The Effects of Breath-Holding on Vocal Fold Adduction

Implications for Safe Swallowing

Joseph Donzelli, MD; Susan Brady, MS

Objective: To determine the effects, if any, of 3 different breath-holding techniques on a person’s ability to attain vocal fold closure (VFC) to successfully complete swallowing maneuvers.

Design: Prospective, randomized study.

Setting: Private practice.

Patients: A total of 150 healthy volunteers recruited from private practice patients and community volunteers.

Intervention: Group 1 received the easy breath-hold instruction; group 2 received the inhale/easy breath-hold instruction; and group 3 received the hard breath-hold instruction.

Main Outcome Measure: Closure of true and false vocal folds following the breath-hold instruction.

Results: In the easy breath-hold group, true VFC occurred in 82% of the subjects, and closure of both the true and false vocal folds occurred in 30%. In the inhale/easy breath-hold group, true VFC occurred in 62%, and closure of both folds occurred in 46%. In the hard breath-hold group, true VFC occurred in 86%, and closure of both folds occurred in 64%. The differences among the 3 groups were significant for true VFC ($\chi^2 = 9.242; P = .01$) and for closure of both folds ($\chi^2 = 11.625; P = .003$).

Conclusions: The hard breath-hold instruction was the most effective method to attain full laryngeal closure, and the inhale/easy breath-hold instruction was the least effective method to attain true VFC for safe swallowing.

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The supraglottic (SG) and super-supraglottic (SSG) swallow are commonly used “safe swallowing” techniques. These maneuvers provide airway protection from aspiration by using voluntary prolonged airway closure followed by forced expiration. During the SG and SSG swallows, the vocal folds are voluntarily closed before and during the swallow, followed by a cough to clear any material from the airway. The SSG swallow provides additional closure to the entrance of the airway by using a breath-hold with increased effort.

The SG and SSG swallows are often used in patients who demonstrate aspiration before and during the swallow. They are also used with patients who have undergone an SG laryngectomy during which the epiglottis and false vocal folds were removed. Because of the effectiveness of these maneuvers in reducing or eliminating aspiration, they have also been used with patients who have dysphagia of varied etiologies and who demonstrate laryngeal penetration and/or aspiration before or during the swallow.

Researchers have evaluated the effectiveness of various breath-holding techniques. Hirst et al found that 26 (58%) of 45 healthy subjects did not fully adduct their vocal folds following the easy breath-holding instruction. Martin et al evaluated 3 different breath-holding techniques (easy hold, inhale/hard hold, and inhale/exhale/hard hold) in 6 healthy adults. All 6 subjects completed all 3 breath-holding techniques, and 5 of the 6 subjects demonstrated maximal laryngeal valving under the hard breath-hold conditions. Mendelsohn and Martin prospectively studied 10 adults during breath-holding under nasal endoscopy. That study revealed that vocal fold closure (VFC) was not consistent with easy breath-holding, but the use of a hard breath-hold and vocalization prior to the breath-hold did assist laryngeal closure.
Currently, there are no studies on the effects of different breath-holding techniques on the true vocal folds and false vocal folds in a larger sample size in healthy adults. The purpose of the present study was to determine the effects, if any, of different breath-holding techniques on a person’s ability to attain complete adduction of both the true and false VFC. This research question is important because to successfully complete safe swallowing maneuvers (eg, the SG and SSG maneuvers), the person must first attain voluntarily closure of the vocal folds.

**METHODS**

A total of 150 subjects were recruited to participate in this study. They represented a convenience sample recruited from private practice patients and hospital and community volunteers. All subjects had the cognitive ability to follow complex directions and were able to demonstrate full VFC on phonation. No subject had a known history of neurologic, swallowing, or spinal deficits. Any subject who presented with a laryngeal and/or pharyngeal abnormality that would prevent the normal closure or movement of the vocal folds was excluded from the study.

All subjects underwent flexible nasal endoscopy. Subjects were randomly placed (without replacement) into 1 of the 3 breath-holding technique groups, 30 subjects per group: group 1 was the easy breath-hold instruction group; group 2 was the inhale/easy breath-hold instruction group; and group 3 was the hard breath-hold instruction group. Table 1 details the specific instructions, adapted from Logemann, provided to each group. These breath-hold instructions are commonly used with the SG and SSG swallows.

Subjects were offered topical nasal anesthesia of Afrin with pontocaine prior to the insertion of the flexible nasal endoscope. If the subjects chose to use the anesthesia, each nostril was sprayed 1 time, and the subjects were allowed up to 3 minutes prior to the insertion of the nasal endoscope. Ninety percent (135/150) of the subjects opted for the topical nasal anesthesia.

Equipment used during this study included a flexible endoscope attached to a light source. Laryngeal closure of true and false vocal folds was evaluated by a board-certified otolaryngologist.

True VFC was considered achieved when full adduction of the true vocal cords was visualized for a minimum of 2 seconds and the false vocal folds remained in the abducted position. When the subjects attained true VFC, with the breath-holding technique for a minimum of 2 seconds, it was assumed that they also attained true VFC, and it was recorded as complete laryngeal closure. The study protocol was approved by the hospital’s institutional review board.

The percentage of successful completions for each breath-holding technique for complete true vocal fold adduction and false vocal fold adduction was calculated. A 3 × 2 χ2 analysis was completed to evaluate the association between the breath-holding technique and the response (adduction).

A total of 150 subjects aged 13 to 91 years (mean ± SD age, 45.57 ± 15.37 years) participated in this study. Sixty-seven subjects were male and 83 were female. Table 2 summarizes the demographics for each group.

Overall, regardless of the instruction provided to the subjects, 76.7% (115/150) demonstrated true VFC, and 47% (70/150) demonstrated complete laryngeal closure of both true and false vocal folds. Table 3 summarizes the results of laryngeal closure by instruction group. A 3 × 2 χ2 analysis revealed that the differences among the 3 groups were significant for true VFC (χ2 = 9.242; P = .01) and for closure of both the true and false vocal folds (χ2 = 11.625; P = .003). Overall, the hard breath-hold instruction group attained the most complete laryngeal closure of both the true and false vocal folds.

Ten percent (15/150) of the total study population chose not to use the topical nasal anesthetic prior to the insertion of the flexible nasal endoscope. The distribution of these 15 subjects into the breath-hold instruction groups was random, consistent with the entire study population protocol (Table 4). Overall, regardless of the instruction provided to the patient without topical nasal anesthesia, 73% (11/15) demonstrated true VFC and 67% (10/15) demonstrated complete laryngeal closure of both the true and false vocal folds. Again, the hard breath-hold group attained the most effective true and false VFC in this subgroup.

**COMMENT**

The results of the present investigation support previous research that the hard breath-hold is the most effective instruction to attain full laryngeal closure of both the true and false vocal folds. It is important for the clinician to be aware of the effects that the differences in verbal instruction may have on the patient’s ability to accurately complete the SG and/or SSG swallows. Since these safe swal-

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**Table 1. Breath-Holding Instructions Given to Subjects**

<table>
<thead>
<tr>
<th>Group No.</th>
<th>Instruction</th>
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<tbody>
<tr>
<td>1 (Easy breath-hold)</td>
<td>“Hold your breath while I count out loud to 5.”</td>
</tr>
<tr>
<td>2 (Inhale/easy breath-hold)</td>
<td>“Take a deep breath, then hold your breath, while I count out loud to 5.”</td>
</tr>
<tr>
<td>3 (Hard breath-hold)</td>
<td>“Hold your breath very tightly, bearing down, while I count out loud to 5.”</td>
</tr>
</tbody>
</table>

**Table 2. Subject Demographics by Group**

<table>
<thead>
<tr>
<th>Group No.</th>
<th>Mean ± SD</th>
<th>Sex Ratio, M/F</th>
<th>No Topical Anesthesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Easy breath-hold)</td>
<td>45.58 ± 14.98 (13-91)</td>
<td>21/29</td>
<td>5</td>
</tr>
<tr>
<td>2 (Inhale/easy breath-hold)</td>
<td>47.36 ± 16.49 (18-83)</td>
<td>25/25</td>
<td>3</td>
</tr>
<tr>
<td>3 (Hard breath-hold)</td>
<td>43.82 ± 14.60 (16-90)</td>
<td>21/29</td>
<td>7</td>
</tr>
</tbody>
</table>

*Unless otherwise indicated data are number of subjects.

**Table 3. Overall Results by Group**

<table>
<thead>
<tr>
<th>Group No.</th>
<th>True Vocal Fold Closure Only</th>
<th>Closure of Both True and False Vocal Folds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Easy breath-hold)</td>
<td>41 (82)</td>
<td>15 (30)</td>
</tr>
<tr>
<td>2 (Inhale/easy breath-hold)</td>
<td>31 (62)</td>
<td>23 (46)</td>
</tr>
<tr>
<td>3 (Hard breath-hold)</td>
<td>43 (86)</td>
<td>32 (64)</td>
</tr>
</tbody>
</table>

*Data are number (percentage) of subjects.
lowing maneuvers are often used for patients who have undergone an SG laryngectomy who may no longer have their epiglottis and/or false vocal folds, it is imperative that patients using these techniques achieve true VFC as it is the only protective valving mechanism that they may have to prevent the aspiration of food and liquid.4,5,9,10

One finding of interest was that the inhale/easy breath-hold instruction was the least effective means to attain true VFC. This occurred because many of the subjects in group 2 who did not achieve true VFC appeared to be holding their breath with their true vocal folds remaining in the abducted (open) position. While taking a deep breath, the subjects in group 2 moved their true vocal folds to the abducted (open) position. Those subjects in group 2 who did not attain true VFC never moved their vocal folds from the abducted position when taking their deep breath to the adducted (closed) position for the breath-hold. These subjects appeared to be holding their breath with their vocal folds in the abducted position. In contrast, the subjects in group 1, who were instructed only to hold their breath, were more likely to attain true VFC. This finding may have clinical importance because often the instructions for the SG swallow include taking a deep breath followed by holding the breath.9 The instruction to take a deep breath may actually be counterproductive in attempts to attain VFC. The instruction to just hold the breath (easy breath-hold) was actually more effective at attaining true VFC than the combination of take a deep breath and then hold the breath.5

The only way to determine if a patient is actually achieving full VFC is through direct endoscopic examination of the larynx. The results of this study support previous findings that endoscopy has merit in assessing a patient’s laryngeal valving ability during various breath-holding techniques for a safe swallow.5 However, endoscopy may not always be readily available, and then the clinician has no way to determine if the patient is actually attaining the necessary glottal closure to complete the SG and/or SSG swallow during a meal or treatment session. Additionally, many patients with dysphagia may also have impaired sensory awareness and may not be able to accurately determine if they are achieving full glottal closure. Since voluntary breath-holding is a common technique used with patients with dysphagia to provide additional protection to the airway, it is important for the physician to know the most effective breath-holding instruction to achieving full VFC for a safe swallow.

A recognized limitation of this study is that subjects were provided the option of topical nasal anesthesia. Even though only 10% of the total study population opted for no topical anesthesia, the results for the whole study population vs the results for the subgroup were relatively similar in that the hard breath-hold instruction was the most effective to attain both true and false VFC. Additionally, the possible sensory adverse effect of the nasal anesthesia must be considered. However, patients with a known dysphagia often have sensory deficits as well, which would further support the use of increased effort or the hard breath-hold instruction to ensure full laryngeal closure while performing these safe swallowing maneuvers.

In conclusion, the hard breath-hold instruction was the most effective method to attain both true and false VFC, and the inhale/easy breath-hold instruction was the least effective in normal healthy adults. It is recommended that instructions to patients in the use of the SG swallow exclude the deep breath-hold and include only holding the breath. For the SSG swallow, the results of this study support the notion that the instruction that includes the hard breath-hold is the most effective to attain full laryngeal valving.

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REFERENCES