

## RADIOLOGICAL CHANGES IN MRI IMAGING OF PARKINSONIAN SYNDROMES

Reem Salem<sup>1\*</sup>, Ruba Shahin<sup>1</sup>, Ziad Bitar<sup>2</sup> and Khalid Khattab<sup>3</sup><sup>1</sup>Faculty of Medicine, Al-Sham Private University, Rif Dimashq, Syria.<sup>2</sup>Department of Internal Medicine, Al-Sham Private University, Rif Dimashq, Syria.<sup>3</sup>Department of Radiology, Damascus University, Syrian Private University, AL- Sham Private University, Rif Dimashq, Syria.

\*Corresponding Author: Reem Salem

Faculty of Medicine, Al-Sham Private University, Rif Dimashq, Syria.

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## ABSTRACT

**Background:** Parkinsonian syndromes are neurodegenerative disorders with overlapping motor features, making early diagnosis challenging. MRI offers non-invasive radiological markers that can aid differential diagnosis. **Methods and Materials:** We conducted a retrospective descriptive study at Al-Mouwasat University Hospital (2020–2024), including 98 patients clinically diagnosed with Parkinson's disease or related syndromes who underwent brain MRI using 1.5 Tesla machines. Data were reviewed from PACS with radiological oversight. **Results:** The cohort was predominantly male (65%) with most patients aged 60–70 years (90%). Tremor (86%) and postural instability (75%) were the most frequent symptoms. MRI revealed white matter hyperintensities in 95%, absence of the swallow tail sign in 79%, and substantia nigra signal loss in 77%. Elevated red nucleus signal was observed in 76%. The hot cross bun sign appeared in 43%, and cortical atrophy was present in 67%, with additional subcortical (23%), cerebellar (5%), and basal ganglia (3%) atrophy. **Conclusion:** MRI findings in this study mirror global trends in PD imaging. The frequent detection of atypical signs suggests a need for careful radiological assessment to improve diagnostic precision.

**KEYWORDS:** Parkinsonian syndromes, MRI, Swallow tail sign, Hot cross bun sign.

## INTRODUCTION

Parkinsonian syndromes comprise a group of neurodegenerative disorders characterized by motor symptoms such as bradykinesia, rigidity, resting tremor, and postural instability. While idiopathic Parkinson's disease (PD) is the most prevalent, other atypical parkinsonian syndromes include multiple system atrophy (MSA), progressive supranuclear palsy (PSP), and corticobasal degeneration (CBD). These conditions often present with overlapping clinical features, making early and accurate differential diagnosis a significant clinical challenge.<sup>[1,2]</sup>

Magnetic resonance imaging (MRI) has emerged as a vital non-invasive tool in the assessment of parkinsonian syndromes, aiding in distinguishing idiopathic PD from atypical variants. Conventional MRI sequences can reveal characteristic structural changes such as atrophy patterns, signal alterations in basal ganglia, and midbrain morphology that may support diagnosis.<sup>[3,4]</sup> Moreover, advanced MRI techniques including diffusion-weighted imaging (DWI), susceptibility-weighted imaging (SWI), and volumetric analysis have provided further insights into the pathophysiological differences between these disorders.<sup>[5,6]</sup>

Understanding radiological signatures specific to each parkinsonian syndrome is essential for improving diagnostic accuracy and optimizing patient management. This study aims to review and compare MRI-based radiological changes associated with common parkinsonian syndromes, with a particular focus on distinguishing features among PD, MSA, PSP, and CBD.

## METHODS AND MATERIALS

## Study Design and Setting

This study was designed as a retrospective observational analysis conducted at Al-Mouwasat University Hospital in Damascus, one of the major medical and academic centers in Syria. Data were collected by reviewing patient records and medical files from the hospital archives between 2020 and 2024. The study population included patients with a clinical diagnosis of Parkinson's disease or parkinsonian syndromes who underwent radiological follow-up using magnetic resonance imaging (MRI). Radiological images were reviewed through the Picture Archiving and Communication System (PACS) in collaboration with attending radiologists and supervising physicians in the radiology department.

### Inclusion and Exclusion Criteria

**Inclusion Criteria:** The study included all patients with a confirmed clinical diagnosis of Parkinson's disease or one of the parkinsonian mimics, who underwent brain MRI as part of their diagnostic or therapeutic follow-up.

**Exclusion Criteria:** Patients who did not receive MRI imaging during the study period were excluded, thus limiting the analysis to cases with available radiological data.

### Ethical Approval

The study protocol was reviewed and approved by the Ethics Committee of Al-Mouwasat University Hospital, under approval number: MW-ETH-2025-116.

### Statistical Analysis

Descriptive statistical analysis was performed using IBM SPSS Statistics software, version 26.0 (IBM Corp., Armonk, NY, USA). Categorical variables such as sex, clinical diagnosis, and specific MRI findings were summarized as frequencies and percentages.

## RESULTS

### Demographic and Clinical Characteristics

The final study sample included 98 patients who met the inclusion criteria. The key demographic and clinical characteristics of the cohort are summarized below. Males constituted 65% of the sample, while females accounted for 35%, indicating a male predominance. The majority of patients (90%) were between 60 and 70 years of age, consistent with the global demographic distribution of Parkinson's disease. Only 10% of patients were younger than 50 years.

Regarding clinical presentation, tremor was the most frequently reported symptom, observed in 86% of patients, followed by postural instability in 75%, muscle rigidity in 65%, and bradykinesia in 55%.

### Radiological Findings on MRI

All MRI scans were performed using 1.5 Tesla machines (Minelise and General Electric systems). The radiological findings were reviewed and summarized based on archived imaging reports.

#### White Matter Signal Changes

Hyperintensities in white matter were noted in 95% of patients, while 3% showed normal white matter signal and 2% exhibited isointense signal patterns.

#### Swallow Tail Sign (Nigrosome-1)

The absence of the swallow tail sign, a key imaging marker of Parkinsonism, was observed in 79% of the patients.

#### Substantia Nigra Signal Loss

Loss of normal signal intensity in the substantia nigra, consistent with neurodegeneration, was seen in 77% of cases.

#### Red Nucleus Signal

A high signal intensity in the red nucleus was present in 76% of patients, while the remaining 24% had normal signal appearance.

#### Other Specific MRI Signs

The hot cross bun sign, commonly associated with multiple system atrophy, was identified in 43% of the cases.

#### Atrophic Brain Changes

Cortical atrophy was found in 67% of patients, subcortical atrophy in 23%, and combined cortical and subcortical atrophy in 2%. In addition, cerebellar atrophy was noted in 5%, and basal ganglia atrophy in 3%.

## DISCUSSION

IN this cohort of 98 patients, demographic distribution showed a male predominance (65%) and an age peak between 60–70 years (90%), consistent with global PD epidemiology and previous data.<sup>[7]</sup>

The high prevalence of clinical symptoms—tremor (86%), postural instability (75%), rigidity (65%), and bradykinesia (55%)—aligns with typical motor profiles reported internationally<sup>[8]</sup>, reaffirming the diagnostic validity of our sample.

### White Matter Hyperintensities (WMH)

We observed WMH in 95% of patients, reflecting age-related cerebrovascular changes. Meta-analysis indicates WMH prevalence in PD patients is comparable to controls and correlates more with cognitive decline rather than motor symptoms.<sup>[9,10]</sup> Our high WMH frequency likely reflects cohort age rather than PD-specific pathology.

### Swallow Tail Sign Absence & Substantia Nigra Signal Loss

The absence of the swallow-tail sign in 79% and signal loss in the substantia nigra in 77% closely match known neurodegeneration markers for idiopathic PD on 1.5 T MRI.<sup>[11]</sup> Although 1.5 T sensitivity is lower than 3 T, these findings are still reliable neuroimaging indicators.<sup>[12]</sup>

### Red Nucleus Signal Elevation

Elevated red nucleus signal in 76% may stem from iron accumulation or microstructural degeneration. While less studied in PD, such changes have been documented in atypical parkinsonism, highlighting the need for further targeted research.

### Hot Cross Bun (HCB) Sign

The HCB sign was found in 43% of our cohort. This is higher than the ~24–92% range reported in cerebellar MSA depending on disease subtype and timing.<sup>[13–15]</sup> It's likely that our sample included both PD and atypical syndromes—MSA-C typically shows HCB in early disease, while it is rare in PD.<sup>[13–15]</sup>

### Atrophic Changes

Cortical atrophy (67%) was more common than subcortical (23%), with combined atrophy in only 2%, a pattern aligning with typical PD—which often shows cortical thinning—while MSA shows more cerebellar atrophy.<sup>[16]</sup> We documented cerebellar atrophy in 5% and basal ganglia atrophy in 3%, matching the relatively low frequency of atypical syndromes in our sample.

### Limitations

The study's retrospective nature and reliance on 1.5 T MRI may limit sensitivity for subtle changes. Lack of a control group hinders comparison of imaging signs within healthy populations. Mixed inclusion of PD and parkinsonian mimics complicates interpretation, especially for signs like HCB.

### CONCLUSIONS

Our findings largely reflect established MRI trends in PD and parkinsonian syndromes globally. WMH prevalence aligns with age-related degeneration rather than PD-specific changes.<sup>[9]</sup> Swallow-tail sign absence and substantia nigra signal loss remain key radiological markers for PD.<sup>[11]</sup> The frequent HCB sign and cerebellar atrophy suggest a notable proportion of atypical parkinsonism, warranting further diagnostic scrutiny.

Further prospective, controlled imaging studies—ideally with 3 T MRI and standardized rating scales—are required to clarify the diagnostic specificity of MRI markers like HCB and red nucleus signal intensity in differentiating PD from atypical syndromes.

### Conflict of Interest

The authors declare no conflicts of interest—financial or otherwise—related to the content of this study.

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### Data Availability

The data that support the findings of this study are available from the corresponding authors upon reasonable request and in accordance with institutional data privacy policies.

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### Author Contributions

Reem Salem contributed to study design, data collection, and drafting the manuscript.

Ruba Shahin conducted radiological analysis and co-interpreted the imaging findings with the Radiology Department.

Ziad Bitar supervised the statistical aspects and edited the final version.

Khalid Khattab coordinated the project, oversaw all stages, and approved the final manuscript for submission.

### Abbreviations

PD: Parkinson's Disease, MSA: Multiple System Atrophy, PSP: Progressive Supranuclear Palsy, CBD: Corticobasal Degeneration, MRI: Magnetic Resonance Imaging, DWI: Diffusion-Weighted Imaging, SWI: Susceptibility-Weighted Imaging, WMH: White Matter Hyperintensities, HCB: Hot Cross Bun sign, PACS: Picture Archiving and Communication System, T: Tesla (unit of magnetic field strength).

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