Immediate Effects of Humming on Computed Electroglottographic Parameters in Patients With Muscle Tension Dysphonia

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Summary: Objectives. To investigate the immediate effects of humming and subsequent um-hum phonation on the computed parameters of electroglottographic (EGG) signals in muscle tension dysphonia (MTD) patients and nondysphonic speakers.

Methods. We included 21 MTD participants exhibiting both vocal roughness and supraglottic compression, who were able to produce successful humming and um-hum phonation. Twenty nondysphonic participants were selected as controls. Each participant was instructed to perform three phonatory tasks: natural phonation, humming phonation without pitch changes, and subsequent um-hum phonation, that is, humming with a pitch glide up as if agreeing with someone. Acoustic and EGG signals were recorded while the participants performed these tasks. Computed parameters reflecting the irregularities in vocal fold vibrations and the degree of glottal contact were calculated and compared between the tasks.

Results. The MTD group showed decreases in both perceptual vocal roughness and acoustic perturbation parameters while performing the tasks. The perturbation parameters of EGG signals and the standard deviation of the contact quotient (CQ) also exhibited significant decreases associated with either of humming or um-hum phonation in both groups. In addition, the CQ exhibited significant increases following humming alone in the MTD group and the combination of humming and um-hum phonation in both groups.

Conclusions. These results suggest that the combination of humming without pitch changes and subsequent um-hum phonation have the immediate effect in adjusting the regularity of vocal fold vibration and augmenting the degree of glottal contact in MTD patients as well as nondysphonic speakers, whereas humming alone increases the degree of glottal contact in MTD patients.

Key Words: Humming–Um-hum–Electroglottography–Perturbation analysis–Contact quotient–Muscle tension dysphonia.

INTRODUCTION

Voice production can result from the inappropriate use of a phonatory organ even without pathologic abnormalities in the vocal folds. Such disorders have been characterized using diverse terminology (functional dysphonia, muscle tension dysphonia (MTD), and muscle misuse voice disorders[1–3]) and can generally be treated with vocal training. We previously reported that MTD patients exhibit improved perceptual vocal quality and a reduced degree of supraglottic compression as well as decreased perturbation parameters of both acoustic (Ac) and electroglottographic (EGG) signals and the standard deviation of the contact quotient (CQ) following voice therapy primarily using humming.[4,5] However, because we did not compare therapeutic and nontherapeutic groups, it remains to be confirmed whether these post-therapeutic changes are actually conferred by the humming itself.

Humming is a vocal facilitating technique used to induce a resonant voice, as introduced in major voice training textbooks.[6–9] Previous authors have emphasized the importance of feeling resonance in the nose, cheeks, or lips during humming to effectively induce a hum.[7–9] Um-hum phonation is another technique described in these textbooks.[6–8] Cooper recommended that patients should be instructed to say "um-hum" with a slight upward glide, as though they were spontaneously and sincerely agreeing with what was just said or responding to someone by asking for clarification.[6] Yiu and Ho[10]also reported that speakers should be instructed to produce the sound /m/ with their lips closed in a relaxed manner and subsequently to glide the pitch to the most comfortable and natural level during humming as if sincerely agreeing with someone. Therefore, humming without a pitch change and subsequent um-hum phonation may be combined into a single training technique.

These textbooks described repositioning of the vocal folds and supraglottic structures to be one of the rationales for using humming.[7,8] In particular, Harris[8] described the endoscopic laryngeal view during humming as follows: (1) humming releases supraglottic muscular tension and corrects supraglottic compression; (2) the aryepiglottic folds and arytenoid tips form a gothic arch appearance; (3) vocal fold closure is gentle with relatively little medial compression, and (4) the closed phase is adequate to produce good mucosal waves. However, these descriptions remain insufficiently verified based on objective evaluations. Recently, we measured the width and length of

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the visible vocal folds under transnasal fiberscopy and demonstrated that humming immediately relieves supraglottic compression during phonation in MTD patients.[11]

EGG is a technique used to analyze the vibratory characteristics of the vocal folds by recording impedance changes across the larynx,[12] and the waveforms of EGG signals consist of a continuum of a simple waveform caused by repeated contacts and dissociations between the bilateral vocal folds during phonation. Accordingly, EGG-period perturbation quotient (PPQ) and EGG-amplitude perturbation quotient (APQ) are generally hypothesized to reflect the period irregularity and cycle-to-cycle variability of the vocal fold contact area, respectively. In addition, the CQ was defined as the ratio of the duration of vocal fold contact during the total vibratory cycle.[13] Previous studies have investigated the EGG perturbation parameters in dysphonic patients to estimate irregularities in the vocal fold vibrations.[5,14–16] In addition, we have recently reported that the EGG perturbation parameters showed superior reliability to the Ac parameters in the assessment of MTD patients, as determined using a receiver operating characteristic analysis.[17]

Concerning the effects of humming on the condition of the vocal folds, a number of studies have investigated the immediate effects of various vocal training techniques on the degree of glottal adduction using EGG.[18–25] In particular, Verdolini et al[19] investigated the CQ values during various phonatory tasks using EGG in trained participants and proposed that resonant voice phonation adjusts the degree of glottal adduction to a barely adducted or barely abducted state. In addition, Titze[26] demonstrated in a computer simulation model that vocal training techniques using semi-occlusion in the front of the vocal tract augment supraglottal and intraglottal pressure during phonation, leading to a slight separation between the vocal folds and the prevention of vocal fold collision. Therefore, humming and um-hum producing a resonant voice with complete lip occlusion are also likely to have the potential to change the degree of glottal contact and the condition of vocal fold vibration.

The aims of the present study were to (1) confirm whether humming without a pitch change and subsequent um-hum phonation immediately changes the perturbation parameters of EGG signals and the standard deviation of the CQ (CQSD) associated with irregularities in vocal fold vibrations; (2) investigate the effects of these vocal training tasks on the CQ (a quantitative measure of EGG signals reflecting the degree of glottal contact) in MTD patients and nondysphonic speakers without experience of vocal training; and (3) to verify whether humming actually decreases the degree of glottal contact, thereby alleviating excessive collision and irregular vibrations of the vocal folds.

MATERIALS AND METHODS

Participants

The protocol of this study complied with the Declaration of Helsinki, and Institutional Review Board approval was obtained (No. 12096). The inclusion criteria for MTD participants were as follows: (1) being seen for an initial assessment at Osaka University Hospital between April 2010 and March 2013, (2) presenting with vocal roughness predominantly relative to breathiness, with more than 1.5 points in the mean R score on the GRBAS scale assessed by two laryngologists at the initial assessment, and (3) exhibiting supraglottic compression during phonation without any organic abnormalities of the vocal folds. The exclusion criteria were as follows: (1) the presence of chronic disorders in the upper aerodigestive tract, (2) the presence of neurologic disease, and (3) experience with musical or theatrical training. Our previous study also demonstrated that not all MTD patients show an improvement in vocal quality during humming and subsequent um-hum phonation.[11] Twenty-eight patients were initially recruited (21 males and seven females). In the present study, we included only MTD participants who achieved the tasks successfully with a decrease of more than one point in the R score assessed by two laryngologists while performing humming and um-hum phonation. We also excluded MTD participants showing contact between either the bilateral false vocal folds or the arytenoids and petiole of the epiglottis, so that EGG signals only reflected changes in glottal contact. Consequently, 21 participants (16 males and five females; median age: 67 years; range: 35–84 years) were included in this study. Another 20 nondysphonic participants (15 males and five females; median age: 42 years; range: 24–72 years) found to have neither functional nor organic laryngeal abnormalities were selected as controls. All participants were initially evaluated based on their medical history including vocal abuse, smoking, psychoneurotic events, and reflux symptoms, then subsequently underwent a routine ear, nose, and throat examinations. Following the topical administration of 1% lidocaine and 0.02% adrenalin, each participant was examined via flexible transnasal laryngo-fiberscopy (P-4; Olympus, Tokyo, Japan) to observe the presence of supraglottic compression during phonation and/or vocal fold lesions.

Recording of acoustic and EGG signals during the phonatory tasks

Ac and EGG signals were synchronously recorded during the phonatory tasks on the first visit. A head-mounted electret condenser microphone with an omnidirectional polar pattern (SE50; Samson Technologies Corp., Hauppauge, NY) was laterally positioned 2 cm away from the lips of the participant, and the EGG electrodes (model 6103; KayPENTAX, Lincoln Park, NJ) were placed on the neck beside the bilateral lamina of thyroid cartilage using a Velcro strap in a soundproof room. A single laryngologist asked each participant to perform the following phonatory tasks: (1) *natural phonation*, stable phonation of /e:/ at a habitual pitch and loudness for more than 3 seconds; (2) *humming phonation*, following the natural phonation task, the patients were asked to close their lips and hum /m:/ for 3 seconds in a relaxed manner while feeling resonance in the nose or lips, without changing the pitch, and (3) *um-hum phonation*, humming with a pitch glide up as if sincerely agreeing with someone several times, and subsequently extending the last portion of the last trial while sustaining the raised pitch for more than 3 seconds. These procedures were repeated up to five times in cases in which the individual failed to show an improvement in vocal quality during humming phonation and