Recovery From Heavy Vocal Loading in Women With Different Degrees of Functional Voice Problems

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Summary: Type of Study. This is a longitudinal, case-control clinical trial.
Objectives. This study aims to track recovery time following a vocal loading task (VLT) imposing vocal fatigue and to explore if patients with functional dysphonia (FD) are worse affected by vocal loading, and if these patients take longer than others to recover.
Methods. Fifty (n = 50) female participants in four vocal subgroups on a spectrum of everyday vocal loading and functional voice complaints, including n = 20 patients with FD, took part in a clinical VLT, inflicting vocal fatigue through loud speech in ambient noise. Short-term recovery was explored through self-assessment of unspecified voice problems every 15 minutes for 2 hours following loading. Long-term recovery was tracked through self-assessments of specific voice symptoms during 3 days following vocal loading. Effects of heavy vocal loading were evaluated through voice recordings, long-time-average spectrum, perceptual assessments, and assessments of digital imaging performed pre- and post vocal loading.
Results. Patients with FD did not return to baseline for unspecified voice problems within 2 hours of vocal loading and were worse affected by vocal loading than other groups. Women with high everyday vocal loading with no voice complaints identified vocal loading more evidently than other groups. Long-term recovery took 7–20 hours for all groups.
Conclusions. Short-term recovery is slower for patients with FD and these patients are worse affected by a VLT than others.
Key Words: Vocal loading–Short-term recovery–Long-term recovery–Functional dysphonia–Voice health self-assessment.

INTRODUCTION

Heavy vocal loading and recovery time may be pivotal for vocal health. The amount of vocal loading, that is, the vocal dose, and the time allowed for recovery can affect the condition of the vocal fold tissue. Therefore, it can be assumed that phonation involves repeated tissue damage and repair. The process of constant repair within the vocal folds has been compared to chronic dermal wound healing by Hunter and Titze. Hunter and Titze have stated that more research investigating the effects of heavy of vocal loading is necessary, as recovery from vocal loading is still theoretically unclear. Such research could better define vocal fatigue and may document potential damage to vocal fold tissue caused by intense voice use.[1] Vocal loading is not only affected by intrinsic loading factors, such as prolonged voice use, but additional, extrinsic loading factors, such as loud background noise and poor ROM acoustics, will add to the negative effects of vocal loading[1,2]

Vocal fatigue has not yet been well defined[3] and may be connected to increased vocal effort. Vocal effort is a physiological response to loud phonation leading to an increase in the sound pressure level (SPL) in the vocal signal. Vocal effort can be measured objectively as a change in signal SPL, and subjectively as a change in self-perceived vocal effort. Vocal effort increases when auditory feedback decreases.[4] Heavy vocal loading may be detrimental to the vocal function, as increased vocal effort, that is, phonation at increased intensity, leads to different kinds of vocal fatigue. For example, Titze has proposed effects such as laryngeal muscle fatigue and laryngeal tissue fatigue, meaning damage brought about in the lamina propria due to heavy vocal loading.[5] Welham and Maclagan focus on short-term functional voice changes, proposing that vocal fatigue entails negative vocal adaptation brought about by prolonged voice use, that is, high vocal dose. The effects may be manifested through changes in self-assessment, perception, acoustics, and physiology of the phonatory function.[6] To explore the effect of vocal loading, multifaceted measurements need to be made. A vocal dose exceeding beneficial levels or vocal warm-up[7] is expected to have a detrimental impact on the following vocal functions, according to Vilkman[8]: (1) fundamental frequency, which is expected to rise as an effect of high vocal dose[9]; (2) type of phonation, which is expected to shift toward hyperfunction or increased vocal effort[10]; (3) phonatory intensity, which is expected to increase due to the Lombard effect[11–13]; and vibratory characteristics of the larynx, both internally[14] and externally.[15]

Another important aspect of vocal loading is the ability to endure a high vocal load and the question of what level of vocal dose, or vocal loading, exceeds the capacity of an individual speaker, before the voice function of each individual speaker are fatigued.[16,17] As aforementioned, there is no uniform definition of vocal fatigue.[3,18] Effects of vocal loading have been keenly examined, but with little conformity,[10] and rarely in a population of patients with confirmed voice disorders.[19] Solomon suggests that vocal fatigue should be defined by its symptoms with great emphasis placed on the patient's self-assessment. Not only is vocal fatigue difficult to define, but also it often co-occurs with vocal pathologies.[10] Vocal fatigue is said to be debilitating, as it implies voice use exceeding the capacity of an individual speaker,[20] yet we know little of what sets the boundaries for such capacity for people from different parts of the "afflicted voice population." We know that some, but not all,

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teachers can be affected by vocal fatigue,[21] and we do not know how this vocal fatigue in teachers compares to individuals with diagnosed function disorders, such as patients with a confirmed diagnosis of functional dysphonia (FD). Vocal fatigue can be identified well through self-assessment of the vocal function,[10] and self-assessment tools are paramount for evaluating the impact of heavy vocal loading and recovery time.[1]

Objectives

The main aim of the present study was to track recovery time from self-assessed vocal fatigue and the acoustic and physiological effects of a clinical vocal loading task (VLT) according to self-assessments of (1) voice health and (2) specific voice symptoms, along short- and long-term courses. A requirement of this aim was to expose participants to heavy vocal loading, thus increasing vocal effort and potentially causing vocal fatigue. A second aim was to compare reaction to heavy vocal loading and recovery courses in patients with FD to other parts of the population, representing different phonatory behaviors and functional voice health.

Research questions

1. Do female cisgender patients with FD take longer to recover from heavy vocal loading, compared to women who experience everyday vocal loading who have not sought medical voice treatment and voice healthy controls?
2. How is the voice signal of cisgender women with varying levels of functional voice problems and varying everyday vocal loading affected by a controlled VLT?

METHODS

The methods used for imposing vocal fatigue and the recording effects of the vocal loading in the current study are explained in detail in Whitling et al.[22] The method includes measurements of instrumental as well as perceptual nature, including perceptual, acoustic, and physiological assessments, but also of self-assessments of voice health, in line with thorough clinical routine. The basic setup requires a VLT in which participants read aloud, seated in a double-walled, soundproof booth (complying with the maximum permissible ambient SPL as specified in ISO 8252–1). As the participants started reading, the booth was silent. After 30 seconds, ambient acceptable noice level (ANL) multi-talker speech-babble noise with 12 North American speakers started airing in free field. The noise was retrieved from the official AND CD (Arizona Travelodge; Cosmos Distributing Inc., Torrence, CA). The noise increased from 55-dB SPL to 85-dB SPL along 10-second intervals, staying at 85 dB for the remainder of the task. The participants were instructed to keep reading and to endeavor to make themselves heard, only terminating when they sensed a distinct discomfort from the throat; that is, the participants set the time limit for vocal loading, with self-assessed vocal fatigue as the outcome measure. The ultimate time limit (30 minutes) was unknown to the participants. Analyses of changes to vocal function and the voice signal were made from recordings of voice, self-assessments, and digital imaging (high-resolution and high-speed modes [4000 frames/s] pre- and post VLT). There have been specific changes to the original method that are explained under each method section. A general difference is the exclusion of phonation threshold pressure measurements.

Self-assessment procedure

This experimental, clinical case-control, longitudinal study examined (1) the indication of vocal fatigue caused by the VLT and (2) the recovery time from vocal fatigue following a VLT. Recovery time was examined along two courses: short-term recovery was tracked by self-assessments of general voice health, using a 100-mm visual analog scale (VAS), measuring general voice health (0 = no voice problems, 100 = maximal voice problems). Long-term recovery was tracked by self-assessments during the hours and days following the VLT, through 10 voice health questions (10VQs), measuring the occurrence specific voice symptoms. The 10VQs were based on VHI-T[23] and contained statements posed on a five-point scale (0 = none or not at all, 1 = low or occasionally, 2 = some or sometimes, 3 = high or often, and 4 = very high or nonstop). The statements were (1) This is my current stress level; (2) My voice feels fatigued; (3) I need to clear my throat; (4) I need to cough; (5) My throat or neck (same word in Swedish: "hals") feels tense; (6) I am hoarse; (7) I am having a hard time making myself heard (like at a party); (8) My voice can suddenly change when I speak; (9) It is effortful to get the voice working; and (10) I have a feeling of discomfort in my throat or neck. Table 1 gives an overview of the self-assessment procedure.

Analyses of self-assessments

Time points for self-assessment, both along the short-term and the long-term recovery courses, were chosen according to McCabe and Titze.[20] Baseline scores were compared to six set time points following the VLT: T2: at VLT termination, T3: 15 minutes after VLT, T4: 30 minutes after VLT, T5: 45 minutes after VLT, T6: 60 minutes after VLT, and T7: 120 minutes after VLT. All vocal subgroups were expected to have different baselines when assessing general voice health with VAS, with the two groups with voice complaints scoring higher than the two groups who had no voice problems. To follow each vocal subgroup's true reaction to the VLT, to follow their short-term recovery course, and to be able to compare between groups, standardized mean scores for general voice health (VAS) at all time points were calculated *ad modum* Atkinson et al,[24] as adapted by Vogel and Maruff.[25] Standardization was made by subtracting the baseline score (T1) from each following time point (Tk) (ie, T2, T3, T4, T5, T6, or T7) and dividing by the within-subject standard deviation (WSD): Tk-T1/WSD, derived from every time point. Long-term recovery was tracked by self-assessments during the hours and days following the VLT, through 10VQs, recorded four times a day for the 3 days following the VLT. Mean and median times for 10VQ scores to return to baseline values recorded pre-VLT were compared between groups. The 10VQs were checked for stability using Spearman's ρ correlation to check the test-retest reliability. A test form was filled out twice by each participant, 15 minutes apart, 2–3 days before the VLT. There was a strong, positive test-retest reliability (ρ = .86), exceeding adequate minimum scale reliability.[26]