Outcomes of Voice Rest after Microflap Surgery for Benign Vocal Fold Lesions

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OUTCOMES OF VOICE REST AFTER SURGERY FOR BENIGN VOCAL FOLD LESIONS

ABSTRACT

Background/Purpose

Research evidence regarding the efficacy of voice rest after microflap excision of benign vocal fold lesions is limited. This both results from and contributes to a lack of agreed-upon practice patterns regarding voice rest among physicians. Patients report decreased quality of life during voice rest. Basic science findings increasingly support vocal fold mobilization after the inflammatory phase of healing (3-5 days postoperatively). The purpose of the present study was to determine if longer durations of postoperative voice rest were associated with improved postsurgical outcomes.

Methods

Retrospective chart review of 74 patients (mean age of 43 years; 53% male, 47% female) who underwent direct microlaryngoscopy with microflap surgery to remove a nodule, polyp, or cyst between June 1, 2009 and May 31, 2014. Outcomes were measured by changes in total Voice Handicap Index (VHI) score and by changes in the stroboscopic parameters mucosal wave and closure.

Results

VHI scores improved by an average of 22.5 points after microflap surgery and voice rest. No statistically significant associations between prescribed or actual duration of voice rest and postsurgical outcomes were found. Patients who completed more preoperative voice therapy sessions were statistically more likely to complete more postoperative therapy sessions and to experience less improvement in VHI scores after surgery. Females completed more therapy sessions and experienced less improvement in VHI severity than males.

Conclusions

Microflap surgery is an effective treatment of benign vocal fold lesions. The efficacy of postoperative voice rest is still unknown and warrants a well-designed prospective study. Pre- and postoperative voice therapy, adherence, gender, and age may be relevant to patient outcomes.
INTRODUCTION

Benign Lesions

Phonotrauma, often referred to as vocal abuse or misuse, can lead to changes in the integrity of vocal fold tissue, and to the eventual formation of benign vocal fold pathology. The mechanical stresses to which the vocal folds are exposed during vibration are often held responsible for the clinical presentation of lesions such as vocal fold nodules, polyps, and cysts. Although these lesions are benign in nature, they can result in dysphonia, which has been associated with decreased patient quality of life (QOL). Thus, the primary focus of intervention often involves ameliorating voice quality to improve QOL. Many physicians favor a conservative approach, in which behavioral intervention (e.g., voice therapy) and treatment for concomitant diagnoses (e.g., gastroesophageal reflux) precede surgical intervention (Johns, 2003). When surgery is necessary, a microflap approach is often used, as described by Courey, Garrett, and Ossoff (1997), followed by a period of voice rest and post-operative voice therapy. The majority of physicians recommend anywhere between 4-14 days of absolute voice rest following vocal fold microsurgery (Johns, 2003).

Voice Rest

Voice rest requires the cessation of voice use to significantly reduce vocal fold motion for a predetermined duration. Voice rest is thought to promote healing by allowing for adherence of the mucosal cover and by reducing inflammation (Ishikawa & Thibeault, 2010). In contrast, some argue that vocal abuse after surgery may prolong inflammation, delay healing and adherence of the mucosa, and result in vocal fold scarring (Cho, Kim, Lee, Kim, & Park, 2000). Given that the primary goal of surgery for benign lesions is to improve voice quality, prolonged post-operative dysphonia secondary to suboptimal tissue healing is detrimental to outcome.

In recent years, a number of animal studies have been performed to better understand the time sequelae of vocal fold wound healing events. Branski, Rosen, Verdolini, and Hebda (2005) observed that
when the epithelium and lamina propria were completely denuded from the underlying vocalis muscle in rabbits, epithelial coverage was present as early as day 3 and complete by day 5. Kojima, Mitchell, Garrett, and Rousseau (2014) measured vibratory characteristics of the vocal folds in rabbits after microflap surgery, and reported that amplitude and symmetry of vibration approximated normal on days 3 and 5-7 post injury, respectively. Mitchell, Kojima, Wu, Garrett, and Rousseau (2014) compared wound healing after microflap surgery in rabbits that underwent no phonation to those that underwent phonation for 30 minutes. Acute inflammation subsided around post-microflap day 3, and phonation did not prolong the inflammatory phase. These findings appear to suggest that judicious vocal fold mobilization as early as days 3 and 7 after surgery may not have ill-fated consequences on the vocal fold wound healing process.

There is a significant lack of agreement in the literature regarding the clinical practice of voice rest. Voice rest falls into two broad categories: complete and relative. Complete voice rest is also referred to as absolute voice rest, or simply as voice rest. Relative voice rest is also described as voice conservation and voice restriction. This lack of agreement in the literature regarding terminology reflects a lack of consensus in clinical practice. Physicians do not agree that complete voice rest involves the total cessation of voice use (Coombs, Carswell, & Tierney, 2013). Behavioral recommendations during relative voice rest vary dramatically among physicians as well (Coombs et al., 2013; Koufman & Blalock, 1989). Common recommendations include avoidance of phonotraumatic behaviors such as speaking at increased volume or duration, singing, hard glottal attacks, throat clearing, coughing, whispering, and lifting heavy objects.

The type and duration of voice rest prescribed after microsurgery for benign vocal fold lesions is inconsistent. Behrman and Sulica (2003) reported that 51.4% of otolaryngologists in the United States would prescribe complete voice rest, that 30.2% would not, and that 18.4% may or may not, dependent on patient factors. In addition, 62.3% were very likely to prescribe relative voice rest, 18.2% were not,
and 19.5% may or may not. Notably, 15% responded that they would “never” prescribe either (Behrman & Sulica, 2003, p. 2183). (Survey responses in this study were not mutually exclusive; therefore, percentages total over 100%.) The most common duration for both types of voice rest was 7 days, with a range of 0-21 days. In the United Kingdom, Coombs et al. (2013) found that 46.3% of otolaryngologists preferred relative voice rest, 22.8% preferred first complete and then relative voice rest, and 22.2% preferred complete voice rest. Of those polled, 8.6% prescribed no voice rest after surgery to remove nodules, polyps, and cysts. With regard to duration, 34.3% prescribed 1-2 days of voice rest after surgery, 23.8% prescribed 3-5 days, another 23.8% prescribed 5-7 days, and 18.2% prescribed voice rest lasting more than 7 days. Surgeons with less experience were more likely to recommend shorter durations of voice rest.

The paucity of data supporting the efficacy of voice rest after vocal fold surgery is well-documented (Koufman & Blalock, 1989; Behrman & Sulica, 2003; Ishikawa & Thibeault, 2010). Koufman and Blalock (1989) attributed this gap in the literature to inconsistent recommendations regarding type and duration of voice rest, variable patient adherence to recommendations, and inconsistent diagnostic measures of voice disorders. They studied the effect of voice rest on prolonged postoperative dysphonia after vocal fold surgery. Prolonged dysphonia was defined as that lasting four or more weeks. The study included all lesions treated with mucosal resection of one or more vocal folds; of the 127 patients included, 54 had surgery to remove nodules ($n = 31$), polyps ($n = 19$), and cysts ($n = 4$). Patients were prescribed either complete or relative voice rest. Length of complete rest varied from 5-10 days, depending on the surgeon. Relative voice rest consisted primarily of limited speaking and avoidance of vocally harmful behaviors for 7-10 days. The type of prescribed voice rest did not influence patient outcomes, and the effect of voice rest duration was not reported in this study. However, both preoperative voice therapy and adherence to postoperative recommendations were associated with decreased postoperative dysphonia.
Diminished QOL during the rest period and low patient satisfaction with voice outcomes may affect adherence to voice rest. Rousseau et al. (2011) found that patients reported decreased QOL while on complete voice rest, and that this negative impact increased with duration. Patients with high baseline voice use (e.g., teachers, singers, and more talkative patients) were most adversely affected by voice rest, while patients over 60 years of age who were more likely to be retired were less adversely affected than those under 60. While on voice rest, patients reported difficulty communicating, fewer interpersonal interactions, restrictions in their personal and social lives, increased effort to get through the day, and feeling frustrated and handicapped. Behrman et al. (2008) observed that patients in a vocal hygiene program were largely dissatisfied: 77% were not satisfied with their voice after treatment, compared with 32% of patients who practiced resonant voice therapy at home for four weeks. The vocal hygiene group reported difficulty reducing both overall voice use and loudness level while responding to the functional demands of daily life. These reactions to voice rest may explain low patient adherence.

**Study Purpose**

Data regarding the efficacy of voice rest after surgical treatment of benign vocal fold lesions is limited. This lack of research evidence both results from and contributes to a lack of agreed-upon practice patterns regarding voice rest among physicians (Behrman & Sulica, 2003; Coombs et al., 2013; Koufman & Blalock, 1989). Patients report decreased QOL during complete voice rest (Rousseau et al., 2011). Basic science findings increasingly support vocal fold mobilization after the inflammatory phase of healing (Branski et al., 2005; Kojima et al., 2014; Mitchell et al., 2014). Therefore, a study examining the outcomes of postoperative voice rest is warranted. The purpose of the present study was to determine if longer durations of postoperative voice rest are associated with improved postsurgical outcomes.
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METHODS

Participants

This study was approved by the Vanderbilt University Institutional Review Board (#141014). A retrospective chart review was performed. Participants included all patients who underwent microflap surgery (CPT code 31545) at the Vanderbilt Voice Center to remove benign vocal fold lesions between June 1, 2009 and May 31, 2014. Inclusion criteria were as follows: primary diagnosis of nodules, polyps, or cysts; surgical excision of lesion using the medial microflap technique; and 18 years of age or over. Patients with concomitant medical and neurological diagnoses affecting voice at the time of surgery as judged by the attending physician were excluded.

Procedures

A search was conducted in StarPanel, Vanderbilt’s electronic medical record system, for all patients who met inclusion criteria. Data were collected and stored in the Research Electronic Data Capture (REDCap; Harris et al., 2009), a secure web-based application hosted at Vanderbilt University that was developed around HIPAA guidelines. Demographic data collected included age, gender, and occupation/avocation. Patients who self-identified as singers, teachers, coaches, or ministers/pastors were analyzed separately, as the functional vocal demands of these professions are high. Data regarding the history of the lesion included type of lesion (nodule, polyp, or cyst), surgeon, smoking status at the time of surgery, concomitant voice-related diagnoses at the time of surgery, and number of pre- and postoperative voice therapy sessions at the Vanderbilt Voice Center.

After vocal fold microflap surgery, most laryngologists at the Vanderbilt Voice Center recommend one week of complete voice rest until follow-up, two weeks of gradual incremental increase in voice use, and 2-3 months of speaking and/or singing intervention. The duration of complete voice rest was the focus of this study. Voice rest data captured from patient charts included prescribed duration, actual duration, and self-reported vegetative voice use, talking, or whispering during voice
rest. Prescribed duration of voice rest was determined from physician recommendations. Most patients were instructed to resume voice use at their first postoperative follow-up visit with their physician; therefore, in most cases, actual duration of voice rest was calculated from the date of that first follow-up visit. When physician or clinician notes indicated that the patient resumed voice use before the first follow-up appointment, the earlier date was used. In cases where physicians recommended voice rest “until follow-up,” the date of the first postoperative follow-up visit to the Voice Center was used to calculate both prescribed and actual duration of voice rest. Patient self-reported adherence to voice rest was recorded as well.

**Outcome Measures**

The outcome measures analyzed in this study were scores from the Voice Handicap Index (VHI; Jacobson et al., 1997) and clinician notes regarding two parameters of laryngeal videostroboscopy: mucosal wave and closure. At Vanderbilt, VHI and stroboscopic data were frequently not captured during the same clinic visits. Therefore, for each measure independently, the data available closest to the operative date before and after surgery were recorded. Outcome measures collected more than two months before or after surgery may not be relevant to the effectiveness of either the surgical procedure or to the postoperative healing period; therefore, only VHI and stroboscopic data collected within 60 days of the surgical date pre- and postoperatively were included in this study.

**Voice Handicap Index.** The VHI is a validated measure of patient self-perception of the functional, physical, and emotional impact of dysphonia on quality of life (QOL). Patients answer 30 questions on a 5-point Likert scale anchored by 0 and 4, representing “never” and “always,” respectively. Higher scores indicate a higher degree of self-perceived handicap and a more negative impact of dysphonia on QOL. The maximum total score is 120 points; a shift of 18 points is considered to be statistically and clinically significant. Because QOL is subjective, the best use of the VHI is to measure changes in a single patient over time (e.g., before and after treatment) (Jacobson et al., 1997).
Voice-related QOL measures provide information independent of both objective acoustic measures (Hummel, Scharf, Schuetzenberger, Graessel, & Rosanowski, 2010) and clinicians’ auditory perceptual ratings (Karnell et al., 2007). This is true in patients with benign vocal fold lesions as well (Behrman, Sulica, & He, 2004). In a review of evidence-based clinical voice assessment, Roy et al. (2013) recommended that both objective and subjective measures, including QOL measures, be used to supplement the use of laryngoscopy in a comprehensive voice assessment. Karnell et al. (2007) noted that “the patient’s perceptions of the effects of dysphonia on quality of life often drive the need for intervention” (p. 587). Given that dysphonia—particularly dysphonia associated with benign lesions—primarily affects not health but QOL, improved QOL may be considered the primary goal of intervention.

In addition, patient self-report measures are the primary outcome measures in Cochrane reviews of dysphonia treatment (Ruotsalainen, Sellman, Lehto, Isolato, & Verbeek, 2007; Ruotsalainen, Sellman, Lehto, Jauhiainen, & Verbeek, 2007). The total VHI score of patients with polyps and cysts decreases an average of 25 points after microflap surgery (Johns, Garrett, Hwang, Ossoff, & Courey, 2004; Rosen, Murry, Zinn, Zullo, & Sonbolian, 2000). There are, however, no studies of the effect of variations in voice rest after phonomicrosurgery on VHI scores. In the present study, complete VHI data included a total score as well as scores on the physical, functional, and emotional subscales.

**Laryngeal Videostroboscopy.** Visualizing the larynx allows laryngologists and speech-language pathologists (SLPs) to analyze the structure and function of the vocal folds during a variety of phonatory tasks. Laryngeal endoscopy is effective in detecting the presence and nature of voice disorders, and is recommended as a primary assessment tool (Roy et al., 2013). Stroboscopy, in which the endoscope contains a strobe light that creates the illusion of slower rates of vibratory cycles, allows for detailed analysis of vocal fold vibration and more accurate diagnoses than laryngoscopy without a strobe light (Woo, Casper, Colton, & Brewer, 1994). Vocal fold nodules, polyps, and cysts present with distinct stroboscopic signs, allowing for accurate diagnoses of the presence of benign lesions and their effect on
vocal function (Johns, 2003). At Vanderbilt, vocal fold movement during stroboscopy is described using six parameters. The present study focuses on two parameters: mucosal wave and closure. Data were extracted from extant notes by the clinician who performed stroboscopy at the time of the patient’s presentation to the Voice Center.

Mucosal wave, or the shimmering, wave-like lateral movement of the mucosa over the superior surface of the vocal folds, is an indicator of tissue health. Mucosal wave should reach 50% of the width of a healthy vocal fold (Poburka, 1999). Patients with benign lesions associated with partial absence of mucosal wave may be more likely to require surgery (Colton, Woo, Brewer, Griffin, & Casper, 1995). Postoperatively, scarring or edema may result in reduced or absent mucosal wave (Woo et al., 1994). For the purpose of analysis, mucosal wave may be classified as normal/abnormal (Behrman et al., 2004) or present/absent (Courey et al., 1997). In the present study, mucosal wave was classified as normal/abnormal. Only mucosal wave that was normal across the entire surface of both true vocal folds at modal pitch, including the lesion site, was considered normal.

Vocal fold closure is defined as the shape created by the edges of the true vocal folds at maximum adduction. Closure is crucial to maintaining the balance between respiration and phonation required for efficient use of air during voicing. An irregular configuration may be more likely to result in surgery for patients with benign lesions (Colton et al., 1995). Other common glottic closure configurations in this population are hourglass, anterior gap, and posterior gap (Behrman et al., 2004; Courey et al., 1997; Zeitels, Hillman, Desloge, Mauri, & Doyle, 2002). Postoperatively, incomplete excision or recurrence of the lesion may result in incomplete closure (Woo et al., 1994). Closure data may be summarized for analysis as complete/incomplete (Behrman et al., 2004; Courey et al., 1997). In the present study, closure was classified as complete/incomplete. Only closure described as complete or complete with a small posterior gap at modal pitch was considered complete.

**Statistical Analysis and Data Interpretation**
Data were analyzed using SPSS (IBM Corp., 2013). Normal distributions of data could not be assumed given the small sample size, so non-parametric tests were conducted. To assess the differences between outcome measures before and after surgery, the Wilcoxon signed-rank test or related samples McNemar test was used. Spearman correlation was used to assess associations between continuous variables, and chi-square to assess associations between categorical variables. The Mann-Whitney U test and Kruskal-Wallis H test were used to assess associations between categorical and continuous variables. The alpha level was set at .05 to determine significance.
RESULTS

The electronic medical records of 252 patients treated at the Vanderbilt Voice Center between June 1, 2009 and May 1, 2014 included CPT code 31545 (direct microlaryngoscopy with microflap). Of these, 125 did not complete surgery, had operative dates outside the target range, or underwent concomitant surgical procedures, such as CO2 laser excision of varices. Of the remaining 127 patients, 53 were excluded for the presence of lesions other than nodules, polyps, and cysts, such as granulomas or squamous cell carcinomas. A total of 74 patients underwent direct microlaryngoscopy with microflap (CPT code 31545) to remove a nodule, polyp, or cyst between June 1, 2009 and May 31, 2014. This is the largest cohort of postoperative voice rest patients in a retrospective review to date. Patients’ mean age was 42.96 years (SD = 12.46; range = 18-72). Gender distribution was roughly equal (53% males; 47% females). Most patients (89%) were not current smokers. Roughly half of the sample (46%) included singers, teachers, coaches, or ministers. Some patients fulfilled two of these roles, such as choir teachers, music ministers, and a substitute teacher/gymnastics instructor. Almost three-quarters of the lesions excised were polyps (72%), 24% were cysts, and 4% were nodules; this is in keeping with the Voice Center’s standard practice of behavioral, rather than surgical, intervention for nodules.

Voice Rest Patterns

As expected, most patients (82%; n = 61) were prescribed one week of postoperative voice rest (Figure 1). One physician routinely prescribes 14 days of postoperative rest, rather than 7; this accounts for 8% (n = 6) of the sample.
One patient was instructed to adhere to complete voice rest for 3 days, and then voice conservation until follow-up. Two were prescribed complete voice rest for 5 days, and then voice conservation until follow-up. The remainder of the patients were instructed to adhere to complete voice rest “until follow-up,” which occurred on postoperative day 5, 6, 8, or 9.

The duration of actual voice rest was more normally distributed (Figure 2). Most patients were instructed to resume voice use at their first postoperative visit, accounting for many of the patients who completed 5, 6, 8, and 9 days’ actual voice rest.
Of the six patients who were prescribed 14 days of complete voice rest, five resumed speaking at the first follow-up visit on postoperative day 13. One was advised to continue complete voice rest until a second follow-up at day 18 due to poor outcome in terms of tissue healing.

A Spearman’s rank-order correlation found a strong positive correlation between prescribed and actual duration of voice rest, which was statistically significant ($r_s = .61; p < .001$; Figure 3). This finding indicates that most patients are judged safely able to resume voice use at the first postoperative follow-up visit, which is scheduled according to the physician’s voice rest recommendation.
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Figure 3. Scatterplot for prescribed versus actual voice rest duration
\((N = 74; r_s = .61; p < .001)\).

Voice Therapy

The majority of patients completed 0-2 voice therapy sessions both before and after surgery.

Preoperatively, 40% of patients completed one voice therapy session at Vanderbilt, and 30% completed none (Figure 4). Postoperatively, 28% of patients completed one voice therapy session at Vanderbilt, 27% completed two sessions, and 22% completed none (Figure 5).
Figure 4. Raw data of preoperative voice therapy sessions ($N=74$).

Figure 5. Raw data of postoperative voice therapy sessions ($N=74$).
A Spearman’s rank-order correlation demonstrated a moderate positive correlation between preoperative and postoperative voice therapy sessions, which was statistically significant ($r_s = .45; p < .001$; Figure 6). In other words, patients who completed more preoperative voice therapy sessions at Vanderbilt were statistically more likely to complete more postoperative voice therapy sessions.

A Mann-Whitney $U$ test revealed that females attended more preoperative ($U = 374.5; p < .001$; Figure 7) and postoperative ($U = 421.5; p = .004$; Figure 8) voice therapy sessions at Vanderbilt than males. Males completed a median of one preoperative ($M = .79; SD = .89$) and one postoperative ($M = 1.23; SD = 1.06$) voice therapy session. In contrast, females completed a median of two preoperative ($M = 2.45; SD = 2.93$) and two postoperative ($M = 2.37; SD = 1.86$) therapy sessions.
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Figure 7. Raw data of preoperative voice therapy sessions across males ($n = 39$; $Mdn = 1$; $M = .79$; $SD = .89$) and females ($n = 35$; $Mdn = 2$; $M = 2.45$; $SD = 2.93$).

Figure 8. Raw data of postoperative voice therapy sessions across males ($n = 39$; $Mdn = 1$; $M = 1.23$; $SD = 1.06$) and females ($n = 35$; $Mdn = 2$; $M = 2.37$; $SD = 1.86$).
Outcome Measures

**Voice Handicap Index.** The medical records of 25 patients contained complete VHI scores within 60 days of surgery both pre- and postoperatively. The average preoperative VHI survey was administered 18.08 days before surgery (SD = 15.58; range = 1-50). The average postoperative VHI survey was administered 24.80 days after surgery (SD = 9.98; range = 6-41).

A Wilcoxon signed-rank test revealed a statistically significant change in total VHI scores in patients with benign vocal fold lesions after microflap surgery and postoperative voice rest (Z = -3.74, p < .001). Median total VHI score significantly decreased from 56 pre-treatment to 34 post-treatment (Figure 9).

Thirteen of 25 patients (52%) had a clinically significant 18-point decrease in total VHI score after surgery. The remaining 12 (48%) had a change in total VHI within +/- 17 points. That is, there was not a clinically significant change according to the criteria set by Jacobson et al. (1997). No patients
experienced an increase in total VHI score that was 18 points or higher, that is, a clinically significant increase in voice handicap.

No significant associations were found between changes in VHI total score and prescribed or actual duration of voice rest. No significant associations were found between changes in total VHI score and reported voice behaviors during voice rest, age, lesion, surgeon, smoking, or occupation/avocation. There was a moderate positive correlation between number of preoperative voice therapy sessions and change in total VHI score according to a Spearman’s rank-order correlation, which was statistically significant ($r_s = .40; p = .049$; Figure 10). A more negative change in VHI score indicates a greater reduction in self-perceived voice handicap. These data, therefore, suggest less improvement after microflap surgery for patients who complete more preoperative voice therapy sessions.

![Figure 10. Scatterplot for preoperative voice therapy sessions versus change in total VHI score ($n = 25; r_s = .40; p = .049$).](image)

There was also a moderate positive correlation between postoperative voice therapy sessions and change in total VHI score ($r_s = .47; p = .017$; Figure 11). This correlation indicates less improvement within patients who completed more postoperative therapy sessions.
Figure 11. Scatterplot for postoperative voice therapy sessions versus change in total VHI score \((n = 25; r_s = .47; p = .017)\).

In the patients with complete VHI data \((n = 25)\), there was a strong positive correlation between pre- and postoperative voice therapy sessions \((r_s = .72; p < .001)\), compared with a moderate positive correlation in the full group of patients who had microflap surgery to remove benign lesions \((N = 74; r_s = .45; p < .001)\). Patients in the VHI group completed slightly more voice therapy sessions both pre- and postoperatively than all microflap patients. The mean number of therapy sessions was 2.24 preoperatively in the VHI group \((SD = 3.15)\), compared with 1.58 \((SD = 2.25)\) in all patients.

Postoperatively, patients in the VHI group completed an average of 2.28 voice therapy sessions \((SD = 1.72)\), compared with 1.77 \((SD = 1.58)\) in all patients.

The Vanderbilt Voice Center classifies the severity of total VHI score as follows: normal (0-9), mild (10-39), moderate (40-59), and severe (60-120). Preoperatively, no patients’ scores placed them in the normal range, 20% were mild \((n = 5)\), 40% were moderate \((n = 10)\), and 40% of patients were severe \((n = 10)\). Postoperatively, 8% of patients were normal \((n = 2)\), 52% were mild \((n = 13)\), 36% were moderate \((n = 9)\), and one patient was severe (4%) \((Figure 12)\).
Figure 12. Raw data of number of patients classified by severity of total VHI score pre- and postoperatively (n = 25).

The majority of patients (72%) improved by one level or remained at the same severity after surgery and voice rest. One patient (4%) improved by three steps in severity, that is, from severe to normal. Five (20%) improved by two levels (severe to mild or moderate to normal). Nine (36%) improved by one step (severe to moderate, moderate to mild, or mild to normal). Nine (36%) more did not improve. One patient (4%) experienced an increase in VHI severity from mild to moderate; however, her score increased by 10 points, below the 18-point criterion for clinical significance according to Jacobson et al. (1997). Figure 13 displays changes in VHI severity level in all 25 patients.
Figure 13. Raw data of number of patients who experienced changes in VHI severity as classified by the Vanderbilt Voice Center ($n = 25$).

Figure 14. Raw data of number of patients who experienced changes in VHI severity as classified by the Vanderbilt Voice Center across males ($n = 12$) and females ($n = 13$).

Figure 14 classifies change in severity by gender. Males were more likely than females to make larger improvements in VHI severity. This was statistically significant according to a chi-square test ($\chi^2 (4, N =$
There was no significant difference between genders in raw change in total VHI score or the likelihood of an 18-point improvement pre- and postoperatively.

**Laryngeal Videostroboscopy.** The medical records of 47 patients contained notes regarding mucosal wave and closure within 60 days of surgery both pre- and postoperatively. The average preoperative stroboscopy with mucosal wave and closure notes was conducted 21.81 days before surgery ($SD = 15.61$; range = 0-50). The average postoperative stroboscopy with mucosal wave and closure notes was conducted 7.32 days after surgery ($SD = 1.77$; range = 5-13).

In clinician notes, descriptors of mucosal wave classified as normal included “WNL” (i.e., within normal limits), “WFL” (within functional limits), “grossly” WNL or WFL, “present,” and “obvious.” All others were classified as abnormal. Descriptors of abnormal mucosal wave included “reduced,” “minimal,” “absent,” “adynamic,” “not obvious,” emerging,” and “excessive” across all or a portion of either true vocal fold. Descriptors of glottic closure that were classified as complete included “complete,” “complete with posterior gap,” “complete with posterior chink,” and “small posterior chink.” Descriptions that were classified as incomplete included “incomplete,” “hourglass,” “possible bowing,” and “anterior slit” or “gap.” “Small posterior gap” was classified as complete, and “large posterior gap” and “posterior gap” were classified as incomplete.

No patients had both normal mucosal wave and closure preoperatively. Postoperatively, both parameters were judged normal in 9% of patients ($n = 4$). Mucosal wave was abnormal in 96% of patients preoperatively ($n = 45$) and 83% of patients postoperatively ($n = 39$; Figure 15).
Figure 15. Raw data of mucosal wave properties pre- and postoperatively ($n = 47$).

The pre- and postoperative difference in mucosal wave was not statistically significant according to a related-samples McNemar test. The classification of most patients’ (79%; $n = 37$) mucosal wave did not change postoperatively; that is, abnormal mucosal wave was still abnormal postoperatively (Figure 16).

Figure 16. Percentage of change in mucosal wave after microflap surgery ($n = 47$).
No patients with normal preoperative mucosal wave had normal mucosal wave after surgery. Mucosal wave changed from abnormal to normal in 17% of patients \((n = 8)\), and from normal to abnormal in 4% of patients \((n = 2)\) postoperatively.

Glottic closure was incomplete in 77% of patients preoperatively \((n = 36)\) and 74% of patients postoperatively \((n = 35; \text{Figure 17})\).

The pre- and postoperative difference in closure was not statistically significant according to a related-samples McNemar test. The classification of most patients’ \((70\%; n = 33)\) closure did not change postoperatively. In other words, complete closure before surgery was complete after surgery, or incomplete closure was still incomplete postoperatively \((\text{Figure 18})\).
After surgery, closure changed from incomplete to complete in 17% of patients \((n = 8)\), and from complete to incomplete in 13% of patients \((n = 6)\).

There were no significant associations between preoperative mucosal wave and preoperative closure or postoperative mucosal wave and postoperative closure. There were also no significant associations between changes in mucosal wave or closure and prescribed or actual duration of voice rest, vegetative voice use or talking during voice rest, or any confounding variables. Despite a low number of patients who reported whispering \((n = 2)\), a chi-square test revealed that patients who whispered during voice rest were statistically less likely to improve from abnormal to normal mucosal wave \((\chi^2 (2, N = 47) = 10.85; p = .004; \text{Figure 19})\).
The medical records of 19 patients had complete data for both VHI scores and target stroboscopic parameters within 60 days of surgery. Patients whose mucosal wave improved from abnormal to normal had a larger median improvement in total VHI score (Figure 20).
Figure 20. Change in total VHI score in patients with negative change in mucosal wave (normal to abnormal; n = 0), no change (abnormal to abnormal; n = 16; Mdn = -19.5; M = -22.44; SD = 22.66), and positive change (abnormal to normal; n = 3; Mdn = -50; M = -51.33; SD = 16.05).

This approached statistical significance according to a Kruskal-Wallis H test ($\chi^2 (1, N = 19) = 3.84; p = .050$). Median change in total VHI was -50 ($n = 3; M = -51.33; SD = 16.05$) in the group with a positive change in mucosal wave, compared with -19.5 ($n = 16; M = -22.44; SD = 22.66$) in the group with no change. Both patients whose glottic closure improved from incomplete to complete, and those whose closure changed from complete to incomplete, had a larger median improvement in total VHI score than patients whose closure did not change postoperatively (Figure 21).
Figure 21. Change in total VHI score in patients with negative change in glottic closure (complete to incomplete; \( n = 3; Mdn = -50; M = -45.67; SD = 8.39 \)), no change (complete to complete or incomplete to incomplete; \( n = 13; Mdn = -12; M = -16.46; SD = 17.69 \)), and positive change (incomplete to complete; \( n = 3; Mdn = -68; M = -54.00; SD = 29.60 \)). As with mucosal wave, this approached statistical significance according to a Kruskal-Wallis \( H \) test (\( \chi^2 (2, N = 19) = 5.79; p = .055 \)). Median change in total VHI score was -68 in the group with a positive change in glottic closure (\( n = 3; M = -54.00; SD = 29.60 \)); -50 in the group with a negative change (\( n = 3; M = -45.67; SD = 8.39 \)); and -12 (\( n = 13; M = -16.46; SD = 17.69 \)) in the group with no change.

Adherence

For 9% of the sample (\( n = 7 \)), there was no self-reported adherence to voice rest recorded in the chart. For another 66% (\( n = 49 \)), adherence was recorded using qualitative descriptors. For another 24% (\( n = 18 \)), percent adherence was estimated. One patient reported his adherence as “fair.” A quarter of the sample (23%; \( n = 17 \)) reported that their adherence was “strict,” “complete,” or “total”; or estimated 100%. All others reported that they were “compliant,” “adherent,” or “observant”; “very,” “largely,” “essentially,” or “mostly” compliant or adherent; or estimated a percentage between 85% and 99%. In addition to estimated adherence, some patients reported specific behaviors that adduct the
vocal folds or disturb the mucosal cover during voice rest. Eighteen (24%) reported coughing, throat clearing, or vomiting; two (3%) reported whispering; and seven (9%) reported talking. A Mann-Whitney U test showed that patients who reported talking during voice rest had a higher median age than patients who did not; this was statistically significant ($U = 108.5; p = .020$; Figure 22).

*Figure 22.* Age (years) in patients who reported talking during voice rest ($n = 7; Mdn = 53; M = 51.57; SD = 6.08$) and those who did not ($n = 67; Mdn = 40; M = 42.06; SD = 12.64$).

Patients who reported talking had a median age of 53 years ($M = 51.57; SD = 6.08$), compared to 40 years ($M = 42.06; SD = 12.64$) in those who did not report talking during voice rest.
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DISCUSSION

The results of this study provide support for the effectiveness of microflap surgery and voice rest for vocal fold polyps and cysts. The mean decrease in total VHI score was 22.5 postoperatively. Johns et al. (2004) found that total VHI score decreased by a mean of 25 in patients with cysts and 25.7 in patients with polyps after microflap surgery and 1-2 weeks of voice rest. Rosen et al. (2000) observed a mean decrease of 25 in patients with polyps and cysts, although duration of postoperative voice rest was not discussed. In the present study, duration of complete voice rest ranged from 3-18 days. No significant associations were found between duration of voice rest and either VHI or stroboscopic outcomes.

No statistically significant improvement was found in either mucosal wave or closure after microflap surgery and voice rest. A total of 18% experienced a change in mucosal wave from abnormal to normal postoperatively, and a different 18% experienced a change in glottic closure from incomplete to complete. Only 3 out of 47 patients (6%) experienced a positive change in both parameters simultaneously. This is in contrast to the postoperative improvement described in previous studies. Courey et al. (1997) found that, after microflap surgery, mucosal wave was preserved where present and restored in patients for whom it was absent preoperatively, and that incomplete closure became complete in 82% of patients. In a study of phonomicrosurgery for benign lesions in vocal performers, Zeitels et al. (2002) observed that mucosal wave and closure both “dramatically improved” (p. 33) after surgery.

The difference between results of the present study and the extant literature may be attributed to low reliability of stroboscopic data. Even when rated prospectively, reliability of stroboscopic ratings is low without multiple independent raters (Poburka & Bless, 1998; Teitler, 1995). Reliability may be especially low for dynamic parameters such as mucosal wave (Yiu, Lau, Ma, Chan, & Barrett, 2014). In the present study, data were gathered from extant notes created by one of nine possible raters, each of
whom described stroboscopic parameters slightly differently. Some clinicians focused on the presence of mucosal wave, and some focused on normalcy. Some simply described glottic closure as incomplete, and some further described the shape created by the free margins of the vocal folds. These descriptions were then classified using all-or-nothing criteria. Therefore, reliability of the stroboscopic parameters as reported here is very low, and results of the current analysis should be considered preliminary, even if statistically significant. In a prospective study, stroboscopic videos should be reviewed in pre/post pairs by a panel of expert raters, who should use a consistent rating methodology to quantify stroboscopic parameters. Whether a formal rating scale such as the Stroboscopy Examination Rating Form (SERF; Poburka, 1999), a binary distinction such as normal/abnormal, or some other agreed-upon set of descriptors is used, it should be noted for each parameter whether the postoperative video represents an improvement from the preoperative video. In a multi-center study, clinicians should rate videos from the other site, or clinicians at both sites should rate all videos, to ensure that a significant portion of raters had not personally treated each patient.

The present study revealed a positive correlation between number of pre- and postoperative voice therapy sessions. That is, patients who completed more preoperative voice therapy sessions required more postoperative therapy sessions. More therapy sessions were associated with less improvement in total VHI score postoperatively. This is in contrast to the findings of Koufman and Blalock (1989), who observed that preoperative voice therapy was associated with improved postoperative outcomes. It is possible that patients who required more therapy had a more intractable functional dysphonia overlay in addition to the lesion. This could include more deeply ingrained phonotraumatic behaviors or more extralaryngeal tension and strain during habitual voice production. Females attended more pre- and postoperative therapy sessions than males, and were more likely to report smaller changes in VHI severity. However, females did not improve less than males as measured by raw change in total VHI score or the likelihood of a clinically significant 18-point improvement. It is
possible that males were more likely to benefit from surgical treatment of the lesion alone, while females were more likely to present with functional dysphonia in addition to the lesion and therefore to require longer behavioral treatment in addition to surgery; this point certainly merits further study. However, the number of pre- and postoperative therapy sessions skewed higher in the VHI group ($n = 25$) than in the full microflap group ($N = 74$). It is likely that VHI data were gathered during patients’ visits to the Voice Center for therapy. Future studies should more consistently capture VHI data from patients who do not attend voice therapy. In addition, this retrospective chart review was approved by the IRB as an exemption, and the demographic information that could be recorded was limited. Future prospective studies should capture patients’ cities of residence, to determine their distance from the Voice Center; insurance information, to determine any financial explanation for patients who do not attend voice therapy; and the number of therapy sessions completed at outside health facilities. These external factors may influence the number of therapy sessions completed at the Voice Center. Future studies should also include documentation of extralaryngeal tension, such as degree of ventricular hyperfunction, visible recruitment of strap muscles during phonation, and patient report of pain on palpation of the submental musculature or thyrohyoid space.

The preliminary finding that patients who require more treatment sessions pre- and/or postoperatively may have poorer postsurgical outcomes may be used to improve clinical practice. It may be prudent to delay surgery until a healthy balance of respiration and phonation can be established in voice therapy. The voice therapist can set an expectation for the patient’s best possible voice with the lesion, helping the patient give him- or herself permission to be perceptually rough or breathy, and perhaps reducing strain and “pressing” to produce a target sound. The focus of therapy should then be on reducing extralaryngeal tension and patient reports of effort during voicing, not necessarily on reducing dysphonia. Clinicians can also manage patient expectations that surgery will “cure” their voice.
disorder, explaining that prolonged postoperative voice therapy may still be necessary unless habitual voice production, vocal hygiene, and functional voice demands can be improved preoperatively.

A potential association was found between whispering during voice rest and poorer mucosal wave outcomes. Most patients demonstrate more severe supraglottic hyperfunction when whispering than when speaking (Rubin, Praneetvatakul, Gherson, Moyer, & Sataloff, 2006). Thus, whispering would likely be counterproductive in patients with hyperfunctional dysphonia as a contributor to or result of a benign lesion. In addition, at least part of the vocal folds make contact in most patients during whispering, an inverted Y being the most common configuration (Rubin et al., 2006). Whispering involves producing frication at the level of the vocal folds. Higher translaryngeal airflow rates have been found during whispering than during speaking (Stathopoulos, Hoit, Hixon, Watson, & Solomon, 1991). Therefore, whispering may disrupt the delicate layered structure of the vocal folds as they are healing postoperatively. The effect of whispering during voice rest is an area that merits further investigation.

The present study revealed a possible association between improvement in total VHI score and improvements in both mucosal wave and closure. Uloza, Vegiené, and Šaferis (2013) found correlations of $r = .52$, .63, and .65 between total VHI score and deviance from normal in mucosal wave on the healthy side, mucosal wave on the affected side, and glottal closure, respectively. Simultaneous improvement in more than one outcome measure makes intuitive sense: as stroboscopic parameters of the vocal folds improve, patients are likely to perceive a decrease in the effect of dysphonia on their quality of life. Patients with glottic closure that changed from complete to incomplete postoperatively also demonstrated more improvement in total VHI than patients whose closure did not change. This is likely a result of the current study’s methodology. Closure was complete for 3 patients with both VHI and stroboscopic data preoperatively. For one of these, preoperative closure was complete secondary to ventricular hyperfunction that was not mentioned in the postoperative stroboscopic exam. It is possible that hyperfunction was reduced or eliminated during treatment, leading to improved VHI scores and
reduced closure simultaneously. For another patient, preoperative closure was complete with an occasional anterior and posterior slit. This was interpreted as complete for a majority of the vibratory cycle of the vocal folds and therefore classified as complete; perhaps there are more effective methods to use for interpretation to reduce the amount of error.

Due to the variety of types of adherence data recorded in patients’ charts, it was not possible to determine an association between adherence to voice rest and VHI or stroboscopic outcomes in the present study. Adherence to physician recommendations is an important factor in postoperative outcomes, based on Koufman and Blalock’s findings (1989). They observed that 76.4% of patients adhered to both complete and relative voice rest after surgery, based on a definition of adherence as the presence or absence of specific behaviors. However, this methodology involved a degree of inferring adherence from voice outcomes (e.g., stable voice data from visit to visit) rather than patient self-report or voice dosimetry. Rousseau et al. (2011) found that 42.5% of postsurgical patients adhered to complete voice rest, defined as a response of “never” to the statement “I used my voice while on voice rest.” In other words, patients who reported speaking even once during voice rest were considered nonadherent. However, Rousseau et al. (in press) later observed that patients were in fact largely adherent to postsurgical voice rest. During the 7 days immediately preceding surgery, patients reported average daily voice use of 70-90%. While on complete voice rest for 7 days postoperatively, patients reported daily voice use of 0-4%. Voice use was calculated from patient response to the question, “How much did you use your voice today (including whispering)?” on a 10-cm VAS ranging from “not at all” to “every time I wanted to communicate.” The variability of results in the above studies clearly demonstrates that survey methodology affects reported adherence rates, and that considering a patient with one deviation from recommendations to be nonadherent may not accurately reflect that patient’s overall behavior. We can conclude from the above that most patients do not demonstrate complete adherence to voice rest, but that most do significantly reduce their overall voice use postoperatively.
This was reflected in the present study, with no adherence data for 7 patients, one patient reporting his adherence as “fair,” and the remaining self-reported adherence ranging from “observed voice rest” to “100%.” Self-reported adherence may correlate negatively with age in adults (DiMatteo, 2004); however, Rousseau et al. (2011) found no association between age and adherence to voice rest. Therefore, the present study’s finding that patients who reported talking during voice rest had a higher mean age than those who did not merits further investigation.

Low reliability and consistency of adherence data is a limitation of the current study. One major drawback of retrospective studies is increased potential for error when interpreting extant data. In collecting clinicians’ reports of patients’ reported adherence to voice rest, it is likely that data were omitted or misinterpreted. It is probable that, for example, some clinicians asked about specific behaviors such as coughing and whispering, and some did not. It is also probable that some patients misremembered or misrepresented their voice use in the 5-18 days since their surgery. To collect more reliable adherence data in a prospective study, patients should be sent home with forms or diaries to be completed on a daily basis during postoperative voice rest. These should include a VAS to estimate daily voice use, similar to the methodology used by Rousseau et al. (in press). They should also include daily estimates of whispering and vegetative voicing. Another possibility is using instrumentation such as the Ambulatory Phonation Monitor (KayPENTAX, Lincoln Park, NJ, USA) to objectively measure vocal doses, intensity, fundamental frequency, and phonation time.

The present study is limited by a low number of participants. Over 5 years, 74 patients underwent microflap surgery with no concomitant procedures to remove a nodule, polyp, or cyst. Of these, only 25 had pre- and postoperative VHI data in the chart within a meaningful timeframe, and 47 had stroboscopic data. For some interesting patients who completed 3 and 18 days of voice rest respectively, outcomes data were incomplete. This could be rectified in a future prospective study by recording data methodically at each visit to the Voice Center. Another limitation of this study is that
prescribed voice rest duration is not varied at Vanderbilt: three laryngologists recommend 7 days, and one recommends 14 days. A voice rest duration of 3-5 days is relevant to recent basic science research. However, no surgeon at Vanderbilt routinely prescribes 3-5 days of voice rest. Instead, patients sometimes complete 5 days when they are told to observe voice rest “until follow-up.” In addition, when physicians do vary voice rest duration, it is individualized to each patient. For example, a patient who is judged to be adherent to healthcare recommendations in general and who has a pedunculated polyp with a small base is likely to be prescribed 3 days’ voice rest after surgery. Perhaps that patient would have positive postoperative outcomes regardless of voice rest duration, due to the nature of the lesion and the patient’s habits. In a prospective study, Vanderbilt could partner with a site where surgeons regularly prescribe 3-5 days of voice rest, in order to better compare outcomes of different voice rest durations.

Voice rest after surgery to remove a nodule, polyp, or cyst has serious socioeconomic implications. In the United States, the current most prevalent recommendation of 7 days’ rest (Behrman & Sulica, 2003) can prevent many employed patients from working for a week postoperatively. Paid sick leave is not provided to 70% of the lowest quartile of private-industry wage earners, and paid vacations are not provided to 51% (United States Department of Labor, 2014). Without these benefits, people with low-paying jobs will simply lose pay during voice rest, and they may be at risk for unemployment. Recommending a shorter duration of voice rest may remove an economic barrier that currently limits access to care, allowing more patients whose benign lesions require surgical intervention to complete procedures that would improve their quality of life. There is no extant prospective study of the efficacy of postoperative voice rest after microflap surgery for benign vocal fold lesions. Koufman & Blalock (1989) performed a retrospective chart review that failed to find any association between complete or relative voice rest and improved postoperative outcomes. The present study is a retrospective chart review that has failed to find any association between duration of voice rest and improved
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postoperative outcomes. Therefore, a well-designed prospective efficacy study of postoperative voice rest is warranted.

CONCLUSIONS

Microflap surgery is an effective treatment for benign vocal fold lesions. The efficacy of postoperative voice rest is still unknown and warrants a well-designed prospective study. Pre- and postoperative voice therapy, gender, and age may be relevant to patient outcomes. Future studies should also focus on reliable measures of adherence and stroboscopic parameters.
REFERENCES


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