THE JOURNAL OF DIAGNOSTIC AND THERANOSTIC IMAGING [TheJODTi]

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Detection of an Isolated Solitary Brain Metastasis from Colon Adenocarcinoma via 18F-FDG PET/CT: A Rare Case and It's Multimodal Management

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Abstract

Background: Brain metastasis (BM) is observed in approximately 0.3–3.2% of cases involving metastatic colon cancer and is almost invariably associated with extracranial dissemination. The occurrence of isolated intracranial disease in the absence of systemic metastases is, therefore, exceedingly rare.

Case presentation: We report a 74 year-old female who presented with new-onset focal seizures 18 months after curative surgery for stage IIIC sigmoid adenocarcinoma. The 18Fluorine fluorodeoxyglucose positron emission tomography/computed tomography (18F- FDG PET/CT) scan revealed increased 18F-FDG uptake in an 18x19 mm hyperdense lesion located in the right temporal lobe, accompanied by a substantial edematous region in the surrounding area (SUV max:8.0) but no abnormal 18F-FDG accumulation elsewhere, confirming isolated BM. Brain Magnetic Resonance Imaging (MRI) revealed a 28x30 mm contrast-enhancing lesion in the right temporal lobe with vasogenic edema. The patient underwent gross-total resection followed by adjuvant stereotactic radiosurgery (SRS, 18 Gy single fraction). Histopathology showed metastatic moderately-differentiated colon adenocarcinoma (CK20+, CDX-2+, CK7+, P53+). Post-operative capecitabine plus bevacizumab was given for six cycles. At 12-month follow-up the patient remains disease-free on surveillance MRI and 18F-FDG PET/CT.

Conclusion: This case illustrates the diagnostic value of 18F-FDG PET/CT in excluding extracranial disease and supports an aggressive local-therapy strategy (surgery ± SRS) for solitary colon adenocarcinoma BM, which may confer prolonged survival.

Keywords: colon cancer, solitary brain metastasis, 18F-FDG PET/CT.

Received 31 May; Accepted 18 June; Published 27 June 2025

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Cite: Bıçakcı N, Batı F. Detection of an Isolated Solitary Brain Metastasis from Colon Adenocarcinoma via 18F-FDG PET/CT: A Rare Case and It's Multimodal Management. TheJODTi. 2025;1(1):1-4. https://doi.org/10.5455/TheJODTi.1606.2404

Introduction

Brain metastases (BM) occur in only 0.3 – 3.2% of patients with colorectal cancer (CRC) and in approximately 1% of those presenting with metastatic disease (1,2). When present, these metastases are almost invariably associated with liver and/or lung metastases; genuinely solitary intracranial disease accounts for less than 2% of cases (2). In carefully selected patients, aggressive local therapy, such as surgery with or without stereotactic radiosurgery (SRS), can extend median overall survival (OS) from 4 – 8 months to 12 – 24 months (3). We describe an exceptional case of isolated brain metastasis from previously resected CRC detected via PET/CT and discuss diagnostic and therapeutic considerations in light of contemporary evidence.

Case Presentation

A 74-year-old female was disease-free after laparoscopic anterior resection for pT4a pN2b M0 (stage IIIC) sigmoid adenocarcinoma and adjuvant FOLFOX. Two years later the patient developed focal motor seizures of the left upper limb. There was no headache, visual disturbance, or systemic symptom.

Neurological exam showed subtle left pronator drift; Karnofsky Performance Status was 90. No stigmata of extracranial recurrence were present.

Modality Findings Interpretation

The patient underwent whole-body 18F-fluorodeoxyglucose positron emission tomography/computed tomography (18F-FDG PET/CT) imaging using a Siemens Biograph mCT 64-slice PET/CT scanner (Siemens Healthcare, Erlangen, Germany) following 6 hours of fasting and intravenous injection of 296 MBq (8.0 mCi) of 18F-FDG. Blood glucose prior to injection was 108 mg/dL. Imaging was initiated 60 minutes post-injection, with acquisition from vertex to mid-thigh. PET images were reconstructed with an iterative algorithm and fused with low-dose non-contrast CT for attenuation correction and anatomical localization.

The PET/CT demonstrated increased 18F-FDG uptake in a hyperdense lesion measuring 18x19 mm in the right temporal lobe (maximum standardized uptake value (SUVmax: 8.0), surrounded by marked vasogenic edema. No other areas of abnormal FDG accumulation were noted, suggesting an isolated brain metastasis (Figure 1). Subsequent contrast-enhanced magnetic resonance imaging (MRI) of the brain confirmed a 28x30 mm heterogeneously enhancing mass in the right temporal lobe with perilesional edema and midline shift of approximately 2 mm.

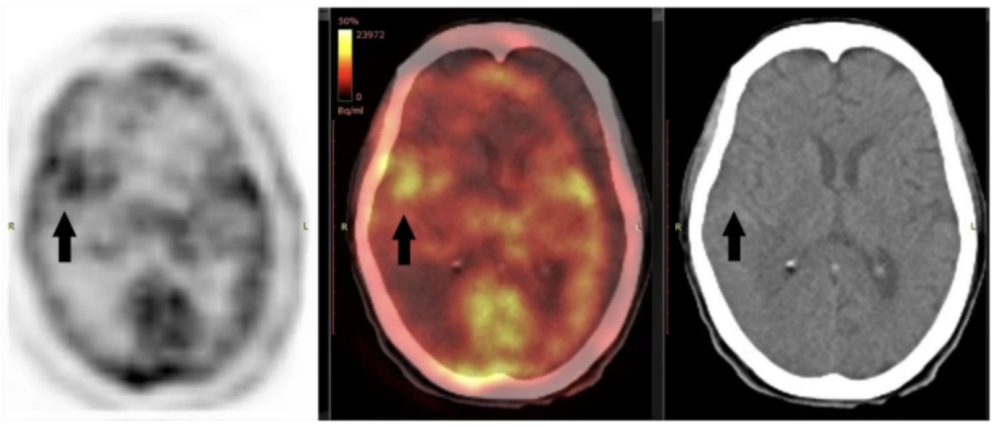

Figure 1. *The axial CT (right), fused (middle), and PET (left) brain images of brain-included whole-body FDG PET/CT showing right temporal lesion (black arrow) that appears as a subtle hypodense area in CT with max SUV 8.0. The primary tumor turned out to be colon adenocarcinoma*

Surgical intervention was performed using neuronavigation-guided right temporal craniotomy with gross total resection of the lesion. Histopathological analysis of the resected brain lesion confirmed metastatic moderately-differentiated adenocarcinoma of colorectal origin. Immunohistochemistry demonstrated strong positivity for cytokeratin 20 (CK20), caudal-type homeobox 2 (CDX-2), and p53, while cytokeratin 7 (CK7) was negative, consistent with colorectal phenotype. Molecular profiling identified a KRAS exon 2 mutation (c.35G>T; p.G12V), identical to the mutation previously detected in the primary tumor. Due to tissue limitations, extended RAS (NRAS), BRAF, and microsatellite instability (MSI) analyses could not be performed on the brain metastasis specimen. Nevertheless, the recurrence was managed as KRAS-mutant, microsatellite-stable colorectal cancer. Notably, KRAS exon 2 mutation (c.35G>T; p.G12V) was detected, consistent with the primary colorectal tumor. NRAS, BRAF, and microsatellite instability (MSI) analyses were not performed due to limited tissue.

Postoperative adjuvant stereotactic radiosurgery (SRS) was delivered to the resection cavity using a LINAC-based system (Elekta Versa HD, Stockholm, Sweden) with a single-fraction dose of 18 Gy prescribed to the 80% isodose line, conformally shaped around the surgical bed using a volumetric arc technique. Dose constraints for critical structures (e.g., optic nerves, brainstem) were respected according to international radiosurgery planning protocols.

The patient then received systemic chemotherapy with capecitabine (1,250 mg/m² orally twice daily on days 1–14 of a 21-day cycle) plus intravenous bevacizumab (7.5 mg/kg every 3 weeks) for a total of six cycles. Tolerability was good, and no dose reductions were required.

Follow-up included serial brain MRI at 3, 6, and 12 months and a repeat whole-body PET/CT at 12 months, all of which showed no evidence of recurrence or extracranial disease (Figure 2).

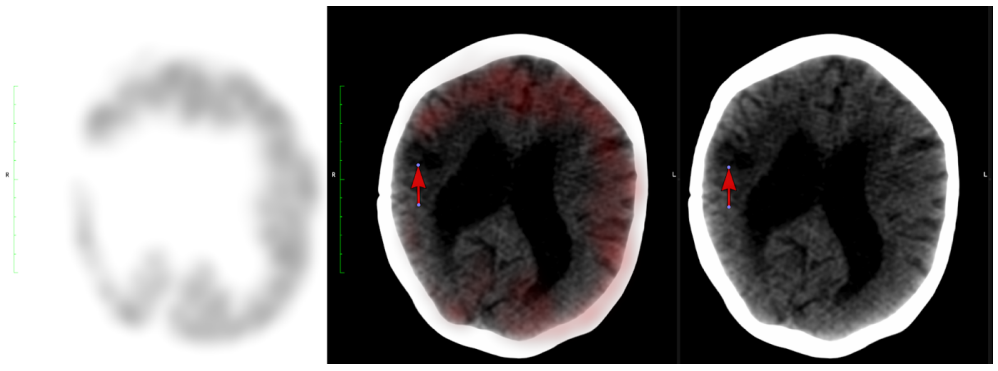

Figure 2. *The axial CT (right), fused (middle), and PET (left) brain images obtained from a whole-body FDG PET/CT scan, which included the brain, indicate that the patient underwent a gross-total resection followed by adjuvant stereotactic radiosurgery (SRS, 18 Gy single fraction).*

During the 24-month disease-free interval following initial curative surgery, the patient underwent a structured surveillance program, which included contrast-enhanced abdominal and thoracic CT every 6 months and measurement of serum carcinoembryonic antigen (CEA) levels every 3 months. CEA values remained within normal range (≤5 ng/mL) throughout the follow-up period. No radiological or biochemical evidence of recurrence was detected until the onset of new neurological symptoms, which prompted further evaluation with PET/CT and brain MRI as detailed above.

Discussion

Epidemiology and routes of spread

Extensive population-based datasets indicate that brain metastases (BM) occur in ≤3% of colorectal cancer (CRC) patients, typically manifesting at a later stage (1). Systematic reviews reveal that less than 2% of these patients present with truly isolated intracranial disease (2). Identified risk factors include younger age, right-sided primary tumors, KRAS or HER2 alterations, and, most significantly, concurrent pulmonary metastases (4). While hematogenous dissemination via the pulmonary arterial "filter-and-seed" mechanism is prevalent, venous reflux through Batson's valveless vertebral plexus can bypass the lungs, accounting for rare solitary BM cases, as observed in our patient (5). Early isolated presentations have also been documented in single-institution case reports, highlighting the necessity for neurological vigilance even when systemic imaging results are negative (15).

Imaging considerations

Contrast-enhanced MRI continues to be the gold standard for intracranial staging. Whole-body 18F-FDG PET/CT, despite its high physiological cortical uptake, is crucial for the exclusion of occult extracranial disease, thereby supporting the justification for curative-intent local therapy (6). Emerging tracers such as 18F Fluoroethyltyrosine (18F-FET) and Gallium-68 prostate-specific membrane antigen (68Ga-PSMA), along with hybrid Positron Emission Tomography/Magnetic Resonance Imaging (PET/MRI,) have the potential to enhance lesion detection and improve the differentiation between radiation necrosis and recurrence (6).

In our case, the initial neurological assessment included a non-contrast cranial computed tomography (CT), which revealed a hyperdense lesion in the right temporal lobe suggestive of a space-occupying lesion. Given the patient's history of stage IIIC colorectal adenocarcinoma and absence of systemic symptoms, an 18F-FDG PET/CT scan was promptly performed to assess for possible systemic disease recurrence and to determine whether the intracranial lesion was part of a disseminated metastatic process. PET/CT findings revealed an isolated hypermetabolic lesion in the brain without evidence of extracranial FDG-avid disease, thus supporting the decision to pursue curative-intent local therapy. Cranial magnetic resonance imaging (MRI) was subsequently obtained for superior anatomical delineation and radiotherapy planning. This imaging sequence reflects a pragmatic approach wherein PET/CT served both diagnostic and staging purposes in a single modality, especially in a patient with previously treated systemic malignancy presenting with new neurological symptoms.

Management strategies

Given the relative radio- and chemo-resistance of colorectal cancer brain metastases (CRC BM), the recommended approach for solitary lesions in patients with adequate fitness is maximal safe resection followed by focal radiotherapy. A meta-analysis conducted in 2022, encompassing 1,438 patients, demonstrated superior overall survival (OS) for metastasectomy compared to radiotherapy alone, with a hazard ratio of 0.53 (7). Multicenter series on stereotactic radiosurgery report 12-month local control rates approaching 80% when marginal doses of ≥25 Gy are administered (8,9). Retrospective data comparing single-fraction SRS (median 20 Gy) with multi-fraction SRS indicate comparable local control and toxicity, thereby offering flexibility in dose-fractionation for radio-resistant colorectal histology (17).

Post-operative whole-brain radiotherapy (WBRT) is currently designated for cases involving multiple lesions or leptomeningeal disease. Randomized trials have demonstrated that WBRT offers equivalent survival outcomes but results in greater neuro-cognitive toxicity compared to postoperative stereotactic radiosurgery (10). The current EANO–ESMO guidelines similarly advocate for postoperative cavity SRS or hypofractionated stereotactic radiotherapy over routine WBRT to preserve neuro-cognitive function in patients with resected solitary metastases (16). Systemic therapy generally aligns with standard metastatic colorectal cancer (mCRC) regimens. Retrospective studies suggest that capecitabine, oxaliplatin, and bevacizumab exhibit some activity within the central nervous system, with bevacizumab providing a modest overall survival benefit (11–13). Additionally, HER2-amplified colorectal cancer may respond to tucatinib-based combinations, and immune-checkpoint inhibition is under investigation for tumors deficient in mismatch repair (14).

Prognosis

Independent predictors of extended survival include the presence of a single brain metastasis (BM), a Karnofsky Performance Status (KPS) greater than 70, a controlled primary tumor and extracranial disease, and an interval exceeding 12 months from the initial colorectal cancer (CRC) diagnosis (2,4,12). Our patient met all these favorable criteria and remains disease-free 12 months following multimodal therapy.

Future directions

Prospective trials are needed to define optimal systemic partners for local therapy and to refine SRS dose-fractionation schemes for radio-resistant colorectal histology. Molecular PET tracers hold promise for earlier detection and response assessment.

Conclusion

This case highlights the pivotal role of whole-body ^{18}F-FDG PET/CT in the accurate staging of colorectal cancer patients presenting with new neurological symptoms, enabling exclusion of extracranial metastases and identification of an isolated brain lesion. Combined with contrast-enhanced MRI, PET/CT guided an aggressive local-therapy approach—gross-total surgical resection followed by stereotactic radiosurgery—resulting in durable intracranial control and a favorable 12-month, disease-free outcome. Immunohistochemical and molecular analysis confirmed colorectal origin and informed postoperative systemic therapy. Although exceedingly rare, solitary brain metastasis from colon adenocarcinoma should be considered in patients with focal neurological deficits and normal conventional systemic imaging. Early utilization of hybrid metabolic-anatomical imaging supports curative-intent interventions that may significantly prolong survival and preserve neurological function in this select patient population.

Ethical Approval: *All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.*

Conflict of Interests: *The authors declare that there is no conflict of interest in the study.*

Financial Disclosure: *The authors declare that they have received no financial support for the study.*

Informed Consent: *Informed consent was obtained from all individuals participants included in the study.*

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