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ORIGINAL RESEARCH

Respiratory-Swallow Training in Patients With Head and Neck Cancer

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Abstract

Objective: To test a novel intervention to train swallowing to occur in the midexpiratory to low expiratory phase of quiet breathing to improve swallowing safety and efficiency.

Design: Safety and efficacy nonrandomized controlled trial with 1-month follow-up.

Setting: Ambulatory clinics.

Participants: Patients (N=30) with head and neck cancer (HNC) and chronic dysphagia completed the intervention. Fifteen of these patients participated in a 1-month follow-up visit.

Interventions: Training protocol based on hierarchy of motor skill acquisition to encourage autonomous and optimal respiratory-swallowing coordination. Visual feedback of respiratory phase and volume for swallowing initiation was provided by nasal airflow and rib cage/abdomen signals.

Main Outcome Measures: Respiratory-swallow phase pattern, Modified Barium Swallow Impairment Profile (MBSImP) scores, Penetration-Aspiration Scale (PAS) scores, and MD Anderson Dysphagia Inventory scores.

Results: Using visual feedback, patients were trained to initiate swallows during the midexpiratory phase of quiet breathing and continue to expire after swallowing. This optimal phase patterning increased significantly after treatment ($P<.0001$). Changes in respiratory-swallowing coordination were associated with improvements in 3 MBSImP component scores: laryngeal vestibular closure ($P=.0004$), tongue base retraction ($P<.0001$), and pharyngeal residue ($P=.01$). Significant improvements were also seen in PAS scores ($P<.0001$). Relative to pretreatment values, patients participating in 1-month follow-up had increased optimal phase patterning ($P<.0001$), improved laryngeal vestibular closure ($P=.01$), tongue base retraction ($P=.003$), and pharyngeal residue ($P=.006$) MBSImP scores and improved PAS scores ($P<.0001$).

Conclusions: Improvements in respiratory-swallowing coordination can be trained using a systematic protocol and respiratory phase-lung volume-related biofeedback in patients with HNC and chronic dysphagia, with favorable effects on airway protection and bolus clearance.

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A growing body of literature indicates the existence of a highly stable, coordinative relation between respiration and oropharyngeal swallowing in healthy adults.[1-22] Normative swallows occur most frequently during a pause in the expiratory phase of the breathing cycle, between middle and low expiratory lung volumes at quiet breathing, with some variability caused by bolus

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consistency and a swallowing task.[1-24] This coordinative phase relation appears to serve 2 related functions. First, expiratory flow surrounding swallowing may be vital to airway protection. Second, expiratory flow facilitates mechanical functions advantageous to swallowing (eg, laryngeal elevation and closure, pharyngeal pressure generation with consequent bolus clearance, pharyngoesophageal segment opening).[1-3,10]

Previous data suggest that consistent, coordinative patterning may be perturbed in patients with dysphagia, including those with head and neck cancer (HNC).[25-33] We have shown that patients with HNC who tended to initiate swallowing by interrupting the inspiratory phase of the breathing cycle had greater severity of airway invasion and swallowing impairment when contrasted with those with more stable patterning.[25] Further, patients with HNC tend to have severe swallowing impairments often refractory to current therapeutic approaches.[34-51] This led to the current work and speculation that training a more beneficial mechanical and airway protective coordinative relation might improve swallowing impairments in these patients. Testing of patients with HNC as the first study patient population has the advantage of clinical stability in the early years posttreatment, thereby enabling investigators to differentiate spontaneous recovery from the treatment effect. Because chronic obstructive pulmonary disease (COPD) is another common disease in the HNC population, the impact of COPD on swallowing function was determined.

Our primary aims were 3-fold: use a novel respiratory-related feedback protocol to train optimal respiratory-swallowing coordinative patterns; determine the effect(s) of training on respiratory-swallowing phasing and primary swallowing outcome measures; and test the stability of the training effect 1 month posttreatment. We hypothesized that more optimal respiratory-swallowing coordination could be learned, be sustained, and have a beneficial impact on swallowing function in patients with chronic dysphagia treated for HNC. The study was designed to have a minimum of 80% power to detect a reduction of 50% in impairment comparing post- with preintervention rates, based on analyses accounting for the paired study design with a 2-sided alpha=.05.

Methods

Institutional review board approval

The Medical University of South Carolina Institutional Review Board for Human Research approved the study for enrollment at the Medical University of South Carolina and the Ralph H. Johnson Veterans Affairs Medical Center (VAMC).

List of abbreviations:

COPD	**chronic obstructive pulmonary disease**
FEV_1	**forced expiratory volume in 1 second**
HNC	**head and neck cancer**
MBSImP	**Modified Barium Swallow Impairment Profile**
MBSS	**modified barium swallow study**
MDADI	**MD Anderson Dysphagia Inventory**
PAS	**Penetration-Aspiration Scale**
SLP	**speech-language pathologist**
VAMC	**Veterans Affairs Medical Center**

Participants

Adult patients aged ≥21 years were recruited during a 3-year period from head and neck tumor ambulatory clinics at the academic hospital and the VAMC. Patients provided written informed consent and were >6 months post-HNC treatment. Patients underwent a preassessment pulmonary function test and modified barium swallow study (MBSS). Participants meeting inclusion criteria entered the intervention phase.

Patients were included if they had persistent complaints of swallowing difficulty that were resistant to traditional dysphagia therapy, Penetration-Aspiration Scale (PAS)[52] scores ≥3 and ≤7, and a sum ≥5 on the following Modified Barium Swallow Impairment Profile (MBSImP)[53] components: initiation of pharyngeal swallow, anterior hyoid excursion, pharyngoesophageal segment opening, tongue base retraction, and pharyngeal residue. These components were selected based on previous studies and preliminary work as salient impairments in patients with HNC.[25] Participants were required to tolerate at least 1 liquid consistency indicated by PAS scores ≤6 as observed on the MBSS. If the patient received a PAS score >6 on a particular liquid consistency (eg, thin liquid), it was not used during the intervention as a concern for patient safety. All participants had nonoptimal (nonexpiratory-swallow-expiratory) respiratory-swallow patterns on at least 60% of swallows or had inconsistent nonoptimal respiratory-swallow patterns. Patients were excluded for evidence of recurrent HNC, concomitant neurologic disease, evidence of stricture, or having a nasogastric feeding tube. Patients with recent aspiration pneumonia, forced expiratory volume in 1 second (FEV_1) <30% predicted,[54] or impaired cognition identified on a standardized tool (Cognistat Cognitive Assessment)[55,56] were excluded.

Clinician raters and trainers

Two expert speech-language pathologists (SLPs) (B.M.-H. and J.B.) conducted and interpreted the deidentified MBSSs. To use the MBSImP, the SLPs must have exceeded the reliability criterion of 80% of interrater reliability.[57] These 2 SLPs had ≥90% inter- and intrastudy agreement on MBSImP scoring, PAS scoring, and identification of respiratory-swallowing phase patterns based on unpublished laboratory data. For purposes of this study, each MBSS was scored using consensus scoring (between B.M.-H and J.B.).

Four SLPs with 2 to 15 years of clinical experience were trained individually by the first author (B.M.-H.) and carried out the treatment sessions. The standardized treatment methods were contained in an instruction manual, which was modeled by 2 authors (B.M.-H. and D.M.). Competency was assessed during simulated practice. The instruction manual also included detailed instructions regarding equipment setup, how to provide feedback, and how to monitor and measure success of treatment goals. The clinicians treated at both institutions.

Radiographic evaluation of respiratory-swallow phase pattern, swallowing function, and airway invasion

Pre- and postintervention MBSSs were conducted in a routine fluoroscopy suite with a radiologist present. The patients were seated upright and positioned in the lateral viewing plane. The visualization field included the lips anteriorly, nasal cavity