NeuroRehabilitation 32 (2013) 949–955
DOI:10.3233/NRE-130918
IOS Press

Do swallowing exercises improve swallowing dynamic and quality of life in Parkinson's disease?

Natalie Argolo[a], Marília Sampaio[a,b], Patrícia Pinho[a], Ailton Melo[a] and Ana Caline Nóbrega[a,b,*]
[a]*Division of Neurology and Epidemiology, Federal University of Bahia, Salvador, Brazil*
[b]*Department of Speech-Language Pathology, Health Sciences Institut, Federal University of Bahia, Salvador, Brazil*

Abstract.
OBJECTIVE: To investigate the effect of motor swallowing exercises on swallowing dynamic, quality of life and swallowing complaints in Parkinson's disease (PD).
DESIGN: A before-after trial.
SETTING: University Medical Center.
PARTICIPANTS: Parkinson's disease patients with dysphagia complaints.
INTERVENTIONS: Motor swallowing exercises designed to increase the strength and range of motion of the mouth, larynx and pharyngeal structures, coordination between breathing and swallowing, and airway protection. Patients should perform the exercises twice a day, five days a week, for five weeks.
MAIN OUTCOME MEASURE(S): The primary outcome was the difference before and after the intervention in number of swallowing videofluoroscopic events (Swallowing Score). The secondary outcomes were quality of life (QOL) and swallowing complaints.
RESULTS: Fifteen patients concluded the study (10 man/5 woman; mean age 59.2 $\pm$ 9.17). The videofluoroscopic events with greater improvement were loss of bolus control ($P < 0.03$), piecemeal swallow ($P = 0.05$) and residue on the tongue ($P < 0.01$), valleculae ($P = 0.01$) and pyriform sinuses ($P = 0.05$). Lingual pumping and dental absence were interfering factors associated with treatment failure (beta standardized coefficient = -16.6, 26.2; $P = 0.02$, 0.002, respectively). The domains with greater improvements in QOL were fear ($P = 0.02$) and symptom frequency ($P = 0.05$). Regarding swallowing complaints, patients reported to have reduced mainly their difficulty in moving food in the mouth when chewing ($P = 0.02$). Reduction in swallowing disorders was not related with QOL improvement (cor = 0.13, [95% CI, 0.6–0.4], $P = 0.63$).
CONCLUSIONS: Motor swallowing exercises may reduce swallowing disorders in PD patients without lingual pumping and dental absence and impact positively QOL and swallowing complaints in individuals with PD.

Keywords: Parkinson's disease, rehabilitation, deglutition disorders

LIST OF ABREVIATIONS

PD	Parkinson's disease
LP	Laryngeal penetration
TA	Tracheal aspiration

*Address for correspondence: Ana Caline Nóbrega, Division of Neurology and Epidemiology, Rua Padre Feijó, 29 (4° floor) – Canela, Salvador, Bahia, CEP: 40.110-170, Brazil. Tel.: +55 71 3247 6982; E-mail: anacaline@uol.com.br.

UKPDBB	United Kingdom Parkinson's Disease Brain Bank
H&Y	Hoehn and Yahr scale
SWAL-QOL	Quality of Life in Swallowing Disorders Questionnaire

1. Introduction

Parkinson's disease (PD) is the most prevalent motor disorder in the world and affects approximately 1% of the population aged more than 60 years (Samii, Nutt & Ransom, 2004). Braak et al. (2003) found that neuronal degeneration often begins many years before diagnosis, and although initially described as an essentially motor disease, non-motor symptoms such as constipation, hyposmia and dysphagia have been described.

Oropharyngeal dysphagia can affect 100% of patients with Parkinson's disease (PD) (Rodrigues, Nóbrega, Sampaio, Argolo & Melo, 2011). In this population, rigidity and bradykinesia of oropharyngeal muscles, incoordination between swallowing and breathing and reduction of sensitivity are involved in swallowing disorder. Preswallow spill, lingual pumping, oral and pharyngeal stasis, laryngeal penetration and tracheal aspiration of saliva and food are events described as more prevalent in PD (Nagaya, Kachi, Yamada & Igata, 1998) (Sung et al., 2010) (Leopold & Kagel, 1996).

Nevertheless, most patients do not perceive swallowing disorder (Ali et al., 1996). This is particularly dangerous because the presence of TA increases the risk of aspiration pneumonia and death in this population (Nobrega, Rodrigues & Melo, 2008). Regarding the perception of well-being, dysphagia worsens the quality of life in Parkinson's disease and reduces the feeding moments shared with friends and family (Miller, Noble, Jones & Burn, 2006).

Despite this broad impact on physical and psychological aspects, there are few papers regarding the treatment for dysphagia in PD. The main treatment for motor symptoms in PD, the dopamine reposition, did not reveal a beneficial effect on deglutition (Menezes & Melo, 2009). Similarly, botulinum toxin in the parotid glands may minimize drooling but does not affect swallowing performance (Nobrega, Rodrigues, Torres, Enzo & Melo, 2007).

Exercises have been studied as a possible rehabilitative treatment. One study showed a reduction of swallowing events immediately after training (Nagaya, Kachi & Yamada, 2000); in another, vocal exercises increased tongue and pharyngeal mobility, reduced oral transit time and improved oropharyngeal swallow efficiency (Sharkawi et al., 2002). Expiratory muscle strenght training also have been studied as a possible rehabilitative tool for dysphagia in PD with impact in submentual muscles (Troche et al., 2010).

Literature addresses a number of exercises for tongue, lips, pharyngeal, laryngeal and submentual muscles that have been used in traditional therapy for swallowing disorders (Logeman, 1995) (Carrau & Murry, 2006). However, its effect in PD patients remains understudied. Therefore, the aim of this preliminary study was to investigate the effect of swallowing motor exercises on swallowing dynamic, quality of life and swallowing complaints in PD.

2. Methods

2.1. Patients and ethics procedure

Seventeen consecutive patients from Movement Disorders Ambulatory at Federal University of Bahia in Brazil with idiopathic PD and complaint of dysphagia were recruited. The diagnosis of PD was made by a certified neurologist and fulfilled the criteria of the United Kingdom Parkinson's Disease Brain Bank (UKPDBB). Level of disease was rated according to the Hoehn and Yahr scale (H&Y).

Exclusion criterea: presence of other neurologic diseases; cognitive, psychiatric disorders; head and neck cancer; cardiologic diseases; subjects in H&Y stage V (because of inability to come to the hospital); patients who had had oral exercise therapy for swallowing in the previous three months or patients who missed three consecutive sessions. After beginning the intervention, subjects did not begin new therapies or change their medication doses. All patients took levodopa throughout the study.

Two patients were excluded: one missed follow-up appointments and the other asked to be dismissed.

This study was conducted according to the Helsinki Declaration, approved by the local ethics committee and is registered on clinicaltrials.gov under the identifier NCT01131494. All patients signed an informed written consent prior to all procedures.

2.2. Assessments

An identification form has been filled with the following data: age, sex, marital status, education, duration of disease, Hoehn & Yahr stage, presence of dyski-

nesia, drugs, use of dentures and missing teeth, diet modification and previous speech therapy.

It was used videofluoroscopy of swallowing (VSS) to assess dysphagia on average 3 days before and after five weeks of intervention. The VSS was conducted by a radiologist and a speech language pathologist. Subjects completed the exam in a single phase in a seated, lateral position. To this examination was offered a spoon with 5 and 10 ml and a cup with 20 ml of thin liquid (Barium mixed with water at a 1:1 ratio), a spoon with 5 and 10 ml and a cup with 20 ml of thick liquid (pure Barium), a spoon with 5, 10 and 15 ml of puree (Barium mixed with Nestlé® natural yogurt at a 2:1 ratio) and soft solid foods (1/2 *wafer* dipped in Barium). All assessments were performed durig the "on" state, i. e., after the administration of anti-parkinsoniam drugs.

The videos were randomized and analyzed in slow motion and frame-by-frame by a trained speech therapist blinded to the moment before or after intervention.

In videofluoroscopy, we assessed the presence of lingual pumping and the swallowing events listed in Table 1. Lingual pumping was defined as repetitive tongue movement on the soft palate before bolus transfer to pharynx. The events were scored to each consistency and volume and summed to form a total swallowing score (TSS).

Regarding temporal parameters, the oral and pharyngeal transit time (OTT, PTT, respectively) was measured in milliseconds with the Avidemux software 2.5.3. The OTT was considered adequate until 2 seconds and the pharyngeal transit time was normal when less than 1 second. Because the duration of mastication, the OTT for solids was considered adequate until 18 s (Logeman, 2007).

The difference in TSS and scores for each event before and after intervention were analyzed by dividing patients into groups with and without lingual pumping, dyskinesia and dental absence, factors that can influence the dynamics of swallowing in this group of patients (Umemoto, Tsuboi, Kitashima, Furuya & Kikuta, 2011) (Yoshikawa et al., 2006) (Monte, da Silva-Júnior, Braga-Neto, Nobre e Souza & de Bruin, 2005).

To assess quality of life, all patient answered the SWAL-QOL questionnaire. This tool is a validated and language-adapted instrument that assesses swallowing-related quality of life and that contains 44 questions divided into domains (burden, symptom frequency, food selection, eating duration, eating desire, communication, fear, mental health, social functioning, fatigue and sleep) (Portas, 2009) (McHorney et al., 2000).

Swallowing complaints were assessed with this questions: 1) Do you have difficulty in moving foods in your mouth when you chew? 2) Do you have difficulty in beginning to chew foods? 3) Are you taking more time to chew foods? 4) Are you taking more time to swallow foods? 5) Do you need to make more effort to chew or swallow foods? 6) Has the amount of saliva in your mouth increased? 7) Do you cough or choke during or after eating? 8) Do you cough or choke with saliva? 9) Do you cough or choke when swallowing pills? 10) Have you lost weight in the past three months?

2.3. Intervention

All participants underwent oral motor exercises twice a day, five days a week, for five weeks. On one of the five days, each patient did the exercises under the supervision of a speech therapist at the clinical setting; on the other four days, the patients did the exercises at home.

As part of the training, the patients were provided with an illustrated booklet, where they had to mark after the exercise. The exercises were designed to increase the strength and range of motion of the mouth, larynx and pharyngeal structures, oral control of the bolus, coordination between breathing and swallowing and airway protection through increasing glottic closure (Logeman, 1995) (Carrau & Murry, 2006). All patients performed the same exercises, which consisted of ten repetitions of sustained vowel phonation of /a/, pushing of plosive phonemes in a forceful manner to increase glotic closure, vertical range of motion of the larynx and posterior tongue to soft palate contact; sucking of wet gauze – to increase oral control of bolus and tongue-palate contact; swallowing with the tongue held – to increase pharyngeal posterior wall range of motion during swallowing; modified supraglottic maneuver – to close vocal folds (breath hold) and clear any residue that may enter the laryngeal vestibule (to emit the /a/ vowel in a forceful manner) before breathing again. And five repetitions of ascending and descending gliding phonations of the vowels /a/ and /u/ – to increase glottic closure and vertical range of motion of larynx; and three series of five repetitions for each side of rotating the tongue in the oral vestibule – to promote tongue strength and range of motion.

2.4. Statistical analyses

Data were analyzed using R software 2.11.0. Demographical data were analysed with descriptive statistics.

Table 1
Parameters of videofluoroscopy swallowing study, definition and score

Parameters	Name	Definition	S Score	Unit of Measurement
Visuo-perceptual parameters	Loss of bolus control	Bolus falls into the lateral or anterior sulci before the swallow is initiated (Logeman, 1995)	0 = Absent; 1 = Present	(0–1) Two point scale
	Swallow hesitance	Delay in the onset of the bolus transfer to pharynx (Ali et al., 1996)	0 = Absent; 1 = Present	(0–1) Two point scale
	Oral residue	Food remains in lateral or anterior sulci after the swallow	0 = Absent; 1 = Mild; 2 = Moderate; 3 = Severe	(0–3) Four point scale
	Residue in tongue	Food remains above the tongue after the swallow	0 = Absent; 1 = Mild; 2 = Moderate; 3 = Severe	(0–3) Four point scale
	Residue in hard palate	Material remains in hard palate after swallow	0 = Absent; 1 = Mild; 2 = Moderate; 3 = Severe	(0–3) Four point scale
	Piecemeal swallow	Bolus is fractioned in oral cavity and swallowed in two or more parts (Ali et al., 1996)	0 = Absent; 1 = Present	(0–1) Two point scale
	Multiple swallows	Multiple swallows to clear the bolus that remains in pharynx	0 = Absent; 1 = Present untill 3 swallows; 2 = Present more than 3 swallows	(0–2) Three point scale
	Residue in valleculae, pyriform sinuses, posterior pharyngeal wall or pharyngo-esophageal transition	Material remains in valleculae, pyriform sinuses, posterior pharyngeal wall or pharyngo-esophageal transition after swallow	0 = Absent; 1 = Mild; 2 = Moderate; 3 = Severe	(0–3) Four point scale
	Laryngeal penetration	Material enters the airway but remains at the vocal folds level (Rosenbek, Robbins, Roecker, Coyle & Wood, 1996)	0-absent; 1-high, with spontaneous clearance; 2-high, with induced clearance; 3-high, without clearance; 4-low, with spontaneous clearance; 5-low, with induced clearance; and 6-low, without clearance	(0–6) Seven point scale
	Tracheal aspiration	Material enters the ariway and pass the vocal folds level	0-absent; 1-present, with spontaneous and effective clearance; 2-present, with induced and effective clearance; and 3-present, without effective clearance	(0–3) Four point scale
Temporal parameters	Oral transit time	From the first tongue movement untill the bolus head arrives the mandibular ramus (Nagaya et al., 1998)		Seconds
	Pharyngeal transit time	From the arrival of the bolus head in mandibular ramus untill the bolus tail passess the upper esophageal sphincter		Seconds

Shapiro test was used to assess normality of sample. Analyses of nonnormally distributed samples were performed with the nonparametric Wilcoxon signed-rank test. Relation between swallowing score difference before and after intervention and the presence of dyskinesia, lingual pumping and dental absence was tested with multiple linar regression. Correlation of Spearman was made to identify correlation between difference in swallowing scores and in SWAL-QOL scores. A P-value ≤ 0.05 was considered significant.

3. Results

Fifteen subjects concluded this study (10 man, 5 woman; mean age 59.2 ± 9.17). Their Hoehn & Yahr mean were 2.23 ± 0.7 and disease duration mean 79.3 ± 46 months. All men were marriage and all women were single or divorced. Regarding education, 9 (60%) of patients had eleven or more years of study. None of them had modified their diet consistency and 3 (20%) made previous speech therapy for swallowing.

In Table 2 it is observed that patients exhibited different performances in swallowing outcome: factors as lingual pumping, teeth absence and dyskinesia were absent in individuals with better performance. In mutiple linear regression was observed that lingual pumping and dental absence were interfering factors associated with treatment failure (beta standardized coefficient = −16.6, 26.2; $P = 0.02$, 0.002, respectively), but regarding dyskinesia no relation was found (beta standardized coefficient = −11.37, $P = 0.22$).

Analyzing the difference in scores for swallowing by interfering factors we observed a statistically significant difference for loss of bolus control ($P = 0.02$), piecemeal swallow ($P = 0.05$), residue on the tongue ($P = 0.01$) and residue in pyriform sinuses ($P = 0.05$) when divided groups by lingual pumping. By dental absence, the events with statistical significance were loss of bolus control ($P = 0.03$), residue on the tongue ($P = 0.007$) and vallecular residue ($P = 0.01$). By dyskinesia, only two patients presented this condition, difference in swallowing events by this factor were not found.

The transit time measures were not reduced after the intervention. In pasty 15 ml, patients without lingual pumping showed a mild reduction at oral transit time, but it was not statiscally significant.

Regarding quality of life, nine subjects showed reduction in total SWAL-QOL scores. The difference in this score before and after intervention had no correlation with the difference in swallowing scores (cor = 0.13, [95% CI, −0.4 0.6], $P = 0.63$). The mean of difference in SWAL-QOL scores before and after intervention for the fear ($P = 0.02$) and symptom frequency ($P = 0.05$) domains were statiscally significant (Table 3).

In swallowing complaints analyses from all patients, only the item related to difficulty in moving food in the mouth when chewing had a significant improvement ($P = 0.02$).

4. Discussion

This study demonstrates that a five-week course of motor exercises may be effective in reducing some swallowing disorders and increasing quality of life in dysphagic individuals with PD. Individual factors such as lingual pumping and dental absence may severely intefere in the results.

The events with greater improvement were loss of bolus control, piecemeal swallow, residue on the tongue, residue in valleculae and residue in pyriform sinuses. Therefore, patients are more able to control bolus in mouth, eject the bolus more efficiently, leaving fewer residues after swallow.

The lack of change in the time of oral and pharyngeal transit should be analyzed with caution. Despite its reduction is often analyzed as an outcome of improvement of dysphagia, there is still no consensus that a

Table 2
Demographical and clinical data of research subjects

PT	SEX	AGE	HY	DD	SB	SA	LinP	DYS	TeeA
1	M	71	3	96	43	26			
2	M	63	2	72	38	31			
3	F	57	2.5	96	23	15			
4	M	80	1.5	156	75	49			
5	M	66	2	72	55	45			
6	M	49	3	75	36	32			
7	F	61	1.5	68	37	31			□
8	M	68	4	180	43	23			□
9	M	59	2	96	45	31		□	□
10	F	50	2.5	96	40	45			□
11	F	57	2	72	27	37	□		□
12	F	49	2.5	12	33	55	□	□	□
13	M	52	2	15	54	94	□		□
14	M	49	1.5	23	73	87	□		
15	M	57	1.5	60	26	47			□

PT: Patient; Sex: M = Male; F = Female; HY: *Hoehn & Yahr* Scale; DD: Disease durantion in months; SB: Swallowing score before; SA: Swallowing score after; LinP: Lingual pumping; DYS: Dyskinesia; TeeA: Teeth absence; □: Event present in the assessment.

Table 3
SWAL-QOL scores by each domain

Domain	Before			After			*P*-value
	Min-Max	Median	Mean ± SD	Min-Max	Median	Mean ± SD	
Burden	0–100	62.5	64.2 ± 30.6	25–100	75	73.3 ± 25.8	0.3722
Eating desire	33.3–100	75	78.3 ± 24.4	33.3–100	91.7	84.4 ± 19.4	0.2842
Eating duration	0–100	37.5	44.2 ± 40.0	0–100	25	38.3 ± 40.8	0.2561
Symptom frequency	42.8–83.9	62.5	64.96 ± 14.32	32.1–85.7	75	69.85 ± 14.77	0.05002*
Food selection	20–100	62.5	64.7 ± 30.5	0–100	87.5	70.5 ± 34.8	0.2773
Communication	0–100	50	50.8 ± 33.6	12.5–100	50	59.2 ± 27.7	0.2091
Fear	12.5–100	62.5	56.2 ± 28.9	31.2–100	75	67.9 ± 18.6	0.02772*
Mental health	0–100	65	63.7 ± 37.6	20–100	95	72 ± 32.2	0.2777
Social functioning	0–100	60	57.7 ± 38.2	15–100	85	68.3 ± 36.2	0.1275
Sleep	0–100	50	53.3 ± 30.0	0–100	62.5	52.4 ± 34.8	0.9232
Fatigue	0–100	33.3	50.5 ± 33.5	0–100	50	48.9 ± 32.4	0.789

swallowing faster is necessarily safer (Troche, Okun, Rosenbek, Musson & Fernandez, 2010).

Sharkawi et al. (2002) explored changes in deglutition after eight weeks of vocal exercises in Parkinson's disease and found a reduction in oral transit time and oral stasis, but not in LP. In the present study, we observe that exercises designed to increase oral bolus control, expand airway protection and promote better coordination between breathing and swallowing can indeed induce changes in a short period of time.

Regarding interferent factors on swallowing outcome, associations between dental absence and pharyngeal stasis and LP may be related to the difficulty that these subjects have in organizing a bolus and ejecting it efficiently to the pharynx. Absence of teeth is related to modifications in tongue movements, increased swallowing time and the occurrence of LP (Yoshikawa et al., 2008) (Furuya, 1999). Additionally, dental absence in this study may have hindered exercise performance.

Lingual pumping, which is a common finding in swallowing among PD patients, is associated with rigidity and bradikynesia on lingual muscles affecting food transport (Umemoto et al., 2011). This may explain the relationship between lingual pumping and increased oral residue and pharyngeal stasis, which contributes to poorer swallowing scores in subjects with this condition during the post-intervention assessment.

Regarding quality of life, the improvement in SWAL-QOL domains of fear and frequency of symptoms suggests that the treatment decreased the fear of choking episodes. By increasing their knowledge about swallowing, the patients may also increase their ability to predict risk factors for the aspiration of food and to avoid eating certain foods.

The lack of an observed association between improvements in QOL and improvements in swallowing dynamics is supported by previous studies showing no relationship between QOL and the degree of dysphagia (Miller et al., 2006). Interference from other aspects of the QOL of patients, such as family, leisure activities, marriage and friends, may have contributed to this result (Lee, Walker, Hildreth & Prentice, 2006).

Despite reports of significant improvements only in the complaint about food drive while eating, the inability of subjects with PD to perceive their swallowing disorders should be taken into account. The studies of Leopold and Kagel (1996) and Sung et al. (2010) have shown that, while dysphagia has a number of consequences, increasing morbidity and mortality, individuals with PD do not realize and do not complain about their swallowing disorders. This inability to perceive changes in swallowing may be associated with the decreased sensitivity of the larynx and pharynx found in this population (Rodrigues et al., 2011).

Is important to stress that we evaluated functional changes in the dynamics of swallowing. Other studies should be conducted to detect neuromuscular changes after oral exercises because there is a paucity of data on structural adaptations after exercises, which raises questions about the optimal duration, intensity and load used to influence neuromuscular changes.

4.1. Study limitations

Limitations to our paper are the small sample without a control group. Our findings may support further larger and randomized trials to assure the effectiveness of exercises for swallowing dynamics, quality of life and swallowing complaints in PD and clarify others interfering factors in swallowing treatment.

5. Conclusion

Motor swallowing exercises may reduce swallowing disorders in PD patients without lingual pumping and dental absence and impact positively QOL in individuals with PD. The interfering factors in swallowing outcome and the lack of correlation between improvement in swallowing dynamic and QOL underscore the need for an interdisciplinary approach for this population.

Declaration of interest

There was no financial support and no conflict of interests relative to this research.

References

Ali, G. N., Wallace, K. L., Schwartz, R., DeCarle, D. J., Zagami, A. S., & Cook, I. J. (1996). Mechanisms of oral-pharyngeal dysphagia in patients with Parkinson's disease. *Gastroenterology*, *110*(2), 383-392.

Braak, H., Del Tredici, K., Rüb, U., de Vos, R. A. I., Jansen Steur, E. N. H., & Braak, E. (2003). Staging of brain pathology related to sporadic Parkinson's disease. *Neurobiol Aging*, *24*(2), 197-211.

Carrau, R., & Murry, T. (2006). *Comprehensive management of swallowing disorders*. San Diego: Plural Pub.

Furuya, J. (1999). Effects of wearing complete dentures on swallowing in the elderly. *Kokubyo Gakkai Zasshi*, *66*(4), 361-369.

Lee, M. A., Walker, R. W., Hildreth, A. J., & Prentice, W. M. (2006). Individualized assessment of quality of life in idiopathic Parkinson's disease. *Mov Disord*, *21*(11), 1929-1234.

Leopold, N. A., & Kagel, M. C. (1996). Prepharyngeal dysphagia in Parkinson's disease. *Dysphagia*, *11*(1), 14-22.

Logemann, J. (1995). *Evaluation and treatment of swallowing disorders*. Austin Tex.: PRO-ED.

Logemann, J. (2007). Swallowing disorders. *Best Practice & Research Clinical Gastroenterology*, *21*(4), 563-573.

McHorney, C. A., Bricker, D. E., & Kramer, A. E. (2000). The SWAL-QOL outcomes tool for oropharyngeal dysphagia in adults: I. *Conceptual foundation and item development Dysphagia*, *15*(3), 115-121.

Menezes, C., & Melo, A. (2009). Does levodopa improve swallowing dysfunction in Parkinsons disease patients? *Journal of Clinical Pharmacy and Therapeutics*, *34*(6), 673-676.

Miller, N., Noble, E., Jones, D., & Burn, D. (2006). Hard to swallow: Dysphagia in Parkinson's disease. *Age and Ageing*, *35*(6), 614-618.

Monte, F. S., da Silva-Júnior, F. P., Braga-Neto, P., Nobre e Souza, M. A., & de Bruin, V. M. S. (2005). Swallowing abnormalities and dyskinesia in Parkinson's disease. *Mov Disord*, *20*(4), 457-462.

Nagaya, M., Kachi, T., Yamada, T., & Igata, A. (1998). Videofluorographic study of swallowing in Parkinson's disease. *Dysphagia*, *13*(2), 95-100.

Nagaya, M., Kachi, T., & Yamada, T. (2000). Effect of swallowing training on swallowing disorders in Parkinson's disease. *Scand J Rehabil Med*, *32*(1), 11-15.

Nobrega, A., Rodrigues, B., Torres, A., Enzo, A., & Melo, A. (2007). Does botulinum toxin decrease frequency and severity of sialorrhea in Parkinson's disease? *Journal of the Neurological Sciences*, *253*(1-2), 85-87.

Nobrega, A., Rodrigues, B., & Melo, A. (2008). Is silent aspiration a risk factor for respiratory infection in Parkinson's disease patients? *Parkinsonism & Related Disorders*, *14*(8), 646-648.

Portas, J. G. (2009). Validação para a língua portuguesa-brasileira dos questionários: Qualidade de vida em disfagia (SWAL-QOL) e Satisfação do paciente e qualidade do cuidado no tratamento da disfagia (SWAL-CARE). [Dissertation]. São Paulo: Fundação Antônio Prudente.

Rodrigues, B., Nóbrega, A. C., Sampaio, M., Argolo, N., & Melo, A. (2011). Silent saliva aspiration in Parkinson's disease. *Mov Disord*, *26*(1), 138-141.

Rosenbek, J. C., Robbins, J. A., Roecker, E. B., Coyle, J. L., & Wood, J. L. (1996). A penetration-aspiration scale. *Dysphagia*, *11*(2), 93-98.

Samii, A., Nutt, J., & Ransom, B. (2004). Parkinson's disease. *The Lancet*, *363*(9423), 1783-1793.

Sharkawi, A., Ramig, L., & Logemann, J. A. (2002). Swallowing and voice effects of Lee Silverman Voice Treatment (LSVT(R)): A pilot study. *Journal of Neurology Neurosurgery & Psychiatry*, *72*(1), 31-36.

Sung, H. Y., Kim, J. -S., & Lee, K. -S. (2010). The prevalence and patterns of pharyngoesophageal dysmotility in patients with early stage Parkinson's disease. *Mov Disord*, *25*(14), 2361-2368.

Troche, M. S., Okun, M. S., & Rosenbek, J. C. (2010). Aspiration and swallowing in Parkinson disease and rehabilitation with EMST: A randomized trial. *Neurology*, *23*, *75*(21), 1912-1919.

Umemoto, G., Tsuboi, Y., Kitashima, A., Furuya, H., & Kikuta, T. (2011). Impaired food transportation in Parkinson's disease related to lingual bradykinesia. *Dysphagia*, *26*(3), 250-255.

Yoshikawa, M., Yoshida, M., Nagasaki, T., Tanimoto, K., Tsuga, K., & Akagawa, Y. (2008). Effects of tooth loss and denture wear on tongue-tip motion in elderly dentulous and edentulous people. *J Oral Rehabil*, *35*(12), 882-888.