

# Dopamine Transporter Scan (DAT) in Parkinsonism – a Short Review for Non-Neurologists

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## ABSTRACT

The Dopamine Transporter Scan (DaT) is a radionuclear imaging technique which was approved by the FDA to differentiate essential tremor (ET) from Parkinson's disease (PD). The scan is a crude indicator of the number of dopamine-secreting cells and is abnormal in presynaptic parkinsonian syndromes. In this article we review this and other possible clinical situations in which a DaT scan may be useful.

**KEYWORDS:** DaT Scan, essential tremor, Parkinson's disease, dementia with Lewy bodies

## INTRODUCTION

The Dopamine Transporter Scan (DaT) is a single photon emitting computed tomographic (SPECT) nuclear imaging study that provides a crude estimate (reduced or normal) for the number of dopamine secreting cells in the midbrain. The dopamine transporter is a receptor on the dopamine secreting neurons. Its function is to resorb the secreted dopamine so that it can be recycled.<sup>1</sup> To accomplish the scan, a radioactively tagged chemical, Ioflupane,<sup>1,2,3</sup> is injected intravenously, which binds to the dopamine transporter, thereby labeling the synapse where dopamine is secreted.

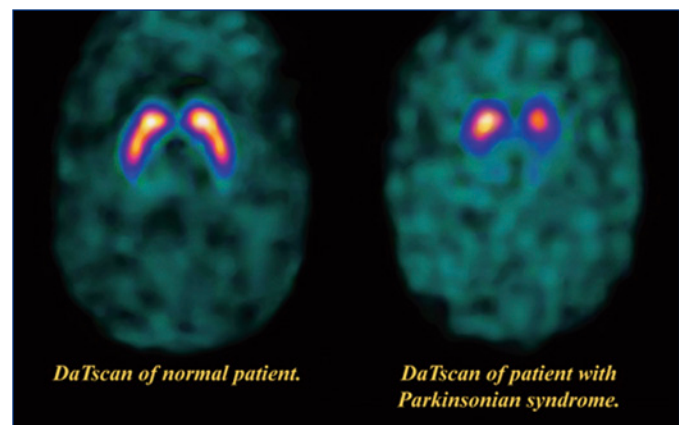
Although the cell body is in the midbrain, the synapse where dopamine is secreted is in the putamen (**Figure 1**). In Parkinson's disease (PD) and several related disorders, the first clinical signs of disease become evident when dopaminergic cells are decreased by over 50%. The study is considered abnormal if the uptake is significantly reduced. The FDA approved use of the DaT scan (Ioflupane I 123 Injection) in 2011 to assist in the differentiation of essential tremor (ET) from tremor due to PD and recently approved DaT scan in diagnosing dementia with Lewy bodies (DLB).

## FDA-APPROVED INDICATIONS

### 1. ET versus PD or when both are coexisting

Distinguishing ET from PD is usually straightforward. The tremor in ET is not present at rest, whereas it is in PD, and ET patients generally exhibit action tremors, which are not

**Figure 1.** On the left side of the image is the DaT scan of a normal patient; right side of image shows asymmetric decrease in the uptake in basal ganglia region consistent with presynaptic parkinsonian syndromes.



usually seen with PD. Furthermore, ET patients generally do not have the other features seen in PD such as slowness, stooped posture, stiffness and imbalance. Older patients, however, commonly exhibit many of these signs, and some PD patients also have ET, thereby confounding evaluation. Dopamine is not affected in essential tremor, so an abnormality supports the diagnosis of a parkinsonian disorder. The DaT scan has approximately 90-95% sensitivity and specificity in diagnosing dopamine deficiency and increases diagnostic certainty. It cannot determine whether ET is present or absent. The pathology for ET is generally thought to be predominantly in the cerebellum, involving the inferior olive, dentate nucleus, and cerebellar outflow tracts.

### 2. Alzheimer's dementia (AD) versus dementia with Lewy bodies (DLB)

It is often difficult to distinguish DLB from AD. In academic memory disorders clinics, the accuracy of distinguishing DLB from AD is about 50%. Some AD patients have mild parkinsonian signs and some DLB patients do not meet criteria to make the diagnosis. An abnormal DaT scan is considered an "indicative biomarker" for the diagnosis of DLB. Distinguishing AD and DLB is becoming increasingly important as disease-specific treatments are being developed.<sup>2</sup>

## OTHER CLINICAL SITUATIONS

### WHERE DaT SCAN CAN HELP

#### 1. Early PD and DaT scan

It is believed that DaT scans are abnormal years before the clinical signs appear, based on animal models of PD and studies of people with REM sleep behavior disorder, a herald syndrome of PD. It should only be ordered when the diagnosis is questionable, which is common in early cases. Even though there is no disease modifying treatment for PD, making a firm early diagnosis is sometimes important for both patients and clinicians. A study from a movement disorder center concluded that DaT scan results have an impact on physicians' confidence in their diagnosis and may also have a positive impact on patients.<sup>3</sup> In regions of the U.S. where there are no neurologists, a DaT scan can be a crucial diagnostic tool for a physician with little experience in PD.

#### 2. PD versus drug-induced parkinsonism

Dopamine receptor blocking (DRB) medications block the effect of dopamine but do not alter the dopamine transporter levels. These drugs therefore may cause clinical syndromes that mimic PD exactly, and patient sensitivity to this side effect is notoriously variable. A person with mild PD pathology may be highly sensitive to DRB medications so that even small doses of the drugs can unmask subclinical PD. DaT scan is normal in drug-induced parkinsonism, since the dopamine cells are normal. This often cannot be assessed clinically since stopping a DRB will usually worsen the psychiatric disorder before the parkinsonism wears off, which usually takes weeks to months.

#### 3. PD versus secondary parkinsonism

In conditions which can mimic PD, including vascular parkinsonism, the clinical findings alone may not distinguish PD from secondary parkinsonism. When the clinical distinction is unclear, DaT scan may help, as the DaT scan will be normal in some secondary parkinsonism, such as vascular parkinsonism.

#### 4. Rapid eye movement sleep behavior disorder (RBD) and synucleinopathies

RBD is a syndrome in which the normal muscle paralysis in dream (REM) sleep is lost. The patient typically acts out dreams of violence, punching or kicking, or sports activities like throwing or catching a ball, while asleep. When it occurs in middle-aged people, usually men, it is usually a premonitory symptom of one of the three "alpha synucleinopathies" {PD, DLB, Multiple system atrophy (MSA)}. In a landmark study,<sup>4</sup> the majority of patients (73.5 %) developed one of the synucleinopathies within 12 years of the start of RBD. Although DaT scan will be abnormal prior to the development of parkinsonian features, the severity of the abnormality has not been shown to have prognostic value.

A positive scan cannot be used to predict when PD motor signs will emerge. Therefore, until an intervention to slow PD progression is developed, we believe, there is no role for DaT scan in assessing RBD and should be discouraged.

## CONCLUSIONS AND RECOMMENDATIONS

DaT scans may be a useful adjunct to clinical findings in differentiating neurodegenerative causes of parkinsonism {PD, Progressive supranuclear palsy (PSP), MSA, DLB} from other etiologies, especially in their early stages. It is not diagnostic. It is a supportive laboratory test. DaT scan will distinguish PD from ET, vascular parkinsonism, drug-induced parkinsonism, and normal aging and DLB from AD. It is an expensive test that simply detects a dopamine deficit. It is best ordered on a case-by-case basis and should not be used as a routine test to validate a diagnosis. It is too crude to be used to follow disease progression or to be used for prognostic purposes, so it rarely needs to be repeated.

## References

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