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Clinical Voice Outcomes for Two Voice Rest Protocols after Phonomicrosurgery

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Objectives: Voice rest is commonly recommended for patients with benign vocal fold lesions (BVFLs) after phonomicrosurgery. The study compares the clinical voice outcomes of two protocols, 7-day complete voice rest (CVR) and 3-day CVR followed by 4-day relative voice rest (CVR + RVR), for patients with BVFLs after phonomicrosurgery.

Study Design: Prospective, randomized controlled trial.

Method: Patients with BVFLs undergoing phonomicrosurgery were recruited prospectively and randomly assigned to either protocol. Outcomes were assessed on objective measures of acoustics (fundamental frequency, frequency range, mean intensity, cepstral peak analysis) and aerodynamics (vital capacity, airflow rate, subglottal pressure, phonation threshold pressure), as well as subjective measures, both provider-reported through the Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V), and patient-reported through the Voice Handicap Index (VHI). Clinical measures were collected at three-time points: preoperatively, 1-week postoperatively (on voice rest), and 1-month postoperatively. In addition, adherence was estimated using a vocal dosimeter.

Results: Twenty-five patients were recruited and randomized to 7-day CVR ($n = 13$) and CVR + RVR regimen ($n = 12$). Statistically significant changes were found within both groups for subglottal pressure ($p = 0.03$) and VHI score ($p < 0.001$) comparing pre-operative baseline to 1-month postoperative follow-up. There were no statistically significant differences between the groups. Regardless of group assignment, a significant decrease in overall severity ratings for the CAPE-V was found by comparing the preoperative scores to postoperative scores at 1-week ($p < 0.001$) and 1-month ($p < 0.001$).

Conclusion: Both groups improved their overall voice quality comparably 1 month after undergoing phonomicrosurgery as measured by objective and subjective parameters.

Levels of Evidence: 2.

Key Words: clinical outcomes, microflap, phonomicrosurgery, voice rest.

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INTRODUCTION

Despite a consensus on the necessity of voice rest following laryngeal phonomicrosurgery, there is disagreement regarding its optimal duration and type.[1–4] Survey studies highlight the heterogeneity among current practices for laryngologists.[1,3] Recommendations in the United States vary from 0 to 28 days, with the prevalent approach being a 7-day rest period for patients with benign vocal fold lesions (BVFLs) after undergoing phonomicrosurgery.[3] Complete voice rest (CVR) and relative voice rest (RVR) are the two predominant protocols. CVR entails a restriction of all voice use, requiring patients to use non-verbal forms of communication.[3,4] On the other hand, RVR commonly entails voice usage limited to only essential needs, along with avoiding phonotraumatic activities such as loud speaking, heavy lifting, and throat clearing.[3]

The timing of voicing initiation is a critical point to investigate to optimize regenerative healing. Animal models have provided insight into the stages of wound healing to inform the design of postoperative voice rest programs. On the one hand, early and excessive postoperative vocal fold vibration was found to cause and exacerbate scarring in one canine model, which is thought to increase the risk of chronic dysphonia.[5] On the other hand, data from other animal models and the orthopedic literature suggest early mobilization, such as with low levels of vocal loading, may aid in the functional recovery of the voice folds post-surgically.[2,6,7] In rabbit models, the inflammation period following the microflap incisions lasted up to 3 days, after which there was no significant difference in the level of protein markers of inflammation between the silent group and the early phonation group. Tissue remodeling, marked by significant cellular infiltration into the wound bed, was observed 3 days post-injury.[6] This period could be crucial in the vocal fold wound healing process as it provides an opportunity to influence the wound healing response. Remobilization of vocal fold tissue, after the initial inflammation has subsided, may promote active tissue remodeling.[2,7]

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However, a discrepancy arises between wound healing evidence and clinical studies given that previously studied RVR protocols have permitted voicing from day 0.[8–12] This evidence suggests the potential advantages of a modified voice rest protocol, which incorporates a period of absolute voice rest, followed by controlled vocal fold remobilization by daily voicing dosage recommendation, aligning with the stages of vocal fold wound healing.[3,6]

A balance is needed in our voice rest recommendations, to find the optimum dosage of phonation that promotes wound healing and is feasible for patient adherence. Extended periods of CVR can significantly impact the quality of life (QOL) for patients.[13] This is particularly true for individuals in vocally demanding professions, who may require additional time off work to adhere to the voice rest protocol, despite an otherwise swift post-surgical recovery. A meta-analysis of randomized control trials revealed limited evidence supporting the benefit of voice rest programs that are longer than 7 days.[14] Objective measurements of voicing behaviors indicate that adherence to extended CVR programs is challenging.[8,9] Clinical outcome studies have demonstrated improvements in voice outcomes, for short CVR protocols of 1–5 days, as measured across patient-reported outcomes, auditory-perceptual analyses, and objective voice parameters.[10–12] Furthermore, voice pathologists show a higher consensus toward adopting an RVR protocol, which maintains a balance between wound healing and early epithelium mobilization postoperatively, as compared to implementing a CVR program.[15] This protocol could improve patient adherence and minimize the impact on the patient's QOL of post-operative voice rest.[13]

The purpose of this randomized clinical trial was to compare the clinical voice outcomes of two voice rest protocols, 7-day CVR and 3-day CVR followed by 4-day RVR (CVR + RVR), for patients with BVFLs after phonomicrosurgery. Based on current evidence, we hypothesized that patients on the CVR + RVR protocol would have greater improvement in voice quality measures than the 7-day CVR program at both 7-day and 1-month postoperatively.

MATERIALS AND METHODS

Participants

Twenty-five patients ($M = 9$, $F = 16$) (Table I) were prospectively recruited by the providers at the Texas Voice Center at Houston Methodist Hospital, which includes two fellowship-trained laryngologists and two speech-language pathologists (SLPs). The inclusion criteria were: at least 18 years of age, proficiency in conversational English, a primary diagnosis of BVFLs, a recommendation for phonomicrosurgery with microflap technique, and no prior experience with voice rest. The study excluded individuals with neurological or cognitive impairments, significant hearing or vision impairments, and non-English speakers.

Procedures

The study was approved by the Institutional Review Boards at the University of Houston and the Houston Methodist Hospital. Data collection occurred 3–7 days preoperatively, 1-week (8–12 days) postoperatively, and 1-month postoperatively.

TABLE I.
Demographic Data on Participants in the Complete Voice Rest (CVR) and Complete Voice Rest + Relative Voice Rest (CVR + RVR).

	CVR	CVR + RVR
Participants	13	12
Males	5	4
Females	8	8
Mean age in years (SD)	48 (13.37)	45 (14.33)
Type of benign vocal fold lesion	Polyps ($n = 10$), Cysts ($n = 3$)	Polyps ($n = 4$), Cysts ($n = 6$), Nodules ($n = 1$), Reinke's edema (1)

Voice Rest Program

Block randomization with a block size of four was used to assign participants to two groups of different voice rest regimens, 7-day CVR and CVR + RVR (3-day CVR+ 4 day-controlled voice use increasing in duration), during the initial pre-surgical session. The two groups were stratified for sex and lesion type. Participants were given handouts with detailed instructions (Table II). All participants recruited in this study underwent phonomicrosurgery via microflap technique by one of two laryngologists (authors Y.Y or A.T). One participant also underwent KTP laser ablation for varices following the microflap portion of the surgery. The laryngologists were blinded to the voice rest designation assigned to the patient.

Data Collection

This study evaluated clinical voice outcomes based on both objective and subjective measures. Objective measures included acoustic parameters and aerodynamic parameters. Subjective measures incorporated provider-reported assessments via the CAPE-V and patient-reported outcomes through the Voice Handicap Index (VHI). Acoustic stimuli were recorded using a Shure SM48 dynamic cardioid microphone and the Multidimensional Voice Program (MDVP, Pentax Medical). Analyses were performed on the following tasks: 3 trials of/a/sustained for 3–5 s, the sentence stimuli of CAPE-V, and a vocal glide on/a/from lowest to highest pitch.[16] Mean fundamental frequency (f_o), habitual intensity, and frequency range were obtained using MDVP, while CPP with sustained vowel (CPP_{vowel}) was derived using the Analysis of Dysphonia in Speech and Voice (ADSV) Pentax Medical computer software. The randomized CAPE-V recordings were rated by four voice-specialized SLPs blinded to group assignment and time points (pre- or post-surgical). The VHI was only administered at

TABLE II.
Instructions Provided to Patients for Complete Voice Rest (CVR) or Relative Voice Rest (RVR).

CVR	CVR + RVR
Days 1–7: No voicing, whispering, throat clearing, coughing (avoid as much as possible), use of soft glottal attack, use of the alternate mode of communication (text message, e-mail, writing, gestures, etc.)	Days 1–3: same as CVR Days 4–7: Use of comfortable pitch and loudness (speaking to a person only within arm's length) soft glottal attack, no whispering, throat clearing, coughing (avoid as much as possible) Day 4: 5 min in AM/ 5 min in PM Day 5: 10 min in AM/ 10 min in PM Day 6: 15 min in AM/ 15 min in PM Day 7: 20 min in AM/ 20 min in PM

TABLE III.
Descriptive Statistics for Acoustic Outcome Measurements for the CVR and CVR + RVR Group at Three Time Points, Pre-Operation (Pre-op), One-Week Post-Operation (1-Week), and One-Month Post-Operation (1-Month).

		CVR			CVR + RVR		
Acoustic outcome	Sex	Pre-op	1-week	1-month	Pre-op	1-week	1-month
F_0 (Hz)	Male	110.98 (14.87)	99.69 (18.22)	101.66 (18.22)	128.78 (3.51)	133.16 (22.43)	111.1 (8.22)
	Female	187.11 (30.01)	196.81 (31.91)	194.75 (34.19)	183.78 (34.67)	185.38 (21.64)	183.57 (30.21)
Range (Hz)	Male	207.85 (58.75)	*	254.58 (7.73)	214.62 (38.76)	*	215.18 (46.91)
	Female	210.68 (31.38)	*	211.7 (23.27)	237.13 (27.37)	*	203.26 (32.49)
CPP-vowel	Male	9.95 (3.27)	9.82 (3.92)	14.09 (1.78)	11.82 (1.43)	13.29 (1.05)	12.62 (2.35)
	Female	7.61 (2.33)	9.76 (2.60)	9.13 (5.72)	8.58 (3.54)	8.11 (2.76)	9.10 (1.32)
Habitual intensity (dB SPL)	Male	55.39 (5.93)	53.44 (7.35)	56.76 (2.17)	60.29 (5.65)	66.88 (3.11)	54.83 (7.49)
	Female	54.09 (8.87)	54.51 (9.19)	56.44 (5.02)	53.14 (7.91)	51.53 (4.97)	57.86 (5.47)

*This measurement was not taken at 1 week post-operatively as a precaution against excessive vocal strain.

the preoperative and the one-month postoperative stage. The rationale behind this timing is that the completion of a VHI 7 days post-surgery, during the voice rest period, would not yield valid data as patients would not have been actively using their voice.

Aerodynamic assessment was performed using the Phonatory Aerodynamic System (PAS), including vital capacity, airflow rate for vowels, airflow rate for continuous speech, subglottal pressure (Ps), and phonation threshold pressure (PTP).[16] The PAS system was calibrated before every session using a 1-liter calibration syringe as described in the PAS instruction manual.[17] The protocols of vital capacity, comfortably sustained phonation, and voicing efficiency were used for the corresponding measurements.[18] Airflow measurements using the comfortable sustained phonation protocol were obtained for the/a/vowel and connected speech using the Rainbow Passage.[17] Participants were instructed to produce seven iterations of/pa/at a habitual pitch and loudness for the Ps measurement. Likewise, for the measurement of PTP, participants were asked to repeat/pa/seven times, with each set beginning in a whisper and transitioning to phonation.[17] The initial moment of voicing during this transition was identified, and the pressure was denoted as PTP. The vital capacity and airflow rate in vowel production, Ps, and PTP were repeated for three trials.

Vocal dosimeters are used to objectively measure the duration of voice use as an estimate of patient adherence to their assigned voice rest programs.[8,9] The dosimeter of choice in this study, *VocaLog2™ Vocal Activity Monitor* (Griffin Laboratories, Temecula, CA) detects and records phonation duration and intensity through a neck-mounted contact microphone and provides monitoring and biofeedback simultaneously.[19] The device registers the presence of phonation once per second. The device was calibrated for each participant using the *Vocalog* Software (Version 1.2.4.2) before starting the voice rest protocol. Patients were asked to wear the device during all waking hours. Objective adherence was quantified by the daily duration of phonation measured in seconds.

Voice Therapy

Protocol and session frequency of the post-operative voice therapy services were consistent across both groups. All participants received individual therapy weekly for 4 weeks following their voice rest period by one of two voice-specialized SLPs (authors T.P and M.G). Sessions included consultation on resuming voice use, vocal hygiene, semi-occluded vocal tract exercises such as cup bubble and straw phonation, and resonant voice therapy. Participants were advised to practice voice therapy exercises while resuming normal voice use during the weeks of voice therapy.

TABLE IV.
Descriptive Statistics ($n = 25$) for Aerodynamic Outcome Measurements for the CVR and CVR + RVR Group at Three Time Points, Pre-Operation (Pre-Op), One-Week Post-Operation (1-Week), and One-Month Post-Operation (1-Month).

		CVR			CVR + RVR		
Aerodynamics outcome	Sex	Pre-op	1-week	1-month	Pre-op	1-week	1-month
Vital capacity (Liters)	Male	3.50 (1.17)	3.34 (1.53)	4.26 (1.36)	4.88 (1.72)	4.50 (1.39)	3.61*
	Female	2.84 (1.28)	2.97 (1.53)	3.17 (1.21)	2.49 (0.94)	1.85 (0.94)	2.16 (1.22)
P_{sub} (cmH_2O)	Male	8.91 (3.51)	8.76 (5.29)	6.11 (1.26)	11.93 (2.59)	10.38 (1.41)	9.59 (0.74)
	Female	9.45 (2.71)	10.57 (3.06)	11.21 (1.24)	10.51 (2.21)	6.36 (1.83)	5.41 (1.06)
PTP (cmH_2O)	Male	10.19 (3.09)	6.75 (5.37)	5.42 (2.14)	7.29 (4.76)	4.70 (0.84)	No data
	Female	7.92 (2.65)	7.74 (2.64)	7.81 (2.81)	9.00 (4.94)	6.28 (1.19)	4.31 (1.34)
Air flow rate (Vowel, L/sec)	Male	0.25 (0.14)	0.15 (0.09)	0.21 (0.07)	0.29 (0.12)	0.27 (0.11)	0.15*
	Female	0.22 (0.09)	0.18 (0.14)	0.19 (0.09)	0.14 (0.03)	0.12 (0.05)	0.22 (0.09)
Air flow rate (Continued Speech, L/sec)	Male	0.21 (0.02)	0.16 (0.07)	0.19 (0.08)	0.25 (0.09)	0.15 (0.04)	0.15*
	Female	0.17 (0.06)	0.14 (0.07)	0.15 (0.08)	0.13 (0.06)	0.13 (0.06)	0.12 (0.01)

*($n = 1$).

TABLE V.
Descriptive Statistics ($n = 25$) for Rating-Scale Measurements (CAPE-V and VHI) for the CVR and CVR + RVR Group at Three Time Points, Pre-Operation (Pre-Op), 1-Week Post-Operation, and 1-Month Post-Operation.

	CVR			CVR + RVR		
Rating scale outcome	Pre-op	1-week	1-month	Pre-op	1-week	1-month
Mean total VHI score (SD)	72 (20.08)	*	36.78 (24.46)	61.50 (24.50)	*	39.85 (26.23)
CAPE-V overall severity (SD)	55.27 (15.95)	26.6 (13.66)	22.34 (16.50)	49.85 (15.93)	37.97 (22.05)	23.70 (14.97)

*VHI not collected.

Data Analyses

Twenty participants completed the testing protocol at the 1-week visit and 12 participants completed it at the 1-month post-surgical visit. Reported attrition was a consequence of patient dropout during the pandemic or technical issues with the equipment. *An intention-to-treat analysis was performed. All participants were included in the analysis even if they were unable to complete the assessment at the 1-month time point*.[20] Of special interest were the main effects of group (CVR and CVR + RVR), time (pre-surgical, 1-week post-surgical, and 1-month post-surgical), and the interaction between group *and time*. *Statistically significant main effects of time were followed up with pairwise comparisons, maintaining family-wise alpha level at 0.05*. Analyses were computed in SAS 9.4 using the PROC MIXED procedure using the full information maximum likelihood to account for missing data.[18,20,21] An interclass correlation coefficient (ICC) was calculated to examine interrater reliability between the CAPE-V raters.[22]

RESULTS

Three outcome measurements showed statistical significance. A main effect of time was found for Ps ($F_{2,23} = 4.10$, $p < 0.05$), overall severity ratings for CAPE-V ($F_{2,23} = 11.30$, $p < 0.001$), and total score for VHI ($F_{1,23} = 26.57$, $p < 0.05$). There were no statistically significant main effects of group or an interaction effect (group × time) for the CAPE-V, acoustic, aerodynamic, and VHI. Tables III–V provide descriptive statistics for the aforementioned comparisons.

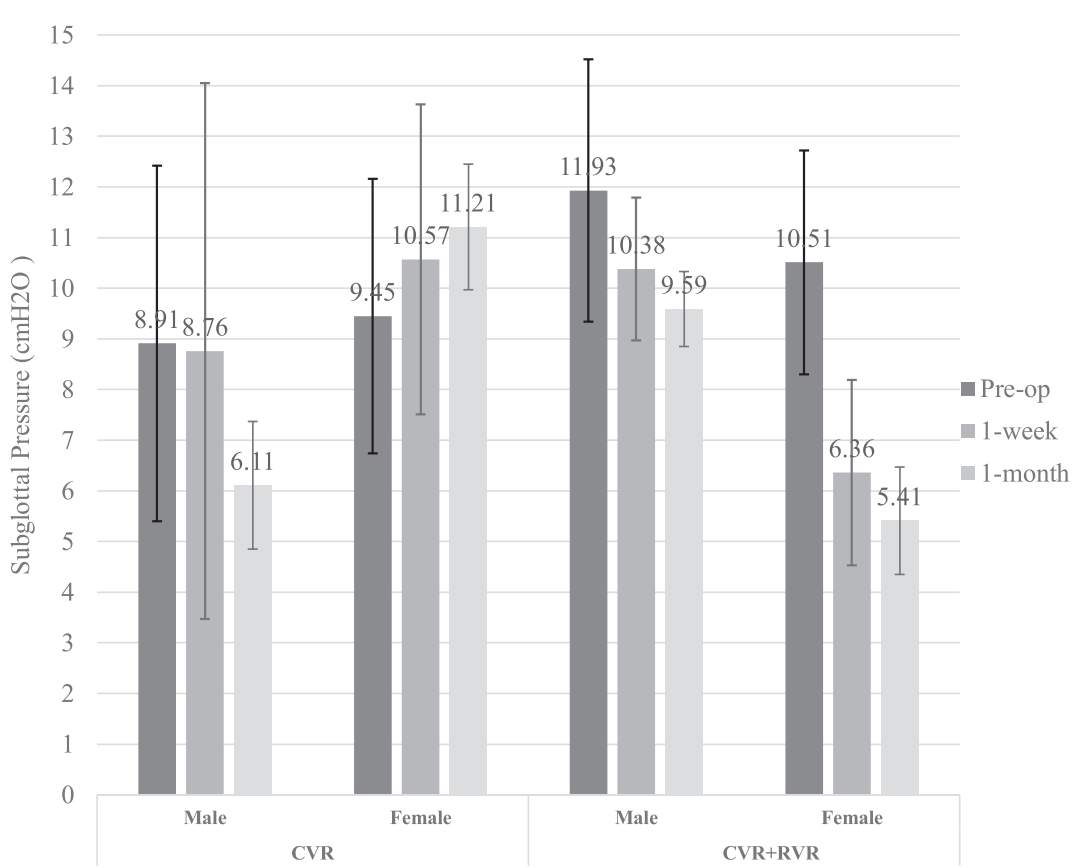

Fig. 1. Marginal means and standard deviations for subglottal Pressure (Ps), which were measured preoperatively, and at 1 week and 1 month postoperatively. Within-group comparisons showed a significant decrease of Ps between measurement pre-operation and 1 month postoperatively for both CVR and RVR groups.

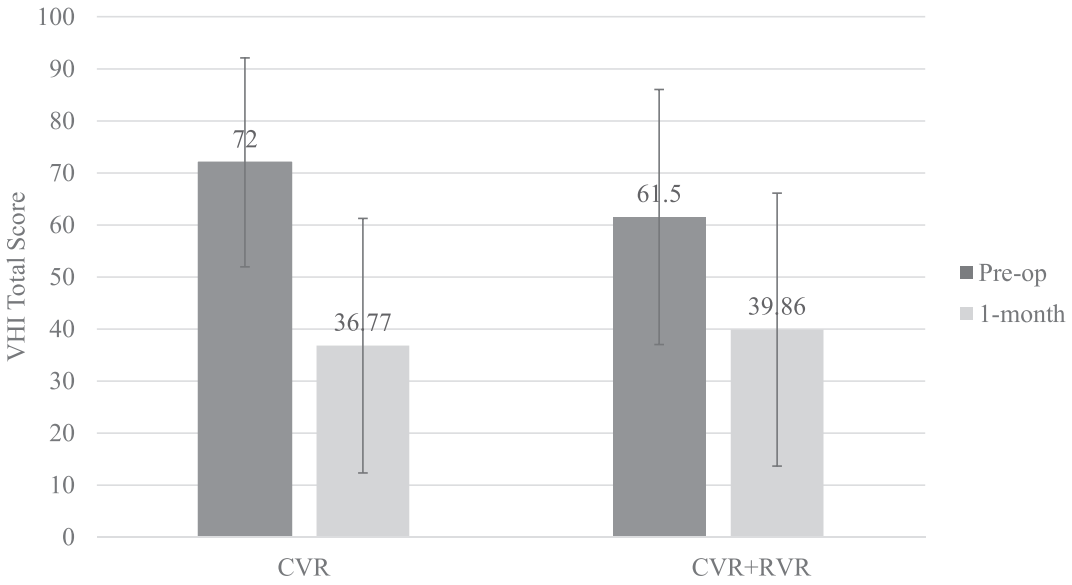

Fig. 2. Marginal means and standard deviations for the total score of the Voice Handicap Index (VHI), which was measured preoperatively and 1 month postoperatively. Within-group comparisons showed a significant decrease in the score between measurement pre-operation and 1 month postoperatively for both CVR and RVR groups.

Follow-up comparisons of the main effect for time suggested a statistically significant decrease in P_s ($p < 0.05$). As shown in Figure 1, the findings revealed a decrease in P_s when comparing the pre-surgical to the post-surgical measurement at 1-month. The follow-up comparisons also revealed that the average rating of CAPE-V was significantly lower at the post-operative 1-week and 1-month relative to pre-operative levels ($p < 0.001$; as shown in Fig. 2). Given high inter-rater reliability among the four raters (intraclass correlation = 0.92) for the CAPE-V, the scores were averaged for the raters.[22] The total score of the VHI was decreased when comparing the pre-operative and the 1-month post-operative timepoints ($p < .001$; as reflected in Fig. 3).

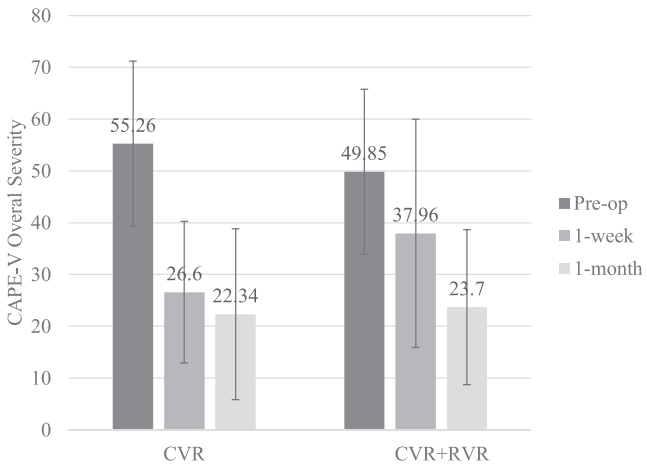

Fig. 3. Marginal means and standard deviations for the overall severity of Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V), preoperatively, at 1 week, and 1 month postoperatively. Given the high inter-class correlation, average scores among the ratings from the four raters were used for analysis.

The duration of voice used in the assigned voice rest program was assessed for both groups. A mixed analysis of variance (ANOVA) was employed to examine the effects of group, day, and group × day interaction on daily voicing duration. The results indicated that there were no significant interaction effects ($F_{\text{group}\times\text{day}}$ (6, 19) = 0.04, $p = 0.85$) or main effects observed (F_{group} (1, 19) = 0.04, $p = 0.85$; F_{day} (6, 19) = 0.37, $p = 0.77$). The CVR ($M_{\text{Day1-7}} = 3179.89$ s, $SE = 1453.46$) and CVR + RVR ($M_{\text{Day1-7}} = 3539.09$ s, SE = 1758.74) groups showed no difference in voicing duration during their voice rest period.

DISCUSSION

The objective of this study was to compare clinical voice outcomes between two 7-day voice rest protocols: the CVR + RVR protocol (3 days of CVR followed by 4 days of controlled voice use) and the conventionally recommended CVR program.[3] Our findings indicate that both programs resulted in improved voice outcomes for patients with BVFL following phonomicrosurgery.

Across the three time points, no statistically significant differences were observed between protocols, as evidenced by the non-significant interaction of group and time. Contrary to the hypothesis, the RVR group did not outperform the CVR group postoperatively. The reason for this may lie in the data we obtained from objective measurement of their voice use with the Vocalog2. As per the recommended protocol, both groups were expected to engage in minimal to no voice use during the first 3 days, with an anticipated increase in voice use for the CVR + RVR group alone over the following 4 days. However, our data showed that the two groups exhibited remarkably similar voice use behaviors over the seven-day period, with no statistically significant differences in duration of voice use. This finding differed from previous

studies with different 7-day RVR instructions (there was no component of CVR) that found RVR groups phonated more than the CVR groups.[8,9] The results of improvement in both our groups align with existing literature favoring RVR or a shorter duration of CVR, as opposed to the more demanding 7-day CVR protocol. The similarity in phonation duration between the CVR and the CVR + RVR groups provides objective data for previously established patient-reported data on the difficulty patients experience adhering to prolonged CVR recommendations.[9–12]

Both groups demonstrated a similar level of recovery, as evidenced by the findings of the statistical significance across time points for the measures of CAPE-V, Ps, and VHI. These metrics reflect improvement in perceived voice quality, laryngeal valving, and patients' voice-related QOL.[12] For the VHI score, patients reported a decrease in their perceived voice handicap 1-month post-surgery. A shift of 18 points or greater in the total score signifies clinically meaningful changes in patient-reported outcomes.[23] The difference of 25.6 between the pre-operative ($mean_{CVR}$ 72, SD 20.1; $mean_{RVR}$ 61.25, SD 25.5) and 1-month postoperative ($mean_{CVR}$ 36.78, SD 24.46; $mean_{RVR}$ 39.85, SD 26.23) indicated that patients perceived their voice issues to have less impact on the functional, physical, and emotional aspects of life. However, a total score above 35 still indicates that patients consider their voice problems to have a mild impact on their life.[23] Furthermore, a total severity rating of 22 on the CAPE-V at the 1-month post-surgical time point shows the presence of mild dysphonia, suggesting that the patient could benefit from continued voice therapy.[12,24]

Limitations

The study was limited by its small sample size. However, the current sample size ($N = 25$) was consistent with other prospective randomized controlled trials ($N = 20–32$),[8–12] post-hoc power analysis using G*Power 3.1 for the significant outcome variables using estimates from the mixed model revealed power = 0.52 for subglottal pressure, power = 0.89 for CAPE-V ratings and power = 0.99 for the VHI results.[25] These findings need to be confirmed with a larger sample as some of the acoustic and aerodynamic outcome variables were approaching statistical significance. Moreover, there were some missing data due to technical issues with the equipment or missed sessions by the participants. Due to participant attrition and duration of post-operative therapy, outcomes beyond the one-month post-operative period were not assessed.

Future research may explore the impact of voice therapy beyond this one-month post-surgical timepoint, as well as long-term effects. The Vocalog2 measures voice in 1-second cycles, and this may have led to reduced accuracy in the voice use data.[19] Stroboscopic analyses were not included in this study and would have provided further insight. While lesion types were stratified between the groups in the current study, future studies could delve into investigating other specific factors, such as lesion types, size, and depth since recovery times may vary across these lesions.

CONCLUSION

Voice rest has been demonstrated as an essential component of post-operative management for BVFL in both human clinical trials and animal model studies.[1–7] Our study demonstrated that improved clinical outcomes did not differ by the type of voice rest protocols (CVR or CVR + RVR). With the absence of evidence supporting a specific type of voice rest protocols over the other, consideration of voice rest recommendation should focus on the more feasible duration of voice rest, examine factors to maximize patient adherence, and minimize the possible impact of voice rest on patients' QOL. Future studies should examine different RVR programs for appropriate dosage. Measurement of the outcomes at the 3- and 6-month mark will also help to clarify the long-term impact of the CVR and RVR protocols.

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CONFLICT OF INTEREST STATEMENT

The authors are salaried employees at their primary institutions and do not have any other significant financial or non-financial conflicts of interest.

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