



## PET Clinics

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# The Role of PET/CT in Radiation Oncology for Central Nervous System Tumors

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## Section snippets

### Key points

- PET is increasingly used for brain tumors to aid in diagnosis, prognostication, evaluation of extent of disease, treatment planning, and response assessment. ...
- Somatostatin receptor PET has established a role in assessment and treatment planning for meningioma, while amino acid PET continues to be evaluated for glioma. ...

- Histology-specific PET tracers may help guide care of patients with brain metastases, while other tracers may help differentiate progressive tumor from necrosis and treatment effects. ...

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## Diagnostic role of PET/CT

PET imaging of brain tumors has been an active area of research for nearly 50 years.<sup>2</sup> Despite this fact, PET imaging is only now beginning to be regularly used for brain tumor assessment in the United States. In coming years, it is anticipated that PET imaging will continue to find greater use in a wide variety of brain tumors, including gliomas, meningiomas, and intracranial metastatic disease.

Fluorodeoxyglucose (FDG) is the prototypical PET agent and is widely used both for CNS imaging of ...

## Gliomas

Well-established predictors of outcomes for patients with glioma include tumor histology, molecular tumor characteristics, and patient characteristics.<sup>8,9</sup> More recently, the volume of tumor as measured by PET imaging has demonstrated prognostic value.<sup>10,11</sup> For patients with high-grade glioma, studies of directed biopsy and surgical resection demonstrate tumor extension outside of visualized regions on anatomic T1-weighted contrast-enhanced MR imaging.<sup>12, 13, 14, 15</sup> The biologic relevance of ...

## Role of PET/CT in guiding radiation treatment for glioma

The implementation of advanced PET imaging for tumor targeting with radiation therapy among patients with newly diagnosed GBM has been successfully undertaken in recent phase I and II clinical trials. Across these studies, a consistent finding is the extension of disease outside of tumor identified using anatomic MR imaging alone. In studies incorporating advanced MR imaging techniques such as perfusion and diffusion MR imaging, the advanced PET and advanced MR imaging are complementary, ...

## Role of PET for glioma response assessment in neuro-oncology

Post-treatment surveillance for patients with GBM relies on radiographic response assessment using conventional, anatomic imaging techniques. The updated Response Assessment in Neuro-

Oncology (RANO) criteria have been widely used in contemporary clinical trials to enable comparison of outcomes between studies.<sup>50</sup> These criteria rely on conventional T1-weighted contrast enhanced and T2-weighted/fluid-attenuated inversion recovery (FLAIR) MR images, and specifically recognize the limitations of ...

## Response assessment for brain metastases

A significant challenge in the management of patients with brain metastasis is the differentiation of adverse radiation effects and true tumor progression. Standard anatomic MR imaging and reliance on volumetric changes is inaccurate and insufficient in determining tumor progression. Advanced imaging techniques such as dynamic susceptibility contrast MR imaging, DCE MR imaging, and MR spectroscopy are additional imaging modalities that have been used to improve the sensitivity and specificity ...

## Diagnostic utility of PET in identifying disease recurrence and therapeutic utility in guiding glioma reirradiation

Gliomas have the tendency to recur locally, often necessitating reirradiation which is accompanied by several challenges. First, it is difficult to distinguish between recurrent tumor and effects of prior treatment. Second, treatment volumes should incorporate limited margins beyond gross disease to minimize toxicity, as risks are increased with larger volumes in the setting of prior radiation.<sup>62</sup> Third, recurrences can include biologically relevant nonenhancing progressive tumor that could be ...

## Future directions

Moving forward, investigations focusing on the individualization and refinement of radiation treatment planning using advanced PET techniques are in development across a range of benign and malignant CNS tumors. Adaptation of radiation during the course of treatment is the focus of a number of ongoing studies, and implementation of PET imaging represents a potential opportunity to interrogate the temporal evolution of tumor during treatment. Validation of its utility in improving the ...

## Clinics care points

- PET imaging is increasingly utilized for the diagnosis, assessment of disease extent, radiation treatment planning, and response assessment of select benign and malignant central nervous system (CNS) tumors. ...
- DOTATATE PET aids in the assessment and radiation target delineation for meningioma, and has been incorporated into guidelines. ...

- The role of amino acid PET for the assessment and radiation treatment of newly diagnosed and recurrent glioma remains a promising area of active investigation. ...

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 ...  
 ...

**Disclosure**

M.M. Kim receives research funding from Blue Earth Diagnostics, United Kingdom. D.R. Johnson has served on advisory boards for Telix Pharmaceuticals, Novartis, and Collectar Biosciences. W.G. Breen has participated in consulting/advisory boards for GE Healthcare and Miltenyi Biotech, with funds paid to the institution. ...

**First page preview**

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**KEYWORDS**

- PET • Amino acid PET • Radiotherapy • CNS • Brain tumor

**KEY POINTS**

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- Histology-specific PET tracers may help guide care of patients with brain metastases, while other tracers may help differentiate progressive tumor from necrosis and treatment effects.

**INTRODUCTION**

The role of PET imaging in the management of patients with central nervous system (CNS) tumors has reached a promising juncture. Beyond its diagnostic utility, PET imaging is emerging as a tool to guide multidisciplinary management and next-generation precision radiotherapy. Its prognostic and predictive capabilities have the potential to inform the timing, sequencing, and intensification of local therapy platforms across benign and malignant CNS tumors.<sup>1</sup> Increased utilization of PET imaging for CNS tumors in the United States in both routine care and clinical trials attests to its growing role in neuro-oncology, across the spectrum of diagnosis, treatment, and surveillance.

with MR imaging in identifying and treating biologically relevant tumor in glioblastoma (GBM), the most aggressive primary CNS malignancy, as well as recent clinical trials assessing the role of PET as an integral imaging biomarker to guide patient-specific radiotherapy. We review its potential role in enhancing response assessment to multimodality therapy and to guide earlier and more accurate decision-making regarding adjuvant or salvage treatment of patients with CNS tumors. Finally, we discuss promising future directions of research aimed at maximizing the potential applications for advanced PET modalities in the multidisciplinary care of the neuro-oncology patient.

**DIAGNOSTIC ROLE OF PET/CT**

In this review, we overview the diagnostic roles of PET modalities for CNS tumors, and the evidence of its prognostic and predictive significance among the most common as well as rarer malignant and benign CNS tumors. We compare PET modalities

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