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Pineal Gland Metastasis from Gallbladder Adenocarcinoma with Leptomeningeal Dissemination: A Rare Radiological Presentation

Sachin Khanduri, K Prithvi Perumal*, Upasana Chatterjee, Sajida Ansari, Yash Milind Deole, Mameeza Azad

Department of Radiodiagnosis, Era's Lucknow Medical College & Hospital, Lucknow, India

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***Corresponding author:** K Prithvi Perumal, Department of Radiodiagnosis, Era's Lucknow Medical College & Hospital, Lucknow, India

ABSTRACT

Background: Metastatic lesions of the pineal gland are rare and account for a small percentage of intracranial secondary tumors. The most common primary sources include lung and breast carcinoma. Metastasis from gallbladder adenocarcinoma to the pineal region is exceptionally uncommon. When associated with leptomeningeal dissemination, it reflects advanced systemic spread and carries a poor prognosis.

Case Presentation: A 64-year-old male with a history of moderately differentiated gallbladder adenocarcinoma presented with diplopia, dizziness, upper limb paresthesias, and progressive weakness. MRI brain with contrast revealed a well-defined 10 × 10 mm homogeneously enhancing pineal mass (Figure 1A and 1B) with associated cerebellar folial and upper cervical leptomeningeal enhancement (Figure 1C). MR spectroscopy demonstrated elevated choline and reduced N-acetylaspartate peaks, supporting a malignant neoplasm (Figure 1D). No obstructive hydrocephalus was observed. Based on imaging characteristics and oncologic history, pineal metastasis with leptomeningeal carcinomatosis was strongly suspected.

Conclusion: Enhancing pineal lesions in elderly patients with known malignancy should raise suspicion for metastatic disease, particularly when accompanied by leptomeningeal enhancement. MR spectroscopy provides supportive metabolic evidence of malignancy. Early recognition of this rare metastatic pattern is essential for appropriate oncologic management.

Keywords: pineal metastasis, gallbladder carcinoma, leptomeningeal carcinomatosis, MR spectroscopy, brain MRI

INTRODUCTION

The pineal gland is an uncommon site for metastatic disease, accounting for approximately 0.4-3.8% of intracranial metastases in autopsy studies [1]. Primary pineal tumors such as germ cell tumors and pineal parenchymal tumors are more frequently encountered in this region. Secondary involvement most commonly arises from lung carcinoma, breast carcinoma, melanoma, and renal cell carcinoma [2].

Gallbladder adenocarcinoma is an aggressive hepatobiliary malignancy characterized by early lymphovascular invasion and systemic dissemination [3]. Central nervous system (CNS) metastases are rare and usually occur late in the disease course. Pineal gland involvement is particularly unusual, with very few reported cases.

Leptomeningeal carcinomatosis results from tumor cell dissemination through cerebrospinal fluid pathways and is associated with advanced systemic disease and poor prognosis [4]. MRI with contrast is the imaging modality of choice for detection, while MR spectroscopy may assist in differentiating neoplastic from non-neoplastic processes [5].

We report a rare case of pineal gland metastasis from gallbladder adenocarcinoma with associated leptomeningeal dissemination, emphasizing imaging findings and diagnostic considerations.

CASE PRESENTATION

A 64-year-old male presented with complaints of diplopia and dizziness of two weeks' duration. He also described tingling sensations in the upper limbs, mild upper limb weakness, intermittent vomiting, and back pain. He reported a fall several months earlier.

His medical history was significant for moderately differentiated adenocarcinoma of the gallbladder treated surgically one year prior. There was a history of unintentional weight loss over the preceding three months.

On examination, blood pressure was 150/90 mmHg. Neurological evaluation revealed diplopia without lower limb motor deficits.

MRI Findings

MRI brain with contrast demonstrated a well-defined 10 × 10 mm lesion in the pineal region. The lesion appeared isointense on T2-weighted sequences and showed intense, homogeneous post-contrast enhancement (Figure 1A to D). Mild mass effect on the adjacent tectal plate was noted without evidence of significant obstructive hydrocephalus.

Diffuse enhancement along the cerebellar folia and upper cervical leptomeninges was observed (Figure 1C), suggestive of leptomeningeal spread.

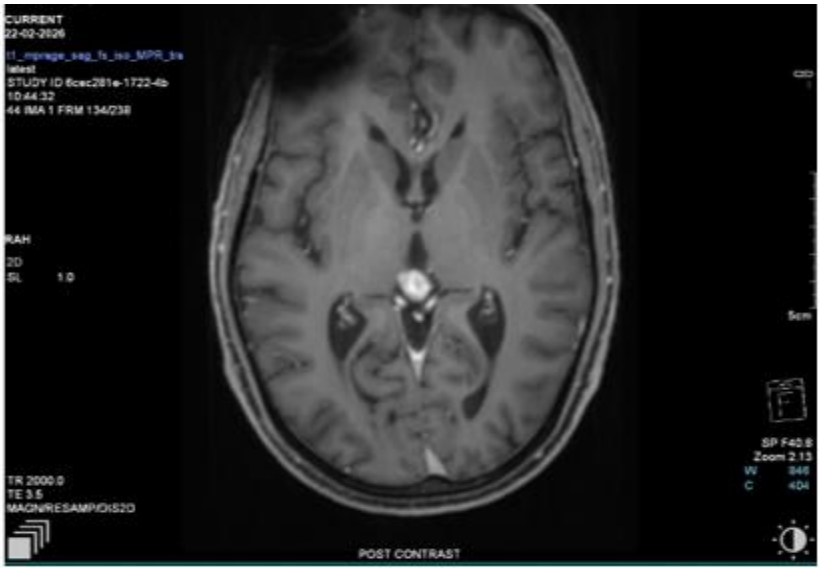

Figure 1A: Axial post-contrast T1-weighted MPRAGE image showing homogeneously enhancing pineal mass.

No additional intra-axial enhancing lesions were identified. Diffusion-weighted imaging showed no restricted diffusion. Ventricular size and configuration were preserved.

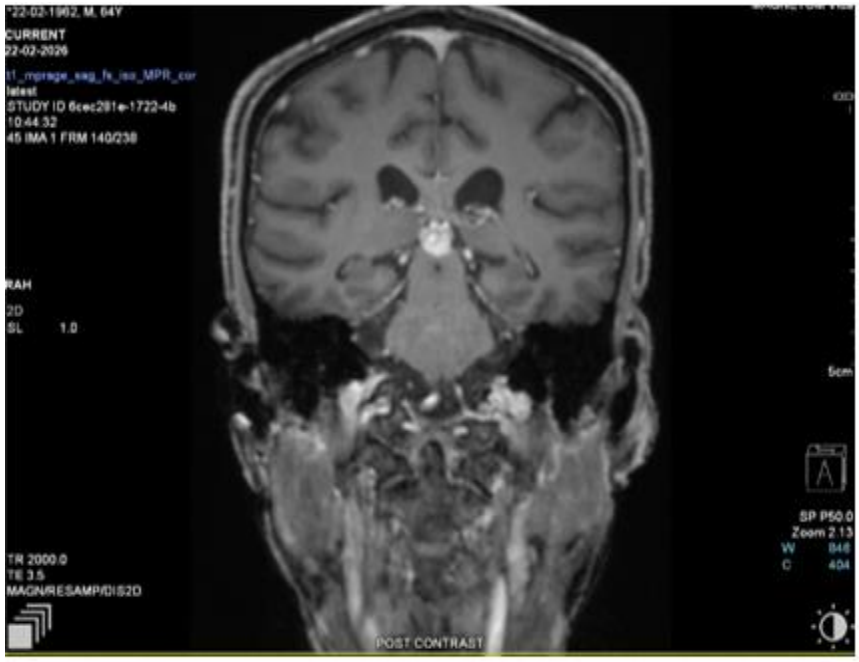

Figure 1B: Coronal post-contrast MPRAGE image demonstrating pineal enhancement

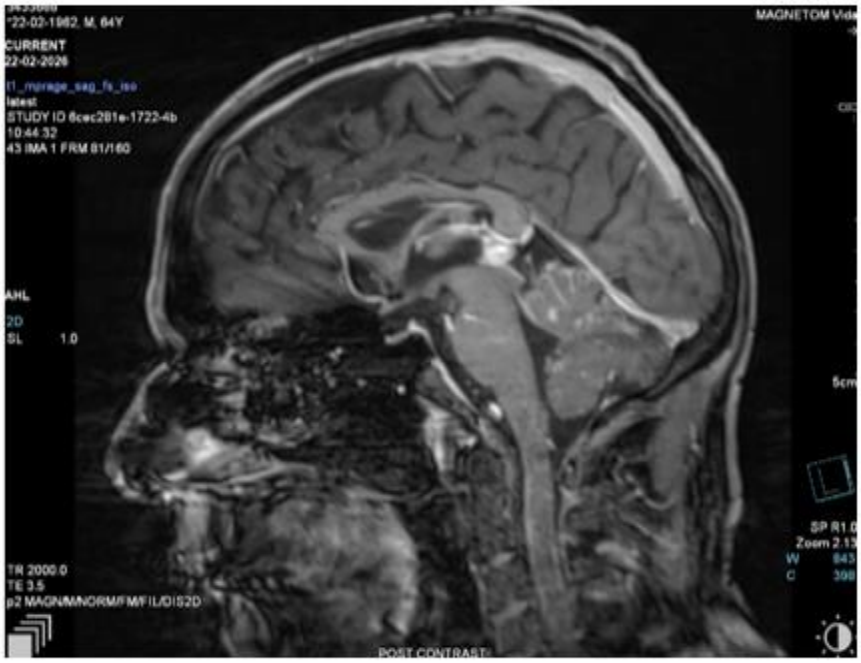

Figure 1C: Sagittal post-contrast image showing pineal lesion with mild tectal compression and cerebellar folial leptomeningeal enhancement.

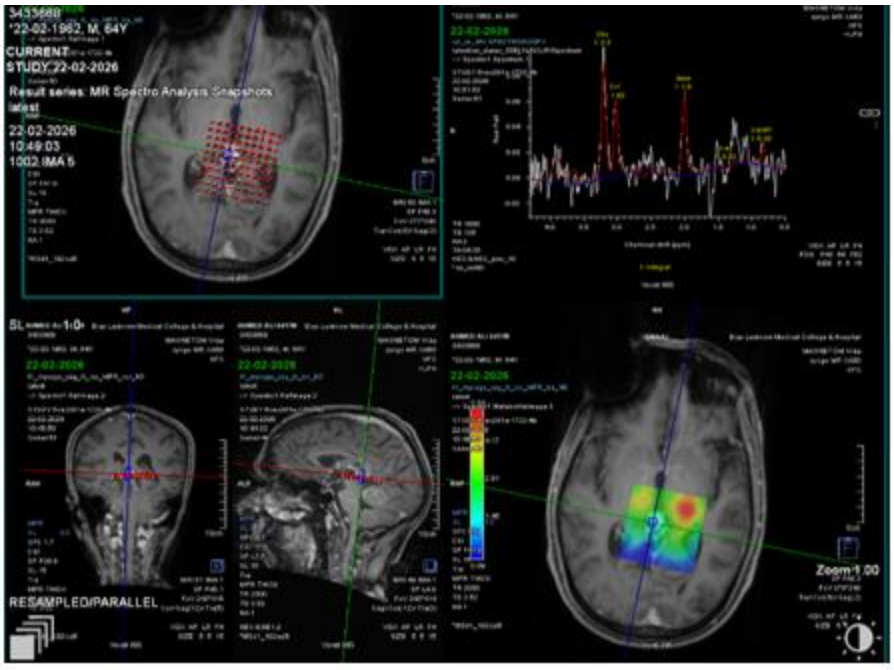

Figure 1D: MR spectroscopy demonstrated elevated choline levels with reduced N-acetylaspartate (NAA)

MR Spectroscopy

Single-voxel MR spectroscopy obtained from the pineal lesion demonstrated elevated choline levels with reduced N-acetylaspartate (NAA), indicating increased membrane turnover and neuronal compromise consistent with malignancy.

Radiological Impression

Enhancing pineal mass with associated leptomeningeal enhancement. In the context of known gallbladder adenocarcinoma, metastatic disease with leptomeningeal dissemination was considered most likely. Granulomatous disease remained a differential consideration.

Written informed consent was obtained from the patient.

DISCUSSION

Pineal metastases are rare due to the small size of the gland, although its rich vascular supply theoretically permits hematogenous spread [1]. Lung and breast carcinomas are the most common sources [2]. Gastrointestinal malignancies account for a minority of cases.

Gallbladder carcinoma predominantly spreads to the liver, lymph nodes, and peritoneum [3]. Brain metastases are uncommon and usually reflect advanced disease. Pineal involvement is exceedingly rare and indicates hematogenous dissemination.

Leptomeningeal carcinomatosis occurs in approximately 5% of patients with solid tumors [4]. MRI findings typically include diffuse sulcal, basal cisternal, cranial nerve, or spinal leptomeningeal enhancement. In this case, cerebellar folial and upper cervical leptomeningeal enhancement strongly suggested CSF-mediated tumor spread.

The differential diagnosis for enhancing pineal lesions includes pineocytoma, pineoblastoma, germinoma, lymphoma, meningioma, metastasis, and granulomatous diseases such as tuberculosis or sarcoidosis [6].

Several features favored metastasis in this case:

- Advanced patient age
- Known systemic malignancy
- Small solid homogeneously enhancing lesion
- Concomitant leptomeningeal enhancement
- Spectroscopy demonstrating elevated choline and reduced NAA

MR spectroscopy plays a supportive role in lesion characterization. Elevated choline reflects increased cellular proliferation, while reduced NAA indicates neuronal loss or displacement, typical of malignant tumors [5].

The absence of obstructive hydrocephalus suggests early detection before significant aqueductal compression. Recognition of this rare metastatic pattern is critical because it influences therapeutic strategy and prognosis.

Primary pineal parenchymal tumors, including pineocytoma and pineoblastoma, represent important differentials. Pineocytomas are typically well-circumscribed, slow-growing lesions seen in younger adults and may show mild to moderate enhancement with cystic components. Pineoblastomas are more aggressive, usually occurring in pediatric populations, and often demonstrate heterogeneous enhancement, necrosis, hemorrhage, and diffusion restriction due to high cellularity. In contrast, the present case involved an elderly patient with a small, homogeneously enhancing lesion without necrosis or diffusion restriction. Furthermore, the presence of diffuse leptomeningeal enhancement favors metastatic dissemination rather than an isolated primary pineal neoplasm.

Granulomatous conditions such as tuberculosis and sarcoidosis must also be considered, particularly in endemic regions. Tuberculous lesions frequently demonstrate central caseation with T2 hypointensity and ring enhancement, sometimes with diffusion restriction. Sarcoidosis typically presents with multifocal meningeal or cranial nerve involvement and associated systemic findings. In this case, the lesion showed uniform avid enhancement without central necrosis, and MR spectroscopy revealed elevated choline with reduced N-acetylaspartate, indicating increased cellular turnover consistent with malignancy. The patient's known history of gallbladder adenocarcinoma further supported metastatic disease over inflammatory etiologies

CONCLUSION

Pineal gland metastasis from gallbladder adenocarcinoma is extremely rare. When accompanied by leptomeningeal enhancement, it indicates advanced systemic dissemination.

In elderly patients with a history of malignancy, a homogeneously enhancing pineal lesion should raise strong suspicion for metastasis. MR spectroscopy findings of elevated choline and reduced NAA further support malignant etiology.

Early identification of this uncommon presentation facilitates timely oncologic referral and appropriate management.

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