COMPARISON BETWEEN POST CONTRAST T1 WEIGHTED AND T2 WEIGHTED FLAIR AXIAL SEQUENCES IN VARIOUS INTRACRANIAL PATHOLOGIES

IMTIAZ ATHAR, SHAHZAIB ALI KHAN, MUHAMMAD AWAIS BUTT, SARAH MARYAM, HASEEB MANZOOR, MUHAMMAD FAIQ BUTT , SANA ALI,YOUSAF GELLANI,ZAIN UL ABIDIN

University Institute of Radiological Sciences & Medical Imaging Technology, Faculty of Allied Health Sciences, The University of Lahore.

Abstract

MRI is an imaging modality that uses magnetic field and radio frequency waves instead of ionizing radiations to produce diagnostic images. To detect intracranial pathologies, post contrast T1 weighted sequences are being commonly used these days. T1 shortening effect results in contrast enhancement, as compared to T1 weighted images enhancement of meninges is easy to notice on post contrast FLAIR images due to nullification of cortical vessels and CSF signals. post contrast T2 FLAIR do not show enhancement in vessels due to slow blood flow.

Objective

Purpose of this study was to compare contrast enhanced T2 FLAIR and contrast enhanced T1 sequences in intracranial pathologies.

Methods

The significance of the procedure was explained to all the patients than inform consent was taken. MRI safety checklist and a brief history of the patient was taken before the examination. Enhanced T1W axial images were acquired immediately after injecting contrast agent and Enhanced T2 FLAIR axial acquired after 10 min. The contrast was given manually and dose was decided according to the patient weight i.e. 0.3mmol/kg. Images of pre and after contrast T1W and T2 weighted FLAIR axial were compared for conspicuity and degree of contrast enhancement by our radiologist to conclude which sequence is more helpful in the diagnosis of various intracranial pathologies.

Results

33 patients of different ages between 10 to 76 years with various signs and symptoms underwent brain MRI examination with contrast, 15 patients (45.5) % were females and 18 patients (54.5) % were males. 8 patient's reports (24.2) % were unremarkable and 25 patients had various

abnormalities. Out of these 25 patients post contrast T1 weighted images had better enhancement in 6 patients (18.2) %. But 19 cases (57.6) % shows less enhancement as compare to post contrast T2 FLAIR weighted images, in remaining 8 cases (24.2) % both sequences do not reveal any abnormality so considered as equal. Post contrast T1 images reveals more clear outlines of abnormality in 15 patients (45.5) % and less clear in 10 patients (30.3) % but in 8 patients (24.2) % they reveals no abnormality. So on the base of contrast enhancement and ability to reveal clear outline of lesions as well as demarcation of lesions from surrounding complication post contrast T1 axial sequence was found better in 12 cases (36.4) % and post contrast T2 FLAIR axial sequence found better in 13 cases (39.4) %. But in 8 cases (24.2) % no abnormality was found on both T1 and T2 FLAIR images.

Conclusion

Enhanced T2 FLAIR axial is little bit more helpful in some cases but it cannot replace enhanced T1 axial sequence. Enhanced T1 axial is good in differentiating lesions from surrounding edema. It is used as standard post contrast sequence these days, but T2 FLAIR can be helpful for better diagnosis so it should be used in addition to post contrast T1 axial sequence.

Key Words

Fluid attenuation inversion recovery (FLAIR), Blood brain barrier (BBB)

Introduction

MRI is an imaging modality that uses magnetic field and radio frequency waves instead of ionizing radiations to produce diagnostic images. Images may be obtained in various planes (axial, sagittal, coronal or oblique). MRI is ideal for the examination of brain because it has superior contrast resolution for soft tissues as compared to CT[1]. In 2015, the lowest age standardized disability-adjusted life year rates were less than 3000 per 100 000 and deaths were less than 100 per 100,000 from neurological disorders in high-income regions. The highest DALY rates of more than 7000 per 100,000 and highest death rates of more than 280 per 100,000 people were estimated for Central African Republic and Afghanistan[2]. Spinal cord and brain are covered by 3 protective membranes called dura, arachnoid and pia mater. These membranes are usually referred as meninges. CSF is produced in choroid plexus and fills the ventricles of brain and then move towards subarachnoid space. CSF protects central nervous system from trauma and act as a shock absorber. The innermost pia mater covers sulci and gyri, it extends over arteries and nerves, pia is vascular membrane that lies closely to brain as compared to arachnoid and dura mater[3]. Relaxation properties of tissues can be changed by using contrast agent, Gadolinium used as contrast agent in MRI which shortens relaxation time of T2 and T1. Contrast study is necessary to evaluate most of the pathologies in brain such as meningitis and multiple sclerosis. Intravenous Contrast is normally used to enhance lesions and to classify CNS pathologies. Gadolinium chelated with DTPA is used as contrast material in MRI. It reduces both the T2 and T1 relaxation time of the tissues which concentrated with contrast[4, 5]. It may produce some side effects and can be costly in price. Contrast

is distributed rapidly through blood vessels after IV injection and then diffuses into extracellular spaces. Contrast gets collected within the tissues and looks hyper intense on T1 images but hypo intense on T2 images. Gd-contrast accumulates in tumors and produce enhancement which is very important to diagnose the stage of tumor. Enhancement also helps to distinguish between reoccurrence of tumor and necrosis. T1 weighted images usually acquired after contrast injection. Ultra-fast sequence is used to follow contrast dynamically[6]. CNS vessels have some additional properties that strictly regulates the movement of ions between the blood and central nervous system. The blood brain barrier plays an important role in the function of central nervous system by maintaining its microenvironment. This disruption of blood brain barrier can also lead to altered signaling, immune infiltration, ionic homeostasis and edema that ultimately lead to degeneration because of neuronal deregulation[7]. Abnormal contrast enhancement is produced by many pathologic and physiologic conditions. The permeability of BBB is altered by many conditions such as active inflammation, cerebral ischemia, angiogenesis and pressure overload that results in abnormal contrast enhancement on static gadolinium-enhanced magnetic resonance images[8]. To detect intracranial pathologies, post contrast T1 weighted sequences are being commonly used these days. Post contrast FLAIR has been used as an effective sequence for the detection of leptomeningeal disease in the last ten years. As compared to T1 weighted images, enhancement of meninges is easy to notice on post contrast FLAIR images due to nullification of cortical vessels and CSF signals[9]. According to Splendiani et al, contrast enhanced FLAIR sequences shows more sensitivity, 100% for infectious meningitis, while enhanced T1 weighted sequence show a relatively low sensitivity of 50% and are largely used in the diagnosis of many pathologies of the CNS[10]. FLAIR (fluid attenuation inversion recovery) is a distinctive pulse sequence that has a long echo time (TE), repetition time (TR) and an inversion time (TI) that efficiently nullifies signals from the CSF[4]. Undesired signals in magnetic resonance images like signals from fluid or fat can be suppressed by using inversion recovery pulse sequence. Selection of TE and TR can control the contrast weighting. Time between the first applied 180-degree radio frequency pulse and 90-degree pulse is called time of inversion. Short inversion time of about 170 milliseconds is used to suppress fat signal[11]. Post contrast T1-weighted sequences also enhances cortical vessels that can be confused with enhancement of meninges. In T2 FLAIR sequence slow flowing blood is not usually hyper-intense, but repeatedly hyper-intense on T1 weighted images that results in clear differentiation of cortical veins and meninges on T2 FLAIR images. post contrast T2 FLAIR do not show enhancement in vessels due to slow blood flow. Contrast resolution between normal brain and lower concentrations of gadolinium is higher on T2 FLAIR images as compare with T1-weighted images with or without magnetization transfer saturation[12].

Methods

The significance of the procedure was explained to all the patients than inform consent was taken. MRI safety checklist and a brief history of the patient was taken before the examination. Enhanced T1W axial images were acquired immediately after injecting contrast agent and Enhanced T2 FLAIR axial acquired after 10 min. Contrast enhanced T1 axial parameters were: TR: 518, TE: 11, Field of view: 240 mm, Matrix size: 512x512, slice thickness: 5 mm, phase direction: R to L, time of acquisition was: 4 min 29seconds.

Enhanced T2 FLAIR parameters were: TR: 7770, TE: 79, Field of view: 240 mm, Matrix size: 512x512, slice thickness: 5 mm, phase direction: R to L, Time of acquisition was: 6 min 07 seconds. The contrast was given manually and dose was decided according to the patient weight i.e. 0.3mmol/kg. Images of pre and after contrast T1W and T2 weighted FLAIR axial were compared for conspicuity and degree of contrast enhancement by our radiologist to conclude which sequence is more helpful in the diagnosis of various intracranial pathologies.

Results

33 patients of different ages between 10 to 76 years with various signs and symptoms underwent brain MRI examination with contrast.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Age	33	10.00	76.00	45.0000	17.21736
Valid N (list wise)	33				

15 patients (45.5) % were females and 18 patients (54.5) % were males.

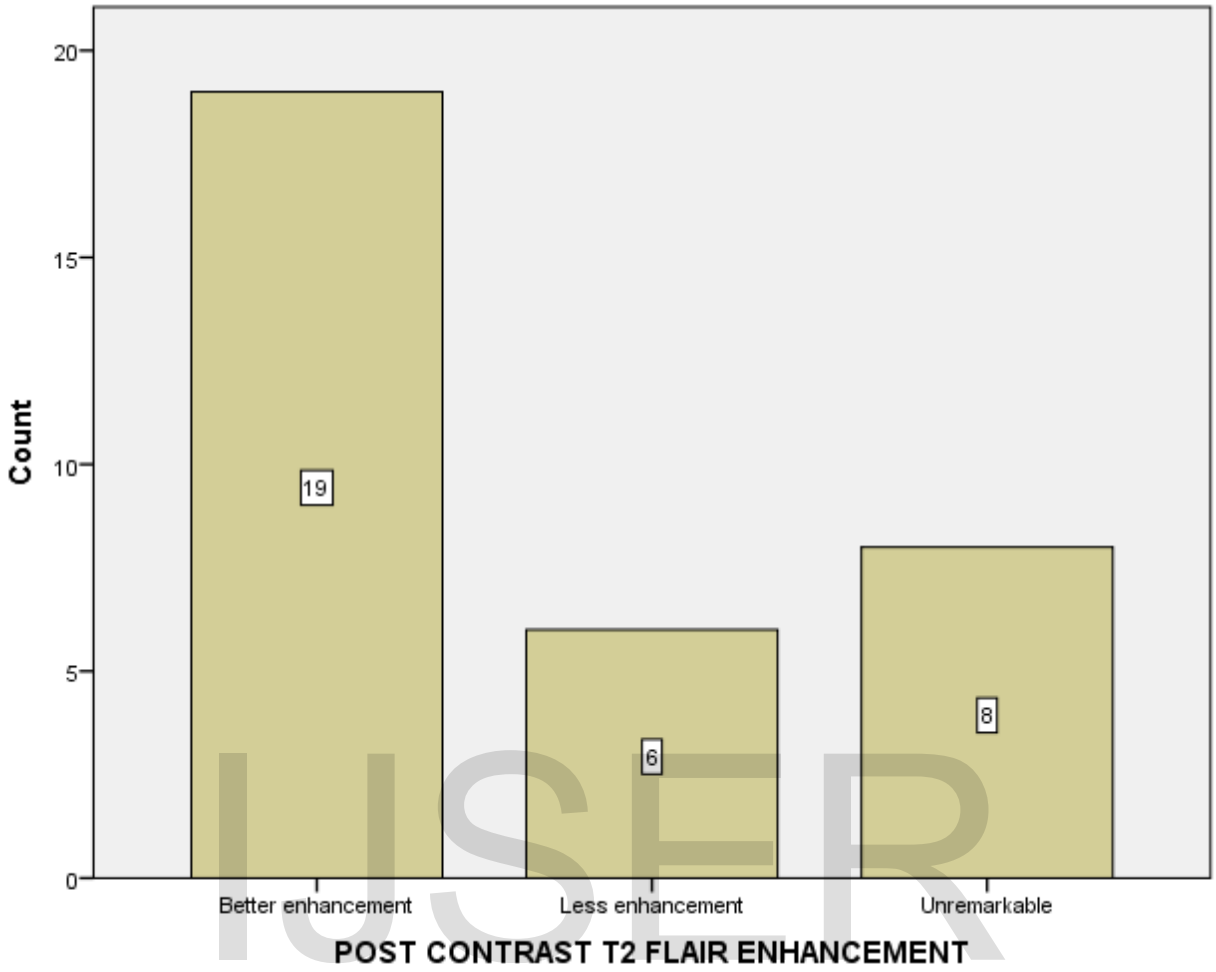
Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	F	15	45.5	45.5	45.5
	M	18	54.5	54.5	100.0
	Total	33	100.0	100.0	

8 patient's reports (24.2) % were unremarkable and 25 patients had various abnormalities. Out of these 25 patients post contrast T1 weighted images had better enhancement in 6 patients (18.2) %. But in 19 cases (57.6) % shows less enhancement as compare to post contrast T2 FLAIR weighted images, in remaining 8 cases (24.2) % both sequences do not reveal any abnormality so considered as equal.

Post Contrast T1 Enhancement

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Better enhancement	6	18.2	18.2	18.2
	Less enhancement	19	57.6	57.6	75.8
	Unremarkable	8	24.2	24.2	100.0
	Total	33	100.0	100.0	



Post contrast T1 images reveals more clear outlines of abnormality in 15 patients (45.5) % and less clear in 10 patients (30.3) % but in 8 patients (24.2) % they reveals no abnormality.

Post Contrast T1 Lesion Outline

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less clear	10	30.3	30.3	30.3
	More clear	15	45.5	45.5	75.8

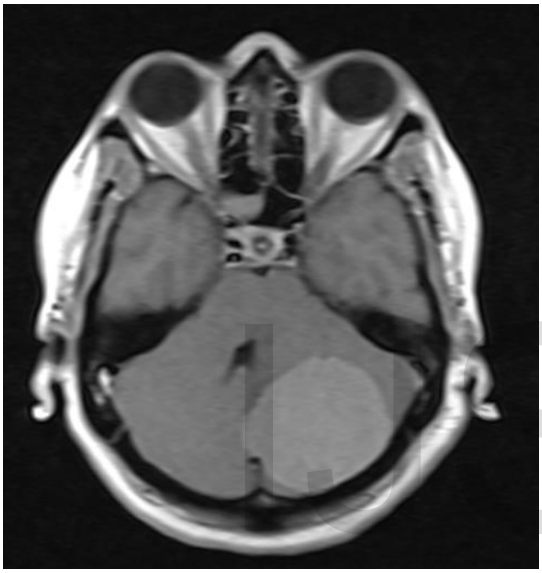
	Unremarkable	8	24.2	24.2	100.0
	Total	33	100.0	100.0	

So on the base of contrast enhancement and ability to revels clear outline of lesions as well as demarcation of lesions from surrounding complication post contrast T1 axial sequences was found better or more helpful in 12 cases (36.4) % and post contrast T2 FLAIR axial sequence was found better or more helpful in 13 cases (39.4) %. But in 8 cases (24.2) % no abnormality found on both T1 and T2 FLAIR weighted images.

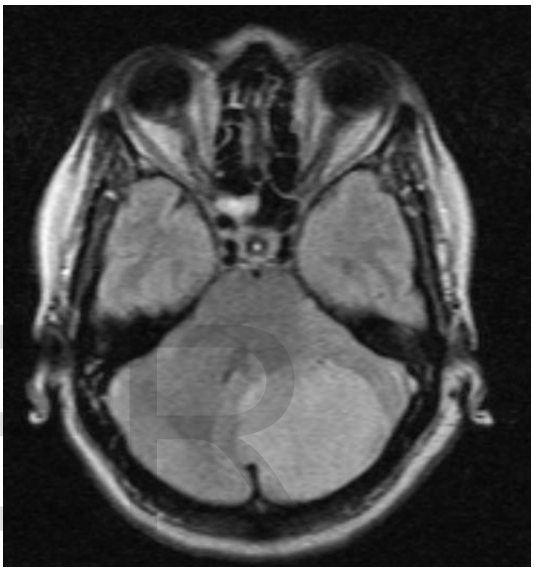
Better

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Equal	8	24.2	24.2	24.2

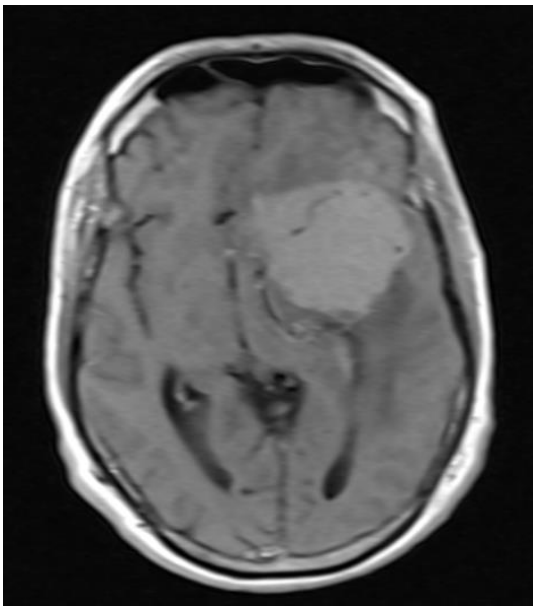
T1 axial	12	36.4	36.4	60.6
T2 FLAIR axial	13	39.4	39.4	100.0
Total	33	100.0	100.0	



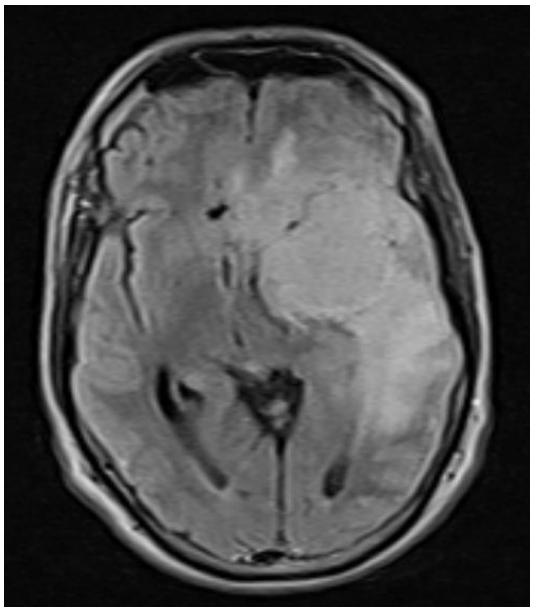
Enhanced T1 axial



Enhanced T2 FLAIR



Enhanced T1 axial



Enhanced T2 FLAIR

Discussion

Many studies have been done to see the value of post contrast T2 FLAIR sequences in many diseases, many of them concluded that post contrast T2 FLAIR sequence shows better results in diagnosis. We conducted study that involved many diseases and some diseases shows better enhancement on one sequence but other diseases show less degree of enhancement on same sequence. we focus only on enhancement and capacity of the sequence to reveal clear outlines of lesion. In 2003, Goo, H.W. & Choi, CG conducted a study. They concluded that enhanced FLAIR imaging is far better than enhanced T1 weighted imaging in the diagnosis of extra-axial contrast enhancing lesions in children[13]. In our study post contrast T2 FLAIR reveals better enhancement in most of the cases as compare to post contrast T1 but if we focus on capacity to reveal clear outline of one abnormality from surrounding complications. Post contrast T1 showed better results because it showed only contrast enhanced areas and we could differentiate oedema from contrast enhanced mass but in post contrast T2 FLAIR it was difficult to differentiate mass from oedema, so both of the sequences have their pros and cons. It is better to use post contrast T2 FLAIR to make diagnose more accurate. According to Nil Ercan et al post contrast T2 FLAIR is valuable sequence adjacent to post contrast T1squence in the case of lesions[14]. Our study shows lesions and mass shows better enhancement on contrast enhanced T2 FLAIR as compare to contrast enhanced T1 but lesion outline is more clear from other complications on post contrast T1 images. According to Kremer S et al diagnosis is improved on post contrast T2 FLAIR images[15]. Our study also supports his results and our supporting statistics could have been stronger if we had a large number of patients involved in our study.

Conclusion

Post contrast T2 FLAIR axial is little bit more helpful in some cases but it cannot replace contrast enhanced T1 axial sequence. Contrast enhanced T1 axial is good to differentiate lesions from surrounding edema. It is used as standard post contrast sequence these days, but T2 FLAIR can be helpful for better diagnosis so it should be use in addition to post contrast T1 axial sequence.

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