Purpose: To evaluate the impact of adding 18F-FDOPA-PET, an amino acid tracer, to standard of care MRI for radiotherapy target volume delineation for gliomas.

Methods: 6 patients with newly diagnosed brain tumors were given 5.0 mCi +/- 10% of 3,4-dihydroxy-6-[18F]-fluoro-L-phenylalanine (18F-FDOPA), and underwent a 10-minute PET/CT acquisition. Overall pathology confirmed WHO grade 3 astrocytoma (n=3), grade 3 oligoastrocytoma (n=1), and glioblastoma (n=2). T1-weighted post gadolinium (T1-gad) and T2-weighted/FLAIR MRI sequences were rigidly aligned to the 18F-FDOPA-PET/CT. Three experienced radiation oncologists contoured the T2/FLAIR abnormality, T1-gad enhancement, and areas of 18F-FDOPA uptake separately. An experienced nuclear medicine physician contoured 18F-FDOPA uptake, which was considered as the gold standard for positive disease on PET imaging. Intersection, union, and exclusion boolean operators were performed to determine discordance and concordance between MRI and 18F-FDOPA-PET, along with interobserver variability defining 18F-FDOPA-PET volume. In addition, uniform expansions of the T1-gad contours were performed in increments of 0.5 cm until 100% of the 18F-FDOPA-PET volume was covered.

Results: 18F-FDOPA-PET uptake was observed in all patients, with interobserver delineation variability between radiation oncologists (RadOnc1-RadOnc3) and the gold standard ranging from 47% less to 191% more volume. On average 9.5% (0.3%-29.1%) of the 18F-FDOPA-PET gold standard volume extended beyond the RadOnc T2/FLAIR volumes. Half of the cases had no enhancement, and of the remainder on average 77.8% (61.3%-93.1%) of the 18F-FDOPA-PET volume extended outside the T1-gad enhancement. An average expansion of 2.0cm (1.0cm–5.0cm) beyond the T1-gad contours was necessary to cover 100% of the 18F-FDOPA-PET volume.

Conclusions: This work introduces the potential utilization of 18F-FDOPA-PET for identifying positive disease not visible with conventional MRI and the potential to customize radiotherapy target volumes to the active disease. Future studies will correlate pathology with concordant and discordant regions, and compare biopsy confirmed results with automatic segmentation techniques for 18F-FDOPA-PET.

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