Case Study

The Potential Effects of the “SPEAK OUT!®” Voice Program for Parkinson’s disease on Swallowing Behaviors

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ARTICLE INFO

ABSTRACT

Background: Individuals with Parkinson’s disease (PD) commonly experience communication and swallowing disorders.

Objective: We investigated whether improving musculature control of the oral, pharyngeal, and laryngeal structures with voice therapy could also improve the swallowing behaviors of individuals with PD.

Methods: Seven idiopathic PD individuals participated. Voice recordings and Video fluoroscopic Swallowing Study (VFSS) were performed on four occasions over the 12-week study period, including (Time 1) pre-therapy baseline; (Time 2) post-therapy right after the 12 sessions of the SPEAK OUT!® voice remediation program over four weeks; (Time 3) 4-weeks post-therapy, after attending four weekly LOUD Crowd® group sessions; and (Time 4) 8-weeks post-therapy, after attending eight LOUD Crowd® group sessions. Data were collected from a single participant at a time. The voice and swallowing data were each analyzed separately before exploring the potential relationship between them.

Results: Repeated measure ANOVA and other nonparametric tests revealed statistically significant improvements in voice production. In contrast, the swallowing data measured by the incidence of aspiration and penetration events recorded by VFSS and the participant’s perceived swallowing status were not consistent. The results suggest that the sensory/motor improvements in voice production do not directly correlate to those required for swallowing.

Conclusions: The perception of improved swallowing along with voice remediation of individuals with PD may not accurately reflect the physiological workings of the swallowing functions. The results of the present study suggest the swallowing deficit could emerge without awareness of the participants. It is critical to include the VFSS procedure at regular intervals in the routine health condition assessment of the individuals with PD.
1. INTRODUCTION

Approximately 90% of the individuals with Parkinson’s disease (PD) present with challenges in verbal communication that are characterized by reduced vocal intensity, breathy voice quality, limited vocal pitch, and unclear articulation [1]. The deficit in the motor function is not limited to limb movements and speech. According to Duffy (2013) [1], 40% to 80% of individuals with PD experience difficulties with swallowing. Because of reduced amplitude and kinetic force for movements along with poor timing coordination, food often drops into the airway without moving into the esophagus (aspiration). The infection due to food in the airway frequently causes aspiration pneumonia (AsPNA), which could be life-threatening to individuals with PD [2]. An investigation by Akbar and colleagues (2015) [3] found that the incidence of AsPNA among individuals with PD was 3.8 times greater than those without PD. The critical function of the larynx is airway protection [4]. Complete closure of the vocal folds protects the airway during swallowing, and it also accomplishes adduction (closure) of the two vocal folds for vibratory motions during the speech. For this reason, indirect therapy techniques for swallowing disorders include vocal fold adduction exercise to improve vocal fold closure and falsetto exercise (to achieve adequate vocal cord closure while raising the level of the larynx) [5] when transferring food into the esophagus.

Also, it is critical to maintain sensory awareness from the intra-oral structures to initiate movements necessary for both verbal communication and swallowing [2]. Speech and swallowing mechanisms share many of the intra-oral and pharyngeal structures that provide proper sensory information for the targeted movements. These shared structures are used to perform reflexive movements to ingest food or drinks into our bodies during swallowing, and they are used to execute dynamic movements to produce a variety of speech sounds and string them together as meaningful units for communication. Although the actions required for speech and swallowing are very different, the sensory and motor control mechanisms in these structures strengthened by voice therapy may be generalized to improve swallowing behaviors.

It is vital to examine whether improving the oral and pharyngeal musculature and vocal folds adduction accomplished by voice therapy could enhance the coordination of the movements of food from the oral structures to the digestive system while the airway is tightly closed. Because communication and enjoyment of food are essential elements to the quality of life (QOL), restoring the effectiveness of these two motoric behaviors is of utmost concern to individuals with PD. To date, a pilot study about the change in the swallowing behaviors after the Lee Silverman Voice Treatment (LSVT®) has been documented [6]. With eight participants of ages ranging between 48 and 77, Sharkawi and colleagues [6] noted an overall 51% reduction in swallowing motility disorders after LSVT®. However, the researchers did not find a consistent correlation between the changes in swallowing and voice production [6]. The goal of the present investigation was to explore further the relationship between voice therapy and swallowing performance.

If voice therapy could improve muscular control of (1) the vocal folds adduction to protect the airway and (2) the coordination of the intra-oral and pharyngeal musculature, the prevalence of swallowing impairment and consequent AsPNA may be reduced as a result. The present study was designed to advance our knowledge about the potential effects of voice therapy on swallowing behaviors.

The SPEAK OUT® voice remediation program emphasizes speaking “with intent” in an attempt to activate the Pyramidal pathway of the brain, which is relatively intact in individuals with PD [7]. The program offers its standard format of 12 intensive one-on-one therapy sessions over four weeks. However, it is criteria-based and flexible to complete its set of voice therapies in more or less than 12 sessions. An American Speech-Language-Hearing Association (ASHA)-certified Speech-Language Pathologist with the Certificate of Clinical Competence (CCC-SLP) guides each session to improve the verbal communication progressively by using the SPEAK OUT® workbook. Upon completion of the SPEAK OUT® program, each participant becomes a member of one of the LOUD Crowd® groups. The LOUD Crowd® program provides weekly group sessions to continue utilizing the improved verbal communication skills in informal settings without specified durations [7, 8]. The goal of the LOUD Crowd® group sessions is to maintain and generalize the remediated voice by the SPEAK OUT® program, as well as offering social interaction opportunities for the elder group members who do not have other interactive environments for communication.

To date, the effects of the SPEAK OUT® and LOUD Crowd® programs are reported in terms of the increased vocal intensity as measured by the unit of dB SPL, expanded vowel spaces estimated from the formant frequencies 1 and 2 (F1 and F2) of the three corner vowels (/a/, /i/, and /u/), and the improved self-rating of the Quality of Life (QOL) measured by the Voice-Related Quality of Life (V-RQOL) [9] index [7, 8]. Motivated by the subjective
reports by many of the SPEAK OUT!® and LOUD Crowd® participants about the perceived improvements in swallowing, the present study investigated the potential evidence of the generalization effects of the SPEAK OUT!® voice therapy to the swallowing behaviors of the individuals with PD.

2. MATERIALS AND METHODS

2.1. Participants

The data were derived from a greater scale of study concerning the verbal communication of individuals with PD. The inclusion criteria for participation were (1) individuals with idiopathic PD between 40 and 80 years of age, (2) monolingual speakers of General American English (GAE), (3) right-handed, (4) vision and hearing within normal limits by self-report with or without corrective devices, and (5) no other neurogenic and psychiatric conditions that could affect the ability to follow the researchers’ guidance.

The original study started with 33 individuals with PD. Ten of them dropped from the study due to health or transportation issues. Three of these ten dropouts experienced silent aspiration repeatedly during the first two sessions. Therefore, the researchers asked them to withdraw from the study to seek immediate medical consultation to address their swallowing problems. Of the remaining 23 participants who completed the study, seven of them presented with at least one incident of mild or moderate aspiration during the four Videofluoroscopic Swallowing Study (VFSS) assessments over the 12-week research period. The present report includes the analyses of the voice and swallowing data of the seven participants who completed the voice and VFSS studies.

The seven participants have a mean age of 69 \( SD = 7.44 \), age range: 57-76 years), including three females and four males. The onset of PD occurred within eight years from the initial day of data collection for these participants (see Table 1). The participants were recruited through the Parkinson Voice Project clinic (PVP) in Richardson, Texas. All seven participants are in Stage 1 of the Hoehn and Yahr Scale of the Parkinson’s disease stage [10], presenting with unilateral involvement of minimal functional impairments. All seven participants were taking the L-dopa/Carbidopa, and they continued their PD medications as prescribed by their physicians for the entire research period without changing dosage or types of medications.

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To comply with the regulations set forth by the Institutional Review Board (IRB) of Texas Woman’s University (TWU), each participant had an informational meeting with one of the researchers (first author) to learn about the study protocol, participant’s rights, potential benefits/risks, and each had ample opportunities to ask questions. Then, participants signed consent forms to enroll in the study.

2.2. Data Collection and Instrumentations

2.2.1. Overview

The voice data and swallowing data with VFSS were collected at four equal intervals during the 12-week study period. These four times included (Time 1) pre-voice treatment baseline, (Time 2) after completing the 4-week SPEAK OUT!® program with 12 individual sessions (one-on-one with a speech pathologist), (Time 3) after attending four weekly LOUD Crowd® group sessions, and (Time 4) after attending four more weekly LOUD Crowd® group sessions. To preserve the integrity of the results, all the participants attended 12 of the SPEAK OUT!® sessions at the rate of three sessions per week, regardless of how well they attained the criteria. Three ASHA-certified speech-language pathologists (SLP) at the Parkinson Voice Project
clinical, who were not familiar with the protocols and purpose of the present study, administered the therapy sessions.

Although some participants could not strictly follow the equal intervals between the data collections due to various health and environmental restrictions, an effort was made to keep the data collection dates as close as possible to the schedule defined by the research protocol. Participants were scheduled for the data collection at the approximately same time of the day for all four sessions. Both voice and swallowing data collection was carried out individually.

### 2.2.2. Voice Data

The purpose of recording the participants’ voices was to measure changes in vocal intensity and quality of voice signals over the 12-week research period. An SLP with research training (first author) conducted the voice recordings in a quiet room at the Parkinson Voice Project clinic. Two sets of recording devices were used. Each set included a laptop computer with a Solid State Drive (SSD) and a desktop condenser microphone (Yeti USB Microphone). The microphone of one set was placed 30 cm from each participant’s mouth to record the vocal intensity. The other microphone was placed further from the participant to ensure the recording without clipping due to the potentially increased vocal intensity after the series of voice therapy. The voice recordings without clipped parts were used for the vocal quality analyses. Both microphones were calibrated using a 70 dB SPL white noise as a calibration signal at 30 cm from the signal generator. The microphones were set to the Cardioid mode, and the participants’ voices were recorded directly to the computer by using the Audacity (v. 2.1.1) audio software program. Each recording was created as a single audio file throughout each meeting, and two trained graduate students segmented the recorded voice to the target units (i.e., phoneme, word, or sentence), using Audacity (v.2.1.1). The graduate students were not familiar with the protocols and purpose of the investigation.

The tasks for the voice recordings were (1) Rainbow passage [11] reading, (2) sustained corner vowels (/a/, /i/ and /u/) phonation for six seconds, and (3) six sentences described on the CAPE-V protocol [12, 13]. Participants recorded three repetitions of each component of the items (2) and (3) and one attempt of the item (1). The instruction was to say (or read) the presented materials at the participant’s comfortable pitch and loudness levels when s/he was ready. For the sustained vowel production, the researcher counted six seconds with a hand gesture to cue the beginning and end of the phonation. The reading material was held at the participant’s eye-level to maintain his/her optimal posture for voice/speech production. Participants were frequently prompted to take some water during the voice recordings for hydration. The order of the stimuli presentation was randomized for each patient to prevent systemic bias [14].

A linear predictive coding (LPC)-based algorithm encoded in the PRAAT (v.6.0.08) Acoustic Analysis Software Program [15] was used to organize and analyze the recorded voices. Voice remediation for the PD has focused on addressing the reduced intensity of voice production. Consequently, the research to date has mainly reported the improvement of the vocal intensity. The present study followed the examples of the past studies and measured vocal intensity, using the recordings of the Rainbow Passage [11]. As shown in the recent speech kinematic image studies [16], speech production requires coordinated actions of respiration, phonation, and articulation. Various spatiotemporal aspects of the vocal quality contribute to the intelligibility of utterance, as well as vocal intensity. Time-based analyses of voice such as jitter and shimmer provide informative data when the voice is stable with some variability. The dysphonic voice often does not have the temporal stability that forms the foundation of time-based voice analysis methods. In contrast, spectral analysis methods do not rely on the temporal regularity, and therefore, they are well suited for the qualitative analyses of dysphonic voices. For this reason, the present study used the Cepstral Peak Prominence analysis explained by Maryn and colleagues [17].

### 2.2.3. Swallowing Data

Concurrently with the voice recordings, a mobile medical clinic equipped with a C-Arm fluoroscopy was on site at the PVP clinic to collect instrumental swallow study data four times with each participant. The purpose of a VFSS is to assess physiological motility disorders in the pharyngeal phase of the swallow. A VFSS is most commonly administered by SLPs trained in dysphagia evaluations. VFSS uses a low dose of radiation that measures between 0.2 and 0.85 mSv, which imposes a minimal risk on one’s health [18]. The level of radiation exposure was explained to the participants during the consent process of the study so that they could make informed decisions to participate.

The VFSS was conducted by two SLPs (second and third authors) with the presence of a medical technician and a state licensed physician as required by the Texas Department of State Health Services. Following Sharkawi and colleagues (2002) [6], the VFSS was performed in accordance with the standard protocol defined by...

3. RESULTS

The data collected throughout the four sessions during the 12-week research period were organized for the separate analyses of voice and swallowing. Then these two types of data were contrasted for analyses. For statistical analyses including the outliers and normality checks, IBM SPSS Statistics 24 (v.24.0.0.0) was used. The significance level was set at $p < .05$.

3.1 Voice Data

Figure 1 shows the changes of the mean vocal intensity of the Rainbow Passage [11] reading over the four phases of the 12-week research period. There were no outliers in the data set, as examined by a boxplot. Shapiro Wilk test revealed that the data are normally distributed ($p > .05$) for Times 2, 3, and 4, however, it was not the case with Time 1 ($p < .05$). Therefore, a nonparametric Friedman test was performed to determine whether there were differences in the vocal intensity between the four time periods. The test revealed the vocal intensity of the four time points were significantly different, $\chi^2(3) = 13.11$, $p < .005$. Pairwise comparisons with a Bonferroni correction revealed the differences between the pre-treatment (Time 1: $Mdn = 68.58$ dB SPL) and three post-treatment phases (Time 2: $Mdn = 77.39$ dB SPL; Time 3: $Mdn = 76.54$ dB SPL; and Time 4: $Mdn = 78.51$ dB SPL) are statistically significant ($p < 0.05$ for Time 1 vs. Time 2 and Time 1 vs. Time 3; and $p < 0.01$ for Time 1 vs. Time 4). No statistically significant

Logemann (1988) [5] and adjusted as needed for the individuals with PD.

All participants were guided to be seated comfortably in an upright position at 90 degrees with a neutral head position. The researchers applied gentle pressure on the participant’s shoulders as needed to adjust his/her posture for the optimal view. The VFSS was completed with the participant seated and viewed in a lateral plane [5]. The view included the lips anteriorly, the hard palate and nasal cavity superiorly, cervical spine posteriorly, and upper esophageal sphincter (UES) and vocal folds inferiorly. This position allowed a complete viewing of the structures needed to observe bolus transit between cavities, the timing of bolus transit, and any penetration or aspiration of the bolus into the laryngeal vestibule and tracheal opening. The instructions were to bring the spoon (cup, or straw) to the mouth and take one drink and swallow when he/she was ready. The self-feeding administration was used to reflect their natural swallowing behaviors.

Swallow trials utilized a standard commercial product E-Z-EM Barium Sulfate for Suspension from Bracco Diagnostics (45% w/w , 70% w/v) in three different mixtures to form various consistencies. Three consistencies included (1) Thin liquids, (2) Nectar consistency, and (3) Honey consistency. The Thick-It® pre-thickened water from Dysphagia Nutrition Solutions was used to prepare for uniform consistencies of the items (2) and (3). Each participant completed a total of twenty-four (24) swallows by self-feeding administration of the materials.

The participants used a 3-ml-teaspoon, 6-oz-cup, and a straw to take the Thin liquids and Nectar-thick liquids and a teaspoon and cup for Honey-thick liquids. The quantity was 3 ml for the teaspoon and 6 oz for the cup and straw intake. The mode of presentation with each consistency followed a hierarchical order of teaspoon, cup, and straw to examine the swallowing motions progressively. The order of presentation for Thin liquids, Nectar-thick liquids, and Honey-thick liquids was randomized to prevent order bias [14]. Because the present study focused on the pharyngeal phase of swallowing, oral preparation processes including mastication were not assessed.

For the method of analysis, the researchers initially attempted to monitor the temporal aspect of each stage of swallowing, following the methods used by Sharkawi and colleagues [6]. However, it became evident that the motility or swallowing could be delayed for various reasons, including slowness of the movement (bradykinesia), limited movement amplitude (hypokinesia), freezing of the movements, or any combination of these behaviors. To preclude confounded results, the analysis of swallowing data focused on identifying the material’s entrance or flow to the airway. The incidents of aspiration and penetration of the participants were rated using the 8-Point Penetration-Aspiration Scale (P-A Scale) [19].

2.2.4. Participant’s Self-rating perceptual scales

The participant’s perceptual ratings of their voice and swallowing behaviors were examined, using the Voice-Related Quality of Life (V-RQOL) [9] and the Dysphagia Handicap Index (DHI) [20], respectively. The V-RQOL contains ten questions about voice, and the DHI has 25 questions pertaining to swallowing. In addition, the DHI has the 7-point-Likert-scale severity rating of swallowing difficulty. Each participant provided the rating options for these two quality-of-life measurement questions as the researcher (the first author) read each question. Before the questions were asked, the researcher presented a sheet with descriptions of the rating options. After the participant had finished answering the set of questions, the researcher read each question for the second time to verify the participant’s responses. Each participant provided his/her perceptual ratings using these instruments four times during the 12-week research period. The responses were converted into indices by using the formula of each instrument.

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change was identified in any combination of Times 2, 3, and 4. The average gain from Time 1 and 2 was 8.72 dB SPL.

Figure 1: Vocal intensity (dB SPL) changes over the 12-week period. The bars represent the mean changes, and the error bars show the Standard Error Mean (SEM).

The Smoothed Cepstral Peak Prominence (CPPS) was measured by using PRAAT (v.6.0.08) with a script developed by Maryn and Weenink [17]. Figure 2 shows the changes in the CPPS measurements of seven participants over four 4-week intervals, indicating the voice quality change over time. The CPPS shows the extent to which speech signal distance from the noise signals at the given moment. Therefore, the greater CPPS reflects the existence of a more prominent voice signal. The CPPS figures are variable depending on the algorithm and tools one uses. Maryn and colleague’s study of voice analyses [21] reported the mean figure of the CPPSpraat figures as 16.77 with a standard deviation of 2.08.

Five participants increased the CPPS figures from Time 1 (pre-SPEAK OUT!® treatment phase) to Time 2 (post-SPEAK OUT!® treatment phase). Two participants decreased the CPPS figures from that phase by 0.33 and 0.59, respectively. These two individuals showed the CPPS figure increase by 0.58 and 0.17 at the last recording (Time 4), respectively. However, there were no outliers in the data set, as examined by a boxplot. Shapiro-Wilk test revealed that the data are normally distributed (p > .05). A repeated measure ANOVA revealed the changes of the CPPSpraat during the 12-week research period were statistically significant [F(3, 18) = 4.81, p < 0.05]. A contrast analysis revealed the differences between the difference between the CPPpraat of Time 1 and Time 2 were statistically significant (P < 0.5). No statistically significant change was identified in any other combinations.

Figure 2: Vocal quality changes over the 12-week period, measured by the Smoothed Cepstral Peak Prominence (CPPS) figures (CPPSpraat). The CPPS figures were computed from the sustained /a/ phonation and one of the CAPE-V sentences, “We were away a year ago,” by using PRAAT (v.6.0.08). The bars represent the mean changes, and the error bars show the Standard Error Mean (SEM).
The changes of the responses of the participants for the ten questions of V-RQOL were recorded. The participants’ responses were converted to the V-RQOL index, using the algorithm developed by Hogikyan and Sethuraman [9]. Figure 3 shows the V-RQOL scores. There were no outliers in the data set, as inspected by a boxplot. The V-RQOL data were normally distributed as assessed by Shapiro Wilk’s test (P > .05). A repeated measure ANOVA revealed the changes in the Quality of Life perception related to the verbal communication during the 12-week research period were not significant \( F(3, 18) = 2.99, \ p = .058, \ ns \), although the \( p \)-value was close to the significant level.

Figure 3. The V-RQOL index from the ten questions of the Voice-Related Quality of Life (V-RQOL) Responses. The bars represent the mean changes, and the error bars show the Standard Error Mean (SEM).

3.2 Swallowing Data

The swallowing data were graphed and thoroughly visually inspected. The inspected swallowing data did not yield any consistent changes across the participants or the data collection phases. For example, one participant who had four aspiration events at the pre-treatment phase (Time 1) did not have any aspiration at the end of the SPEAK OUT!® program (Time 2). However, the aspiration events presented four times (Time 3) and three times (Time 4) at the two post-SPEAK OUT!®-treatment assessments. Other participants presented with highly variable aspiration events without any systematic changes, making statistical analyses not feasible with swallowing data. For this reason, this section descriptively summarizes some findings.

A total of 24 events of aspirations were observed across the different consistency of the material. Aspiration occurred more frequently with Thin liquids than with Nectar thick liquids or Honey thick liquids. An equal amount of aspirations occurred with Nectar thick liquids and with Honey thick liquids (4 occurrences each). Regarding the timing of the aspiration incidents, a total of 13 aspirations was identified during the swallow, nine (9) aspirations occurred after the swallow and two (2) aspirations before the swallow. The aspiration events during the swallow were due to the reduced hyolaryngeal elevation and incomplete closure of the vocal folds as well as the delayed trigger of the swallow. Seven (7) of the nine events of aspirations after the swallow were due to residue that was penetrated and not ejected and then later progressed below the vocal folds. The remaining two aspirations after the swallow were due to progressing pharyngeal residue and retention that entered the airway after the swallow. The two (2) aspirations that occurred before the swallow were due to premature loss and pharyngeal phase delay.

Table 2 shows the summary of the aspiration events rated by the Penetration-Aspiration Scale (P-A Scale) [19]. The rating of “8” refers to the incidence of an aspiration without coughing, and “7” refers to the incidence of an aspiration with coughing. The sequences of “8” indicate multiple aspiration events without coughing. Two of the experienced Speech-Language Pathologists (SLP) with swallowing evaluation (second and third authors) assigned the P-A Scale by viewing the images in real time and frame-by-frame modes. For inter-rater-reliability check, a blinded external rater evaluated the VFSS data independently. There was one disagreement out of the 28 VFSS video clips (four time points x seven participants) for aspiration events, yielding the 96.43% overall agreement. This discrepancy involved rating the productive expectoration of aspirated residue resulting a variation of score of the P-A Scale; the first rater assigned a score of 7 and the second rater assigned 6. The ratings by the researchers and the external rater
completely agreed for all 28 VFSS clips for penetration events. Therefore, Cohen's *Kappa* inter-rater reliability test was not performed.

**Table 2. Aspiration Events**  
Penetration Aspiration Scale (P-A Scale) [19] (Unit: P-A Scale)

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A total of 53 penetration cases were identified across the different consistency presentations. The greatest number of penetrations occurred with Thin liquids (35 occurrences), followed by the Nectar thick liquids (12 occurrences). The Honey thick liquids presented with six cases of penetration. Concerning the timing of the penetration, forty-four (44) penetration events were found during the swallow (83%). Five of the penetration events occurred before the swallow (9.5%) and four of them after the swallow (7.5%). The reduced hyolaryngeal elevation, as well as the delayed trigger of the swallow, contributed to the penetrations occurring during the swallow. Penetrations before the swallow were due to the premature loss of bolus, as well as timing of hyolaryngeal elevation. Penetration events subsequent to the swallow were due to progressing residues that remained on the tongue base and subepiglottic area. The P-A Scale for penetration shows 51 events with the rating of “3,” which implies the material entered the airway, remained above the vocal folds level, and was not ejected from the airway. Two penetration events were rated as “5” with material entering the airway, contacting the vocal folds, and not being ejected from the airway.

The responses to the 25 questions on the Dysphagia Handicap Index (DHI) [20] questionnaire and the self-rated swallowing severity (Likert scale of 0 to 7) were also variable and inconsistent. The smaller index figures represent lesser awareness of swallowing difficulties. Similarly, the smaller scores of the 7-level Likert scale imply a lower perception of swallowing severity.

![Figure 4](image)

**Figure 4.** Scores from the 25 questions of the Dysphagia Handicap Index (DHI). The greater figures represent the higher levels of concern expressed about the swallowing. The bars represent the mean changes, and the error bars show the Standard Error Mean (SEM).
Figure 5. Scores from the 7-level Likert-scale rating of the current swallowing status described on the DHI. The greater figures represent the higher levels of concern expressed about the swallowing. The bars represent the mean changes, and the error bars show the Standard Error Mean (SEM).

4. DISCUSSION

The voice data show similar improvement in vocal intensity (dB SPL) to the previously reported SPEAK OUT!® studies [7, 8]. The VFSS data were visually rated by the P-A Scale [19], as well as organized by the counts of the aspiration and penetration events for each data collection phase. The P-A Scale ratings showed the temporal changes with a wide range of variability without continuing improvements in the pre- and post-voice treatment phases across the participants. Additionally, the percentages of oral and pharyngeal residues were examined in an attempt to validate the P-A Scale ratings. These residue figures were also inconsistent with the voice data, suggesting no systematic co-relationship with the voice improvements. Among the 24 total events of aspirations, only one incident presented the sign of sensory awareness of aspiration by coughing.

Taken together, the results suggest that the improvements in the verbal communication yielded from the SPEAK OUT!® therapy do not carry over to swallowing patterns. The present study included only seven participants. Before generalizing the results, the present investigation should be replicated with a control group and a greater number of participants. In addition, the aerodynamic measurements should be included in the future studies, as in the investigation of Miles and colleagues with LSVT® [25].

Pneumonia caused by silent aspiration is the most common cause of hospitalization for individuals with PD [3, 22]. If the results of the present study are replicated in future studies of greater scale, they will provide important information about the dissociated workings of the shared anatomical structures for voice/speech production and swallowing of individuals with PD. Speech production involves dynamic motoric functions that require a wide range of vocal tract configurations, airstream mechanisms, and vibratory actions of the vocal folds for different speech sound production to express various emotional, affective, intellectual, and linguistic content [23]. The major purpose of voice production is communication, which involves interaction with others who perceive and react to the produced utterance. In contrast, the swallowing behavior is focused on accomplishing the single goal of transporting materials from the oral structure to the digestive pathway safely. Swallowing involves both voluntary and involuntary responses. It is more difficult to identify deficit patterns with swallowing than with speech because swallowing does not usually involve direct interactions with others. It became evident that the individuals with PD often do not recognize developing swallowing problems due to their reduced sensory awareness. The perception of improved swallowing along with the voice remediation may be psychological in origin rather than an accurate reflection of the physiological workings of the patient’s swallowing functions.

5. CONCLUSIONS

Researchers agree with the importance of the clinical bedside swallowing assessments (CBSA) performed by SLPs. However, the variability of CBSA procedures is documented to date [24]. The present investigation identified that the aspiration with PD is more likely asymptomatic due to the sensory deficit, which is consistent with the reports by Hammer and colleagues [26, 27].
Therefore, the participants did not cough in 23 aspiration events (silent aspiration) out of the total of 24 incidents. The results of the present study suggest that it is critical to include the VFSS procedure in the assessment of the health conditions of the individuals with PD at periodic intervals to proactively address the swallowing problems that could potentially cause aspiration pneumonia.

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