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Application of the Unified Parkinson's Disease Rating Scale in Progressive Supranuclear Palsy: Factor Analysis of the Motor Scale

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Summary: An important criterion in scale validation is the demonstration of a stable factor structure. The Unified Parkinson's Disease Rating Scale (UPDRS) is widely used to assess Parkinson's disease (PD). The reliability and applicability of the motor subscale of the UPDRS (UPDRSm) when applied to patients diagnosed with progressive supranuclear palsy (PSP) is unknown. In a sample of 175 patients with PSP, factor analysis revealed five clinically distinct factors: two independent bradykinesia factors (axial/gait and extremities), one rigidity factor, and two independent tremor factors (rest and action). Two items (posture and rest head tremor) did not reach criteria for factor loadings. There was a high degree of internal consistency. These results suggest that UPDRSm is a reliable and applicable scale for assessing most aspects of PSP function as well as severity measures of five clinical disability domains.
Key Words: Progressive supranuclear palsy—Factor analysis—Motor examination—UPDRS.

The Unified Parkinson's Disease Rating Scale (UPDRS)[1] was designed to provide a measure of signs and symptoms of Parkinson's disease (PD) in clinical practice and research. It has rapidly become one of the most widely used assessment devices for studies involving patients with PD. As with any scale, the use of the UPDRS depends on its reliability and validity. The motor subscale of the UPDRS (UPDRSm) has met psychometric criteria for reliability and validity in PD.[2,3]

In addition to PD, parkinsonism predominates as the major clinical feature of several other primary neurodegenerative conditions. Progressive supranuclear palsy (PSP) is the most common and best recognized entity among the parkinsonism-plus syndromes. PSP shares some clinical features with PD, such as bradykinesia, rigidity, dysarthria, dysphagia, and dementia. However, patients with PSP rarely exhibit rest tremor, usually have more profound postural instability, and axial rigidity is more prominent than limb rigidity.[4] Because the UPDRS is so commonly used and familiar to movement disorders physicians, and because PSP often is diagnosed in patients who were followed as PD patients for several years, the use of the UPDRSm is important to define. The specific aims of the present study were (1) to conduct an exploratory analysis of the factor structure and internal consistency of the UPDRSm in patients with clinically diagnosed PSP; and (2) to compare this factor structure with a previously published cohort of PD subjects. We chose the UPDRSm section because it is the only section for which information on current PSP disability is gathered by direct examination of physical function of the patient as opposed to information gathered by interview.

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METHODS

Subjects

One hundred seventy-five patients were evaluated at the Movement Disorder Section at the Department of the

Department of Neurological Sciences at Rush-Presbyterian-St. Luke's Medical Center in Chicago, Illinois, and at UMDNJ-Robert Wood Johnson Medical School in New Brunswick, New Jersey. All patients met clinical diagnostic criteria for PSP (99 patients were diagnosed with possible and 60 patients with probable PSP)[4] and 16 patients had autopsy-confirmed diagnosis of PSP.[5] Each patient was evaluated by movement disorder specialists using the UPDRSm. These specialists already successfully demonstrated high interrater reliability as established by the Movement Disorder Society UPDRS Teaching Tape.[6] Examiners also determined Hoehn & Yahr (H&Y) stage, which was also collected to assess the relationship between this measure and the UPDRSm.

Data Analyses

All data analyses were conducted using the SPSS version 4.0 statistical package (Chicago, IL, USA). Internal consistency was assessed using Cronbach's coefficient alpha. This statistic provides a measure of the estimation of the average correlation between two halves of the scale over all possible ways of splitting the scale into two halves. Factor structure was assessed with a principal components factor analysis with oblique rotation using an oblimin algorithm. We chose to use an oblique rotation[7] because we could not assume that any resultant factors would be uncorrelated.

The number of factors used in the rotation of factor loadings was determined by examination of a scree plot, which provides an index of the amount of sample variance accounted for by each factor. The relationship between the resultant factors and H&Y stage was assessed using an Eta coefficient.[8] The Eta coefficient has a range of −1 to +1 and when squared can be interpreted as the proportion of the total variability in the factor score that can be accounted for by knowing the values of H&Y and the resultant factor scores. This statistic was chosen because it provides a measure of association between interval data (factor scores) and ordinal data (H&Y stage).

RESULTS

Demographics

The sample reflected the general demographics of PSP with more men (n = 99) than women (n = 76). Mean age at onset was 72.1 years (standard deviation [SD] = 0.4 yrs) and a duration of 4.9 years (SD = 3.46 yrs). There was a wide range of the UPDRSm total scores (median = 39, range = 14–80), demonstrating that the sample captured the full spectrum of disease severity. All H&Y stages were represented except for H&Y stage 1, with seven patients classified as H&Y stage 2, 11 patients as H&Y stage 2.5, 65 patients as H&Y stage 3, 37 patients as H&Y stage 4, and 55 patients as H&Y stage 5.

Internal Consistency

Overall internal consistency, as assessed by Cronbach's alpha, was high (alpha = .90). A high degree of internal consistency was maintained across all H&Y stages (stages I & II & III alpha = .86, stage IV alpha = .89, stage V alpha = .91).

Factor Structure

Five factors were obtained from the analysis (Table 1). The scree plots revealed a significant decrease in the

TABLE 1. *Factor analysis results*

	Factor loadings				
	I	II	III	IV	V
Measure of association					
Hoehn & Yahr	0.33*	0.80*	0.1	0.18	0.24
Approximate percent variance	32	11.1	8.3	6.20	6
Speech		.62			
Facial		.58			
Rest tremor					
H/N				.02†	
RUE				.84	
RLE				.60	
LUE				.89	
LLE				.63	
Post. tremor					
Right			.87		
Left			89		
Rigidity					
H/N					.48
RUE					.69
RLE					.78
LUE					.74
LLE					.79
Finger taps					
Right	.87				
Left	.85				
Hand mov.					
Right	.80				
Left	.83				
Alt. mov.					
Right	.70				
Left	.76				
Leg agility					
Right	.78				
Left					
Arising		.73			
Posture		−.31†			
Gait		.86			
Stability		.81			
Bradykinesia		.61			

H/N, head and neck; RUE, right upper extremity; RLE, right lower extremity; LUE, left upper extremity; LLE, left lower extremity; Post. tremor, postural tremor; hand mov., hand movements; Alt. mov., alternating movements.

* $p < 0.05$.

† Factor loadings less than .4.

eigenvalue after five factors (8.63–1.61). Following oblimin rotations, all items assessing bradykinesia of the extremities (factor 1), axial bradykinesia and gait (factor 2), action tremor (factor 3), rest tremor (factor 4), and rigidity (factor 5) clustered together. These five factors accounted for approximately 64% of the sample variance. Two items (posture and rest head tremor) did not reach criteria for factor loadings (factor loadings less than .4). Resting and action tremor were infrequently present; only 9% of the patients with PSP had resting tremor and 30% of the patients had action tremor.

Results of correlational analyses among the factors revealed a low degree of association ($r = 0.02–0.26$). The only significant correlation was factor 2 (axial bradykinesia and gait) with factor 5 (rigidity; $r = 0.26$). Other correlations among the factors were not significant.

Relationship Between Factors and Other Measures of PSP-Parkinsonism Disability

The degree to which the factor scores agreed with other measures of PSP-parkinsonism disability, or its construct validity, was assessed by examining the relationship between the individual factor scores and H&Y stage (Table 1). Individual factor scores were computed by summing the scores subjects received on individual items that comprised each factor. Factors assessing axial bradykinesia and gait (factor 1) and extremity bradykinesia (factor 2) were significantly related to H&Y stage. Rest tremor (factor 4), action tremor (factor 3), and rigidity (factor 5) were not significantly associated with H&Y.

DISCUSSION

Factor analysis of the UPDRSm revealed five distinct and clinically meaningful factors when applied to examination of patients diagnosed with PSP. The present exploratory study provides evidence of a stable factor structure to the UPDRSm in patients with PSP, and has important implications for the validation of the scale in PSP. The low correlations found among the factors suggest that each is measuring distinct aspects of PSP parkinsonian motor impairment while contributing to an overall assessment of PSP motor impairment. There was a high level of internal consistency for the entire scale as well as each of the five factors. Internal consistency was also high across different H&Y stages suggesting the scale may be applicable to all stages of the disease, but we did not examine the factor structure for each H&Y stage because of the limited sample sizes in each stage. The measures of internal consistency must be otherwise viewed cautiously because they are dependent on the number of items in the scale and may be artificially elevated.

H&Y stage is an accurate global measure of motor disability in PD. In this PSP sample, bradykinesia of the extremities (factor 1) and axial bradykinesia/gait (factor 2) were significantly associated with H&Y. These results suggest that ratings of bradykinesia, postural stability, and gait are influential in determining partially motor disability in PSP, but other clinical features, such as severe oculomotor, cognitive, bulbar, and speech disturbances, are not included in the UPDRSm or H&Y stage. In addition, UPDRS part II (activities of daily living) was not collected. These additional clinical features also contribute to disability in PSP.

The results from the present study on PSP are different from those of previous exploratory analyses of the factor structure of the UPDRSm for PD during "on"[2] and "off" states.[3] Whereas these studies also revealed that UPDRSm is valid and reliable scale for PD, in both the "on" and "off" stages of PD, six distinct factors were found: axial functioning/gait, rigidity, bradykinesia affecting right extremities and left extremities, action tremor, and rest tremor. Instead, the factor structure of the UPDRSm in PSP showed no side-to-side difference in bradykinesia. It is widely known that PSP[4] is a symmetric disease, and in contrast with PD, retrocollis occurs infrequently.[4] The latter may explain that "posture" and "rest head tremor" did not load at all.

Resting tremor and action tremor were infrequently found in this PSP sample. It is well known that PD differs from PSP in that resting tremor is a prominent and highly characteristic feature of PD but it is either absent[9] or of low amplitude in PSP.[10,11] In our study, we found resting tremor in 9% of the patients (47% of the patients met criteria for possible and 53% of the patients for probable PSP) and postural tremor in 30% of the patients (46% of the patients met criteria for possible, 50% for probable, and 4% for definite PSP). These results are comparable to two PSP necropsy-confirmed studies.[12,13] In addition, postural instability is an early symptom in approximately two thirds of patients with PSP. The latter may explain the higher H&Y stage seen in PSP sample (H&Y median score = 4), compared with H&Y stage in PD "on" sample (H&Y median score = 2) and H&Y stage PD "off" sample (H&Y median score = 3).

Golbe et al. have developed a disease-specific rating scale for PSP (PSPRS).[14] This scale rates several motor elements characteristic of PSP, which are not captured in the UPDRSm, such as eye movements, bulbar function, neck extension, and dystonia. It also permits a specific assessment of clinical progression in PSP and PSP staging. This is a specific scale that we can use once the

patients are diagnosed with PSP. The NINDS-SPSP criteria for the clinical diagnosis of PSP are highly specific (100%) but they are not very sensitive, because they can detect only about half of the patients at the first visit as probable PSP and 83% of the patients as possible PSP.[4] An inclusionary criteria is slowing of vertical saccades, and this has been suggested as an early sign in PSP, but up to 13% of the patients do not present significant abnormal eye movements early in the disease.[4] Therefore, patients with PSP are frequently misdiagnosed with PD at the beginning of the disease, especially when the abnormal vertical eye movements are not detected, and they show some improvement with levodopa,[4] and UPDRSm is usually used.

These results support the use of the UPDRSm in general clinical settings for the measurement of the PSP parkinsonian features but for some features, like eye movements, additional measures must be appended. Because the initial diagnostic impression for cases of PSP is usually PD, the UPDRSm is useful for tracing parkinsonian disability throughout the entire clinical course of the disease. A complementary disease-specific scale for PSP would be useful to focus on clinical features specific to this degenerative disorder after the diagnosis is firmly established.

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