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Challenges, Limitations and Pitfalls of PET and Advanced MRI in Patients with Brain Tumors – A Report of the PET/RANO Group

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Abstract

Brain tumor diagnostics have significantly evolved with the use of PET and advanced MRI techniques. In addition to anatomical MRI, these modalities may provide valuable information for several clinical applications such as differential diagnosis, delineation of tumor extent, prognostication, differentiation between tumor relapse and treatment-related changes, and the evaluation of response to anticancer therapy. In particular, joint recommendations of the RANO group, the EANO, and major European and American Nuclear Medicine societies highlighted that the additional clinical value of radiolabeled amino acids compared to anatomical MRI alone is outstanding and that its widespread clinical use should be supported. For advanced MRI and its steadily increasing use in clinical practice, the Standardization Subcommittee of the Jumpstarting Brain Tumor Drug Development Coalition provided more recently an updated acquisition protocol for the widely used dynamic susceptibility contrast perfusion MRI. Besides amino acid PET and perfusion MRI, other PET tracers and advanced MRI techniques (e.g., MR spectroscopy) are of considerable clinical interest and are increasingly integrated into everyday clinical practice. Nevertheless, these modalities have shortcomings which should be considered in clinical routine. This comprehensive review provides an overview of potential challenges, limitations and pitfalls associated with PET imaging and advanced MRI techniques in patients with gliomas or brain metastases. Despite these issues, PET imaging and advanced MRI techniques continue to play an indispensable role in brain tumor management. Acknowledging and mitigating these challenges through interdisciplinary collaboration, standardized protocols, and continuous innovation will further enhance the utility of these modalities in guiding optimal patient care.

Keywords: CEST; MR spectroscopy; amino acid PET; diffusion-weighted imaging; perfusion-weighted imaging.