18F-FDOPA PET/CT for evaluating striatal dopaminergic system and cardiac sympathetic denervation in advanced idiopathic Parkinson's disease (IPD): A one stop shop imaging agent

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Introduction

- Several studies have focused on the involvement of cardiac innervation in primary neurologic disorders (IPD & MSA).
- Cardiac innervation have been assessed to differentiate these neuro-degenerative disease using 123I-MIBG, 11C-HED, 18F- Dopamine.
- Studies reported that patients with IPD and autonomic dysfunction have significant cardiac sympathetic denervation.
- In this study we evaluated the feasibility of 18F-FDOPA PET/CT in evaluation of cardiac sympathetic dysfunction in patients with advanced-IPD with autonomic dysfunction.

Materials and Methods

- This prospective study was approved by the institutional review board and informed consent was obtained.
- We recruited 28 patients of advanced IPD with autonomic dysfunction.
- Autonomic dysfunction was assessed by autonomic function tests (AFT) and found to have moderate to severe loss of sympathetic reactivity with loss of cardiac autonomic tone & orthostatic hypotension.
- Mean symptom duration was 7.46+3.26 years, H&Y stage was 2.9+0.66 and UPDRS was 56.46+6.65.
- Twenty-two age matched subjects who had undergone 18F-FDOPA PET-CT for indications other than Parkinsonism and had no h/o CAD or coronary risk factors, were recruited as controls.
- Both cardiac and Brain 18F-FDOPA PET/CT were acquired in the same sitting for all the subjects.

Image Acquisition

- Both cardiac-PET/CT (40 minutes post IV-injection of 185-259MBq 18F-FDOPA) and Brain-PET/CT (60 minutes post-IV) were acquired in same session.
- The PET-CT study performed and data was reconstructed using a 3D VUE algorithm, and images were viewed for interpretation on a Xeleris workstation using the Volumetrix protocol.
- Cardiac and brain 18F-FDOPA PET-CT images were interpreted visually and semi-quantitatively using SUVmax value.
- ROIs were drawn over the entire left ventricular myocardium, individual walls and mediastinum for quantification.

Results

- Striatal and myocardial tracer uptake were significantly lower in patients compared to controls (Figure 1 & 2).
- Myocardial-uptake of 18F-FDOPA in controls did not change significantly with age or sex.
- Myocardium/mediastinal ratio (MyMR) and myocardium/liver ratio (MLR) correlated negatively with the BP-drop (systolic) during AFTs {Pearson- coefficient=(-0.565), p=0.002}.
- Mean MyMR in patients with abnormal-AFTs was significantly lower than patients with borderline-AFTs. 9/20 patients with abnormal-AFTs showed functional worsening during follow-up, compared to 2/8 with borderline-AFTs.
- Cardiac-ratios did not show significant correlations with striatal-parameters, H&Y stage, UPDRS or symptom duration.

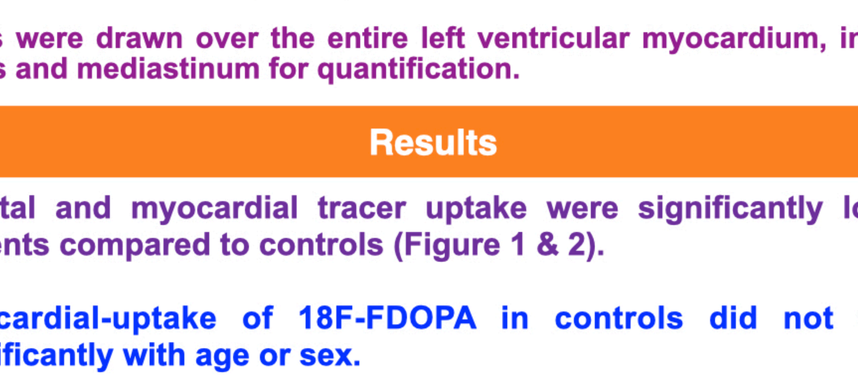

Figure 1 : 18F-FDOPA PET Brain images demonstrating normal striatal FDOPA uptake in the controls, mildly decreased FDOPA uptake in the left posterior putamen with early IPD features and significantly decrease striatal FDOPA uptake in the bilateral basal ganglia in advance IPD patient.

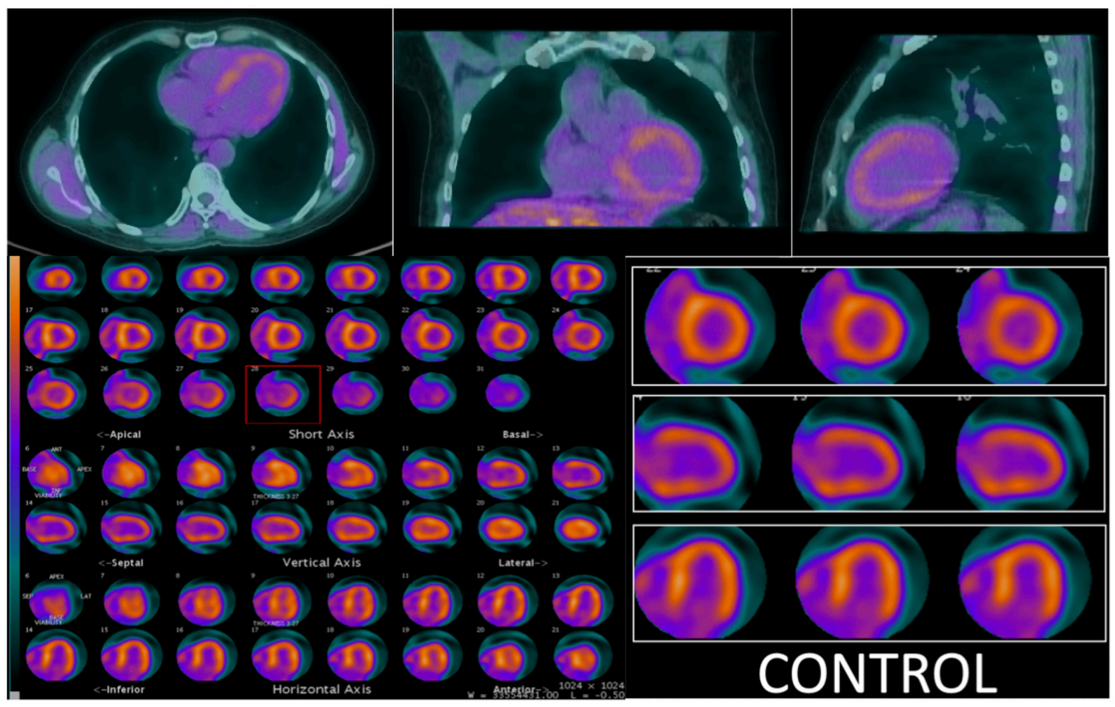

Figure 2 : 18F-FDOPA PET/CT Cardiac images : demonstrating homogenous FDOPA uptake in the LV myocardium in control group.

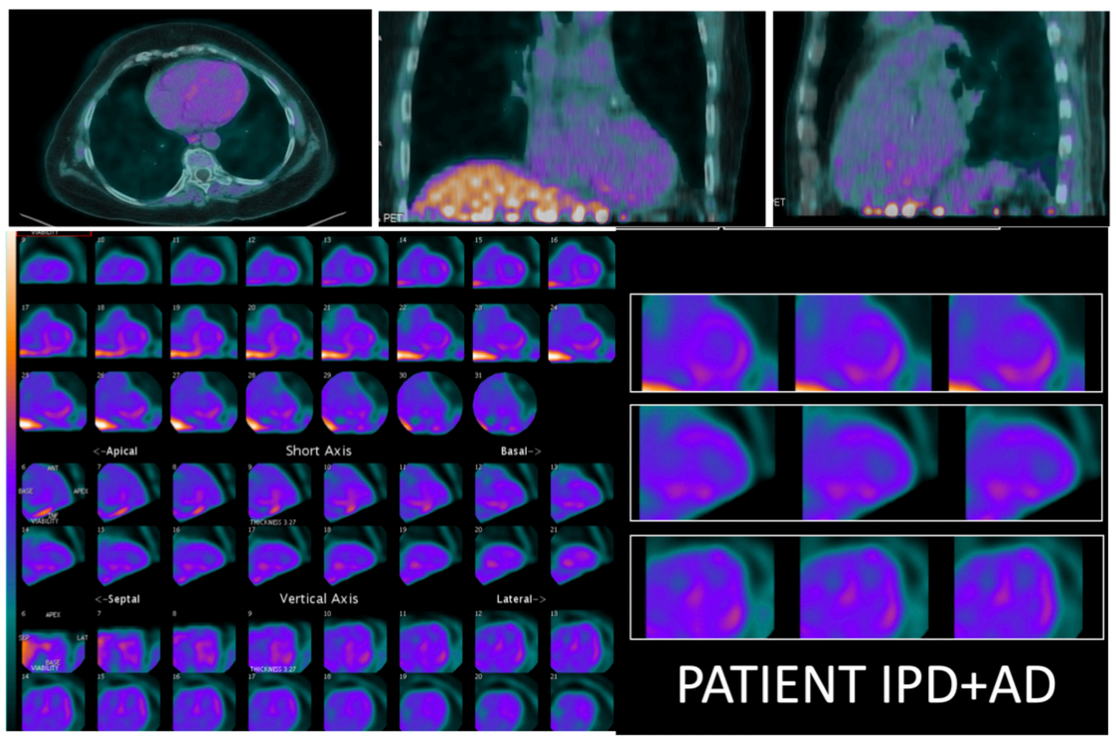

Figure 3: 18F-FDOPA PET/CT Cardiac images : there is significantly reduced FDOPA uptake in the entire LV myocardium in the patient with advanced IPD with proven cardiac autonomic dysfunction (AD).

Discussion

- The autonomic failure in IPD is caused by damage and Lewy body deposition in the postganglionic part of the autonomic nervous system.
- Studies using 123-I MIBG, 11C-HED have shown reduced myocardial uptake in IPD, which was pronounced when accompanied by orthostatic hypotension reflecting sympathetic neuro-circulatory failure.
- Earlier studies suggested that 18F-FDOPA metabolized to FDA and its metabolites only in dopaminergic areas of brain.
- 18F-FDOPA enters the catecholamine metabolic pathway of endogenous L-DOPA both in the brain and peripherally.
- Transported into the cell by the L-type amino acid transporter (LAT) .
- Decarboxylated by aromatic L-amino acid decarboxylase (AADC) to 18F-DA. Transported into specific storage vesicles by vesicular monoamine transporter and protected from enzymatic degradation.
- The results of 18F-FDOPA are consistent with findings of previous studies thereby suggesting the feasibility of 18F-FDOPA in assessing cardiac sympathetic denervation in IPD with AD.

Conclusion

18F-FDOPA PET-CT can be used to evaluate myocardial sympathetic denervation in patients of advanced IPD with autonomic dysfunction.

Reference :

1. Goyal H, Sharma A, Patel C, Deepak KK, Tripathi M, Gupta P, Kumar R, Bal CS, Goyal V. Assessment of myocardial sympathetic innervation with 18F-FDOPA-PET/CT in patients with autonomic dysfunction: feasibility study in IPD patients. J Nucl Cardiol. 2022 Jun;29(3):1280-1290. doi: 10.1007/s12350-020-02474-w. Epub 2021 Jan 10. PMID: 33426586.

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