Dysphagia (2019) 34:862–868
https://doi.org/10.1007/s00455-019-09982-z

ORIGINAL ARTICLE

Dysphagia in Parkinson's Disease Improves with Vocal Augmentation

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Received: 20 June 2018 / Accepted: 18 January 2019 / Published online: 29 January 2019

Abstract
While voice-related disorders in Parkinson's disease (PD) are commonly discussed in the literature, dysphagia in PD is less widely published. Vocal fold augmentation, including injection laryngoplasty (IL), is a well-established treatment for glottal insufficiency (Cates et al. in Otolaryngol Head Neck Surg 155(3):454–457, 2016). This study aimed to observe the effects of IL in PD patients with vocal bowing, with or without therapy, on glottic closure and patient-reported dysphagia outcomes. The study design was based on retrospectively collected database and cohort–case series. PD patients selected for retrospective review over a 2-year period were referred and evaluated in the Voice, Swallowing, and Airway multidisciplinary clinic by speech language pathologist and laryngologist, and were undergoing IL. Charts were reviewed for age, gender, Body Mass Index (BMI), onset of PD, and Movement Disorders Society-Unified Parkinson's Disease Rating Scale Part 3 (MDS-UPDRS) scoring. We compared pre/postoperatively (> 1 < 3 months) using validated patient-reported outcome tools: Reflux Symptom Index (RSI), Glottal Function Index (GFI), Eating Assessment Tool-10 (EAT), and stroboscopic examinations. The study included 14 patients undergoing 22 IL or 1.6 IL/patient: mean age 70 years (63–80), 100% male, and BMI 25.9 ± 4.3 (mean ± SD). MDS-UPDRS scoring 33 ± 20 (moderate severity), with time between PD diagnosis and IL 8 ± 10 years. All patients had pre- and post-stroboscopic examinations; however, only 4:14 underwent formal swallowing evaluation. Overall, 14 IL patients improved on patient-reported measures (ΔRSI = 4; ΔGFI = 3; ΔEAT = 4). Based on the findings of the study, we conclude that PD is a progressive neurodegenerative condition with dysphagia. The presented pilot data suggest that IL may be considered as a beneficial adjunct for PD patients with glottal insufficiency.
Level of Evidence 4.

Keywords Parkinson's disease · Parkinsonism · Injection laryngoplasty · Dysphagia · Vocal augmentation

Introduction

Parkinson's disease (PD) is an age-related progressive neurodegeneration of the substantia nigra pars compacta dopamine deficiency. The disease is characterized by bradykinesia, rigidity, resting tremor, and postural instability. Prevalence rates range from 41 per 100,000 (age range from 40–49) up to 1903 per 100,000 (age range 80 +) [2]. Older age, male sex, and family history of PD are associated with higher PD risk [3].

Parkinson's voice is a well-known symptom of the disease affecting up to 90% of those with PD [4].

Lee Silverman voice therapy (LSVT) is the primary treatment option for patients with PD dysphonia but the effects of LSVT on symptoms of dysphagia are less understood [5]. LSVT may not yield the same benefits for all PD patients including those with the following important clinical restraints: lacking regular transportation, maximum phonation time < 5 s, significant bowing, severe cognitive deficits, intolerable pain, lack of motivation, time constraints, and little stimulability. Patients with these limitations may benefit from adjunct treatments such as speech therapy or injection laryngoplasty (IL).

The literature describing the effects of glottal insufficiency on dysphagia is limited. In fact, dysphagia may be a marker for disease progression at the level of the glottis.

Presented at Combined Otolaryngology Spring Meetings, ALA poster as an in San Diego, CA, April 26–29, 2017.

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Aspiration pneumonia is a cause of death in PD and has been reported in 20–40% compared to 8% in a normal population [6]. Pneumonia and cachexia are significantly more frequent in PD compared with normal elderly [7]. PD dysphagia may be under appreciated in the current literature.

We sought to retrospectively review our experience at the University of Cincinnati (UC) Voice, Swallowing, and Airway Center performed in accordance with our Institutional Review Board. We hypothesized that PD patients report symptoms of dysphagia; furthermore, undergoing IL will report improved dysphagia (EAT-10 scores) in patient (or caregiver)-reported outcomes comparing pre- and (< 3 months) postinjection laryngoplasty with or without speech therapy.

Materials and Methods

UC Institutional Review Board approved the retrospective review of medical records to identify all patients with diagnosis of PD (ICD-10 G20, J38.3, R49) with procedural codes injection laryngoplasty (CPT 31570 or 31571) from August 1, 2014 to August 1, 2016. Patient charts were reviewed to confirm diagnosis and procedures. Patients were included with preoperative examination and postoperative follow-up at < 3 months from initial procedure. Patient-reported outcomes (EAT-10, RSI, GFI) were recorded only for the first IL; however, charts were reviewed for those undergoing multiple IL and/or medialization laryngoplasty (ML). One patient was excluded from the data analysis due to undergoing ML alone, but was included for discussion only. Demographic information such as age (at time of procedure), gender, Movement Disorders Society-Unified Parkinson's Disease Rating Scale Part 3 (MDS-UPDRS) score, age at diagnosis of PD, placement of a deep brain stimulator, voice therapy (VT), swallow therapy (ST), or Lee Silverman voice therapy (LSVT) were all recorded. Patients undergoing traditional voice and swallowing therapy did not follow a set protocol, rather specific goals and therapy targets were determined by the treating clinician. Given that this was a retrospective study, no control group was included for this case series.

All patients were evaluated by speech language pathology and a laryngologist in the multidisciplinary clinic at UC Voice, Swallow, and Airway Center. LSVT was considered and discussed with patient and caretaker at the initial intake. When patients were unable to commit to (16 sessions) of LSVT, then traditional voice therapy (VT) or swallow therapy (ST) was offered as an alternative. In PD patients with glottal insufficiency and vocal bowing on stroboscopy, IL was offered as an adjunct to therapy. Each follow-up evaluation was performed by both SLP and a fellowship-trained laryngologist in a multidisciplinary clinic.

We used the MDS-UPDRS to assess burden of disease (preferred by our neurology colleagues over the classic Hoehn and Yahr scoring). MDS-UPDRS is separated into four parts: we measured part three (motor) where PD was characterized as mild (< 32) moderate (33–58) and severe (> 59) [8, 9]. Both neurology and otolaryngology records were reviewed simultaneously, and the most recent MDS-UPDRS scoring recorded with the nearest matching dates of service.

Patients underwent either in-office bilateral IL ($n = 18$) via the thyrohyoid or cricothyroid approach or suspension microlaryngoscopy with injection ($n = 4$) based on surgeon and patient preference, for a total of 22 injections in 14 patients between two fellowship-trained laryngologists. Six patients underwent medialization laryngoplasty (ML) as a definitive surgical intervention. Patients were scheduled to follow-up at one, three, and six months postinjection. For the purposes of this study, we included the initial/preoperative visit and > 1 but < 3 months postoperative visit.

Validated patient survey instruments were obtained including Glottal Function Index (GFI), Reflux Symptom Index (RSI), and Eating Assessment Tool-10 (EAT-10) to elicit patient (or caregiver)-reported outcomes [10–12]. In addition, stroboscopic evaluation was obtained on all patients. These images were reviewed and recorded to evaluate glottic closure by three independent speech pathologists (see Fig. 1). Interrater reliability was calculated using Excel. Descriptive statistical analysis was used to qualify our initial pilot study results.

Results

Twenty two IL were performed in 14 patients over 2 years, for a total of 14 PD patients undergoing vocal augmentation. No immediate postoperative or postprocedure complications were observed. In the 2-year follow-up, two were deceased; all the others are followed at least annually (see Table 1). In 22 IL treatments, calcium hydroxyapatite (Prolaryn™ Plus) was used in 3; carboxymethylcellulose (Prolaryn™ Gel) was used in 13; and micronized particulate (Cymetra®) was used in 6. The mean age was 70 years old (range 63–80) and 100% male gender. The mean Body Mass Index (BMI) was 25.9 ± 4.3 (SD). The mean score for the cohort for the MDS-UPDRS was 34 ± 20 (moderate severity), with the range of 10–79. Mean duration (time in years) between PD diagnosis and IL was 8 ± 10 years (Table 1). Four patients had a history of deep brain stimulator (DBS) implantation.

Table 1 demonstrates our case series divided into mild ($n = 6$), moderate ($n = 5$), and severe ($n = 3$) based on MDS-UPDRS scoring. In the 14 patients undergoing first IL, with MDS-UPDRS scores of 33 ± 20, the cohort improved based on all patient-reported measures in mean change (ΔRSI = 4;

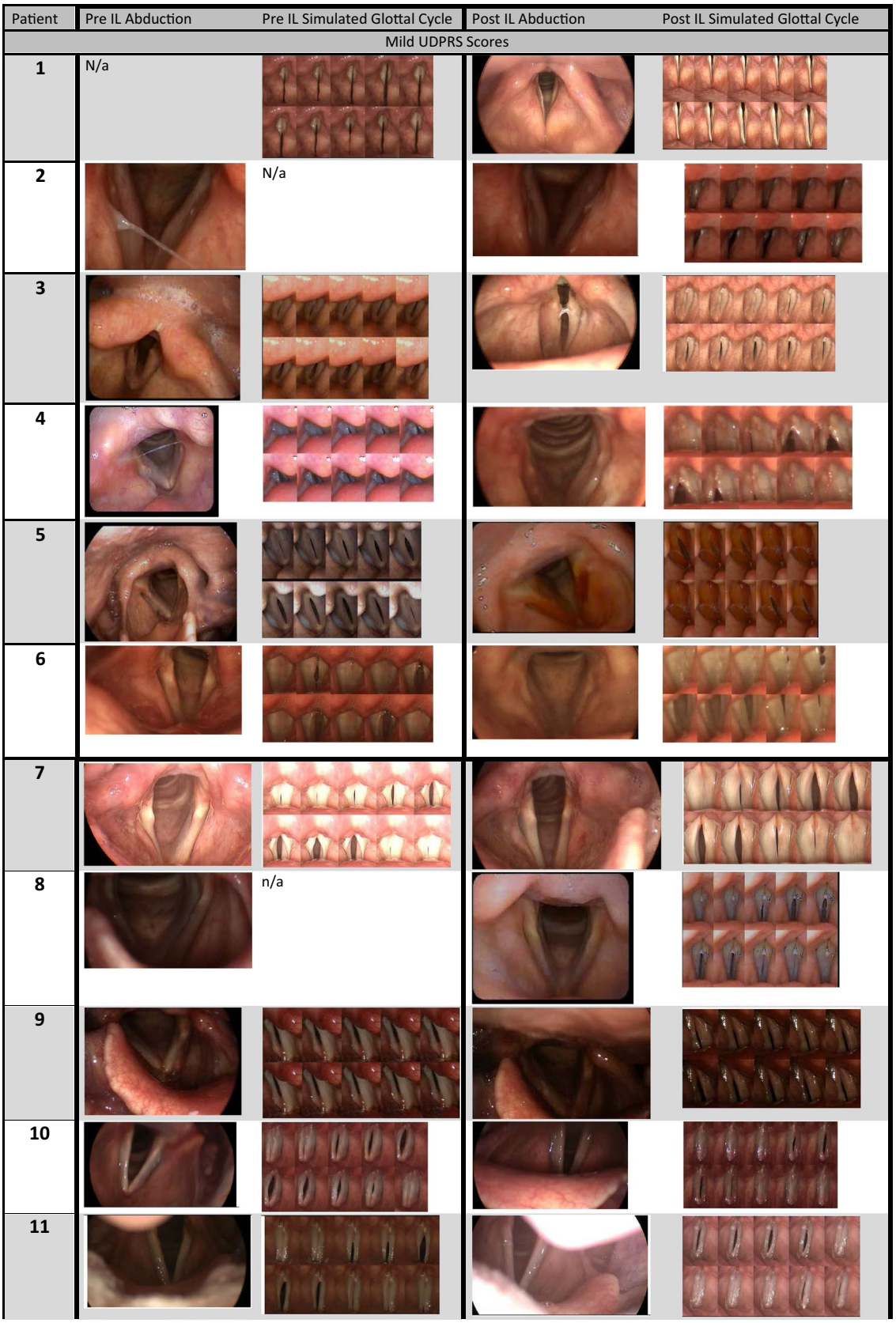

Fig. 1 Pre- and postinjection laryngoplasty stroboscopy examinations: abduction, simulated glottal cycle categorized into mild, moderate, and severe UPDRS scoring

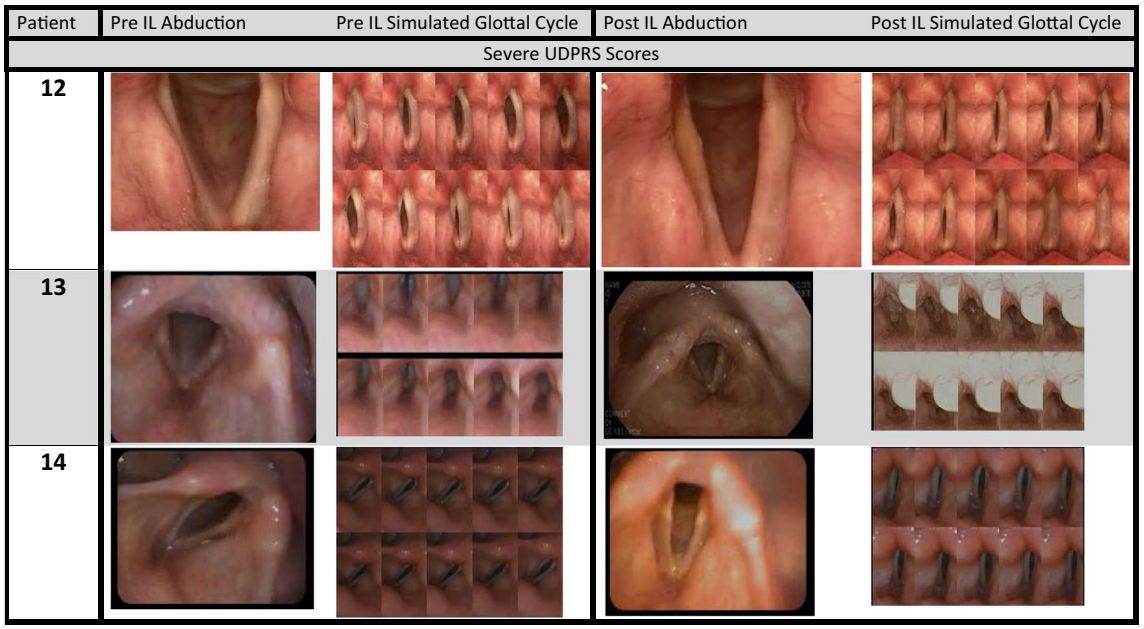

Fig. 1 (continued)

Table 1 Demographics pilot data for Parkinson's disease cohort

Participant	Age	Years from PD diagnosis to Injection	BMI	UDPRS Score	Participated in Therapy	RSI			GFI			EAT-10		
Mild Severity UDPRS Scores						Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ
1[ab]	78	0	29.54	25	Yes	27	16	11	13	8	5	8	0	8
2[ab]	71	10	25.07	21	Yes	28	20	8	13	11	2	6	6	0
3[b]	67	3	26.12	10	No	6	0	6	12	7	5	2	0	2
4	71	12	23.42	16	No									
5	69	5	23.71	20	Yes	12	4	8	4	0	4	13	5	8
6	64	18	19.79	26	Yes	27	27	0	6	11	-5	34	17	17
Moderate Severity UDPRS Scores														
7[ab]	79	1	25.52	33	Yes	27	20	7	7	5	2	4	11	-7
8[a]	63	15	24.39	46	No	8	9	-1	6	0	6	0	0	0
9[a]	75	7	21.9	35	Yes	33	28	5	16	13	3	36	20	16
10	77	10	24.01	36	No									
11[a]	57	4	25.47	34	Yes	16	18	2	13	11	2	1	5	-4
Severe Severity UDPRS Scores														
12[b]	67	6	32.63	64	Yes	–	17	–	–	10		–	0	
13	65	15	36.49	62	Yes	14	–	–	14	–		4	–	
14	80	5	24.13	79	Yes	14	10	4	10	6	4	1	1	0

UPDRS movement disorders society-unified Parkinson's disease rating scale part 3

[a]Pt underwent second injection

[b]Pt underwent subsequent thyroplasty

Gray boxes, indicates missing data

ΔGFI = 3; ΔEAT = 4) (see Table 1). The preoperative Reflux Symptom Index improved from 19 ± 9 (mean ± SD) to reach 15 ± 9; Glottal Function Index improved from 10 ± 4 to 7 ± 4; and EAT-10 improved from 10 ± 13 to 6 ± 2. Overall, ML patients ($n = 6$) with MDS-UPDRS scores of 34 ± 23 also improved on all patient-reported measures; (ΔRSI = 10; ΔGFI = 6; ΔEAT10 = 2). Improvement in glottic closure was inconsistent among three blinded speech pathologists for 50% interrater reliability. Of those that were in agreement, all were patients had improved, i.e., more reliably agreed on improvements versus worse or cannot rate/unchanged (see Fig. 1).

Discussion

Injection laryngoplasty (IL) is a well-accepted, safe, effective treatment for glottal insufficiency including presbylarynges or vocal fold atrophy. Furthermore, IL can be performed in the office potentially avoiding costly operating room charges and risks of general anesthesia (GA) especially in PD population where GA is known to have unique risks of postoperative aspiration [13–15].

Vocal augmentation for glottal insufficiency for PD voice is not novel; however, its role in the care of PD is less widely adopted. In 1999, Berke described 35 patients undergoing collagen injection laryngoplasty (IL) with 75% patient satisfaction, correlating with duration of effect [16]. In 2003, Hill reported another 12 patients undergoing collagen IL with improved voice and improved quality of life using the validated Glascow Benefit Inventory [17]. In 2007, Remacle demonstrated safety in micronized particulate in 6 PD patients undergoing IL [18].

There is evolving literature demonstrating the effects of IL for glottal insufficiency for improved cough and swallow. Cates et al. showed that patients with unilateral vocal fold paralysis have abnormal EAT-10 scores which improve after IL [1]. Dion et al. studied the effects of peak airflow during maximal volitional cough before and after IL in patients with glottal insufficiency [19]. Dion et al. demonstrated IL improves dyspnea especially in those with BMI < 30 [20]. Ruddy et al. was the first to describe the immediate benefits of IL in PD to improve cough [21]. The relationship between cough and dysphagia was further elucidated in another cohort of PD patients where peak expiratory flow rate (PEFR) was correlated to penetration aspiration scale (PAS). Similarly, the stages of disease, measured by Hoehn and Yahr scales, were also significantly correlated to PEFR, where worse stage of Parkinsonism demonstrated worse PEFR scores [22].

Our pilot data are a part of a newly emerging area of research to suggest that vocal augmentation (specifically IL) improves patient satisfaction in swallowing. The observations of PD caregivers that cough and swallowing improved after augmentation stimulated the current review. Our cohort included 100% male gender and mean age of 70 years—this is consistent with trends in the literature (male predominant and older age). The mean Body Mass Index (BMI) was 25.9 which also coincides with the literature that demonstrates IL improves most with BMI < 30. Overall, our hypothesis was confirmed, 7 of 11 patients reported abnormal EAT-10 (> 3) with 6 of 7 improved EAT-10 after first IL. There were two patients (Patients: 7 and 11) with moderate MDS-UPDRS scores that had worse EAT-10 scores after initial injection. We used the stroboscopy exams to confirm or deny adequate medialization and improvement in glottal closure, and both these patients were likely undermedialized and subsequently underwent repeat IL or ML. While both agreed to speech therapy, neither of these patients completed LSVT.

The effects of LSVT on PD dysphagia are unclear. However, the importance of recalibration of the motor and perceptual systems in LSVT LOUD on PD voice likely has a positive effect on dysphagia as well. We included data on patient participation in speech therapy to include speech, swallow, and LSVT. A limitation of this study includes lack of standardization in therapy for those patients opting out of or previously treated with LSVT. Patient 10 is included here in the discussion as an example of the importance of speech therapy. Patient 10 was exempt from data due to his decision to undergo ML not IL. He initially refused therapy and underwent ML with poor outcome measures in all reported PROs, but after swallow therapy, his scores improved. We have subsequently *strongly recommended* ST/VT/LSVT with the option of IL as an adjunct, but have not determined a difference in timing, before or after vocal augmentation. Patients in this study were used as their own comparative data; future study design will include comparative cohorts opting for therapy alone vs therapy and adjunct IL.

Our experience with a variety of injectable materials was further evaluated in case examples. Initially carboxymethylcellulose was chosen ($n = 16$), calcium hydroxyapatite was attempted ($n = 3$), and micronized particulate ($n = 6$) became the preferred material due to its improved duration of effect without stiffness of the cover. For example, in Patient 1, we used calcium hydroxyapatite which medialized into the superficial lamina propria causing initial additional strain that slowly improved over time (as seen in Table 1). Patient 2 had a thyroplasty years earlier and then underwent two subsequent IL with his last being micronized particulate giving him the longest effect compared to the carboxymethylcellulose. Most patients were preferentially treated in the office and using IL compared to ML based on surgeon preference. Given the progressive neurodegeneration of PD, ML is likely not as effective in the long term compared to bilateral ML for presbylarynges; however, this cannot be proven by the current data but will

be further elucidated in future research. PD patients have an increased risk of perioperative complications after undergoing general anesthesia, including an increased risk of aspiration pneumonia [14, 15].

Stroboscopy imaging was compared with confirm adequate medialization and improved glottal closure after IL. While, the still images are useful for comparison, it highlights the controversy of what defines glottal insufficiency. Interrater reliability was poor at only 50% agreement. In this cohort, raters agreed on improvement only. This is a limitation of the study and content for future directions. A larger cohort of patients is necessary to define the importance of UPDRS scoring on dysphagia symptoms and blinded raters on stroboscopic examinations would be useful to better objectively correlate patient-perceived symptoms to surgical/procedural success. A possible benefit of IL is that it can be repeated as the PD symptoms progress.

PROs, including EAT-10, have significant limitations particularly in the PD population where caregivers often aid in completing the scores and are another potential source of bias. EAT-10 is a marker of dysphagia and can be used as a tool to assess changes after an intervention with restrictions. Only 4:14 underwent formal swallowing evaluation with either modified barium swallow (MBS) or flexible endoscopic evaluation of swallow (FEES). Further studies including before and after swallowing imaging are further warranted to better understand and define the mechanism of improved swallow and reflux symptom scores after vocal augmentation. It remains unclear how the role of calibration of the subsystems (i.e., ST/VT/LSVT) effects swallowing function. Our current proposed mechanism is that augmentation improves the laryngeal valve thereby increasing pressurization of the pharynx, which is further improved with recalibration of the subsystems for proper coordination of breath hold followed by the swallow.

While vocal augmentation for PD is a controversial topic, given the inevitable neurodegeneration of the disease, this pilot study is the first to indicate that vocal augmentation as an adjunct to speech and/or swallow therapy does improve patient-perceived swallowing in most. Based on our preliminary data, we believe that PD dysphagia needs to be better elucidated and the adjunctive use of IL will be further evaluated in future studies. We are unable to make conclusions based on statistical significance, but the trend toward improving glottal function symptoms of dysphagia using IL are promising.

Conclusion

PD is a progressive neurodegenerative condition with known symptoms of dysphonia and dysphagia. The presented pilot data suggest that IL should be considered as a beneficial adjunct to voice and swallow therapy for PD dysphagia.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no competing interest.

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