Automated VMAT2 [18F]AV-133 PET analysis in Parkinson's Disease

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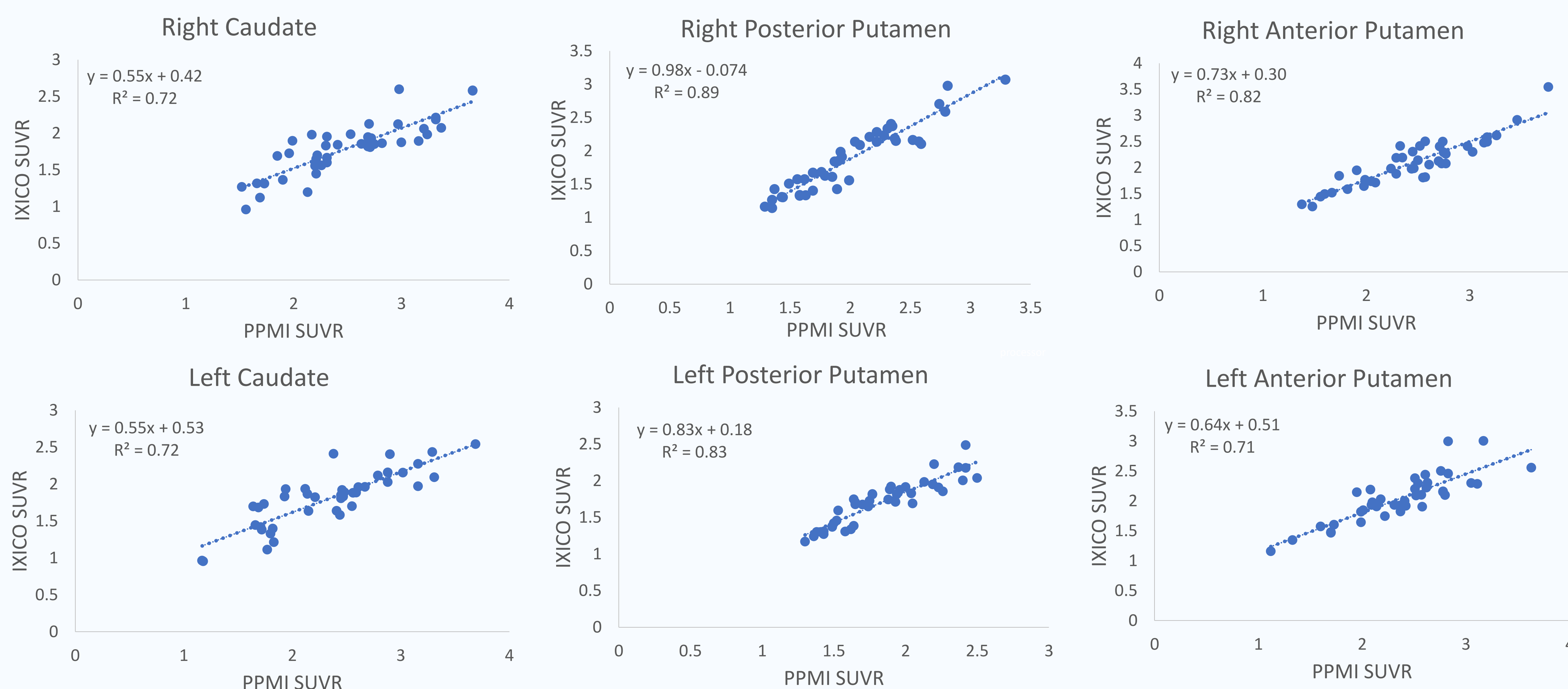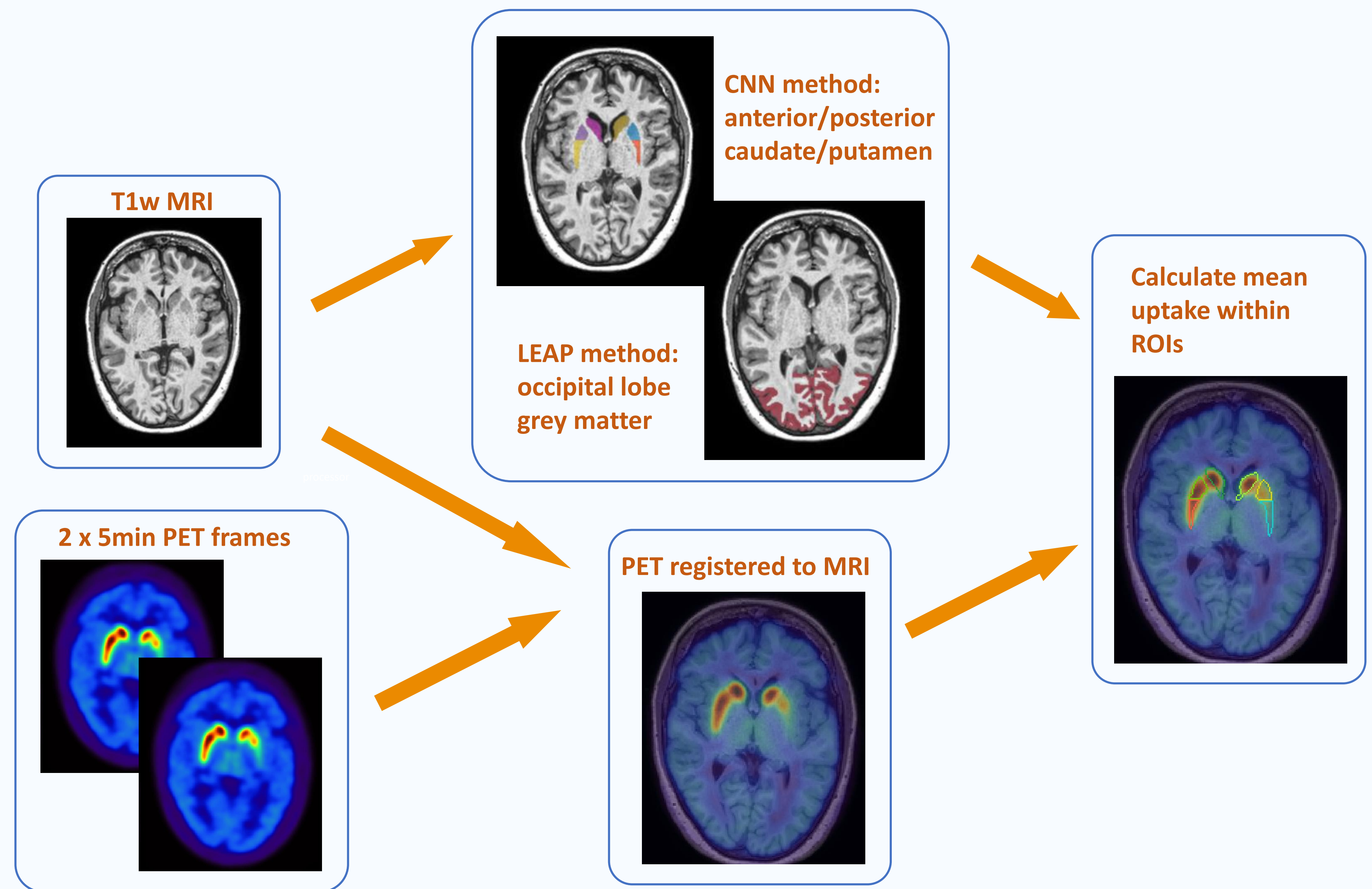
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IXICO

Objective

- To evaluate a **fully automated** image analysis pipeline to process **vesicular monoamine transporters type 2 (VMAT2) [18F]AV-133 tracer positron emission tomography (PET) images**, by comparison with a methodology requiring manual intervention.

Background

- VMAT2 is a presynaptic protein that regulates package and release of dopamine and other monoamines into the synaptic vesicles.
- Nigrostriatal pathway integrity, measured with **[18F]AV-133 PET binding, is a useful diagnostic biomarker in Parkinson's Disease** (PD), where VMAT2 and [18F]AV-133 signal reduces with disease progression.
- Quantification of [18F]AV-133 PET typically requires manual placement of volumes of interest (VOIs), which is both subjective and time consuming.

Methods

- **41 PET images** (2 x 5min frames, mean 76.8 + 2.2min post injection) from **21 'idiopathic PD' subjects**, with associated T1-weighted (T1w) structural magnetic resonance images (MRI) from PPMI database[1].
- **PET frames** were co-registered then registered to the subject **T1w-MRI**. Six striatal regions of interest (ROIs) (**left and right caudate, anterior putamen, and posterior putamen**) were segmented from the T1w-MRI using multi-atlas- (LEAP)[2] and convolutional neural network (CNN)-based[3] approaches.
- SUVR calculated using the **occipital grey matter** as the reference region and compared via Pearson 's coefficient to the PPMI's published results.

T1w MRI

CNN method: anterior/posterior caudate/putamen

LEAP method: occipital lobe grey matter

2 x 5min PET frames

PET registered to MRI

Calculate mean uptake within ROIs

Results

- There were **significant positive linear correlations between IXICO and PPMI SUVR** results for all six ROIs (r= 0.85 to 0.94, p<0.0001).
- Mean regression slope was 0.71 + 0.15, and mean intercept was 0.31 + 0.21.

Right Caudate — $y = 0.55x + 0.42$, $R^2 = 0.72$

Right Posterior Putamen — $y = 0.98x - 0.074$, $R^2 = 0.89$

Right Anterior Putamen — $y = 0.73x + 0.30$, $R^2 = 0.82$

Left Caudate — $y = 0.55x + 0.53$, $R^2 = 0.72$

Left Posterior Putamen — $y = 0.83x + 0.18$, $R^2 = 0.83$

Left Anterior Putamen — $y = 0.64x + 0.51$, $R^2 = 0.71$

Conclusion

- Our fully automated pipeline to quantify VMAT2 [18F]AV-133 PET images produced **comparable results to the PPMI** pipeline requiring manual intervention, **despite the differences in the definition of reference region** (inclusion of white matter versus grey-matter only) and target regions (spherical VOI versus whole region ROI).
- The proposed pipeline is **objective** and **reproducible**, therefore allowing for application in PD studies or other studies using nigrostriatal pathway integrity as a biomarker.

References

[1] Parkinson's Progression Markers initiative (PPMI) database (http://www.ppmi-info.org/data

[2] Wolz, Robin, et al. "LEAP: learning embeddings for atlas propagation." NeuroImage 49.2 (2010): 1316-1325.

[3] Weatheritt, Jack, et al. "Fully-automatic AI segmentation of subcortical regions". HSG conference (2020)