Voice Outcomes of Lipoinjection Versus Medialization Laryngoplasty for Nonparalytic Glottic Insufficiency

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**Objective:** To compare voice outcomes of autogenous fat injection versus medialization laryngoplasty in patients with glottic insufficiency due to vocal fold paresis or atrophy.

**Methods:** A retrospective review was performed from 2009 to 2017 of all patients who underwent lipoinjection or medialization laryngoplasty (ML) for glottic insufficiency. Charts were reviewed for demographic information, preoperative diagnosis, surgical intervention, Voice Handicap Index-10 (VHI-10) and Glottal Function Index (GFI) scores, follow-up time (minimum 3 months), and concomitant voice therapy.

**Results:** Eighty-three patients were initially identified and limited to 28 based on the inclusion/exclusion criteria. Thirty-five procedures were performed with a total of 15 fat injections and 20 MLs. The mean age was 60.7 years in the lipoinjection group and 55.6 years in the ML group. There was no significant difference in pretreatment VHI-10 scores between the two groups. Using the lowest recorded voice scores during the follow-up period, both groups had a significant decrease (P < 0.05) compared to preoperative scores (VHI-10: fat decreased from 27.8 to 14.2, ML decreased from 30.5 to 9.1; GFI: fat decreased from 13.7 to 5.27, ML decreased from 13.6 to 4.6). When evaluating the entire follow-up period (median 19 months in fat group, 16.3 months in ML), only the ML group maintained a significant improvement in VHI-10 (median delta 14.5) and GFI (median delta 7) compared to preoperative scores.

**Conclusion:** Although both autogenous fat injection and ML result in improved voice scores in the short term, the effect of fat injection appears to be limited, as evidenced by worsening VHI-10 and GFI scores over time.

**Key Words:** Glottic insufficiency, autologous fat, lipoinjection, medialization laryngoplasty.

**Level of Evidence:** 4

**INTRODUCTION**

Glottic insufficiency is described as incomplete glottic closure of the true vocal folds during phonation.1–3 It can result from a variety of conditions, including vocal fold motion impairment (i.e., paralysis or paresis), atrophy, scar, or soft tissue loss.4 Symptoms of glottic insufficiency include vocal fatigue; decreased vocal projection; shortness of breath with speaking; odynophonia; and, in some cases, dysphagia and aspiration.1–3 Treatment options for glottic insufficiency include voice therapy, vocal fold injection augmentation, or type 1 medialization laryngoplasty (ML).5,6 These methods are commonly utilized in patients with vocal fold paralysis; however, ideal treatment of glottic insufficiency in the setting of mobile vocal folds remains controversial.

An assortment of temporary injectable materials for vocal fold augmentation are available but vary as far as longevity, with most lasting 3 to 12 months. “Permanent” injectable materials, however, are limited to autogenous fat. The advantages of autogenous fat include a readily available source in most patients and little to no risk of immune reaction.7 Resorption rates, however, are highly unpredictable, with some reports of fat retention up to 31 months after injection and other studies reporting failure rates as high as 45% after 48 months.8,9 This variability, in combination with some expected resorption in the immediate postoperative period, necessitates a significant degree of overcorrection of the vocal folds, ranging anywhere from 40% to 100%.10–12

Medialization laryngoplasty, on the other hand, does not require overcorrection and is advantageous in that it is a permanent implant that allows great precision in contouring the vocal fold. It has shown great long-term results in patients with vocal fold paresis.13 The disadvantages include need for a neck incision as well as placement of a foreign body into the paraglottic space. Additionally, although implants such as Gore-Tex (W.L. Gore and Associates, Flagstaff, AZ) and Silastic (Medtronic ENT, Jacksonville, FL) are permanent, previous studies have demonstrated declining Voice-Related Quality of Life scores over time in individuals with vocal fold atrophy who have undergone type I ML. It has been hypothesized this is due to a progressive loss of vibratory function of the vocal fold.12

Although there are numerous studies looking at outcomes of ML and autogenous fat injection to the vocal folds in the setting of vocal fold paralysis, to our knowledge no...
data exists directly comparing voice outcomes in patients with nonparalytic glottic insufficiency who have undergone autogenous fat injection versus ML. The purpose of this study is to compare voice outcomes in these two groups over an extended follow-up period to determine if one method provides superior voice results.

MATERIALS AND METHODS

Patient Selection

Institutional review board approval was obtained at the University of Texas Health Science Center at San Antonio. A retrospective review was performed of all patients at our institution between January 2009 and October 2017 who underwent treatment for nonparalytic glottic insufficiency (i.e., vocal fold paresis or atrophy) with either injection augmentation with autogenous fat or ML. A diagnosis of vocal fold atrophy was made based on vocal fold appearance (i.e., thin vocal folds, prominent vocal processes, or prominent ventricles). A diagnosis of paresis was made based on one or more of the following: electromyography (EMG), decreased mobility on laryngoscopy, or increased amplitude on videostroboscopy. Patients with mid-membranous vocal fold pathology (i.e., lesions or scar), insufficient follow-up time (less than 3 months), incomplete voice scores/surveys, vocal fold paralysis, or revision framework procedures were excluded.

Surgical Technique

The senior author (C.B.S.) performed or supervised all injection augmentations and MLs. Autologous fat was harvested from the patient’s right lower quadrant and then irrigated with a 1 L mixture of lactated ringers and 100 units of insulin over a 5-minute period. The fat was placed in an Instrumentarium lipoinjection device (Terrabone, QC, Canada) and injected into the thyroarytenoid muscle at the junction of the superior arcuate line and vocal process until fat extruded through the injection site, generally correlating with 40% to 100% overcorrection, as recommended in previous literature.12

Type 1 MLs were performed under local anesthesia, as previously described, with either a hand-carved Silastic block (Medtronic ENT) or Gore-Tex (W.L. Gore and Associates) implants.12 The degree of medialization was determined based on the patient’s voice quality and contour of the vocal fold.

Data Collection and Analysis

Medical records were reviewed for patient demographic information, preoperative diagnosis, Voice Handicap Index-10 (VHI-10) scores, Glottal Function Index (GFI) scores, concomitant voice therapy, and follow-up time. The VHI-10 is a validated tool used to quantify the patient’s perception of voice handicap.14 The GFI is a 4-item validated patient questionnaire useful in detecting glottal dysfunction and response to therapy and has been used as a surrogate for glottic insufficiency.12 Operative reports were reviewed for details on unilateral versus bilateral intervention and surgical complications. Treatment groups were compared with nonparametric testing (Wilcoxon signed-rank test for matched pairs, Mann-Whitney test for independent samples) with regard to changes in VHI-10 and GFI scores from pre- to posttreatment.

RESULTS

Eighty-three patients were initially identified in our search and then limited to 28 based on the exclusion criteria. Diagnosis of vocal fold paresis was made due to vocal fold hypomobility (55%), EMG characteristics (20%), or increased amplitude on videostroboscopy (25%). Patients who could not tolerate EMG or declined the procedure led to diagnosis via videostroboscopy findings.

Thirty-five procedures were performed with a total of 15 fat injections (67% bilateral) and 20 MLs (70% bilateral). Six patients underwent both types of procedures throughout the follow-up period. The indication for ML was atrophy in 20% of cases, paresis in 30% of cases, and a combination of paresis and atrophy in 50% of cases. Of the patients who underwent fat injection, the indication was as follows: 35.7% atrophy, 14.3% paresis, and 50% for a combination of paresis and atrophy. The mean age was 60.7 years (60% male) in the lipoinjection group versus 55.6 years in the ML group (55% male). Three patients had complications after ML, with one experiencing suspected implant migration, one requiring revision ML, and one requiring implant removal with subsequent fat placement due to worsened dysphonia. In the fat-injection group, one patient experienced respiratory difficulties postoperatively, requiring reintubation and brief admission to the medical intensive care unit.

Voice Handicap Index-10

There was no significant difference in pretreatment VHI-10 scores between the two groups. Using the lowest/best recorded VHI-10 during the follow-up period, both groups had a significant decrease compared to preoperative scores (fat decreased from 27.8 ± 8.8 to 14.2 ± 10.8 at 3.4 months, P = 0.005; ML from 30.5 ± 6.5 to 9.1 ± 10.2 at 7 months, P = 0.0001). When evaluating the entire follow-up period (median for fat: 19 months, ML 16.3 months), over time VHI-10 returned close to the pre-treatment levels in the fat-injection group (pretreatment 27.8, posttreatment 23.5 ± 12.1, P = 0.29) but maintained a significant improvement in the ML group (30.5 to 15.0 ± 12.4, P = 0.0004) (Fig. 1A.). When mean VHI-10 scores were grouped according to follow-up time, the fat-injection patient voice scores notably worsened after 6 months (Fig. 2A.). The median improvement in final VHI-10 in the fat-injection group was 1 point versus 14.5 in the ML group. The majority of patients in both groups demonstrated some improvement in final voice scores, although a greater number improved in the ML group (Table I). Of the patients who showed any improvement in VHI-10, 50% of the fat-injection patients (5 out of 10) and 88% of the ML group (15 of 17) improved by at least 4 points.

There was no difference in mean VHI-10 posttreatment scores in patients who underwent bilateral versus unilateral procedures in either group. Similarly, there was no difference in mean VHI-10 posttreatment scores in those patients who participated in voice therapy and those who did not, or in those patients who underwent Silastic (Medtronic ENT) versus Gore-Tex ML (W.L. Gore and Associates).

Six patients underwent both fat injection and ML during their follow-up period. Five patients underwent ML after fat injection, and one patient had a fat injection during their follow-up period. Five patients underwent ML after fat injection, and one patient had a fat injection during their follow-up period. Five patients underwent ML after fat injection, and one patient had a fat injection during their follow-up period.
after ML. Of the patients who underwent ML after fat injection, 40% normalized in their VHI-10 scores. The patient who underwent fat injection (bilateral) after ML reported a worsened VHI-10 score.

Glottal Function Index

Pretreatment GFI scores were also similar between the two groups. Using the lowest/best recorded GFI score during the follow-up period, both groups had a significant decrease compared to preoperative scores (fat decreased from 13.7 ± 4.8 to 5.27 ± 4.6, \( P = 0.003 \) over 3.4 months; ML decreased from 13.6 ± 4.9 to 4.6 ± 5.4 over 3.2 months, \( P = 0.0002 \)). In the fat-injection group, similar to VHI-10 scores, over time GFI scores increased back up toward baseline from 13.7 to 11.67 ± 6.6 (\( P = 0.36 \)) with a median improvement of 1 point. The ML group maintained a significant improvement of 13.6 to 7.1 ± 5.5 (\( P = 0.009 \)) with a median improvement of 7 points (Fig. 1B.). When mean GFI scores were grouped according to follow-up time, GFI mirrored the worsening of VHI-10 scores after 6 months (Fig. 2B.).

DISCUSSION

Autogenous fat injection and ML are both widely accepted methods in the treatment of glottic insufficiency. The direct comparison of these two techniques has not been evaluated in the patient with mobile vocal folds with glottic insufficiency symptoms. The purpose of this study was to identify the form of surgical intervention that resulted in superior, long-lasting voice outcomes.

Both groups showed significant improvement in voice outcomes in the short term, but these declined over time, albeit to a lesser degree in the ML group. Tracking mean VHI-10 and GFI scores over time revealed a worsening of both after 6 months in the fat-injection group. The simultaneous worsening of VHI-10 and GFI scores suggest that patient dysphonia was related to glottic insufficiency rather than other potential sources such as muscle tension dysphonia. This information could potentially be useful for patient counseling, particularly relating to postoperative expectations (Fig. 2A., 2B.). Although scores worsened in the ML group after 3 to 5 years, it was still not to the same degree as the fat-injection group. Declining voice scores could potentially be explained by progression of vocal fold atrophy over the follow-up period. This natural progression of atrophy, however, would be assumed to be similar in both treatment groups and would not explain the better short-term results and preservation of significant voice improvement demonstrated in the ML group (Fig. 1A.). One could speculate that fat resorption plays a large role in these outcomes because previous studies have reported variable retention rates over time.\(^9\)

In 2014, there was a shift in practice at our institution to treatment of vocal fold paresis and atrophy with medialization laryngoplasty due to the perception that autogenous fat injection did not yield as durable results. It is likely that ML allows for better surgical precision in this population due to immediate feedback from the patient that cannot be obtained during a fat injection under general anesthesia. This interaction with the patient allows great meticulousness in creating an implant with the appropriate contour and degree of medialization. The patient input allows achievement of maximal voice outcome and eliminates the need for the surgeon to estimate degree of overcorrection required with almost all injectable materials. This may lead to better voice outcomes for patients with nonparalytic glottic insufficiency in contrast to fat injection, which requires a significant degree of overcorrection.

When evaluating the final reported VHI-10 and GFI scores at the end of the follow-up period, the degree of improvement in many of the fat-injection patients was minimal. Even at the point of lowest/best VHI-10 score, the patients in the ML group still reported better voice.

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<th>Table I. Final VHI-10 Outcome Compared to Pretreatment Scores</th>
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<td>Improved (%) of patients</td>
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ML = medialization laryngoplasty; VHI-10 = Voice Handicap Index-10.
outcomes. In patients with vocal fold paralysis, an improvement of 4 points on the VHI-10 scale has been suggested to be the minimal clinically important difference that results in a perceivable voice change.\textsuperscript{16} Misono et al. also reported on patients with a variety of vocal fold disorders and found that the minimal important difference on the VHI-10 scale was 6 points.\textsuperscript{17} Currently, these are the only reference values to indicate a clinically significant voice improvement that is notable by patients. In the fat-injection group, only half of the patients who were improved at their final visit did so by at least 4 points on the VHI-10 scale. Of the improved patients in the ML group, nearly 90% improved their VHI-10 scores by at least 4 points. One could therefore assume that many patients failed to achieve any appreciable longstanding voice improvement after fat injection, but the vast majority of patients had a noticeable improvement in their dysphonia after ML.

Six patients required multiple procedures and actually received both methods of treatment. Less than half of patients who underwent ML after a fat injection improved in their VHI-10 scores (40%) and returned to a normal VHI of 11 or less. Only one patient had a fat injection after ML and the VHI-10 score significantly worsened. These patients clearly had inferior outcomes when compared to the rest of the cohort. This subset is extremely small, so it is difficult to make any meaningful conclusions from the data. These individuals may have had unique characteristics rendering them more difficult to treat. Preoperative discussion with the patient regarding expectations is important with any surgical intervention, but particularly in those requiring multiple procedures.

This study has several limitations in that it is small and retrospective in nature. Due to the small sample size, it was not possible to meaningfully analyze how individual etiologies (i.e. paresis, atrophy, or both) influenced voice outcomes. Additionally, because many patients travel a long distance to receive treatment at our institution, follow-up time is extremely variable and likely affected the median time to the lowest/best-reported voice scores as well as the total follow-up time. There were no specific criteria documented as to why patients underwent fat injection versus ML; therefore, the possibility of selection bias cannot be discounted. These patients were all treated by the senior author (C.B.S.), so surgeon judgement was likely the most influential factor in treatment selection. A larger, prospective trial separating groups by etiology of glottic insufficiency and type of ML.

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**Fig. 2A.** Mean VHI-10 scores over time. ML = medialization laryngoplasty; VHI-10 = Voice Handicap Index-10.

**Fig. 2B.** Mean GFI scores over time. GFI = Glottal Function Index; ML = medialization laryngoplasty.
material, such as Silastic (Medtronic ENT) versus Gore-Tex (W.L. Gore and Associates), would provide stronger outcomes data in these different subsets of patients.

CONCLUSION
Nonparalytic glottic insufficiency can result in decreased vocal projection, vocal fatigue, and odynophonia. Permanent treatment options in this patient population are limited to autogenous fat injection or ML. Whereas both forms of treatment result in significant improvement in voice outcomes in the short-term, over time dysphonia can return, and to a significantly greater degree after fat injection. Medialization laryngoplasty may be a better option in this patient population due to the superior precision in vocal fold contouring, as well as the lack of resorption one might see with fat injection. Further studies with longer follow-up are required to determine the durability of ML in patients with glottic insufficiency.

BIBLIOGRAPHY