Section: Radiodiagnosis

Original Research Article

ROLE OF DIFFUSION WEIGHTED MR IMAGING IN NON NEOPLASTIC INTRACRANIAL LESIONS

Aishwarya Ranjan Rai[1], Vijay Kumar Yadav[2], Amiteshwar Singh Randhawa[3]

[1]Junior Resident, Department of Radiodiagnosis, MGMMC & LSK Hospital Kishanganj, India.
[2]Assistant Professor, Department of Radiodiagnosis, MGMMC &LSK Hospital Kishanganj, India.
[3]Junior Resident, Department of Radiodiagnosis, MGMMC & LSK Hospital Kishanganj, India.

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Corresponding Author:
Dr. Vijay Kumar Yadav,
Email: dkvijaykumar121@gmail.com

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Abstract

Background: The incidence of brain and central nervous system tumors has been increasing in recent years. The Conventional MRI of many intracranial non-neoplastic diseases, such as brain abscess, tuberculosis, and cerebral cysticercosis, mimics cerebral high-grade glioma, which could all manifest as space-occupying lesions with cystic necrosis, and ring enhancement. Diffusion-weighted magnetic resonance imaging (DW-MRI) has revolutionized the diagnostic approach to non-neoplastic intracranial lesions by providing critical information on the microstructural environment of brain tissues. **Materials and Methods:** It was an observational/correlational study conducted in Department of Radiodiagnosis, MGM Medical College and LSK Hospital, Kishanganj (Bihar). **Result:** Age of patients ranges from 1 month to 74 years. The largest numbers of patients were in 51-60yr age groups. The majority of patients with diffusion restriction having intracranial lesions belong to stroke. MRI signal intensity changes are noted in 6 patients of viral encephalitis, patchy diffusion restriction is noted in 5 patients. There were four patients diagnosed with brain abscess and all of them showed restricted diffusion mainly in the center of abscess. All patients showed T2 hypo intense rim with peripheral enhancement. Two patients with Wilson disease included in the study, one of them showed diffusion restriction mainly in basal ganglia, mid brain and cerebral cortex. **Conclusion:** Diffusion-weighted imaging (DWI) has proven to be a highly efficient and rapid imaging technique, offering substantial benefits in the evaluation of various non-neoplastic intracranial lesions by detecting restricted water molecule movement within cells. The critical role of DWI in providing rapid, accurate diagnosis across a spectrum of intracranial conditions, enhancing clinical decision-making and patient management.

INTRODUCTION

The incidence of brain and central nervous system tumors has been increasing in recent years. There are about 308,000 new cases of brain tumors worldwide until 2020. The morbidity rates of men and women are 3.9% and 3.0%, respectively, and the mortality rates are 3.2% and 2.4%, respectively.[1] Conventional MRI has a good value in differentiating diagnosis by assessing the shape, location, and mass effect of lesions.[2] Sometimes, conventional MRI of many intracranial non-neoplastic diseases, such as brain abscess, tuberculosis, and cerebral cysticercosis, mimics cerebral high-grade glioma, which could all manifest as space-occupying lesions with cystic, necrosis, and ring enhancement. However, the treatment strategies and prognosis of non-neoplastic and neoplastic are completely different, so how to accurately differentiate those two kinds of diseases is quite important.[3]

Diffusion-weighted magnetic resonance imaging (DW-MRI) has revolutionized the diagnostic approach to non-neoplastic intracranial lesions by providing critical information on the microstructural environment of brain tissues. This advanced imaging modality relies on the diffusion of water molecules, which can be altered in various pathological states, making DW-MRI particularly sensitive to changes in cellular density and the integrity of cell membranes.[4]

One of the most prominent applications of DW-MRI is in the acute diagnosis of ischemic stroke. It is capable of detecting cytotoxic edema within minutes of stroke onset, significantly earlier than traditional MRI sequences or CT scans, thereby facilitating timely intervention and improving patient outcomes. Additionally, DW-MRI is invaluable in

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differentiating between types of intracranial infections. For instance, it helps distinguish pyogenic abscesses, which show restricted diffusion due to high cellularity and viscosity, from other types of lesions like necrotic tumors or non-infectious cysts, which typically do not restrict diffusion.[5,6]

Moreover, DW-MRI is used extensively in the assessment of demyelinating diseases such as multiple sclerosis (MS). It aids in the identification of acute MS lesions, which exhibit high signal intensity on DW-MRI due to increased cellularity and inflammation, and can also be used to monitor the efficacy of therapeutic interventions by tracking changes in these lesions over time. Another significant application is in the evaluation of encephalitis and other inflammatory conditions of the brain, where DW-MRI can detect areas of restricted diffusion indicative of acute inflammation and edema.

By enhancing the detection and characterization of various non-neoplastic intracranial lesions, DW-MRI not only improves diagnostic accuracy but also guides clinical management and therapeutic decisions, making it an indispensable tool in modern neuroradiology.

Aim and Objective:

Aim

To study the role of diffusion weighted imaging (DWI) in various non-neoplastic intracranial lesions.

Objectives

Establish the findings of DWI MRI in various non neoplastic intracranial lesions.

Correlation of DWI findings of various non neoplastic intracranial lesions with their conventional MRI findings.

Establish the usefulness of DWI MRI in diagnosis of various non neoplastic intracranial Lesions.

Establish the findings of DWI in different stages of stroke.

MATERIALS AND METHODS

Type of Study: An observational/correlational study.

Place of Study: Department of Radiodiagnosis, MGM Medical College and LSK Hospital, Kishanganj (Bihar).

Duration of the study: 1stSeptember 2022 to 30thApril2024.

Study population: The study subjects were 60 patients, who attended the Outpatient Department Medicine ward of M.G.M. Medical College & LS.K. Hospital, Kishanganj with clinical symptoms and signs suggestive of non-neoplastic intracranial lesions of the brain.

Inclusion Criteria

- Patients with neurological disease affecting the brain who are sent for MRI including DWI study.
- Patients/relatives willing to participate in the study.

Exclusion Criteria

- Patients with symptoms and signs, and prior imaging suggestive of neoplastic intracranial lesions.
- Patients admitted with head trauma.
- Patients having contraindications for MRI study
- Patients/relatives unwilling to participate in the study.

Study tools

- Case data sheet and filled up Performa.
- MRI (Machine Siemens 1.5 Tesla)

RESULTS

Table 1: Age distribution.

Age Group (in years)	Number of patiens	percentage
0-10	8	13%
11-20	4	6.6%
21-30	6	10%
31-40	8	13.3%
41-50	8	13.3%
51-60	17	28%
61-70	7	11.6%
71-80	2	3.3%

Table 2: Distribution of patients according to diagnosis

Diagnosis	No.of patients
Ischemic stroke	27
Hemorrhage	3
Cerebral abscess	4
Viral encephalitis	6
Wilson disease	2
Central pontine myelinolysis	1
Posterior reversible encephalopathy syndrome	2
Post ictal change	5
Demyelinating condition	1
Hypertensive encephalopathy	2
Hypoglycemic encephalopathy	1
TB granuloma	6

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Table 3: MRI Signal intensity changes in stroke

MRI sequences	No. of patients	Percentage
DWI(restriction)	27	100%
T1WI(hypointensity)	24	88%
T2WI(hyperintensity)	26	96%
FLAIR(hyperintensity)	25	92%
GRE(hypointensity)	9	30%

Table 4: Signal intensity changes in late hyperacute stage

MRI sequence	No.of patients	Percentage
T1W (Hypointensity)	4	100%
DWI (Restriction)	3	75%
T2W (Hyperintensity)	3	75%
FLAIR (Hypointensity)	3	75%
GRE	0	0%

Table: 5 Showing S.I in acute stage of stroke.

MRI sequence	No.of patients	percentage
DWI	25	100%
T2W	25	100%
T1W	23	92%
FLAIR	22	88%
GRE	9	33%

Table 6: MRI signal intensity changes in HSV encephalitis patients

MRI sequences	No.of patients	percentage
DWI (Restriction)	5	83%
T1WI (Hypointensity)	6	100%
T2WI (Hyperintensity)	6	100%
FLAIR (Hyperintensity)	6	100%
GRE	0	0%

Table 7: MRI signal intensity changes in brain abscess

MRI sequences	No.of patients	percentage
DWI (Restriction)	4	100%
T1WI (Hypointensity)	4	100%
T2WI (Heterogeneously Hypo)	4	100%
FLAIR (Incomplete suppression)	1	25%
GRE	0	0%

Table 8: MRI signal intensity changes in Wilson disease

MRI sequences	No.of patients	Percentage
DWI	1	50%
T1WI	1	50%
T2WI	2	100%
FLAIR	2	100%
GRE	0	0%

Table 9: MRI signal intensity changes in hemorrhage:- Late sub acute bleed showed diffusion restriction which is hyperintense in both T1W AND T2W images. three cases of late subacute bleed were studied.

MRI sequences	No.of patients	Percentage
DWI	3	100
T1WI(hyperintensity)	3	100
T2WI(hyperintensity)	3	100
FLAIR	3	100
GRE	3	100

Table 10: MRI signal intensity changes in Central pontine myelinosis.

MRI sequence	T1WI	T2WI	FLAIR	DWI	GRE
Central pontine myelinolysis	hypointensity	hyperintensity	hyperintensity	restriction	

Table 11: MRI signal intensity changes in PRES.

MRI sequences	T1WI	T2WI	FLAIR	DWI	GRE
PRES	hypointensity	hyperintensity	hyperintensity	restriction	

Table12: MRI signal intensity changes in Post ictal changes.

MRI sequence	T1WI	T2WI	FLAIR	DWI	GRE
Post ictal change	hypointensity	hyperintensity	isointensity	restriction	

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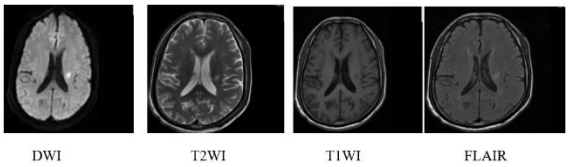
Table 13: MRI S.I changes in Hypertensive encephalopathy.

MRI sequence	T1WI	T2WI	FLAIR	DWI	GRE
Hypertensive encephalopathy	hypointensity	Hyperintensity	hyperintensity	Restriction	

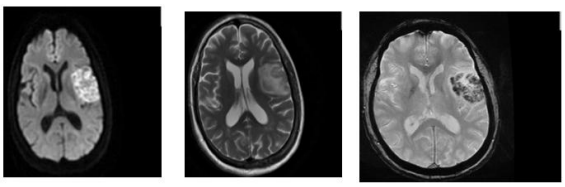
Table14: MRI S.I changes in TB granuloma

MRI sequence	No.of patients	Percentage
DWI	2	33%
T1WI	Isointensity(3),hypo(3)	100%
T2WI	Hyperintensity(4),Iso(2)	100%
FLAIR	Hyperintensity(5),iso(1)	100%
GRE	0	0.0



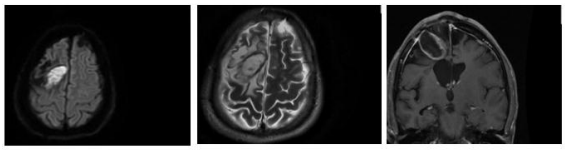
DWI T2WI T1WI FLAIR

Infarction with hemorrhagic transformation



DWI *T2WI* *GRE*

Brain Abscess



DWI **T2WI** **T1Contrast**

DISCUSSION

It was Observational cross-sectional study, 60 patients, who were attending the Outpatient Department Medicine ward of M.G.M. Medical College & LS.K. Hospital, Kishanganj with clinical symptoms and signs suggestive of non-neoplastic intracranial lesions of the brain were enrolled for the study, after investigation we have found:

- DWI is a less time-consuming faster imaging technique.
- DWI detects restriction of movement of water molecule within the cells.
- In our study we have got diffusion restriction in number of conditions including stroke, cerebral abscess, HSV encephalitis, TB granuloma, Wilson disease, central pontine myelinolysis, posterior reversible encephalopathy syndrome, hypertensive encephalopathy, post ictal change, intra cerebral hemorrhage and hypoglycemia encephalopathy.
- In the late hyperacute stage of stroke, DWI was the most sensitive sequence (100%) compared to the T2W (75%), T1W (75%) and FLAIR (75%).
- In the acute stage of stroke, both DWI and T2W showed 100% sensitivity and better in detecting lesion compared to T1W(92%) and FLAIR(88%).Overall in stroke patients DWI was the most sensitive sequence(100%),followed by T2W(96%),T1W(89%)and FLAIR(86%).
- In Viral encephalitis both DWI and T2W imaging showed 85% sensitivity, followed by FLAIR (71%),T1W(71%).Diffusion restriction in Viral encephalitis may be due to cytotoxic edema.
- In cerebral abscess all our four patients with cerebral abscess showed diffusion restriction mainly in the center of the lesion. All patients showed T2W hypointense rim with thin, smooth wall enhancement. In our study DWI,T2W,T1W showed 100% sensitivity followed by FLAIR(25%).
- In TB granuloma, two patients out of 6 TB granuloma cases showed diffusion restriction in the centre of the granuloma(33%).All patients showed conglomerated rim type enhancement. conventional MRI sequences showed higher sensitivity,T1W(100%),T2W(100%) and FLAIR(100%).
- In Wilson disease, Diffusion restriction is noted in 2 cases (60%), mainly in basal ganglia, midbrain and cerebral cortex,which may be due to copper accumulation in cells leading to cytotoxicity.

CONCLUSION

Diffusion-weighted imaging (DWI) has proven to be a highly efficient and rapid imaging technique, offering substantial benefits in the evaluation of various non-neoplastic intracranial lesions by detecting restricted water molecule movement within cells. Our study has demonstrated that DWI effectively identifies diffusion restriction in a wide range of conditions, including stroke, cerebral abscess, Viral encephalitis, TB granuloma, Wilson disease, central pontine myelinolysis, posterior reversible encephalopathy syndrome, demyelination, Hypertensive encephalopathy, post ictal changes, intracerebral hemorrhage, and hypoglycemia encephalopathy.

In the context of stroke, DWI showed unparalleled sensitivity, particularly in the late hyperacute stage, with a 100% sensitivity rate, outperforming T2-weighted (T2W), T1-weighted (T1W), and FLAIR sequences. During the acute stage of stroke, both

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DWI and T2W exhibited 100% sensitivity, surpassing T1W and FLAIR in lesion detection. Overall, DWI emerged as the most sensitive sequence for stroke patients, followed by T2W, T1W, and FLAIR.

For Viral encephalitis, DWI and T2W both demonstrated 85% sensitivity, with DWI effectively highlighting cytotoxic edema. In cases of cerebral abscess, all patients exhibited diffusion restriction centrally, with DWI, T2W, and T1W showing 100% sensitivity, whereas FLAIR showed lower sensitivity. In TB granuloma, 33% of cases displayed central diffusion restriction, with conventional MRI sequences (T1W, T2W, FLAIR) showing higher overall sensitivity.

In Wilson disease, diffusion restriction was observed in 50% of cases, predominantly in the basal ganglia, midbrain, and cerebral cortex, likely due to copper accumulation causing cytotoxicity.

These findings underscore the critical role of DWI in providing rapid, accurate diagnosis across a spectrum of intracranial conditions, enhancing clinical decision-making and patient management.

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