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Therapeutic singing as an early intervention for swallowing in persons with Parkinson's disease

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ABSTRACT

Objective: For persons with Parkinson's disease (PD), secondary motor symptoms such as swallow impairment impact the quality of life and are major contributors to mortality. There is a present need for therapeutic interventions aimed at improving swallow function during the early stages of PD. The purpose of this pilot study was to examine the effects of a group therapeutic singing intervention on swallowing in persons with PD with no significant dysphagia symptoms.
Design: Cohort study.
Setting: University in the United States.
Participants: Twenty-four participants with PD.
Intervention: Eight weeks of group therapeutic singing.
Main outcome measures: Electromyography (EMG) was used to assess muscle activity associated with swallow pre and post the group singing intervention. Swallow quality of life (SWAL-QOL) and the Unified Parkinson's Disease Rating Scale (UPDRS) were also obtained pre- and post-intervention.
Results: Participants reported minimal difficulty with swallowing, yet results revealed a significant increase in EMG outcome measures, as well as significant improvement in UPDRS total and UPDRS motor scores. No significant differences were revealed for SWAL-QOL.
Conclusion: Increases in EMG timing measures may suggest that group singing results in the prolongation of laryngeal elevation, protecting the airway from foreign material for longer periods of time during swallow. Combined with the improvement in UPDRS clinical measures, therapeutic singing may be an engaging early intervention strategy to address oropharyngeal dysphagia while also benefiting additional clinical symptoms of PD.

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1. Introduction

Many non-motor symptoms are common in Parkinson's disease (PD) which impair quality of life (QOL) and are major contributors to mortality.[1–3] In particular, pneumonia is a leading cause of death in PD[3] and is frequently linked to oropharyngeal dysphagia (OPD),[4] a symptom experienced by 72–87% of persons with PD.[5] Signs of OPD can emerge in the early stages of PD, with 40–78% of patients demonstrating changes in swallowing.[6–8] There is limited research on early intervention for OPD in persons with PD, which is alarming given that the mean survival time after the significant onset of OPD is only 2 years.[6,9] Thus, there is a present need for early therapeutic interventions aimed at reducing the impact of OPD and improving QOL.

Measurement techniques related to OPD have ranged from instrumental swallowing evaluation to patient-reported QOL ratings. Electromyography (EMG) is another promising measurement technique that assesses a swallowing-specific physiology, is objective, reliable, valid, noninvasive, and does not require exposure to radiation.[4] Previous research has revealed the effectiveness of EMG for identifying differences in swallow characteristics between PD and healthy individuals and assessing the effectiveness of training targeting swallowing muscles.[10] Moreover, EMG has been used to characterize swallowing in non-dysphagic patients with PD and EMG results indicate that L-Dopa generally does not impact swal-

Abbreviations: PD, Parkinson's disease; EMG, electromyography; SWAL-QOL, swallow quality of life; UPDRS, Unified Parkinson's Disease Rating Scale; QOL, quality of life; OPD, oropharyngeal dysphagia; HD, high dosage group; LD, low dosage group; AUC, area under the curve; ANOVA, analysis of variance.

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lowing function.[11] Overall, the use of EMG in the assessment and treatment of OPD is a promising, yet under-utilized, technique.

As OPD measurement has developed, therapeutic treatments have progressed. However, these treatments have displayed minimal agreement or conclusive utility.[12] Dopaminergic medication is still the primary treatment, but it has not been shown to improve swallowing.[4] Other direct treatments, including exercises targeting the swallowing musculature, expiratory muscle strength training, Video-assisted Swallowing Therapy, surface electrical stimulation, and thermal-tactile stimulation, have shown varying potential for OPD treatment, with more research needed to refine their use.[4,13–20] Speech therapy, including Lee Silverman Voice training (LSVT), has also contributed to the treatment of OPD in PD, because of the common musculature for voice and respiration,[12] but therapeutic singing has also been proposed as a viable rehabilitative treatment.[21,22] Because singing utilizes the same musculature as speech, it may have a unique combative potential against OPD. Singing offers several additional benefits, namely its memorable nature, ease of self-administration, and potential impact on QOL. Yet, research examining the effect of singing on voice and respiration in persons with PD have shown equivocal effects.[21,23–25] No study has examined changes in swallow function after therapeutic singing in persons with PD. The development of singing therapies represents a potential novel means of combatting OPD and accompanying QOL factors.

The purpose of this pilot study was to test the effects of an eight-week group singing intervention on swallow using EMG and swallow-related QOL. Swallow evaluations, the SWAL-QOL and the Unified Parkinson's Disease Rating Scale (UPDRS) were completed before and after the intervention, which was administered in two dosages; once or twice per week. We hypothesized that the singing training would improve swallowing EMG activity and swallow-related QOL. We also hypothesized that participants who had two sessions per week would show greater improvements than those who only had one.

2. Methods

2.1. Participants/intervention overview

Twenty-four non-smoking participants diagnosed with idiopathic PD and on a stable antiparkinsonian medication regimen completed the study. The diagnosis of OPD was not an inclusion/exclusion criteria for this study; however, no participant was formally diagnosed with OPD. Participants were excluded if untreated hypertension, history of head or neck cancer, significant cognitive impairment (Mini Mental State Exam score <24), or major psychiatric disorder (Beck Depression Inventory score <18) were present. Written informed consent was provided by all participants, and the study was approved by the University Institutional Review Board.

Participants completed testing and singing interventions while on their normal PD medication regimen. No changes in medication were made throughout the length of the study. Previous research has demonstrated that medication does not significantly improve EMG activity associated with swallowing in persons with PD.[11] Six participants were placed in a high dosage group (HD) that completed two sessions each week; the remaining eighteen participants were placed in a low dosage group (LD) that completed one session each week. To minimize the potential for drop out due to transportation problems, participants completed the group that was most feasible for them. Table 1 summarizes participant demographics. The intervention lasted eight weeks, with sessions consisting of various singing exercises to target vocal and respiratory musculature. All groups followed the same protocol, consisting of warm-up exercises followed by group singing. See supplementary material for a more detailed description of the intervention. Participant enrollment and the intervention methods have been reported in detail elsewhere.[25]

Table 1
Participant characteristics for each group.

	Low dosage(n = 18)	High dosage(N = 6)
Gender (%M)	33	33
Age (yr)	69 ± 7	65 ± 11
MMSE	28.8 ± 1.2	28.9 ± 1.3
BDI	10.3 ± 3.4	7.5 ± 5.0
Education (yr)	16 ± 4	16 ± 2
Disease duration (yr)	6 ± 5	10 ± 6
More affected side (%R)	50	67
UPDRS	54 ± 17	59 ± 20
Motor UPDRS	27 ± 11	28 ± 12

All values are presented as mean ± standard deviation. M = male; yr = year, R = right; MMSE = Mini Mental State Exam; BDI = Beck Depression Inventory, UPDRS = Unified Parkinson's Disease Rating Scale.

2.2. Pre/post-testing

The UPDRS, measures of swallow function, and SWAL-QOL questionnaire were collected before and after the intervention. Only participants with PD completed the UPDRS and SWAL-QOL. Caregivers did not assist with the completion of these assessments. The total UPDRS score and motor UPDRS score were summed for each participant. Because neck rigidity may affect swallow and EMG measures, neck rigidity and swallow scores were obtained for statistical analysis.[11] Higher scores on UPDRS measures indicate more severe impairment. Swallow function was assessed using surface EMG during three swallows for both the THIN condition (10 mL of water) and THICK condition (10 mL of pudding). Mean scores were calculated for the THIN and THICK conditions separately. QOL was assessed using the SWAL-QOL questionnaire, which is a 44-item questionnaire using Likert-scale ratings to assess QOL related to dysphagia.[26,27] Scores for each domain were calculated and expressed as a percentage of the maximum possible points in the corresponding domain. For the total score, each domain score was summed and divided by 10 to produce an overall summary of QOL related to dysphagia.[28] The first author administered the UPDRS, as she is trained and has completed this evaluation on many persons with PD. The second and third authors administered the SWAL-QOL and EMG testing under the supervision of the first author.

2.3. EMG data processing

EMG (Delsys Trigno) was recorded from electrodes placed over the right and left submental and laryngeal muscle groups (see supplementary material) using The Motion Monitor software (Innovative Sports Training, Inc., Chicago IL) and sampled at 2000 Hz. A low pass filter at 500 Hz, a high pass filter at 1 Hz, and a notch filter at 60 Hz were applied. The raw signal was DC-corrected, full-wave rectified, and smoothed using a root-mean-square envelope of 50 ms. The EMG signal was manually inspected for artifacts which resulted in a total of 433 swallow trials available for statistical analysis. Peak amplitude, area under the curve (AUC), time to peak amplitude, time to onset, time to offset, rise time, fall time and duration were calculated from the resulting curve for both muscle groups (Fig. 1).

Peak amplitude was obtained as the peak in EMG activity. AUC was calculated using the trapezoidal rule. For rise time, the duration of the EMG activity from time to onset to time of peak amplitude was calculated. For fall time, the duration of the EMG activity from time to peak amplitude to time to offset was calculated. For EMG

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