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Can Postcontrast-T2FLAIR be a Boon over Postcontrast-T1GRE Images in MR Brain Imaging?

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Abstract

We are all familiar with the role of postcontrast-T1GRE images in MR brain imaging especially in the presence of space occupying lesions. But very few are aware of the role of postcontrast-T2FLAIR images in similar circumstances. Though T2-effect of gadolinium and T1-effect of T2FLAIR has been established for long yet it has not been utilized intensively and extensively in practice. However, there have been few isolated studies establishing the role of postcontrast-T2FLAIR images in variety of brain pathologies. In this study, we aim to evaluate the role of postcontrast-T2FLAIR images in various pathological conditions of brain in wider spectrum and evaluate its usefulness in comparison with postcontrast T1GRE images in clinical practice.

Keywords: Brain; Gadolinium; T2FLAIR; T1GRE

Introduction

Gadolinium-chelates are frequently used to evaluate a variety of pathological conditions of brain during magnetic resonance imaging (MRI). Pre and postcontrast T1-gradient recalled echo (T1GRE) scans are usually compared for assessing the various characteristics of lesions as vascularity, internal necrosis or breach in blood brain barrier.

Postcontrast T1GRE scans utilizes the T1-shortening effect of gadolinium for conspicuous delineation of variety of lesions. In addition to T1-shortening, gadolinium also produces T2-shortening effect which is inversely proportional to gadolinium concentration resulting in increased contrast to noise ratio [1].

However, the post-gadolinium enhancement seen on T2-fluid attenuated inversion recovery (T2FLAIR) images is because of the T2-prolongation effect of various lesions and T1-shortening effect of gadolinium acting in synergism [2]. In this article, we share our experience on postcontrast-T2FLAIR images *versus* postcontrast-T1GRE images in variety of brain pathologies.

Material and Methods

Twenty patients visiting the department of Radiodiagnosis with clinical suspicion of brain pathologies were randomly selected for our study. All the selected patients underwent noncontrast and postcontrast MRI brain examinations.

Although multiple sequences were used to achieve the final diagnosis but we included noncontrast and postcontrast T1GRE and T2FLAIR images, both acquired on 1.5T magnet system with a high-resolution matrix. Postcontrast-T1GRE scans preceded postcontrast-T2FLAIR images, thus producing an inherent delay of 4-5 minutes in the two postcontrast sequences.

All the acquired images were examined and findings on postcontrast-T2FLAIR images were recorded first followed by postcontrast-T1GRE scans by a single radiologist. A separate mention was made of the findings exclusively recorded on postcontrast-T2FLAIR images.

Observations

Out of twenty patients, four patients were excluded from the study due to suboptimal scan quality as the patients could not be sedated adequately at the time of examination due to clinical limitations resulting in significant motion during scanning.

Out of remaining sixteen patients, two had neurocysticercosis; two had pyogenic abscess; four had only meningitis; four had tuberculoma (two with accompanying meningitis) and four patients had different intracranial tumors (see table 1).

Patients ranged from 15-50 years of age with equal number of male and female subjects.

In patients with neurocysticercosis, postcontrast-T2FLAIR did not reveal any additional finding. In fact, the lesion was better demonstrated on postcontrast-T1GRE scans (Figure 1).

In patients with pyogenic abscess, the air within the abscess was seen with more conspicuity on postcontrast-T2FLAIR images than on postcontrast-T1GRE images with greater enhancing-mural thickness appreciated on the T2FLAIR images (Figure 2). Demonstration of air within the lesion is a specific indicator of pyogenic etiology especially anaerobic and thickness of wall is an indicator of stage of abscess and may predict surgical removal.

In patients with meningitis, detection of extent of abnormal meningeal enhancement was more on postcontrast-T2FLAIR images with similar or more-measurable thickness than noted on postcontrast-T1GRE images (Figures 3 and 4). Extent of meningitis and thickening of meninges is linked to etiology and may indicate further course of action for example en plaque meningioma or meningeal metastases have different treatment than chronic meningitis

noted in tubercular disease where extent or meningeal thickness is a criteria of diagnosis.

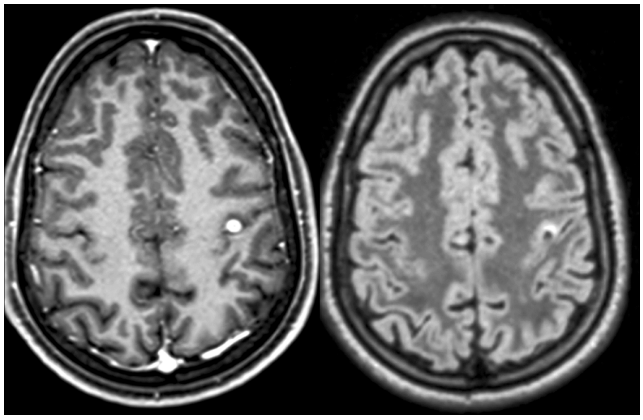

Figure 1: Postcontrast T1GRE image (on left) shows focal, subcentimeter, nodular-enhancing lesion in left frontal lobe corresponding to neurocysticercus cyst which was not that well delineated on postcontrast T2FLAIR image (on right side).

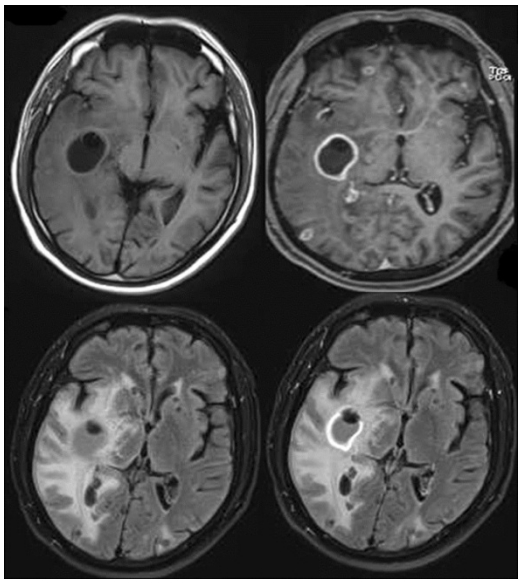

Figure 2: Pre and postcontrast T2FLAIR images (on left and right sides respectively in lower row) shows thicker-walled, ring-enhancing, space occupying lesion in right temporal lobe with aerocele in anterior aspect with severe surrounding edema and mass effect corresponding to pyogenic abscess which was not that well delineated on postcontrast T1GRE images (on left and right respectively in upper row). The patient had concomitant neurocysticercosis which were better delineated on postcontrast T1GRE scans.

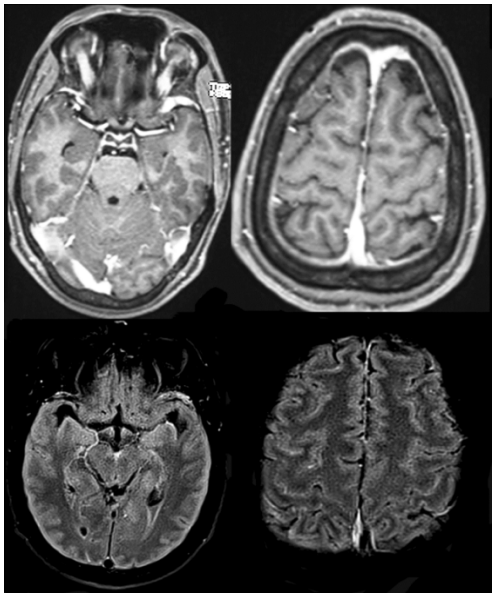

Figure 3: Postcontrast T2FLAIR images (in lower row) shows enhancing meninges in sulcal spaces and meningeal walls of superior sagittal sinus near the vertex in a patient with pyogenic meningitis which was not that well delineated on postcontrast T1GRE images (in upper row). However, the abnormal basilar leptomeningeal enhancement was seen equivalent on both scans.

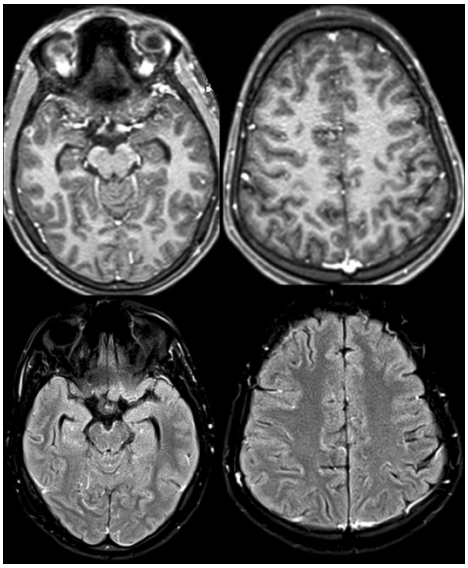

Figure 4: Postcontrast T2FLAIR images (in lower row) shows enhancing meninges in interpeduncular cisterns, sulcal spaces and parasagittal regions in a patient with tubercular meningitis which was not that well delineated on postcontrast T1GRE images (in upper row). However, the abnormal perisylvian leptomeningeal enhancement was seen equivalent on both scans.

In patients with tuberculoma, the nature of internal contents as well as the number of lesions along with extent of perilesional edema was better delineated on postcontrast T2FLAIR images than on postcontrast T1GRE images (Figures 5 and 6). Delineation of CSF-intense internal contents may indicate cysticercus or other cystic lesions with internal transudative content while presence of more intense internal content favour proteinaceous or cellular contents as noted in tuberculoma or necrotic tumors.

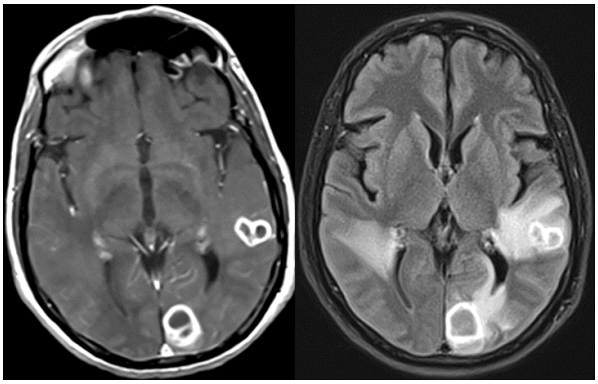

Figure 5: Postcontrast T2FLAIR images (on right side) shows internal content of intermediate intensity corresponding to caseous proteinaceous in a patient with tuberculoma which was not delineated on postcontrast T1GRE images (on left side). Perilesional edema was demonstrated in addition on T2FLAIR images.

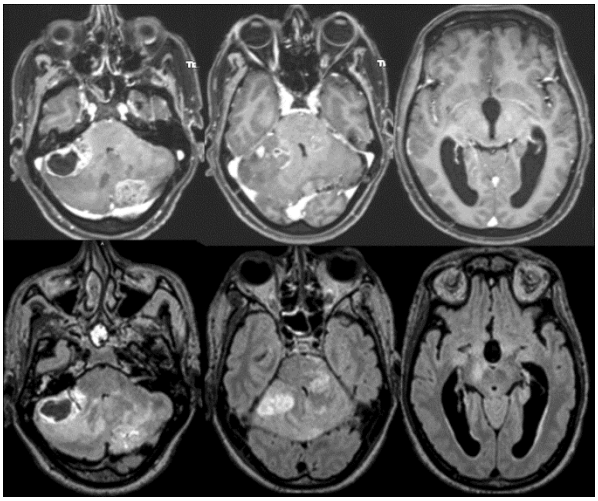

Figure 6: Postcontrast T2FLAIR images (in lower row) shows more number and larger size of enhancing lesions in cerebellum but more marked in pontine region with better detection of abnormal meningeal enhancement in a patient with tuberculoma and tubercular meningitis than on postcontrast T1GRE images (in upper row).

In patients with tumors, postcontrast T2FLAIR images show more extensive enhancement (corresponding to solid part) and thicker and more nodular wall enhancement in necrotic tumor than on postcontrast T1GRE images (Figures 7 and 8). These findings not only determine the differential diagnosis among tumors but also help in deciding the site of stereotactic biopsies to reach the final diagnosis.

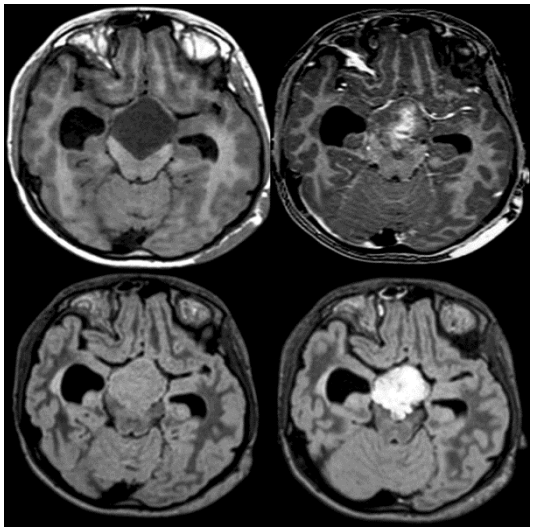

Figure 7: Pre and postcontrast T2FLAIR images (on left and right sides respectively in lower row) shows more extensive and homogeneous enhancement signifying solid nature of the tumor in a patient with pituitary macroadenoma than on pre and postcontrast T1GRE images (on left and right sides respectively in upper row).

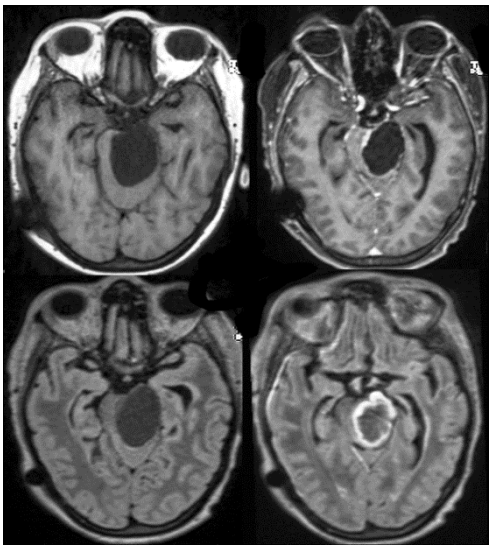

Figure 8: Pre and postcontrast T2FLAIR images (on left and right sides respectively in lower row) shows thicker and more nodular ring enhancement in a patient with trigeminal Schwannoma with malignant degeneration than on pre and postcontrast T1GRE images (on left and right sides respectively in upper row).

Discussion

T2FLAIR image sequence is an inversion recovery sequence acquired with long TR (time to repetition), long TE (time to echo) and inversion time (TI) that effectively suppresses the signal from CSF at all locations including sulcal spaces allowing better detection and delineation of extent of the lesions lying adjacent to meninges especially sulcal spaces as variable hyperintensities. Though T2FLAIR images are heavy T2-weighted, yet their mild T1-weighting is also responsible for better delineation of lesions on postcontrast-T2FLAIR images making it a highly sensitive sequence in detecting meningeal inflammation, infections and carcinomatosis.

S.No.	Disease	Number of Patients
1	Neurocysticercosis	2
2	Pyogenic abscess	2
3	Meningitis	4
4	Tuberculoma	4
5	Tumors	4
Total		16

Table 1: Distribution of disease with number of patients in the study group.

Many studies have concluded that postcontrast T2FLAIR images are more sensitive than both postcontrast-T1GRE and noncontrast T2FLAIR images especially in detections of subtle and smaller cortical and deeper lesions for example leptomeningeal carcinomatosis which is devoid of mass effect as seen in our study [3-5]. In deeper lesions, the contrast between the enhancing lesion and surrounding vasogenic edema is superior than that seen on noncontrast T2FLAIR images (Figure 2, 5, 6).

Meningeal enhancement detected on postcontrast T2FLAIR images can help in detecting subtle traumatic brain lesions as well as additional lesions in symptomatic post-traumatic patients with otherwise normal MRI brain [2]. Normal meningeal enhancement is thin, linear and discontinuous but thick, linear and continuous meningeal enhancement is considered abnormal arising secondary to increased water content of dura mater that can be seen with variety of benign and malignant conditions including intracranial hypotension, post-traumatic (including post-surgical) condition, inflammatory conditions including granulomatous diseases and infections and metastases [2,6-10]. In fact, some studies have concluded that double-dose; postcontrast 3D-T2FLAIR images may be complementary to postcontrast-3D-T1GRE images in detections of small brain metastases [11].

Studies have also demonstrated that postcontrast T2FLAIR images can detect variable degrees of CSF changes in variety of brain pathologies [12].

Better demonstration of internal nature of tuberculoma and tumors; walls of abscesses and tumors and enhancing meninges of dural venous sinuses by postcontrast-T2FLAIR images than with postcontrast-T1GRE scans have not been evaluated / demonstrated in previous studies. Inclusion of neurocysticercosis was also not noted in previous studies.

Limitations of the Study

The major limitation is the small number of patients that were included in the study. Another limitation is non-representation of other brain pathological conditions where postcontrast scans may provide additional information viz. demyelinating and dysmyelinating diseases.

Minor limitations include the slight increase in scan time, higher post-injection delay in acquisition of postcontrast-T2FLAIR images and clinical implications of the additional information recorded.

Conclusions

Based on the systematic analysis of the imaging findings in the above study group following conclusions can be drawn:

- Postcontrast-T1GRE images are superior to postcontrast-T2FLAIR images in delineating degenerating cysts of cysticerci.
- Postcontrast-T2FLAIR images are superior to postcontrast-T1GRE images in demonstrating internal air and perilesional edema simultaneously in addition to wall enhancement with greater mural thickness in patients with pyogenic abscesses.
- Postcontrast-T2FLAIR images are superior to postcontrast-T1GRE images in determining the extent of meningeal enhancement especially in sulcal spaces (especially in tubercular meningitis) and dural sinuses due to presence of luminal signal void of sinus lumen on T2FLAIR images.
- Postcontrast-T2FLAIR images are superior to postcontrast-T1GRE images in determining the nature of internal contents and number of lesions in cases of tuberculoma with an additional advantage of demonstrating edema.
- Postcontrast-T2FLAIR images are superior to postcontrast-T1GRE images in determining the nature of internal contents and mural characteristics in cases of intracranial tumors.
- Finally, postcontrast-T2FLAIR images may obviate the need for noncontrast-T2FLAIR images. Also if postcontrast-T2FLAIR images are normal, then postcontrast-T1GRE images are unlikely to be abnormal while if postcontrast-T2FLAIR images are abnormal than pre and postcontrast-T1GRE images may tell us whether the increased signal intensity on postcontrast-T2FLAIR images is due to T1-shortening effect of gadolinium or T2-prolongation effect of brain pathology.

Summary

To summarize, postcontrast-T2FLAIR images may be routinely used as an additional tool to postcontrast-T1GRE scans in MRI examination of a variety of brain pathological conditions as it provides additional clinically useful information that may be helpful in management and predicting prognosis except in cases of neurocysticercosis. However, more studies preferably with larger number of patients and wider spectrum of brain pathologies may be required to validate the results of this study in routine clinical practice.

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