Section: Radiodiagnosis

Original Research Article

UNCOVERING THE CAUSES OF HEADACHE: INSIGHTS FROM A MRI BASED STUDY IN A TERTIARY CARE CENTRE

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Received *: 29/01/2025*
Received in revised form *: 06/04/2025*
Accepted *: 28/04/2025*

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DOI: 10.70034/ijmedph.2025.2.381

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (2); 2117-2123

ABSTRACT

Background: Headache, a common neurological symptom is characterized by pain in the head or upper neck region. Headache may be primary or secondary. Magnetic Resonance imaging (MRI) is an important tool in the evaluation of patients with secondary causes of headache. It is preferred over other imaging modalities due to its good spatial resolution and demonstration of superior soft tissue contrast without radiation. **Aim:** To evaluate the role of Magnetic Resonance Imaging (MRI) in identifying causes of headache and assess the spectrum of MRI findings in patients with headache.

Materials and Methods: The study is a retrospective observational study conducted in department of Radiodiagnosis, Jorhat Medical College and Hospital, in the months of February and March, 2025. It includes 45 patients aged 18-60 years, who presented with headache complaints. The cases were selected based on the presence of secondary headache features. All 45 patients underwent standardized MRI protocols including T1-weighted, T2-weighted, Fluid-attenuated inversion recovery (FLAIR), Diffusion weighted imaging (DWI), contrast-enhanced sequences and additional sequences like MR spectroscopy and MR venography to evaluate for secondary causes of headache.

Results: Out of 45 patients, abnormal MRI findings were observed in 26 patients (57.8%) patients. The commonest aetiology was sinonasal pathology (35%) followed by infective (27%), neoplastic (19%) and vascular causes (19%).

Conclusion: MRI proves to be a valuable diagnostic tool in evaluation of headache, enabling detection of various underlying aetiologies. It helps in identifying treatable and serious conditions such as infections, neoplasms and vascular lesions, thus guiding timely and appropriate clinical management.

Keywords: Headache, Magnetic resonance imaging, secondary headache, sinonasal, infective, neoplastic, vascular.

INTRODUCTION

A large percentage of people worldwide suffer from headaches, making it one of the most prevalent neurological symptoms seen in clinical practice.[1] Headaches are classified into primary or secondary . Secondary headaches are caused by pathological or structural abnormalities in the brain or its surrounding structures.[2] Since secondary headaches may be a sign of more serious disorders that need immediate attention , it is important to diagnose them accurately.[3]

When clinical characteristics point to the potential for secondary causes, Magnetic Resonance Imaging (MRI) has emerged as a key component in the assessment of headache.[4] In comparison to other imaging modalities, MRI uses no ionizing radiation and offers higher resolution of soft tissues, including detailed images of the brain, meninges and vessels.[5] Hence, MRI is very useful for detecting a variety of intracranial disorders that may manifest as headaches.[6]

MRI has a variety of uses in the assessment of headaches. It plays a crucial role in identifying abnormalities such as infections, vascular

malformations and neoplasms.[3] Furthermore, MRI can detect consequences like brain abscesses and tuberculomas.[5] MRI helps in differentiating between primary and secondary headache aetiologies by providing a thorough image of the brain's parenchyma and cerebrovascular anatomy, which helps clinicians chose the best course of action.[4]

This study explores the diverse range of findings observed in MRI examinations of patients presenting with headache complaints. Through detailed analysis of cases, this research aims to highlight the diagnostic significance of MRI in identifying the underlying causes of secondary headaches. We seek to emphasize the importance of MRI as a diagnostic tool and provide insights into how imaging can inform clinical decision-making and improve patient outcomes.

MATERIALS AND METHODS

The study involved a retrospective observational study of 45 patients referred for MRI to assess secondary causes of headaches based on clinical suspicion at Jorhat medical college and Hospital, Jorhat, Assam in the months of February and March, 2025. Using 1.5T GE MR systems, axial T1 weighted images were acquired followed by T2 weighted and FLAIR sequence. In addition, sagittal T2W, Coronal T2W images were taken along with axial diffusion weighted images(DWI). Contrast enhanced sequences with additional MR spectroscopy (MRS) and MR venography (MRV) sequences were taken. Final diagnostic impressions were formulated based on imaging features and clinical presentation.

RESULTS

MRI scans of 45 patients were reviewed, out of which 21 were female subjects and 24 were male subjects as shown in Fig 1. The age range of subjects was 18-60 years with clustering between the ages of 30 to 55 years. The mean age was 35 years. Abnormal MRI findings were seen in 26 patients, 19 patients showed no significant abnormality on MRI as shown in Fig 2. The commonest pathology seen was sinusitis in 9 patients out of which maxillary sinus was the most commonly involved sinus. This was followed by infective causes; 2 cases of cerebral abscesses , 2 cases of neurocysticercosis , 1 case of cerebral toxoplasmosis and 2 cases of tuberculoma with meningitis . Neoplastic aetiologies were seen in 5 cases; 2 cases of meningioma, 2 cases of glioblastoma multiforme and 1 case of lymphoma. Vascular causes were seen in 5 patients ; 1 case of dural venous sinus thrombosis, 1 case of AV malformation and 3 cases of subarachnoid haemorrhage as shown in Table 1 and Fig 3.

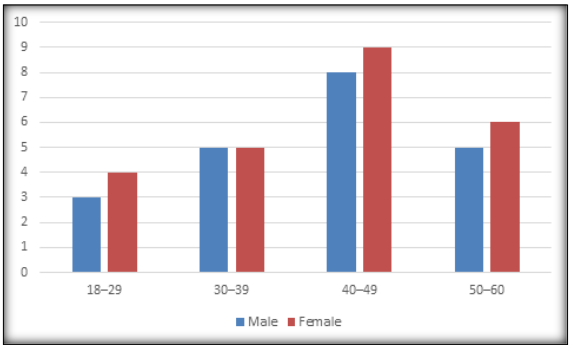

Figure 1: Bar diagram illustrating the age and sex distribution among the patients

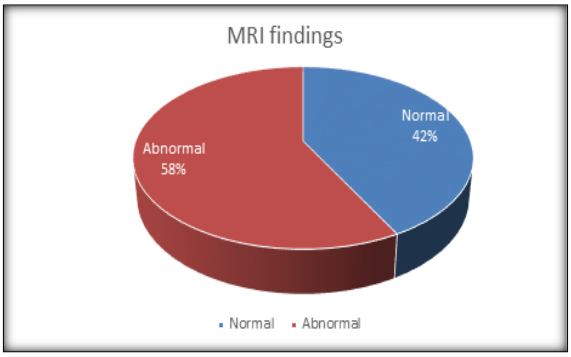

Figure 2: Pie diagram illustrating distribution of MRI findings among study participants

Table 1: Table showing the distribution of aetiologies in MRI findings

Aetiology	Specific Diagnoses	Number of Patients
Sinonasal Pathology	Sinusitis (Maxillary sinus most common)	9
Infective	Cerebral abscess	2
	Neurocysticercosis	2
	Tuberculoma with meningitis	2
	Cerebral Toxoplasmosis	1
Neoplastic	Meningioma	2
	Glioblastoma multiforme	2
	Lymphoma	1
Vascular	Dural venous sinus thrombosis	1
	Arteriovenous malformation (AVM)	1
	Subarachnoid haemorrhage	3

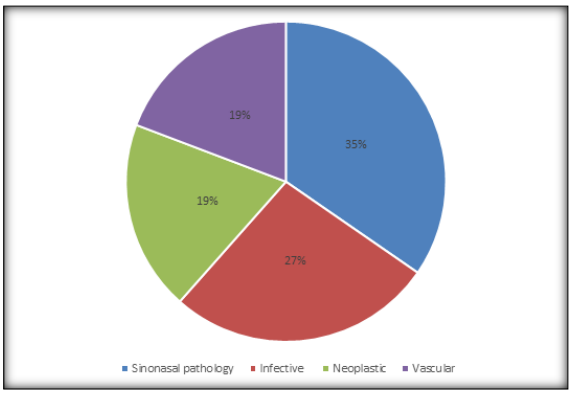

Figure 3: Pie diagram illustrating distribution of aetiology among study participants

REPRESENTATIVE CASES:

Case 1: A 50 year old male presented with dull and diffuse headache, facial pain and nasal congestion since a week.

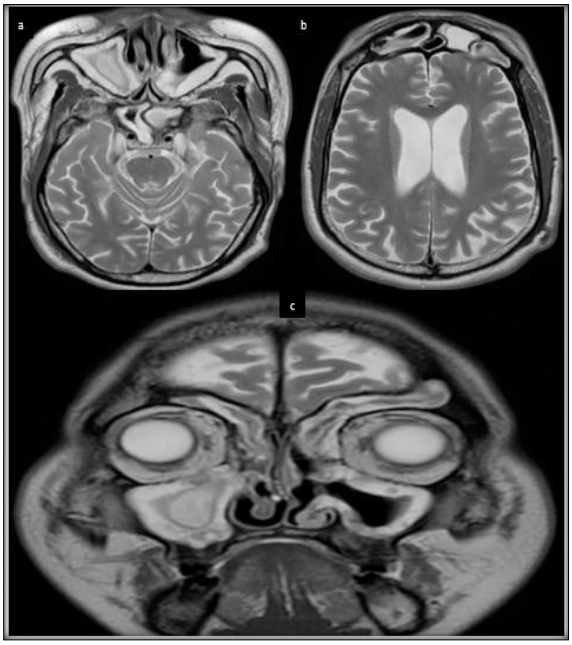

Figure 4: (a,b) T2 axial and (c) Coronal images show mucosal thickening in bilateral maxillary , sphenoidal , ethmoidal and frontal sinuses. These features are suggestive of pansinusitis

Case 2: A 39 year old immunocompromised male presented with severe headache, fever and right sided weakness over the last week. Examination revealed signs of raised intracranial pressure.

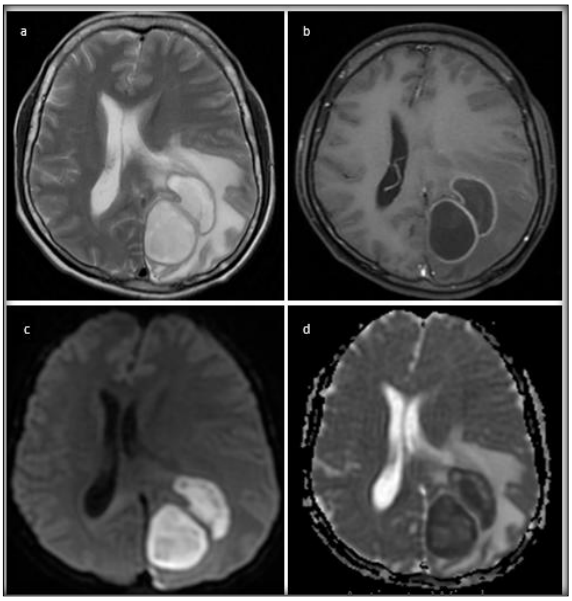

Figure 5: (a) T2 axial image shows hyperintense conglomerated lesion involving left occipito-parietal lobe with hypointense rim and surrounding perilesional edema .
(b) T1 axial post contrast image shows peripherally enhancing smooth walls of the lesion. (c) DWI image with corresponding (d) ADC images show central diffusion restriction with low ADC values in the centre. These features are suggestive of cerebral abscess. Origin: Department of Radiology , Jorhat Medical College and Hospital, Jorhat , Assam , India 2025

Case 3: A 34 year old male presented with generalized tonic clonic seizures and intermittent headaches for the past two months.

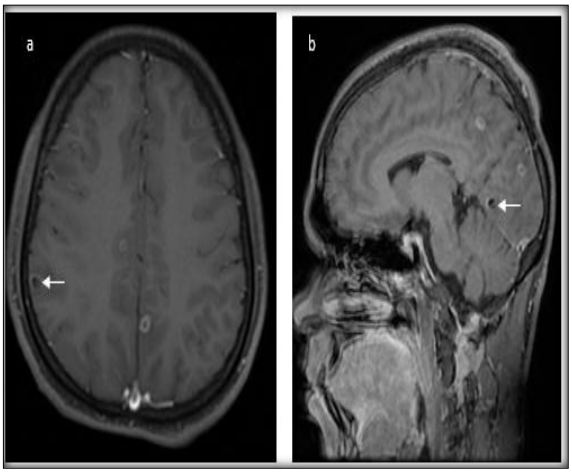

Figure 6: (a,b) T1-weighted postcontrast axial and sagittal images show ring enhancing, small well defined nodular lesions in bilateral parieto-occipital lobes at grey white matter interface. There is presence of eccentric T1 iso to hyper intense nodular component within representing scolex (white arrows) . These features are suggestive of neurocysticercosis in vesicular stage. Origin: Department of Radiology , Jorhat Medical College and Hospital, Jorhat , Assam , India 2025.

Case 4 : A 50 year old immunocompromised female with HIV positive status presented with headache and fever since 10 days.

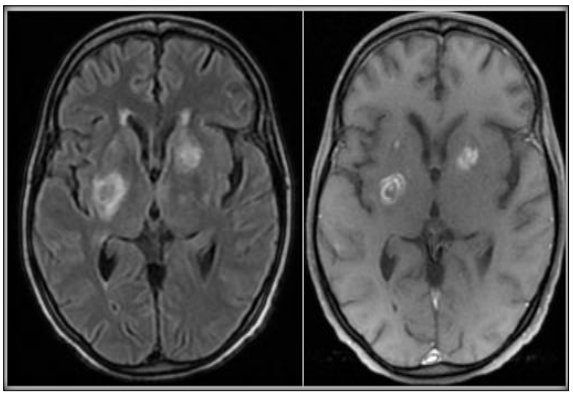

Figure 7: T2 axial and T1 post contrast axial images show ring and nodular enhancing discrete lesions with concentric T2 hyper and hypointense zones giving "concentric target sign" in bilateral basal ganglia. These features are suggestive of cerebral toxoplasmosis. Origin: Department of Radiology , Jorhat Medical College and Hospital, Jorhat , Assam , India 2025

Case 5: A 30-year-old male with a history of tuberculosis presented with severe headache, neck stiffness and fever for 1 week.

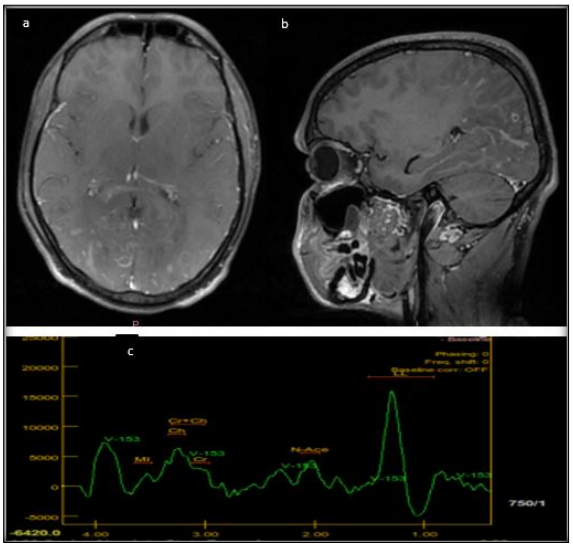

Figure 8: a) T1 axial contrast and (B) T1 sagittal contrast images shows ring enhancing lesions in bilateral parieto-occipital lobes with surrounding leptomeningeal enhancement. (C) MR spectroscopy shows lipid-lactate peak. Features are suggestive of tuberculoma. Origin: Department of Radiology , Jorhat Medical College and Hospital, Jorhat , Assam , India 2025.

Case 6: A 55 year old male presented with a progressive 6 month history of headaches and new onset seizures with subtle cognitive decline.

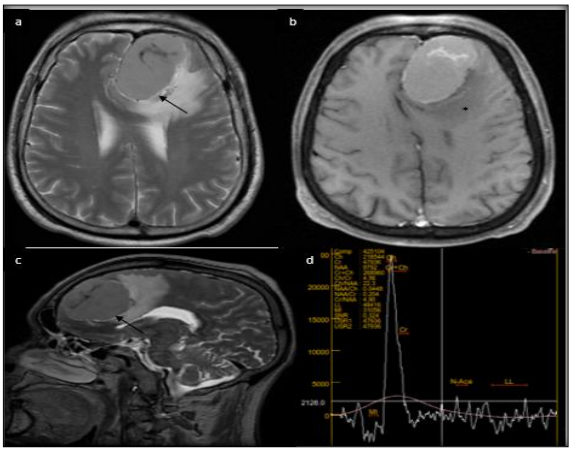

Figure 9: (a) T2 weighted axial (b) T1-weighted postcontrast axial and (c) T2 weighted Sagittal images show an enhancing extra-axial falx based mass lesion epicentered towards the left frontal region in parasagittal location with surrounding vasogenic oedema (asterisk) causing gray-white matter buckling with characteristic CSF cleft (straight arrow) . Subfalcine herniation noted towards right side along with compression of the left lateral ventricle. (d) MR spectroscopy of the above described lesion shows choline peak with an increased Choline/NAA ratio (22.3). These features are consistent with parafalcine meningioma.
Origin: Department of Radiology , Jorhat Medical College and Hospital, Jorhat , Assam , India 2025

Case 7: A 53 year old female presented a 3 month history of rapidly worsening headaches and recent onset weakness on the left side. His family noted personality changes and episodes of confusion

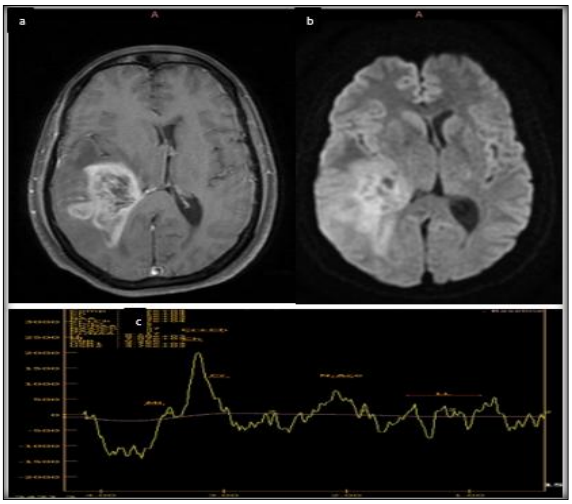

Figure 10: (a) T1-weighted postcontrast axial image and (b) Diffusion-weighted MRI image of the patient shows heterogeneously enhancing intra-axial lesion involving the right parieto-occipital region causing effacement of the occipital horn of right lateral ventricle and adjacent sulci with diffusion restriction on DWI. (c)MR spectroscopy of the above described lesion shows increased choline and decreased NAA . These features are consistent with glioblastoma multiforme. Origin: Department of Radiology , Jorhat Medical College and Hospital, Jorhat , Assam , India 2025

Case 8: A 45 year old male presented with a 2 week history of worsening headache and drowsiness.

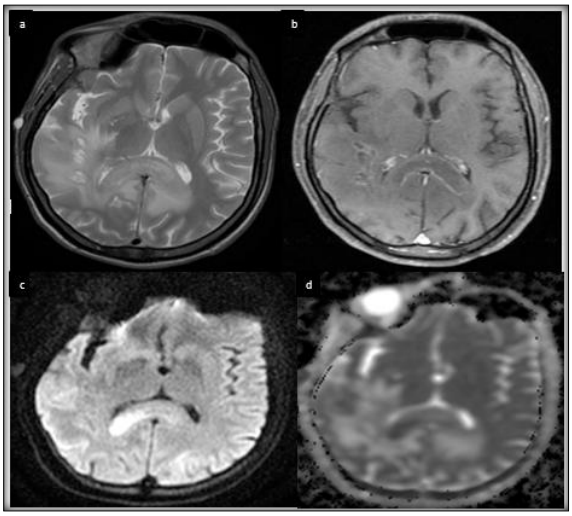

Figure 11: (a) T2 axial image shows heterogeneously hyperintense lesion in right occipital region with perilesional oedema, extending to the splenium of corpus callosum crossing midline. (b) T1 axial post contrast image shows peripheral enhancement of the lesion. (c) DWI and (d) corresponding ADC images show diffusion restriction with low ADC values. These features are likely suggestive of CNS lymphoma. Origin: Department of Radiology , Jorhat Medical College and Hospital, Jorhat , Assam , India 2025

Case 9: A 30 year old male presented with sudden severe headache , described as the worst headache of his life, accompanied by vomiting and blurred vision.

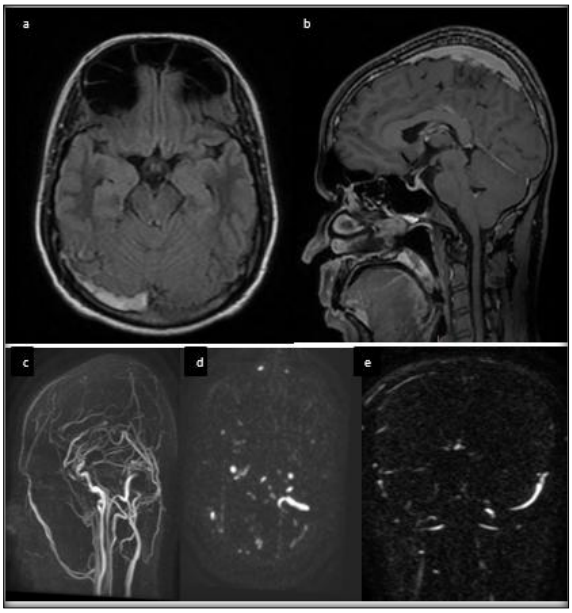

Figure 12: (a) T2 flair axial image shows hyperdense right transverse sinus and (b) sagittal T1 contrast image shows enhancing hyperdense superior sagittal sinus with loss of flow voids. (c,d,e) MR venogram images shows filling defect involving superior sagittal sinus, right sigmoid sinus and right transverse sinus. Features are suggestive of Dural venous sinus thrombosis. Origin: Department of Radiology , Jorhat Medical College and Hospital, Jorhat , Assam , India 2025

Case 10: A 54 year old woman presented with a sudden severe headache accompanied by nausea and vomiting. She reports of mild weakness since the event.

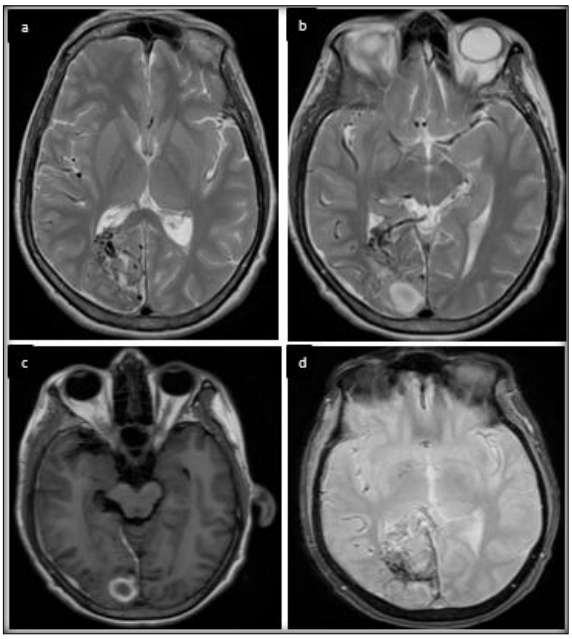

Figure 13: T2 axial images show multiple serpentine flow voids with a central nidus in right occipital lobe. Its feeding arteries are predominantly from branches of right posterior cerebral artery with draining veins to the vein of galen and rosenthal. Fig (a,b,c) shows extra-axial T2/T1 hyperintensities along the right temporo-occipital convexity and falx cerebri . An intra-axial T2 hyperintensity is noted in right occipital lobe showing peripheral T1 hyperintensity with central iso intensity . Axial GRE sequence shows susceptibility artefacts in the region . These features are suggestive of cerebral arterio-venous malformation with subdural haemorrhage and intraparenchymal haemorrhage in right occipital lobe. Origin: Department of Radiology , Jorhat Medical College and Hospital, Jorhat , Assam , India 2025

Case 11: A 55 year old male presented with a sudden intense headache described as "thunderclap", followed by vomiting and confusion.

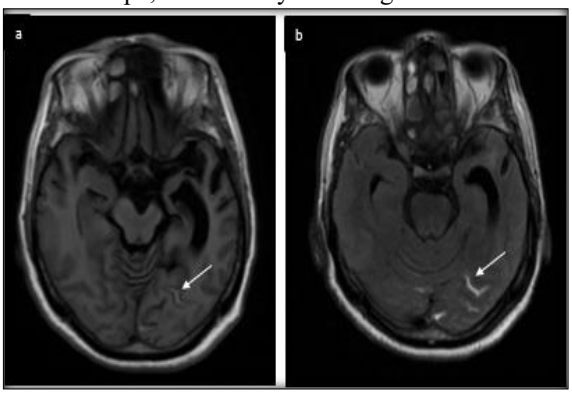

Figure 14: (a) T1 axial non contrast and (b) contrast images show T1 hyperintensities along sulcal spaces of left occipital lobe. These features are consistent with subarachnoid haemorrhage. Origin: Department of Radiology, Jorhat Medical College and Hospital, Jorhat , Assam , India 2025

DISCUSSION

MRI plays a crucial role in evaluating causes of headache, providing superior soft-tissue contrast and detailed visualization of intracranial structures.[7] It is indispensable in cases of suspected secondary headaches.[8] In our study, along with conventional sequences , additional sequences such as Diffusion – Weighted Imaging (DWI), Magnetic resonance Spectroscopy (MRS) and Magnetic Resonance Venography (MRV) were used.

In our cohort of 45 patients, 58% exhibited abnormal MRI findings which is similar to abnormal rates reported in some prior studies. A study from Nigeria observed abnormal findings in 52% of chronic headache patients, with sinusitis being the most common abnormality.[9] In Ethiopia, among 590 patients 49.2% had abnormal brain MRI findings , with clinically significant findings in 21% of cases, including tumours, infections and vascular abnormalities.[10]

Our slightly higher detection rate may be explained by the use of additional imaging modalities, particularly MR spectroscopy, MR Venogram which allowed for better lesion characterization.

Moreover, our findings align with other studies regarding the types of abnormalities detected. Sinusitis particularly maxillary sinus involvement is the most common pathology in our study consistent with findings from Nigeria and other countries. Our study identified several infective aetiologies including neurocysticercosis, tuberculoma, cerebral toxoplasmosis and cerebral abscesses along with neoplastic lesions such as meningioma, glioblastoma and lymphoma. Differentiating between these entities is crucial as management strategies differ substantially.

Similar to present study, in a study by Kim et al,[11] brain abscesses exhibited hyperintense signals on DWI .The central diffusion restriction is due to high viscosity and cellularity of purulent material within the abscess cavity.[11]

A study by Gupta et al,[12] showed that intracranial tuberculomas exhibit a prominent lipid lactate peak on MR spectroscopy , a finding attributed to the necrotic and caseating nature of these lesions,[12] which was seen in our study as well.

In the study by Horskà and Baker et al,[13] MR spectroscopy of Glioblastoma Multiforme revealed a significant increase in Choline levels accompanied by decreased N- acetyl aspartate (NAA) levels , similar to our study, reflecting increased membrane turnover and neuronal loss.[13]

In vascular category, subarachnoid haemorrhage, arteriovenous malformation and dural venous sinus thrombosis were identified in patients presenting with acute or thunderclap headache. In our study, the case of DVST demonstrated filling defect in the affected sinuses on MR venography confirming thrombosis. These findings are consistent with those described by Poon et al,[14] who noted that MR venography is highly effective in visualisation of non opacification of venous sinuses.[14]

These findings reinforce the idea that a tailored multimodal MRI approach can substantially enhance diagnostic yield in patients with headache.

CONCLUSION

MRI plays a vital role in the evaluation of patients presenting with headache, particularly in identifying secondary causes which may be missed on clinical assessment alone. In this study, a wide range of pathologies including sinonasal disease, infections, neoplasms and vascular abnormalities were detected, demonstrating diversity of underlying pathologies. The use of additional MRI sequences such as Diffusion Weighted Imaging, MR spectroscopy, MR Venography significantly enhanced diagnostic accuracy and lesion characterization. Incorporating these modalities into routine headache evaluation, especially in patients with atypical presentations or red flags can aid in early diagnosis, guide management decisions and prevent potential complications.

Acknowledgements: A special thanks to the staff of Department of Radiology, Jorhat medical college and hospital

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