



MR morphometry

Maurizio Morelli M.D.

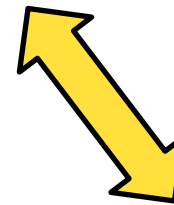
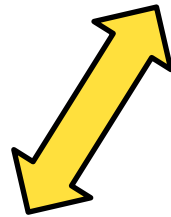
V Corso della Scuola Superiore di Neurologia - SIN
Neuroimmagini nella malattia di Parkinson e Parkinsonismi

Parkinson
disease

Differential
diagnosis

Progressive
supranuclear
palsy

Multiple
system
atrophy



Clinical research criteria for the diagnosis of progressive supranuclear palsy (Steele-Richardson-Olszewski syndrome): report of the NINDS-SPSP International Workshop

I. Litvan, Y. Agid, D. Calne, G. Campbell, B. Dubois, R.C. Duvoisin, C.G. Goetz, L.I. Golbe, J. Grafman, J.H. Growdon, M. Hallett, J. Jankovic, N.P. Quinn, E. Tolosa, D.S. Zee.

Postural instability with falls in the first year of onset
and vertical supranuclear gaze palsy



**Probable
PSP**

Vertical supranuclear gaze palsy
or
Postural instability with falls in the first year of onset
and slowing of vertical saccades



**Possible
PSP**











Diagnosis ?????

PD ?

PSP ?

Group A features: characteristic of Parkinson disease

Resting tremor
Bradykinesia
Rigidity
Asymmetric onset

Group B features: suggestive of alternative diagnoses

Features unusual early in the clinical course

Prominent postural instability in the first 3 years
after symptom onset

Freezing phenomena in the first 3 years

Hallucinations unrelated to medications in the first 3 years

Dementia preceding motor symptoms or in the first year

Supranuclear gaze palsy (other than restriction of upward gaze) or
slowing of vertical saccades

Severe, symptomatic dysautonomia unrelated to medications

Documentation of a condition known to produce parkinsonism
and plausibly connected to the patient's symptoms (such as
suitably located focal brain lesions or neuroleptic use within
the past 6 months)

Gelb DJ et al. Arch Neurol 1999;56:33-9

Table 3 NINDS-SPSP clinical criteria for the diagnosis of PSP

PSP	Mandatory inclusion criteria
Possible	Gradually progressive disorder Onset at age 40 or later
	<i>Either vertical (upward or downward gaze) supranuclear palsy* or both slowing of vertical saccades* and prominent postural instability with falls in the first year of disease onset</i> No evidence of other diseases that could explain the foregoing features, as indicated by mandatory exclusion criteria
Probable	Gradually progressive disorder
	Onset at age 40 or later Vertical (upward or downward gaze) supranuclear palsy* and prominent postural instability with falls in the first year of disease onset*

Litvan I et al. Neurology 1996;47:1-9

Giovanni Rizzo, MD
 Massimiliano Copetti, PhD
 Simona Arcuti, PhD
 Davide Martino, MD
 Andrea Fontana, MSc
 Giancarlo Logroscino, MD

Accuracy of clinical diagnosis of Parkinson disease

A systematic review and meta-analysis

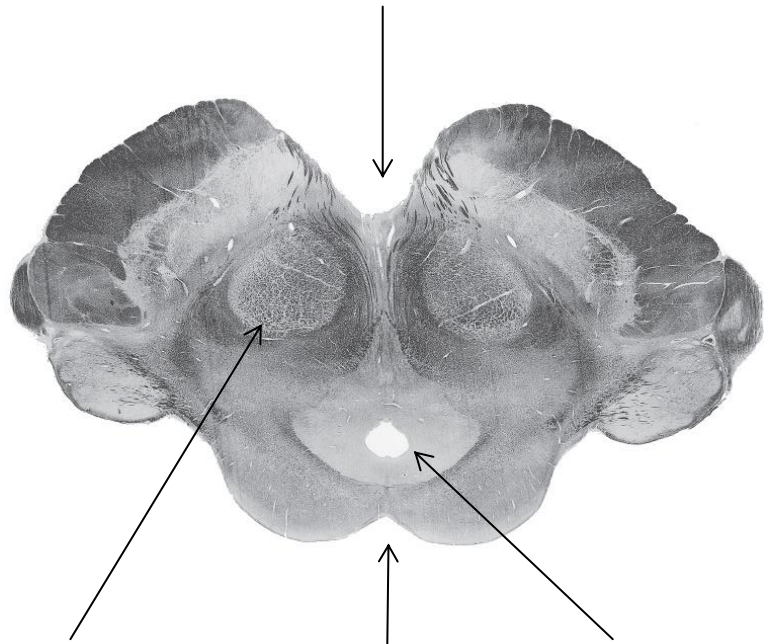
Study name	TP/FN/FP/TN	Info	ACC% [95% CrI]
Ref #11 record 1	28/3/15/13	ADH	69.10 [56.90 , 80.00]
Ref #11 record 2	31/0/10/18	AFH	82.40 [71.60 , 90.30]
Ref #12	73/3/16/8	AGH	80.60 [72.30 , 87.50]
Ref #13	52/24/4/20	AFH	71.70 [62.40 , 79.80]
Ref #14 record 1	11/4/13/77	AEH	83.50 [75.80 , 89.60]
Ref #14 record 2	14/1/21/69	ADH	78.70 [70.20 , 85.70]
Ref #14 record 3	12/3/7/83	AFH	89.90 [83.40 , 94.80]
Ref #17	81/9/7/3	AGH	83.60 [75.60 , 89.90]
Ref #19	72/7/1/63	AFH	94.00 [89.30 , 97.00]
Ref #29	111/15/20/54	BDI	82.20 [76.50 , 87.00]
Ref #30 *	7/9/6/17	BFH	61.20 [45.80 , 74.90]
Ref #2 record 1	33/4/13/16	BEL	73.80 [62.40 , 83.30]
Ref #2 record 2	28/5/18/15	RFI	64.80 [52.80 , 75.60]



MR midbrain signs in PSP

Interpeduncular fossa enlargement

Yekhlief F et al. J Neural Transm 2003;110:151-69



Atrophy or signal increase in red nuclei

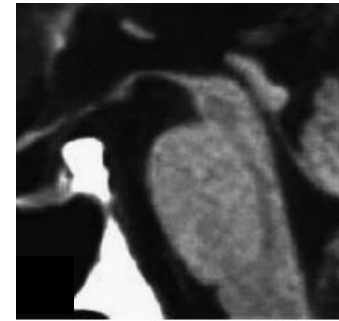
Asato R et al. J Neural Transm 2000;107:1427-36

Aqueduct enlargement with gray matter hyperintensity

Savoirdo M et al. J Neural Transm 1994;42:93-110

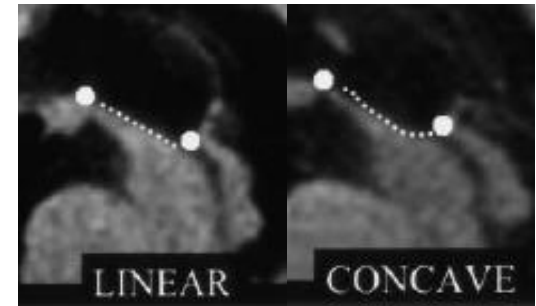
Atrophy of the superior colliculi with intercollicular sulcus enlargement

Colosimo C et al. Radiol Med 2003;106:19-23



Hummingbird Sign

Kato N et al. J Neurol Sci 2003;210:57-60



Abnormal superior profile of the midbrain

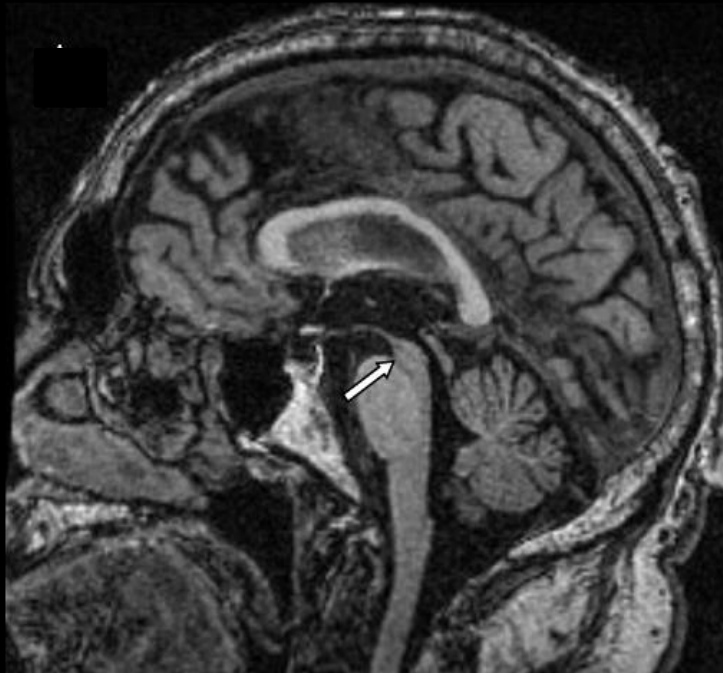
Righini A et al. AJNR 2004;25:927-32



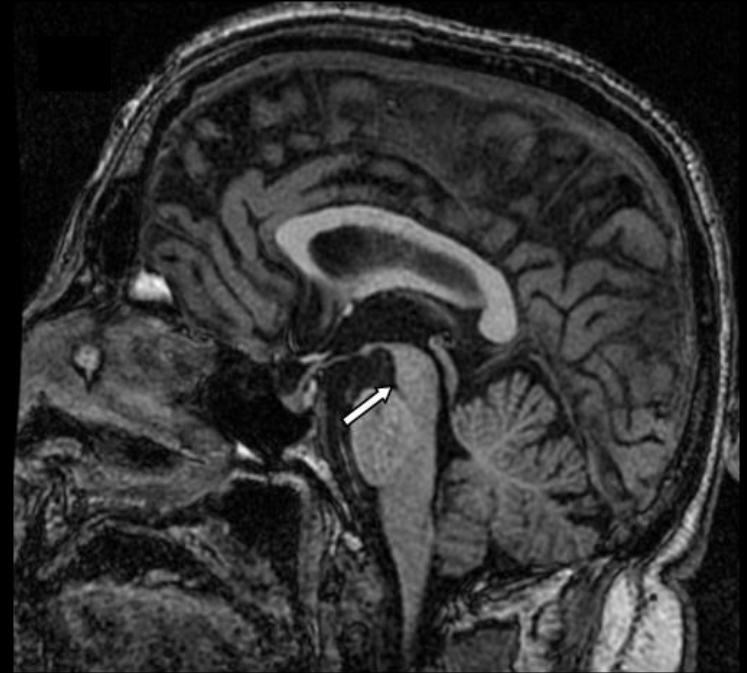
Morning Glory sign

Adachi M et al. Magn Reson Med Sci 2005;3:125-32

Conventional MR imaging

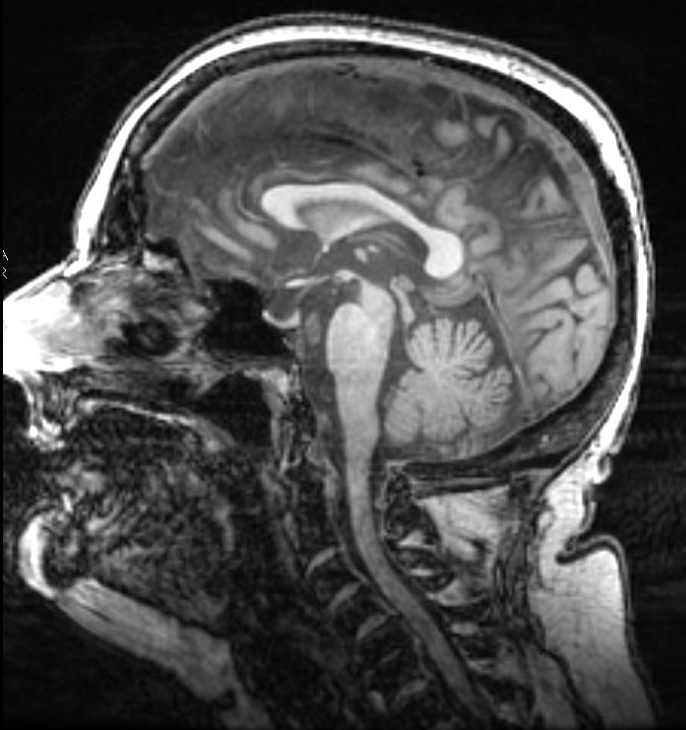


Progressive supranuclear palsy

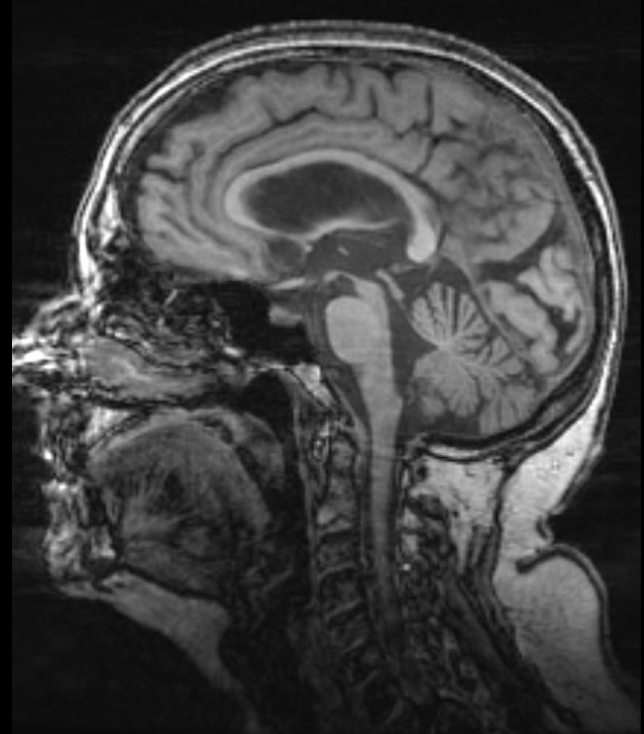


Parkinson disease

Conventional MR imaging



Progressive supranuclear palsy



Parkinson disease

Effect of Aging on Magnetic Resonance Measures Differentiating Progressive Supranuclear Palsy From Parkinson's Disease

Maurizio Morelli, MD,^{1¶} Gennarina Arabia, MD, MSc,^{1¶} Demetrio Messina, MD,² Basilio Vescio, PhD,³ Maria Salsone, MD,¹ Carmelina Chiriaco, PhD,³ Paolo Perrotta, MD,³ Federico Rocca, PhD,³ Giuseppe Lucio Cascini, MD,⁴ Gaetano Barbagallo, MD,¹ Salvatore Nigro, PhD,³ and Aldo Quattrone, MD^{1,3*}

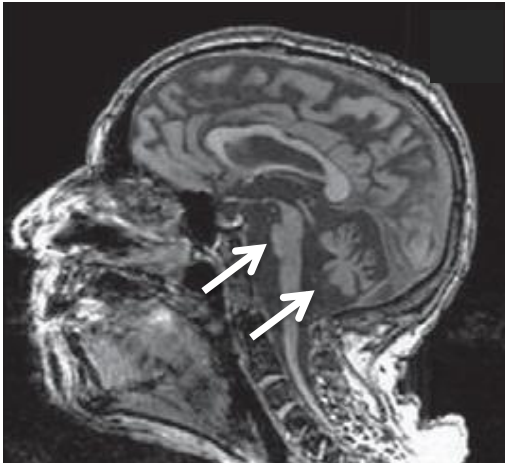
Correlation of age with single and combined magnetic resonance imaging measurements

Group	Pons		Midbrain	MCP	SCP	M/P	MRPI
Controls							
<i>P</i> value	0.45	→	<0.001	0.68	0.10	<0.001	0.19
Spearman's rho ^a	−0.08		−0.42	−0.05	0.18	−0.36	0.15
PD patients							
<i>P</i> value	<0.001	→	<0.001	<0.001	0.40	<0.001	0.09
Spearman's rho ^a	−0.33		−0.60	−0.29	0.07	−0.40	0.14
PSP patients							
<i>P</i> value	0.05		0.16	0.11	0.02	0.98	0.17
Spearman's rho ^a	−0.40		−0.29	−0.33	−0.46	−0.04	0.28

^aSpearman's rank correlation coefficient.

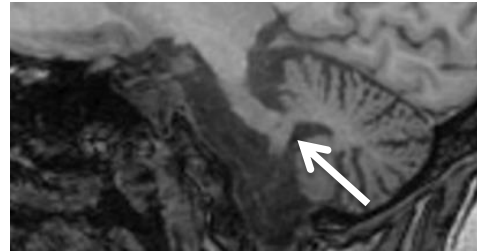
MCP, middle cerebellar peduncle width; SCP, superior cerebellar peduncle width; M/P, midbrain area to pons area ratio; MRPI, Magnetic Resonance Parkinsonism Index; PD, Parkinson's disease; PSP, progressive supranuclear palsy.





Pons and cerebellar atrophy

Schulz JB et al. J Neurol Neurosurg Psychiatry 1994;57:1047-56



MCP atrophy

Nicoletti G et al. Radiology 2006;239:825-30

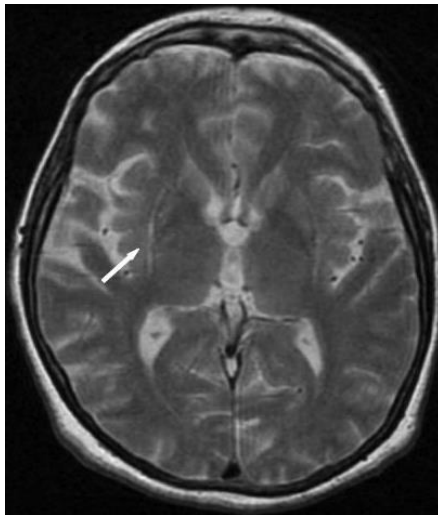
Infratentorial
abnormalities



Hot cross bun sign

Savoiardo M et al. Radiology 1990;174:693-6

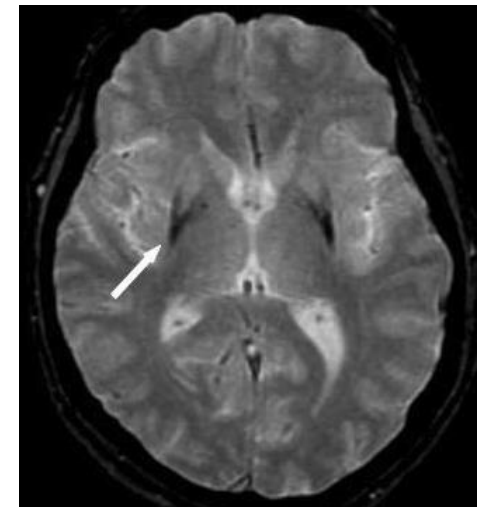
MR signs of MSA



Hyperintense putaminal rim sign

Schrag A et al. J Neurol Neurosurg Psychiatry 1998;65:65-71

Basal ganglia
abnormalities



Putaminal hypointensities

Vymazal J et al. Radiology 1999;211:489-95

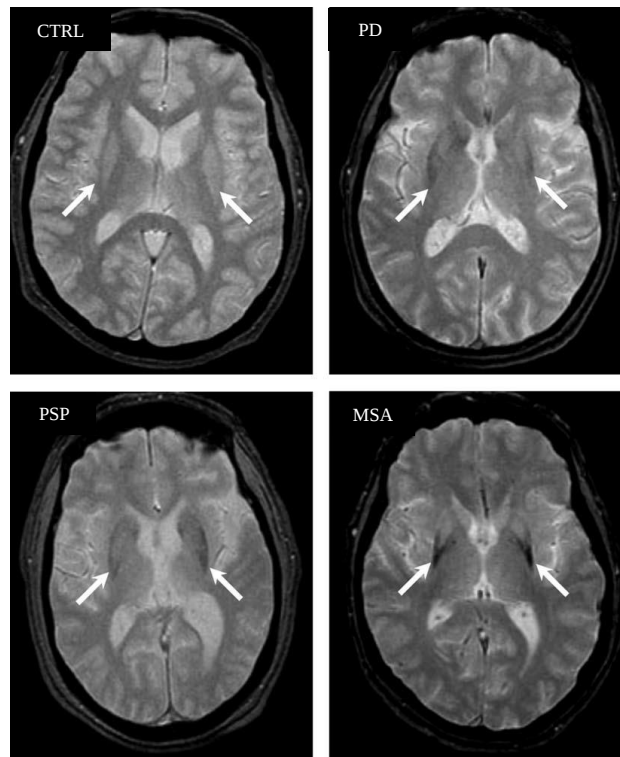
An Magnetic Resonance Imaging T2*-Weighted Sequence at Short Echo Time to Detect Putaminal Hypointensity in Parkinsonisms

Gennarina Arabia, MD, MSc, Maurizio Morelli, MD, Sandra Paglionico, MD, Fabiana Novellino, MD, Maria Salsone, MD, Laura Giofrè, MD, Giusi Torchia, STC, Giuseppe Nicoletti, MD, Demetrio Messina, MD, Francesca Condino, PhD, Pierluigi Lanza, MD, Olivier Gallo, STC, and Aldo Quattrone, MD



2010;16:2728-34

TE=15 msec



	Putaminal hypointensities
CTRL	0 %
PD	5.3 %
PSP	24.4 %
MSA	35 %

Giuseppe Nicoletti, MD
Francesco Fera, MD
Francesca Condino, PhD
William Auteri, MD
Olivier Gallo, STc
Pierfrancesco Pugliese, MD
Gennarina Arabia, MD
Letterio Morgante, MD
Paolo Barone, MD
Mario Zappia, MD
Aldo Quattrone, MD

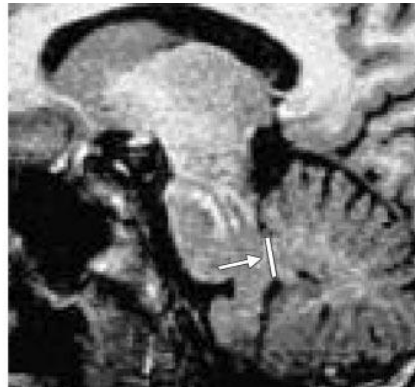
MR Imaging of Middle Cerebellar Peduncle Width: Differentiation of Multiple System Atrophy from Parkinson Disease



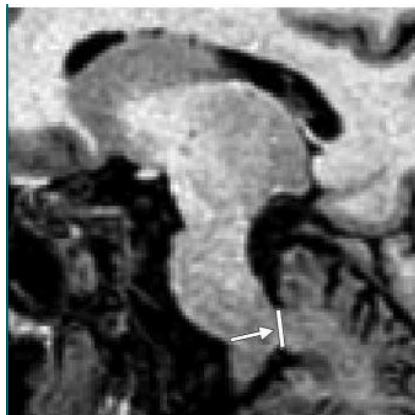
2006;239:825-30



Control



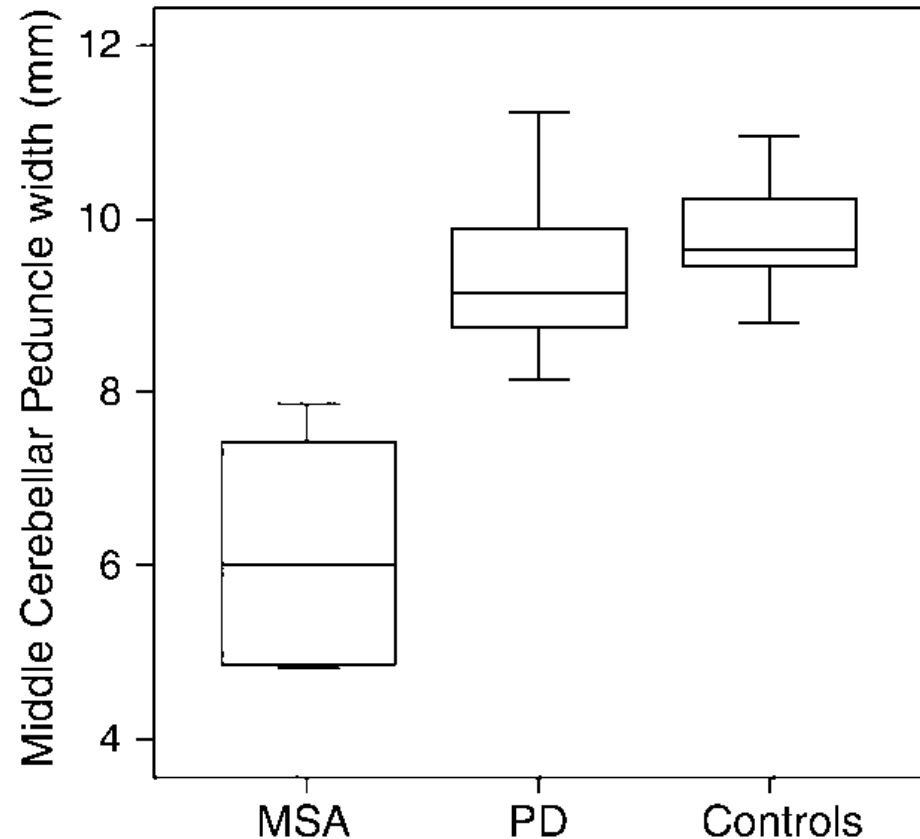
Parkinson disease



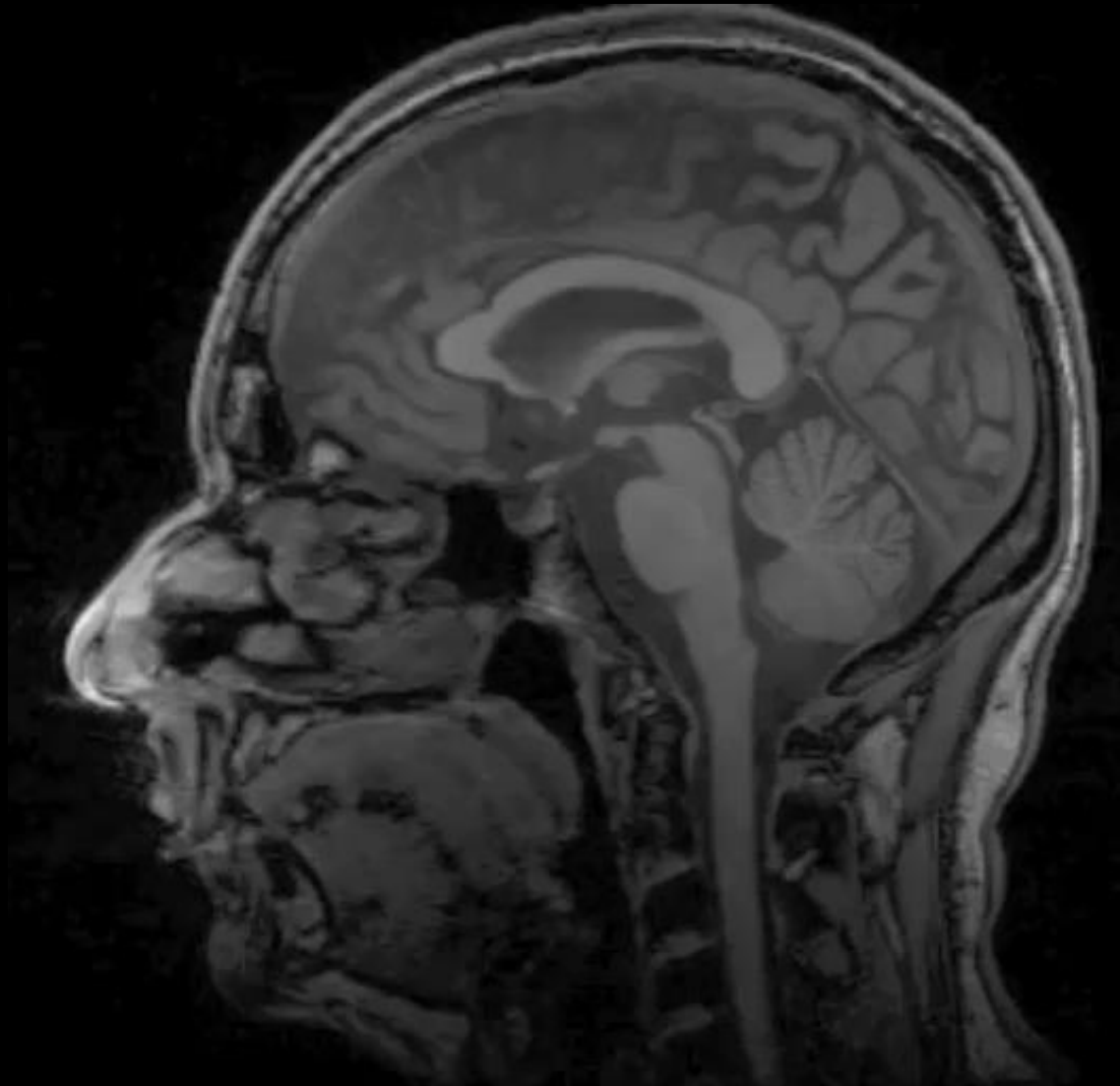
MSA-P



MSA-C



Measurement of the middle cerebellar peduncles width



Second consensus statement on the diagnosis of multiple system atrophy



Gilman S. et al.
2008;71:670-6

Probable
MSA

A sporadic, progressive, adult (> 30 y)-onset disease characterized by

- Autonomic failure involving urinary incontinence (inability to control the release of urine from the bladder, with erectile dysfunction in males) or an orthostatic decrease of blood pressure within 3 min of standing by at least 30 mm Hg systolic or 15 mm Hg diastolic *and*
- Poorly levodopa-responsive parkinsonism (bradykinesia with rigidity, tremor, or postural instability) *or*
- A cerebellar syndrome (gait ataxia with cerebellar dysarthria, limb ataxia, or cerebellar oculomotor dysfunction)

Possible
MSA

A sporadic, progressive, adult (> 30 y)-onset disease characterized by

- Parkinsonism (bradykinesia with rigidity, tremor, or postural instability) *or*
- A cerebellar syndrome (gait ataxia with cerebellar dysarthria, limb ataxia, or cerebellar oculomotor dysfunction) *and*
- At least one feature suggesting autonomic dysfunction (otherwise unexplained urinary urgency, frequency or incomplete bladder emptying, erectile dysfunction in males, or significant orthostatic blood pressure decline that does not meet the level required in probable MSA) *and*
- At least one of the additional features shown in table



Possible MSA-P or MSA-C

- Babinski sign with hyperreflexia
- Stridor

Possible MSA-P

- Rapidly progressive parkinsonism
- Poor response to levodopa
- Postural instability within 3 y of motor onset
- Gait ataxia, cerebellar dysarthria, limb ataxia, or cerebellar oculomotor dysfunction

- Dysphagia within 5 y of motor onset

- Atrophy on MRI of putamen, middle cerebellar peduncle, pons, or cerebellum
- Hypometabolism on FDG-PET in putamen, brainstem, or cerebellum

Possible MSA-C

- Parkinsonism (bradykinesia and rigidity)
- Atrophy on MRI of putamen, middle cerebellar peduncle, or pons
- Hypometabolism on FDG-PET in putamen
- Presynaptic nigrostriatal dopaminergic denervation on SPECT or PET

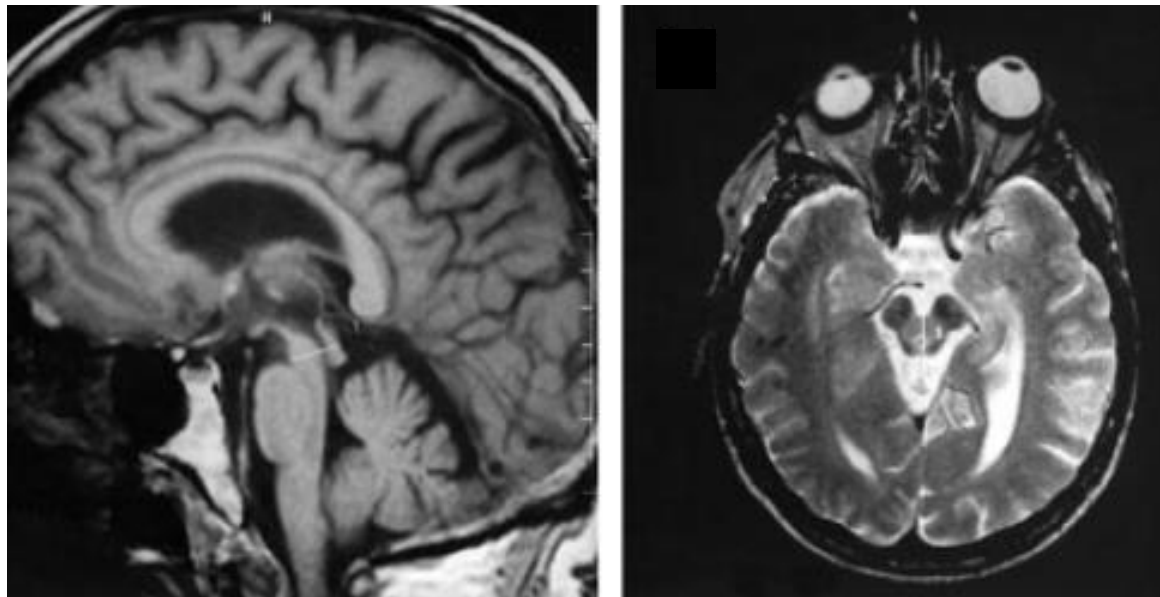
Measurement of the Midbrain Diameter on Routine Magnetic Resonance Imaging

A Simple and Accurate Method of Differentiating Between Parkinson Disease and Progressive Supranuclear Palsy

Monika Warmuth-Wetz, MD; Markus Naumann, MD; Ilona Csoti, MD; Laszlo Solymosi, MD

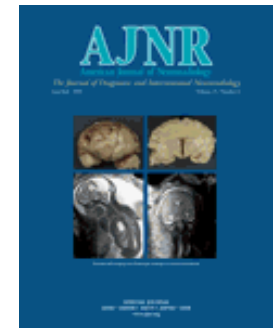


2001;58:1076-9



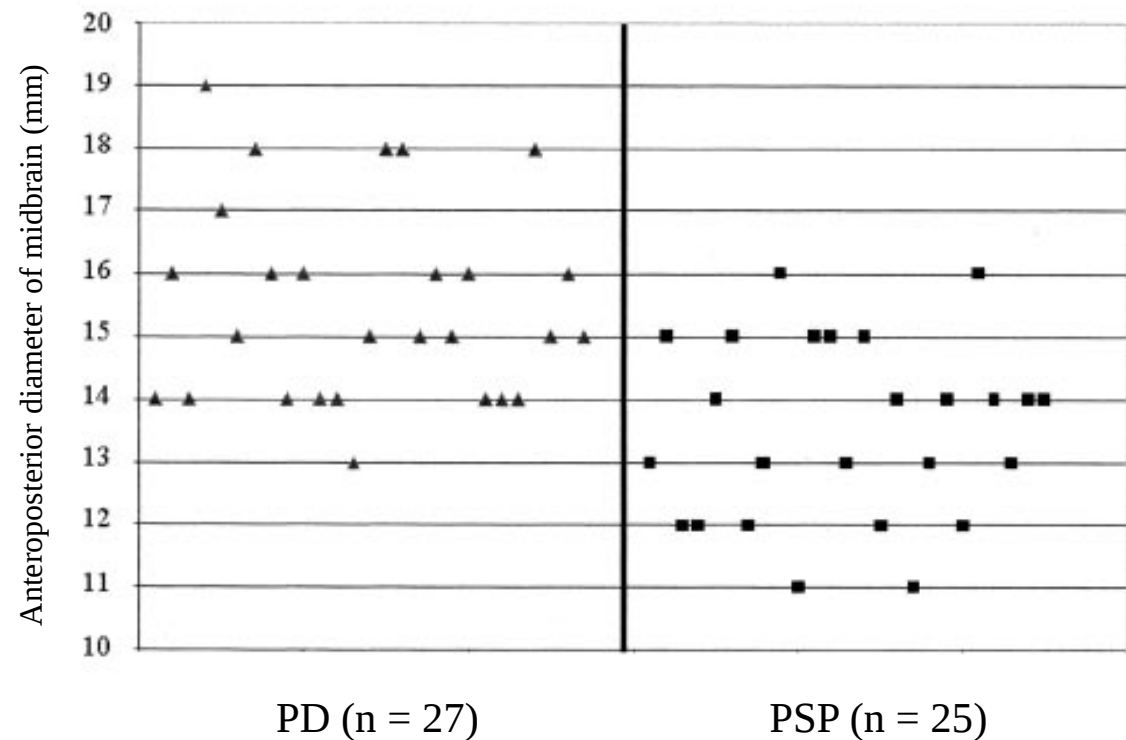
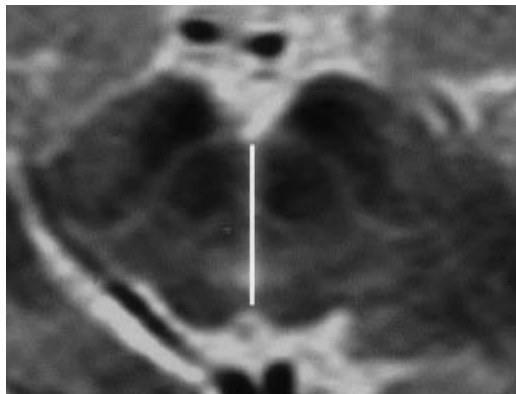
	PSP (n = 16)	MSA-P (n = 14)	PD (n = 20)	Controls (n = 12)
Midbrain diameter, mm	13.4 (11-15)	16.7 (14-19)	18.5 (17-19)	18.2 (17-20)

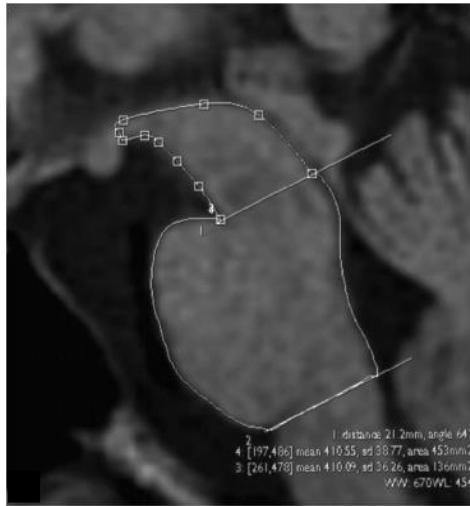
MR Imaging of the Superior Profile of the Midbrain: Differential Diagnosis between Progressive Supranuclear Palsy and Parkinson Disease



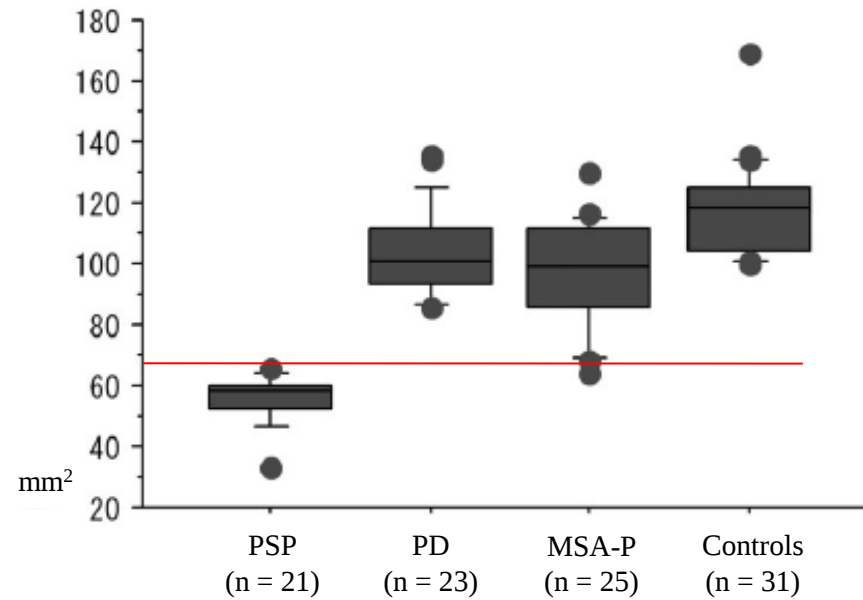
2004;25:927-32

Andrea Righini, Angelo Antonini, Roberta De Notaris, Elena Bianchini, Nicoletta Meucci, Giorgio Sacilotto, Margherita Canesi, Danilo De Gaspari, Fabio Triulzi, and Gianni Pezzoli

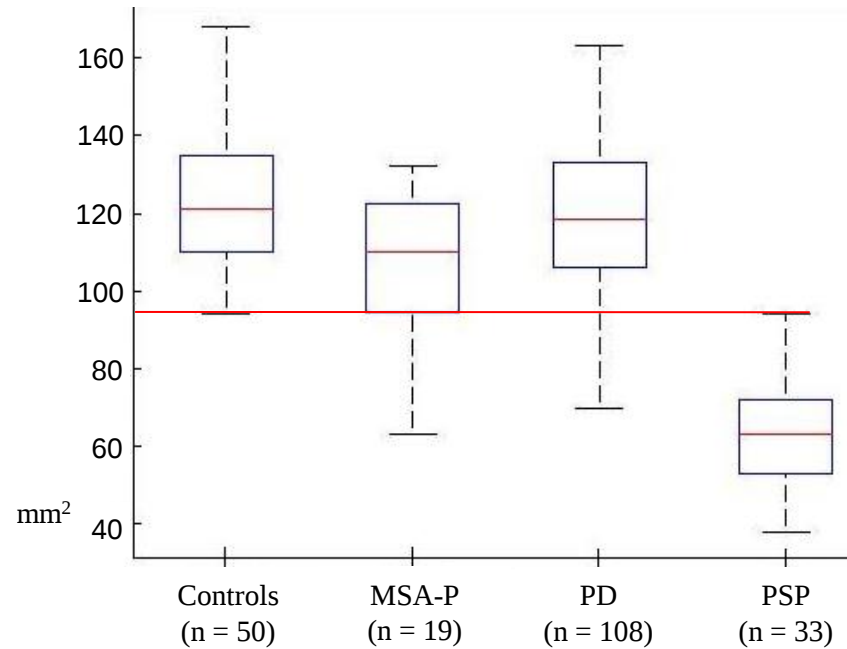




Midbrain area

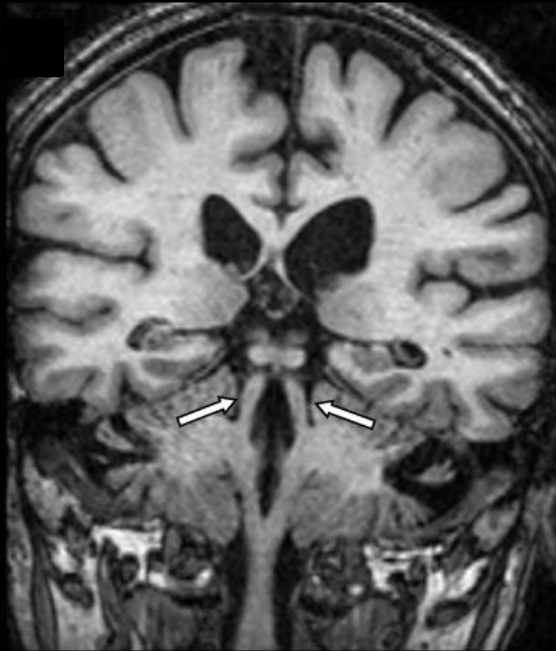


Oba H et al.
2005;64:2050-5

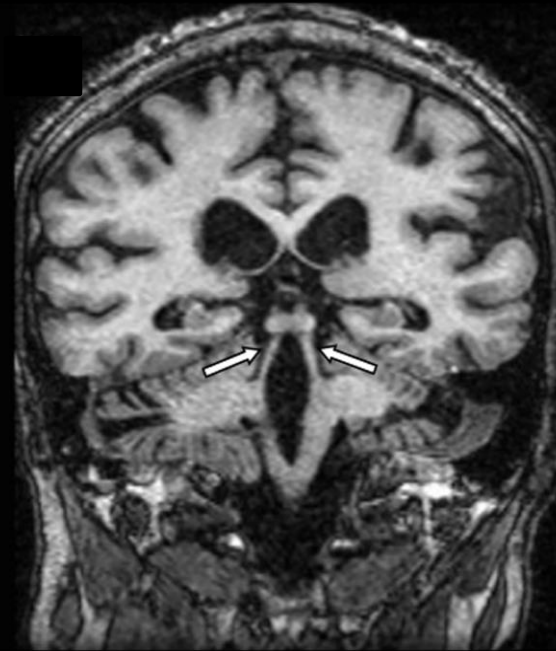


Quattrone A et al.
2008;246:214-21

Superior cerebellar peduncles width



Control



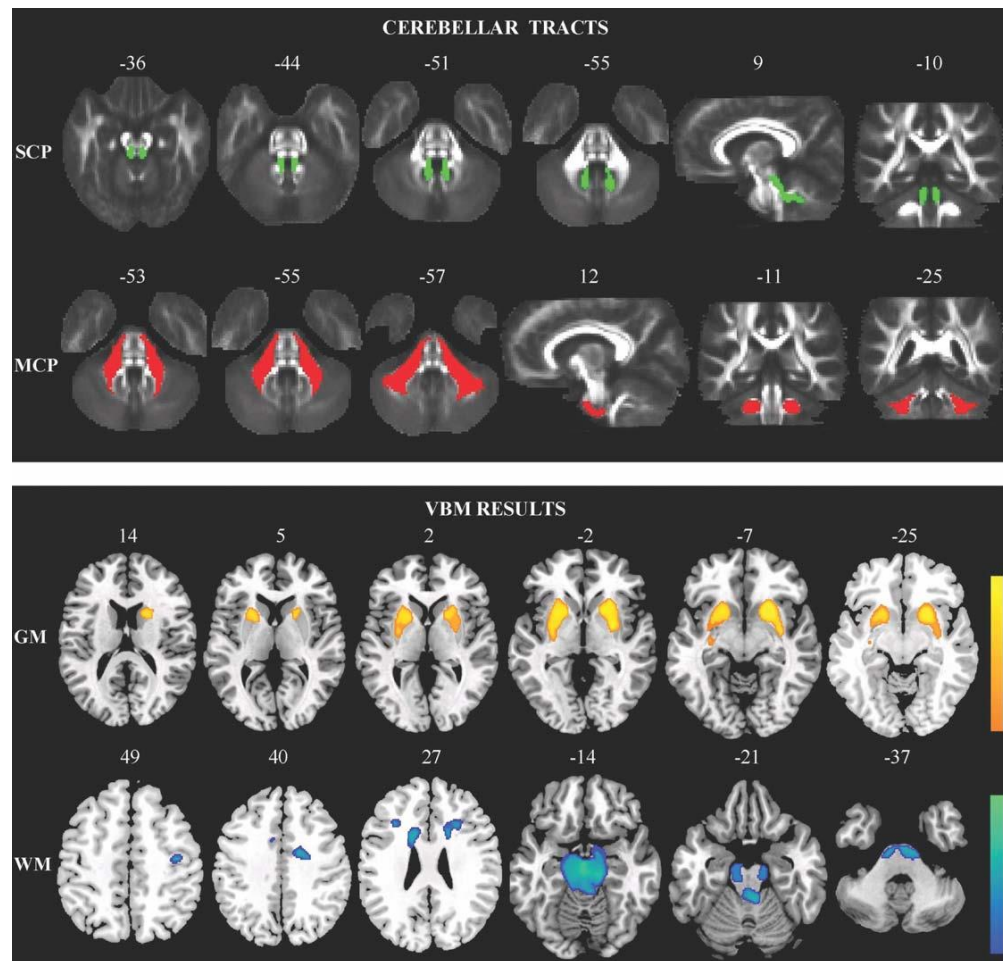
PSP

Diffusion Tensor Magnetic Resonance Imaging Tractography in Progressive Supranuclear Palsy

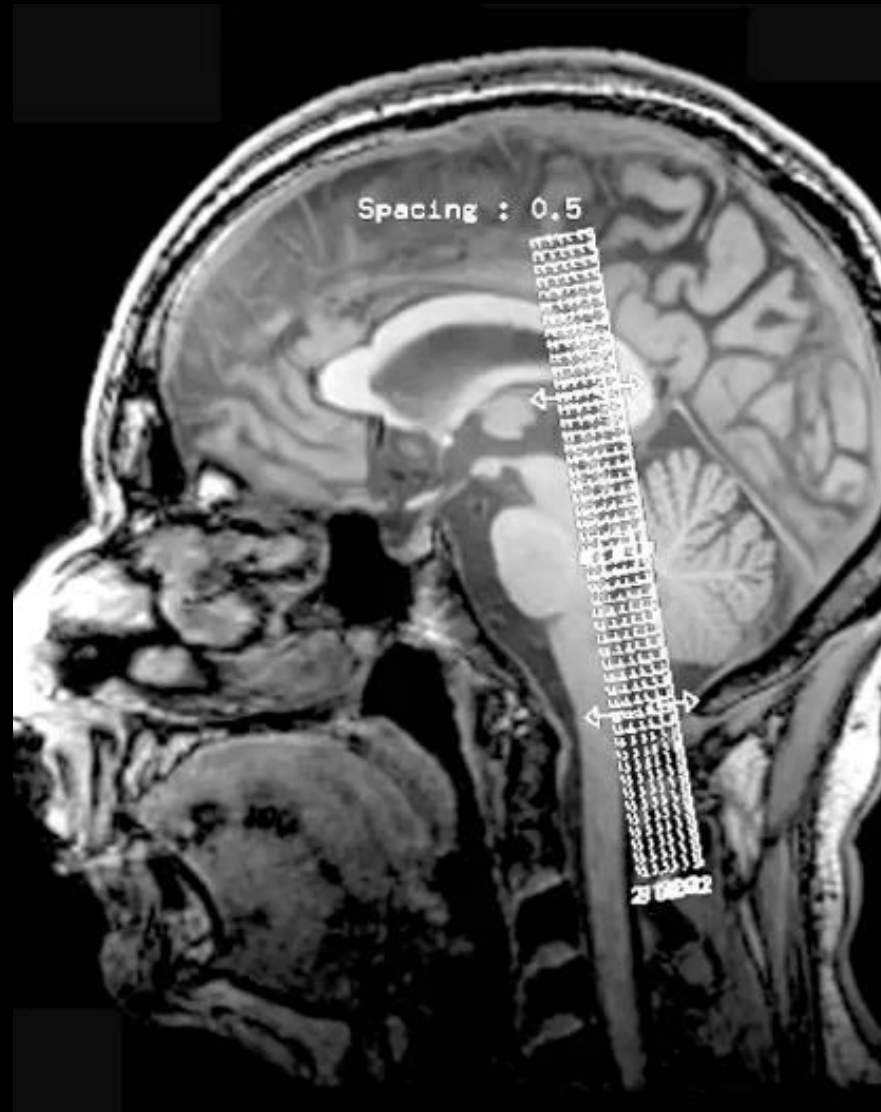
Elisa Canu, MSc, Federica Agosta, MD, Francesca Baglio, MD, Sebastiano Galantucci, MD, Raffaello Nemni, MD, Massimo Filippi, MD.



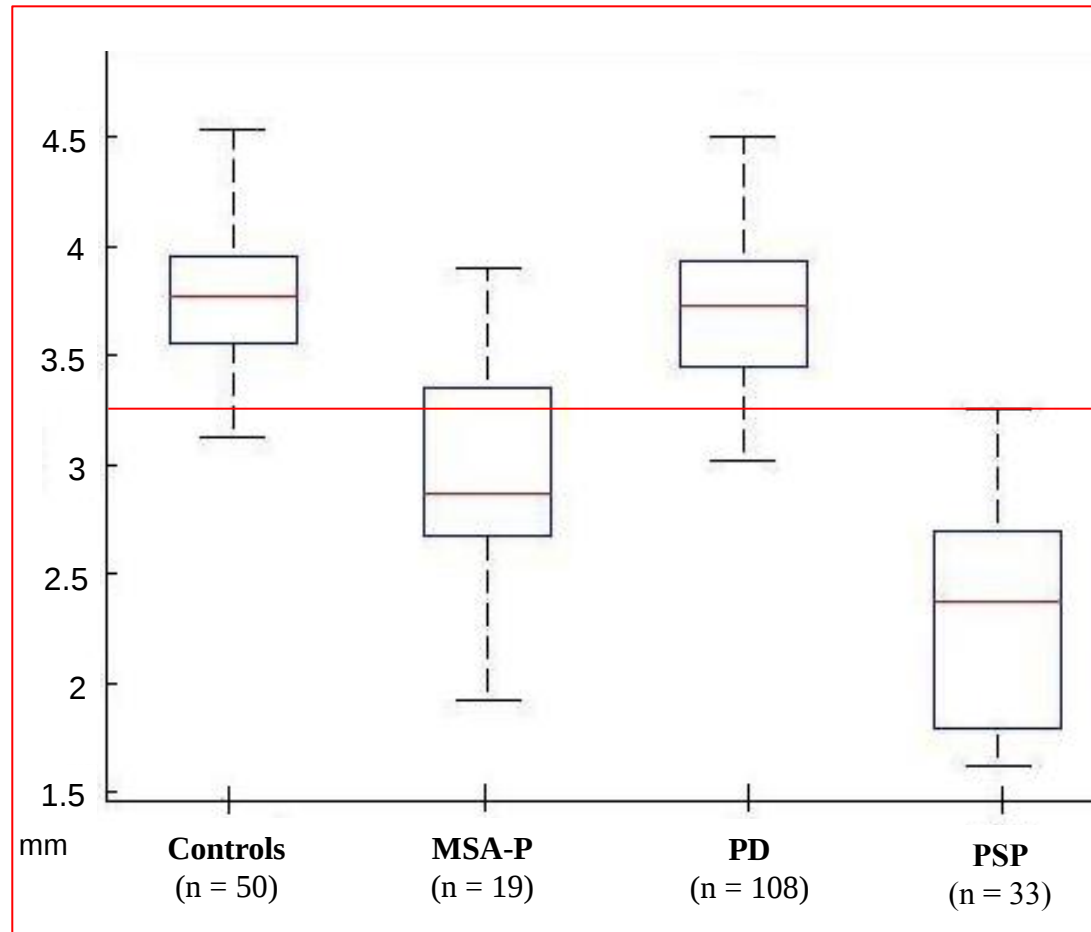
2011;26:1752-55



Measurement of the superior cerebellar peduncles width



Superior cerebellar peduncles width



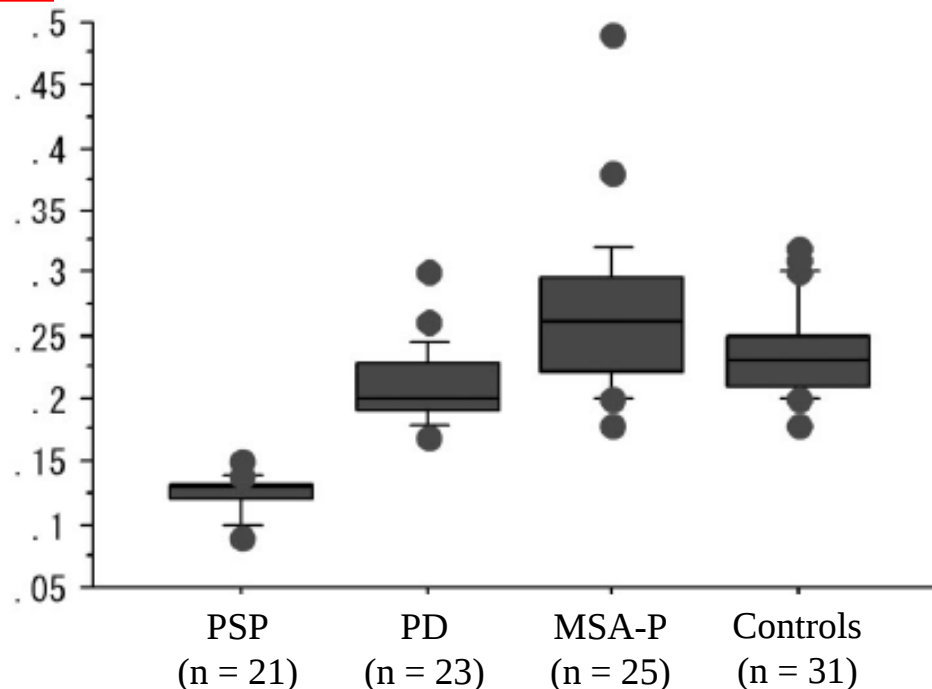
New and reliable MRI diagnosis for progressive supranuclear palsy

H. Oba, MD; A. Yagishita, MD; H. Terada, MD; A.J. Barkovich, MD;
K. Kutomi, MD; T. Yamauchi, MD; S. Furui, MD; T. Shimuzu, MD; M. Uchigata, MD;
K. Matsumura, MD; M. Sonoo, MD; M. Sakai, MD; K. Takada, MD; A. Harasawa, MD;
K. Takeshita, MD; H. Kohtake, MD; H. Tanaka, MD; and S. Suzuki, MD



2005;64:2050-5

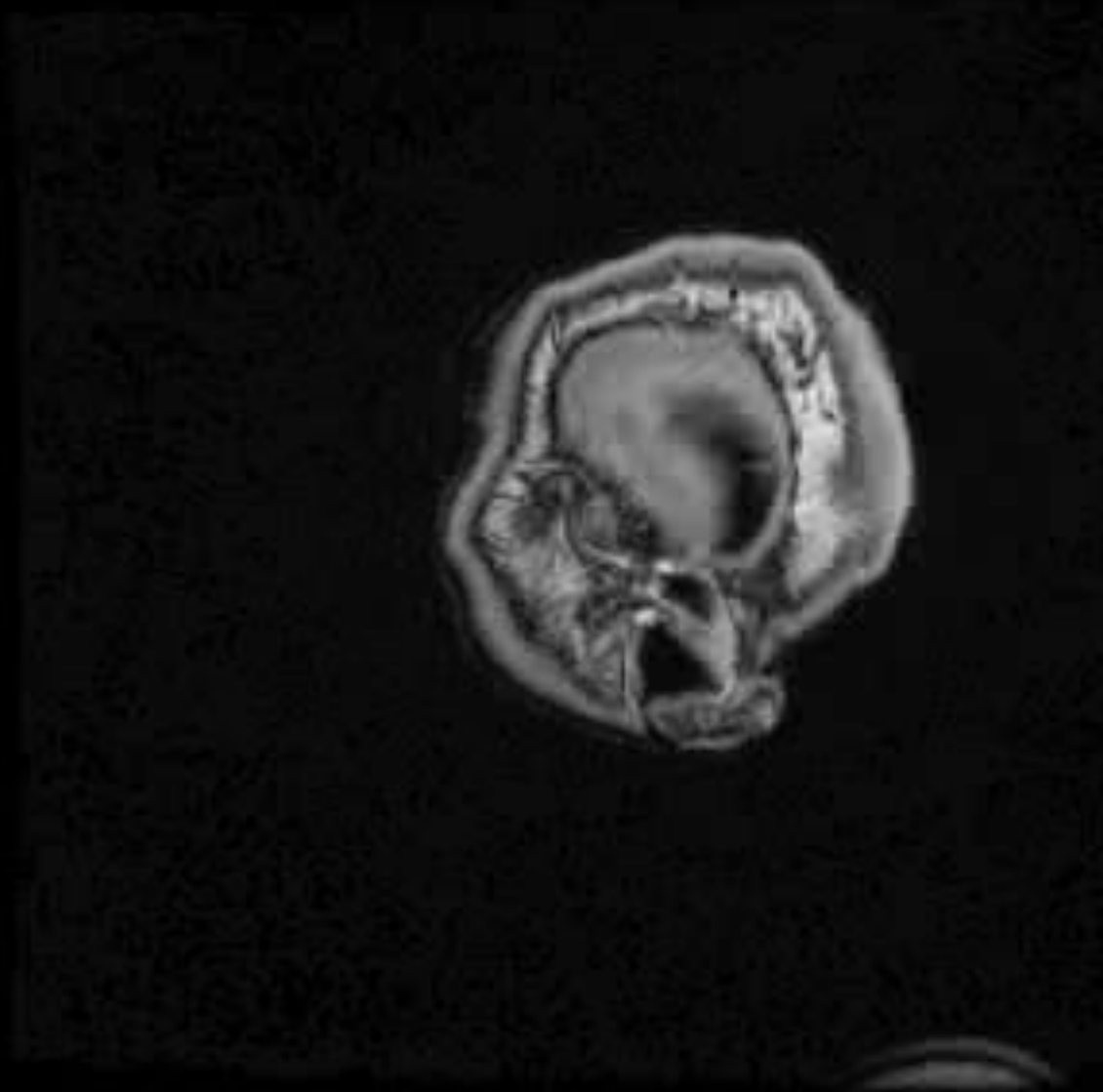
M/P



PSP vs non PSP

M/P cutoff	< 0.15
Sensitivity	100%
Specificity	100%

Measurements of the pons and midbrain areas

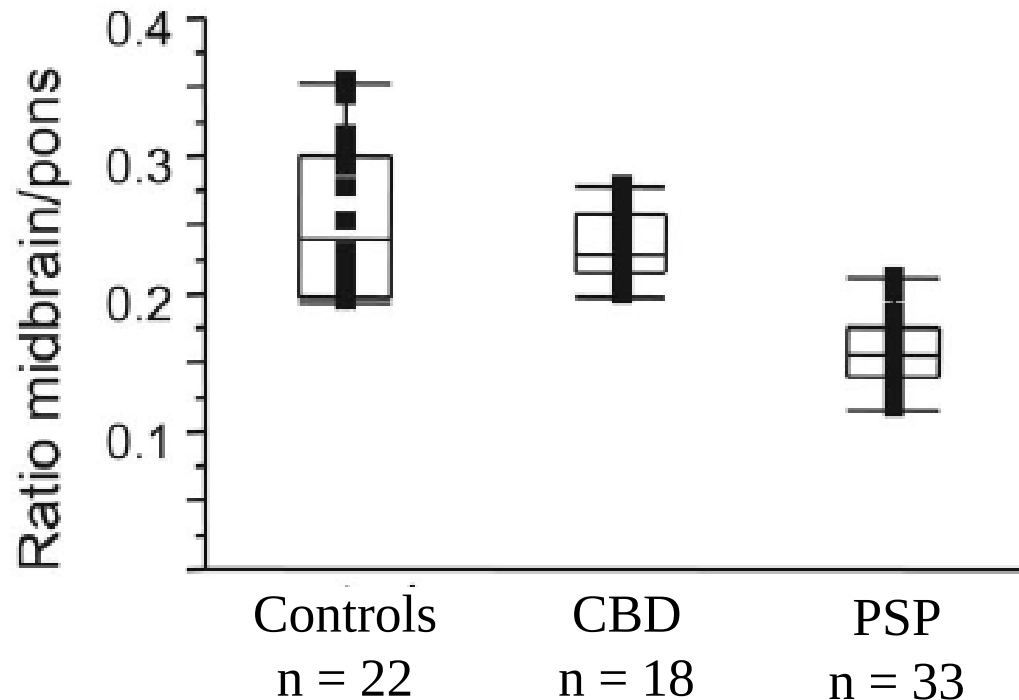


Penguins and hummingbirds: Midbrain atrophy in progressive supranuclear palsy

K. Gröschel, MD; A. Kastrup, MD; I. Litvan, MD; J.B. Schulz, MD



2006;66:949-50



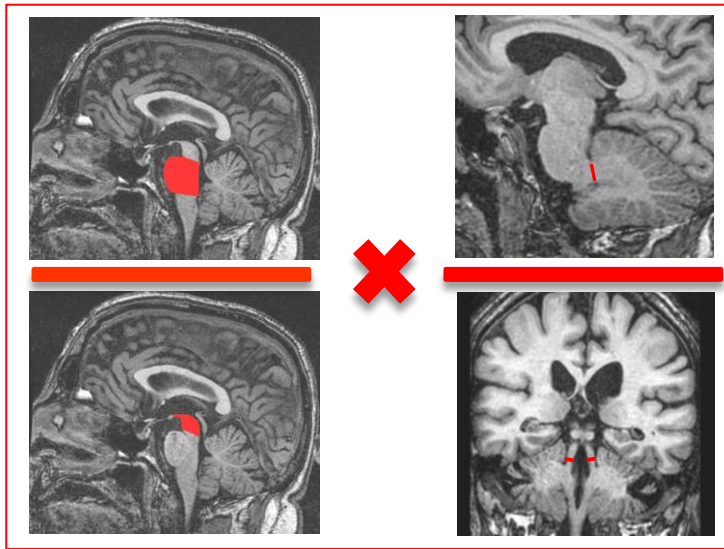
**6% PSP group
showed an overlap
with the control group**

MR Imaging Index for differentiation of Progressive Supranuclear Palsy from Parkinson disease and the Parkinson variant of Multiple System Atrophy

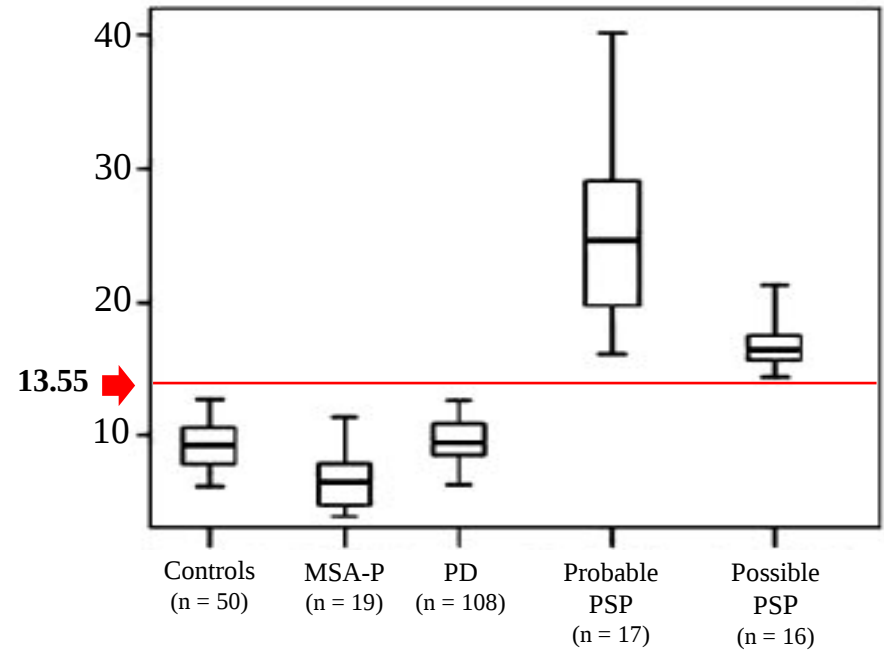


2008;246:214-21

Quattrone A, Nicoletti G, Messina D, Fera F, Condino F, Pugliese P, Lanza P, Barone P, Morgante L, Zappia M, Aguglia U, Gallo O.



$$\text{MRPI} = \frac{P}{M} \times \frac{\text{PCM}}{\text{PCS}}$$



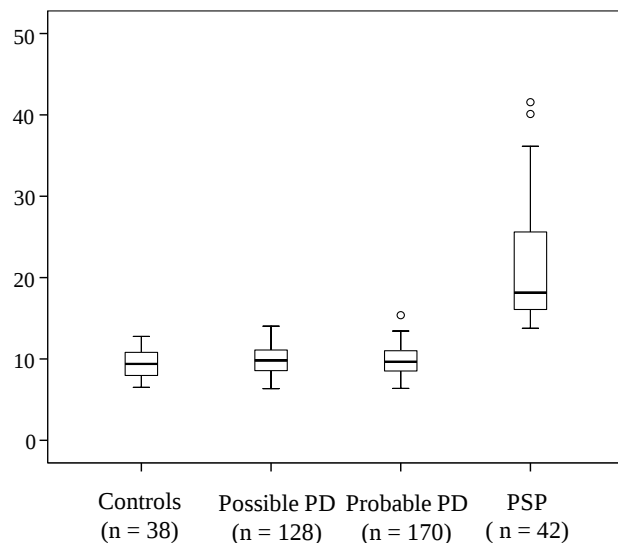
Accuracy of Magnetic Resonance Parkinsonism Index for differentiation of Progressive Supranuclear Palsy from probable or possible Parkinson disease

Morelli M, Arabia G, Salsone M, Novellino F, Giofrè L, Paletta R, Messina D,
Nicoletti G, Condino F, Gallo O, Lanza P, Quattrone A.

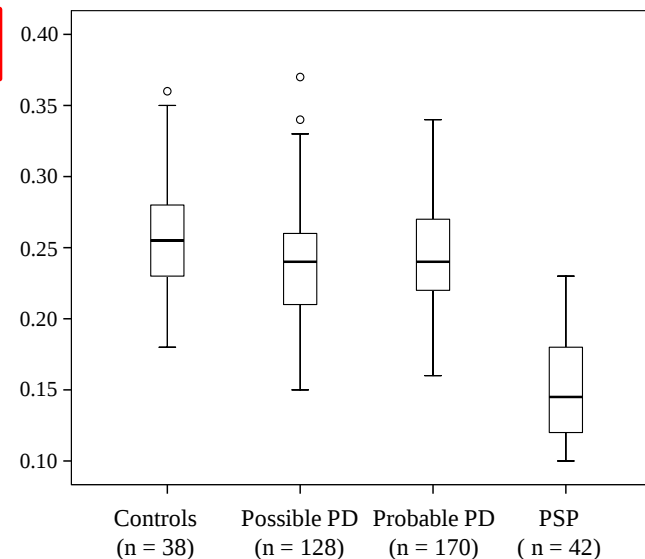


2011;26:527-33

MRPI



M/P



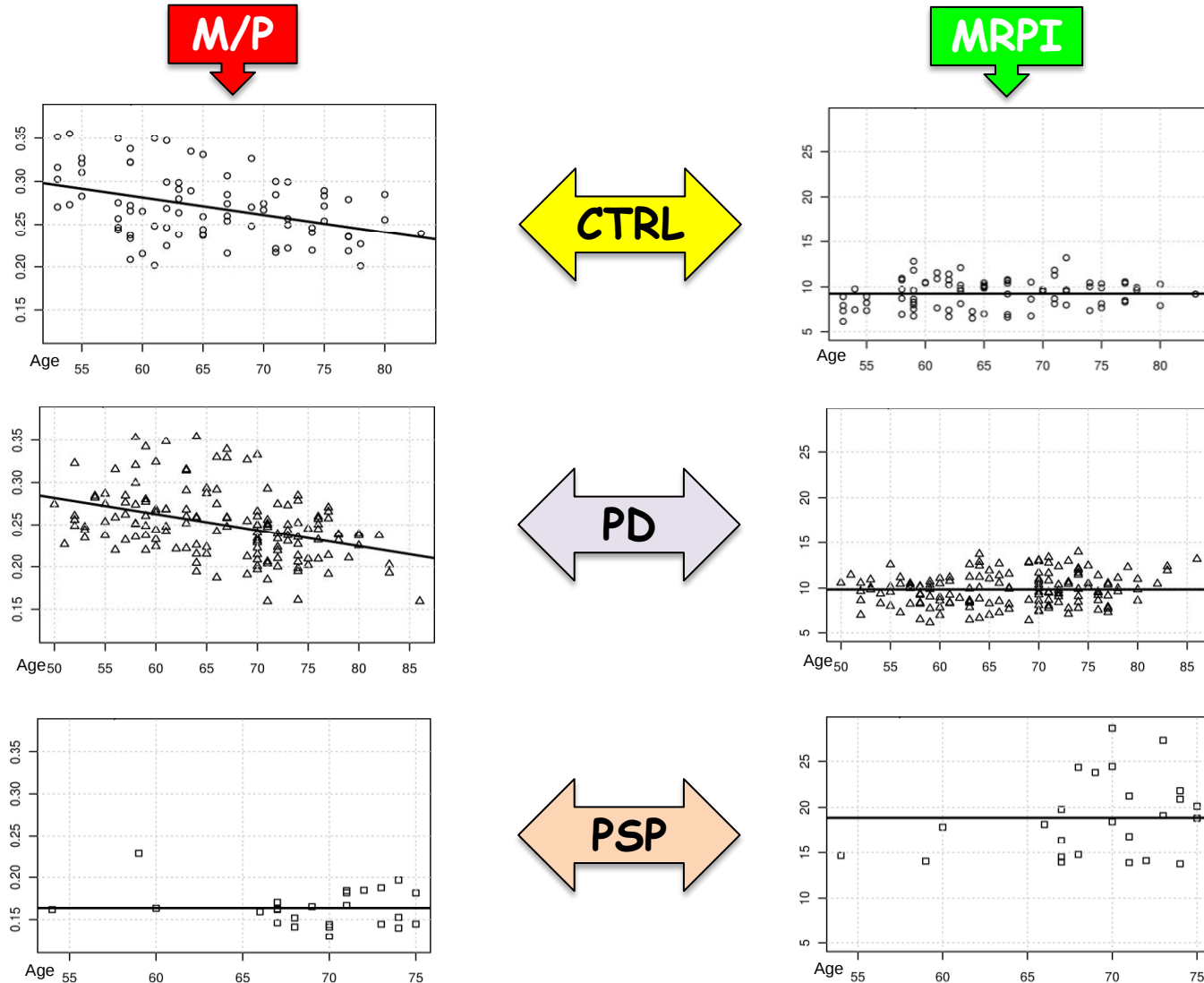
	MRPI	M/P
PSP vs probable PD		
Accuracy (%)	99.5	86.8
PSP vs possible PD		
Accuracy (%)	99.4	88.2
PSP vs control subjects		
Accuracy (%)	100	95

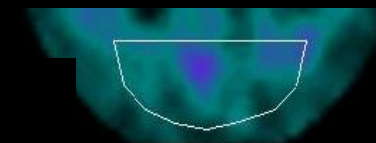
Effect of aging on MR measures differentiating Progressive Supranuclear Palsy from Parkinson disease

Maurizio Morelli, Gennarina Arabia, Demetrio Messina, Basilio Vescio, Maria Salzone, Carmen Chiriaco, Paolo Perrotta, Federico Rocca, Lucio Cascini, Gaetano Barbagallo, Salvatore Nigro, Aldo Quattrone.



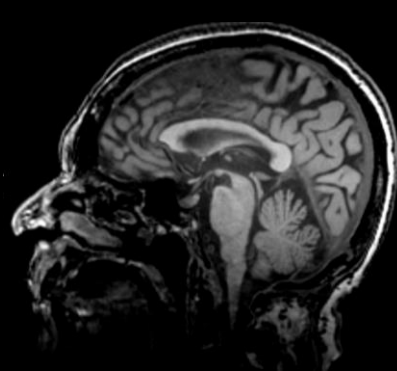
2014;29:488-95



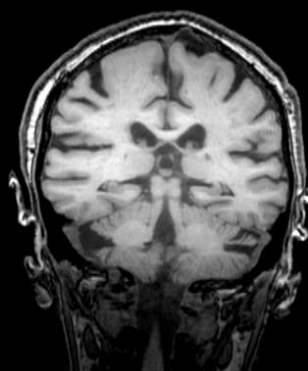


Put-L	Put-R	Occ
34.3	29.9	15.6
34.2	30.1	15.4
32.9	30.5	15.2
33.8	30.2	15.4

DAT-SPECT

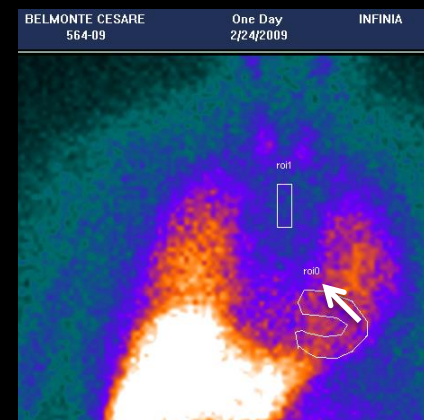
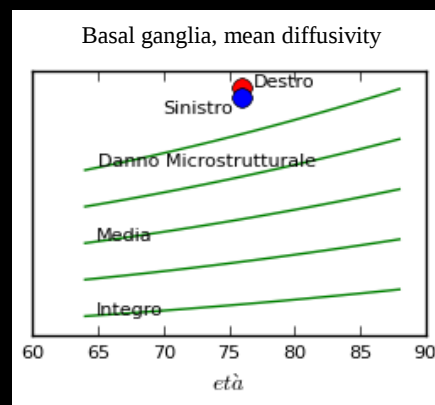


Pons area: 540 mm²
Midbrain area: 104 mm²
MCP width: 8.0 mm



SCP width: 3.49 mm
M/P: 0.19
MRPI: 11.89

BRAIN MRI



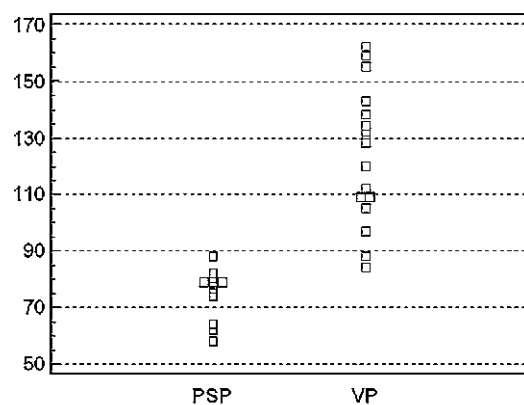
MIBG Scintigraphy



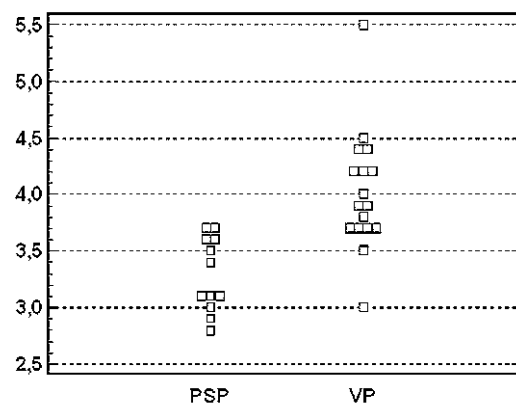
Magnetic resonance parkinsonism index in progressive supranuclear palsy and vascular parkinsonism

Giovanni Mostile¹ · Alessandra Nicoletti¹ · Calogero Edoardo Cicero¹ ·
Tiziana Cavallaro¹ · Elisa Bruno¹ · Valeria Dibilio¹ · Antonina Luca¹ ·
Giorgia Sciacca¹ · Loredana Raciti¹ · Donatella Contrafatto¹ · Ignazio Chiaramonte¹ ·
Mario Zappia¹

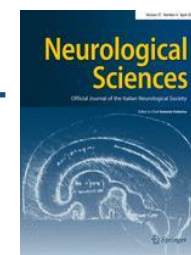
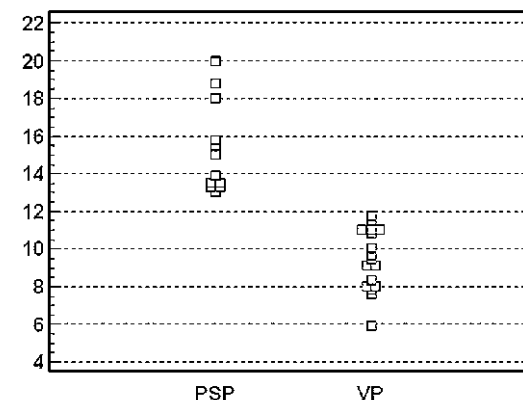
Midbrain area, mm²

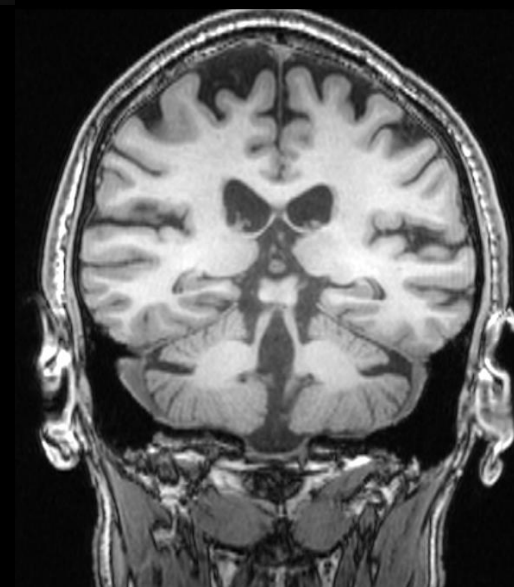
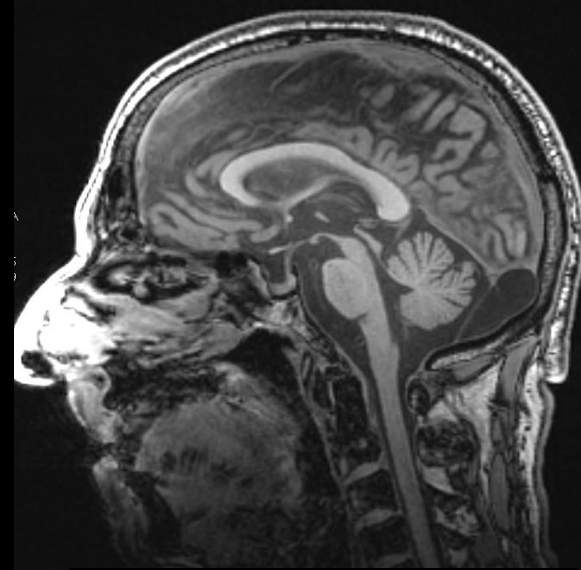


SCP width, mm



MRPI



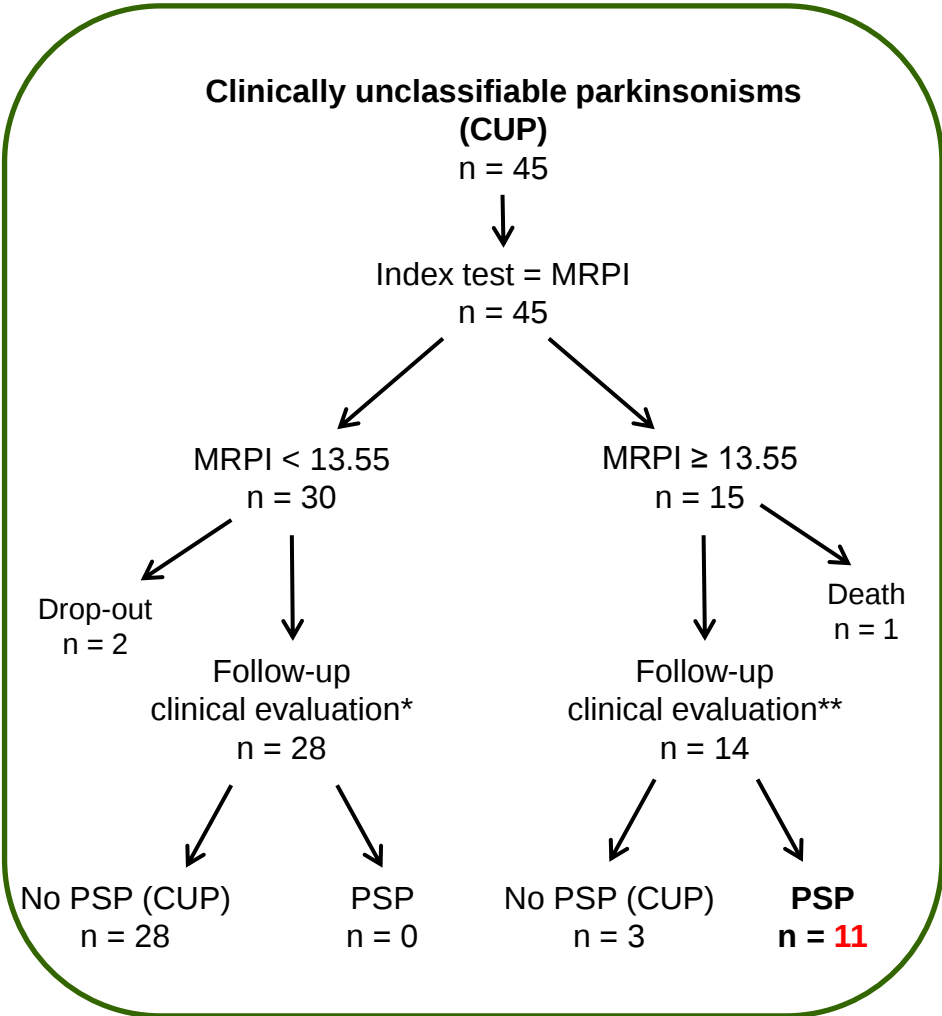


- Pons area: 490 mm²
- Midbrain area: 82 mm²
- MCP width: 8.55 mm
- SCP width: 2.71 mm
- M/P: 0.16
- MRPI: 18.83

MRI measurements predict PSP in unclassifiable parkinsonisms

A cohort study

M. Morelli, G. Arabia, F. Novellino, M. Salsone, L. Giofrè, F. Condino, D. Messina, A. Quattrone.

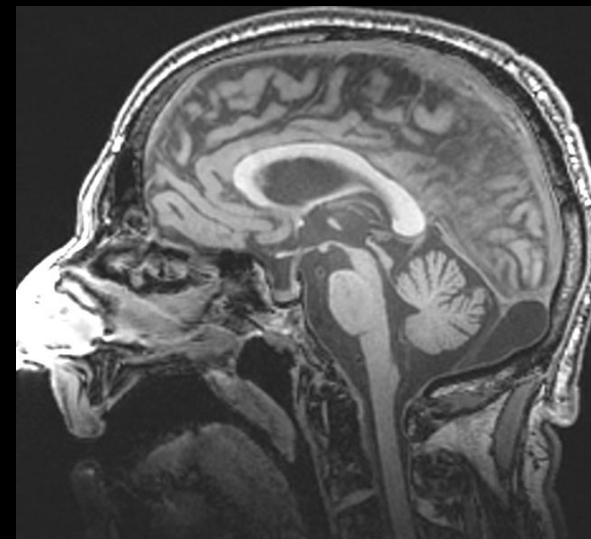


Baseline evaluation	Accuracy %
Clinical features	
Isolated postural instability with falls in the first year of disease	73.8
Slowness of vertical saccades	61.9
Postural instability with falls after the first year of the disease and slowness of vertical saccades	76.2
Freezing in the first 3 years of disease	45.2
MRI features	
MRPI value ≥ 13.55	92.9

* Duration of clinical follow-up: 29.6 ± 10.1 months (range 24-60)

** Duration of clinical follow-up: 26.1 ± 14.6 months (range 6-48)

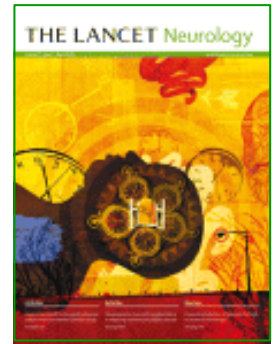
Follow-up evaluation



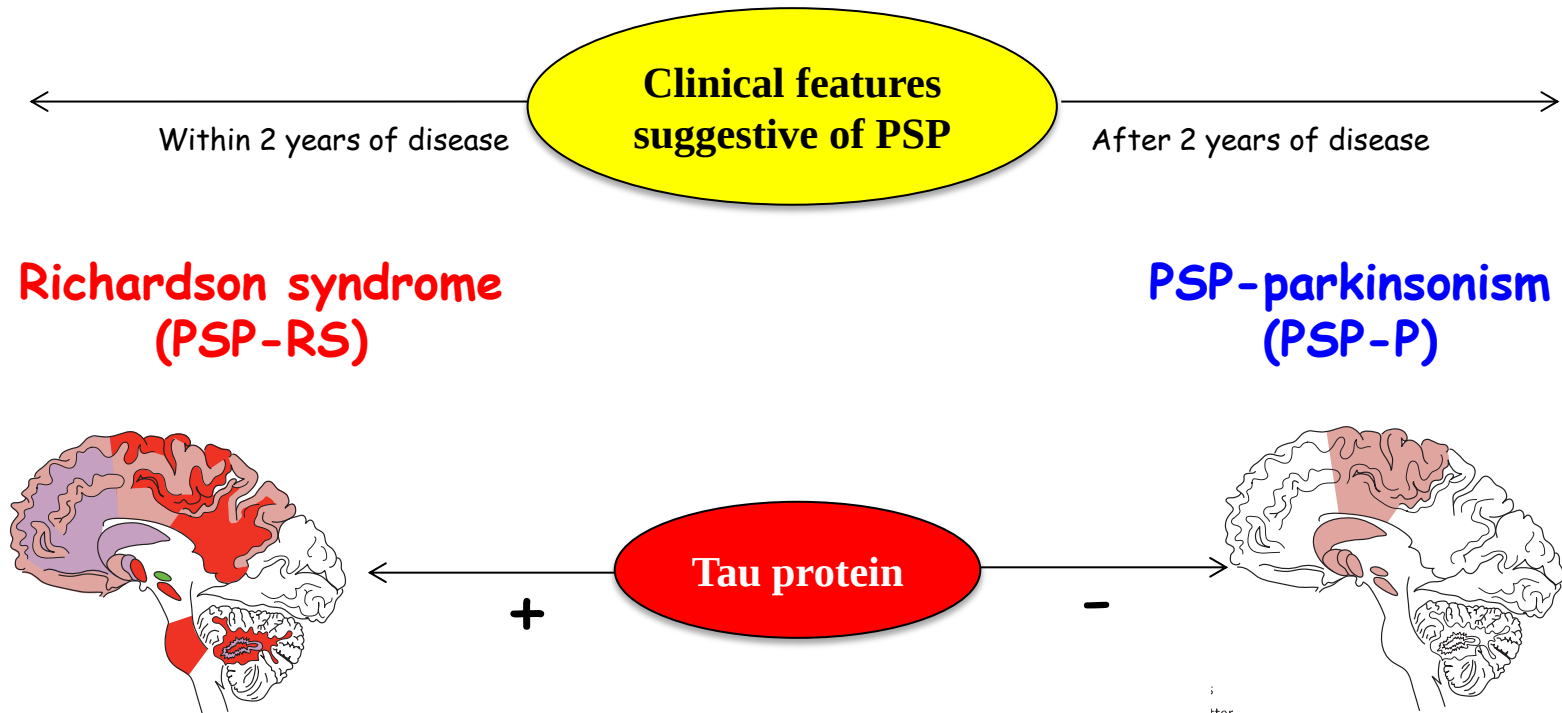
- Pons area: 480 mm²
- Midbrain area: 77 mm²
- MCP width: 8.1 mm
- SCP width: 2.62 mm
- M/P: 0.16
- MRPI: 19.26

Progressive supranuclear palsy: clinicopathological concepts and diagnostic challenges

David R Williams, Andrew J Lees



2009; 8: 270-9

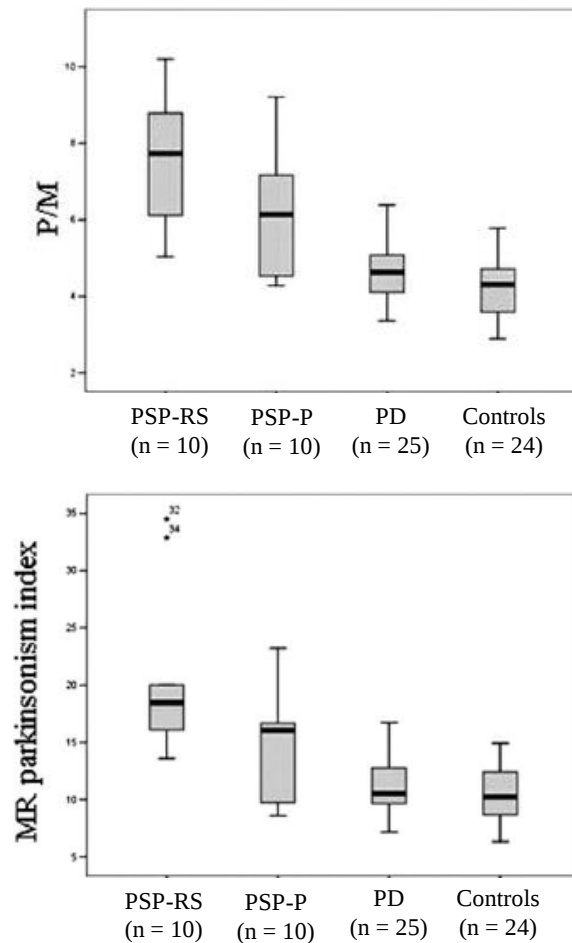




MRI Measurements of Brainstem Structures in Patients with Richardson's Syndrome, Progressive Supranuclear Palsy-Parkinsonism, and Parkinson's Disease

Giulia Longoni, MD,¹ Federica Agosta, MD,¹ Vladimir S. Kostić, MD,² Tanja Stojković, MD,² Elisabetta Pagani, MSc,¹ Tatjana Stošić-Opinčal, MD,³ and Massimo Filippi, MD^{1*}

2011;26:247-55



	Cut-off values	Sensitivity (%)	Specificity (%)	Accuracy (%)
<u>Pons/midbrain ratio</u>				
PSP-RS vs. controls	≥5.00	100	87.5	91
PSP-P vs. controls	≥4.52	80	67	47
→ PSP-RS vs. PD	≥6.01	90	96	94
PSP-P vs. PD	≥6.02	60	96	86
PSP-P vs. PSP-RS	<7.32	90	70	80
<u>MR parkinsonism index</u>				
PSP-RS vs. controls	≥13.44	100	92	94
PSP-P vs. controls	≥15.40	60	100	88
→ PSP-RS vs. PD	≥13.57	100	92	97
PSP-P vs. PD	≥11.07	70	68	40
PSP-P vs. PSP-RS	<17.50	80	70	75

What Features Improve the Accuracy of the Clinical Diagnosis of Progressive Supranuclear Palsy-parkinsonism (PSP-P)?

David R Williams, and Andrew J Lees,



2010; 3: 357-62

PSP-P vs. PD

<i>Frequency of clinical features in progressive supranuclear palsy-parkinsonism vs. Parkinson's disease</i>							
Criteria	PSP-P (%)	PD (%)	* χ^2 P value	Sensitivity	Specificity	PPV	NPV
Late features							
Falls	97	71	<0.001	0.97	0.29	0.21	0.99
Tremor	58	89	<0.001	0.58	0.11	0.12	0.96
Axial rigidity	71	29	<0.001	0.71	0.71	0.17	0.97
Limb rigidity	92	99	0.004	0.92	0.01	0.07	0.57
Postural instability	97	74	0.003	0.97	0.26	0.10	0.99
Vertical SNGP	68	11	<0.001	0.68	0.89	0.74	0.86
Abnormal saccades	83	29	0.014	0.83	0.71	0.76	0.81
Dysphagia	75	57	0.039	0.75	0.43	0.13	0.94
Non-specific eye symptoms	56	24	<0.001	0.56	0.76	0.18	0.95
Drug induced dyskinesias	8	58	<0.001	0.08	0.42	0.01	0.84
Autonomic dysfunction	6	38	<0.001	0.06	0.62	0.01	0.87
Any hallucinations	6	53	<0.001	0.06	0.47	0.01	0.89

PSP-P vs. MSA

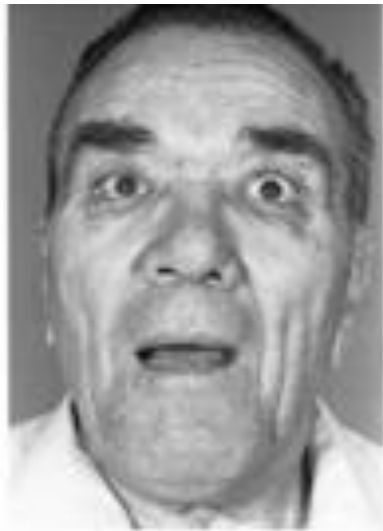
<i>Frequency of clinical features in progressive supranuclear palsy-parkinsonism vs. multiple system atrophy</i>							
Criteria	PSP-P (%)	MSA(%)	* χ^2 P value	Sensitivity	Specificity	PPV	NPV
Late features							
Falls	97	78	0.012	0.97	0.22	0.34	0.95
Cognitive dysfunction	60	26	0.006	0.59	0.74	0.49	0.81
Axial rigidity	71	48	0.04	0.71	0.53	0.37	0.82
Vertical SNGP	68	10	<0.001	0.68	0.90	0.72	0.89
Dysphagia	75	90	0.027	0.75	0.10	0.27	0.47
Non-specific eye symptoms	56	10	<0.001	0.56	0.90	0.69	0.83
Pyramidal signs	14	57	<0.001	0.14	0.43	0.10	0.52
Cerebellar signs	3	35	<0.001	0.03	0.65	0.03	0.62
Autonomic dysfunction	6	90	<0.001	0.06	0.10	0.03	0.20

The Phenotypic Spectrum of Progressive Supranuclear Palsy: A Retrospective Multicenter Study of 100 Definite Cases

Gesine Respondek, MD,^{1,2,3†} Maria Stamelou, MD,^{3,4†} Carolin Kurz, MD,^{1,2} Leslie W. Ferguson, MD,⁵ Alexander Rajput, MD,⁵ Wan Zheng Chiu, MD,⁶ John C. van Swieten, MD,⁶ Claire Troakes, PhD,⁷ Safa al Sarraj, FRCPath,⁷ Ellen Gelpi, MD,⁸ Carles Gaig, MD,⁸ Eduardo Tolosa, MD,⁹ Wolfgang H. Oertel, MD,³ Armin Giese, MD,¹⁰ Sigrun Roeber, MD,¹⁰ Thomas Arzberger, MD,¹⁰ Stefan Wagenpfeil,^{11,12} and Günter U. Höglinger, MD,^{1,2,3*}
for the Movement Disorder Society—endorsed PSP Study Group



2014;14:1758-66



Vertical Supranuclear
Gaze Palsy
(VSGP)

Onset in PSP-P patients



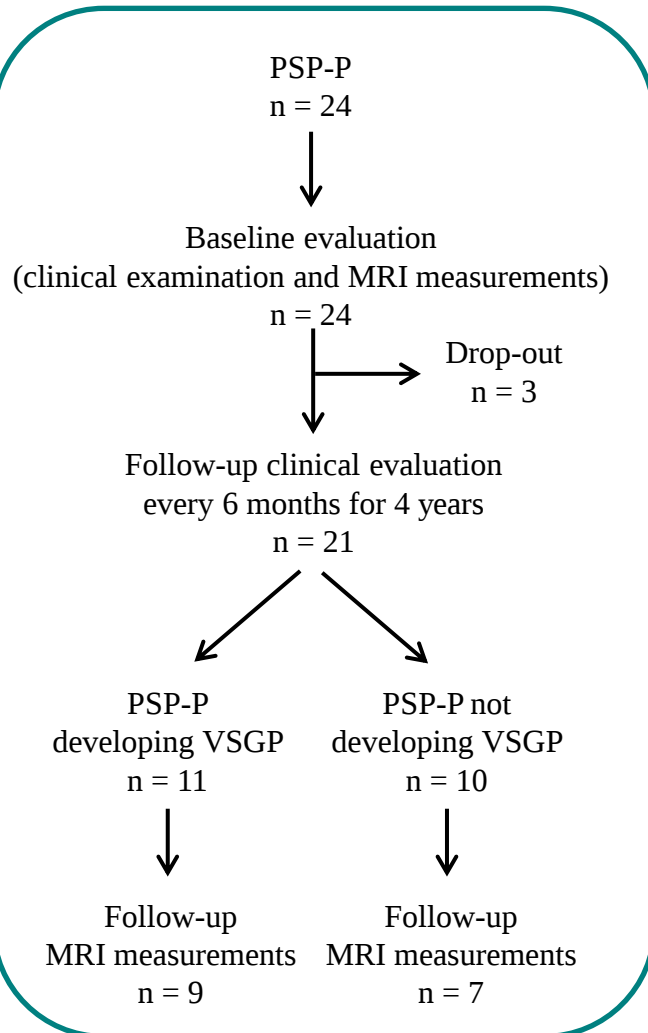
From 7 to 19 years (mean, 10.8 years)

MR parkinsonism index predicts vertical supranuclear gaze palsy in patients with PSP–parkinsonism

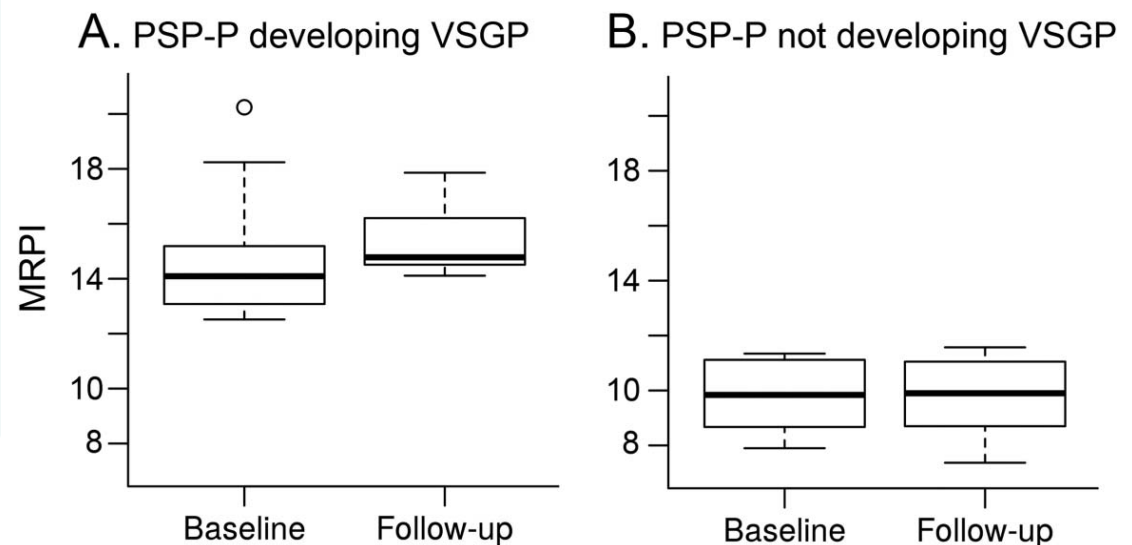
OPEN



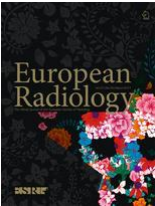
Quattrone et al.
2016;87:1266-73



	Sensitivity, %	Specificity, %	PPV, %	NPV, %	Accuracy, %
Clinical features					
Isolated postural instability with backward falls after 2 y of disease onset	0	90	0	45	42.9
Slowness of vertical saccades after 2 y of disease onset	45.5	20.0	38.5	25.0	33.3
Postural instability with backward falls and slowness of vertical saccades after 2 y of disease onset	54.6	90.0	85.7	64.3	71.4
MRI measurements					
Midbrain area (cutoff value ≤ 95.0) ^a	81.8	90	90	81.8	85.7
SCP width (cutoff value ≤ 3.41) ^a	63.6	100	100	71.4	81.0
MRPI (cutoff value ≥ 12.52) ^a	100	100	100	100	100



Magnetic Resonance Parkinsonism Index: diagnostic accuracy of a fully automated algorithm in comparison with the manual measurement in a large Italian multicentre study in patients with progressive supranuclear palsy



2016 [Epub ahead of print]

Salvatore Nigro¹ &Gennarina Arabia² &Angelo Antonini³ &Luca Weis³ &Andrea Marcante³ &Alessandro Tessitore^{4,5} &Mario Cirillo^{4,5} &Giacchino Tedeschi^{4,5} &Stefano Zanigni^{6,7} &Giovanna Calandra-Buonaura^{7,8} &Caterina Tonon^{6,7} &Gianni Pezzoli⁹ &Roberto Cilia⁹ &Mario Zappia¹⁰ &Alessandra Nicoletti¹⁰ &Calogero Edoardo Cicerò¹⁰ &Michele Tinazzi¹¹ &Pierluigi Tocco¹¹ &Nicolò Cardobi¹² &Aldo Quattrone^{1,2}



Bologna

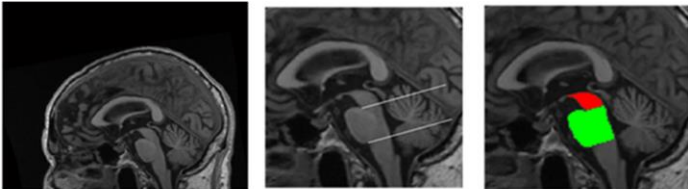


Catanzaro

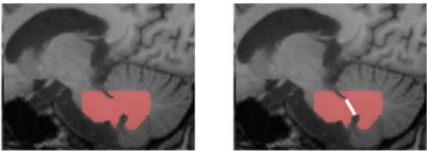


Catania

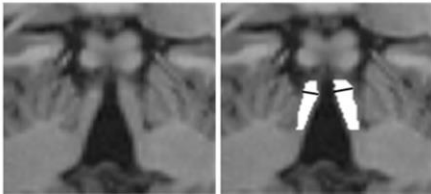
First stage:
Individuation of midsagittal and segmentation of pons and midbrain



Second stage:
Individuation and automated measurement of middle cerebellar peduncle (MCP)



Third stage:
Individuation and automated measurement of superior cerebellar peduncle (SCP)



Scanner	Cutoff and statistical value	Automatic MRPI	Manual MRPI
PSP vs. PD			
1.5 T	Cutoff value	>13.42	>13.43
	Accuracy (%)	95.76	96.61
PSP vs. PD			
3 T	Cutoff value	>13.42	>13.37
	Accuracy (%)	97.40	100



Milano



Naples



Venice



Verona

Conclusions

- *Measurement of middle cerebellar peduncle width on MR images may be useful for distinguishing patients with MSA from those with PD*
- *The Magnetic Resonance Parkinsonism Index can help distinguish patients with PSP from those with PD and MSA on an individual basis*
- *The Magnetic Resonance Parkinsonism Index is more powerful than clinical features in predicting the evolution of unclassifiable parkinsonisms toward PSP phenotypes*
- *The Magnetic Resonance Parkinsonism Index accurately predicted, on an individual basis, the appearance of vertical supranuclear gaze palsy in patients with PSP-P, thus confirming clinical diagnosis in vivo*



Thank you for your attention

V Corso della Scuola Superiore di Neurologia - SIN
Neuroimmagini nella malattia di Parkinson e Parkinsonismi