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Voice outcomes in high-grade Reinke's edema: Comparing microflap excision and microdebrider surgery

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Abstract

Objectives: Patients presenting with hoarseness and diagnosed with high-grade Reinke's edema (RE) will often require surgical intervention for polypoid changes of the true vocal folds. We compared patient outcomes in patients who had microflap or microdebrider excision surgeries.

Methods: Patients with the diagnosis of grade II or grade III RE based on laryngoscopy or videostroboscopy who failed conservative management underwent surgery using the standard excision practice of the primary surgeon. Voice outcomes were compared using VHI-30 (Voice Handicap Index), V-RQOL (Voice-Related Quality of Life), and MPT (maximum phonation time) preoperatively and at 1-month and 6-months postoperatively.

Results: Of the 115 patients included, there were 46 RE grade II patients and 69 RE grade III patients with 52 patient undergoing microflap surgery and 63 patients undergoing microdebrider surgery. Both procedures resulted in significant improvement in VHI-30, V-RQOL, and MPT at 1-month and 6-months postoperatively. The microdebrider group had better 6-month VHI scores (40.84) than the microflap group (44.54) (CI −7.27 to −0.12). The microdebrider group also had better 6-month V-RQOL measures (62.56) than the microflap group (57.79) (CI 0.38–9.16).

Conclusion: Both microflap excision and microdebrider excision for high-grade RE lesions resulted in significant improvement in VHI-30, V-RQOL, and MPT at 1-month and 6-months postoperatively with the microdebrider excision group scoring statistically significantly better at 6 months in comparison to the microflap group. Overall, the results support the use of both surgical modalities for treating high-grade RE patients.

Level of evidence: 3.

KEYWORDS
microdebrider, microflap, Reinke's edema, VHI-30, V-RQOL

1 | INTRODUCTION

Reinke's edema (RE) is a polypoid degeneration of one or both true vocal folds. This condition was first described by Hajek in 1891, and then redescribed by Freidrich Berthold Reinke in a series of two articles in 1895 and 1897.[1–3] The condition is characterized by deposition of mucoid gelatinous soft tissue within the superficial lamina propria (SLP) immediately beneath the surface epithelium (Reinke's space).[4] Although its etiology is still unclear, the condition seems to be related to prolonged laryngeal irritation usually associated with smoking, voice abuse, and acid reflux.[5–12]

Polypoid changes in RE patients can range from mild fullness and minor symptoms to severe exophytic edema with significant voice and airway symptoms.[13] This varied presentation created the need for classification systems based on the severity of polypoid changes noted on endoscopy. The first of these staging systems was proposed by Yonekawa in 1988 in which there were three grades.[14] Subsequent systems have stratified these vocal fold changes into four grades but all use endoscopic vocal fold edema and impact on the laryngeal airway to grade severity.[15,16] Patients with more severe exophytic polypoid changes were noted to have more severe impact on vocal fold vibration and thus fail conservative treatment, resulting in more frequent surgical intervention.[17–19] This more severe Yonekawa grade II and grade III group was the focus of our evaluation.

Despite its typical presentation in smokers, RE is generally considered a benign condition with only a small percentage of cases progressing to dysplasia and even more uncommonly to true carcinoma.[20–22] RE patients will generally present with dysphonia as the primary complaint, however will also frequently describe a host of associated laryngeal symptoms including globus sensation, sore throat, dyspnea, and chronic cough.[23] The constellation of symptom severity and its impact on patients' quality of life determines the decision to pursue conservative management or surgical intervention.[24]

Surgical options for RE patients initially focused on complete removal of the epithelium and excess soft tissue in the SLP in "stripping" procedures. Over the last few decades, more conservative procedures have become the standard of care focusing on removal of subepithelial mucoid tissue with optimum preservation of the surface epithelium.[25] This was initially accomplished with cold instruments creating a microflap and removal of soft tissue from the SLP via suctioning or dissection.[26,27] These procedures demonstrated improved voice outcomes when compared to traditional stripping procedures.[28] Microflap procedures were further modified using a microdebrider to achieve tissue removal in a more controlled fashion, also with good results on vocal function.[29,30] Many other procedures have subsequently been used to achieve good results including CO_2 laser reduction, photoangiolytic laser reduction, and steroid injection.[31–38]

We believed the microflap excision technique and the microdebrider technique allowed the most precise removal of soft tissue with ability to send tissue biopsy for pathologic evaluation. Thus far no study has compared these two commonly used surgical procedures and their effect on patient voice outcomes. We chose to compare these two groups using the Voice Handicap Index-30 (VHI-30), the Voice-Related Quality of Life measure (V-RQOL), and maximum phonation time (MPT), all validated, easy to use, and readily available tools for qualitative and quantitative assessment of patient outcomes.[39–41]

2 | MATERIALS AND METHODS

Patients were evaluated in the clinic and diagnosed with RE via laryngoscopy or video stroboscopic evaluation by the senior laryngologist. They were initially offered a course of smoking cessation, medical management of acid reflux if appropriate, and voice therapy.[42–44] Patients who felt significant improvement and had no suspicious epithelial findings were monitored. Patients whose symptoms failed conservative management and had Reinke's grade II or III lesions by Yonekawa criteria (Table 1) were included in the study group. Informed consent for inclusion in the study was obtained from the patient. All patients included in the study were asked to fill out a symptom data sheet and a demographic survey including detailed smoking history. Patients were then asked to fill out a VHI-30, V-RQOL, and were tested for MPT. To measure MPT, the subject was asked to phonate a sustained /a:/ at a comfortable pitch and loudness for as long as possible during a single exhalation.[45] These instruments were completed preoperatively and then again at 1-month and 6-months postoperatively.

Patients from 2005 to 2011 underwent microflap excision technique with either suctioning or blunt removal of subepithelial tissue from the SLP as described by Hirano in 1976.[25] This was the preferred technique of the senior laryngologist at that time. This technique involved subepithelial injection of epinephrine followed by incision of the epithelium lateral to the polypoid tissue with a micro scissor under operative microscopy. The epithelium was then elevated as a flap, and the gelatinous hypertrophied SLP was reduced via suctioning or direct removal. The flap was then re-draped and excess epithelium trimmed to account for loss of volume in the SLP. Care was taken not to remove too much tissue from the SLP, leaving an adequate buffer for the vocal ligament which is not manipulated during the procedure.

Patients from 2012 to 2019 underwent microdebrider resection technique initially described by Sant'Anna and Mauri in 2000 and redescribed by Honda et al. in 2010.[29,30] This procedure was also done under operative microscopy in which the flap was similarly dissected and elevated but the tissue removal from the SLP was

TABLE 1 Yonekawa classification system.

Grade I	Edematous swelling is observed on the upper surface of the vocal folds, whereas patency of the glottis is adequately preserved.
Grade II	Edematous swelling extends from the upper to the lower surface beyond the margins of both vocal folds, which are partly in contact with each other.
Grade III	Edematous swelling is further advanced so that an opening can be seen only at the posterior portion of the glottis, or the swelling is so bulged in sack-like shape that it hands down to the subglottic space during inspiration.

achieved using the XPS powered ENT system and Medtronic Xomed Handpiece with a 2.9 mm laryngeal blade microdebrider on a low suction setting and very low oscillation mode settings between 500 and 800 rpm. Redundant epithelium was trimmed with the microdebrider and the flaps were re-draped without tension.

All surgical procedures were performed by one supervising fellowship-trained laryngologist in a tertiary referral center. All patients postoperatively were placed on strict voice rest for 1 week and full PO intake was initiated on POD1.[46] All patients followed up in clinic at 2 weeks postoperative for laryngoscopy. Patients were then seen at 1-month and 6-months postoperatively.

Data were analyzed using RStudio (Boston, MA). Statistical analysis was done using *t*-test for quantitative variables and a Pearson Chi squared test for the categorical variables. IRB approval was obtained from the primary surgical institution.

3 | RESULTS

3.1 | Demographics and patient characteristics

A summary of the demographics is presented in Table 2. There were 115 patients included in this study who were 90% female and a mean age of 52.4 years old. The average pack per day smoked among patients was 1.18 packs and the average pack year history among patients was 32.52 years.

The subpopulations of patients who were found to have Reinke's grade II and III were compared to each other. Patients who had grade III disease were older than grade II at 54.0 and 50.7 years old, respectively, and a greater pack year history at 35.1 and 27.5 pack years, respectively (Table 2). Notably, there was no significant difference in average pack per day smoked between the two.

3.2 | Presenting symptoms of patients

A summary of the presenting symptoms of the patient subpopulations is presented in Table 3. Patients who had grade III disease were significantly more likely to have dyspnea, globus sensation, and cough in comparison to those who had grade II disease.

3.3 | Voice outcomes improved significantly after surgery

The average VHI-30 score across all patients undergoing surgical intervention for their RE was noted to improve after surgery (Figure 1A). Both the average 1-month postoperative score (48.89, CI

TABLE 2 Demographics of the overall patient population and the subpopulations of patients who were treated with different surgical excision techniques (MFE = microflap excision, MD = microdebrider excision) and the subpopulations of patients diagnosed with different grades of Reinke's edema (II or III).

		Technique			Reinke's grade		
	Total	MFE	MD	*p* value (CI)	II	III	*p* value (CI)
n	115	52	63		46	69	
Age	52.35	52.11	53.21	.507 (−2.14 to 4.34)	50.7	54.0	.046 (−6.51 to −0.06)
Sex (F:M)	103:12	47:5	56:7	.794	39:7	64:5	.290
Average PPD	1.18	1.21	1.15	.572 (−0.25 to 0.14)	1.13	1.21	.395 (−0.28 to 0.11)
Average PY	32.52	34.33	31.30	.279 (−8.55 to 2.49)	27.5	35.1	.002 (−13.97 to −3.25)

Note: Patient characteristics included average pack per day (PPD) smoked and average pack year (PY) history. *p* values including confidence intervals (CI) are included where appropriate.

TABLE 3 Presenting symptoms of the subpopulations of patients who were treated with different surgical excision techniques (MF = microflap excision, MD = microdebrider excision) and the subpopulations of patients diagnosed with different grades of Reinke's edema (II or III).

	Technique			Reinke's grade		
	MFE	MD	*p* value (CI)	II	III	*p* value (CI)
Duration	8.24	6.58	.180 (−4.11 to 0.78)	6.75	7.71	.431 (−3.38 to 1.45)
Hoarseness	52	63	1.0	46	69	1.0
Dyspnea	8	10	.943	1	17	.001
Globus sensation	20	20	.452	10	30	.016
Sore throat	7	6	.507	5	8	.904
Cough	8	10	.943	3	15	.028

Note: *p* values including confidence intervals (CI) are included where appropriate.

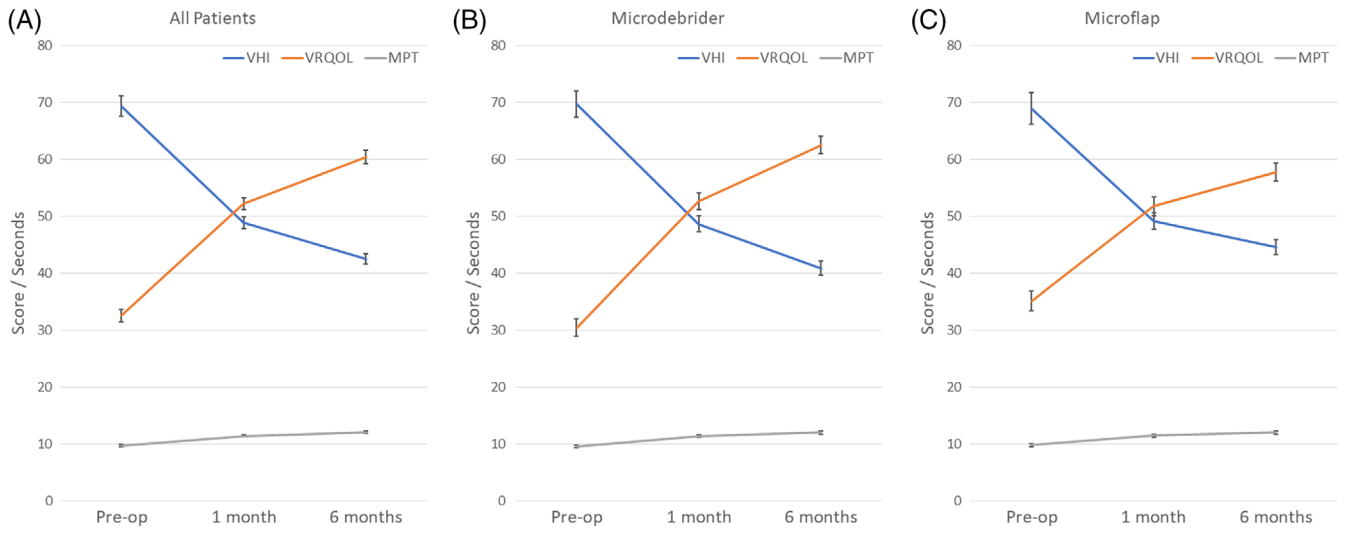

FIGURE 1 Outcomes of the VHI, the V-RQOL, and the MPT pre- and postoperatively. Error bars represent standard error. (A) Outcomes for all patients. (B) Outcomes for patients who underwent microdebrider excision only. (C) Outcomes for patients who underwent microflap excision only. MPT, maximum phonation time; V-RQOL, Voice-Related Quality of Life; VHI-30, Voice Handicap Index.

−21.52 to −16.46) and the 6-month postoperative score (42.51, CI −30.79 to −22.93) were significantly lower in comparison to the preoperative score (69.37). The average V-RQOL score across all patients also improved after surgery. Both the average 1-month postoperative score (52.22, CI 16.55–22.78) and the 6-month postoperative score (60.40, CI 24.65–31.05) were significantly higher in comparison to the preoperative score (32.55). Similarly, the mean phonation time improved after surgery. Both the average 1-month postoperative time (11.40 s, CI 1.24–2.27) and the 6-month postoperative time (12.01 s, CI 1.84–2.89) were higher than the preoperative time (9.65 s).

Voice outcomes for each separate surgical technique were also shown to improve after surgical intervention. The average VHI-30 score across all patients undergoing microdebrider excision was noted to improve after surgery (Figure 1B). Both the average 1-month postoperative score (48.67, CI −26.41 to −15.75) and the 6-month postoperative score (40.80, CI −34.07 to −23.74) were significantly lower in comparison to the preoperative score (69.74). The average V-RQOL across all microdebrider patients also improved after surgery. Both the average 1-month postoperative score (52.62, CI 18.05–26.32) and the 6-month postoperative score (62.56, CI 27.80–36.44) were significantly higher in comparison to the preoperative score (30.44). Similarly, the mean phonation time improved after surgery. Both the average 1-month postoperative MPT (11.36 s, CI 1.10–2.51) and the 6-month postoperative MPT (12.04 s, CI 1.76–3.22) were higher than the preoperative MPT (9.55 s).

Similar results were seen with the group undergoing microflap excision (Figure 1C). For the VHI-30, both the average 1-month postoperative score (49.15, CI −26.06 to −13.47) and the 6-month postoperative score (44.54, CI −30.51 to −18.26) were significantly lower in comparison to the preoperative score (68.92). Furthermore, the average V-RQOL 1-month postoperative score (51.73, CI 11.88–21.35) and the 6-month postoperative score (57.79, CI 17.99–27.35) were significantly higher in comparison to the preoperative score (35.12). Lastly, the average 1-month postoperative MPT (11.46 s, CI 0.93–2.44) and the 6-month postoperative MPT (11.99 s, CI 1.44–3.00) were higher than the preoperative MPT (9.77 s).

3.4 | Comparison of voice outcomes by surgical technique

The VHI-30 was calculated and compared between the two subpopulations undergoing microflap excision and microdebrider excision (Figure 2A). Of note, the VHI-30 score for the 6-month postoperative microdebrider excision group (40.84, CI −7.27 to −0.12) was significantly lower than the 6-month values in the microflap excision group (44.54).

Similarly, the V-RQOL was compared between the two surgical techniques (Figure 2B). There was a significant difference in the preoperative score between the microflap excision group (35.12) and the microdebrider excision group (30.44, CI −9.29 to −0.06). Again, there was a significant difference in the 6-month postoperative scores with microflap excision group (57.79, CI −9.16 to −0.38) scoring lower than the microdebrider excision group (62.56). There was also a significant difference between the change in 1 month to baseline score with the microflap excision group (+16.62, CI −8.86 to −2.28) increasing less than the microdebrider excision group (+22.18). There was also a significant difference between the change in V-RQOL from preoperative to

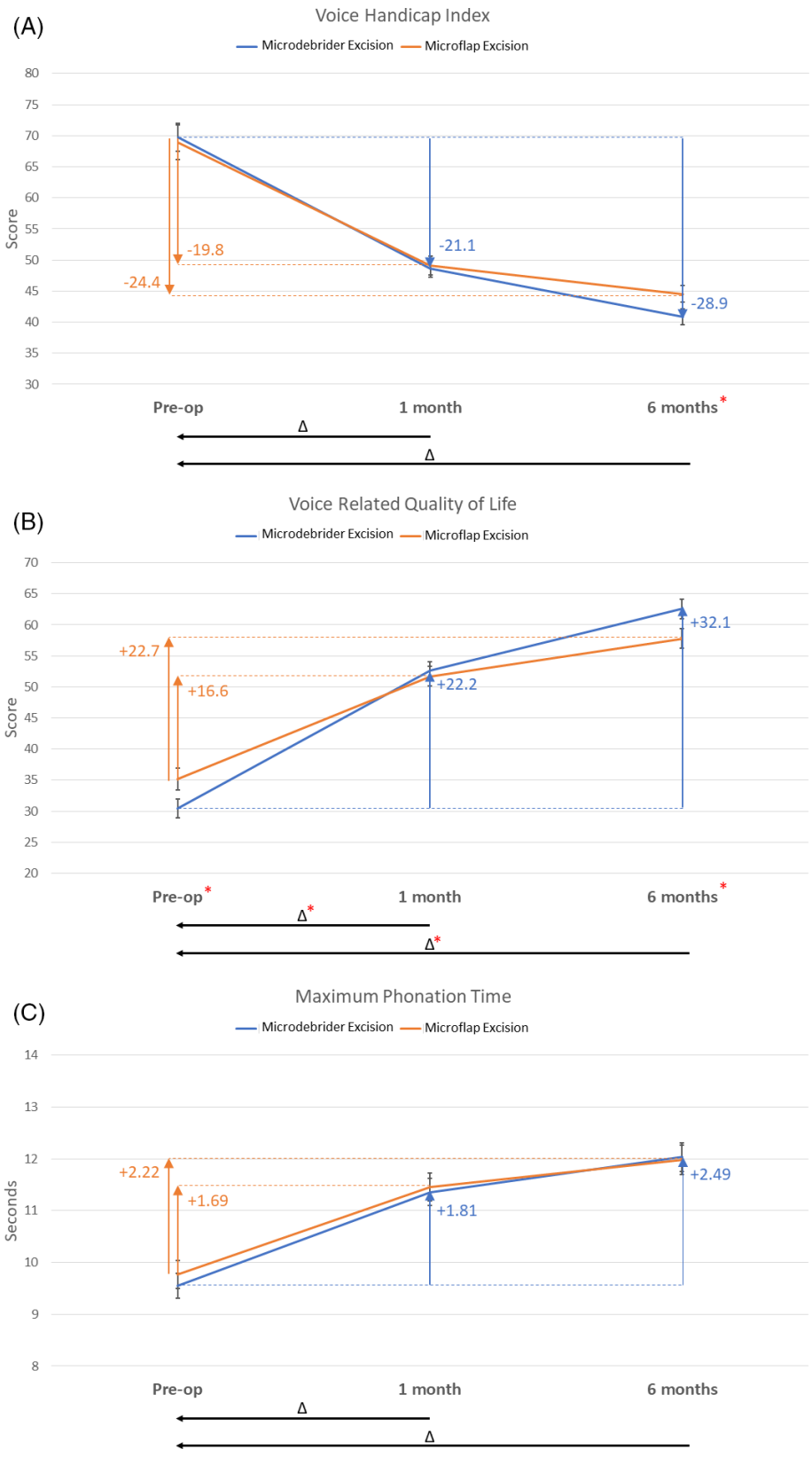

FIGURE 2 Outcomes of surgery compared by surgical technique (microflap excision vs. microdebrider excision) over time. Error bars represent standard error. Change in score from 1 and 6-months postoperatively demarcated by arrows from baseline score. (A) Voice Handicap Index scores preoperatively, 1-month postoperatively, and 6-months postoperatively. The asterisk notes a significant difference in comparison by surgical technique for the 6-month postoperative score only. There were no significant differences in the change in score from baseline. (B) Voice Related Quality of Life scores preoperatively, 1-month postoperatively, and 6-months postoperatively. Asterisks note significant difference in comparison by surgical technique for the preoperative score and the 6-month postoperative score. Additional asterisks mark significant differences in the change in 1-month postoperative from baseline as well as the change in 6-month postoperative from baseline. (C) The maximum phonation time preoperatively, 1-month postoperatively, and 6-months post operatively. There were no significant differences in any maximum phonation times or changes in maximum phonation time from baseline.

6 months with the microflap excision group (+22.67, CI −13.40 to −5.49) again increasing less than the microdebrider excision group (+32.12).

There were no significant differences in the MPT at preoperative, 1 month, and 6 months or changes in MPT when comparing the two surgical techniques (Figure 2C).

3.5 | Comparison of voice outcomes by grade of Reinke's edema

The VHI-30 was compared between the two subpopulations of grade II and grade III lesions (Figure 3A). There was a significant difference in the preoperative scores with grade II patients (64.83, CI −14.15 to −1.01) scoring lower voice handicap results than the grade III patients (72.41). Moreover, there was a significant difference in the 6-month postoperative score with grade II (40.25, CI −7.38 to −0.20) again scoring lower than the grade III (44.03). There was additionally a

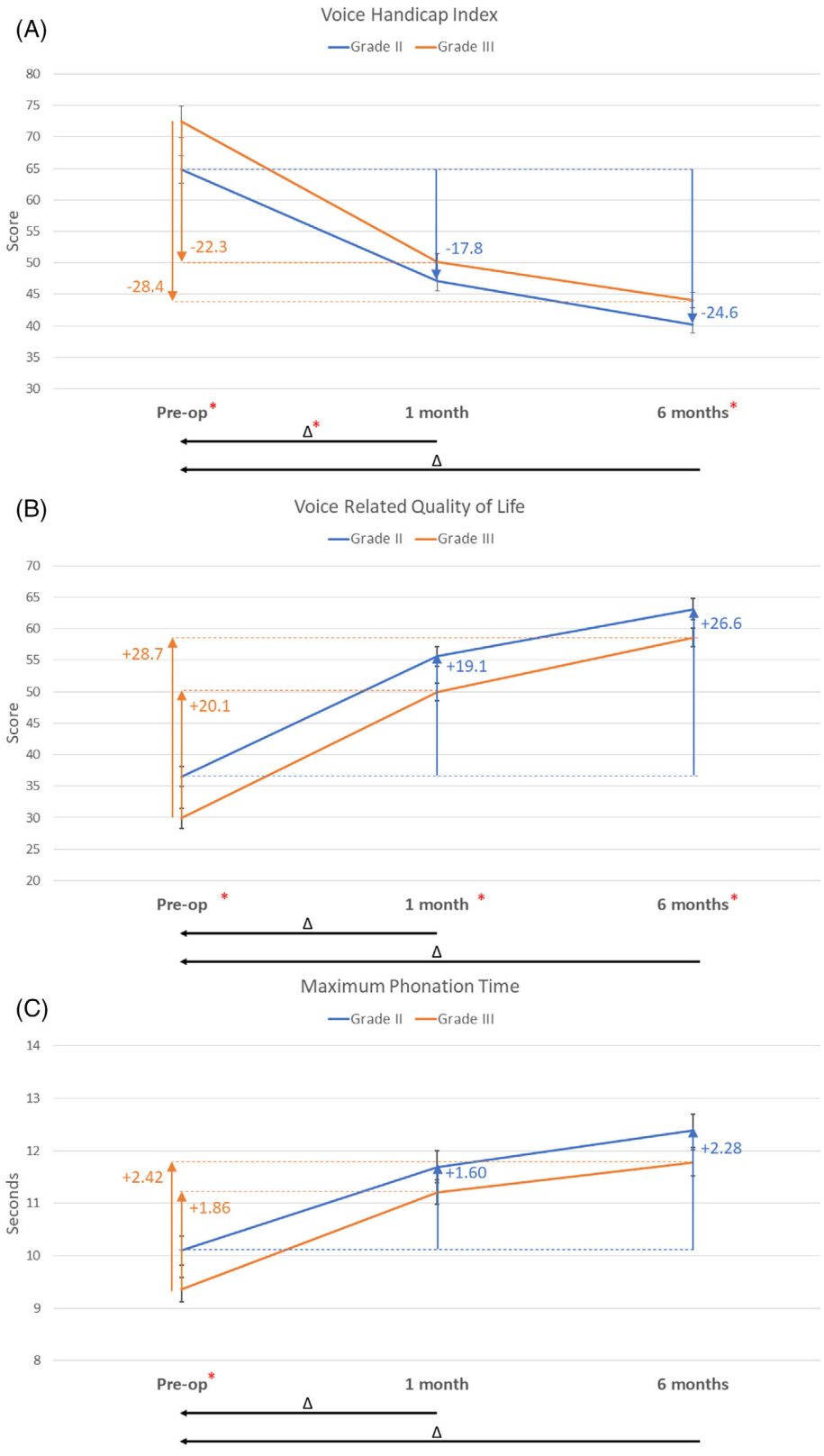

FIGURE 3 Outcomes of surgery compared by Reinke's grade (grade II vs. grade III). Error bars represent standard error. Change in score from 1 and 6-months postoperatively demarcated by arrows from baseline score. (A) Voice Handicap Index scores preoperatively, 1-month postoperatively, and 6-months postoperatively. The asterisks indicate a significant difference in comparison by Reinke's grade for the preoperative and the 6-month postoperative scores. Additionally, an asterisk indicates a significant difference in change from the 1-month postoperative to baseline scores. (B) Voice Related Quality of Life scores preoperatively, 1-month postoperatively, and 6-months postoperatively. Asterisks note significant differences between the two grades across the board for preoperative, 1-month postoperative, and 6-month postoperative scores. However, there were no significant differences in the changes of scores from 1-month or months to baseline. (C) The maximum phonation time preoperatively, 1-month postoperatively, and 6-months postoperatively. The asterisk marks a significant difference in maximum phonation time between the two grades preoperatively; otherwise, there were no other significant differences at 1 or 6 months. There were no significant differences in changes in maximum phonation time from baseline.

significant difference in the change in scores from preoperatively to 1-month postoperative with grade II (−17.78, CI 0.20–8.81) having a smaller decrease in score than grade III (−22.29).

The V-RQOL was compared between the two grades (Figure 3B). There was a significant difference in the preoperative scores with grade II (36.52, CI 2.18–11.05) scoring higher (less handicapped) than grade III (29.91). There was also a significant difference in the 1-month postoperative score with grade II (55.60, CI 1.47–9.79) again scoring higher than grade III (49.96). Lastly there was a significant difference in the 6-month postoperative score with grade II (63.10, CI 0.02–8.97) scoring higher than grade III (58.60).

There was a single significant difference in the preoperative MPT between grade II (10.10 s, CI 0.03–1.46) and grade III (9.35 s) (Figure 3C). Otherwise, there were no other significant differences in MPT or changes in MPT between the two Reinke's grades.

4 | DISCUSSION

Our study included 115 patients with high-grade (grade II or III) RE. The average age of our cohort was 52.4 years old with a slightly older age and a higher average pack year smoking history in the grade III patients (35.1) compared to the grade II patients (27.5). This would be expected as more time exposure to smoking could result in greater polypoid degeneration. This is in agreement with previous work by Marcotullio correlating amount of smoking and higher-grade lesions.[8] Interestingly we could not correlate packs per day smoking and grade of RE with there being no significant difference between the two groups, possibly resulting from patients inaccurately estimating their daily cigarette use over the years.

Symptom differences at presentation were also consistent with expectations. All patients had dysphonia as the main presenting symptom; however the grade III patients had significantly greater rates of dyspnea, globus sensation, and cough. These symptoms would logically correlate to greater bulk of polypoid degeneration within the larynx and airway creating a higher likelihood of airway and mucosal symptoms. Interestingly sore throat and total duration of symptoms were not significantly different between the two groups. We could not identify another study which found these significant differences between grade II and grade III patients. Yonekawa found similar differences in his patient cohort as well, but the groups were not compared statistically.[14] These associated symptoms could be due to other comorbid etiologies such as acid reflux or voice abuse as suggested by Kamargiannis et al., but this was not specifically studied in our patient groups.[47]

Our study also identified statistically significant differences in the preoperative VHI-30 scores, V-RQOL scores, and MPT between the RE grade II and grade III patient groups. This was expected as the two groups differed in disease severity as measured by vocal fold edema and its impact on the glottic airway. The ability to correlate grade of disease and overall patient related voice dysfunction and its impact on quality of life can add another useful clinical tool in decisions about patients medical versus surgical management. This is the first such comparison between RE grade II and grade III patients that shows a statistically significant difference in preoperative patient reported voice handicap and quality of life measures. This may add significant clinical utility in preoperative classification of these RE patients, initially as low grade (grade I) versus high grade (grade II and III) and then further within the high-grade group to gain valuable insight into patient-related disease severity.

Surgical management of RE has been the gold standard for treatment of high-grade lesion for decades.[19] Current practice dictates maximum preservation of epithelium and judicious resection of excess soft tissue from the SLP to ensure optimum postoperative laryngeal function. For this reason, the microflap excision and microdebrider procedures have endured as two of the standard microlaryngoscopic options for RE resection. Both procedures allow precise tissue removal, ability to sample tissue for pathology, and are generally readily available at many surgical centers with limited need for extremely specialized or expensive equipment. Our results found both procedures to significantly improve patient VHI-30, V-RQOL, and MPT in both RE grade II and grade III patient groups. These significant improvements in our three measures were identified at 1 month and continued to improve at 6 months in both procedure groups and both grade groups. Previous studies have shown that the minimal clinically meaningful difference in VHI-30 scores has been 13 points, suggesting that the improvements in VHI-30 score postoperatively were not only statistically but also clinically meaningful.[48] Although the change in VHI-30 and MPT at 6 months was somewhat greater in the microdebrider surgical group, this did not meet statistical significance. Therefore, we conclude that the two procedures performed similarly for these measures. The microdebrider group achieved statistically significantly better overall 6-month VHI scores, but this did not meet clinical significance. The microdebrider group also had significantly greater improvement in V-RQOL scores at 6 months when compared to the microflap surgical group which could suggest a small advantage in our microdebrider surgical group based on the patient-related voice measure of V-RQOL with a difference of 10 points. It is possible that this statistical significance between the two procedural groups may not reflect meaningful clinical significance between the surgical outcomes. Further studies should be done to identify the minimal clinically important difference for the V-RQOL as well as potential measures that the V-RQOL is capturing differently than the VHI-30.

It should be noted that our patients were not randomized but done consecutively, with the first 52 done by microflap excision and the next 63 done by microdebrider. This could have led to bias based on the technical experience of the lead laryngologic surgeon and perhaps differences in surgical outcomes. Furthermore, all cases were done in a tertiary teaching institution with resident assistance possibly contributing to potential bias in comparing surgical groups. Although the primary goal was to measure patient reported voice quality and quality of life, it must be noted that we did not correlate these findings with more objective measure such as GRBAS, videostroboscopic findings, or multidimensional voice analysis technology. The value of MPT as a rough measure of glottic competence has been controversial

and perhaps not as accurate as full glottic analysis software and other quantitative airflow measures.[49] We certainly acknowledge the lack of a true objective instrument as a limitation in comparison of our study groups.

5 | CONCLUSION

High-grade RE patients presented with significant vocal dysfunction and reduced overall voice-related quality of life. Yonekawa grade III patients furthermore presented with significantly more associated airway symptoms including dyspnea, globus, and cough. Total smoking exposure measured in pack years correlated with overall RE grade severity. Preoperative VHI-30, V-RQOL, and MPT differed significantly between the RE grade II and grade III groups suggesting this as a useful simple preoperative tool to evaluate overall vocal dysfunction. Both microflap excision and microdebrider excision for high-grade RE lesions resulted in significant improvement in VHI-30 and MPT at 1-month and 6-months postoperative. The microdebrider surgical group was noted to have statistically significantly improved scores in VHI-30 and V-RQOL scores at 6 months compared to the microflap surgical group which may or may not reflect clinical significance. Overall, the results support the use of both surgical modalities for treating high-grade RE patients.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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