## **Physiologic and Acoustic Effects of Opera Performance**

\*Paul E. Kwak, †C. Richard Stasney, †Jeremy R. Hathway, ‡Danielle Guffey, ‡Charles G. Minard, and

**§Julina Ongkasuwan,** \*Boston, Massachusetts, and †‡§Houston, Texas

**Summary: Introduction/Hypothesis.** Opera performance is physiological and emotional, and singing performers utilize their larynges in often strenuous ways. Historically, the training of a classical voice has been considered the paragon of healthy singing. However, the natural history of a performing larynx has not been studied systematically. There is paucity of scientific studies to guide practice patterns, particularly with regard to the course and extent of postperformance physiologic and acoustic changes.

Study Design. A prospective case series was carried out.

**Methods.** Principal singers in the Houston Grand Opera's 2012–2013 repertory were enlisted, for a total of seven singers. Stroboscopy was performed prior to the start of rehearsals, and at the completion of the opera's run. Data points included erythema, edema, masses or lesions, mucosal waveform, supraglottic posture; acoustic measurements were also performed.

**Results.** There were statistically significant differences (P < 0.05) in the mucosal wave on pre- and postperformance stroboscopic examinations. Acoustical measures did not achieve statistical significance, but there was a trend toward increased harmonic-to-noise ratio in postperformance measures, as well as decreased frequency range and reading  $F_0$ . Measures of intra- and inter-rater reliability indicated varying levels of intra-rater reliability, and generally poor interrater reliability.

**Conclusions.** This pilot study describes physiologic and acoustic changes that may occur over the course of a series of rehearsals and performances in the operatic larynx. In so doing, it highlights a need for larger studies with increased frequency of serial examinations to study in a systematized way what may be natural reactive changes that occur during performance.

Key Words: Professional voice–Stroboscopy–Acoustic measures of voice–Opera–Vocal performance.

#### INTRODUCTION

Opera fans are among the most impassioned of any devotees of any musical genre, their fervor fueled largely by the sonic wonder of a solitary human larynx trained to reach, unamplified, above an orchestra and chorus across space to the back of a cavernous hall. This most inspiring of artistic endeavors remains, simultaneously, the most athletic of challenges to the anatomy and physiology of the human larynx. In the evolution of operatic performance, an arguable pinnacle of which was described famously by Richard Wagner in 1849 in his vision of Gesamtkunstwerk (approximately, "total artwork"), in which the composer conceived opera, specifically, his expansive Ring cycle, as the summation of all arts,<sup>1</sup> more has been demanded of opera singers through each century. Vocal and theatrical exigencies translate into taxing demands on the microanatomy and gross physiology of the larynx. This notwithstanding, opera performance and the training of a classical voice has historically been

Address correspondence and reprint requests to Paul E. Kwak, Division of Laryngeal Surgery, Massachusetts General Hospital, One Bowdoin Square, 11th Floor, Boston, Massachusetts 02114. E-mail: pkwak@partners.org

Journal of Voice, Vol. 31, No. 1, pp. 117.e11-117.e16

0892-1997

considered the paragon of healthy singing, with its focus on breath support, dimension of tone, and minimizing of strain.

Medical understanding of the natural history of a performing larynx is based on decades of anecdotal observation and experience. However, a review of the literature indicates that the scientific studies to guide practice patterns are sparse. Both recent and more historic studies have worked to characterize the dynamic function of the larynx during singing, by analyzing supraglottic activity and posture, and by challenging ideas about what constitutes normal function versus hyperfunction during speaking and singing.<sup>2-4</sup> These studies have contributed to the idea that the singing voice comprises much more than the approximation and vibration of the vocal folds.

What remains missing, however, is knowledge about how these highly coordinated functions of the larynx and glottis, in fact, change the larynx and glottis over time, if at all. There is not yet reproducible evidence about the changes that occur either in the acute setting following a performance, or over the course of an operatic career. For example, it is often cited in informal conversation that vocal fold edema lasts 36–48 hours after an arduous performance, but there are no rigorous studies to support that time course.

This pilot study set out to begin to investigate what, if any, physiologic and acoustic changes happen over the course of operatic performance. Recognizing the enormous multiplicity of variables, ranging from an individual singer's anatomy and physiology, to variations in training and technique, to performance conditions, to influences of lifestyle and environment, the goals of this study were focused, and tailored to a small pilot cohort of elite singers over a specific period of time.

Accepted for publication March 7, 2016.

This study was presented at the American Laryngological Association's 2014 Spring Meeting at COSM in Las Vegas, Nevada, May 15, 2014.

Financial disclosures: None.

Conflicts of interest: None.

From the \*Division of Laryngeal Surgery, Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts; †Texas Voice Center, Houston Methodist Hospital, Houston, Texas; ‡Dan L. Duncan Institute for Clinical and Translational Research, Baylor College of Medicine, Houston, Texas; and the §Bobby R. Alford Department of Otolaryngology-Head and Neck Surgery, Baylor College of Medicine, Houston, Texas.

<sup>© 2017</sup> The Voice Foundation. Published by Elsevier Inc. All rights reserved. http://dx.doi.org/10.1016/j.jvoice.2016.03.004

#### MATERIALS AND METHODS

Principal singers in two of the productions from the Houston Grand Opera's 2012–2013 repertory productions were enlisted, for a total of seven principal singers. Stroboscopy was performed 1 week prior to the start of rehearsals, and 1 week following the completion of the performance period. All together, this represented 4 weeks of rehearsals and 2 weeks that included 7 performances.

At each examination, acoustic measurements were taken using the Multi-Dimensional Voice Program (MDVP). Singers were asked to read the standard "Marvin Williams" passage; the average F<sub>0</sub> was calculated from the first 10 seconds of this reading sample (rF<sub>0</sub>). They were then asked to phonate  $/\alpha/$ . They were then asked to sing  $/\alpha/$  at a comfortable pitch (sF<sub>0</sub>); during their postperformance testing, they were also asked to sing  $/\alpha/$  at the same sF<sub>0</sub>. Finally, they were asked to glissando on  $/\alpha$ / from their lowest to highest pitch and then again from their highest to lowest pitch. They then were asked to sing chromatically ascending and descending scales to the extremes of their ranges. The highest and lowest frequencies with stable phonation were recorded. All sustained tasks were sustained for 4-5 seconds and were repeated for a total of three tokens per task. The first 0.25 second of each token was then discarded and the following 3 seconds were analyzed; the analysis of the three tokens within each task was averaged using the Multiple Tokens Protocol within the MDVP program.

Stroboscopic examinations were performed by a single laryngologist (C.R.S.); singers were asked to phonate a sustained /i/ at the rF<sub>0</sub>. These examinations were reviewed by two laryngologists not involved in the performance of the examination. No identifying information was shown in the examinations, nor was sound heard. The two raters were blinded to the date of the examination as well, so that they were not aware whether the examination was recorded before or after the series of rehearsals and performances. All examinations were shown in a randomized order determined by computer-randomization software. Data points evaluated in stroboscopy included: (1) extent of erythema, (2) extent of edema, (3) presence of masses or lesions, (4) evaluation of mucosal waveform, (5) closure pattern, and (6) supraglottic posture.

The acoustic measures were summarized by means and standard deviations at initial and follow-up time points. Acoustic measures were compared pre- and postperformance for differences using Wilcoxon signed rank tests. Correlations between acoustic measures were evaluated both pre- and postperformance using Spearman rank correlation.

Stroboscopy measures were described for each rater pre- and postperformance. Changes in stroboscopy measures were described as improved, no change, or worsened using frequencies for both raters separately. Changes in stroboscopy measures were compared pre- and postperformance using McNemar's test or Bower's symmetry test for each rater. Agreement between the change in rater's ratings (worsen or not) was measured using a kappa statistic. Agreement within a rater's rating for an examination was measured using a weighted kappa statistic for erythema and edema (they have more than two levels) and a kappa statistic for the other stroboscopy measures. Statistical significance was assessed at the 0.05 level, and no adjustments were made for multiple hypothesis testing.

#### RESULTS

#### Stroboscopy data

When comparing pre-and postperformance stroboscopy measures, there is a significant worsening of mucosal waveform when measured by the first rater (P = 0.046) but not by the second rater. All kappa statistics comparing the two raters' ratings were less than 0.2, indicating poor agreement. Complete stroboscopy rating data from rater 1 is given in Table 1.

When comparing the readings of the examinations within a rater (assessing intra-rater reliability), rater 1 had higher kappa statistics than rater 2. Rater 1 had substantial agreement for erythema and lesions, moderate agreement for edema, supraglottic posture and mucosal waveform, and fair agreement for closure pattern. Rater 2 had moderate agreement for erythema and slight or poor agreement for all others (Figure 1).

### Acoustic data

There was a statistically significant change to lower frequency in the rF<sub>0</sub> (P = 0.047) pre- and postperformance. Although there were changes in the glissando and chromatic ranges in the low and high ends, these did not reach statistical significance. There was also a trend toward increased jitter in the rF<sub>0</sub> (P = 0.078) (Table 2).

#### DISCUSSION

One is constantly reminded in a study such as this one of the gulf between the summative art of a performance and the reductionist lens of laryngoscopic examination and acoustical measurement. It may never become possible to quantify or measure the effects of emotion or interpretation on the microanatomy of the singing voice, nor would such measures necessarily be desirable or even useful. The dearth of literature on the physiologic and acoustic effects of genre, is surprising, given the frequency with which singers seek out care and the window of insight that a highly trained, athletic singing voice would seem to provide into general principles of managing phonotrauma and high vocal demand.

The crux of the challenge may well be found in the gap between isolated, deconstructed larynxes that can be easily studied in the lab, and living, breathing, singing voices in humans on stage, which are much more difficult study. The extensive and innovative work of Titze and Jiang, through computer modeling and study of canine anatomy, has afforded insight into the biomechanics of phonotrauma. An oft-cited study by Gray and Titze in 1988 found in a canine model that hyperphonated vocal folds caused sloughing of the superficial epithelial layers of the vocal folds, as well as breakdown of the anchoring filaments in the basement membrane zone.<sup>5</sup> Indeed, histopathological investigations have generally established a model of injury and remodeling that underlies the development of pathologies like vocal fold nodules and polyps over time.<sup>6,7</sup> But the temporal relationships of these developments to a performance—what some Download English Version:

# https://daneshyari.com/en/article/5124332

Download Persian Version:

https://daneshyari.com/article/5124332

Daneshyari.com