Diagnostic change: the power of DaTscan in Parkinson's disease

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Abstract

Parkinson's disease (PD) is a progressive neurodegenerative disorder primarily characterized by motor symptoms such as bradykinesia, resting tremor, and muscle rigidity. Diagnostic accuracy is crucial for the effective treatment of the disease. This article examines the impact of using SPECT (Single Photon Emis-sion Computed Tomography with high-affinity tracers for the dopamine transporter (DaTscan) in the diag-nosis of Parkinson's disease, highlighting a study conducted at the Hospital of Barletta involving a popula-tion of 63 patients. This study will allow us to understand the diagnostic power of this method both from a diagnostic and therapeutic point of view.

Introduction

The diagnosis of Parkinson's disease (PD) represents a significant challenge for clini-cians, especially in the early stages of the disease. Traditionally, the diagnosis has been based primarily on clinical assessment of motor symptoms, including bradykine-sia, resting tremor, and muscular rigidity. However, the variability of symptoms, the progression of the disease, and the overlap of signs with other neurodegenerative conditions complicate the diagnostic process. Early diagnosis is crucial, not only for the proper management of the disease but also for optimizing the initiation of pharmaco-logical treatments, which can reduce symptom intensity and improve the patient's quality of life.

Parkinson's disease is a neurodegenerative disorder that primarily affects dopaminer-gic neurons in the substantia nigra of the brain, leading to a progressive dopamine de-ficiency. This deficiency disrupts the brain circuits involved in motor control, causing the classic motor and non-motor symptoms. Clinical diagnosis, based on symptoms and the patient's history, can be difficult, particularly in the early stages when the signs are still mild and nonspecific.

The introduction of DaTscan (SPECT with iodine-123, a radioactive tracer) represents a significant diagnostic breakthrough for Parkinson's disease, allowing for objective vis-ualization and quantification of dopamine transporter function in the brain. This tool enables a more accurate classification of patients, reducing diagnostic errors and helping to distinguish PD from other conditions with similar symptoms, such as atypical parkinsonism and essential tremor. Compared to previous imaging modalities, such as clinical diagnosis alone or MRI, SPECT with 123I-DAT provides higher sensitivity and specificity in identifying abnormalities in the dopamine transporter system.

Studies have demonstrated that DaTscan imaging significantly improves diagnostic accuracy in sensitivity with higher than clinical diagnosis alone, particularly in early Par-kinsonian syndromes. Specificity: Improved compared to baseline clinical assessments. Positive Predictive Value (PPV) and Negative Predictive Value (NPV): Enhanced when compared to traditional clinical diagnosis, according to SNM Practice Guideline for Do-pamine Transporter Imaging and the Clinical Utility of DaT-SPECT in Parkinsonian Syn-dromes [2,3]

Materials and Methods

The present study involved 63 patients (36 mens and 27 womans) who presented at the Hospital of Barletta after receiving a preliminary diagnosis of Parkinson's disease from a neurologist. Each patient was clinically evaluated for the presence of bradyki-nesia, restingtremor, and muscular rigidity. Based on this evaluation, the participants were categorized into two groups: "possible" and "probable" Parkinson's disease cas-es. The categorization was made according to the severity and duration of symptoms, aiming to differentiate more uncertain cases from those with a likely diagnosis of Par-kinson's disease. Before the exam, it may be necessary to temporarily suspend certain medications that could interfere with the results, as communicated by the doctor or neurologist. No special dietary restrictions are required, but the patient may be advised to drink water after the exam to help eliminate the radiopharmaceutical. After the clinical evaluation, all patients underwent a DaTscan examination, which uses a radioactive tracer called ioflupane-123. This tracer binds to dopamine transporters (DaT) in the brain, enabling visualization and quantification of dopaminergic activity, particularly in the striatum, the brain region involved in motors function.

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The tracer was administered intravenously at a dose of 185 MBq, and subsequent SPECT images were acquired to evaluate dopamine uptake in the relevant brain areas. After the necessary biodistribution time of the radiopharmaceutical, tomographic acquisition using SPECT was performed for a duration of 20 to 30 minutes. A gamma camera with two or three heads and high-resolution collimators, either parallel or fan-beam, was used. In the case of fan-beam collimators, it is important to account for the different sensitivity levels depending on the distance. The acquisition method used was step-and-shoot, meaning there were moments of acquisition followed by pauses (each acquisition period lasted between 30 to 45 seconds), with angular sam-pling no less than 3°, equivalent to 120 projections. The matrix used was 128x128 with pixel sizes of 3-6 mm, and the total counts ranged from 1 to 3 million. The data obtained were then compared with normal values to identify abnormalities in dopamine uptake, which are indicative of Parkinson's disease. The entire process of the exam takes about 3-4 hours, including the waiting time for the radiopharmaceutical to distribute in the brain. The exam involves minimal exposure to radiation and is gener-ally safe, though it is not recommended for pregnant or breastfeeding women. A posi- tive result, with reduced uptake of the radiopharmaceutical, may indicate do-paminergic deficits, characteristic of Parkinson's disease and other related neurodegenerative dis- eases.

The use of SPECT to visualize dopaminergic activity in the brain is widely supported by scientific literature, confirming its effectiveness in detecting dysfunctions in dopamine transporters in patients with Parkinson's disease. SPECT has proven to be a valuable diagnostic tool, especially for distinguishing Parkinson's disease from other forms of parkinsonism. Additionally, techniques like PET (Positron Emission Tomography) have been used for more in-depth studies of dopaminergic function. In particular, PET with tracers such as fluorodopa allows precise visualization of damage to dopaminergic neurons and is often used to monitor the progression of Parkinson's disease. While SPECT is less expensive and more widely available than PET, both techniques have significant complementary diagnostic value in the context of Parkinson's disease.

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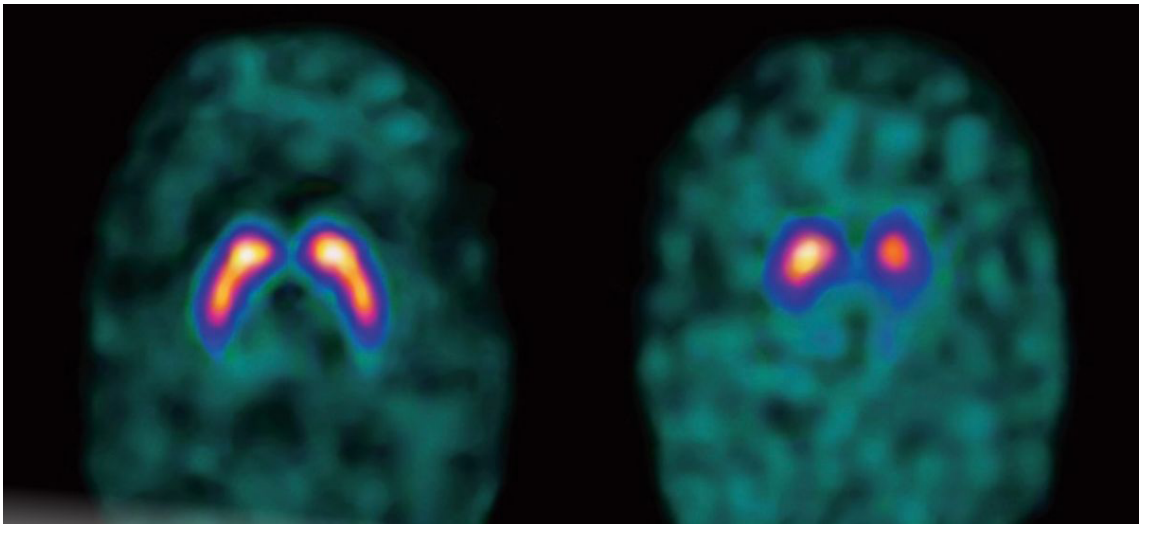
Results

The analysis of the collected data revealed that 26 patients showed significantly re-duced dopamine uptake, confirming a positive diagnosis of Parkinson's disease. These patients exhibited a reduction in dopaminergic activity in the striatum, confirming the diagnosis of PD. In contrast, the remaining 37 patients did not show significant altera-tions in dopamine uptake parameters, ruling out Parkinson's disease in these cases.



Figures 1. *On the left there is a negative test while on the right there is a patient suffering from Parkinson's*

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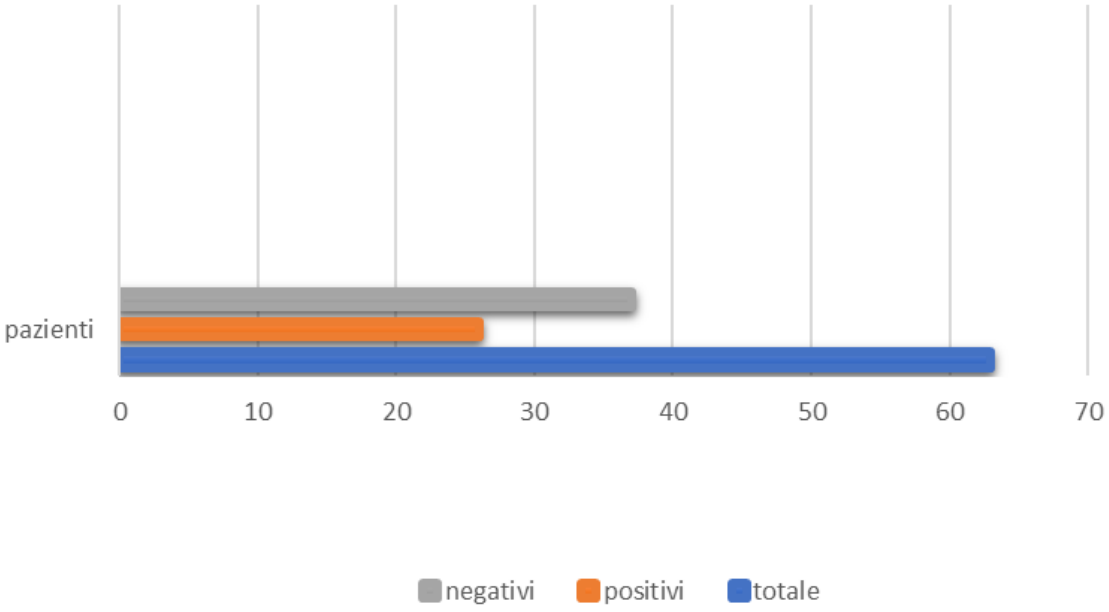
Figure 2. *Graphical representation of positives and negatives patients to DatScan*



The results of this study confirm that the use of DaTscan greatly improves diagnostic accuracy in Parkinson's disease, especially in cases with uncertain or overlapping symptoms. In particular, DaTscan helped identify PD cases that would have otherwise been misclassified as possible or probable due to symptoms that overlap with other neurological conditions. This highlights how DaTscan can be an essential complemen-tary tool in the differential diagnosis of parkinsonian syndromes.

Integrating DaTscan into routine diagnostic practices can lead to earlier and more tar-geted clinical interventions, enabling healthcare providers to initiate appropriate pharmacological treatments at a more timely stage of the disease. Additionally, the use of a precise diagnosis allows for closer monitoring of patients, reducing the risks of untreated disease progression.

Discussion

At this point it can be said that DaTscan demonstrated high sensitivity (the ability to detect the disease in patients showing typical symptoms of Parkinson's disease) and specificity (the ability to exclude the disease in patients without significant abnormal ities in dopaminergic uptake). The data analysis also suggested that using DaTscan at an early stage can prevent misdiagnoses that may arise from confusion with other parkinsonian syndromes, such as vascular parkinsonism or essential tremor.

Although DaTscan does not replace a thorough clinical evaluation, its objective results provide neurologists with an additional tool to make more confident diagnoses, re-ducing the likelihood of diagnostic errors and improving the overall therapeutic ap-proach.

In conclusion, the introduction of DaTscan represents a significant advancement in the diagnosis of Parkinson's disease, particularly in the early stages and in cases where symptoms are less apparent or easily confused with other conditions. The results of the study conducted at the Hospital of Barletta demonstrate that this technology not only improves diagnostic precision but also supports more effective therapeutic management, contributing to a substantial improvement in the quality of life for pa-tients.

The use of DaTscan complements traditional clinical diagnostic methods, seamlessly integrating into routine diagnostic practices. The ability to visualize and quantify do-paminergic activity provides a more detailed and objective assessment of brain dam-age, uncovering conditions that may not be visible with other imaging modalities. In the future, further refinement of imaging techniques and the introduction of new ra-dioactive tracers could further enhance the diagnostic and predictive capacity of DaTscan, contributing to even earlier diagnosis and more targeted treatment.

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