Assessing the Reproducibility of MRI Radiomics for Predicting PIB PET SUVR

Mehrnoosh Karimipourfard[1,2], Nicole Lofroth[1,2], Abhari Limbu[1,2], M. Ethan MacDonald[1-4]

[1] Department of Biomedical Engineering, University of Calgary, Calgary, Alberta, Canada, [2]Hotchkiss Brain Institute, University of Calgary, Calgary, Alberta, Canada, [3] Department of Electrical and Software Engineering, University of Calgary, Calgary, Alberta, Canada, [4]Department of Radiology, University of Calgary, Calgary, Canada

2026 JULY 19–22 VANCOUVER, BC
JOINT AAPM | COMP MEETING

ABSTRACT

Purpose: MRI-based radiomics offers a PET-free approach for estimating amyloid burden but remains limited by feature instability and variable model performance. This study developed a stability-driven MRI radiomics framework for predicting global PiB PET SUVR.

Methods: Cortical MRI radiomic features were extracted from paired MRI and PiB PET scans (GAAIN, 50–70 min). Feature stability was evaluated using 300 bootstrap iterations with Random Forest importance ranking, and only consistently stable features were retained. Model performance was assessed using nested cross-validation and independent validation.

Results: Stability analysis identified a compact set of reproducible cortical texture and shape biomarkers while eliminating unstable features. The final model achieved strong predictive performance (R^2 = 0.842, MAE = 0.142 SUVR) and demonstrated increased prediction variability only at higher amyloid burden.

Conclusion: Stability-aware feature selection substantially improved the robustness and reproducibility of MRI-based amyloid SUVR prediction. These findings support MRI radiomics as a promising PET-free approach for amyloid screening and emphasize feature stability as a prerequisite for clinically reliable radiomics biomarkers.

CONTACT

- *Mehrnoosh Karimipourfard, PhD (Postdoctoral Research Fellow)*
- *Department of Biomedical Engineering, University of Calgary*
- *mehrnoosh.karimipour@ucalgary.ca*

INTRODUCTION

- Amyloid PET is the clinical reference standard for assessing cerebral β-amyloid deposition in Alzheimer's disease. However, widespread clinical implementation is limited by high cost, restricted availability, and ionizing radiation.
- Structural MRI is routinely acquired in clinical practice and contains quantitative imaging information related to neurodegenerative changes. Radiomics can exploit these data by extracting high-dimensional intensity, shape, and texture descriptors.
- A major challenge in MRI radiomics is ensuring feature stability and reproducibility, as unstable feature selection can lead to overfitting and poor model generalizability.
- **We propose a stability-driven MRI radiomics framework for accurate PiB PET SUVR prediction using reproducible imaging biomarkers, demonstrating reproducible performance across the GAAIN and OASIS-3 cohorts.**

METHODS AND MATERIALS

1. Study Cohorts
- GAAIN: Model development and internal evaluation.
- OASIS-3: Independent replication using the same radiomics framework.

2. Image Processing
- MRI preprocessing, cortical GM segmentation, PET-to-MRI registration, and global PiB PET SUVR calculation.
- Radiomics: Cortical shape, first-order, and texture features extracted using PyRadiomics.

3. Model Development
- Feature stability: 300 bootstrap iterations using selection frequency and Random Forest feature importance.
- Prediction model: Leakage-controlled Random Forest regression with nested cross-validation and independent hold-out testing.

4. Performance Evaluation
- Global PiB PET SUVR and corresponding Centiloid values evaluated using R^2 and MAE.

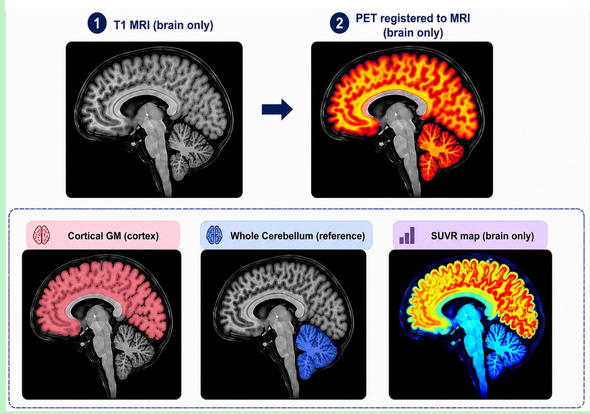

Figure 1. MRI and PiB PET preprocessing pipeline with cortical and cerebellar ROIs.

RESULTS

- Stable biomarkers: Bootstrap-based feature stability analysis identified a small but highly reproducible set of cortical MRI radiomic biomarkers, dominated by first-order intensity, shape, and GLRLM texture features.
- GAAIN performance: The stability-selected biomarkers enabled accurate prediction of global PiB PET SUVR in the development cohort (R^2 = 0.842, MAE = 0.142 SUVR), with the highest accuracy observed at lower amyloid burden.
- OASIS-3 cohort: The proposed framework achieved strong predictive performance in the independent OASIS-3 cohort (R^2 = 0.777, MAE = 0.069), demonstrating good agreement and minimal systematic bias.
- Key predictors: Texture, shape, and first-order radiomic biomarkers dominated model performance, with GLRLM ShortRunLowGrayLevelEmphasis, Shape SurfaceVolumeRatio, and First-order Kurtosis identified as the most influential features.

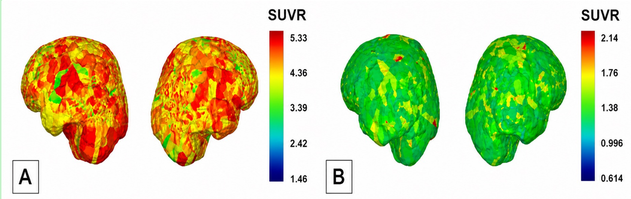

Figure 2. Representative PiB PET SUVR maps: AD (A) and YC (B).

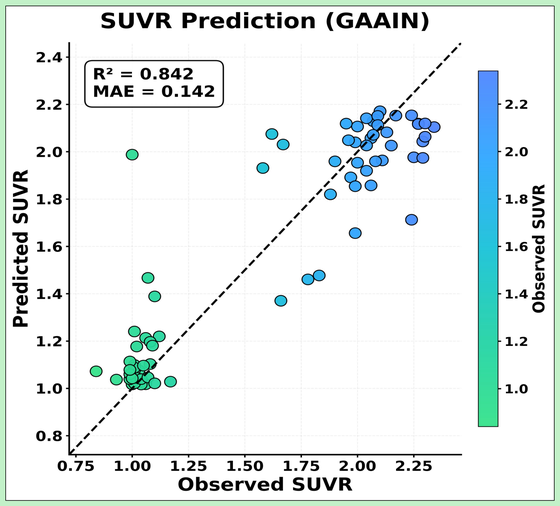

Figure 3. Global PiB PET SUVR prediction (GAAIN cohort).

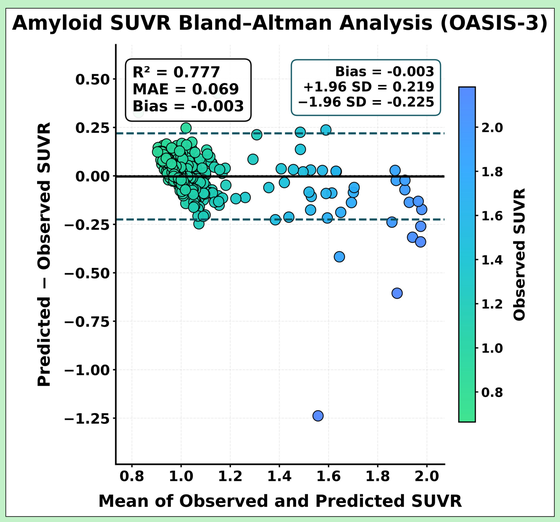

Figure 4. Bland–Altman plot of PiB PET SUVR prediction in OASIS-3.

DISCUSSION

- The proposed stability-driven framework improved the reproducibility and external generalizability of MRI radiomics for predicting global PiB PET SUVR.
- Application of the proposed framework to the independent OASIS-3 cohort demonstrated robust prediction with strong agreement and minimal bias.
- Texture and shape related radiomic biomarkers consistently provided the greatest contribution to model prediction, highlighting their value as reproducible imaging signatures of amyloid burden.
- Although prediction variability increased at higher amyloid burden, the framework remained robust, supporting further validation in larger multi-center cohorts.
- **These findings highlight feature stability as a prerequisite for reliable MRI radiomics and support MRI as a promising PET-free tool for amyloid screening.**

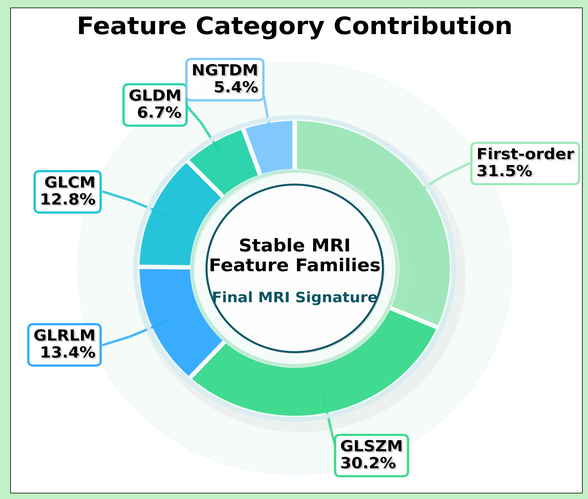

Figure 5. Contribution of radiomic feature families to the final MRI signature (OASIS-3).

CONCLUSIONS

- A stability-driven MRI radiomics framework achieved accurate and reproducible prediction of global PiB PET SUVR from structural MRI.
- Stable cortical radiomic biomarkers enhanced model robustness and generalized successfully to the independent OASIS-3 cohort.
- Feature stability is essential for reliable MRI radiomics and supports MRI as a scalable, PET-free tool for amyloid screening and Alzheimer's disease assessment.

REFERENCES

1. Karlsson L, Vogel J, Arvidsson I, et al. Machine learning prediction of tau-PET in Alzheimer's disease using plasma, MRI, and clinical data. Alzheimers Dement. 2025;21(2):e14600.
2. Goenka N, Tiwari S. Deep learning for Alzheimer prediction using brain biomarkers. Artif Intell Rev. 2021;54(7):4827–4871.