

PILOT STUDY: HYOLARYNGEAL MUSCLE ACTIVATION IN RESPONSE TO RMT USING THE BREATHER



Hyolaryngeal Musculature Activation in Response to a Respiratory Resistance Device



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Purpose

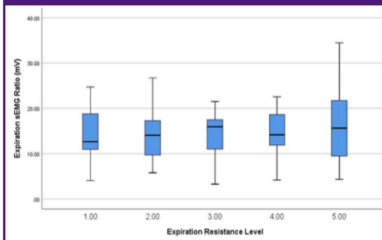
Resistance to airflow during expiration can elicit increased activity in the submental musculature. These muscles influence hyolaryngeal excursion during swallowing. However, little is understood regarding a sustained expiratory or inspiratory resistive protocol in hyolaryngeal muscle function. Protocols implemented in other studies vary widely, although generally a threshold pressure device is used to create a percentage of maximum expiration strength (Laciuga, Rosenbek, Davenport, and Sapienza, 2014). These studies typically use a coil or spring loaded device. In this study, we examined overall activation of the hyolaryngeal muscles via surface electromyography (sEMG) in response to a continuous resistive load with a screen loaded resistance device applied to expiration and inspiration in healthy subjects.

Methodology

- All participants had no prior dysphagia or neurological impairment history.
- Hyolaryngeal musculature activity was measured via sEMG electrodes over the submental musculature.
- Participants completed a protocol utilizing a resistance breathing device (The Breather™) for both exhalation and inhalation tasks, 3 times at each resistance level. There were 5 resistance levels for exhalation, and 6 resistance levels for inspiration.
- A sustained expiratory/inspiratory pattern was used, rather than generating a maximum breath
- Baseline and peak amplitudes were collected from each trial, and then averaged across each trial.
- Baseline amplitude was subtracted from peak amplitude means, providing a normalized amplitude for each resistance level.
- Expiratory and inspiratory activation. were averaged across all trials, at each level, to obtain a stabilized ratio.

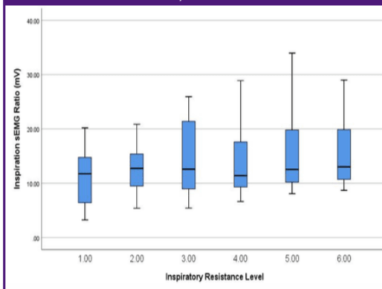
Results

- Paired T-tests revealed significant differences ($p < .05$) between expiratory & inspiratory baselines vs. expiratory and inspiratory peak activity.
- There were no differences between expiratory and inspiratory activation ratios.
- Cohen's *d* for effect size was calculated as .77 (moderate-large effect) for expiratory and .88 for inspiratory changes from baseline.



- Degree of resistance did not have an effect on submental activation during expiratory tasks

- Resistance changes did have an effect during inspiratory tasks, Level 1 was different from 3, 5, 6; Level 2 different from 5, 6

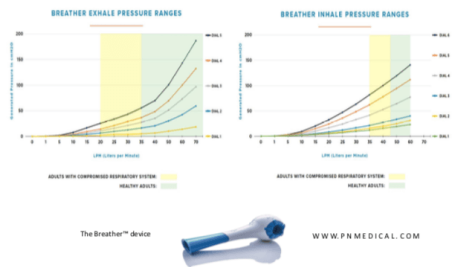


Conclusion

- This study found that the utilization of a respiratory resistance protocol increased hyolaryngeal musculature activation to significant levels over baseline on both expiratory and inspiratory trials.
- There were no differences in the degree of activation between expiratory or inspiratory tasks.
- These findings align with related research regarding increased submandibular musculature activation during an expiratory resistance task, even in healthy individuals (Wheeler, Chiara, and Sapienza, 2007).
- These results also provide initial support for sustained respiratory resistance activities providing increased activation patterns, rather than generating a maximum or percentage-of-maximum breath.
- This was a small cohort of healthy, non-injured individuals with no history of illness. Larger studies in affected populations should be studied to determine effectiveness in specific contexts.

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POSTER PRESENTATION – DYSPHAGIA RESEARCH SOCIETY, 2019, SAN DIEGO, CA

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KEY FINDINGS

- In neuromuscular disease, such as Parkinson's, activation of muscle groups for voice and swallowing may be impaired, causing dysphonia and dysphagia.
- Strengthening those muscle groups by respiratory muscle training (RMT) can improve voice and swallow function, and health-related quality of life.
- In the study presented here, activation of the hyolaryngeal muscles in response to RMT using The Breather is assessed by surface electromyograph (sEMG).
- RMT using The Breather improved muscle activation both during inspiration as well as during expiration against resistance significantly above baseline level.
- The Breather can be recommended as a useful exercise tool to maintain swallow function longer.

INTRODUCTION

Eating and drinking rank among the most necessary, but also the most enjoyable tasks in life, even more so if the experience is spiced up with exhilarating flavors and inspiring company. Being top of the hit list of life's joys, any impact on our ability to eat and drink, for example due to disease or stroke, can have devastating consequences on physiological and mental health, and dramatically reduce the quality of life.

We spoke with Dr Chris Watts, researcher and newly appointed Dean of the Harris College of Nursing and Health Sciences at the Texas Christian University, about swallowing, speech, and how to best preserve these important physiological functions at the onset of neuromuscular diseases such as Parkinson's. As a speech language pathologist by training, Dr Watts follows his passion as a clinician, a teacher, as well as a scholar. His academic research revolves around laryngeal function in voice and swallowing. While the muscle groups used for voice production and for swallowing may overlap, their specific roles in these distinct physiological processes differ significantly. *"What happens in the larynx during swallowing, is very different than what happens in the larynx during voice production"* explains Dr Watts. While the larynx has to close during swallowing to protect the lower airways, it remains open during speech production to allow for airflow through the vocal folds.

DR. WATTS EXPLAINS THE DIFFERENT FUNCTIONS THE LARYNX SERVES DURING VOICE PRODUCTION AND SWALLOWING:



What are the distinct functions of the larynx during voice and swallowing.mov

In people affected by neuromuscular diseases such as Parkinson's or after a stroke, muscle recruitment and activation can go wrong, and lead to impaired speech and swallow function. Dr. Watt's research interest focuses in particular on the deterioration of laryngeal muscle activation during the early stages of Parkinson's, as well as on rehabilitation or prevention of this functional decline.

Respiratory muscle training (RMT) offers a potential intervention here by increasing activity of the laryngeal muscle groups. The method of RMT follows the same principles as resistance or weight training for any other skeletal muscles. Muscles get activated by increasing their workload through resistance, which leads to an increase in muscle mass (hypertrophy) and improves muscle function. And what dumbbells are for the biceps, is a respiratory muscle trainer for the respiratory and laryngeal muscles. The

Breather is a respiratory muscle trainer that provides resistance for strengthening both inspiratory and expiratory muscles, including those muscle groups used for voice and swallowing.

In a recent exploratory study conducted in the research lab of Dr Watts, the graduate researcher Matt Dumican set out to investigate the effect of the Breather on the submandibular muscles in healthy individuals. These muscles are attached to the underside of the mandible or the chin, and connect to the hyoid bone, pulling the larynx forward during swallowing to prevent food or liquid from entering the lower airways of the lungs. Dr Watts and his team were particularly interested in what happens to these muscles if you add resistance by using the Breather.

DR. WATTS DISCUSSES THE IMPORTANCE OF RESISTANCE TRAINING USING THE BREATHER FOR THE HYOLARYNGEAL MUSCLES:



Role of resistance training using the Breather for the hyolaryngeal muscles.mov

The researchers therefore designed a study to assess the level of activation of the submandibular muscles during the use of the Breather at different resistance settings. They measured activation of this hyolaryngeal musculature via surface electromyography (sEMG) in response to continuous resistance. Electrodes were placed on the submandibular muscles, and activity was recorded during resistance training. The study population in this exploratory study consisted of 10 healthy volunteers, with no history of dysphagia or other swallowing impairments.

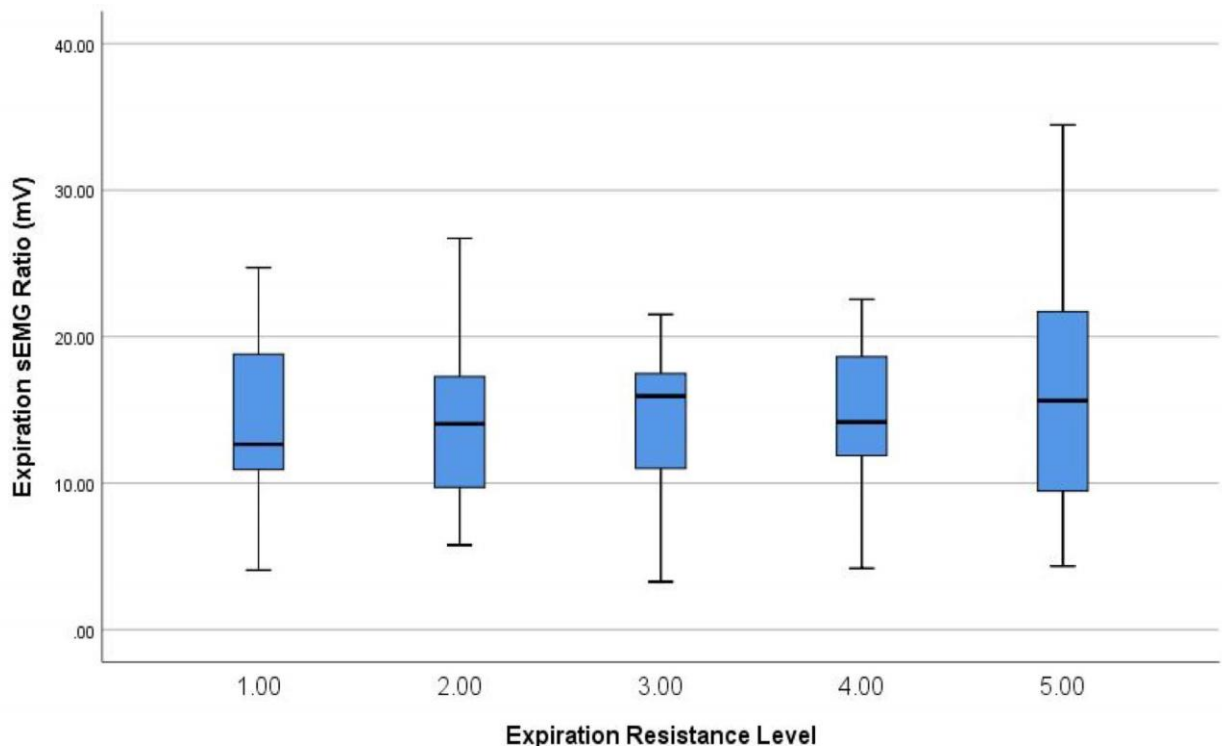
DR. WATTS EXPLAINS THE STUDY DESIGN AND MAIN FINDINGS:



Pilot study design and main findings.mov

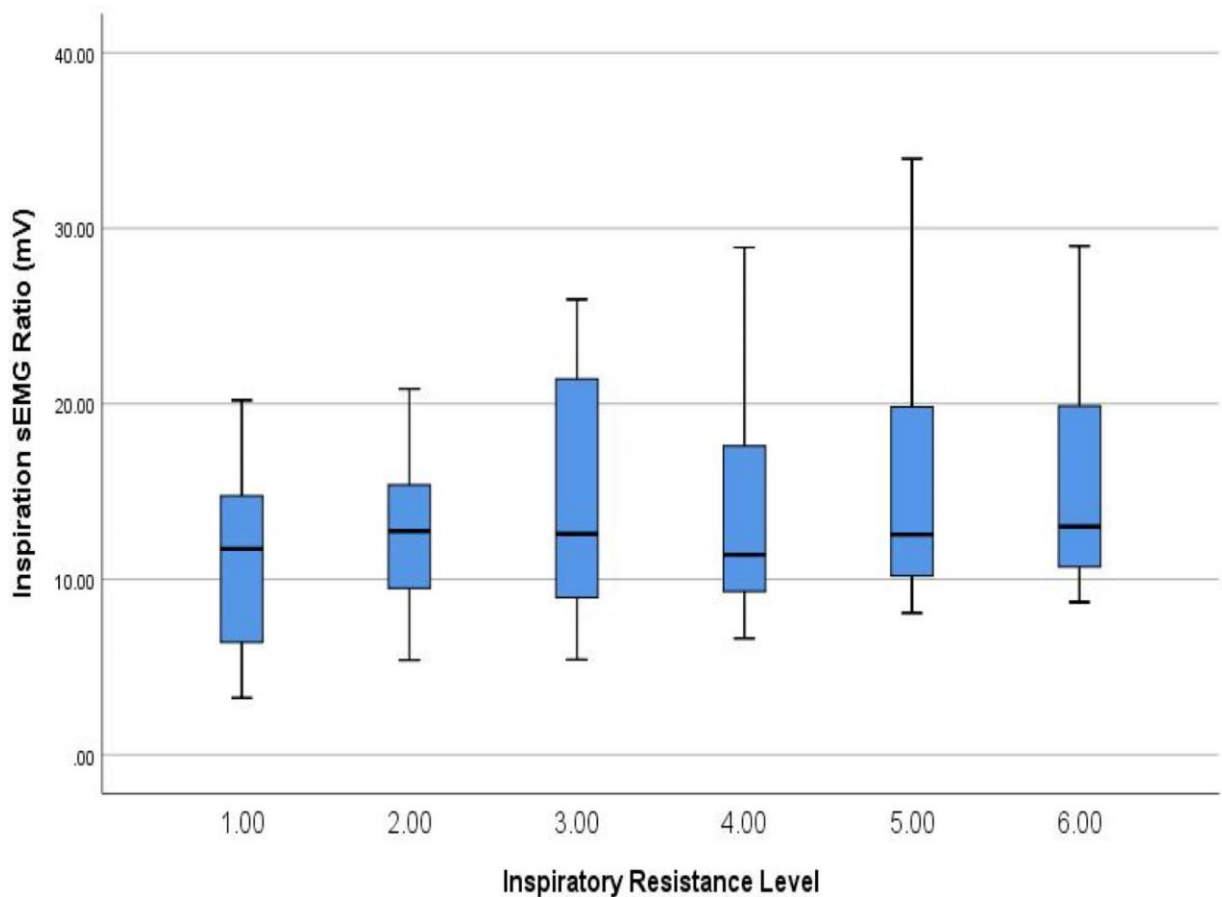
The successful outcomes of the study were presented at the 2019 annual meeting of the Dysphagia Research Society in San Diego, CA. The research team around Dr Watts showed that the submandibular muscles were activated to a significant level during breathing against resistance vs breathing without resistance. Importantly, muscle activation was recorded during both inspiration as well as expiration. Figure 1 shows the average muscle activation during expiration across the 5 different resistance settings provided by the Breather.

Figure 1: Average Hyolaryngeal Muscle Activation During Expiration Using The Breather



The effect size of peak muscle activation compared to baseline activity was .77 (Cohen's d; moderate-large effect). Inspiratory tasks against resistance elicited a slightly higher effect size of .88.

Figure 2: Average Hyolaryngeal Muscle Activation During Inspiration Using The Breather



Interestingly, as shown in Figure 2, muscle activation during inspiration against resistance increased with higher settings. The Breather has 6 different resistance settings for inspiration. Muscle activation was more pronounced at the higher settings (5 and 6) than at the lower settings (1 and 2), indicating a correlation between muscle activation and training intensity.

Why a similar correlation was not observed during expiration requires further investigation, Dr Watts suggests. However, as inspiratory muscles are more accustomed to training, for example by doing exercise, higher activation levels may be possible even in people new to RMT. Expiration on the other hand is passive at rest, and relies on the natural recoil of the lung. Expiratory muscles typically take longer to train using RMT than inspiratory muscles. As none of the subjects in this study have used the Breather or similar RMT devices before, muscle response may reflect the natural strength of their respiratory muscles, with the expiratory muscles being less active than the inspiratory muscles. A second assessment after several weeks of RMT may be useful to investigate a change in activation patterns. However, these speculations need to be confirmed by future investigations.

As Dr. Watts points out, the outcomes of the study clearly show that breathing against resistance using the Breather increases activation of the hyolaryngeal muscles. The wider implications of these findings include the potential of the Breather *“as a tool as part of an exercise program for these muscles in people who have an impairment that causes dysphagia.”*

DR. WATTS DISCUSSES THE POTENTIAL IMPACT OF RMT ON PEOPLE WITH PARKINSON’S:



What are the wider implications for people with PD.mov

In people with neuromuscular disease, recruitment and activation of muscles involved in speech and swallow function may be impaired and decline during disease progression. The consequences of voice and swallow dysfunction can have both physiological and psychological effects. While malnutrition and an increased risk of aspiration pneumonia are linked to dysphagia and poor cough effectiveness, the social impact may be even more burdensome in people with Parkinson’s. Gathering with loved ones around a dinner table, and enjoying food, drink and conversation are an integral part of our culture, and greatly enhance our wellbeing. Not being able to fully enjoy these aspects of life due to worries about choking or the inability to make one’s voice heard can lead to stress, anxiety, social isolation and depression.

Respiratory muscle training may offer an effective therapy here, especially in the early stages, to preserve voice and swallow function as long as possible,

and to maintain a longer quality of life. Dr Watts emphasizes the need for exercises, particularly for those muscles that are involved in voice and swallowing, for people with Parkinson's, as it will help people *“go for a longer time without handicap or disability related to voice and swallowing.”*

Based on his findings as well as on the evidence from numerous other studies confirming the benefits of RMT in neuromuscular disease, Dr Watts paints a future scenario in which “the Breather, or other devices, in the future, we might recommend at the time of diagnosis.” In a concluding remark, Dr Watts points out that *“using a device such as the Breather will do more good than it will ever do harm”, and that this is something that “people with Parkinson’s disease are looking for.”*

DR. WATTS DESCRIBES A POTENTIAL FUTURE SCENARIO OF THE USE OF THE BREATHER IN PARKINSON’S:



What is the importance of RMT from disease onset.mov

[See Original Poster Presentation](#)

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