ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2014;95:1374-82

ORIGINAL ARTICLE

Skill Training for Swallowing Rehabilitation in Patients With Parkinson's Disease

Ruvini P. Athukorala, MSc,[a,b] Richard D. Jones, PhD,[a,b,c] Oshrat Sella, PhD,[a,b] Maggie-Lee Huckabee, PhD[a,b]

From the [a]Department of Communication Disorders, University of Canterbury, Christchurch; [b]New Zealand Brain Research Institute, Christchurch; and [c]Department of Medical Physics and Bioengineering, Christchurch Hospital, Christchurch, New Zealand.

Abstract

Objective: To examine the effects of skill training on swallowing in individuals with dysphagia secondary to Parkinson's disease (PD) and to explore skill retention after treatment termination.

Design: Within-subject pilot study with follow-up after 2 weeks of treatment and after a 2-week nontreatment period.

Setting: Clinic in a research institute.

Participants: Patients (N=10; mean age, 67.4y) included 3 women (mean Hoehn and Yahr score, 2.6) and 7 men (mean Hoehn and Yahr score, 2.4).

Intervention: Patients underwent 10 daily sessions of skill training therapy focused on increasing precision in muscle contraction during swallowing using visual feedback.

Main Outcome Measures: Data from the timed water swallow test, Test of Mastication and Swallowing Solids, surface electromyography (sEMG) of submental muscles, and swallowing-related quality of life questionnaire were collected at 2 baseline sessions (conducted 2wk apart) at the end of treatment and after 2 nontreatment weeks to assess skill retention.

Results: Immediately after posttreatment, the swallowing rate for liquids ($P=.034$), sEMG durational parameters of premotor time ($P=.003$), and preswallow time ($P<.001$) improved. A functional carryover effect was seen from dry to water swallows ($P=.009$). Additionally, swallowing-related quality of life improved ($P=.018$). Reassessment at 2 weeks after treatment termination revealed short-term retention of treatment effects.

Conclusions: A skill-based training approach produced functional, biomechanical, and swallowing-related quality of life improvements in this cohort indicating compelling evidence for the effectiveness of this novel approach for dysphagia rehabilitation in PD.

Archives of Physical Medicine and Rehabilitation 2014;95:1374-82

Approximately 90% of patients with Parkinson's disease (PD) are reported to have dysphagia,[1] with all stages of swallowing being affected.[2] Dysphagia can result in malnutrition, dehydration, and aspiration pneumonia.[3] Additionally, negative impact on quality of life in PD[4] has been indicated with reduced subsection scores on the Swallowing Quality of Life (SWAL-QOL) questionnaire.[5]

Current rehabilitation practices focus primarily on increasing muscle strength to alter biomechanical features of swallowing pathophysiology.[6] Techniques performed within the functional context of swallowing include the effortful swallow, tongue-hold maneuver, and Mendelsohn maneuver, whereas techniques outside the context of swallowing include the head-lift exercise, expiratory muscle strength training,[6] and lingual exercises.[7,8] The effects of these exercises on swallowing biomechanics remain mixed, with both positive[9] and adverse effects[10] reported on swallowing biomechanics. In addition to strength, effective swallowing requires neuromuscular coordination, precision, timing, speed of reaction, and planning of motor movements.[11] In PD, swallowing deficits have been attributed to muscle rigidity, tremor, and bradykinesia.[2,12] Strength training may exacerbate deficits resulting from muscle rigidity[13] or could be ineffective for impairments as a result of imprecise timing. Hence, an alternative approach of skill training is proposed.

Skill training is the process of learning and fine-tuning new sequences of movements.[14] When an individual executes a novel

Presented to the Dysphagia Research Society, March 14, 2013, Seattle, WA.

Clinical Trial Registration No.: URB/10/11/046.

No commercial party having a direct financial interest in the results of the research supporting this article has conferred or will confer a benefit on the authors or on any organization with which the authors are associated.

0003-9993/14/$36 - see front matter © 2014 by the American Congress of Rehabilitation Medicine
http://dx.doi.org/10.1016/j.apmr.2014.03.001

task and/or challenging activity, skill learning occurs. A challenge component requires an individual to problem-solve the movement during practice rather than memorizing and replaying the sequences of muscle/joint contractions.[15] The literature in swallowing reports positive outcomes after the use of task-specific exercises in combination with surface electromyography (sEMG) biofeedback.[16,17] Using biofeedback modalities to master task-specific exercises enhances the skill component likely through recruitment of cognitive modulation of biomechanical performance. This type of task-specific treatment regimen, which challenges the functional system, may bring about optimal swallowing outcomes.[6] Current evidence of skill training comes from limb rehabilitation.[18] Furthermore, effects of oromotor training at the neural level have been documented,[19,20] suggesting the possibility of corticobulbar skill training.

The aims of this pilot study were to evaluate the effects of a newly designed skill training paradigm on swallowing function using multiple outcome measures (timed water swallow test,[21] Test of Mastication and Swallowing Solids, sEMG, SWAL-QOL) and to determine the retention of treatment effects after training in patients with dysphagia associated with PD.

Methods

Participants

Ten patients were recruited from 4 PD outpatient movement disorders clinics. Selection criteria included the following: diagnosis of PD by a neurologist, self-identified dysphagia of $\geq$3 months' duration using the Eating Assessment Tool,[22] and dysphagic presentation on clinical swallowing evaluation. The primary researcher conducted the clinical swallowing evaluation for all the patients. This consisted of a detailed case history, cranial nerve examination, inhalation cough challenge, oral intake trials, and the timed water swallow test.[21] Dysphagia presentation was defined as patients who showed deficits with structural symmetry, strength, range of movement, and laterality on the cranial nerve examination; exhibited consistent overt signs of coughing, altered voice, breathlessness, clearing throat, oral residue, and multiple swallows on $\geq$1 consistency; reduced scores on the timed water swallow test, as subsequently described, when compared with age- and sex-matched controls; and/or exhibited consistent overt signs (first 4 signs as described above) on the timed water swallow test, and/or failed the inhalation cough challenge.

Patients with dementia, stroke, head and/or neck injury/surgery, muscular disease, and Parkinsonism signs that were caused by multiple system atrophy, progressive supranuclear palsy, and side effects of medications were excluded. The study was approved by an appropriate regional health ethics committee, and patient consent was obtained. The mean age was 67.4$\pm$8.6 years with a mean disease duration of 6.6$\pm$4 years, mean dysphagia onset of 1.9$\pm$1 years, and mean Hoehn and Yahr score of 2.7$\pm$0.4. Patient characteristics and demographics are summarized in table 1.

List of abbreviations:

BiSSkiT	**Biofeedback in Swallowing Skill Training**
PD	**Parkinson's disease**
PMT	**premotor time**
sEMG	**surface electromyography**
SWAL-QOL	**swallowing-related quality of life**

Outcome measures

Patients underwent 2 baseline and 2 posttreatment data collection sessions, all conducted 2 weeks apart. As this was a pilot study, a broad range of outcome measures (ie, timed water swallow test,[21] Test of Mastication and Swallowing Solids, sEMG, SWAL-QOL) were engaged to identify potential areas of change. All outcome measures were conducted at all evaluations points. The timed water swallow test was performed using the protocol proposed by Hughes and Wiles[21] in which patients were asked to swallow 150mL of water "as quickly as is comfortably possible." The number of swallows, time taken, and total volume swallowed were measured as per protocol, and the following were calculated: time per swallow, volume per swallow, and swallowing capacity.

A similar Test of Mastication and Swallowing Solids was developed to assess the swallowing rate of solids. Patients were given a quarter (1 portion) of an Arnotts Salada cracker[a] to ingest with the instruction, "Eat this biscuit as quickly and comfortably as possible." The number of swallows and time taken were measured as per the method in the timed water swallow test.[21] The number of bites was identified by discrete segments of cracker taken to eat the whole. The number of masticatory cycles was confirmed with sEMG measures recorded from the masseter muscles using the KayPentax Digital Swallowing Workstation.[b] Measures calculated were time per swallow, masticatory cycles per swallow, and swallows per bite. Both the timed water swallow tests and Test of Mastication and Swallowing Solids were video recorded[c] for all patients at each session to facilitate inter/intra-rater reliability assessment.

Submental sEMG duration during swallowing was also collected and analyzed using the KayPentax Digital Swallowing Workstation. The data were saved to a patient database on this workstation for offline analysis by the raters. After skin preparation underneath the chin, a triode patch electrode[d] was placed midline between the mental spine of the mandible and the superior palpable notch of the thyroid cartilage. Patients performed 5 saliva and 5 10-mL water swallows with task types randomized within and between participants. The instructions were, "Hold the water/saliva in your mouth and when you hear the go signal, swallow as quickly as possible." A digital tag was placed in the data acquisition file with time locked to the "go" command, which was presented at random intervals. Durational measurements extracted included premotor time (PMT), preswallow time, and duration of submental muscle contraction (fig 1). PMT was defined as the time duration between the presentation of the stimulus ("go" signal/digital tag) to the first change in the sEMG waveform. Preswallow time was defined as the time duration between the first change in the sEMG waveform to the base of the onset of swallowing, which was identified as the highest peak of the overall event. Duration of submental muscles contraction was defined as the duration between the onset and offset of the sEMG waveform. These extraction methods were conducted for all saliva and 10-mL water bolus swallows. The average PMT, preswallow time, duration of submental muscle contraction for saliva and 10-mL water bolus swallows were calculated separately across the 5 trials, at each session, per patient.

Finally, patients were evaluated for perceived changes in quality of life related to swallowing using the SWAL-QOL.