Clinical Trial J Neurooncol. 2026 Oct 14;180(1):20. doi: 10.1007/s11060-026-05831-w.

Volumetric discordance between ^{18}F-FET-PET/MRI and MRI-based radiotherapy target volumes in high-grade glioma: a prospective pilot study (FETSMaRT)

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PMID: 42875659 DOI: 10.1007/s11060-026-05831-w

Abstract

Purpose: High-grade gliomas carry a poor prognosis, and MRI-based radiotherapy (RT) planning may inadequately capture metabolically active tumor infiltration. ^{18}F-fluoroethyl-tyrosine (FET) PET provides superior tumor delineation, yet prospective North American evidence supporting integration with RT planning remains limited.

Methods: FETSMaRT enrolled 30 patients with WHO grade 3 or 4 high-grade glioma receiving post-operative RT. FET-PET/MRI was acquired before RT with the radiation oncologist blinded to PET, enabling retrospective quantification of discordance between MRI-based and FET-PET/MRI-derived gross tumor (GTV), clinical target (CTV), and planning target (PTV) volumes. In the glioblastoma subgroup (n = 23), Kaplan-Meier and Cox analyses related GTV and CTV discordance to time to progression.

Results: Median age was 60 years; 77% had glioblastoma and 60% MGMT promoter methylation. GTV discordance occurred in 17/30 patients (56.7%) and CTV discordance in 15/30 (50.0%). FET-PET/MRI-derived volumes significantly exceeded MRI-based volumes for GTV (43.6 vs. 38.6 cc; $p < 0.0001$), CTV (119.2 vs. 110.8 cc; $p = 0.0045$), and PTV (171.1 vs. 159.6 cc; $p = 0.0003$). Larger GTVΔ and CTVΔ change values were associated with numerically shorter median time to progression, but neither association was statistically significant. Radiation treatment failures were predominantly central (60.0%).

Conclusion: FET-PET/MRI-derived target volumes were significantly larger than MRI-based volumes, confirming systematic underestimation of metabolically active tumor extent by anatomical MRI. While not meeting significance in this pilot study, directional CTV and GTV discordance suggests a possible association with progression; the hypothesis generating exploratory pilot data nonetheless justify a prospective trial of FET-PET-guided RT in high-grade glioma. NCT06499831.

Keywords: 18F-FET-PET; Glioblastoma; High-grade glioma; Radiotherapy planning.

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