Swallowing problems in Parkinson disease: frequency and clinical correlates

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ABSTRACT

Background: Changes to the efficiency and integrity of swallowing mechanisms are inevitable in Parkinson disease (PD); however, it remains unclear how many people with PD are at risk of dysphagia. The aim of this study was to establish the frequency of impaired swallowing in people with PD and the relationship between swallowing performance and indicators of disease progression.

Methods: A community-based and hospital-based cohort of 137 individuals with PD were asked to drink 150 ml of water as quickly as possible while in an 'off drug' state.

Results: Thirty-one (23%) patients could not completely drink the full 150 ml. Swallowing rate (ml/sec) fell to more than 1SD below published norms for 115 (84%) patients and to more than 2SD below for 44 (32%) individuals. There were moderate correlations between rate of swallowing and disease severity, depression and cognition, but not between swallowing speed and disease duration. There was poor correlation between subjective reports of dysphagia and performance on the water swallow test.

Conclusions: Swallowing problems are frequent in PD. Self-report of 'no difficulty' is not a reliable indicator of swallowing ability. Studies employing more-objective assessment of aspiration risk to compare with water swallow test performance are advocated.

On objective assessments, nearly all people with Parkinson disease (PD) have an impaired ability to swallow.[1 2] Nevertheless, patients may remain clinically asymptomatic and unaware of swallowing difficulties until later in the disease course.

Dysphagia is associated with negative outcomes, including reduced quality of life.[3–7] Medical and surgical treatments for PD may only partially ameliorate swallowing difficulties.[8] It is, therefore, important to identify patients at risk of swallowing-associated problems.

Estimates of the incidence of significant dysphagia in PD vary from around 18% to 100%, with disagreement concerning how seriously one should take the symptoms. The relationship of swallowing changes to other PD variables remains disputed.[9 10] In addition, there has been no investigation of swallowing status in relation to PD motor subtype.[11]

We aimed to establish, using a water swallow test, the prevalence of symptomatic swallowing changes in people with PD and how many cases might warrant referral for detailed objective assessment/intervention. We also investigated how performance variability related to other disease variables. We hypothesised that there would be a high frequency of objective dysphagia among patients with PD in comparison to published norms and that dysphagia severity would be greater in patients with more 'axial' motor involvement.

METHODS

Participants

We recruited participants from a community-acquired and hospital-acquired cohort of patients[12 13] meeting UK Parkinson's Disease Society Brain Bank Criteria for PD.[14] Individuals were excluded if they had a history of dysphagia prior to PD symptom onset, comorbidity associated with swallowing changes or did not wish to join the study. Recruitment and testing followed procedures approved by the local Research Ethics Committee.

Assessment procedure

Individuals had fasted since midnight on the day of the study and were assessed first thing in the morning before receiving any antiparkinsonian therapy. Swallowing was measured using a standard timed 150 ml water swallow test.[15] Before swallow testing, participants were assessed on the Unified Parkinson's Disease Rating Scale (UPDRS),[16] Hoehn and Yahr rating,[17] Geriatric Depression Scale (GDS)[18] and Mini Mental State Exam (MMSE).[19]

To compare PD phenotypes, patients were classified as tremor dominant (TD), postural instability/gait disorder (PIGD) or indeterminate according to a previously described formula that uses items from the UPDRS.[11]

Statistical analysis

Binomial tests were applied to proportional data, whereas stepwise linear regression was used to assess the prognostic value of variables in relation to swallowing speed. Correlation analysis was used to assess the relationship between variables.

RESULTS

One hundred and forty people with PD (female n = 52) consented to assessment, all of whom were feeding and drinking orally. Three participants could not reliably complete swallowing assessment due to upper limb control problems. For the remaining participants, there was no correlation between rate of drinking or total amount drunk and UPDRS facial and upper limb rest or action tremor. Details of the 137 participants who completed or attempted the glass of water test appear in table 1.

Table 1 Descriptive statistics and swallowing test performance for all participants and subgroups

	All patients (n = 137)		Patients who drank 150 ml (n = 106)		Patients who drank <150 ml (n = 31)	
	Median	**IQR**	**Median**	**IQR**	**Median**	**IQR**
Age (years)	73	67.5 to 77.0	73	67 to 77	74	68 to 78
Disease severity						
Hoehn and Yahr rating (5 = severe)	2	2 to 3	2	2 to 2.5	3	2 to 4
UPDRS part II score (68 = severe)	14.58*	6.55*	13.70*	6.21*	17.61*	6.85*
UPDRS part III score (108 = severe)	34.14*	14.52*	32.10*	14.10*	41.29*	13.85*
MMSE score (30 = normal)	26	23 to 28	27	23 to 28	25	20.75 to 27.25
GDS score (15 = severe)	4	2 to 7	3	2 to 6	5	4 to 8
Disease duration (years)	5	3.5 to 11	5	3 to 11	8	4 to 15
Swallowing test						
Swallowing speed (ml/sec)	6.47	3.5 to 12.2	8.4	4.9 to 14.1	2.79	1.3 to 4.2
Swallowing volume (ml/swallow)	15	10 to 21	16.7	12.5 to 21	7.4	4.2 to 12.0
Swallowing duration (sec/swallow)	2.0	1.5 to 3.3	2.0	1.5 to 2.7	2.8	1.9 to 4.2

*mean and SD for normally distributed data. GDS, Geriatric Depression Scale; IQR, interquartile range; MMSE, Mini Mental State Exam; UPDRS, Unified Parkinson's Disease Rating Scale.

Glass of water test

One hundred and six participants drank the full 150 ml of water. A total of 31 (23%) patients started but could not finish—18 females (35% of the female cohort) and 13 males (15% of the male cohort). The individuals who could not finish the full 150 ml drank a mean of 68 ml (SD 28.73 ml, range 8 ml to 120 ml). For 29 participants, drinking was discontinued because they indicated they wished to stop. The examiner halted two cases because of severe coughing. Three patients coughed mildly during swallowing but were not stopped; 16 coughed on completion of the test.

Regarding normal performance, Nathadwarawala *et al.*[15] established mean swallowing speed values of 32.07 ml/sec (SD 14.01 ml/sec) for males (n = 56) and 20.90 ml/sec (SD 10.98 ml/sec) for females (n = 45). In the present study 115 (84%) participants (males n = 76, 89%; females n = 39, 75%) fell more than 1SD below these mean control values. Twenty-one males (25%) but no females fell more than 2SD's below Nathadwarawala *et al.* means (2 SD below the female mean gave a minus score). Taking inability to complete 150 ml as indicative of an abnormal swallow and adding these individuals to those who did complete 150 ml, but fell more than 2SD below normal mean values, 44 (32%) patients overall had significant swallowing difficulties (male n = 26, 31%; female n = 18, 35%).

Those patients unable to complete 150 ml had a significantly slower drinking rate ($p<0.01$), less favourable Hoehn and Yahr stage ($p<0.01$), significantly different UPDRS part II and part III totals ($p<0.01$), greater depression ($p = 0.01$) and longer disease duration ($p = 0.04$) than patients who drunk the whole 150 ml. Age and MMSE were not significantly different between the two groups.

Volume drunk per swallow and time per swallow appear in table 1. These measures correlated highly with swallow speed (ml/sec vs ml/swallow: $r = 0.656$, $p<0.01$; ml/sec vs seconds per swallow: $r = 0.680$, $p<0.01$). Individuals who managed 150 ml had significantly higher volumes ($p<0.01$) and shorter times ($p = 0.01$) per swallow than those who could not complete 150 ml.

Relationship of swallowing speed to PD severity and phenotype

There were moderate correlations between swallowing speed and UPDRS part II score ($r = 0.380$; $p<0.001$), UPDRS part III score ($r = 0.337$; $p<0.001$), Hoehn and Yahr stage ($r = 0.411$; $p<0.001$), GDS score ($r = -0.391$; $p<0.001$) and MMSE score ($r = -0.316$; $p<0.001$), but not between swallowing speed and disease duration ($r = -0.135$; $p = 0.12$).

Motor phenotype groups differed in performance: the median swallowing speed for those patients classed as having PIGD (n = 67) was 4.98 ml/sec (IQR 2.1 ml/sec to 8.9 ml/sec), compared with 7.54 ml/sec (IQR 4.9 ml/sec to 16.3 ml/sec) for those classed as TD (n = 41) and 11.97 ml/sec (IQR 4.6 ml/sec to 15.1 ml/sec) for those classed as indeterminate (n = 29). Differences between the PIGD and TD groups ($p<0.01$) and between the PIGD and indeterminate groups were significant ($p<0.01$), but the difference between the indeterminate group and the TD group was not significant. In total, 71% of the PIGD group was able to drink the full 150 ml compared with 81% of the TD group and 91% of the indeterminate group. Differences between the PIGD and the TD groups and between the TD and the indeterminate groups in the number of patients who were able to drink 150 ml were not significant; however, the difference between the PIGD group and the indeterminate group was significant ($p = 0.02$).

To examine the joint effects of variables on swallowing speed, a multivariate regression model was constructed that included Hoehn and Yahr stage, UPDRS part II score, UPDRS part III score, MMSE score, GDS score, disease duration, age, gender and phenotype (PIGD vs non-PIGD). One case was removed from this analysis owing to a missing value. In addition, diagnostics revealed three outliers affecting the model, which were also removed. A backwards-stepwise model was subsequently applied (n = 133). Five variables affecting swallowing

speed remained: age, gender, GDS score, disease phenotype and UPDRS part III score (multiple $R^2 = 0.375$).

Relationship of millilitres drunk to perceived difficulties with swallowing

One hundred and twenty two participants answered the question 'do you have a problem swallowing food or drink?': 45 responded yes (38% of males, 35% of females). Twelve (27%) of those who noted they had a problem could not manage 150 ml, compared to 14 (18%) who said they had no problem ($p = 0.4$).

Of those patients who felt they had no difficulty swallowing, 60 (78%) fell more than 1SD below control mean values and 21 (27%) fell more than 2SD below these means or could not manage 150 ml. Two individuals who felt they had problems swallowing fell within the normal range, whereas 16 (35%) fell more than 2SD below the control mean values or could not manage 150 ml.

DISCUSSION

The estimated frequency of symptomatic swallowing difficulties in this study lies between 32% (swallowing speed >2SD below control mean) and 70% (slower than the slowest control subject <70 years[15]) Twenty-three percent of participants did not drink the entire 150 ml. Completion of a water test, however, does not preclude swallowing difficulties.[20] Neither does a higher swallowing speed necessarily indicate intact swallowing.[21]

A greater susceptibility to swallowing problems in the PIGD group supports the contention that swallowing may be associated with more 'axial' motor disturbance. The fact that dysphagia is at best partially ameliorated by dopaminergic therapy is consistent with the view that swallowing dysfunction relates to degeneration in nondopaminergic systems.[2 8] Large-scale studies comparing patients in 'on' versus 'off' drug states and the associations between changes in putative dopaminergic motor functions and changes in nondopaminergic motor functions are required to confirm this.

Contrary to earlier findings (e.g. those by Clarke *et al*.[9] and by Coates and Bakheit[10]), disease stage (UPDRS totals and Hoehn and Yahr rating) was not a strong indicator for swallowing difficulties. Our results should be viewed with caution, however, since our sample clustered around the middle stages of PD progression. The association of increased depression with poorer swallow ratings requires investigation, as we were unable to further elucidate the issue with the present data.

Self-reported difficulties with swallowing did not predict completion of the task nor swallow speed. Individuals unaware of their dysphagia may be at higher risk of aspiration than those who are aware.[21] Measurement of speed of drinking is influenced by breaths and pauses during the task. In so far as excessive pauses and breaths are abnormal, these factors themselves may identify functional impairment. Poor coordination of respiration and swallowing may underlie dysphagia in some individuals.[22]

Glass of water tests have high sensitivity, though not consistently high specificity. Adjunct measures such as cough during/after swallow and cervical auscultation (to detect altered laryngeal sounds) have been claimed to increase predictive power. Cough on/after swallowing was not frequent in this cohort. Speculatively, slowed rates of swallowing—with more frequent, smaller sips—and discontinuing the task were compensatory tactics to avoid penetration/aspiration. Smith *et al*.[20] found that 276 of 469 confirmed aspirators had no cough on swallowing. Cervical auscultation is not recommended as a reliable measure of aspiration,[23] although data relating specifically to PD are absent.

The water test may underestimate the severity of swallowing difficulties in patients with PD. The test requires concentration on a single task: swallowing a single consistency. In daily living, swallowing involves different consistencies and competing attentional demands. People with PD are likely to be more impaired in such situations than in the test situation.[24]

On the basis of current findings, approximately 30% of people with PD might be expected to require intensive active management for swallowing difficulties and up to 80% advice and close monitoring. Direct detection of aspiration and pooling of food or secretions is only achieved through videofluoroscopy or fibreoptic examination. To date, no large-scale studies have compared bedside evaluation with these methods in people with PD.

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