/Kg, 2. FLAIR 1.74±0.48, 3. FSE 1.73±0.53 W/Kg, 4. GRE 1.65±0.46 W/Kg, 5. SE 1.54±0.41W/Kg. In all these 5 sequences diffusion delivers high SAR in comparison to other.

The SAR received by the patient did not exceed the SAR limits set by the FDA. It recommends that the SAR of the whole body study be less than 4 W / kg within 15 minutes. For the head and neck, the SAR should be less than 4 W / kg. Within 10 minutes 3 W / kg W / kg should be minutes and for limbs less than 12 W / kg within 5 minutes. To reduce the potential effects of radio waves used on MRI on the patient's tissues.(10)

In our study mean of SAR value of 5 sequences are listed in decreasing order 1. Diffusion 1.96±0.74 W/Kg, 2. FLAIR 1.74±0.48, 3. FSE 1.73±0.53 W/Kg, 4. GRE 1.65±0.46 W/Kg, 5. SE 1.54±0.41W/Kg. In all these 5 sequences diffusion delivers high SAR in comparison to other. On the basis of mean SAR of all sequences which is 1.724 is lower than recommended SAR value by FDA.

CONCLUSION

SE images showed frequently higher SAR in all patients compared to FSE, FLAIR, DWI and GRE. It is generally believed that SE sequences apply a minimal RF pulse, which reduces SAR. But in our study Diffusion exhibited higher SAR for all patients in comparison to other sequences that is FLAIR, FSE, GRE and SE. The following factors may contribute to increase SAR in the Diffusion sequence for diagnostic practice: (i) the use of a T1-weighted picture with a shorter repetition period, which may result in less time for the tissue to disperse the absorbed RF energy; and (ii) the use of a high RF power.

SAR would be decreased in underweight patients (<58). SAR would be increased in obese patients (>68). SAR might be minimized by increasing TR and decreasing the flip angle.

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