The Effects of Expiratory Muscle Strength Training on Voice and Associated Factors in Medical Professionals With Voice Disorders

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Summary: Objectives. This research used expiratory muscle strength training to explore the factors relevant to medical professionals with voice disorders. The maximal expiratory pressure (MEP) improved, which is measured by the maximal contracting force of expiratory muscles. The expiratory muscle strength increased, which can affect the positive pressure of pulmonary volume, thereby influencing subglottal pressure for speech to change the voice performance and vocal-fold vibration.

Methods. Twenty-nine participants with voice disorders who are working in a hospital and who are using their voice for more than 4 hours per day were recruited. The participants were randomly assigned to either the study group (STU) or the control group (CON). All participants underwent aerodynamics analysis, pulmonary function, MEP, and completed a vocal symptoms questionnaire before and after STU was provided. The interventions in the STU were conducted 3 days per week and involved performing 25 expiratory exercises (five cycles, each comprising five breaths) for 5 weeks. The CON did not receive any intervention.

Results. The voiceless /S/ expiratory time, symptom questionnaire scores, and MEP were greater in the STU than in the CON ($P < 0.05$). However, no statistically significant difference in the results of the pulmonary function was observed between the groups. The STU exhibited a greater percentage change in maximal voiced /Z/ phonation and voiceless /S/ expiratory compared with the CON ($P < 0.05$).

Conclusions. The participants' voiceless /S/ expiratory time, symptom questionnaire scores, and MEP significantly improved after the intervention. Future studies can increase the number of participants, increase the number of study groups, and examine the effectiveness of long-term treatment.

Key Words: Expiratory muscle strength training (EMST)–Voice disorder–Maximal expiratory pressure (MEP)–Medical professionals–Self-awareness of vocal symptoms questionnaire.

INTRODUCTION

The voice is essential to people's occupational, recreational, and social lives, and voice performance depends on coordination among the respiratory, phonation, and resonance systems.[1] Voice disorders can influence daily communication and, thus, hinder professional and occupational performance.

Speaking during breathing requires well incorporations between vocal organs and respiratory function to sufficiently compress subglottal pressure (Ps) for stabilizing sound production and speaking.[2] During the speaking, more airflow would be required to support sound production, thus respiratory muscle needs to rapidly perform fine adjustments to maintain a dynamic balance between active and passive air pressures. The active pressure origins form respiratory muscles, including negative pressure of inspiratory muscles and positive pressure of expiratory muscle. The passive pressure is produced by elastic flexibility of thoracic cage.[3–6]

The respiratory system provides the energy required for sound production, and airflow during respiration is essential for phonation. Impaired coordination between respiratory and laryngeal systems can lead to vocal fatigue when speaking. The rate and forces during the expiratory phase in phonatory respiration must be controlled to maintain smooth and stable airflow, thereby ensuring that Ps is constant and that voice quality is high.[3–6]

When the respiration system is unable to provide sufficient power for sound production, the laryngeal system overcompensates for this lack of power, causing changes in vocal tissue and in voice quality.[7] Like other muscles, the strength and endurance of respiratory muscles can be improved through exercise training.[8,9] The purpose of respiratory muscle training is to improve voicing efficiency by strengthening respiratory muscles and reducing laryngeal overcompensation or hyperfunction.[7] In a study conducted by Baker, normal participants were divided into two groups that separately underwent 4-week and 8-week respiratory muscle training programs. Both groups exhibited significant improvements in maximal expiratory pressure (MEP) and decreases in the intraoral or mouth pressure/MEP ratio. A significant decrease in the Ps/MEP ratio was observed only in the group that underwent 4 weeks of training. Baker concluded that respiratory muscle training benefits the voice.[10] The study conducted by Wingate et al yielded a similar outcome.[11] After undergoing 5 weeks of expiratory muscle strength training (EMST), professional voice users exhibited improvements in MEP, the Voice

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Handicap Index (VHI), and Ps when asked to speak loudly. However, Roy et al determined that 6 weeks of EMST exerted no effect on voice performance.[7] The effect of respiratory muscle training on the voice performance remains unclear.

Therefore, we proposed the present study to investigate the effects of a 5-week EMST intervention on the respiratory system and vocal performance in people with voice disorders.

MATERIALS AND METHODS

Participants

Twenty-nine participants, three men and 26 women, were enrolled in this study (Table 1). All participants were medical professionals recruited from the Shuang Ho Hospital in Taiwan. People who (1) used their voice for more than 4 hours while working,[11] (2) were aware of their voice problems, (3) and were generally healthy and had no systemic diseases were included in this study.

The criteria for case selection was depended on whether the paticipants had both severe self-awareness of vocal abnormality, and we then matched their ages, genders, maximal phonation time, and self-aware their voice problems in both experimental groups. The participants in this study mostly exhibited hoarseness voice pattern and smaller voice volume.

People with respiratory system problems, cardiovascular disease, or oral and laryngeal structural abnormality, as well as those who were pregnant were excluded. The Institutional Review Board of Taipei Medical University approved this study.

The 29 participants were randomly assigned to one of two groups, the study group (n = 15) and the control group (n = 14). The study group underwent an expiratory muscle training program for 5 weeks, whereas the control group received no intervention. All participants were administered a voice-use questionnaire and were subjected to pulmonary analysis and an expiratory muscle strength test before and after the intervention.

Intervention

An expiratory muscle strength trainer (Figure 1) was applied in expiratory muscle training, and the resistance pressure was kept at the intensity of 75% MEP for all participants in the study group. According to the evidence of training effects in skeletal muscle tissue, this intensity is close to the maximal loading of muscle strengthening.[6,9] The training protocol entailed performing 25 expiratory exercises (divided into five cycles) per day for 3 days per week for 5 consecutive weeks.[7,11] To ensure that only oral expiration was performed, a nose clip was used during expiratory muscle training (Figure 2).[11,12] The participants inhaled maximally, sealing the mouthpiece of the device firmly, and then exhaled as forcefully as possible. The intensity had to reach 75% MEP and be sustained for 2 seconds. To increase the efficacy of expiratory muscle training, the MEP values were adjusted every

TABLE 1.
Basic Characteristics of the Participants (n = 29)

Variable	Study (%) (n = 15)	Control (%) (n = 14)	*P*
Sex†			0.508
Male	1 (6.7)	2 (14.3)	
Female	14 (93.3)	12 (85.7)	
Age*			0.481
20–24 years	1 (6.7)	2 (14.3)	
25–29 years	8 (53.3)	7 (50.0)	
30–34 years	5 (33.3)	2 (14.3)	
35–39 years	1 (6.7)	2 (14.3)	
40–44 years	0	1 (7.1)	
Education†			0.883
College	1 (6.7)	2 (14.3)	
University	9 (60.0)	7 (50.0)	
Graduate degree	5 (33.3)	5 (35.7)	
Work experience*			0.234
0–4 years	8 (53.3)	5 (35.7)	
5–9 years	6 (40.0)	6 (42.9)	
10–14 years	1 (6.7)	2 (14.3)	
15–19 years	0	1 (7.1)	
Work environment			
Open area	10 (66.7)	7 (50.0)	
Closed area	5 (33.3)	7 (50.0)	
Time at work spent talking			
4–6 hours	4 (26.7)	8 (57.1)	
6–8 hours	11 (73.3)	6 (42.9)	

* Mann-Whitney *U* test ($P < 0.05$).
† Pearson chi-square test ($P < 0.05$).