International journal of medical sciences and academic research ISSN 2582-7197

Available at: http://scientificpublications.in/index.php/ijmsar Volume 03, Issue 06, 2022

Original Article

Augmentation of time management in MRI brain non -co-operative patients with routine sequences by comparing of T2 and T2 propeller brain axial image acquisition

Mr. ARUL.S , Mr. KARTHIK.B.D.
Assistant professor
Department of Medical Imaging
Acharya Institute of Allied Health Sciences, Bangalore - 560107.
Mr. KASIMURUGAN
Lecturer,
Department of Radiodiagnosis
Sapthagiri Institute of Medical Sciences and Research Centre, Bangalore -560090.
Ms. VISMAYA.P
Research Associate and Project Engineer
ADBS Neuro Imaging Centre
National Institute of Mental Health and Sciences.Bangalore - 560030.

Article Received 1-11-2022 /Article Revised 10-12-2022 / Article Accepted 20-12-2022

ABSTRACT:

Objective

The objective of this study is to estimate how to manage time in non-cooperative individuals having an MRI brain study.

Place and duration of the study

The National Institute of Mental Health and Neuro sciences. Bangalore. Between February 1st and March 30th, 2022, there will be a 59-day period.

Methodology

This is a prospective observational study. The study included 30 non-cooperative MRI brain patients with three different types of clinical complaints. Images and time were acquired using standard MRI sequences: T2axial, T2 PROPELLER axial, and both sequences (T2 axial&T2 PROPELLER axial) image acquisition techniques. They were classified into three categories based on clinical complaints, with radiographs obtained using standard protocols with and without T2 PROPELLER with each category. Data is analysed using R software version 4.1.2 and Excel. Categorical variables are given in the form of

How to Cite

CHOKKAN, A. The Augmentation of time management in MRI brain non -co-operative patients with routine sequences by comparing of T2 and T2 propeller brain axial image acquisition: Time management for MRI brain non-cooperative patients. . **International Journal of Medical Sciences and Academic Research**, v. 3, n. 06, p.33-43, 24 Dec. 2022.

frequency table. To check the inter-rater agreement Fleiss Kappa is used. P-value less than or equal to 0.05 indicates statistical significance.

Results

In non-cooperative patients, time can be decreased by employing the T2 PROPELLER axial sequence in conjunction with standard sequences, and scans can be adequate for a mediocre investigation. two significant agreement present between 3 technologists for Impact on motion artifacts in T2 Axial and Impact on non-co-operative patients in T2 propeller.

Conclusion

For non-cooperative patients and healthcare practitioners, the T2 propeller axial sequence can be employed to reduce time - and - motion artefacts.

Keywords: Magnetic resonance imaging; non-co-operative patients; T2axial sequence;T2 axial propeller sequences; acquisition methods; time minimizing

INTRODUCTION:

An MRI scan is noninvasively obtained images with better visualisation of anatomical structures of the brain and pathological condition of the brain. Particularly on soft tissues. Which is providing detailed image quality when patient is co-operating to the MRI brain acquisition during the study. Whereas compared to other imaging modalities, MRI has more noise and time during image acquisition. Due to environmental setup of the MRI gantry and noise during acquisition causing the mild claustrophobia to patients which is affecting the patients co-operation. Including non-co-operative patients they were naturally unstable patients because of their neurological complaints like headache, dizziness, stroke, etc...This is all directly leading to patient non-co-operation, introducing the motion artifacts in MR images. To eliminate the certain amount motion artifact, largely prescribed as sedating the patient and great need of increasing the acquisition timing by repeating the sequences were artefacts presented. Most leadingly MRI technologist phasing the overall acquisition time across the handling of non-co-operative patients. Whereas PROPELLER sequence ultimately reducing the motion artefacts.

PROPELLER:

(Periodically rotated overlapping parallel lines with enhanced reconstruction). FSE/TSE method sequences may be greatly lowering the overall acquisition time while obtaining MR imaging. Due to their acquisition, numerous phase encoding lines fill in the k-space between each TR interval. The goal of the propeller sequence is to eliminate visual motion artefacts. In the acquisition, a filled data set was obtained. Because the signal-to-noise ratio and contrast-to-noise ratio in the centre of k-space are the greatest, if any motion occurs while data is being acquired in k-space, the signal is immediately replaced by a second data set. Frame interpolation the k-space, in essence to minimizes artefacts in typical MRI sequences.

Corresponding Author's: Mr. ARUL.S

MATERIALS AND METHODOLOGY:

This study was done in 30 non-co-operative patients who underwent MRI brain study. This population was arranged by three different groups based on their present medical complaints; which were - 1. headache and dizziness- MRI induced mild claustrophobia, 2. seizure disorder, and 3.stroke. Each groups consisting the 10 patients with same complaints as disoriented to MRI. Images were acquired by using 1.5T MRI brain routine sequences.

Those are 3-planelocalizer, calibration head, DWI, T1&T2-W, FLAIR, GRE, 3D-FIESTA, 3D-TOF 2D-MRV including PROPELLER sequence. While considering time management in routine brain sequences and according to patient complaints without expulsion of routine sequences to obtaining minimal images with minimal time duration, T2 axial image cuts acquisition parameters compared to T2 PROPELLER axial image cuts acquisition parameters. The comparison of T2axial and T2 PROPELLER axial sequences with routine other MRI sequences timing shows in table1, T2 axial sequence acquisition parameters shows in table2, T2 PROPELLER axial sequence acquisition parameter shows in table3. Wheres the significance time is 1 minute 85 seconds. This can be reduced directely in overeall MRI barin acquisition time.

Group-1:Patients with complaints of headache and dizziness followed by MRI induced mild claustrophobia.

This 10 patients images are acquired by routine MRI brain sequences which including T2Axial cut sequence.The actual total sequence running time took 26minuts 88seconds. Approximately ±5 minutes respectively added based on patient co-operation. Those 10 patients were diagnosed as essentially normal study due to MR study of the brain shows no significant neuroparenchymal abnormality detected. Prominent cotical sulcal spaces, ventricles and basal cisterns are detected definable. Prefferd 3D-FIESTA for dizziness to findout vascular compression on nerves and trigeminal nerve root compression which is causing a aspect of dizziness. Followed by 3D-TOF(MRA),2D-MRV for findout intracranial vascular pathologies which is causing a aspect of headache and dizzines,DWI-for finding out ischemic stroke, differentiation between acute and chronic stroke and for grading of glioma,abcess and tumors GRE was used.

Corresponding Author's: Mr. ARUL.S

Table 1: Brain imaging sequences and their overall timing				
S.no	Routine MRI brain sequences includingT2 AXIAL	Scan time	Routine MRI brain sequences includingT2 AXIAL PROPELLER	Scan time
1.	3-Pl T2* Localizer	0.07sec	3-Pl T2* Localizer	0.07sec
2.	Calibration head	0.13sec	Calibration head	0.13sec
3.	Axial-DWI	1.03sec	Axial-DWI	1.03sec
4.	Axial-T2	4.03 sec	Axial-T2 PROPELLER	2.18sec
5.	Axial-T2flair	3.28sec	Axial-T2flair	3.28sec
6.	Axial-T1flair	2.05sec	Axial-T1flair	2.05sec
7.	Cor -T2flair	3.28sec	Cor -T2flair	3.28sec
8.	Sag -T1 flair	2.04 sec	Sag -T1 flair	2.04 sec
9.	Axial -GRE	1.28sec	Axial -GRE	1.28sec
10.	3D FIESTA	1.41sec	3D FIESTA	1.41sec
11.	BRAIN 3D TOF	4.23sec	BRAIN 3D TOF	4.23sec
12.	2D MRV	5.01sec	2D MRV	5.01sec
	Total scan time	26.88 sec	Total scan time	25.03seczarzzzz

Table 2:Sequence parameter of T2 axial sections	
FOV(cm):22.0cm	PHASE FOV(cm):0.75cm
Slice thickness(mm):5mm	TI(ms):
TR(ms):6720ms	TE(ms):100ms
ETL(ms):21ms	Bandwidth(khz):31.25khz
Frequency matrix (mxn):320	Phase matrix(mxn):224
Spacing :1.00mm	NEX:4.00
Scan time	**4.03 sec**

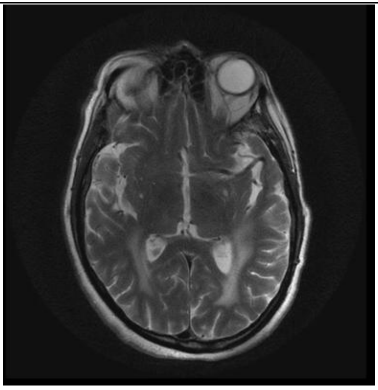
Table 3:Sequence parameter of T2 propeller axial sections	
FOV(cm):22.0cm	PHASE FOV(cm):0.75cm
Slice thickness(mm):5mm	TI(ms):
TR(ms):6000ms	TE(ms):104.832ms
ETL(ms):24ms	Bandwidth(khz):50.00khz
Frequency matrix (mxn):512	Phase matrix(mxn):224
Spacing :1.00mm	NEX:1.00
Scan time	2.18 sec

Group 2: Patients with complaint of seizure disorder

This 10 patiens images are acquired by routine MRI sequences which is including T2 PROPELLAR axial cut sequence. The total time took 25minuts 03seconds. Approximately ±5 minutes respectively added based on patient co-operation. Radiologist diagnosed as small vessel ischemic changes and age related diffuse cerebral atrophy changes due to periventricular/Bilateral punctate/deep white matter hyperintensity noted at T2PROPELLER /T2 FLAIR. Prominent cotical sulcal spaces, ventricles and basal cisterns are detected definable. Timing is ultimately redued directly using T2PROPELLER axial sequence.

Group-3: Patients with complaints of stroke

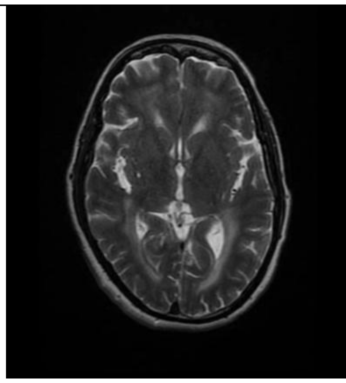
This 10 patients images are acquired by routine MRI sequences which including both groups sequences(T2 axial and T2axial PROPELLAR). The overall timing took 29minuts 06 seconds. Approximately ±5 minutes respectively added based on patient co-operation. Radiologist diagnosed as subacute on chronic subdural haemorrhage-appearing hyperintense on T1FLAIR , isointense on T2 axial and T2axial PROPELLER. Subdural hygroma-appearing hypointense on T1FLAIR , hyperintense on T2axial and T2 axial PROPELLER. Diagnosed such a cases like chronic lacunar infarct, gliosis, subacute intraparenchymal hemorrhage, chronic intra parenchymal hemorrhage and old infarcts. This group patients images aquired for comparison of both sequences images. (inter-rater agreement)



T2 axial -with motion artifact

FIGURE:1

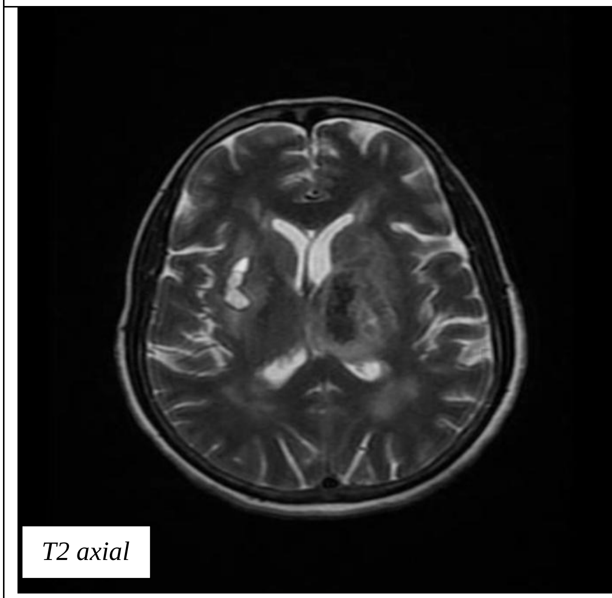
Group3: Patient complaint of stroke 62years/male Diagnosed as chronic lacunar infarct in right basal ganglia, age related diffuse cerebral atrophy changes



T2 axial/T2 PROPELLER hyperintense noted in

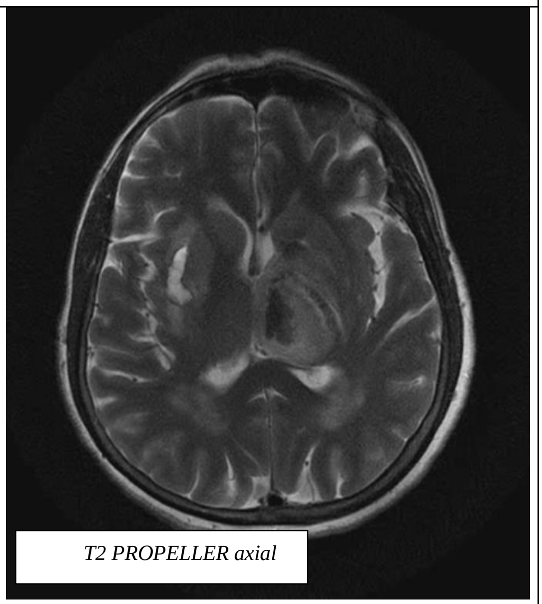
FIGURE:2

T2 PROPELLER axial-motion artifacts got reduced.



T2 axial

Group3: Patient complaint of stroke 80years/female Diagnosed as chronic lacunar infarct in mid brain, Subacute intra-parenchymal hemorrhage noted in right capsulo ganglionic region, chronic intra-parenchymal hemorrhage noted in left capsulo ganglionic region, midline shift and edema noted (Figure 3)



T2 PROPELLER axial

T2 axial/T2 PROPELLER hyperintense noted in bilateral confluent periventricular and deep cerebral white matter (Figure- 4)

Table:4 Comparison of Image Appearances		
Radiological findings	Axial-T2	Axial-T2PROPELLER
Old infarction/gliosis	Hyper intense	Hyper intense
Late Subacute intra-parenchymal haemorrhage	Hyper intense	Hyper intense
Chronic intra-parenchymal haemorrhage	Hyper Intense	Hyper Intense
Edema	Hyper intense	Hyper intense
Chronic lacunar infarct	Hyper intense	Hyper intense
Subdural hygroma	Hyper intense	Hyper intense
Subacute on chronic subdural haemorrhage	Iso intense	Iso intense
Small vessel ischemic changes	Hyper intense	Hyper intense
Age related diffuse cerebral atrophy changes	Hyper intense	Hyper intense
Acute infarct	Hyper intense	Hyper intense
Lesion	Hyper intense	Hyper intense

Table 5: Fleiss Kappa over technologists for different variables

Data contains measurements on 10 subjects for three different technologists. The following table gives the distribution of rating for different variables over each technologist.

Variable	Side	Rating	Technologist			Fleiss Kappa	p-value
			Technologist 1	Technologist 2	Technologist 3		
Timing impact on overall sequences	T2 Axial	1	0 (0%)	0 (0%)	0 (0%)	0.18	0.267
		2	6 (60%)	6 (60%)	10 (100%)		
		3	3 (30%)	4 (40%)	0 (0%)		
		4	1 (10%)	0 (0%)	0 (0%)		
		5	0 (0%)	0 (0%)	0 (0%)		
	T2 Propeller	1	0 (0%)	0 (0%)	0 (0%)	0.114	0.494
		2	0 (0%)	0 (0%)	0 (0%)		
		3	1 (10%)	0 (0%)	0 (0%)		
		4	4 (40%)	7 (70%)	5 (50%)		
		5	5 (50%)	3 (30%)	5 (50%)		
Impact on motion artifacts	T2 Axial	1	4 (40%)	5 (50%)	5 (50%)	0.345	0.0261*
		2	4 (40%)	5 (50%)	5 (50%)		
		3	2 (20%)	0 (0%)	0 (0%)		
		4	0 (0%)	0 (0%)	0 (0%)		
		5	0 (0%)	0 (0%)	0 (0%)		
	T2 Propeller	1	0 (0%)	0 (0%)	0 (0%)	0.282	0.122
		2	0 (0%)	0 (0%)	0 (0%)		
		3	0 (0%)	0 (0%)	0 (0%)		
		4	4 (40%)	4 (40%)	3 (30%)		
		5	6 (60%)	6 (60%)	7 (70%)		
Pathologies similarity appearances	T2 Axial	1	0 (0%)	0 (0%)	0 (0%)	0.186	0.310
		2	0 (0%)	0 (0%)	0 (0%)		
		3	0 (0%)	0 (0%)	0 (0%)		
		4	5 (50%)	4 (40%)	4 (40%)		
		5	5 (50%)	6 (60%)	6 (60%)		
	T2 Propeller	1	0 (0%)	0 (0%)	0 (0%)	0.196	0.282
		2	0 (0%)	0 (0%)	0 (0%)		
		3	0 (0%)	0 (0%)	0 (0%)		
		4	5 (50%)	4 (40%)	5 (50%)		
		5	5 (50%)	6 (60%)	5 (50%)		
Anatomical structures appearances	T2 Axial	1	0 (0%)	0 (0%)	0 (0%)	-0.333	0.0679
		2	0 (0%)	0 (0%)	0 (0%)		
		3	0 (0%)	0 (0%)	0 (0%)		
		4	6 (60%)	5 (50%)	4 (40%)		
		5	4 (40%)	5 (50%)	6 (60%)		
	T2 Propeller	1	0 (0%)	0 (0%)	0 (0%)	-0.2	0.273
		2	0 (0%)	0 (0%)	0 (0%)		
		3	0 (0%)	0 (0%)	0 (0%)		
		4	6 (60%)	5 (50%)	4 (40%)		
		5	4 (40%)	5 (50%)	6 (60%)		
Impact on non-co-operative patients	T2 Axial	1	0 (0%)	1 (10%)	2 (20%)	0.144	0.324
		2	5 (50%)	5 (50%)	4 (40%)		
		3	5 (50%)	4 (40%)	4 (40%)		
		4	0 (0%)	0 (0%)	0 (0%)		
		5	0 (0%)	0 (0%)	0 (0%)		
	T2 Propeller	1	0 (0%)	0 (0%)	0 (0%)	0.389	0.033*
		2	0 (0%)	0 (0%)	0 (0%)		
		3	0 (0%)	0 (0%)	0 (0%)		
		4	2 (20%)	5 (50%)	5 (50%)		
		5	8 (80%)	5 (50%)	5 (50%)		

Discussion :

In this clinical study group1 patients acquisition time were technicaly took more time compared to group 2 patients acquisition time.

weres both groups timing evaluted by trade-offs parametes as well as group 3 patients images were acquired by using both sequences for image similarity. Those ten patients T2 axial and T2 PROPELLER axial images was rated independently by three well-skilled technologists individually scored the duration and image quality of T2 axial and T2 propeller axial images on a five point categorical scale. Fleiss' kappa inter-rater agreement test has been used to test for significant similarities and dissimilarities.

Results:

Group 1-patients overall acquisition time took more than group 2 patients overall acquisition time. Those images obtained by routine sequences, along with T2axial sequence and T2 PROPELLER axial sequence individually in each groups. Were group 3 patients images acquired by using both T2 axial sequence and T2 PROPELLER axial sequence. In the above table, we can observe that, there is only two significant agreement present between 3 technologists for Impact on motion artifacts in T2 Axial and Impact on non-co-operative patients in T2 propeller.

All other turned out as non-significant agreement between the technologists. The extent of agreement found to be fair for Impact on motion artifacts in T2 Axial and Impact on non-co-operative patients in T2 propeller.

Conclusion:

Time management in non-co-operative patients acquisition time reduced by excluding the T2axial sequence and including T2 PROPELLER sequence along with routine MRI brain sequences.

Across routine MRI brain sequences, impact on an individual sequence acquisition timing also has role in increasing overall time of the study while acquiring MRI brain images in non-co-operative patients .This increasing overall timing impact on individual sequence acquisition time in MRI brain study can be reduced by limiting the sequences based on patient complaints and radiologist choice of images for comparative findings. When patient is highly not co-operating during MRI brain acquisition, MRI technologist can apply first sequence as T2PROPELLER and followed by based on findings with radiologist described pathologically highly oriented sequences are sufficient to acquire certain images. This suboptimal study providing minimal images for oral/provisional diagnosis to radiologist.

Abbreviations:

MRI-magnetic resonance imaging ,PROPELLER-Periodically Rotated Overlapping Parallel Lines With Enhanced Reconstruction, DWI-diffusion weighted imaging , FLAIR-fluid attenuated inversion recovery, GRE-gradient recalled echo,3D FIESTA- 3 dimensional fast imaging employing steady state acquisition, 3D TOF-3 dimensional time of flight, MRA-magnetic resonance angiography,2D MRV-2 dimensional magnetic resonance venography, TR-repetition time ,TE-time to echo, FOV-field of view, ETL-echo train

Corresponding Author's: Mr. ARUL.S

length NEX-number of excitations, TI-inversion time.

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CONFLICT OF INTEREST

There is No conflict of interest.

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