Gait and Balance Assessment in Parkinsonian Disorders

Shaheda N. Azher, MD, Kevin Dat Vuong, MA, Joohi Shahed, MD, Alan L. Diamond, MD, and Joseph Jankovic, MD

Parkinson's Disease Center and Movement Disorders Clinic, Department of Neurology, Baylor College of Medicine, Houston, Texas, USA

Abstract

Objective: To correlate gait patterns with corresponding diagnosis in patients with Parkinson's disease (PD), progressive supranuclear palsy (PSP), and vascular parkinsonism (VP). **Background:** In contrast to the classical short and shuffling steps, stooped posture, narrow base and flexed knees, typically seen in PD, the gait in patients with PSP has been described as stiff and broad-based with knees extended, and instead of turning enbloc the patients tend to pivot. VP typically presents with "lower body parkinsonism" and a broad-based gait. The reported gait patterns, however, have not been validated by a controlled study. **Methods:** Subjects were recruited from a population of patients diagnosed with PD, PSP and VP, and spouses (controls) seen at our Movement Disorders Clinic. All patients were videotaped from waist down as not to reveal any clues to the diagnosis such as hand tremor and facial expression. They were assessed by the Gait and Balance Scale (GABS) and Tinetti scales. Provocative tests were used to evaluate freezing (motor blocks). Video segments were randomized and rated according to gait phenomenology by two investigators who were blinded to patients' diagnosis. An algorithm for diagnosis based on characteristic gait patterns was formulated and tested against the known diagnosis in order to determine their predictive sensitivity (SE) and specificity (SP). **Results:** Total 45 subjects (62% males) with mean age 71.5±9.7 years included controls (8), PD (19), VP (9) and PSP (9). The mean duration of symptoms was 8.3±6.8 years. There was a high inter-rater correlation between the two raters (Spearman rho=0.78-0.91, p<0.0001). Both raters were able to differentiate normal gait from the parkinsonian gaits (SE=100%; SP=76-81%; K=0.53-0.60, p<0.0001; intra-rater reliability K=0.61, p<0.0001), but despite good inter-rater reliability (K=0.39, p<0.02), they were not able to reliably differentiate PD gait from the other parkinsonian gaits (SE=63-74%; SP=42-46%; K=0.05-0.19, p=0.2-0.8). The algorithm, however, was quite reliable in the diagnosis of VP (SE=67-100%; SP=61-69%; K=0.27-0.39, p=0.06-0.001), while the algorithm for PSP gait yielded high SP (97-100%), but poor SE (22%) for both raters (K=0.17-0.31, p=0.2-0.04). There was a high concordance for both raters, with good inter-rater reliability (K=0.5, p<0.0001) with respect to primary global impression (K=0.26-0.4, p<0.004) for the diagnosis of controls (100%), PD (68-74%), VP (11%), and PSP (11-33%). **Conclusions:** Examination of gait may differentiate parkinsonian disorders from normal controls, but may not consistently diagnose the cause of the parkinsonism.

Introduction

- Gait is a highly complex motor skill that requires integration of mechanisms of locomotion with those of motor control, musculoskeletal function, balance and stance.[1-3]
- Besides peripheral inputs and proprioceptive reflexes processed in the spinal cord, the cerebellum, basal ganglia and cortical mechanisms contribute to the motor control necessary for normal gait and balance.[4,5]
- Pedunculopontine nucleus (PPN) and the mesencephalic locomotor region (MLR) play an important role in the etiology of gait disturbance in PD.[6]
- PD gait is significant for short and shuffling steps, stooped posture, narrow base and flexed knees, freezing and festination.[7]
- PSP patients typically have a stiff and broad-based gait with a tendency to have their knees extended.[1,8]
- Vascular parkinsonism (VP) is another parkinsonian disorder related to strokes or other vascular causes with lower body parkinsonism and bilateral sub cortical white matter and basal ganglia lesions on imaging studies, presents with erect posture, short steps, and freezing in the absence of resting tremor.[9]

Study / Methods

Subjects enrolled in the study were recruited from the population of patients and spouses seen at the Parkinson's Disease Center and Movement Disorder's Clinic.

Inclusion Criteria

- Controls and patients with diagnosis of PD, PSP and VP after meeting well-established diagnostic criteria (PD[10], PSP[11], VP[9]).
- Capable of following simple instructions and ambulating independently.

Exclusion Criteria

- Severe dementia, malignancy, drug induced parkinsonism or recent history of drug or alcohol abuse.

Procedure

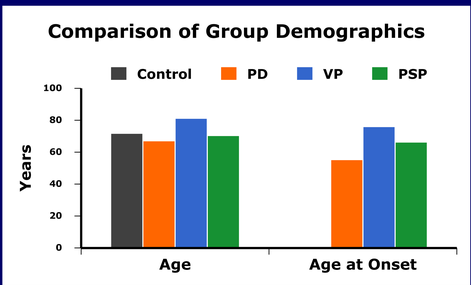
- Subjects were seated and videotaped by the same examiner (SA) in the PDCMDC Laboratory using a digital video camera on a tripod after obtaining the written consent according to IRB protocol.
- The field of vision included mostly the lower body (waist and legs), as not to reveal any other clues to the diagnosis such as facial expression and hand tremor. They were instructed to stand up from a sitting position and walk few times (5 m, 10ms, walk in between chairs) under close supervision to prevent any falls or injury.
- Video segments were randomized and rated according to gait phenomenology by two investigators who were blinded to patients' diagnosis.

Gait and Balance Scale (GABS)- Modified

- Assessment of their gait and balance was done through modified GABS and Tinetti.[2] Item 24 is derived from Tinetti scale and is useful for analysis of step symmetry, height and path deviation.

Gait Clinical Features Algorithm (Appendix 1)

- An Algorithm for diagnosis based on characteristic gait patterns was formulated and tested against the known diagnosis in order to determine their predictive sensitivity and specificity (SP).
- The items based on clinical characters of different gait patterns were scored from 0 to 1 (0 = No and 1 = Yes). The algorithm was based on the sum of all "yes" responses to items relating to the appropriate scales (Controls, PD, VPD and PSP).



Poster Design: Kevin Dat Vuong, MA

Results

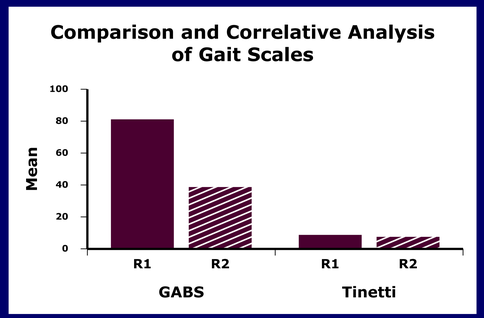
- Total 45 subjects (62% men) with mean age 71.5±9.7 years included controls (8), PD (19), VP (9) and PSP (9). The mean age of onset of symptoms was 63.13 years. The mean duration of symptoms was 8.3±6.8 years.

Modified GABS and Tinetti scales

- Correlative analysis of Gait scales was done using Wilcoxin signed ranks test and Spearman rho correlative analysis. Although raters' scores were consistent for both gait scales (Spearman rho=0.78-0.91, p<0.0001), Rater 2 attributed greater severity on the Tinetti scale than did Rater 1 (p<0.0001).

Algorithm by Diagnosis Cross-Tabulation and Inter-Rater reliability

- Diagnosis was made based on clinical features specific to particular disease according to the algorithm by two different raters Diagnosis was made based on clinical features specific to particular disease according to the algorithm by two different raters.
- Moderate accuracy (SE=100%; SP=76-81%; K=0.53-0.60, p<0.0001) and intra-rater reliability (K=0.61, p<0.0001) were obtained by the algorithm for normal gait from both raters.
- Despite fair inter-rater reliability (K=0.39, p<0.02), the algorithm for PD gait for either rater did not produce the correct diagnosis of PD (SE=63-74%; SP=42-46%; K=0.05-0.19, p=0.2-0.8).
- The algorithm was generally accurate for the diagnosis of VP (SE=67-100%; SP=61-69%; K=0.27-0.39, p=0.06-0.001), while the algorithm for PSP gait yielded absolute specificity (SP=97-100%), but poor sensitivity (SE=22%) for both raters (K=0.17-0.31, p=0.2-0.04).



References

1. Jankovic J, Nutt JG, Sudarsky L, Classification, diagnosis and etiology of gait Disorders. Adv Neurol 2001; 87:119-133.
2. Thomas M, Jankovic J, Suteerawattanon M, Wankadia S, Caroline K, Vuong KD, Protas E. Gait and Balance Scale (GABS): Validation and utilization. J Neurol Sci 2004;217: 89-99.
3. Dickinson MH, Farley CT, Full RJ et al. How animals move: An integrative view. Science 2000;288:100-106.
4. Burke RE. The central pattern generator for locomotion in mammals. Adv Neurol 2001;87:11-24.
5. Dietz V. Physiology of Human Gait: Neural Processes. Adv Neurol 2001;87: 3-61.
6. Pahapill PA, Lozano AM. The pedunculopontine nucleus and Parkinson's disease. Brain 2000;123:1767-1783.
7. Bloem BR and Bhatia KP. Gait and balance in basal ganglia disorders. Clinical Disorders of Balance, Posture and Gait 2004;173-205.
8. Winikates and Jankovic: Clinical correlates of vascular parkinsonism. Arch Neurol 1999;56(1):98-102.
9. Gelb DJ, Oliver E, Gilman S: Diagnostic criteria for Parkinson disease. Arch Neurol 1999;56(1):33.
10. Litvan I, Bhatia KP, Burn DJ, et al. Movement Disorder Society Scientific Issues Committee report: SIC Task Force appraisal of clinical diagnostic criteria for parkinsonian disorders. Mov Disord 2003;18:467-486.
11. Giladi N. Freezing of Gait. Clinical overview. Adv Neurol 2001; 87: 191-197.

Discussion

- The phenomenology and classification of abnormal gaits is challenging because the various gait patterns often overlap and one pattern can evolve into another in the same individual as a consequence of natural progression of the underlying disease process.[1]
- This is the first study to our knowledge performed to identify gait features that differentiate various parkinsonian disorders.
- Our study showed that extension of knees, wide based gait, pivoting or crossing the legs on turning, and slumping in chair, taken together are very specific to PSP.[1,8]
- Patients with PD often walk with a reduced gait speed, shorter stride length, stooped posture and reduced arm swing.[1,8]
- Freezing of Gait is common in all these disorders, but its frequency in the various parkinsonian syndromes is highly variable.[7]

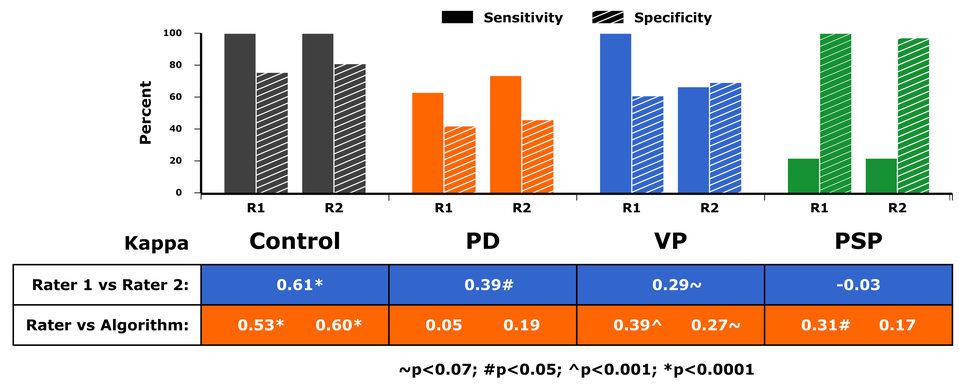
Conclusion

- We have provided evidence for an algorithmic method that may be potentially feasible in identifying gait phenomenology specific to various parkinsonian disorders. Its utility and strength is the standardization that it would provide in future gait protocols. Besides controls, the apriori diagnostic criteria had the highest predictive value for PSP, followed by VP and PD.

Appendix 1. Gait Clinical Features Algorithm

Gait Clinical Feature		Scoring Algorithm ^ Control	PD	VPD	PSP
Knees:	Normal	1	0	0	0
	Flexed	0	1	1	0
	Extended	0	0	0	1
Base:	Normal	1	0	0	1
	Narrow	0	1	0	0
	Wide	0	0	1	1
Stride:	Normal	1	0	0	0
	Decreased	0	1	1	0
	Increased	0	0	0	1
Foot floor clearance:	Normal	1	0	0	1
	Decreased	0	1	1	0
Start hesitation		0	1	1	0
Freezing		0	1	1	1
Shuffling		0	1	1	0
Festination		0	1	0	0
Turning:	Normal	1	0	0	0
	Enbloc	0	1	0	0
	Hesitation	0	0	1	0
	Pivoting or crossing legs	0	0	0	1
Arising from chair:	Normal	1	0	0	0
	Slow	0	1	1	1
Sitting:	Normal	1	0	0	0
	Slow	0	1	1	0
Slumping/Collapsing		0	0	0	1
	Sum	[ ]	[ ]	[ ]	[ ]

^ Scoring based on presence of gait clinical feature.



Kappa	Control		PD		VP		PSP	
Rater 1 vs Rater 2:	0.61*		0.39#		0.29~		-0.03	
Rater vs Algorithm:	0.53*	0.60*	0.05	0.19	0.39^	0.27~	0.31#	0.17

~p<0.07; #p<0.05; ^p<0.001; *p<0.0001