Received: 12 March 2021 | Accepted: 20 April 2021

DOI: 10.1002/lio2.573

ORIGINAL RESEARCH

Laryngoscope Investigative Otolaryngology

Voice assessment of fat injection vs medialization laryngoplasty in nonparalytic dysphonia

Sarah K. Rapoport MD[1] | Thomas Murry PhD[2,3] | Peak Woo MD[1]

[1]Department of Otolaryngology Head and Neck Surgery, Mount Sinai Medical Center, New York, New York, USA

[2]Department of Otolaryngology-Head and Neck Surgery, Loma Linda Health University, Loma Linda, California, USA

[3]Department of Otolaryngology-Head and Neck Surgery, Drexel University College of Medicine, Philadelphia, Pennsylvania, USA

Correspondence
Sarah K. Rapoport, Mount Sinai Hospital, 1 Gustave L. Levy Place, Annenberg 10-40 Box 1189, New York, NY 10029, USA.
Email: sarah.k.rapoport@gmail.com

Abstract

Objective: Compare long-term voice outcomes in patients treated with FIM or BML for nonparalytic dysphonia. There is controversy whether fat injection medialization (FIM) is a durable alternative to bilateral medialization laryngoplasty (BML) for nonparalytic dysphonia (atrophy, sulcus, scar, paresis). Both interventions yield improved voice quality, yet comparison of patients' long-term perceptions of their voice after these procedures has not been performed.

Methods: Retrospective review of patients who underwent FIM or BML for nonparalytic dysphonia was performed from 2008-2018. Charts were reviewed for demographic information, preoperative diagnosis, intervention, Voice Handicap Index-10 (VHI-10), and follow-up time.

Results: Forty-nine patients met our criteria. Fifty procedures were performed (25 FIM, 25 BML). One patient underwent BML with subsequent FIM. There was no significant difference in pre-treatment or post-treatment VHI-10 scores between both groups (Pre-FIM 21 Post-FIM 10.28; Pre-BML 22.48, Post-BML 10.88). Total median follow-up time was 11.3 months (FIM 14.8 months, BML 9.5 months). Using VHI-10 scores recorded at each patient's latest follow-up visit, both groups demonstrated significant decrease ($P < .05$) compared to preoperative scores: VHI-10 decreased by a mean delta of 10.72 in the FIM group and 11.6 in the BML group. There was no significant difference in pre, post and change in VHI between groups.

Conclusions: In patients with nonparalytic dysphonia, FIM is a durable alternative to BML. Patients treated in both groups gained substantial improvement in vocal function. For both treatment groups, we should anticipate less than complete satisfaction with surgery and revision procedures in a minority of patients.

Level of Evidence: IV.

KEYWORDS

fat injection medialization, medialization laryngoplasty, nonparalytic dysphonia, VHI-10

This project was accepted as a poster presentation to the 2021 American Laryngological Association COSM Meeting.

1 | INTRODUCTION

Glottic insufficiency from benign etiologies of nonparalytic dysphonia such as vocal fold atrophy, sulcus vocalis, and paresis commonly results in debilitating voice changes in patients across all age groups. As a result of these underlying conditions, individuals with nonparalytic dysphonia develop diminished vocal endurance. Their once-robust voices become breathy, weak and asthenic with limited capacity for vocal projection.

Improved quality of phonation has been reliably achieved with both medialization and injection laryngoplasties by medializing scarred or atrophic vocal folds to improve glottic closure.[1-3] Augmentation of vocal folds with either medialization laryngoplasty or injection medialization with fat are two interventions that have resulted in improvement in voice quality.[4,5] There is controversy whether one approach is more durable than another.[6] Yet, an evaluation comparing patients' perceptions of their voice outcomes after these two distinct procedures has not been performed. While both procedures have demonstrated clinical success in treating nonparalytic dysphonia, it is paramount to consider patients' own perceptions of their outcomes after these interventions to ensure that patients are provided with the optimal vocal quality they seek. To better counsel patients between choices of surgery, the specific objective was to compare how patients with nonparalytic dysphonia perceive improvements in their voice before and after vocal fold augmentation with either bilateral medialization laryngoplasty (BML) or autologous fat injection medialization (FIM).

2 | MATERIALS/METHODS

2.1 | Patient selection

Institutional Review Board approval was obtained at the Mount Sinai Health System in New York City. A retrospective review was performed of all patients treated by the senior author between January 2008 and December 2018. Those patients underwent bilateral treatment for nonparalytic dysphonia (ie, vocal fold paresis, vocal fold atrophy or type I sulcus vocalis) with either bilateral injection medialization with autologous fat or bilateral medialization laryngoplasty. The decision to proceed with one or the other treatment option was based on patient's preference after discussion of the risks and benefits of the treatment options. A diagnosis of vocal fold atrophy was made based on vocal fold appearance on videostroboscopy (ie, thin vocal folds with prominent vocal processes and bowing of vocal folds, epithelial invagination on the medial vocal fold with apparent groove[7]). The cohort of patients in this study included nonparalytic dysphonia patients due to sulcus vocalis, vocal atrophy and suspected vocal fold paresis. Patients with concurrent mid-membranous lesions on their vocal folds, prior framework surgery, or prior history of cancer resection were excluded.

2.2 | Surgical technique

The senior author (P.W.) performed and/or supervised all injection augmentations and medialization laryngoplasties. Fat injection was done under outpatient general anesthesia. Autologous fat was harvested from the patient's periumbilical abdominal fat and rinsed with Lactated Ringers and Depo-Medrol (methylprednisone acetate injectable suspension, Pfizer). The fat was placed into a 3.0 mL Brunnings-type syringe (Instrumentarium L.70.593.18) lipoinjector device. A straight needle was attached to the injection pistol. The fat was injected lateral to the thyroarytenoid muscle until the vocal fold was medialized and over-injected by approximately 40%, as described in previous literature.[8,9] Medialization laryngoplasties were performed under local anesthesia, as previously described in the literature,[10] with a hand-carved Silicone block (Bentec Medical, Inc., Woodland, California). No complications were observed in our cohort of patients in the days following their procedures.

2.3 | Data collection and analysis

Medical records were reviewed for patient demographic information, preoperative diagnosis, history of prior interventions performed, Voice Handicap Index-10 (VHI-10) scores, and follow-up times. The VHI-10 is a validated tool used to quantify a patient's own perception of his/her voice handicap.[11] Operative reports were reviewed for details on procedural technique. Treatment groups were compared with parametric testing.

3 | RESULTS

Forty-nine patients were found to meet the inclusion criteria. Diagnosis of nonparalytic dysphonia was made due to thinning or bowing of the vocal folds with prominent vocal processes, or notable groove on the medial surface of the vocal fold consistent with a sulcus vocalis in the presence of bilateral motion of the vocal folds.

Fifty procedures were performed with a total of 25 FIMs and 25 BMLs. The patient demographics and underlying etiologies of nonparalytic dysphonia in each cohort is summarized in Table 1. One patient underwent BML with subsequent FIM. The indications for BML were bilateral atrophy in 16/25 (64%) patients, unilateral vocal fold paresis with concurrent atrophy in 5/25 (20%) patients, and sulcus vocalis in 4/25 patients (16%). Among the patients who underwent FIM, 14/25 (56%) patients had vocal fold atrophy, 7/25 (28%) patients had sulcus vocalis, and 4/25 (16%) patients had concurrent paresis and atrophy. The entire age range of our patient cohorts was 19-87 years of age (SD in FIM = 15.7, SD in BML = 14.7). The age range was 28-87 years of age (1 female, 24 males) in the BML group vs an age range of 19-72 years of age (10 females, 15 males) in the FIM group.

3.1 | Voice Handicap Index-10

Figure 1 is a graphical representation of change in the VHI in the two groups. Table 2 summarizes the mean VHI score before and after treatment and the delta VHI-10 score. There was no significant difference in pretreatment VHI-10 scores between both groups. In an effort to assess each patient's perception of their vocal change as far out from the intervention as possible, we used each patient's most recent VHI-10 score recorded in the medical record. Median follow-up time for both groups was 11.3 months (BML 9.5 months, FIM 14.8 months). Both groups demonstrated a significant decrease in VHI-10 scores when comparing pretreatment to posttreatment VHI-10 scores (BML VHI-10 scores decreased from a mean of 22.48-10.88, $P < .0001$; FIM VHI-10 scores decreased from a mean of 21-10.28, $P < .00001$). VHI-10 scores decreased by a mean delta of 11.6 in the BML group and 10.72 in the FIM group. No significant difference was observed when comparing the degree of change (delta) between pretreatment and posttreatment VHI-10 scores between the two groups (Table 2, Figure 1).

TABLE 1 Breakdown of patient characteristics in BML and FIM Cohorts

	BML	Fat
Age range	28–87	19-72
Gender	Males 24	Males 15
	females 1	females 10
Diagnoses		
Scar	1	7
Atrophy	16	14
Paresis	5	4
Sulcus + Paresis + Atrophy	3	0

Note: The demographic characteristics and underlying etiologies of nonparalytic dysphonia of the patients who underwent treatment with BML and FIM.

4 | DISCUSSION

A fundamental difference between BML and FIM is that the silastic implants placed during BMLs remain unchanged over time, whereas the autologous fat in FIMs will be partially resorbed. Moreover, the rate of resorption vs survival of the adipose cells over time is unclear and therefore unpredictable. Controversies persist as to whether the outcome from FIM is equivalent to that observed with BML. In a smaller study, long-term results with FIM were not equal to BML.[6] The latter was not reflected in our team's experience with patients undergoing FIM and BML. The median periods of follow-up between this study and Dominguez et al.'s study were comparable, and therefore unlikely to account for the difference in patient outcomes between their study and this present study. Likely reasons for this difference in outcomes between the Dominguez et al study and this study may include the smaller patient cohort studied by Dominguez et al. as well as divergences in their technique from our team's technique for lipoinjection.

There are various details of our team's fat harvest, preparation, and injection technique—honed over the years through trial and error—which may contribute to the results of this study. During harvest of the adipose tissue, the present team avoided use of all monopolar and bipolar electrocautery and also manipulated the bundles of adipose as little as possible, so they are removed in preserved clusters of adipose. Then, after rinsing the adipose with lactated

TABLE 2 Summary of mean patient-reported VHI-10 scores for each intervention

	Initial VHI-10	Final VHI-10	Delta VHI-10
BML	22.48	10.88	11.6
FIM	21	10.28	10.72

Note: Comparing mean VHI-10 scores in both the BML and FIM patient cohorts prior to treatment and after treatment. Median follow-up time for both groups was 11.3 months (BML 9.5 months, FIM 14.8 months).

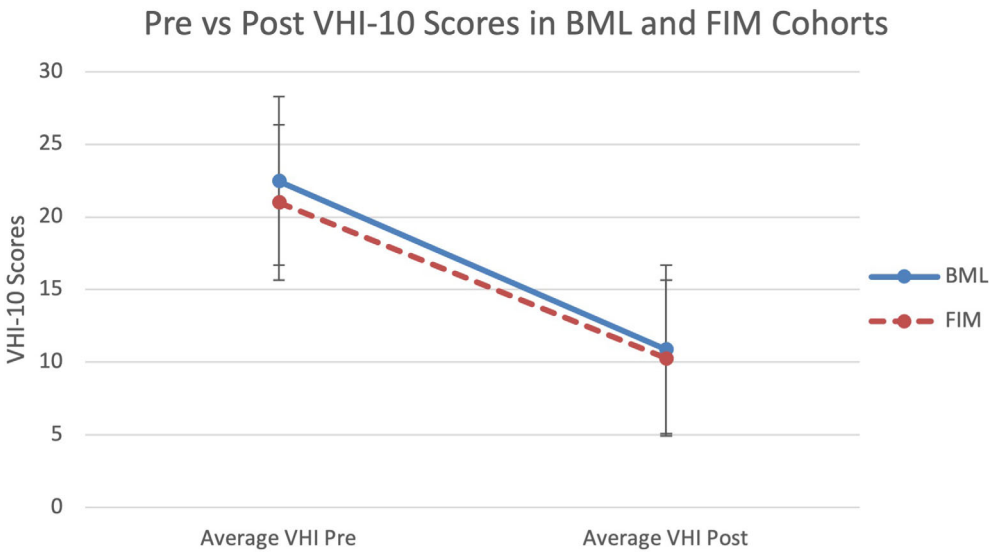

FIGURE 1 Pre and post VHI scores in BML and FIM Cohorts. Comparing mean VHI-10 scores in both the BML and FIM patient cohorts prior to treatment and after treatment. Median follow-up time for both groups was 11.3 months (BML 9.5 months, FIM 14.8 months)

ringers and steroid—a step also performed by Dominguez et al. in their smaller study—the present team used a scalpel to sharply cut the clusters of adipose into 1-2 mm size pieces. Next, during lipoinjection, a single-puncture injection was performed along the lateral vocal fold. Lastly, a large-bore needle such as an 18-gauge needle was used by the present team when injecting the fat to reduce crush injury and trauma to the adipose tissue during the lipoinjection. This detail was adapted from techniques described for optimizing fat injection and implantation for repairing parotid defects after parotidectomy.[12]

Several groups have attempted to establish the rate of survival of adipose after lipoinjection. In one study, three-dimensional computerized tomography (CT) scans were performed at a mean of 26 months after autologous fat injection for treatment of unilateral vocal fold paralysis.[9] In that study, a mean of 1.2 mL was injected into 28 paralyzed vocal folds. They determined that a residual volume of 0.39 mL remained at the time of the three-dimensional CT scan.[13] Despite this significant rate of resorption, studies looking at acoustic analyses after medialization laryngoplasty vs autologous fat injection medialization have demonstrated that speaking fundamental frequency and sound pressure levels remain equivocal.[14] Despite the unpredictable nature of fat resorption, the autologous nature of the injectate remains a reassuring benefit as various other media such as Teflon, calcium hydroxyapatite and even hyaluronic acid have resulted in unwanted injection-related complications.[15,16]

In this study, the decision was made not to look at rates of fat absorption or fibrosis and instead focus on each of the patients' ratings of their own voice outcome after their procedure, as that factor would be the central influence for whether to proceed with further treatment after recovery. The minimal important difference for VHI-10 scores in patients with dysphonia is reported to be a score of 6 on the VHI0-10.[17] The mean delta in pre and posttreatment VHI-10 scores for both FIM and BML cohorts exceeds a change of 6 points on their VHI-10 surveys. In this study, the team elected to compare the patients' VHI-10 scores at two discreet points in time—the patient's pretreatment score and the patient's long-term posttreatment VHI-10 score—to avoid the bias that can occur when outcomes are compared over shorter periods of follow-up time. The results were surprising in that treatment with FIM and BML achieved comparable results. Comparing patients' long-term voice outcomes for BMLs with a silastic implant with FIMs fills a current gap in counseling and recommendation of treatment modality for nonparalytic dysphonia. As we demonstrated here, patients' equivocal perception of voice improvement regardless of treatment modality was consistent across all ages treated. Patients' perception of similar long-term effectiveness for both BML and FIM in the case of nonparalytic dysphonia bolsters the reliability of both modalities. Sharing this finding when counseling patients who are weighing the benefits and risks of each modality suggests that patients who choose to have FIM are just as likely to be satisfied with their voice outcome at one year as compared to patients who chose to undergo BML.

Despite the possibility of further absorption of fat over time, this was not noted in our current study's outcomes. In this current case series, the number of patients who returned for additional treatment after one year was 1/25 (4%) in the BML cohort and 3/25 (12%) in the FIM cohort. This finding suggested that there is a low but real rate of revision needed in each treatment arm. These findings should be discussed with the patient at the time of surgical consultation.

The problem of what to offer patients with nonparalytic dysphonia and glottis incompetence is the primary issue the authors sought to address in this study. While some believe that BML is superior to FIM for nonparalytic dysphonia, the experience and data reflected in this study differs from subsequent findings presented in the literature. The latter served as the impetus for this present study. While this study is nonrandomized, the data supports that there are no significant differences between the two patient cohorts such as age, gender, etiology of dysphonia, or mean follow-up duration. As a result, this study is sufficiently powered to answer the question of whether there is a difference in treatment between the FIM and BML when presented to a patient seeking augmentation. When there is no obvious patient perceived difference in outcome, then patient preference regarding treatment option is appropriate to guide selection of the treatment modality.

The underlying individual etiologies (ie, paresis, atrophy, sulcus, and overlapping combinations of these diagnoses) of nonparalytic dysphonia can affect the vibratory margin of the vocal folds to different degrees. While BML does not modify the vibratory margin of the vocal fold, FIM can result in greater vocal fold mass. Sub-group analysis of the VHI-10 for each cohort did not demonstrate that one treatment was superior to the other. Additionally, there was no difference in distribution of treatment preference between the two treatment arms. As both groups fall under the categorization of medialization for nonparalytic dysphonia, we chose to present the data as one treatment arm vs another for the group of patients with nonparalytic dysphonia.

To best assess the impact of each procedure on the voice, this study looked at the VHI outcomes at a sufficient time after the procedures were completed to account for voice stabilization after resolution of postoperative edema and any initial fat resorption. For this reason, the overall mean duration of time between the procedure and final VHI measurement was 11.3 months. This study did not systematically look at postoperative stroboscopic data to compare short-term recovery duration from each procedure. Such a study may be of interest and considered in the future as it can inform patient counseling as well as postoperative patient expectations during recovery.

5 | CONCLUSION

In patients with nonparalytic dysphonia, FIM is a durable alternative to BML. The cohort of patients treated with both modalities gained substantial improvement in vocal function as measured in their VHI-10 scores over time. While both treatment modalities will continue to be considered by laryngologists for managing nonparalytic dysphonia, both BML and FIM can be considered in the patients considering surgery for nonparalytic dysphonia.

CONFLICT OF INTEREST

Our team has no conflicts of interest to report. Dr. Sarah K. Rapoport has no financial disclosures. Dr. Thomas Murry no financial disclosures relevant to this publication. Dr. Peak Woo has no financial disclosures relevant to this publication.

ORCID

Sarah K. Rapoport https://orcid.org/0000-0003-2697-8480
Peak Woo https://orcid.org/0000-0003-0144-5178

BIBLIOGRAPHY

1. DeFatta RA, DeFatta RJ, Sataloff RT. Laryngeal lipotransfer: review of a 14-year experience. *J Voice*. 2013;27(4):512-515. https://doi.org/10.1016/j.jvoice.2013.03.009.
2. Milstein CF, Akst LM, Hicks MD, Abelson TI, Strome M. Long-term effects of micronized Alloderm injection for unilateral vocal fold paralysis. *Laryngoscope*. 2005;115(9):1691-1696.
3. Zimmermann TM, Orbelo DM, Pittelko RL, Youssef SJ, Lohse CM, Ekbom DC. Voice outcomes following medialization laryngoplasty with and without arytenoid adduction. *Laryngoscope*. 2019;129(8):1876-1881.
4. Dursun G, Boynukalin S, Ozgursoy OB, Coruh I. Long-term results of different treatment modalities for glottic insufficiency. *Am J Otolaryngol*. 2008;29(1):7-12.
5. Daniero JJ, Garrett CG, Francis DO. Framework surgery for treatment of unilateral vocal fold paralysis. *Curr Otorhinolaryngol Rep*. 2014;2(2):119-130.
6. Dominguez LM, Villarreal R, Simpson CB. Voice outcomes of lipoinjection versus medialization laryngoplasty for nonparalytic glottic insufficiency. *Laryngoscope*. 2019;129(5):1164-1168.
7. Soni RS, Dailey SH. Sulcus vocalis. *Otolaryngol Clin North Am*. 2019;52(4):735-743.
8. Rosen CA, Simpson CB. *Operative Techniques in Laryngology*. Berlin, Germany: Springer; 2008.
9. Ricci Maccarini A, Stacchini M, Mozzanica F, et al. Efficacy of transnasal fiberendoscopic injection laryngoplasty with centrifuged autologous fat in the treatment of glottic insufficiency due to unilateral vocal fold paralysis. *Acta Otorhinolaryngol Ital*. 2018;38(3):204-213.
10. Woo P. Arytenoid adduction and medialization laryngoplasty. *Otolaryngol Clin North Am*. 2000;33(4):817-840.
11. Rosen CA, Lee AS, Osborne J, Zullo T, Murry T. Development and validation of the voice handicap index-10. *Laryngoscope*. 2004;114(9):1549-1556.
12. Costan V-V, Trandafir D, Popescu E, Drochioi C. *Autologous Fat Transfer to Reconstruct Facial Defects After Parotidectomy*. Switzerland: Springer International Publishing; 2016:209-215.
13. Fang TJ, Lee LA, Wang CJ, Li HY, Chiang HC. Intracordal fat assessment by 3-dimensional imaging after autologous fat injection in patients with thyroidectomy-induced unilateral vocal cord paralysis. *Surgery*. 2009;146(1):82-87.
14. Umeno H, Chitose S, Sato K, Ueda Y, Nakashima T. Long-term postoperative vocal function after thyroplasty type I and fat injection laryngoplasty. *Ann Otol Rhinol Laryngol*. 2012;121(3):185-191.
15. DeFatta RA, Chowdhury FR, Sataloff RT. Complications of injection laryngoplasty using calcium hydroxylapatite. *J Voice*. 2012;26(5):614-618.
16. Cohen JC, Reisacher W, Malone M, Sulica L. Severe systemic reaction from calcium hydroxylapatite vocal fold filler. *Laryngoscope*. 2013;123(9):2237-2239.
17. Misono S, Yueh B, Stockness AN, House ME, Marmor S. Minimal important difference in voice handicap index–10. *JAMA Otolaryngol Head Neck Surg*. 2017;143(11):1098-1103.

How to cite this article: Rapoport SK, Murry T, Woo P. Voice assessment of fat injection vs medialization laryngoplasty in nonparalytic dysphonia. *Laryngoscope Investigative Otolaryngology*. 2021;6:453–457. https://doi.org/10.1002/lio2.573