The Effect of Stretch-and-Flow Voice Therapy on Measures of Vocal Function and Handicap

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Summary: Objectives. To investigate the efficacy of stretch-and-flow voice therapy as a primary physiological treatment for patients with hyperfunctional voice disorders.

Study Design. Prospective case series.

Methods. Participants with a diagnosis of primary muscle tension dysphonia or phonotraumatic lesions due to hyperfunctional vocal behaviors were included. Participants received stretch-and-flow voice therapy structured once weekly for 6 weeks. Outcome variables consisted of two physiologic measures (s/z ratio and maximum phonation time), an acoustic measure (cepstral peak prominence [CPP]), and a measure of vocal handicap (voice handicap index [VHI]). All measures were obtained at baseline before treatment and within 2 weeks posttreatment.

Results. The s/z ratio, maximum phonation time, sentence CPP, and VHI showed statistically significant (P < 0.05) improvement through therapy. Effect sizes reflecting the magnitude of change were large for s/z ratio and VHI (d = 1.25 and 1.96 respectively), and moderate for maximum phonation time and sentence CPP (d = 0.79 and 0.74, respectively).

Conclusions. This study provides supporting evidence for preliminary efficacy of stretch-and-flow voice therapy in a small sample of patients. The treatment effect was large or moderate for multiple outcome measures. The data provide justification for larger, controlled clinical trials on the application of stretch-and-flow voice therapy in the treatment of hyperfunctional voice disorders.


INTRODUCTION

Among the etiologies underlying voice disorders, hyperfunctional classifications such as muscle tension dysphonia (primary or secondary) and vocal behaviors that result in benign midmembranous lesions are the most commonly diagnosed categories in patients seeking treatment. These vocal disorders are a public health problem, as a substantial proportion of the public will be impacted by voice disorders during their lifespan, with lifetime prevalence approaching 30%. The economic impact of these conditions is substantial. A recent study mined data from a large national health-claims database and found that approximately 1% of claims, corresponding to 536,943 treatment-seeking individuals, were linked to diagnosis codes associated with dysphonia. This evidence supports the argument that efficacious and effective therapies aimed at rehabilitating vocal function in patients with voice disorders can have significant benefits to the individual, the community, and the society at large. As such, the establishment of treatment efficacy for voice therapy approaches is critical to inform best practices for clinicians treating these problems.

Scholarly evidence has supported the efficacy of behavioral voice therapy approaches for a wide range of etiologies underlying voice disorders. Therapy approaches for hyperfunctional etiologies have been studied in a number of clinical trials, with significant treatment effects reported across studies. A number of systematic reviews reporting compilations of data from treatment studies have concluded that the clinical effects of voice therapy applied to hyperfunctional voice disorders are positive. The methodologic approaches to treatment across these studies, and the outcome variables used to assess treatment effects, have been variable. Although reports have demonstrated that voice therapy directly targeting imbalanced or abusive vocal use is superior to no therapy or indirect approaches, multiple authors have called for the need of future treatment studies to restrict the participant population and report a well-defined and scientifically controlled program of treatment. As evidence for the effectiveness of specific voice interventions continues to grow in the literature, greater specificity and control of the processes studied in those interventions will allow clinicians and clinical scientists to better understand which characteristics of specific interventions maximally impact vocal rehabilitation.

A number of voice therapy approaches are constructed in a systematic way, which has allowed their application to investigations using a rigorously controlled scientific methodology while retaining the theoretical constructs supporting the approaches. Examples include the Lee Silverman Voice Treatment for Parkinsonian hypophonia and vocal function exercises for hyperfunctional imbalance between the subsystems of voice production. Stretch-and-flow (SnF) voice therapy is another treatment approach used by clinicians to rehabilitate vocal function secondary to hyperfunctional etiologies. Also known as flow phonation, this approach was first described by Stone and Casteel in the early 1980s as Sn²F. A number of speech-language pathologists (SLPs) who were trained in this technique have gone on to use it as an approach in their clinical practices and have subsequently described, trained, or presented the structure of the approach to other professionals.
The fundamental target in SnF is to initiate volitional control over vocal subsystems, using voiced and unvoiced airflow stimuli, while maintaining a perception of minimal muscular effort during phonation. To achieve this goal, SnF instructs the patient to better control respiratory patterns for support of voice production, coordinate respiratory and laryngeal behavior in speech while focusing on oropharyngeal resonance, and reduce the overall physiological effort when phonating.

SnF is a structured physiological voice intervention characterized by a hierarchy of progressively challenging vocal tasks designed to rebalance the respiratory, phonatory, and resonatory subsystems of voice production. A unique characteristic of SnF is the use of voiceless sounds and words within the hierarchy of stimuli. By its nature SnF lends itself to scientific study through its goal-oriented requirements of progression through the systematic vocal hierarchy. Clinical experience in voice therapy illustrates the need for flexibility in the application of treatments based on the characteristics and needs of the client. However, the adherence to a scientific methodology when studying outcomes in voice therapy requires control of clinical procedures throughout the phases of treatment. As illustrated in Table 1, SnF is characterized by a hierarchy of vocal behaviors (horizontal axis) which must be demonstrated at a specific level of performance across an ascending gradient of challenging contexts (vertical axis). By establishing rigorous requirements for clinician instruction and client progression through the contexts and vocal behaviors, this approach can be scientifically controlled to study its effects on treatment-seeking populations.

Although SnF has been used clinically for some time, the evidence supporting the efficacy of SnF is sparse. Only one outcome study has empirically tested the treatment efficacy of SnF, although additional facilitative approaches were applied concurrently. McCullough et al. used SnF in a case series of six patients with primary muscle tension dysphonia without organic lesion. The authors used an eclectic approach by using SnF in combination with semioccluded vocal tract (SOVT) exercises. In addition, participants were asked to gargle water during the intervention. This combination of tasks was similar to those presented by Gartner-Schmidt in a case study. Results indicated that this eclectic intervention incorporating SnF had a significantly positive effect on auditory-perceptual measures of dysphonia severity and self-perceived vocal handicap. Although intervention effects could not be generalized to SnF separate from the inclusion of SOVT or gargling, the findings of the McCullough et al. study supported the need for additional studies investigating the clinical efficacy of SnF as a primary intervention approach.

The purpose of this study was to investigate the clinical effect of SnF on measures of vocal function and handicap in a treatment-seeking population diagnosed with hyperfunctional voice disorders. Specifically, we tested the following

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**TABLE 1.**

**Hierarchy of Stretch-and-Flow Voice Therapy, Across Levels and Stimuli**

<table>
<thead>
<tr>
<th>HIERARCHY</th>
<th>Stimuli</th>
<th>Degree of Muscle Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>H. Dialogue</td>
<td>c. Clinician</td>
<td></td>
</tr>
<tr>
<td>G. Read</td>
<td>b. Paragraphs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Sentences</td>
<td></td>
</tr>
<tr>
<td>F. Five words</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. Three words</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Two words</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. One word</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. Breathy phonation (vowel)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Voiceless</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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(least)......Degree of Muscle Activity......(most)

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hypotheses: SnF will lead to changes in (1) maximum phonation time, (2) s/z ratio, (3) cepstral peak prominence (CPP) in sustained vowels and connected speech, and (4) voice handicap index (VHI).19

METHODS
Participants
Eight participants were recruited from the treatment-seeking population of the authors’ clinical practices. Potential study participants were identified at the initial voice evaluations. Participant characteristics are listed in Table 2. The severity of dysphonia based on auditory-perceptual evaluation was not controlled in this investigation because this was a preliminary study for efficacy. Inclusion criteria for the study were as follows:

- Adult 18 years old or above.
- Diagnosis of primary muscle tension dysphonia without vocal fold lesion, or phonotraumatic lesions where hyperfunctional vocal behavior was the primary etiologic factor for which voice therapy was recommended as the first-line treatment.
- Diagnosis confirmed by speech-language pathologist via clinical voice evaluation and fellowship-trained laryngologist via assessment of laryngeal videostroboscopy.
- No prior history of voice therapy where SnF was used as a primary treatment approach for the duration of therapy.

Three certified SLP’s with experience treating voice disorders, including the application of SnF, administered the experimental treatment. Before enrolling the first participant, the SLP’s met as a group to formalize a consensus treatment protocol incorporating the SnF hierarchy as illustrated in Table 1 and described in the following.

Procedures
Pretreatment (baseline) recordings and measurements were obtained before the first treatment session. Before initiating SnF, the participant was educated regarding anatomy and physiology of the laryngeal mechanism and voice production in layman’s terms. They were then introduced to aspects of vocal hygiene, using the attached form as guideline (Appendix A). Vocal hygiene was not targeted during the treatment phase of the study. After this, the treatment approach of SnF was introduced. The criterion for advancement through the levels of SnF was standardized and set at 90% accuracy on 10 consecutive trials for the target vocal behavior at each level of the SnF hierarchy (A through H in Table 1), as judged by the clinician and perceptually verified by the participant. Homework consisting of exercises at the current skill level along with a tracking log was required of the participant to increase compliance (Appendix B). These were returned to the treating SLP at the next treatment session. The structure of SnF adhered closely to that reported by Gartner-Schmidt13 and Stone and Casteel,13 as illustrated in Table 1 and as follows:

Skill level 1: flow. The overall goal for this skill level was for the speaker to gain control over airflow. The speaker’s task was to elicit a steady flow of unvoiced air without effort through rounded lips (ie, prolonged, easy exhale), resulting in forward movement of a piece of tissue paper held in front of the mouth for visual feedback. This feedback technique is similar to that described by previous authors.13,15,18 Progression to the next level required 90% accuracy on 10 consecutive trials.

Skill level 2: stretch-and-flow. The goal for this skill level was production of voiceless airflow through the glottis along with slow (stretched out) movements of the articulators, while using minimal effort. The gesture elicited was effortless, whispered, connected speech at a reduced speech rate. Similar to skill level 1, a soft tissue was used as a form of visual feedback. Progression to the next level required 90% accuracy on 10 consecutive trials.

Skill level 3: stretch and voiced flow. The goal for this skill level was production of voiced airflow through the glottis along with slow (stretched out) movements of the articulators, while using minimal effort. The gesture elicited was breathy, effortless voice quality in connected speech at a reduced speech rate. Similar to skill levels 1 and 2, a soft tissue was used as a form of visual feedback. Progression to the next level required 90% accuracy on 10 consecutive trials.

Skill level 4: reduced stretch with increased flow. The goal for this skill level was production of voiced airflow through the glottis with a faster rate of speech, while maintaining minimal effort. The gesture elicited was effortlessly voiced but breathy speech associated with a normal rate. Progression to the next level required 90% accuracy on 10 consecutive trials.

Skill level 5: reduced air flow. The goal for this skill level was production of normal voice quality with an appropriate rate of speech, while maintaining minimal effort. The gesture elicited was perceptually appropriate conversational loudness with normal (nonbreathy) air flow, normal rate, and modal (natural for that person) fundamental frequency. Success at this skill level was defined as 90% accuracy on 10 consecutive trials.

### TABLE 2. Participant Demographics

<table>
<thead>
<tr>
<th>Participant</th>
<th>Gender</th>
<th>Age</th>
<th>Medical Diagnosis</th>
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<tbody>
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<td>1</td>
<td>F</td>
<td>25</td>
<td>VF polyp</td>
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<td>2</td>
<td>F</td>
<td>39</td>
<td>VF nodules</td>
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<td>3</td>
<td>F</td>
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</tr>
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<td>4</td>
<td>F</td>
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</tr>
<tr>
<td>5</td>
<td>F</td>
<td>55</td>
<td>MTD</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>74</td>
<td>MTD</td>
</tr>
<tr>
<td>7</td>
<td>F</td>
<td>47</td>
<td>MTD</td>
</tr>
<tr>
<td>8</td>
<td>F</td>
<td>59</td>
<td>MTD</td>
</tr>
</tbody>
</table>

Abbreviations: F, Female; VF, vocal fold; MTD, muscle tension dysphonia.
Measurement

Pretreatment data were obtained before the first treatment session, whereas posttreatment data were obtained within 2 weeks after the last (sixth) treatment session. Data were collected as follows:

1. Completion of the VHI
2. Producing maximum /a/, /s/ and /z/ prolongations
   a. Participants were instructed to: “Take a deep breath, and sustain the (vowel, consonant) as long as possible, until you run out of air.” Two repetitions of each sound were acquired using a digital timer and the longer maximum prolongation measure was used for data analysis. For /s/ and /z/, the longer prolongation measures were applied to the formula (s/z) to derive the s/z ratio. These measures represented respiratory-phonatory coordination along with the ability to control airflow.20,21
3. Producing sustained /a/ vowels for 3 to 5 seconds.
   a. Acoustic recordings (described in the following) were acquired while participants sustained the vowel /a/, prompted with the following instructions: “Take an easy breath, and sustain the vowel /a/ at a comfortable pitch and loudness, as steady as possible, until I say stop. I will say stop after about 5 seconds.” From the recorded vowel, measures of CPP were obtained. CPP is related to the periodicity and harmonic structure of the cepstrum, can be used as an indirect measure of vocal fold vibratory periodicity, and has been found to correlate well with perceptions of dysphonia.22-27 Larger values of CPP reflected greater periodicity in the cepstrum. For a detailed description of CPP, see Awan and Roy.25
4. Reading the sentence “We were away a year ago.”28
   a. Acoustic recordings were acquired while the participants read the sentence, taken from the stimulus used in the Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V). This sentence was chosen because it has been found in a number of studies to correlate well with auditory-perceptual ratings of dysphonia.24 Table 3 shows the pretreatment and posttreatment measures of the eight participants. Each outcome variable is also illustrated separately in Figures 1–5. Compared with pretreatment average measures, average VHI score reduced by 30 points, average s/z ratio reduced by 0.66 seconds, average maximum phonation time increased by 1.41 seconds, average vowel CPP increased by 1.72 points, and average sentence CPP increased by 1.28 points.

Statistical analysis

The treating clinicians obtained acoustic recordings but did not carry out the CPP calculation, which was performed separately by the first author. The files were presented in sequential order without identifiers. Five outcome variables were obtained during this study, which included (1) VHI score, (2) maximum vowel prolongation (MPT—in seconds), (3) s/z ratio, and (4 and 5) CPP from sustained vowel and connected speech. Paired t tests were applied to each variable, with the level of significance set at 0.05. Statistically significant outcomes were followed-up with effect size calculations using Cohen d (d = pretreatment mean – posttreatment mean/pooled standard deviation).

Reliability

Intermeasurer and intrameasurer reliability was calculated for CPP (in sustained /a/, and connected speech “We were away a year ago”) by randomly selecting 10% of the recorded files and remeasuring the stimuli. A Pearson product-moment correlation was applied to each paired data set. Measurement reliability was high for both inter and intrameasurer analyses, with all correlation coefficients (Pearson r) resulting in values greater than 0.96 (CPP-sustained vowel r = 0.98; CPP-connected speech = 0.96).

This study was approved by the Institutional Review Boards of Texas Christian University (IRB # 312–46) and UT Southwestern Medical Center (IRB# STU06212–103).

RESULTS

Table 3 shows the pretreatment and posttreatment measures of the eight participants. Each outcome variable is also illustrated separately in Figures 1–5. Compared with pretreatment average measures, average VHI score reduced by 30 points, average s/z ratio reduced by 0.66 seconds, average maximum phonation time increased by 1.41 seconds, average vowel CPP increased by 1.72 points, and average sentence CPP increased by 1.28 points.

Results of the paired-samples t tests revealed a statistically significant treatment effect (pretreatment vs posttreatment) for four of the five outcome measurements. VHI scores reduced significantly (t(7) = 3.78, P = 0.007), s/z ratio reduced significantly (t(7) = 2.73, P = 0.029), MPT increased significantly (t(7) = 3.28, P = 0.014), and measures of sentence CPP increased significantly (t(7) = 3.28, P = 0.014), and measures of sentence CPP increased significantly (t(7) = 2.47, P = 0.043). Effect sizes were calculated for the significant outcomes, and were found to be large for VHI and s/z ratio (d = 1.96 and 1.25, respectively), and moderate for MPT and sentence CPP (d = 0.79 and 0.74, respectively). Vowel CPP also changed in the direction of improvement, but the difference did not reach statistical significance.
The results of this small clinical efficacy study found statistically significant changes from pretreatment to posttreatment in four of five outcome measures. Each of the four significant outcome measures changed in the direction of improvement with a moderate to large effect size, suggesting a practical clinical effect. Posttreatment changes in VHI, s/z ratio, MPT, and sentence CPP reflected less perceived vocal handicap, greater control of airflow with voicing, and improved phonatory stability.

The VHI evaluates a patient’s self-perception of handicap resulting from a voice disorder and is widely used as a functional outcome measure from behavioral voice treatment in hyperfunctional and hypofunctional populations.\(^1\)\(^8\),\(^3\)\(^0\),\(^3\)\(^1\) The large 30-point difference in the mean pre- and posttreatment VHI scores in this study is similar in magnitude to that of McCullough et al.\(^1\)\(^8\), whose cohort experienced a posttreatment reduction of 39 points. These differences are substantially larger than the 18-point threshold for judgments of clinical effect using this measure.\(^1\)\(^9\) A primary target of SnF is control over airflow while maintaining a perception of minimal muscular effort during phonation. In the sample of participants studied in this investigation, we believe this physiological target promoted greater efficiency (improved functional output with reduced physiological effort) of voicing along with improvement in voice quality and thus reduced vocal handicap after 6 weeks of treatment. The degree to which VHI improves further with a greater frequency of treatment and/or longer duration of treatment will need to be investigated in further studies.

The s/z ratio was originally developed as an indicator of laryngeal pathology and purported to be influenced by glottal insufficiency due to midmembranous lesions.\(^2\)\(^0\). Some authors have since questioned the validity of the s/z ratio’s sensitivity to membranous pathology, suggesting that individuals with glottal lesions are able to compensate and control airflow for /s/ and /z/ such that maximum sustained duration is equivalent.\(^3\)\(^2\) It has been suggested that the clinical application of s/z ratio should be made with caution given uncertainties regarding the underlying causes of differences between /s/ and /z/ measurements.\(^3\)\(^2\),\(^3\)\(^3\) In our study, this measurement was not used as a diagnostic marker of midmembranous

### TABLE 3

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pre</th>
<th>Post</th>
<th>P</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHI</td>
<td>68.25 (13.7)</td>
<td>38.50 (16.6)</td>
<td>0.007</td>
<td>1.96</td>
</tr>
<tr>
<td>s/z</td>
<td>1.47 (0.44)</td>
<td>1.05 (0.18)</td>
<td>0.029</td>
<td>1.25</td>
</tr>
<tr>
<td>MPT</td>
<td>12.35 s (3.61)</td>
<td>15.49 s (4.33)</td>
<td>0.014</td>
<td>0.79</td>
</tr>
<tr>
<td>Vowel CPP</td>
<td>7.68 dB (2.9)</td>
<td>9.39 dB (1.5)</td>
<td>0.141</td>
<td>n/a</td>
</tr>
<tr>
<td>Sentence CPP</td>
<td>6.00 dB (2.2)</td>
<td>7.27 dB (0.9)</td>
<td>0.043</td>
<td>0.74</td>
</tr>
</tbody>
</table>

**Abbreviations:** VHI, voice handicap index; s/z, s/z ratio, MPT, maximum phonation time (in seconds [s]); CPP, cepstral peak prominence (in decibels [dB]); n/a, not available.

**FIGURE 1.** Box-and-whisker plot showing pretreatment and posttreatment measurement of VHI. Upper and lower borders of the shaded box represent the 75th and 25th percentiles, respectively, whereas the horizontal line within the shaded box represents the median.

**FIGURE 2.** Box-and-whisker plot showing pretreatment and posttreatment measurement of s/z ratio. Upper and lower borders of the shaded box represent the 75th and 25th percentiles, respectively, whereas the horizontal line within the shaded box represents the median.
pathology (e.g., presence vs absence of glottal lesion) but rather a treatment outcome variable related to control of airflow and voicing efficiency during phonation. Measures of s/z ratio decreased in the two participants with benign midmembranous vocal fold lesions and the six participants with muscle tension dysphonia without benign lesion. We believe s/z ratio was positively impacted because SnF targets the participants’ abilities to (a) control respiratory support by efficiently managing breathing cycles, (b) coordinate respiratory-laryngeal interactions during phonation for more efficient voicing, and (c) reduce the physiological level of effort in laryngeal musculature.

This study also found a significant clinical effect of SnF on MPT with sustained /a/. MPT increased on average across the eight participants by 3.13 seconds and corresponded to a medium effect size ($d = 0.79$). This increase paralleled the longest production of /z/, which is also voiced and showed an average pre- to posttreatment increase of 3.74 seconds. Other than a semiocclusion produced by lingual articulation for the /z/ sound, aerodynamic and phonatory control are similar for these phonemes when produced as a maximum prolongation task. We believe the effect of SnF on MPT was due to improvement in similar physiological control strategies resulting in a lower s/z ratio posttreatment, specifically controlling and coordinating respiratory-laryngeal motor activation along with reduced physiological effort.

The CPP is derived from the cepstrum, which itself is derived from the sound spectrum, and is the amplitude of the highest peak in the cepstrum relative to the expected amplitude as derived via linear regression. This statistic reflects the degree of regularity or periodicity in the voiced signal, with higher values reflecting greater phonatory periodicity. Unlike traditional time-based acoustic measures of jitter and shimmer, calculations of CPP can be validly measured from connected speech samples such as words and sentences and in clinical populations with a wide range of dysphonic severity. This measure has also been found to correlate well with auditory-perceptual impressions of dysphonia from vowels and connected speech. The increase in CPP in the present study suggests that SnF resulted in greater periodicity and less spectral noise (i.e., improved phonatory physiology) during production of connected speech. We believe SnF resulted in these physiological changes by improving the ability of the participants to regulate the activity of laryngeal muscles during phonation. Throughout the hierarchy of SnF, participants are required to generate muscle force in a graduated manner from low force contractions (slightly abducted vocal folds requiring...
activity of fewer motor neurons) to normal force contractions (adducted vocal folds with perception of minimal effort—requiring activity in a greater number of motor neurons). By improving control of laryngeal motor activation, participants were better able to negotiate the rapid muscular adjustments required in connected speech, which we suggest is related to the improvement of connected speech CPP measures in this study.

Although the pattern of change from pre- to posttreatment was similar in measures of CPP from connected speech and sustained vowels (Figures 4 and 5), we did not find a significant effect of SnF on vowel CPP. There are several possible explanations. The most important one may be the types of training stimuli used in the SnF hierarchy. As illustrated in Table 1, vowels are only targeted in a single stage, skill level 1. All other training targets are connected speech items. The greater specificity of SnF to connected speech may have influenced phonatory control mechanisms more positively in this context compared with sustained vowel production. An additional possibility lies within the increased variability in CPP exhibited between participants when producing sustained vowels. Although vowel CPP increased posttreatment, which is consistent with previously reported outcomes, the larger variability inherent in the data would necessitate a larger sample size to detect a statistically significant difference.34 Future studies are needed to investigate this supposition. Finally, it may be possible that CPP in connected speech is more sensitive to changes in phonatory periodicity in the current sample of eight participants. This sensitivity may be related to clinically important markers in the acoustic signal of connected speech, which differs from that of sustained vowels. These acoustic markers arise from a number of factors requiring alterations in phonatory physiology during connected speech, such as points of voicing onset and offset, the requirements of frequency amplitude adjustments due to intonation, and/or different requirements for aerodynamic control in connected speech.24,26 These physiological differences potentially support the role of acquiring clinical measurements in both sustained vowel and connected speech contexts, as speakers are likely using different strategies for controlling the vocal mechanism when producing a single sustained sound compared with dynamic vocal changes during connected speech.

There are several important limitations to this study. It was meant as a preliminary investigation to determine if larger controlled trials are warranted. Although a positive clinical effect was demonstrated in a small sample, larger studies will be needed to demonstrate the efficacy and effectiveness of SnF for patients with hyperfunctional voice disorders. Although we did not select for gender, all the participants happened to be female in this cohort, so we could not generalize the findings to males. We chose not to control for dysphonic severity or presence of benign lesions. As a result, the variability these factors may have introduced into the study could have influenced outcome measures. Future studies should attempt to control for these factors to further understand the impact of SnF in different populations and dysphonic speaker subgroups.

Additionally, this study did not include a control group, which will be needed to determine the effect of SnF separate from other factors, such as time or exposure to a voice evaluation.

To our knowledge this is the first study to use SnF as the primary treatment for participants with hyperfunctional voice disorders without using additional facilitative techniques (ie, SOVT or gargling). It is only the second prospective study reporting the effects of SnF using a scientific methodology in peer-reviewed literature. A larger clinical trial with a control group is in progress at our centers.

Acknowledgments

The authors would like to thank Kimberly Chachere-Coker for her assistance in helping to develop the clinical methodology used in this study and for her role as a clinical mentor for the SLPs in their application of SnF in this study. We would also like to thank Janis Deane for her support and participation throughout this study.

REFERENCES

APPENDIX A

Vocal hygiene guidelines

Hydration

- Your goal is 8 glasses (64 ounces) of water per day.
- Anything non-caffeinated counts as water (e.g., Gatorade, Sprite, juice, non-caffeinated herbal teas).
- Caffeine and alcohol are drying to the vocal folds. For every ounce of caffeine or alcohol you consume, add an extra amount of water (ounce for ounce) in addition to your 64 ounces.
- Decaffeinated tea and coffee has a small amount of caffeine, so neither one is a hydrating beverage.
- Add an extra glass of water for drying medications.
- Steam inhalation, OTC glycerin-based throat lozenges and sprays, and room humidifiers are methods of external hydration. Avoid menthol.

No smoking

- Also limit exposure to second-hand smoke

Avoid vocal abuses

- Do a hard, effortful swallow instead of throat clearing or coughing.
- Use a noisemaker or closer proximity instead of yelling or shouting.
- Limit voice use when you have an upper respiratory infection.
- Avoid talking over ambient noise.
- Do not sing out of your comfortable range.
- Limit character voices/impersonations/sound effects if this causes throat discomfort or hoarseness.
- Do not talk louder on the phone.

Vocal fatigue

- Take frequent 5-minute voice rest breaks throughout long periods of talking.
- Always warm-up and cool down your voice prior to and following heavy voice use (speaking or singing).
- Send emails instead of returning phone calls.

Behavioral anti-reflux regimen

- Common triggers for reflux include alcohol, caffeine, and spicy, acidic, or fatty foods
- Do not eat or drink 2 hours before bedtime.

- Eat small frequent meals instead of heavier meals.

APPENDIX B

Homework tracking form - “Practice” represents repetitions of the exercise

Home Practice Log

Step 1: Blow air out through pursed lips. Feel air at the lips and nothing in the throat.

<table>
<thead>
<tr>
<th>Day</th>
<th>Day</th>
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</tr>
<tr>
<td>Practice #1</td>
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</table>

Step 2: Blow air out through pursed lips and add a trace of voice to the airflow to make the sound extremely breathy—90% air and 10% voice.

<table>
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Step 3: Count one to 10, one word per breath, with no voice/open airflow OR with an extremely breathy voice (your therapist will indicate which one to practice). Stretch out the vowels of each word and slow the rate.

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Step 4: Count 1 to 10, two words per breath, with no voice/open airflow OR with an extremely breathy voice (your therapist will indicate which one to practice). Stretch out the vowels of each word and slow the rate.

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