Neuroimaging in Movement Disorders

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Joan Miravite – Relevant Financial Relationships

- Speakers' Bureau, consultant, and/or advisory board member for Medtronic and Abbott.

All relevant financial relationships have been mitigated

Learning Objectives

- Identify appropriate neuroimaging modalities for movement disorders
- Recognize hallmark imaging patterns
- Apply imaging results to differential diagnosis and clinical decision-making

Why Neuroimaging Matters

- Diagnosis of movement disorders remains clinical
- Imaging supports diagnostic confidence
- Helps differentiate PD vs atypical parkinsonism
- Guides referrals, prognosis, and patient counseling

(Samson & Noseworthy, 2022)

Clinical Indications for Structural Imaging in Parkinsonism

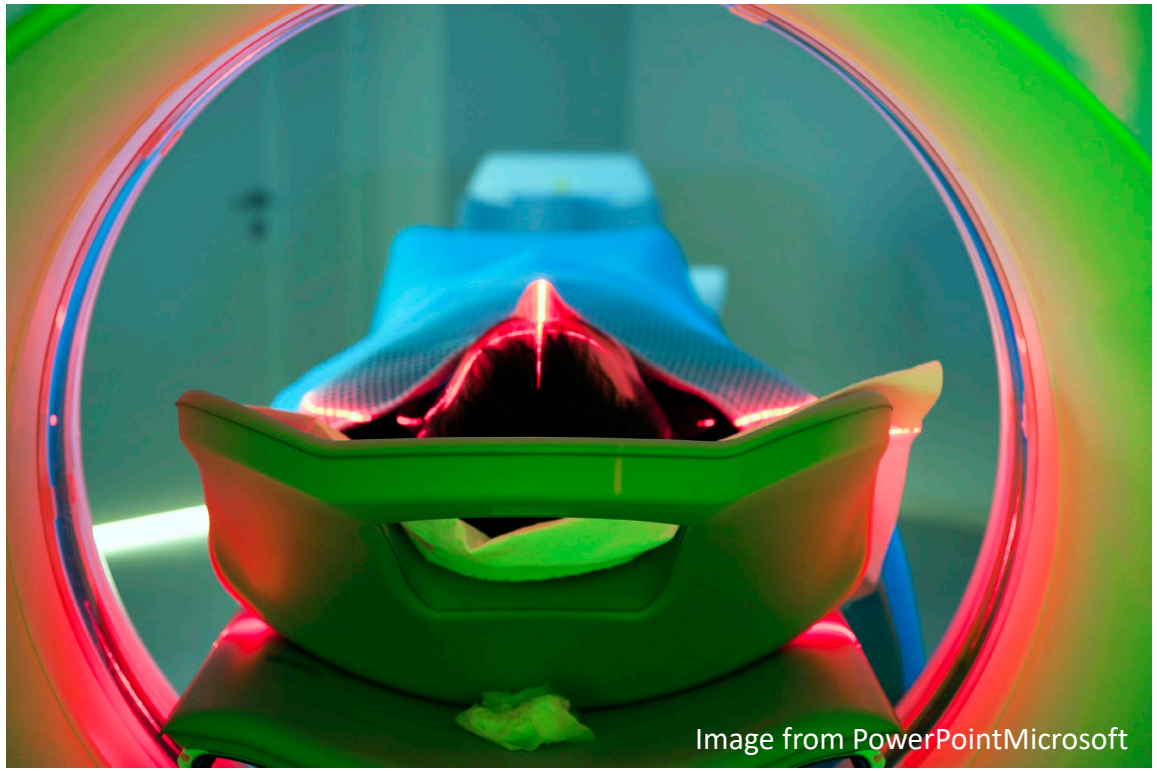
- Focal weakness or numbness
- Upper neuron signs including spasticity and/or hyperreflexia, especially if unilateral
- Acute onset or rapid progression
- Rapidly progressive dementia
- Combination of parkinsonism and other movement disorders, especially if unilateral
- Early onset bulbar or pseudobulbar signs

(Maiti & Perlmutter, 2023)

Structural Imaging

MRI and CT

Structural MRI: First-Line Imaging



- Recommended for most new parkinsonism cases
- Excludes secondary causes
- Can identify disease-specific atrophy patterns (atypical features)

(Samson & Noseworthy, 2022; Maiti & Perlmutter, 2023; Neilson et al., 2025)

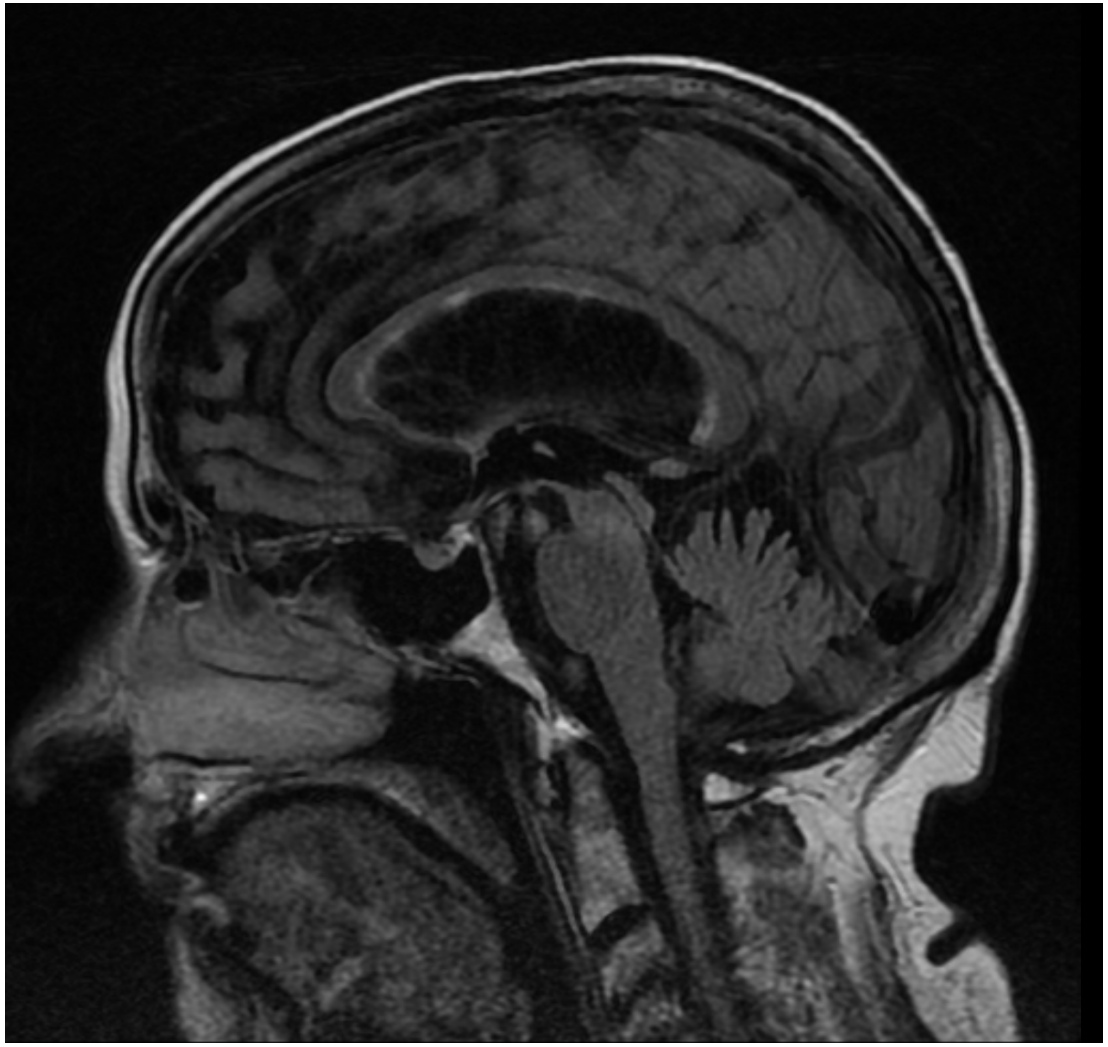
MRI Example: Progressive Supranuclear Palsy (PSP)

- Teaching Points:
  - Midbrain atrophy with preserved pons
  - 'Hummingbird sign' or 'Penguin sign' on sagittal MRI
  - 'Mickey Mouse' sign on axial MRI
  - Correlates with early falls and gaze palsy

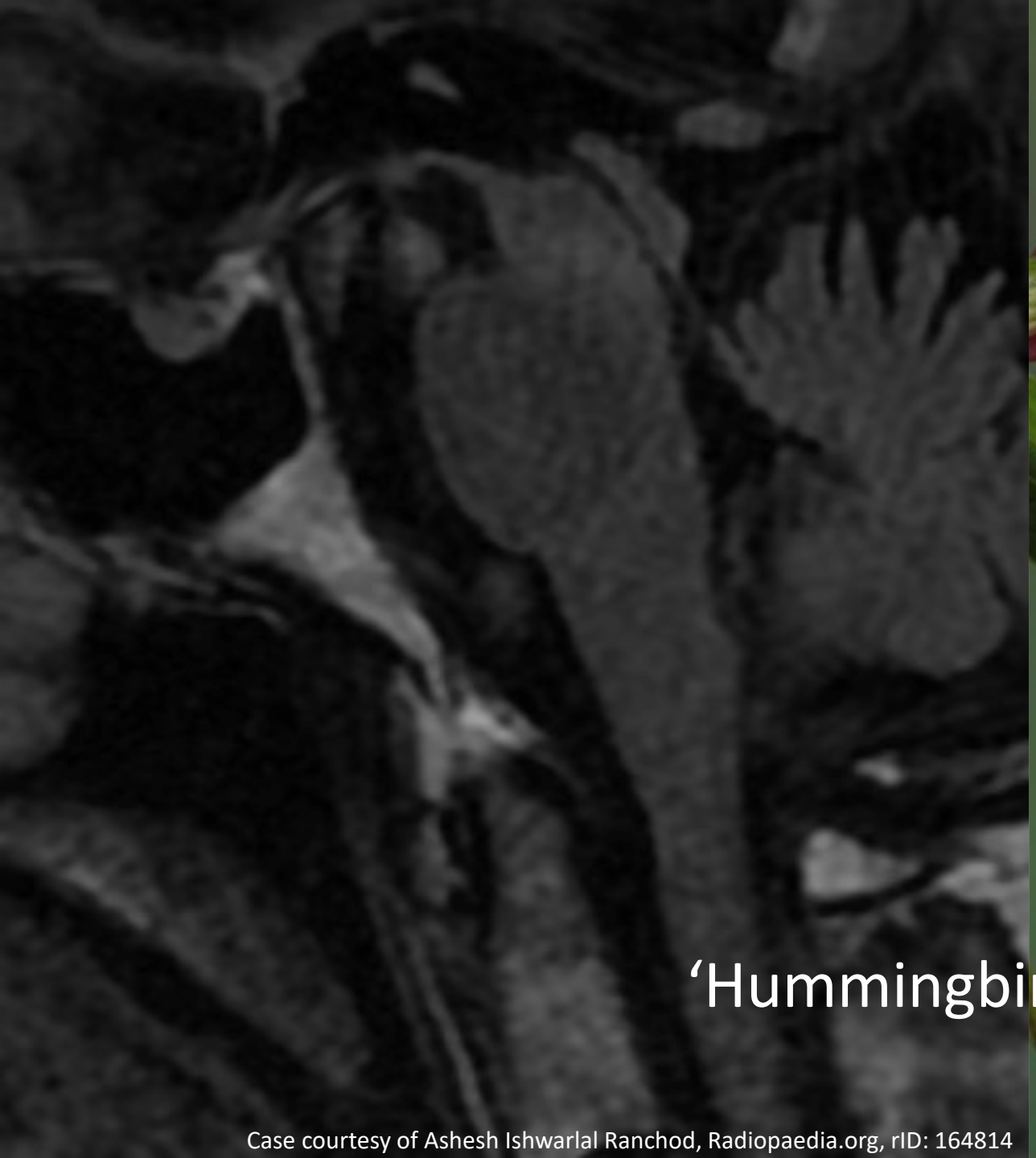
Clinical Pearl:

- Imaging strengthens diagnosis when exam is suggestive

(Samson & Noseworthy, 2022)



Case courtesy of Ashesh Ishwarlal Ranchod, Radiopaedia.org, rID: 164814



‘Hummingbird Sign’: PSP

Case courtesy of Ashesh Ishwarlal Ranchod, Radiopaedia.org, rID: 164814

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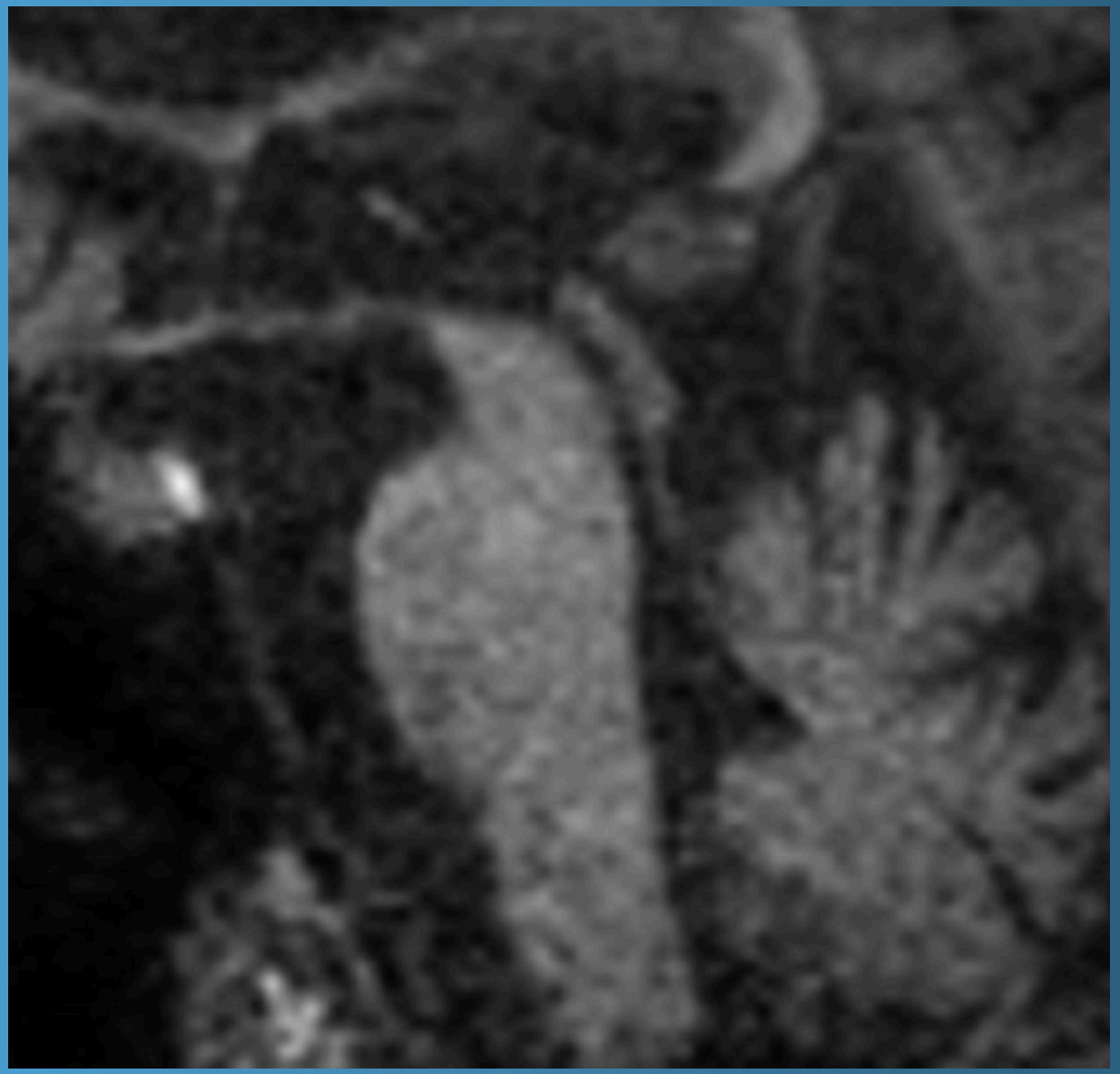
‘Penguin Sign’: PSP



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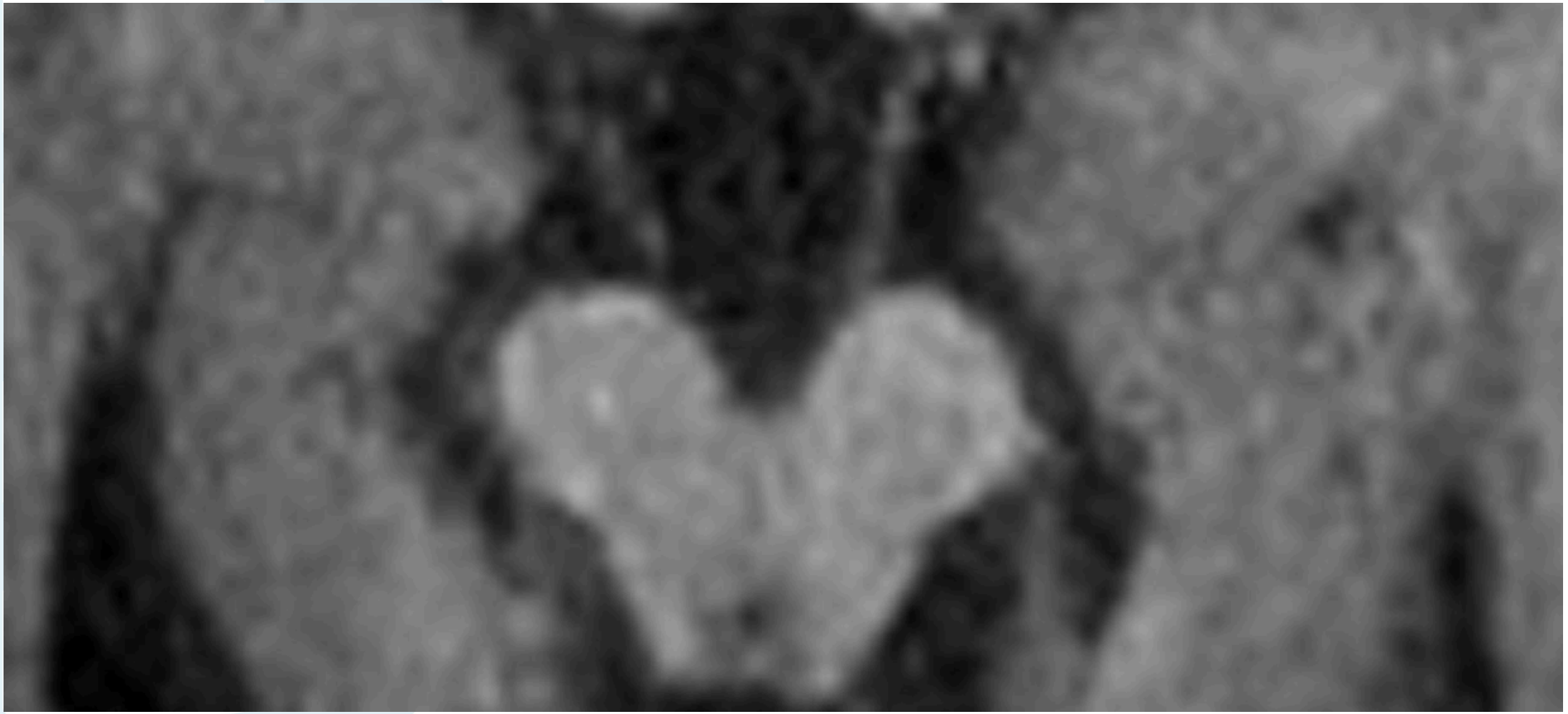
‘Mickey Mouse’ Sign: PSP



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MRI Example: Multiple System Atrophy (MSA)

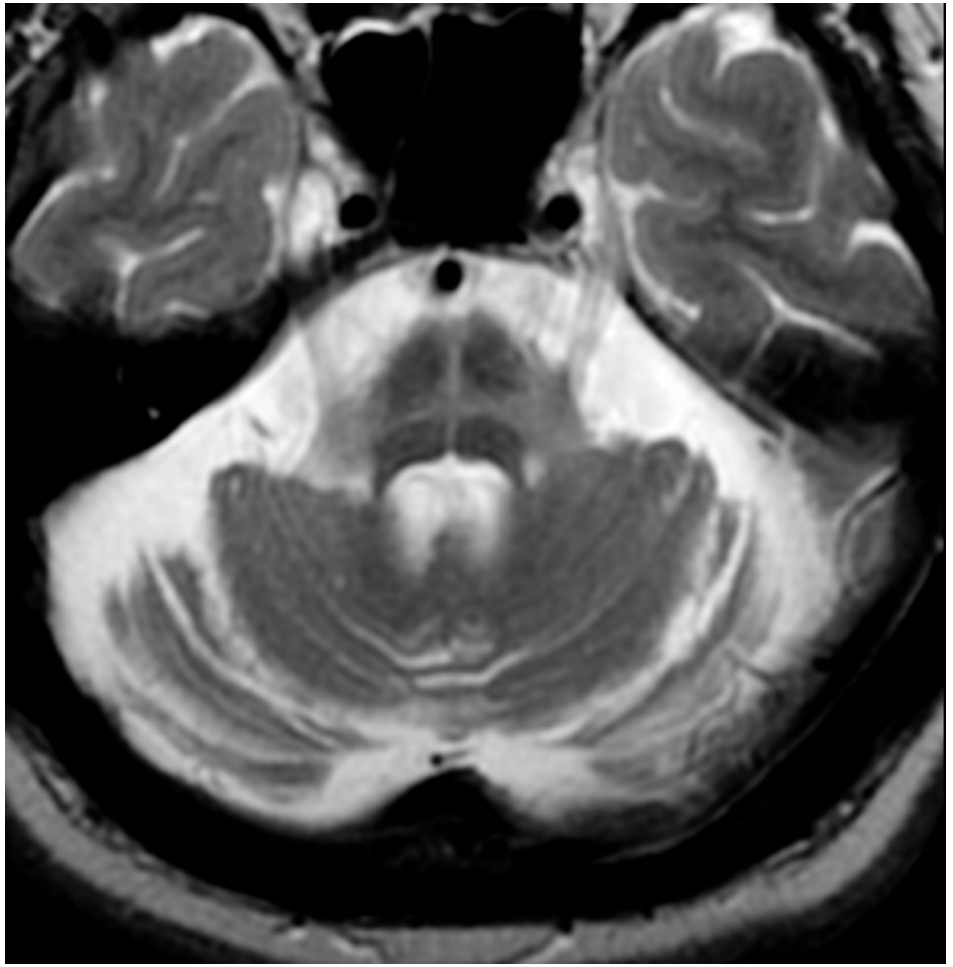
Teaching Points:

- Putaminal atrophy and T2 hypointensity
- 'Hot cross bun' sign in MSA-C
- Supports diagnosis in autonomic failure

Clinical Pearl:

- MRI findings may lag early symptoms

(Samson & Noseworthy, 2022; Maiti &Perlmutter, 2023, Neilson et al., 2025)



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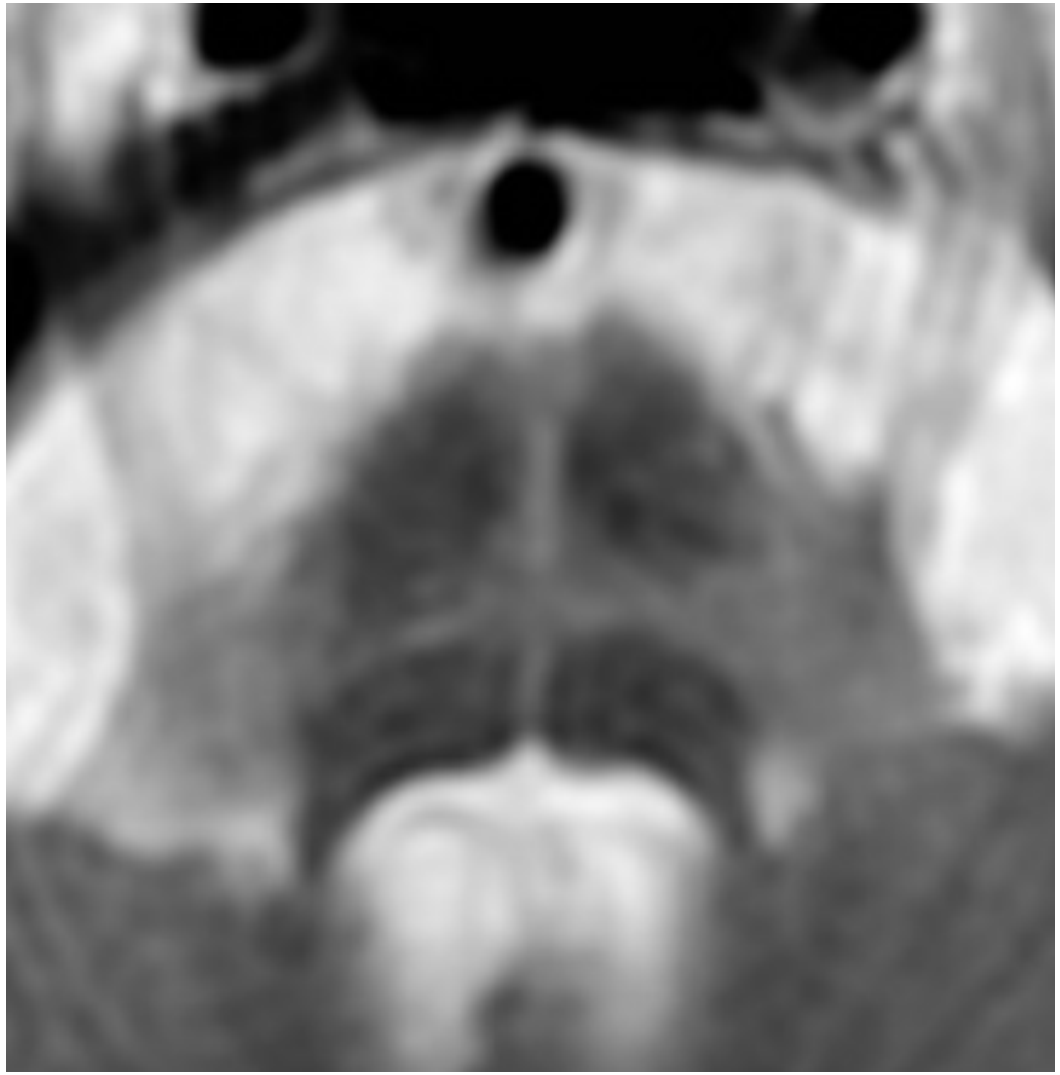
‘Hot Cross Bun’ Sign: MSA



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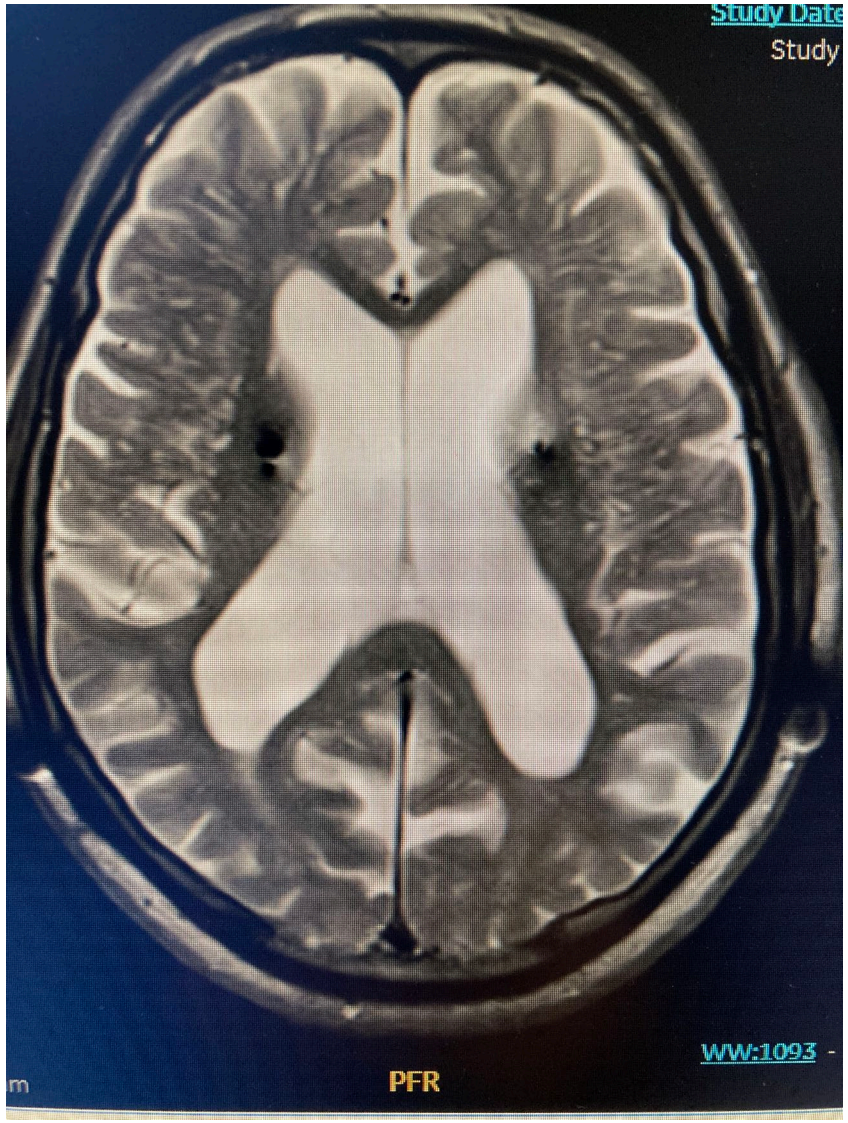
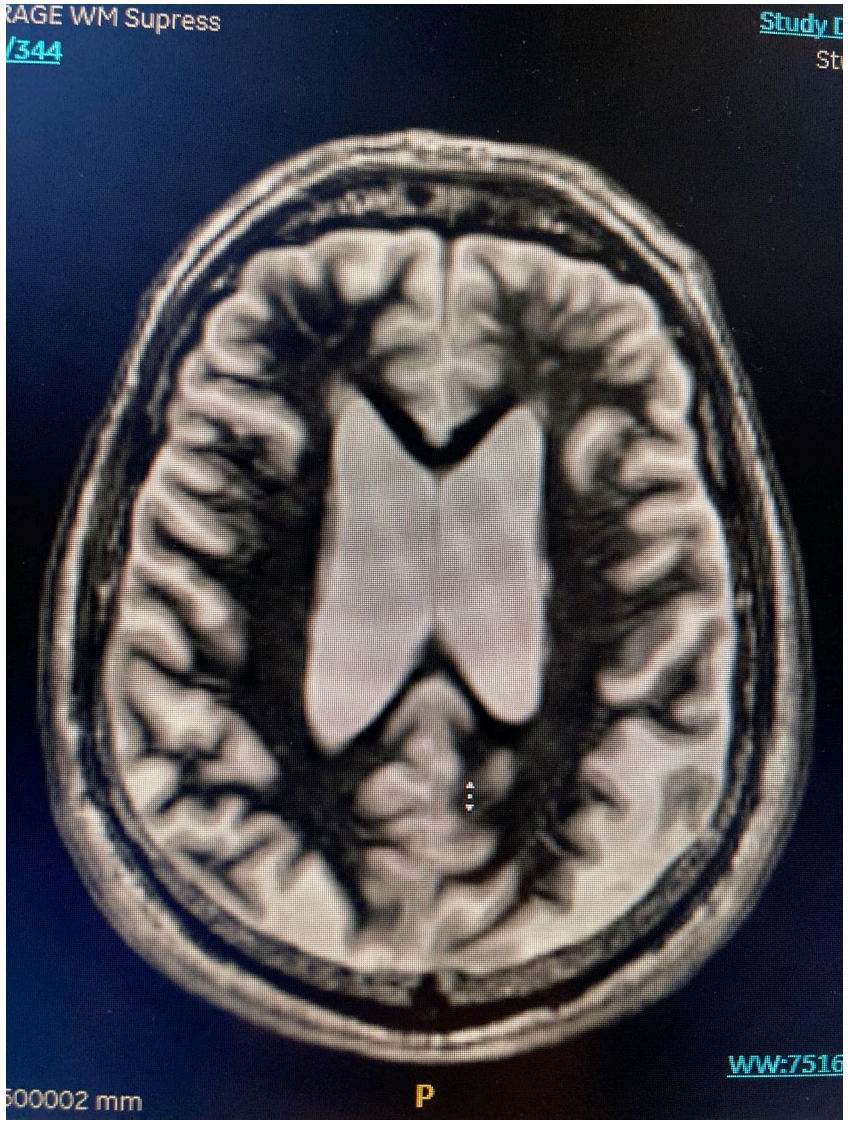
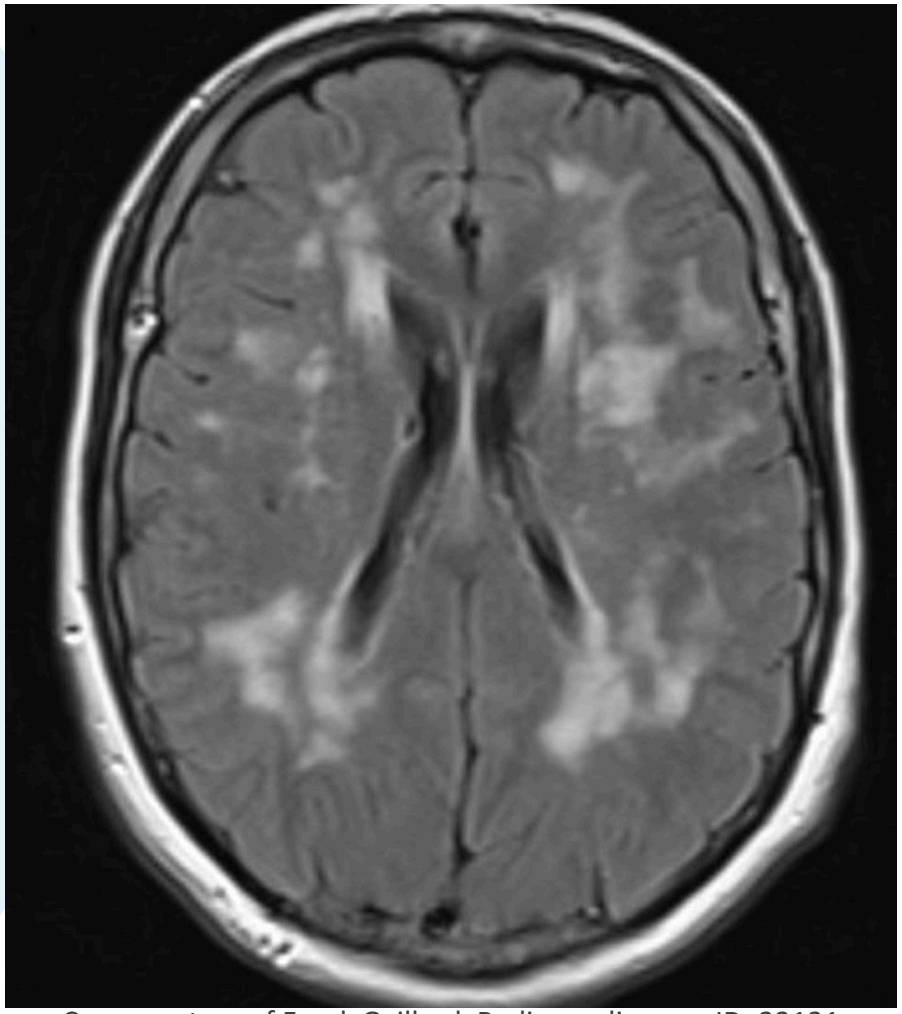
Hydrocephalus





Images courtesy of Joan Miravite

Vascular Disease: Small Vessel Ischemic Changes



Case courtesy of Frank Gaillard, Radiopaedia.org, rID: 22131

When Is CT Imaging Helpful?

Used if MRI contraindicated

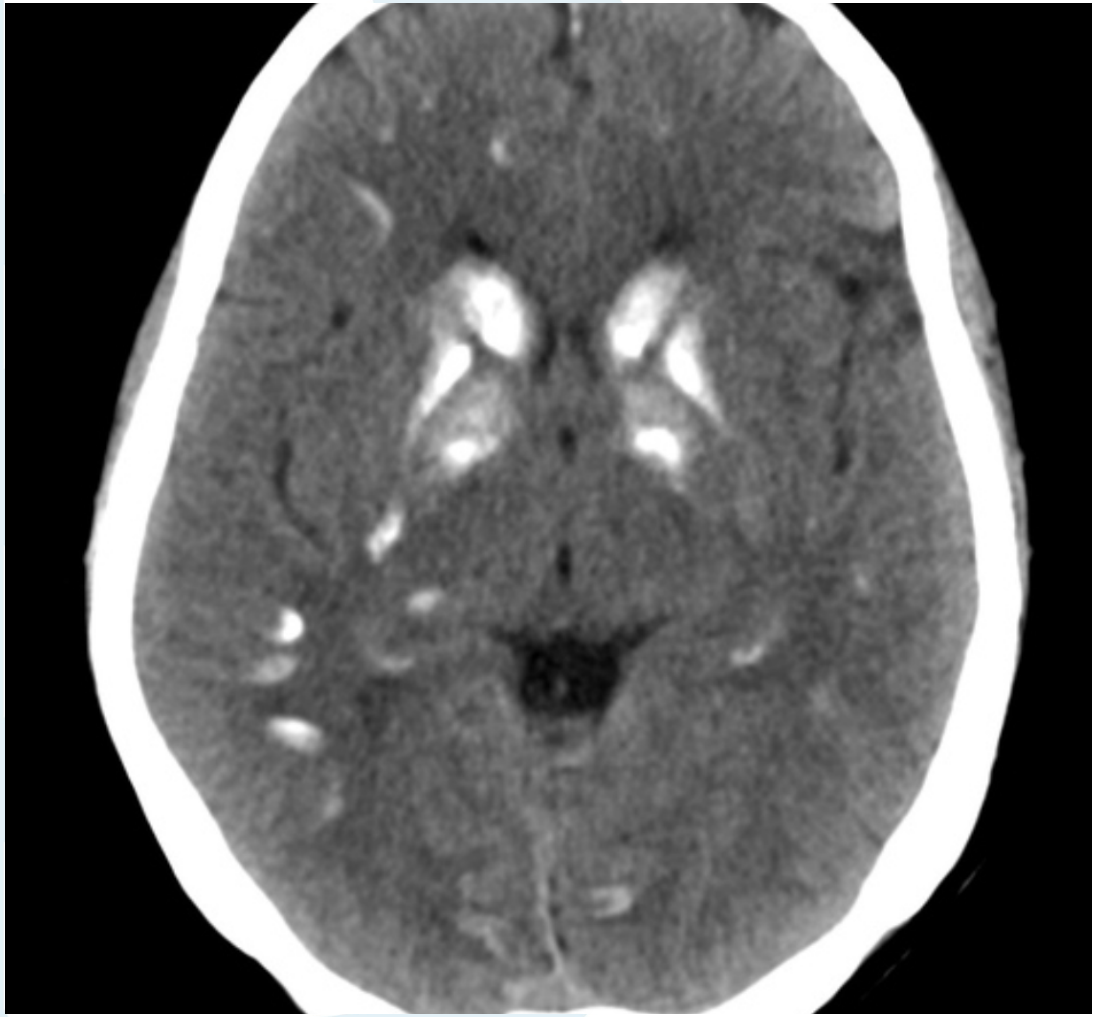
Detects hemorrhage or calcifications

Important for secondary parkinsonism

Low sensitivity for neurodegenerative disease

(Maiti & Perlmutter, 2023)

CT Example: Fahr Syndrome



Case courtesy of Dijendra Nath Biswas, Radiopaedia.org, rID: 210197

Teaching Points:

- Symmetric basal ganglia calcifications
- Can present with parkinsonism, dystonia, or cognitive change
- Key secondary diagnosis to exclude

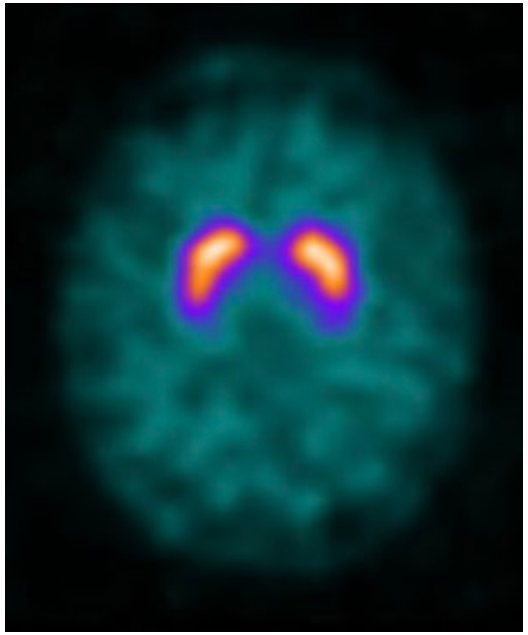
Functional and Molecular Imaging

DaT SPECT and FDG-PET

DaTscan (I-123 Ioflupane SPECT)

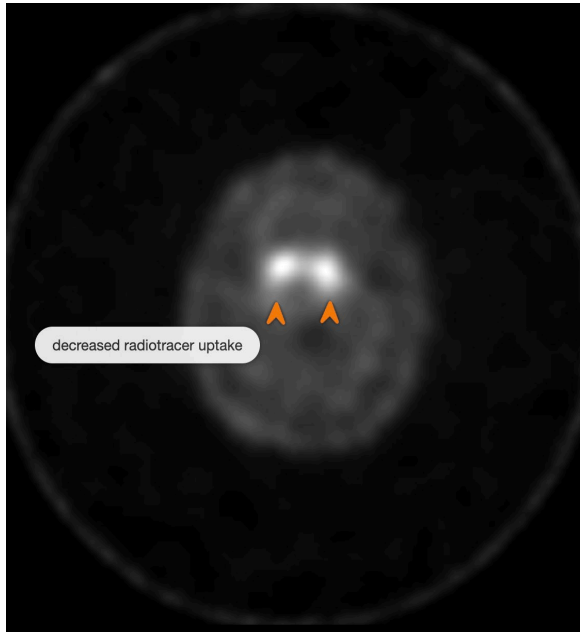
- Evaluates presynaptic dopamine transporter activity
- Abnormal = neurodegenerative parkinsonism
- Normal = essential tremor, drug-induced parkinsonism
- Does NOT distinguish PD from MSA or PSP

Normal DaT



Case courtesy of Stefan Lazic, Radiopaedia.org, rID: 158505

Positive DaT



Case courtesy of Austin Patrick, Radiopaedia.org, rID: 173581

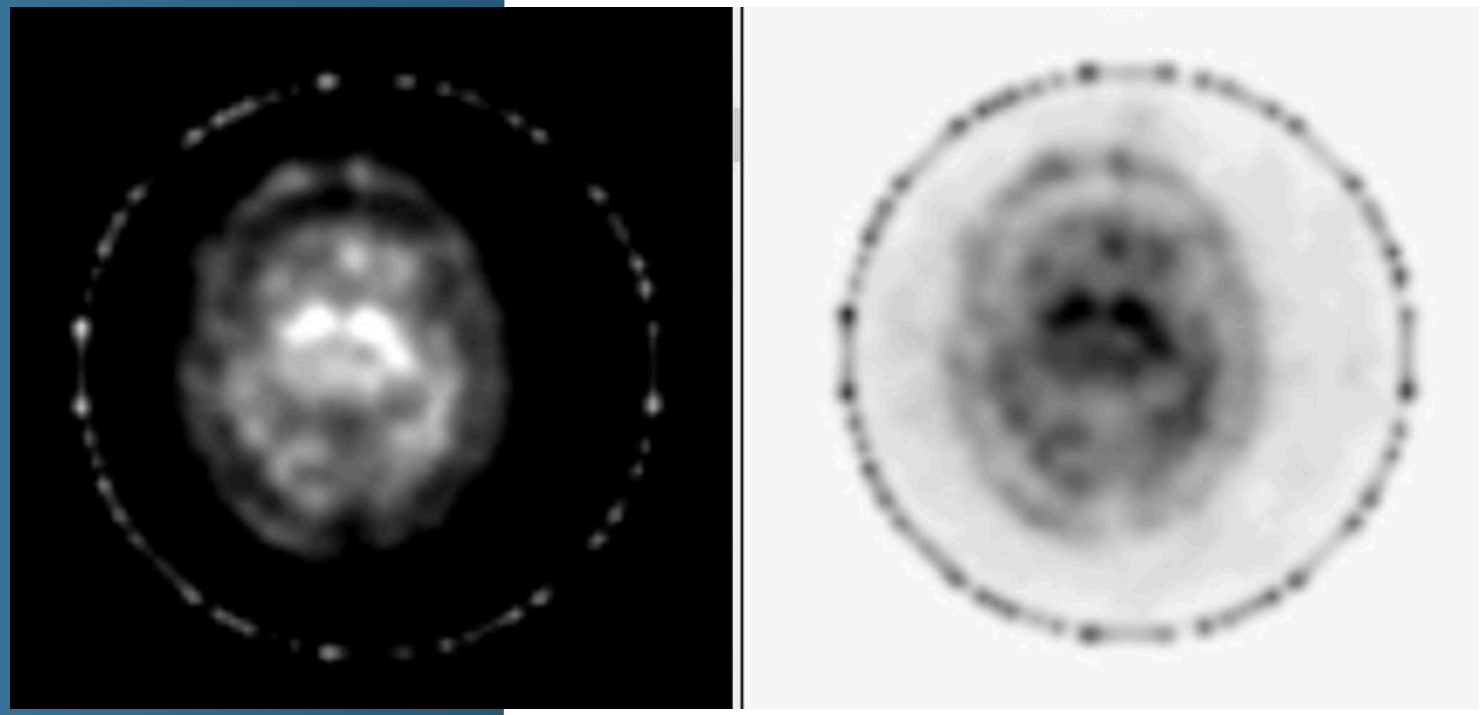
DaT SPECT Example: Parkinson's Disease

Teaching Points:

- Reduced uptake in posterior putamen
- Often asymmetric early
- Reinforces diagnosis in unclear tremor cases

APP Pearl:

- Use to answer ONE question: degenerative or not?



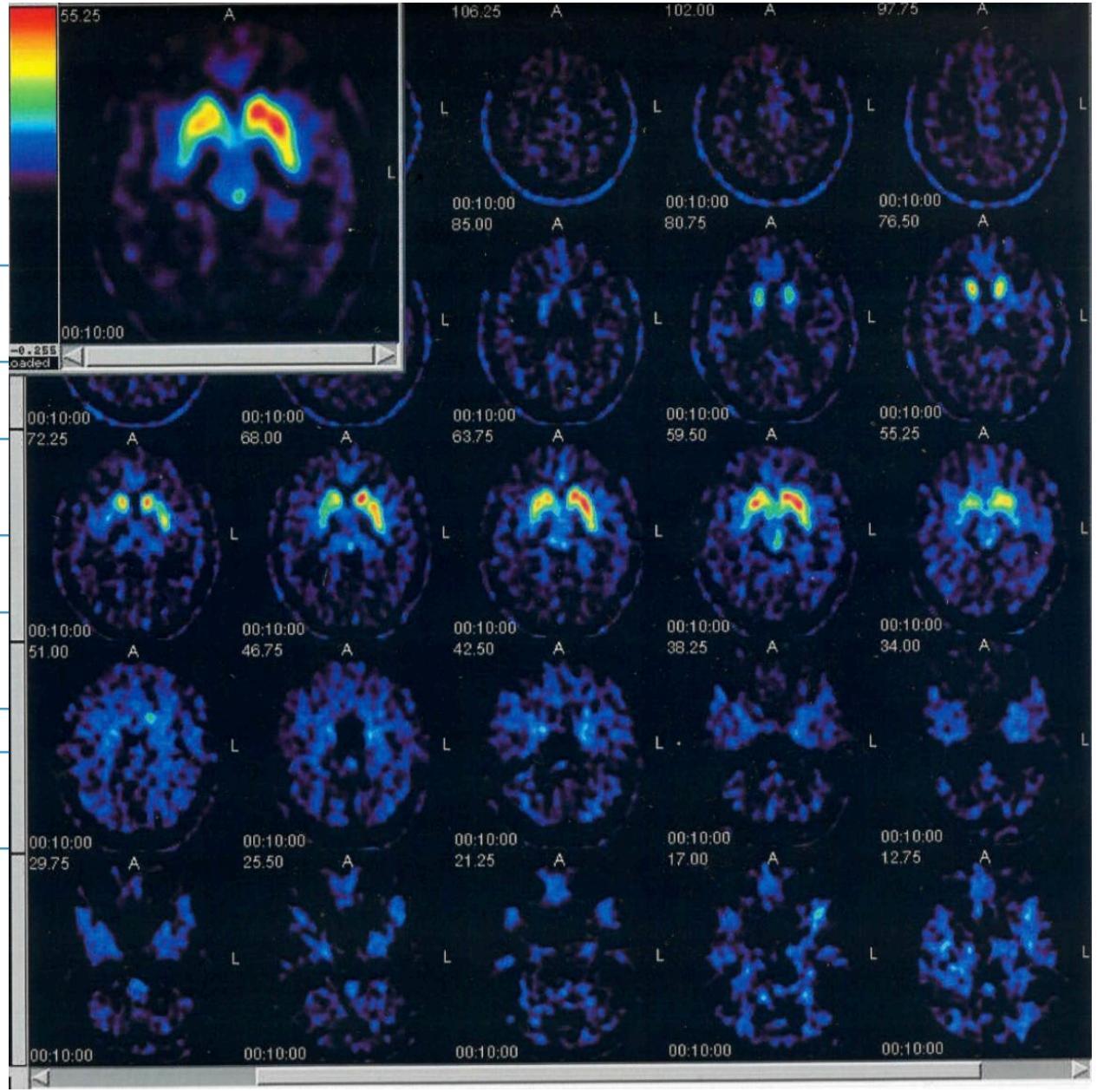
Case courtesy of Alkies Lapas, Radiopaedia.org, rID: 74175

(Neilson et al., 2025; Maiti & Perlmutter, 2023)

FDG-PET: Metabolic Imaging

- Measures cerebral glucose metabolism
- Distinct patterns for PSP, MSA, DLB
- Often ordered at tertiary centers
- Complements MRI findings

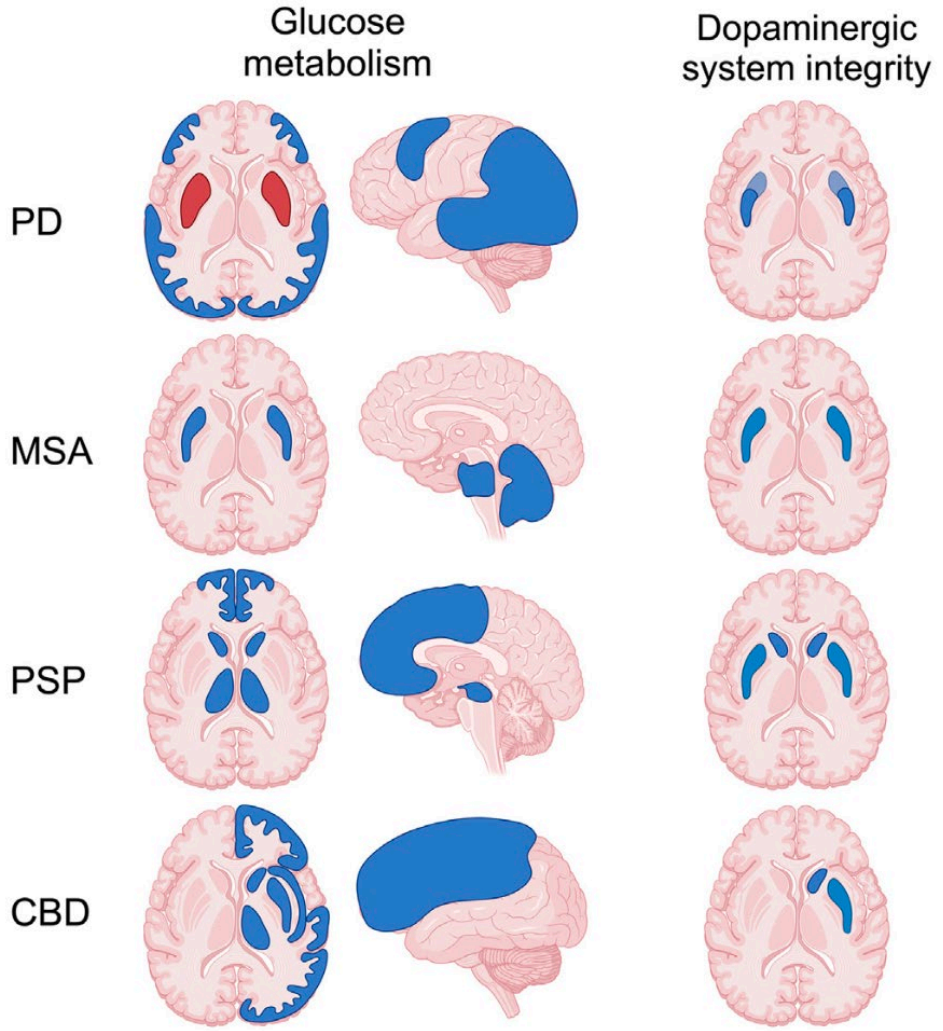
(Maiti & Perlmutter, 2023; Keir et al., 2024; Neilson et al., 2025)



Courtesy of Joan Miravite

FDG-PET Example: PSP vs MSA

- PSP: frontal and midbrain hypometabolism
- MSA: cerebellar and brainstem hypometabolism
- Pattern recognition improves accuracy



(Nerattini et al., 2025)

Case #1

A 68-year-old with action tremor and normal DaTscan.

What is the most likely diagnosis?

a) Parkinson’s disease

b) Essential tremor

c) MSA

d) PSP

Case #2

A patient with early falls, vertical gaze palsy,

and midbrain atrophy.

Which diagnosis is most likely?

a) Parkinson's disease

b) Essential tremor

c) MSA

d) PSP

Case #3

62-year-old man with 2-year history of asymmetric rest tremor, bradykinesia, mild rigidity, good levodopa response, no red flags.

Clinical Question: “Do we need imaging?”

Case #4

- 60-year-old woman with 3-year history of gait ataxia, falls, urinary incontinence, orthostatic dizziness, mild parkinsonism with poor levodopa response.
- Initial differential: late-onset cerebellar ataxia vs atypical parkinsonism.
- MRI brain: pontocerebellar atrophy, cruciform T2/FLAIR hyperintensity in pons (“hot cross bun”)

Common Pitfalls in Imaging Interpretation

- Over-reliance on 'normal MRI'
- Ordering DaT SPECT without a clear question
- Assuming imaging equals diagnosis
- Not correlating with exam and timeline

Neilson et al., 2025; Samson & Noseworthy, 2022)

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Clinical Pearls

- MRI first, functional imaging second-line
- Imaging supports—but does not replace—clinical judgment
- Guides patient counseling, prognosis and management
- Review images yourself when possible

Clinical Pearls

Question / Feature	MRI	DaT SPECT	FDG-PET
Main signal	Structure (atrophy, T2/iron)	Presynaptic dopaminergic terminals	Regional glucose metabolism (networks)
PD vs non-degenerative mimic	Limited; excludes obvious mimics.	Very good; shows or excludes dopaminergic loss.	Useful but less specific for simple “degenerative vs non-degenerative”.
PD vs Atypical PD (MSA, PSP, CBS, DLB)	Helpful if classic patterns present (midbrain, putamen, cerebellum, asymmetric cortex).	Shows loss in both PD and Atypical PD; limited for subtyping.	Strong; disease-specific hypometabolic patterns improve differentiation.
Subtyping Atypical PD (MSA vs PSP vs CBS)	Moderate; pattern-based but overlapping.	Poor; all show reduced uptake.	Good to excellent when pattern-based analysis is used.
When to order first in clinic	First-line in atypical/rapid, early falls, cerebellar or pyramidal signs.	When clinical phenomenology is unclear and question is “degenerative or not?”.	When the key question is PD vs Atypical PD or Atypical PD subtype and MRI is non-diagnostic.

Take Home Messages

- Choose imaging based on clinical question
- Recognize hallmark imaging patterns
- Use DaT SPECT appropriately
- APPs play a central role in diagnostic reasoning

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DBS Imaging

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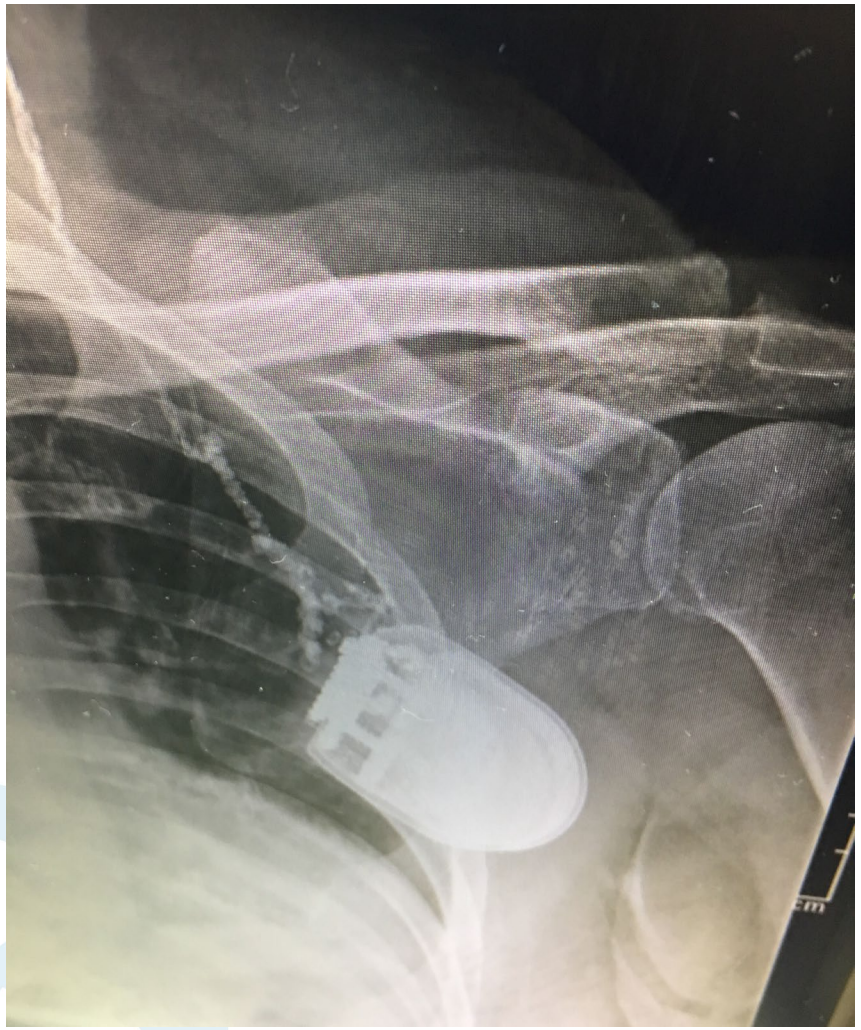
Case

A PD patient with initially excellent STN DBS benefit presents 6 months later with gradual motor decline and intermittent “DBS off” sensations.

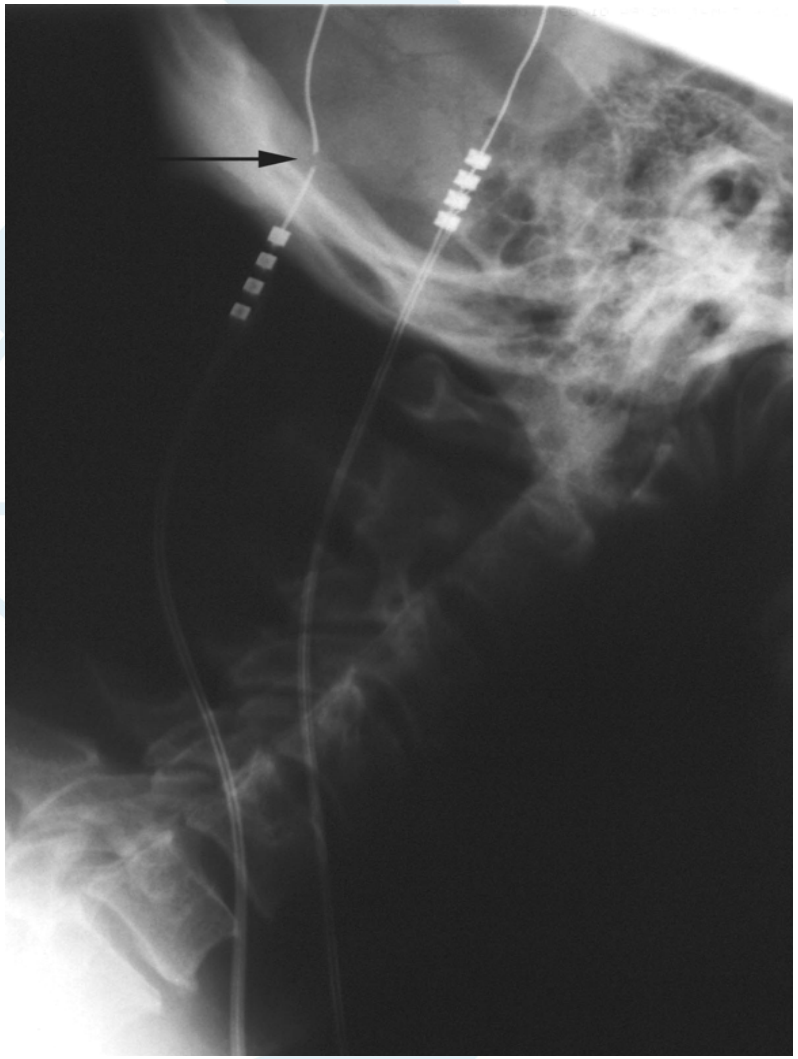
How do you assess your patient?

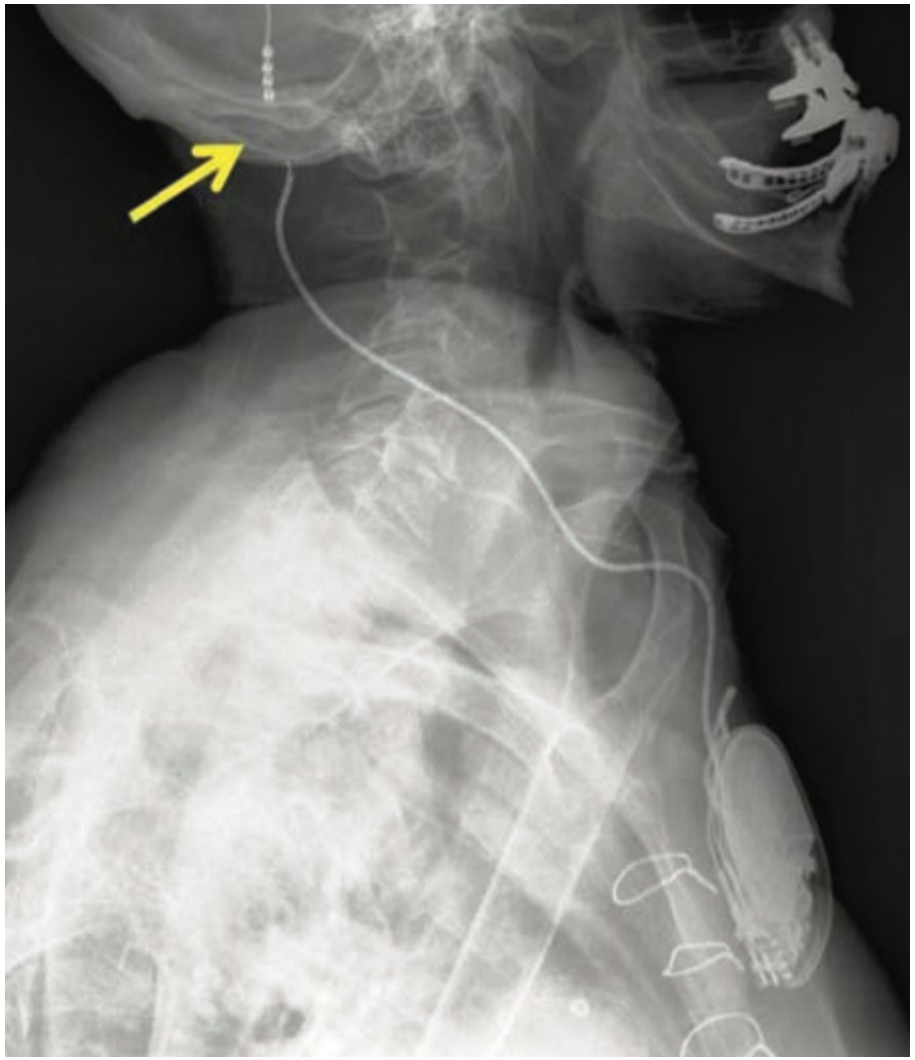
1. Ask about history of trauma
2. Rule out infection
3. Check impedances
4. Imaging

Twiddling



Lead fracture





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Wound erosion

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References

Biswas D, Fahr syndrome. Case study, Radiopaedia.org (Accessed on 12 Jan 2026) https://doi.org/10.53347/rID-210197

Gaillard F, Hot-cross bun sign of multiple system atrophy. Case study, Radiopaedia.org (Accessed on 12 Jan 2026) https://doi.org/10.53347/rID-5465

Gaillard F, CADASIL. Case study, Radiopaedia.org (Accessed on 12 Jan 2026) https://doi.org/10.53347/rID-22131

Keir, G., Roytman, M., Mashriqi, F., Shahsavarani, S., & Franceschi, A. M. (2024). Atypical Parkinsonian Syndromes: Structural, Functional, and Molecular Imaging Features. *AJNR. American Journal of Neuroradiology*, *45*(12), 1865–1877. DOI:10.3174/ajnr.A8313

Lapas A, Parkinson disease. Case study, Radiopaedia.org (Accessed on 12 Jan 2026) https://doi.org/10.53347/rID-74175

Lazic S, Normal DAT scan. Case study, Radiopaedia.org (Accessed on 12 Jan 2026) https://doi.org/10.53347/rID-158505

Maiti, B., & Perlmutter, J. S. (2023). Imaging in Movement Disorders. *Continuum (Minneapolis, Minn.)*, *29*(1), 194–218. DOI:10.1212/CON.0000000000001210

Neilson, L. E., Block, K. L., & Starkey, J. (2025). Neuroimaging of Parkinsonism and Related Disorders. Contemporary Diagnostic Radiology, 48(7), 1-8. DOI:10.1097/01.CDR.0001097840.75112.6d

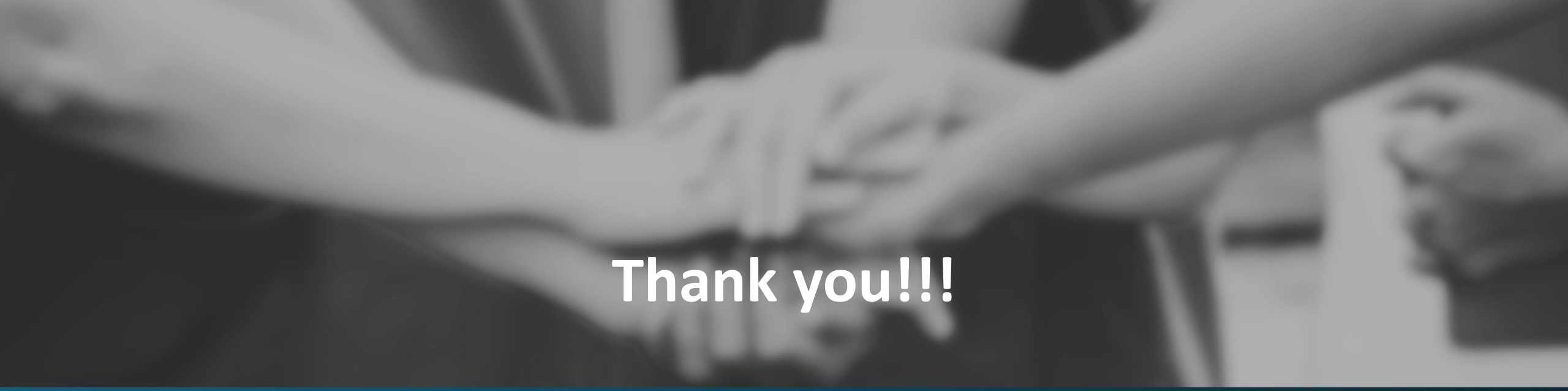
Nerattini, M., Abenavoli, E. M., & Berti, V. (2025). PET/CT in Movement Disorders: Update. *Seminars in Nuclear Medicine*, *55*(4), 565–576. DOI:10.1053/j.semnuclmed.2025.03.007

Patrick A, Parkinson disease. Case study, Radiopaedia.org (Accessed on 12 Jan 2026) https://doi.org/10.53347/rID-173581

Samson, E., & Noseworthy, M. D. (2022). A review of diagnostic imaging approaches to assessing Parkinson's disease. Brain Disord, 6, 100037. DOI: https://doi.org/10.2967/jnumed.108.059998

Schubert R, Progressive supranuclear palsy: with mickey mouse sign. Case study, Radiopaedia.org. (Accessed on 12 Jan 2026) https://doi.org/10.53347/rID-16914

Ranchod A, Progressive supranuclear palsy. Case study, Radiopaedia.org. (Accessed on 12 Jan 2026) https://doi.org/10.53347/rID-164814



Thank you!!!

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