Quantitative simultaneous ^{99m}Tc-ECD/^{123}I-FP-CIT SPECT in Parkinson's disease and multiple system atrophy

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Abstract. *Purpose:* The purpose of this study was to investigate the feasibility and utility of dual-isotope SPECT for differential diagnosis of idiopathic Parkinson's disease (IPD) and multiple system atrophy (MSA).
Methods: Simultaneous ^{99m}Tc-ECD/^{123}I-FP-CIT studies were performed in nine normal controls, five IPD patients, and five MSA patients. Projections were corrected for scatter, cross-talk, and high-energy penetration, and iteratively reconstructed while correcting for patient-specific attenuation and variable collimator response. Perfusion and dopamine transporter (DAT) function were assessed using voxel-based statistical parametric mapping (SPM2) and volume of interest quantitation. DAT binding potential (BP) and asymmetry index (AI) were estimated in the putamen and caudate nucleus.
Results: Striatal BP was lower in IPD (55%) and MSA (23%) compared to normal controls ($p<0.01$) , and in IPD compared to MSA ($p<0.05$). AI was greater for IPD than for MSA and controls in both the caudate nucleus and the putamen ($p<0.05$). There was significantly decreased perfusion in the left and right nucleus lentiformis in MSA compared to IPD and controls ($p<0.05$).
Conclusion: Dual-isotope studies are both feasible in and promising for the diagnosis of parkinsonian syndromes.

Keywords: Idiopathic Parkinson's disease – Multiple system atrophy – ^{99m}Tc-ECD – ^{123}I-FP-CIT – Dual-isotope SPECT

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Introduction

Quantitative simultaneous ^{99m}Tc-ECD/^{123}I-FP-CIT single-photon emission computed tomography (SPECT) has potential clinical application to the simultaneous assessment of dopamine transporter (DAT) density and brain perfusion. This technique not only ensures perfect registration of the two tracers under identical physiological conditions, but also reduces acquisition time. This is particularly important when imaging movement disorders, as patients have difficulty remaining still. Despite these advantages, simultaneous dual-isotope imaging has not been routinely implemented in the clinic because discrimination between ^{99m}Tc (140 keV) and ^{123}I (159 keV) is extremely difficult. We have shown previously that accurate separation of the two radionuclides is possible using two new approaches based on artificial neural networks (ANNs) and constrained spectral factor analysis [1, 2].

The methodology presented in this work consists not only of the scatter and cross-talk corrections previously published, but also of modeling variable collimator response and patient-specific attenuation in the projector–backprojector of an iterative algorithm. Our methodology has been validated in Monte Carlo simulations and physical phantom acquisitions, but never tested in humans. The aim of this work was, thus, to investigate the clinical feasibility and utility of simultaneous quantitative perfusion/neurotransmission SPECT for the diagnosis of idiopathic Parkinson's disease (IPD) and multiple system atrophy (MSA) in the clinical setting.

Materials and methods

Patient studies

Nineteen subjects were included in this study, all of whom provided informed consent according to institutional guidelines. The patient population consisted of five patients clinically assessed as having probable IPD (61.8±4.8 years; disease duration 89.2±73.1 months;

Representative Results:

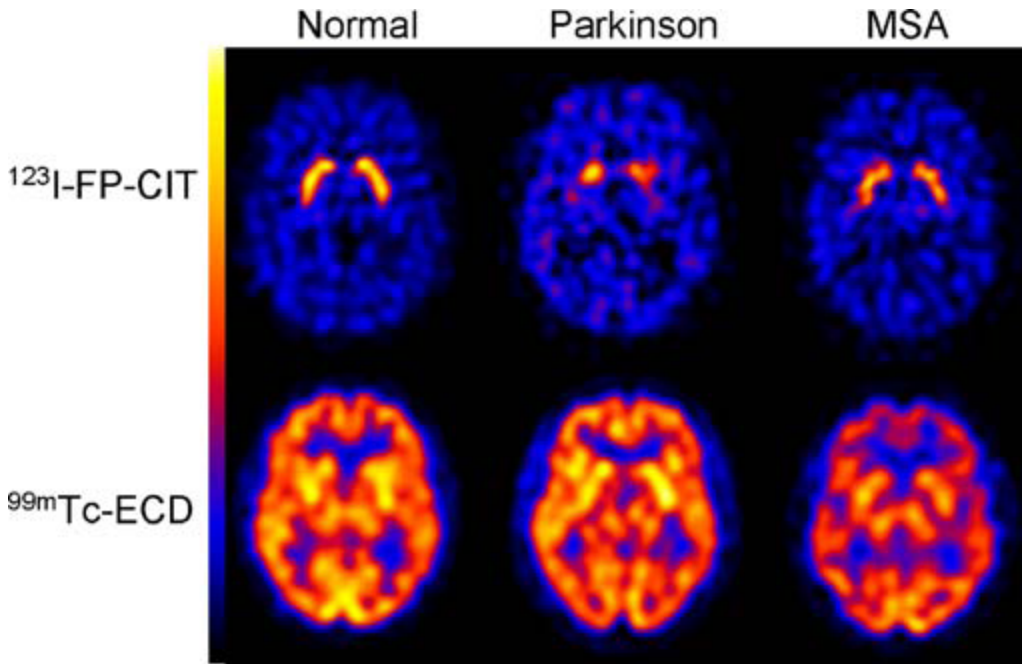

Figure 1. Transaxial slices of the 123I-FP-CIT study at the striatal level and of the corresponding 99mTc-ECD study from representative IPD and MSA patients and a normal control. Images were spatially normalized in the same anatomical referential with SPM2.

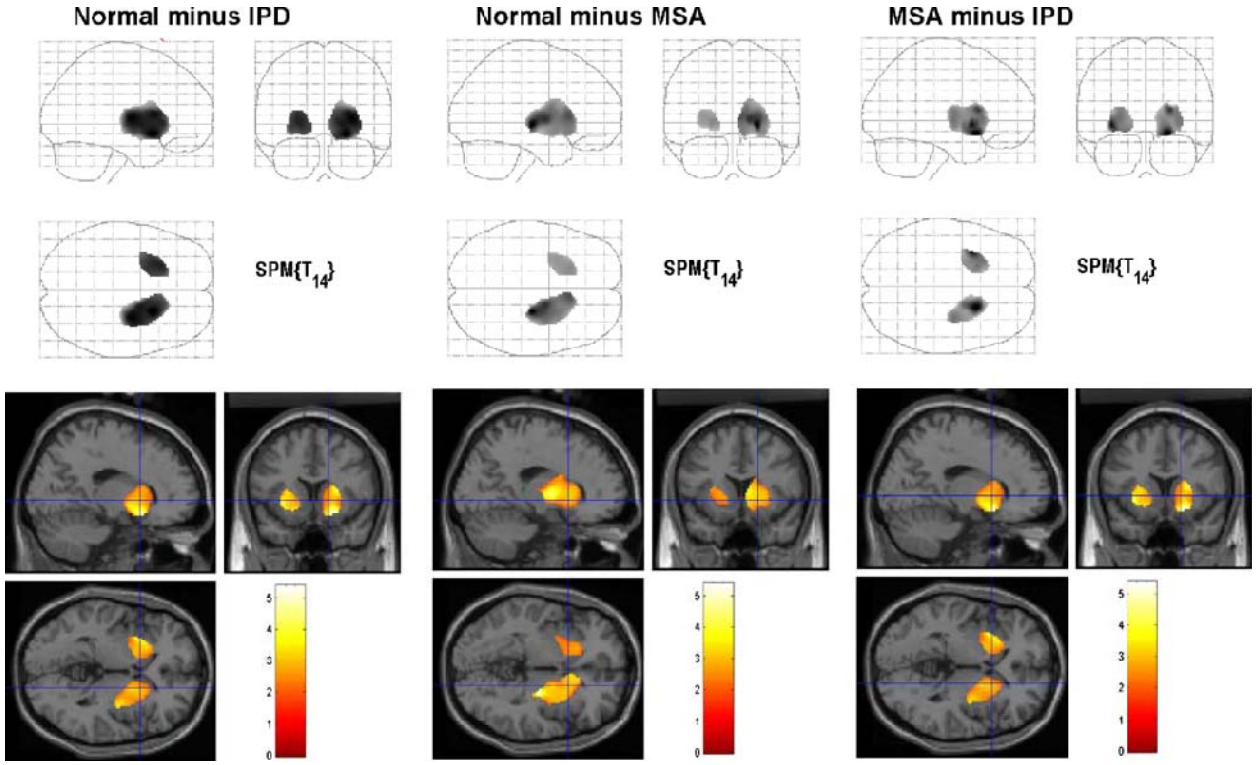

Figure 2. MIP projections and transverse, sagittal, and coronal sections at the mid-brain striatal level (superimposed to the Montreal Neurological Institute single-subject MRI) showing the results of SPM2 group analysis comparing 123I-FP-CIT neurotransmission in IPD and MSA patients with that in normal controls, and in IPD patients with that in MSA patients

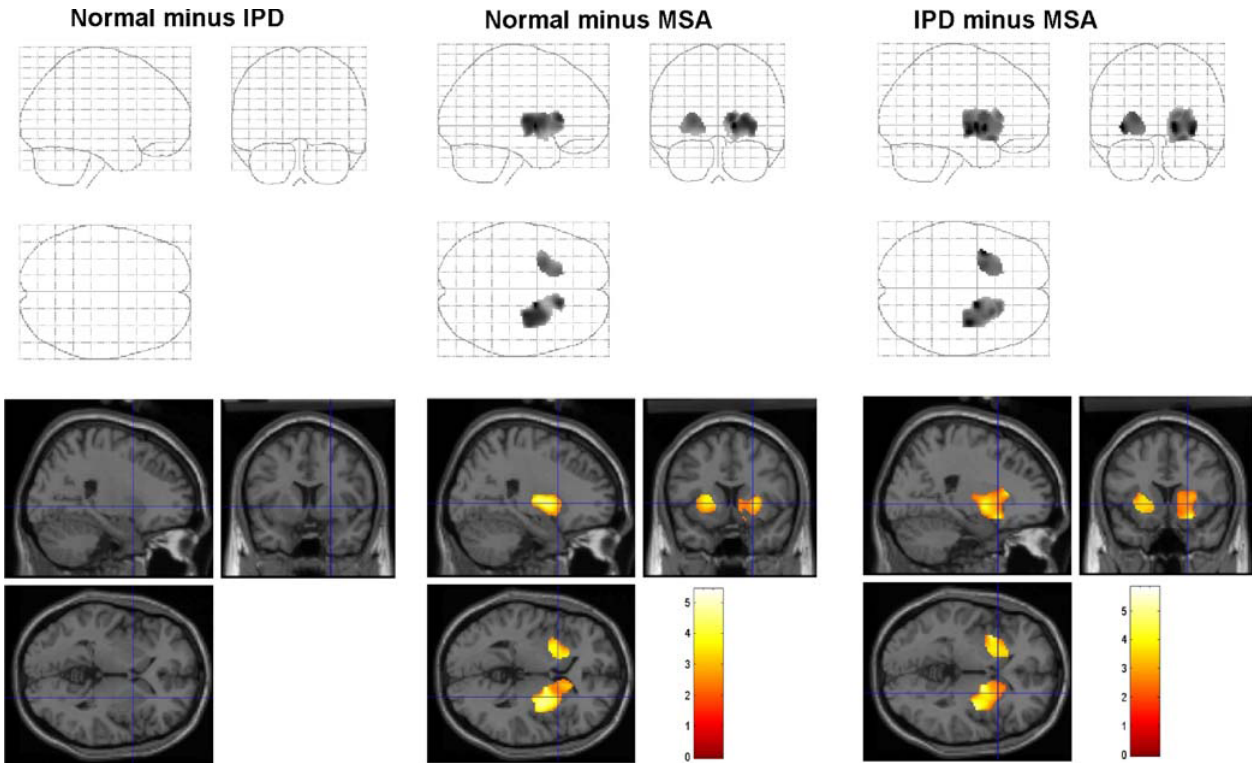

Figure 3. MIP projections and transverse, sagittal, and coronal sections at the mid-brain striatal level (superimposed to the Montreal Neurological Institute single-subject MRI) showing the results of SPM2 analysis comparing 99mTc-ECD perfusion in IPD and MSA patients with that in normal controls, and in IPD patients with that in MSA patients