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Case Study

MRI Evaluation of Different Types of Cerebral Metastases

Sangam Gupta[1*], Younus Syed Uz Zaman[2], Y. P. Sachdev[3]

[1]Postgraduate Resident, Department of Radiodiagnosis, Dr. Balasaheb Vikhe Patil Rural Medical College, Pravara Institute of Medical Sciences, Loni

[2]Postdoctoral fellow in Neuroimaging, Department of Radiodiagnosis, Dr. Balasaheb Vikhe Patil Rural Medical College, Pravara Institute of Medical Sciences, Loni

[3]Professor & Head, Department of Radiodiagnosis, Dr. Balasaheb Vikhe Patil Rural Medical College, Pravara Institute of Medical Sciences, Loni

Corresponding Author:
Dr. Sangam Gupta

Email:
sangam.gupta35@gmail.com

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Abstract:

Background: Cerebral metastases represent the most common intracranial tumors in adults and are associated with significant morbidity and mortality. Magnetic Resonance Imaging (MRI) is the imaging modality of choice for detection, characterization, and evaluation of brain metastases due to its superior soft-tissue contrast and multiparametric capabilities. **Aim:** To evaluate the MRI characteristics of different types of cerebral metastases and correlate their imaging features with the primary tumor origin. **Materials and Methods:** This retrospective descriptive case series included six patients with histopathologically or PET-CT–confirmed primary malignancies and radiologically diagnosed cerebral metastases. All patients underwent brain MRI, including conventional sequences, diffusion-weighted imaging, susceptibility-weighted imaging, and MR spectroscopy where applicable. Imaging features such as lesion location, signal characteristics, enhancement patterns, diffusion restriction, hemorrhage, necrosis, and perilesional edema were analyzed. **Results:** Cerebral metastases demonstrated variable MRI appearances depending on the primary tumor. Lung carcinoma metastases commonly showed cystic lesions with ring enhancement and disproportionate perilesional edema. Hemorrhagic metastases were identified on SWI, particularly in metabolically active lesions. Rare metastatic patterns, such as those from salivary gland tumors, showed extensive multifocal involvement. Diagnostic challenges were encountered in differentiating metastases from primary brain tumors and vascular lesions, especially in cases with mixed solid-cystic components. **Conclusion:** MRI provides critical diagnostic information in the evaluation of cerebral metastases. Recognition of characteristic imaging patterns and their correlation with primary malignancies can improve diagnostic accuracy, aid in differentiation from primary brain tumors, and guide appropriate patient management.

Keywords: Cerebral metastases; Magnetic Resonance Imaging; Brain metastasis; Contrast enhancement; Diffusion-weighted imaging; MR spectroscopy

Introduction:

Cerebral metastases are the most common intracranial neoplasms in adults, occurring in 15-40% of patients with cancer. Most common five primary tumours that account for brain metastases include lung cancer, renal cell carcinoma, breast cancer, melanoma and colorectal cancer.

Magnetic Resonance Imaging (MRI) plays a pivotal role in evaluating cerebral metastases, providing insights into lesion morphology, enhancement patterns, perilesional edema, and hemorrhagic or necrotic changes.

Different primary malignancies exhibit distinct neuroimaging features, which can aid in narrowing the differential diagnosis.

This study aims to systematically evaluate MRI findings in various types of cerebral metastases and correlate them with their primary tumor origins. By identifying imaging characteristics specific to different malignancies, we seek to enhance diagnostic accuracy and improve patient management strategies.

Aim & Objective

To evaluate the MRI characteristics of various types of cerebral metastases and correlate their imaging features with the primary tumor type.

Methods

Study Design - Retrospective descriptive case series

Study Population- Patients with histopathologically or PET CT confirmed primary malignancies and radiologically diagnosed cerebral metastases.

Inclusion criteria: Total 6 patients who underwent brain MRI for suspected or confirmed metastases.

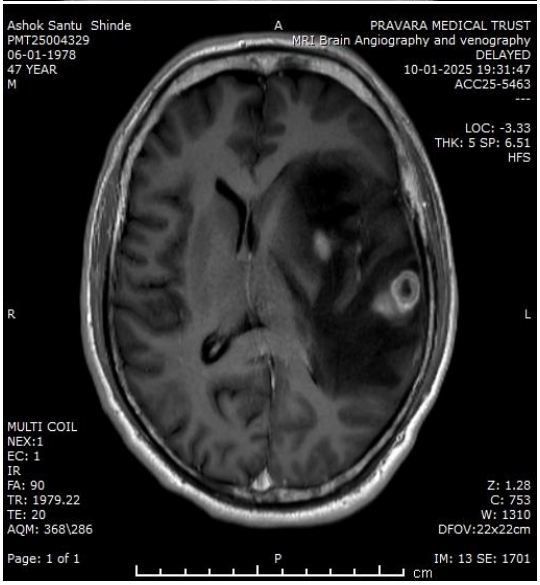
Exclusion criteria: Patients with incomplete imaging data or significant motion artifacts.

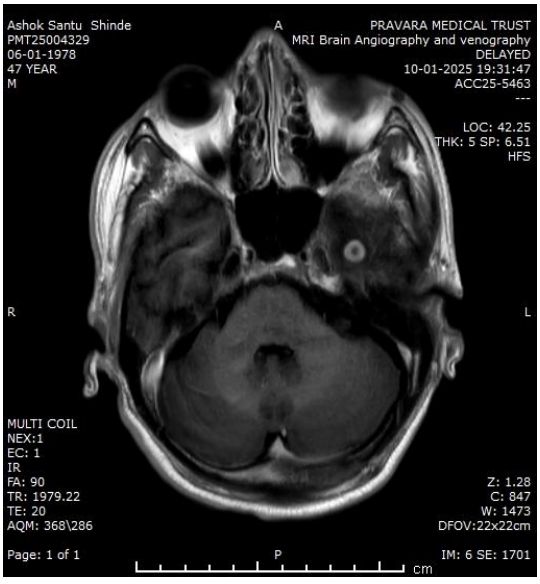
Case 1

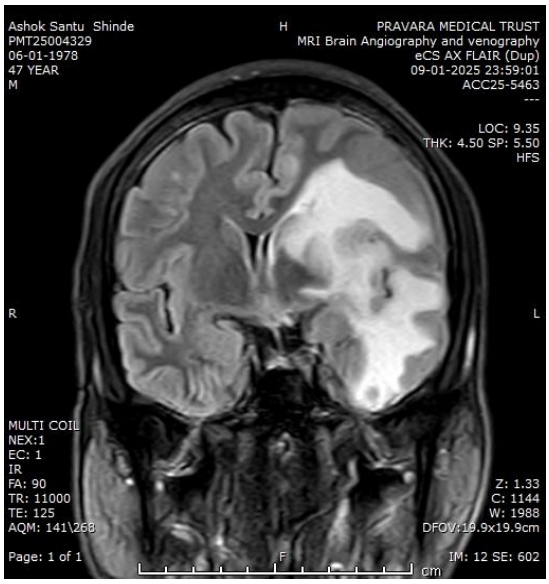
A 46-year-old male (smoker) with slurring of speech since 1 day.

Chest Xray- Solitary mass in left lung.

Needle guided biopsy of a lung mass revealed nonsmall cell lung cancer.







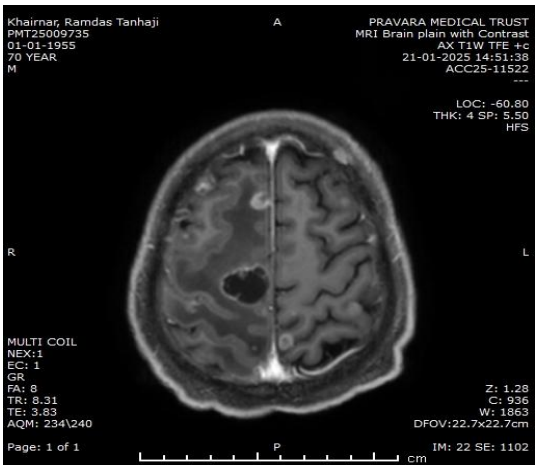
(A) T2W MRI – heterogeneously hyperintense
(B, C) T1W C+ (Delayed) – ring enhancing lesion with central non-enhancing areas
(D) FLAIR – disproportionate surrounding perilesional edema
Above findings are likely s/o Intraparenchymal cystic metastasis

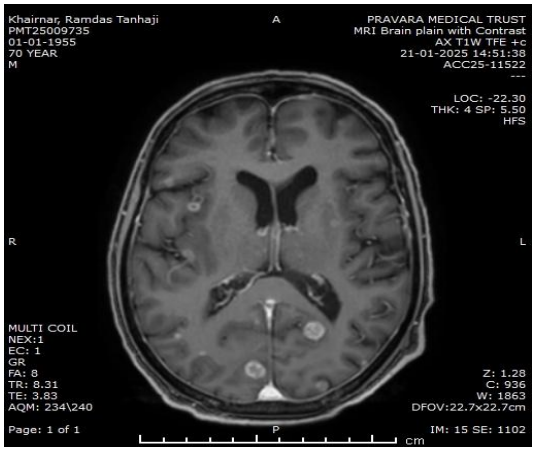
Case 2

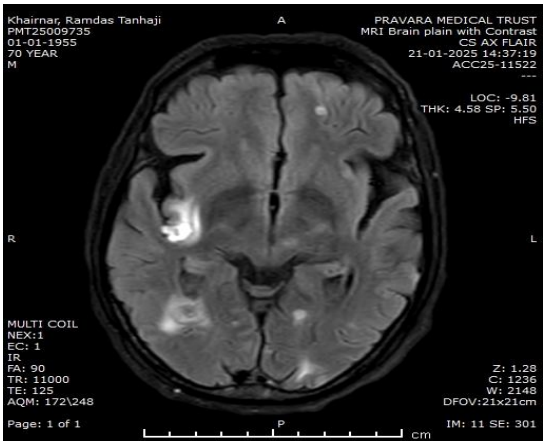
A 70-years-old male with left sided weakness since 3 days.

On Whole body PET CT (Thorax) - Heterogeneously enhancing well defined soft tissue density lesion involving posterior segment of left lower lobe - s/o METABOLICALLY ACTIVE PRIMARY MALIGNANCY.

(A)& (B) Postcontrast T1W - multiple nodular and peripheral rim enhancement
(C) FLAIR - perilesional edema in right fronto-parietal lobar region.
(D) SWI - shows blooming s/o Hemorrhage.



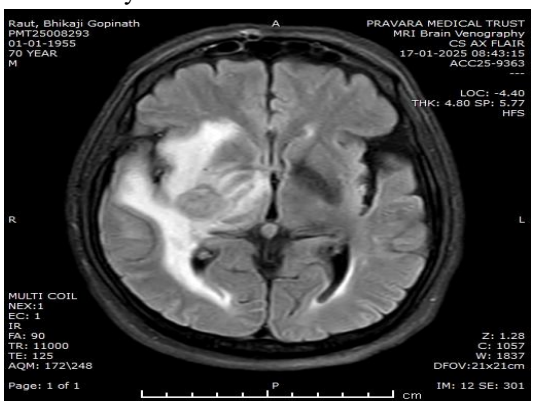




MR Spectroscopy- Choline peak at 3.2 ppm and abnormal elevated Cho/Cr ratio (2.86)

Case 3

A 70-years-old male operated for left parotid Warthins tumor came with new onset headache since 15 days.

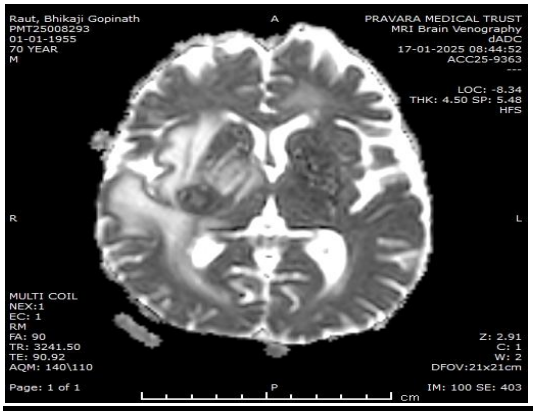


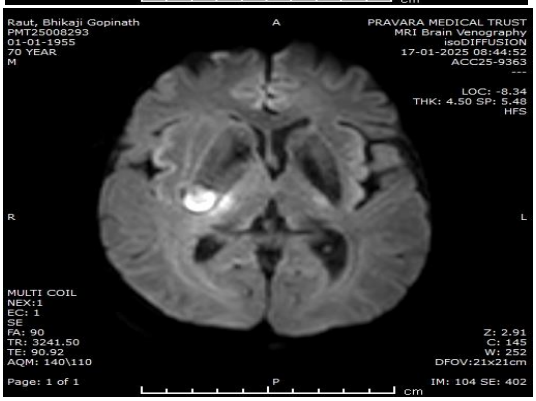
T2W - heterogeneously hyperintense

FLAIR - extensive perilesional edema involving right fronto-parieto-temporal lobes, left frontal lobe and genu of corpus callosum, bilateral cerebellar hemispheres and vermis

(C) Post contrast study - lesion in right capsuloganglionic region & left cerebellar hemisphere shows peripheral enhancement & the lesion in left frontal lobe shows solid enhancement.

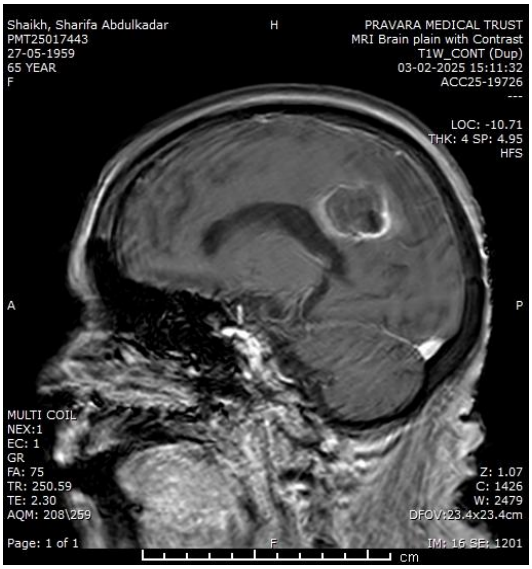
(D) & (E) DWI and ADC – Peripheral diffusion restriction.





Case 4

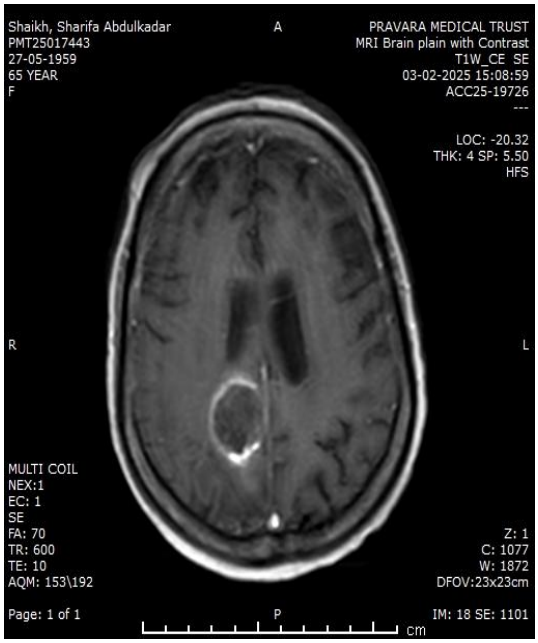
A 65-years-old female with endometrial cancer and weakness in all limbs
T1W – hypointense

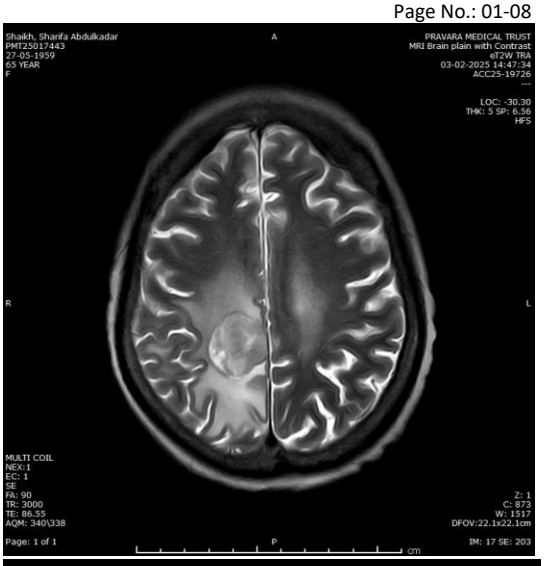


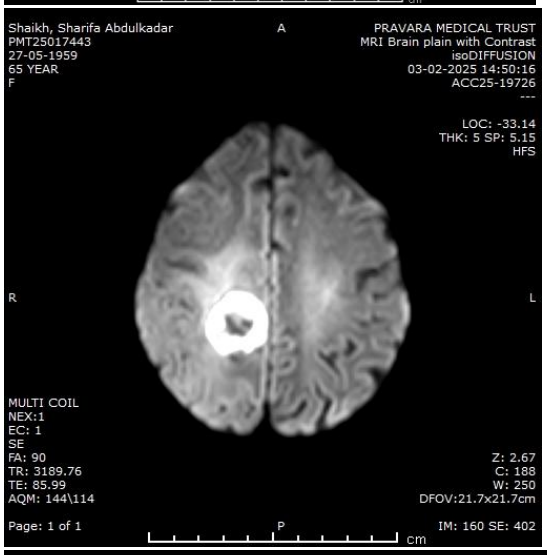
(A) T1W C+ - patchy peripheral enhancement

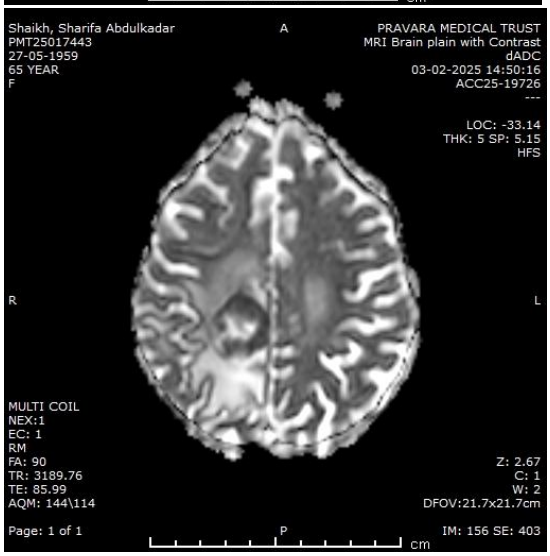
(B) T2W / FLAIR – heterogeneously hyperintense with surrounding perilesional edema.

(C) & (D) DWI and ADC – peripheral and patchy diffusion restriction
MR spectroscopy – inconclusive



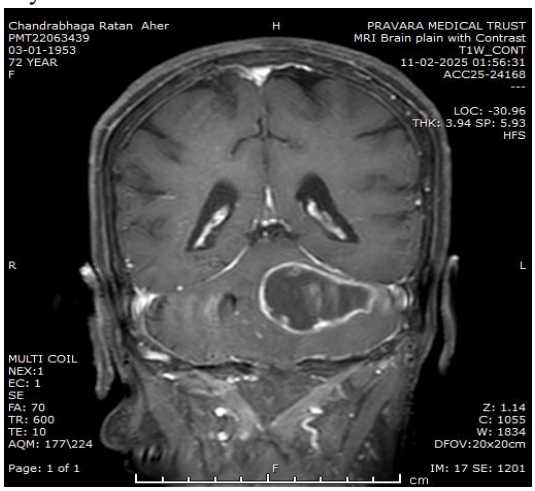


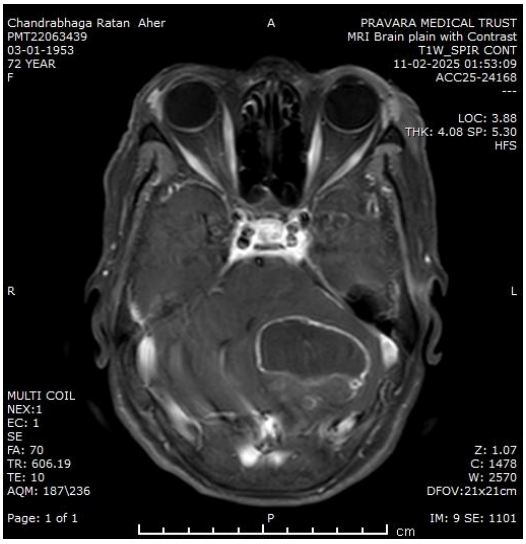


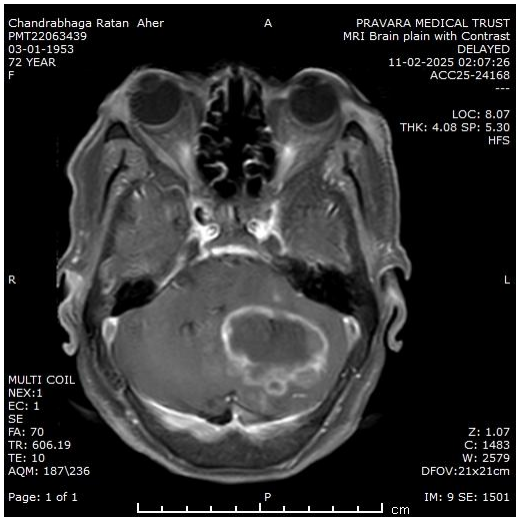


Case 5

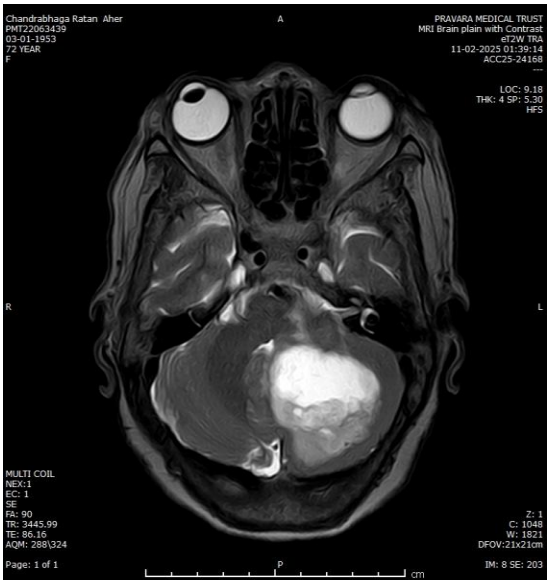
A 71-years-old female with giddiness since 10 days.

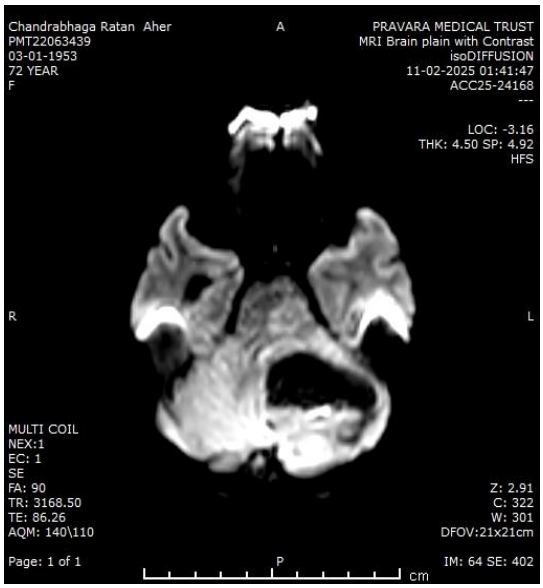






(A, B, C) T1W C+:
heterogeneous enhancement of solid component & peripheral enhancement of cystic component
(D) & (E) T2W and FLAIR – heterogeneously hyperintense with minimal perilesional edema
(F) & (G) DWI and ADC – Solid component shows tiny area of diffusion restriction & cystic component shows no diffusion restriction.
Solid cystic lesion in Left cerebellar hemisphere.
MR Spectroscopy – choline peak at 3.2 ppm
Differential diagnosis: Metastases or Hemangioblastoma



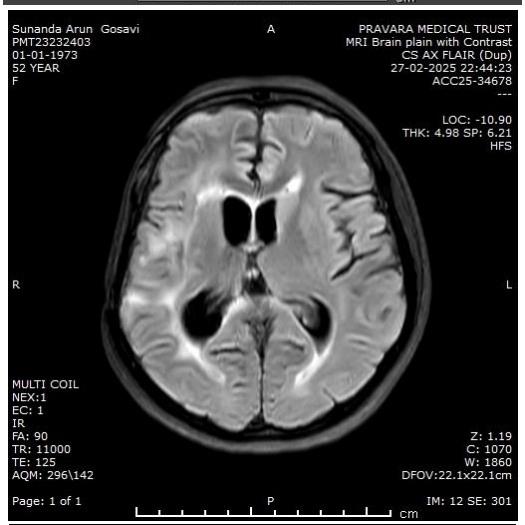


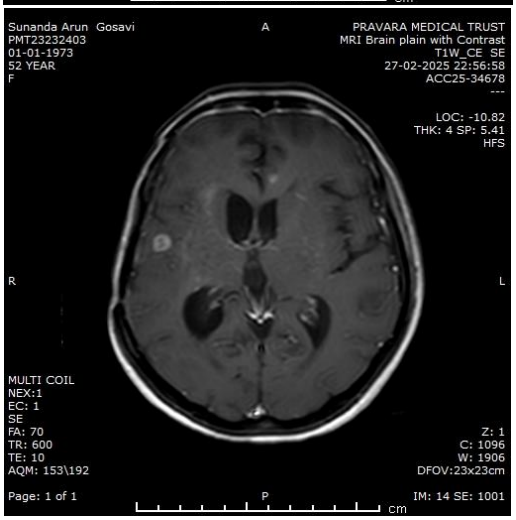
Case 6

A 52-years-old female operated for Glioblastoma Multiforme of right fronto-temporo-parietal region, now came with left sided weakness since 4 days.

(A, B) T1W C+ - homogenous enhancement and few peripheral enhancement with area of necrosis

(C) FLAIR – perilesional edema





Discussion

Metastases that classically haemorrhage include melanoma, renal cell carcinoma, choriocarcinoma and thyroid cancer. Both lung and breast cancers can also occasionally haemorrhage.
Case 1 (NSCLC metastasis) had a cystic appearance with ring enhancement, which can mimic abscesses or gliomas.
Case 5 had a lesion with both cystic and solid components, creating a diagnostic challenge in differentiating it from a hemangioblastoma. Most metastases are either solid or cystic, but a mix of both in the same patient is less common
(Case 3) Brain metastases from salivary gland tumors are rare, and their extensive distribution is an interesting finding.
(Case 6) Distinguishing recurrent GBM from metastases is complex, as both exhibit necrosis and contrast enhancement. However, GBM typically shows irregular, infiltrative margins, whereas metastases are often well-defined with a clear tumor-brain interface.

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