Deep learning PET/CT-based algorithm for estimating tumor burden in metastatic melanoma patients under immunotherapy

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AI has revolutionized radiation oncology

Artificial intelligence (AI) I has helped enhancing tumor and organ identification, treatment planning, and response prediction, with deep learning (DL) models **improving efficiency and saving time**[1,2]. Manual tumor segmentation remains labor-intensive, but automated methods offer significant time savings, though challenges persist, especially with tumors' size variability and complex anatomy. These issues are more pronounced in metastatic diseases like melanoma, where tumor heterogeneity complicates segmentation. **This study evaluates a novel PET-based DL software** *(PARS, Siemens Healthineers)* for detecting and delineating metastatic melanoma lesions and estimating tumor burden, marking the largest cohort for tumor burden quantification in metastatic melanoma and providing valuable insights into AI's role in radiation oncology.

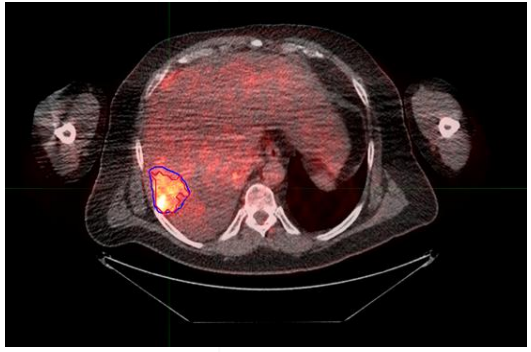

Figure 1. Example of PET/CT scan with expert and PARS segmentations

This study assessed AI-powered lesion detection

This retrospective study included 173 stage IV melanoma patients treated with either single or dual checkpoint inhibitors between 2013 and 2019 at the Comprehensive Cancer Center Zurich. Patients were excluded if they lacked imaging data, had brain-only metastases, or had lesions smaller than 0.5cc. Imaging was conducted with 18F-FDG PET/CT at baseline, 3 months, and 6 months post-treatment. **Lesion segmentation was performed manually by clinicians and compared with automated segmentation using the PET-Assisted Reporting System (PARS).** The accuracy of PARS was assessed by comparing its segmentations with expert annotations, evaluating precision, recall, and tumor burden estimation through statistical metrics. Performance differences by anatomical site and the impact of probability thresholds were analyzed, and a Bland-Altman analysis assessed agreement between manual and automated methods.

Location	Recall	Precision
All	70.3%	49.1%
Lymph node	73.2%	49.6%
Bone	74.8%	33.6%
Liver	**81.4%**	48.6%
Lung	59.4%	**75.4%**

Table 1. Precision and recall of the PARS model

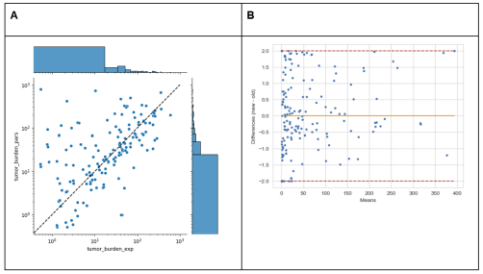

Figure 2. Tumor burden estimation; Note: A – Scatter plot of tumor burden estimates; B – Bland-Altman plot of the relative differences in tumor burden.

PARS shows promise, but needs improvement

The PARS model had a recall of 70.3% but lower precision (49.1%) with high false positives, especially in bone lesions. Tumor burden estimation showed moderate correlation (r=0.31) but overestimated values, particularly in smaller lesions. **The study suggests improvements with multi-modal imaging and advanced AI techniques**, aiming for more accurate, semi-automated workflows, yet PI-powered tools need further refinement.

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