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ORIGINAL RESEARCH

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Risk factors for postoperative vocal fold fibrosis following microlaryngeal surgery

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Abstract

Objective: To analyze the risk factors for postoperative vocal fold fibrosis (PVF) in patients undergoing microlaryngeal surgery (MLS) for benign vocal fold lesions.

Study Design: Retrospective study.

Methods: We retrospectively included patients who had undergone MLS for vocal polyps, nodules, mucus retention cysts, fibrous mass, or Reinke's edema. Data on the patients' clinicodemographic characteristics and intraoperative findings were obtained by reviewing their clinical records. PVF was defined by the presence of an adynamic segment of membranous vocal folds or a marked reduction in mucosal wave amplitude on post-MLS (6 weeks) videolaryngostroboscopy. The risk factors for PVF were analyzed through univariate and multivariate logistic regressions.

Results: This study included 89 patients, of whom 16 (18%) were given a diagnosis of PVF. A significantly increased incidence of PVF was noted in patients with fibrous mass ($p < .01$). The univariate analysis indicated that lesion attachment to the vocal ligament, prolonged surgical duration (>60 min), and symptom duration (>12 months) were significantly correlated with PVF ($p < .05$). The multivariate analysis confirmed that diagnosis of fibrous masses, lesion attachment to the vocal ligament and symptom duration are significant risk factors for PVF.

Conclusion: PVF is more common in patients with fibrous masses. Lesions attachment to the vocal ligament and prolonged symptom duration appear to be other significant risk factors for PVF.

Level of Evidence: 4

KEYWORDS
benign vocal fold lesions, microlaryngeal surgery, postoperative vocal fold fibrosis, risk factors, videolaryngostroboscopy

1 | INTRODUCTION

Benign vocal fold lesions (BVFLs), such as polyps, cysts, and Reinke's edema, are common causes of hoarseness.[1] Microlaryngeal surgery (MLS) is indicated for patients with BVFLs for whom conservative treatment is ineffective. Although the condition of most patients considerably improves after MLS,[2,3] prolonged postoperative dysphonia is common (incidence rate, 5%–10%).[4,5] The predominant cause of prolonged postoperative dysphonia is vocal fold scarring or fibrosis.[6] Other possible causes include residual or recurrent lesions, functional dysphonia, and

tissue granulation.[7] Most of the aforementioned conditions can be successfully managed with medications, voice conservation, and voice therapy. Postoperative vocal fold fibrosis (PVF), which may not be fully reversible, is a cause of distress for patients with this condition. Therefore, identifying the potential cause of PVF and preventing the development of this condition are crucial for laryngologists and phonosurgeons.

Thus far, nearly no numerical data of PVF following MLS were available in the literature; furthermore, few studies have explored the possible prognostic factors for PVF.[4,6] Therefore, we conducted the present study to identify the risk factors for PVF in patients with BVFLs undergoing MLS and provided more supporting evidence. Information on potential surgical outcomes can be useful for preoperative counseling. Furthermore, such information may markedly reduce the likelihood of conflicts between patients and surgeons in the case of suboptimal surgical outcomes.

2 | MATERIALS AND METHODS

We retrospectively reviewed patients with BVFLs who had undergone MLS at the study hospital between December 2020 and April 2022. Because of the retrospective nature of this study, the requirement for informed consent was waived. The cohort had received the following diagnoses: vocal polyps, vocal nodules, mucus retention cysts, fibrous masses, and Reinke's edema.[1] Patients who received a diagnosis of precancerous lesions or laryngeal papillomatosis and those who were lost to follow-up were excluded from the analysis. All patients had undergone MLS under general anesthesia through endotracheal intubation performed using small-diameter endotracheal tubes. All MLS procedures were performed by a single surgeon (C.-T. W.) by using standard microflap techniques with cold microinstruments.[8] Intraoperative findings, such as microflap tear, surgical duration, and lesion attachment to the vocal ligament, were carefully recorded in surgical notes. All patients were instructed to rest their voice for 7 days after MLS. This study was approved by the Research Ethics Review Committee (FEMH-IRB No.:108044-E).

PVF was clinically diagnosed on the basis of the observation of an adynamic segment of membranous vocal folds or a prominent reduction in mucosal wave amplitude on videolaryngostroboscopy (VLS), which was performed 6 weeks after MLS.[5,9] To identify the potential prognostic factors for PVF, we obtained the following data from the patients' clinical records: clinicodemographic characteristics, diagnosis, surgical duration, prior surgery, and intraoperative steroid injection.

The risk factors for PVF were analyzed through univariate and multivariate logistic regressions. The variables with a p value of <.05 in the univariate analysis were included in the multivariate analysis performed using the backward logistic regression method. All statistical analyses were performed using SPSS (version 18.0; IBM Corporation, Armonk, NY, USA). A p value of <.05 indicated statistical significance.

3 | RESULTS

Between December 2020 and April 2022, 103 patients with BVFLs had undergone MLS at our hospital. Ten patients were excluded

TABLE 1 Univariate analysis of benign vocal fold lesions and postoperative fibrosis in the study cohort.

	Fibrosis ($n = 16$)	No fibrosis ($n = 73$)	OR (95% CI)	p Value
Polyps (y/n)	1/15	25/48	0.128 (0.016–1.026)	.053
Mucous retention cysts (y/n)	8/8	34/39	1.147 (0.389–3.386)	.804
Fibrous masses (y/n)	7/9	6/67	8.685 (2.382–31.66)	.001
Reinke's edema (y/n)	0/16	3/70	-	.999
Nodules (y/n)	0/16	5/68	-	.999

Abbreviations: CI, confidence interval; OR, odds ratio.

TABLE 2 Results of univariate analysis performed to identify the risk factors for postoperative vocal fold fibrosis.

	Fibrosis ($n = 16$)	No fibrosis ($n = 73$)	p Value	OR	95% CI
Sex (M/F)	3/13	24/49	.274	0.471	0.123–1.812
Age (>45/≤45)	7/9	34/39	.837	0.892	0.300–2.652
Alcohol (y/n)	2/14	23/50	.136	0.304	0.064–1.452
Smoking (y/n)	0/16	22/51	.998	-	-
Attachment to the vocal ligament (y/n)	9/7	18/55	.017	3.929	1.279–12.07
Microflap tear (y/n)	7/9	29/44	.767	1.180	0.395–3.522
Microflap suture (y/n)	1/15	5/68	.931	0.907	0.099–8.337
Intraoperative steroid injection (y/n)	5/11	39/34	.116	0.396	0.125–1.255
Surgical duration (>60 min/≤60 min)	6/10	7/66	.008	5.657	1.577–20.29
Prior microsurgery (y/n)	4/12	17/56	.789	1.187	0.337–4.187
Symptom duration (>12 m/≤12 m)	8/8	11/62	.001	7.247	2.232–23.53

Abbreviations: CI, confidence interval; OR, odds ratio.

TABLE 3 Results of multivariate analysis performed to identify the risk factors for postoperative vocal fold fibrosis.

	Fibrosis ($n = 16$)	No fibrosis ($n = 73$)	p Value	OR	95% CI
Attachment to the vocal ligament (y/n)	9/7	18/55	.035	4.168	1.108–15.68
Symptom duration (>12 m/≤12 m)	8/8	11/62	.005	6.860	1.801–26.13
Fibrous masses (y/n)	7/9	6/67	.004	8.915	2.004–39.65

Abbreviations: CI, confidence interval; OR, odds ratio.

because of precancerous lesions or laryngeal papillomatosis, and four patients were lost to follow-up. Finally, 89 patients (age: range, 16–77 [median, 41] years; men, 27) were included in this study. Regarding diagnosis, 26, 42, 13, 3, and 5 patients were given a diagnosis of vocal polyps, mucus retention cysts, fibrous masses, Reinke's edema, and vocal nodules, respectively. Sixteen patients (18%) exhibited markedly reduced or absent mucosal wave amplitudes on post-MLS VLS and were subsequently given a diagnosis of PVF. Among the 16 patients, 1 (6.3%), 8 (50%), and 7 (43.8%) patients were given a diagnosis of vocal polyps, mucus retention cysts, and fibrous masses, respectively. The risks of PVF in each benign pathology were analyzed in Table 1. A significantly increased rate of PVF was observed in patients with fibrous masses ($p < .01$; OR: 8.685; Table 1).

Table 2 presents the results of the univariate analysis performed to identify the potential risk factors for PVF. The following were determined to be significantly correlated with PVF ($p < .05$): lesion attachment to the vocal ligament, surgical duration >60 min, and symptom duration >12 months. No significant correlation was noted between PVF and patient demographics, such as age, sex, cigarette smoking, and alcohol consumption. Table 3 presents the results of the multivariate analysis, which revealed that PVF was significantly correlated with fibrous masses, lesion attachment to the vocal ligament and symptom duration >12 months.

4 | DISCUSSION

Common causes of vocal fold fibrosis include laryngeal trauma, intubation, radiotherapy, phonotrauma, inflammatory disorders, and phonomicrosurgery.[10,11] Vocal fold fibrosis results in the loss of the normal pliability of the vocal fold lamina propria. The potential mechanisms include the disorganization of collagen bundles, loss of key extracellular matrix components, and excessive tissue removal during MLS (i.e., cookie-bite appearance on VLS).[6] In patients with vocal fold fibrosis, stroboscopy generally reveals irregularity, asymmetry, and adynamic segments in the mucosa and a reduced amplitude of mucosal waves. Considering the heavy load of routine phonomicrosurgery, PVF is relatively uncommon. However, it substantially reduces patients' quality of life; their voice quality may even worsen after surgery.[5] In Shin et al., 39 of 755 patients developed persistent dysphonia after undergoing phonomicrosurgery for benign vocal fold disease; excessive scarring or bowing was noted in 21 of the aforementioned 39 patients.[4]

The management of PVF is challenging. Although numerous treatment modalities, including medialization laryngoplasty, angiolytic laser, and tissue engineering, have been developed for PVF, treatment outcomes are unpredictable and inconsistent.[10] Consequently, the prevention of PVF and the identification of its potential prognostic factors are crucial for phonosurgeons. Various phonotraumatic lesions may be associated with the development of PVF. We discovered that patients with fibrous masses were highly susceptible to PVF. Fibrous masses are typically amorphous masses without discrete encapsulation and are likely to be associated with fibrotic regeneration following a lamina propria injury. These characteritics make it challenging for surgeons to dissect fibrous masses without damaging the vocal ligament. Thus, as noted in the present study, PVF is common in patients with fibrous masses.

A prolonged symptom duration (>12 months) was found to be correlated with PVF. Patients having BVFL symptoms for a prolonged period may experience repeat episodes of phonotrauma, which may result in the chronic inflammation or fibrosis of vocal folds. During phonomicrosurgery, the dissection of these dense fibrotic tissues may cause damage to the layered structure of vocal folds, leading to PVF. This information is important for clinical decision because an early surgical intervention may be associated with better treatment outcome.

Other risk factors for PVF include techniques used for phonomicrosurgery. During phonomicrosurgery, the layered microstructure must be preserved carefully, and the lesion should be removed precisely.[12] We discovered that lesion attachment to the vocal ligaments is significantly correlated with PVF. If lesions are deeply seated and densely attached to the vocal ligament, they must be conservatively removed while preserving the vocal ligament, even at the cost of residual lesions along the vocal ligament. Restated, the preservation of the vocal ligament may be prioritized over complete lesion removal. We also found that prolonged surgical duration is a risk factor for PVF; this finding indicates the negative effects of over-manipulation and over-dissection during MLS. On the other hand, intraoperative steroid injection did not show significant protective effect for the development of PVF in our cohort. Further prospective, randomized study is mandatory to validate the effectiveness of this historical anecdotal practice routine of intraoperative steroid injection.

This study has some limitations. This was a single-surgeon, single-center study; therefore, the findings may not be generalizable to all patients undergoing MLS for BVFLs because different surgical techniques or surgeon's abilities could significantly impact the outcomes of MLS. In addition, owing to the small sample size, some potential risk factors might have been missed and it would be difficult to draw definite conclusions for the current study results. This study set the presence of PVF was at 6 weeks after MLS according to a previous literature,[5] we were not able answer whether some of the patients with PVF might have recovered spontaneously if they were followed

up for a longer period of time. On the contrast, 9 of the 16 patients showing PVF received adjuvant in-office vocal fold steroid injections to prevent further scar development,[5] which makes us unable to provide an estimation of the risk of long-term scaring. Further prospective study with a longer observation interval and a placebo or control group may overcome this limitation from the current retrospective design.

5 | CONCLUSIONS

Among BVFLs, PVF is more prevalent in patients with fibrous masses. Our findings indicate that lesion attachment to the vocal ligament and prolonged symptom duration are significant risk factors for PVF. Phonosurgeons should maximally preserve the integrity of the vocal ligament while avoiding over-dissection or over-manipulation the superficial lamina propria. Our study results also suggest early removal of vocal lesions because a prolonged disease course may lead to PVF in patients undergoing MLS.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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REFERENCES

1. Ingle JW, Rosen CA. Benign vocal fold lesions and phonomicrosurgery. In: Johnson JT, Rosen CA, eds. *Bailey's Head and Neck Surgery Otolaryngology*. Lippincott WIlliams & Wilkins; 2014:989-1003.
2. Bastian RW. Vocal fold microsurgery in singers. *J Voice*. 1996;10(4):389-404.
3. Zeitels SM, Hillman RE, Desloge R, Mauri M, Doyle PB. Phonomicrosurgery in singers and performing artists: treatment outcomes, management theories, and future directions. *Ann Otol Rhinol Laryngol Suppl*. 2002;190:21-40.
4. Shin YS, Chang JW, Yang SM, Wu HW, Cho MH, Kim CH. Persistent dysphonia after laryngomicrosurgery for benign vocal fold disease. *Clin Exp Otorhinolaryngol*. 2013;6(3):166-170.
5. Hsu YC, Liao LJ, Huang TW, Wang CT. Assessment of patient outcomes after adjuvant vocal fold steroid injection for fibrosis after microlaryngeal surgery. *JAMA Otolaryngol Head Neck Surg*. 2019;145(9):811-816.
6. Woo P, Casper J, Colton R, Brewer D. Diagnosis and treatment of persistent dysphonia after laryngeal surgery: a retrospective analysis of 62 patients. *Laryngoscope*. 1994;104(9):1084-1091.
7. Sulica L, Simpson CB, Branski R, McLaurin C. Granuloma of the membranous vocal fold: an unusual complication of microlaryngoscopic surgery. *Ann Otol Rhinol Laryngol*. 2007;116(5):358-362.
8. Rosen CA, Simpson CB. *Operative Techniques in Laryngology*. Springer; 2008.
9. Rosen CA, Gartner-Schmidt J, Hathaway B, et al. A nomenclature paradigm for benign midmembranous vocal fold lesions. *Laryngoscope*. 2012;122(6):1335-1341.
10. Rosen CA. Vocal fold scar: evaluation and treatment. *Otolaryngol Clin North Am*. 2000;33(5):1081-1086.
11. Friedrich G, Dikkers FG, Arens C, et al. Vocal fold scars: current concepts and future directions. Consensus report of the Phonosurgery Committee of the European Laryngological Society. *Eur Arch Otorhinolaryngol*. 2013;270(9):2491-2507.
12. Ford CN. Advances and refinements in phonosurgery. *Laryngoscope*. 1999;109(12):1891-1900.

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