Dysphagia

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"Whilst at meals the fork not being duly directed frequently fails to raise the morsel from the plate: Which, when seized, is with much difficulty conveyed to the mouth." "… so much are the actions of the muscles of the tongue, pharynx, &c. impeded by impaired action and perpetual agitation, that the food is with difficulty retained in the mouth until masticated; and then as difficultly swallowed." "…the saliva fails of being directed to the back part of the fauces, and hence is continually draining from the mouth, mixed with the particles of food, which he is no longer able to clear from the inside of the mouth."

James Parkinson, 1817 [1]

Abstract

Dysphagia is an often unrecognized complication that occurs in a large majority of patients with Parkinson's disease (PD). Although dysphagia is often asymptomatic at first, with disease progression, a detailed clinical and radiological examination will identify multiple abnormalities in multiple phases of ingestion. Dysphagia treatment options are discussed, but there is inconsistent benefit from medications and limited documented evidence for paramedical modalities.

Keywords

Parkinson's disease • Dysphagia • Swallowing • Ingestion • Videofluoroscopy • Dysphagia therapy

Introduction

James Parkinson unambiguously portrayed advanced dysphagia in "The Shaking Palsy" [1]. Despite his obvious references to aspects of ingestion that precede swallow initiation, early investigators of deglutition in PD attributed dysphagia to esophageal dysmotility, a conclusion supported by numerous radiological observations [2–11] and pathological findings, such as the presence of Lewy bodies in the dorsal motor nucleus of the vagus (DMV) [12] and the esophageal myenteric plexus [13].

Braak et al. observed that, in most cases of sporadic PD, α-synuclein deposition progresses rostrally from the DMV to midbrain and cortex [14]. Miller et al. further quantified medullary α-synuclein, finding the highest levels in the DMV followed by the nucleus ambiguus, which is the somatic efferent innervation to the upper esophagus [15]. Although these findings have been subjected to some criticism [16, 17], they support the idea that esophageal dysmotility may be an early motor manifestation of PD. However, the relevance of this pathology to symptomatic

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dysphagia is not clear. Instead, the numerous motor abnormalities of pre-esophageal transport in PD [18–22] endorse a principal role for basal ganglia pathology in directing bolus movement and spawning dysphagia.

Definition of Dysphagia

Dysphagia is commonly defined as a disorder of swallowing, whether overt or covert (identified by radiological or physiological testing). However, the standard lingual, pharyngeal, and esophageal stages of swallowing inadequately incorporate other motor and cognitive behaviors that may impact swallowing efficiency and safety. Therefore, dysphagia is most inclusively not merely a disorder of the swallow but of ingestion [23], a complex motor cascade beginning prior to the swallow and terminating when a bolus passes the lower esophageal sphincter.

Anatomic Considerations

Reflexive deglutition begins in utero [24, 25] and is likely driven by a medullary central pattern generator (CPG). This functional center includes, but is not limited to, the nucleus solitarius, the dorsal and ventral vagal nuclei, and the intervening reticular activating system [26–28]. Exposed by neuroanatomic labeling techniques, additional polysynaptic connections that assist control and coordination of complex oromotor behaviors extend throughout the brainstem, from the hypoglossal nucleus to the substantia nigra pars reticulata [29–33]. With brain maturation and development of volition over reflex behavior, suprasegmental innervation supercedes the reflex swallow and merges it into the final phase of ingestion. Recent reviews of the supranuclear control of swallowing highlight a complex anatomic network that initiates and supports non-reflexive swallowing [34, 35]. Identified by transcortical magnetic stimulation, functional brain imaging (PET and fMRI) [28, 29, 36], and movement-related cortical potentials (MRCP), the most predominant activated regions include the cingulate, premotor, prefrontal, and primary motor and sensory cortices, along with the insula, cerebellum, and the basal ganglia–thalamic–cortical circuitry [36–40]. Therefore, many integrated neuronal systems, including those known to be defective in PD, control both bulbar and extremity automatic and commanded movements. Recent animal research also places the basal ganglia in position to modify some autonomic medullary motor functions [41]. This extensive functionally related circuitry provides robust evidence against the concept of hierarchial control of ingestion in favor of modular or distributed governance [40].

Prevalence of Dysphagia in PD

The prevalence of dysphagia in PD remains unknown but may range from about 50 to 100% [20, 42, 43]. Disparate results among studies relate in part to inconsistent criteria used to define dysphagia. Eadie and Tyrer [43], in the first systematic investigation of dysphagia in PD, claimed that 47% of their cohort had "symptomatic" dysphagia. Edwards et al. [44] using a more extensive questionnaire, reinforced this conclusion. An additional 28% of both study cohorts had sialorrhea, a complaint often due to an abnormality of swallowing and not to dysautonomic salivary overproduction [45, 46]. Indeed, compared with controls, hyposialorrhea may be an early autonomic feature of PD [47].

The prevalence of dysphagia in PD also increases if its definition, in addition to drooling, also encompasses those asymptomatic patients with radiological abnormalities of swallowing. Logemann et al. [48] reported that 95% of the PD patients referred for dysphagia therapy in their study had cineradiographic swallowing disturbances, but only 15–20% were clinically symptomatic. Other investigations of dysphagia in PD, using varying inclusion criteria, also demonstrate disparity between symptomatic and radiological dysphagia [18–21, 44, 49, 50]. These examples of diminished awareness of dysphagia in PD force the conclusion that responses to the Unified Parkinson Disease Rating Scale (UPDRS) Part II, which queries only about

Ingestion questionnaire

1. Do you have difficulty swallowing _____
2. Do you choke or gag on food? _____
3. Do you choke or gag on liquids? _____
4. Do you choke or gag on your own saliva? _____
5. Do you have difficulty starting to swallow? _____
6. Do you drool?. If so, only during sleep? _____
7. Do you have difficulty chewing? _____
8. Do you have difficulty moving food about in your mouth? _____
9. Does food feel like it gets stuck when you go to swallow? If so where – mouth, throat, chest?

   _____
10. Do you have heartburn? _____
11. Do you have reflux? _____
12. Do you belch frequently? _____
13. Do you get full at meals too quickly? _____
14. Do you have a poor appetite? _____
15. Do you have a fear of swallowing food or pills? _____
16. Does your mouth feel too dry? _____
17. Does it take too long to eat? _____

Fig. 8.1 Ingestion questionnaire

sialorrhea and choking/gagging during meals and even more detailed questionnaires are incomplete markers of dysphagia (see Fig. 8.1). Other scales to measure dysphagia clearly have more clinimetric value [51, 52].

The relationship between the prevalence of dysphagia in PD and the severity of the disease has received limited attention. Several studies report a correlation between disease severity and symptomatic dysphagia [20, 21, 44, 53, 54]. However, these results also hinge on the definition of dysphagia, e.g., whether drooling is included. In one study, all PD subjects reporting drooling had abnormalities of the oral stage of swallowing [55]. Barone et al. also noted that drooling increased along with disease duration and severity [56]. In a cohort of patients with dementia with Lewy bodies, dysphagia characteristics correlated with UPDRS-related severity of disease [57]. Conversely, Kalf et al., in a review of sialorrhea in a community-based PD population, thereby excluding those with more advanced disease, found prevalence rates to be higher in those with more mild PD [58]. Other investigators not only found no correlation of dysphagic symptoms with disease severity [21, 59] but also instead discerned that patients with most advanced disease professed fewer dysphagic symptoms

Table 8.1 Abnormalities of ingestion in Parkinson's disease

Phases of ingestion				
Preoral	Oral preparatory	Lingual	Pharyngeal	Esophageal
↓ Movements to mouth	↓ Lip seal	↓ Peristalsis	↓ Peristalsis	
Impulsive feeding	↓ Bolus movement	Hesitant or delayed transfer	↓ Laryngeal elevation	Tertiary waves
Dysregulation of feeding rate	↓ Mastication	Premature transfer	↓ Hyoid elevation	Reverse peristalsis
	↓ Lingual-centering movements	Segmented bolus transfer	↓ Epiglottic tilting	↓ Transport
		Lingual tremor	Vallecular retention	↓ Emptying
		Lingual "freezing"	Pyriform sinus retention	↓ LES closure
		↓ Lingual seal	↓ Laryngeal closure	GE reflux, hiatal hernia

↓, Slow or impaired; LES, lower esophageal sphincter; GE, gastroesophageal

than those less debilitated by their PD [21, 48]. These unanticipated results were posited to possible dementia, another complication of PD whose prevalence increases with advancing disease. A similar argument is proposed for the underreporting of symptomatic dysphagia when compared to radiological results in patients with corticobasal degeneration [60].

Clinical Dysphagia

The neurologic examination routinely incorporates a detailed cranial nerve examination but no observation of swallowing capacity. A simple bedside screening test of swallowing, although no substitute for the rigorous examination of the clinical dysphagia specialist, provides a rapid estimate of water swallowing capacity [61, 62]. Patients are asked to drink as quickly and as safely as possible 150 ml. of cold water. Observations include the number of swallows, the time to empty the cup, and any aberrant swallowing behavior such as coughing, gagging, or a post-test wet voice. Patients with PD require more swallows and are slower to complete the task than controls; both parameters decline with advancing disease [63]. However, a normal test does not exclude dysphagia since only water swallowing is monitored.

Clinical dysphagia specialists also conduct a detailed examination of cranial nerves 5, 7, 9, 10, and 12 as they relate to ingestion. They also analyze self-feeding by presenting a variety of food substances with varying textures, temperature, and tastes and record atypical feeding behaviors that might precipitate or exaggerate dysphagia. The more common feeding deficits in PD include reduced self-feeding capacity, abnormal neck and body postures while eating, impulsive feeding behaviors, difficulty regulating the quantity of food eaten, slow mastication, and hesitant swallow initiation [21, 64].

Radiological Dysphagia

Numerous videofluoroscopic studies of food and liquid ingestion have been conducted on PD patients. However, methodological and nomenclature differences have yielded incomplete and inconsistent observations of bolus movement (see Table 8.1). In early studies, patients swallowed only liquid barium while lying prone or standing erect [6–11, 65]. Pre-esophageal bolus preparation and transit were largely ignored. The modified barium swallow (MBS) administers test substances including barium impregnated foods of varying quantities and consistencies in the upright seated position. Unfortunately, the MBS

is an example of regional procedural blindness in that it scrutinizes oral preparatory, lingual, and pharyngeal phases of ingestion but ignores the esophageal phase.

Oral Preparatory Phase

The oral preparatory phase of ingestion prepares food or liquids and positions the bolus on the tongue prior to lingual transfer. Once in the mouth, food is captured by a firm lip seal anteriorly and compression of the posterior tongue against the hard palate posteriorly. The tongue squeezes food against the hard palate and then, with the cheeks, guides it onto the teeth for mastication. Once masticated, the tongue properly sizes and centers the bolus prior to the swallow, while any excess is temporarily squirreled between the teeth and cheeks. Prolongation of this phase is a generalized and commonly described abnormality in PD. More circumspect observations include one or several of the following: slow oral acceptance of the bolus, reduced bolus oral manipulation, inadequate or dysfunctional mastication, and poor bolus formation [18, 19, 21, 22, 48, 49, 66–68]. Less frequently observed aberrations include an insufficient lip seal so that oral contents slip from the mouth and lingual tremor [19, 21].

Lingual Phase

The lingual phase of ingestion is the first stage of the swallow. Although there are minor individual variabilities, contraction of tongue blade or tongue dorsum forces the bolus against the hard palate and generates a lingual peristaltic wave that propels the bolus from the mouth into the oropharynx. During this phase, PD patients manifest difficulty initiating the swallow, often displaying repetitive "pumping" movements [18, 19, 21, 49] approximating the leg hesitancies seen in freezing of gait. Segmented or "piecemeal" bolus swallowing is also common. These defective tongue movements may result in the bolus escaping over the tongue to invade the oropharynx and instigate a premature swallow [18, 19, 21, 49, 68]. An inefficient lingual phase also imparts a weakened bolus propulsive force that in turn compromises pharyngeal motility.

Pharyngeal Phase

The pharyngeal phase begins almost simultaneously with swallow initiation. The pharynx elevates and then contracts to surround the bolus, the hyoid bone and laryngeal cartilages rise, the epiglottis tilts to cover the laryngeal vestibule, the vocalis closes, and respiratory muscle activity pauses. A large majority of PD patients evaluated for dysphagia manifest slow or uncoordinated pharyngeal transport [19, 22, 49, 66–68]. The most frequent abnormalities include slowed pharyngeal peristalsis (>45%), bolus retention in the vallecular (>50%) and pyriform sinuses (>30%), and glottic aspiration (>15%) [22]. Because of its more proximate position to the laryngeal vestibule, spillage from pyriform sinus retention is more likely to cause laryngeal penetration or aspiration.

Although ignored in most studies of dysphagia in PD, epiglottic displacement is adversely affected in nearly 50% of patients [22]. When coupled with impaired extrinsic (laryngeal elevation) and intrinsic (vocal fold closure) laryngeal muscle movements during the swallow [69], the risk of aspiration increases significantly. Those PD patients with more advanced disease are most likely to display three abnormalities of the pharyngeal swallow that increase bolus aspiration risk: pyriform sinus retention, absent epiglottic inversion, and defective true vocal cord closure.

The pharyngo-esophageal sphincter (PES) is the anatomic transition between the pharynx and esophagus. This sphincter is pulled open during the pharyngeal phase, which allows unobstructed bolus transfer into the esophagus. Despite the opinion that dysphagia in PD is "…caused simply by clinical cricopharyngeal achalasia" [70] and several reports of PES dyssynergia with the advancing wave of pharyngeal peristalsis [13, 71], radiological studies of large numbers of PD patients do not support significant PES dysfunction. Together, Eadie and Tyrer [3] and Leopold

and Kagel [22] found only 1 of their 143 PD patients to have PES dysfunction. Manometric and electrophysiological evaluations of PES activity have also yielded contradictory results, with either increased or normal PES pressures, respectively [71–73]. These studies likewise failed to discern any radiological PES dysfunction during videofluoroscopy.

Esophageal Phase

Once past the PES, the bolus traverses the length of the esophagus and exits through the lower esophageal sphincter (LES) into the stomach. Bolus movement during the final phase of ingestion is generated foremost by the continuing progression of pharyngeal peristalsis and supplemented by local neuromuscular networks stimulating secondary peristalsis. Whether recorded during videofluoroscopy or inferred by esophageal manometry, more than 85% of PD patients have demonstrated slow, uncoordinated, and ineffectual esophageal bolus transport [22]. Defective peristalsis ranges from minor slowing to aperistalsis [7, 11, 22, 74]. Other esophageal aberrations include tertiary contractions, reverse peristalsis, "spasms," and patulency [4, 75]. Delayed transport and reverse peristalsis are statistically more common in patients with more advanced PD [23],. a finding unconfirmed by esophageal manometry [74, 75].

The lower esophageal sphincter (LES) transitions bolus transport from the esophagus to the stomach. Functionality of the LES in PD has not been examined as extensively as other anatomic regions of ingestion. Those few such studies describe a prevalence of gastroesophageal (GE) reflux that ranges from 26% to 57% [3, 22]. In PD patients studied by Eadie and Tyrer, GE reflux was three times more frequent than in control subjects [3]. Hiatal hernias also are seen but their prevalence may be no more than that of control subjects [76]. In another study of esophageal motility in PD patients (without a control population), both GE reflux and hiatal hernias were common, but no significant differences were uncovered based on disease severity [22].

Implications of Dysphagia

Dysphagia consequences are often both psychosocial and physical [77–79]. Symptomatic dysphagia often goes unrecognized by the PD patient. However, observant family and friends may find aberrant feeding behavior disturbing and withdraw from or become less tolerant of the patient during meals. For those dysphagic patients with insight into their frailties, mealtimes may provoke more anxiety than provide satiety [77]. As dysphagia advances, patients or their caregivers reduce food selection for safety and time constraints [80]. Mealtimes serve for both enteral and emotional nutrition, and neither goal will be satisfied if meals are exceptionally prolonged by slowed feeding, mastication, and swallow initiation. The end of this spiral is a socially isolated and often malnourished patient.

The burden of advancing PD includes an increased aspiration risk or frank aspiration. Choking and coughing may be absent or minimal [18]. The absence of aspiration during a MBS in dysphagic PD patients might suggest that their symptoms are of little consequence. However, the MBS is artificial and does not represent the automatic motor behavior so impaired in PD. Additionally, the MBS directs patients to sit with head and neck to sit erect. During typical daily meals, PD patients tend to eat with their head and neck anteroflexed [21], a posture that prepositions pharyngeal and tracheal structures to self-protect the airway. Disease and dysphagia progression eventuates in respiratory symptoms, with pneumonia as the most common cause of death in PD [81–83].

Treatment

Overview

Reviews of effective therapy for oropharyngeal dysphagia, the most common dysphagia in PD, find no consensus [84–87]. Minimal dysphagia with relatively low risk of aspiration presents historically as isolated sialorrhea. If nocturnal and

mild, such patients often require no specific intervention and therapeutic decisions should be based on other PD symptoms or manifestations. More severe drooling, even in the absence of additional dysphagic symptoms is a sign of more seriously compromised ingestion. Treatment decisions then follow a more considered examination of ingestion by a MBS plus esophageal fluoroscopy administered under the direction of an experienced clinical dysphagia specialist. Fiberoptic endoscopy during swallowing may also be informative.

Compensatory Techniques

During a diagnostic MBS, the dysphagia specialist introduces a variety of compensatory techniques and observes the responses. The result is a collection of facilitory and compensatory strategies taught to the patient and caregiver, intended to remediate abnormalities in one or several phases of ingestion. Direct therapy methods may include changes in body positioning during meals, altering the quantity, taste, temperature, and texture of food permitted, and cued instructions to reduce the automaticity of meals by inserting repetitive cycles of mastication, breath holding, and chin tucking before swallowing to narrow the airway prior to swallow initiation. Swallows may be followed by intentional throat clearing, a more effortful supraglottic swallow [88] and the Mendelsohn maneuver, a technique that prolongs laryngeal elevation during the swallow [89]. Some of these behavioral interventions have been systematically applied to PD patients with statistical improvement, but no single preferred treatment has emerged [59, 90–92].

Indirect strategies, such as stimulation techniques and exercises to strengthen and quicken the swallow, may provide benefit. Lee Silverman voice treatment improved some temporal measures of the oropharyngeal swallow [93]. Using the Mendelsohn maneuver with other indirect therapies in PD subjects, Nagaya et al. reported significantly reduced swallow initiation time after only one swallowing training session [68]. Cued swallowing can also shorten the duration of oropharyngeal swallowing [94]. Extrapolating from gait therapy research in PD [95], cueing may redirect motor instructions so as to minimize disordered basal ganglia influences over the automatic and sequential components of ingestion.

Notwithstanding any other literature support, dysphagia therapy appears experientially successful in remediating dysphagia in PD patients. However, because dysphagia may result in aspiration, subsequent pneumonia, or asphyxiation, researchers confront ethical barriers to the placebo-controlled studies usually demanded to determine treatment efficacy.

Drug Therapies

Drug treatment may diminish some aspects of impaired ingestion in PD, but the supportive literature is so meager as to suggest that dopaminergic pathways have little impact on swallowing [67, 96–98]. However, accurate quantification of drug-induced ingestive changes is limited. Lingual tremor is uncommon, subsides during swallowing [9, 21] and is without known adverse affects. Deglutory muscle rigidity is immeasurable. Only the ingestive equivalent of bradykinesia can be witnessed at the bedside or during videofluoroscopy with few standards by which it can be judged [41, 96, 99]. Consequently, relative to the scaled improvement of limb movement, even modest drug-induced benefits may be inconspicuous or, if radiologically or electophysiologiclly quantifiable, unappreciated by the patient.

Any medication-related benefit should accrue primarily to the prepharyngeal phases of ingestion, those phases under the greatest volitional control. In the first publication of levodopa therapy for PD, Cotzias et al. [100] noted “striking” improvement in “drooling and dysphagia.” Radiographic confirmation was not attempted. Levodopa therapy improves jaw velocity and amplitude [101] and lessens swallow-related deficits in some PD patients [20, 67, 70, 102–104] but may also increase saliva [105]. However, no levodopa-induced improvement of pharyngeal motility was seen by Calne et al. [42] Their cohort may have been less affected, since none had

vallecular or pyriform sinus stasis or aspiration; prepharyngeal bolus transport was insufficiently documented.

Dopamine agonists ameliorate some symptomatic and radiological swallowing abnormalities. In one study, bromocriptine lessened drooling [106]. In another, apomorphine produced some improvement in the oral preparatory and lingual phases [107]; off-period belching and associated esophageal motility also have been reported to improve [108]. Anticholinergic agents and salivary gland botulinum toxin injections [109] may reduce salivary consistency or volume but have little positive impact on the motor act of ingestion. On a cautionary note, anticholinergic-induced xerostomia may further impair swallow initiation and actually worsen ingestion. However, patients experiencing reduced saliva following parotid gland botulinum toxin injections reported no such problem [110]. Finally, although specific drug treatment for dysphagia was not directly addressed, PD patients may incur a significant slowing of swallowing when dopaminergic medications are withdrawn [63].

Prospective Non-pharmacological Therapies

Swallowing efficiency may improve in response to deep brain stimulation [111]. In that prepharyngeal phases of ingestion are more under volitional control, the report of improvements only in the pharyngeal phase of ingestion is somewhat unexpected. The explanation may be in the small numbers of subjects studied or that DBS activated other than thalamocortical targets to achieve the noted benefit. In potentially relevant research, Hamdy et al. demonstrated that short-term pharyngeal stimulation could drive pharyngeal motor cortex reorganization [112]. Jefferson et al. used transcortical direct current stimulation to enhance pharyngeal motor cortical excitability [113]. Together, these studies suggest that increased stimulation via several routes might kindle motor plasticity leading to symptomatic improvement of one or several phases of ingestion in PD patients.

Summary

In summary, the above review gives testimony in PD to an ensemble of ingestive motor deficiencies, extending from lips to lower esophageal sphincter. These abnormalities are not specific for PD, since many have been reported in other bradykinetic-rigid syndromes [60, 114, 115]. However, the early appearance of significant dysphagia is exceptional in PD and should alert the clinician to an alternative diagnosis [116, 117]. Once recognized, a detailed dysphagia evaluation should be considered.

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