The Laryngoscope
Lippincott Williams & Wilkins, Inc.

Bipedicled Strap Muscle Transposition for Vocal Fold Deficit after Laser Cordectomy in Early Glottic Cancer Patients

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Objective: **In treating early glottic carcinomas, the outcomes of endoscopic laser cordectomy have been proven to be valuable in local control, survival, and vocal function preservation. In some extended cases, however, laser cordectomy may leave patients with poor vocal function because of vocal fold deficit. This work assesses the vocal outcome of medialization laryngoplasty with bipedicled strap muscle transposition for vocal fold deficit resulting from laser cordectomy in early glottic cancer patients.** ***Study Design:*** **A prospective clinical series.** ***Methods:*** **Thirteen early glottic cancer patients who had vocal fold deficit caused by previous laser cordectomy underwent medialization laryngoplasty with bipedicled strap muscle transposition. The thyroid lamina on the cordectomy side was paramedially separated. The inner perichondrium was circumspectly raised from the overlying thyroid cartilage. After separating the thyrohyoid and cricothyroid membranes, the lamina was retracted laterally. A bipedicled strap muscle flap was then transposed into the area between the lamina and the paraglottic soft tissue. The thyroid cartilages were carefully sutured back in position. All patients received pre- and postoperative voice assessments comprising laryngostroboscopy and vocal function studies.** ***Results:*** **Vocal enhancement was present in 92% (12/13) of patients after medialization laryngoplasty with strap muscle transposition. The glottal closure and maximal phonation time were noticeably improved by surgery. No dyspnea or other significant complications were observed in any patients.** ***Conclusion:*** **The outcomes show that bipedicled strap muscle transposition is a prosthesis-free, safe, and valuable laryngoplastic technique for correcting glottal incompetence caused by endoscopic laser cordectomy in early glottic cancer patients.** ***Key Words:*** **Early glottic carcinoma, endoscopic laser cordectomy, vocal fold deficit, bipedicled strap muscle transposition, medialization laryngoplasty.**

***Laryngoscope*, 115:528–533, 2005**

INTRODUCTION

Glottal incompetence during phonation may be caused by benign or malignant laryngeal lesions, vocal fold paralysis, vocal fold atrophy, or vocal fold deficit after laryngeal surgery. In treating selected cases of early glottic carcinoma, endoscopic laser cordectomy has proven to be effective in terms of local control, survival, and vocal function preservation. A superior voice quality was measured after laser cordectomy than after open cordectomy or hemilaryngectomy.[1] However, extended or total laser cordectomy may leave patients with poor vocal function because of scarring and soft tissue deficit of the vocal fold, hindering the Bernoulli effect during phonation.[2–4] The clinical manifestations of vocal fold deficit are breathy, husky, and weak/fatigued voice, possibly requiring vocal rehabilitation surgery to improve. In the literature, surgical treatment modalities for these cases comprised laryngeal framework surgery and injection augmentation method.[5–8] The commonest methods are medialization framework surgeries with implantation of autologous cartilages or alloplastic materials.[5,6] Injection augmentation is less often applied because injection of the autogenous materials (fat or collagen) into the stiff scar tissue is frequently ineffectual.[8] In terms of long-term outcome, alloplastic prostheses (e.g., silicone, hydroxylapatite, or titanium) are found to be better than autologous implants (fat, collagen, or cartilage), which are vulnerable to absorption to an irregular degree.[6–9] However, most prostheses are solid and quite unlike the consistency of the adjacent tissue. Therefore, migration or extrusion of the implant is a continual risk.[7] Because of various disadvantages with all current materials used for medialization or

Presented in part at the 10th Asia-Oceania ORL Head and Neck Congress, Kuala Lumpur, Malaysia, February 22–26, 2004.

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Supported in part by grants from the National Science Council, ROC (NSC93–2314-B-182–025), and Chang Gung Memorial Hospital, NMRPD3025.

Editor's Note: This Manuscript was accepted for publication October 27, 2004.

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DOI: 10.1097/01.MLG.0000150091.55295.56

augmentation of the vocal folds, these materials need supplanting with a more stable, autologous tissue.

To restore the best possible vocal performance of the patients, various operational methods have been advocated based on the strap muscle. Kojima et al.[10] treated three patients with bowed vocal fold applying a monopedicled omohyoid muscle flap. Bailey[11] has reported the technique of bipedicle muscle/perichondrial flap for glottic reconstruction after open hemilaryngectomy. Recently, Su et al.[12,13] have developed a paramedian approach to transposition of bipedicled strap muscle flap to treat glottal incompetence caused by vocal fold atrophy or unilateral vocal fold paralysis. However, investigations exploring the value of bipedicled strap muscle transposition for correcting the vocal fold deficit after endoscopic laser cordectomy are lacking.

PATIENTS AND METHODS

From 2000 to 2004, 15 early glottic cancer patients who had previously undergone total or extended laser cordectomy experienced medialization laryngoplasty with strap muscle transposition. After cordectomy, a minimum 12-month delay was imposed before using this procedure to confirm the absence of tumor recurrence. The surgery was recommended only when the post-cordectomy voice outcome did not match the patient requirement. Informed consent was obtained from every patient before surgery. Pre- and postoperative clinical examinations were implemented.

Technique

In the 15 cases, the surgery was performed with local anesthesia and light sedation in 9 cases and with general anesthesia in 6. A horizontal neck-crease cut was made over the upper level of the thyroid lamina on the cordectomy side, from the midline of the neck to the anterior edge of the sternocleidomastoid muscle. The strap muscles were divided in the midline and retracted laterally, exposing the thyroid ala. The thyroid lamina was paramedially separated roughly 5 mm off the midline, using a 15# scalpel or an oscillating saw. Care was taken not to cut too far into the inner perichondrium or penetrate the laryngeal lumen (Fig. 1A). The inner perichondrium was gently released from the covering thyroid ala. After the division of the thyrohyoid and cricothyroid membranes, the thyroid lamina was retracted laterally. Then the sternohyoid muscle or sternohyoid-omohyoid muscle was mobilized along its lateral border, with efforts being made to interfere as little as possible with its nerve and blood supply. To contain the muscle flap more readily, the caudal edge of the thyroid lamina was reduced slightly with a small burr. The complete muscle flap, with its upper and lower attachments undamaged, was then transposed into the space between the thyroid lamina and the paraglottic tissue (Fig. 1B). The thyroid cartilage incision was then cautiously sutured back in position with 2 to 0 Prolene or 0.4 to 0.45 mm stainless wires. After hemostasis was achieved, the wound was closed in several layers with absorbable sutures.

Subjective and Objective Voice Assessment

Patients were assessed 1 or 2 weeks preoperatively and followed up 1, 3, 6, 12, 18, and 24 months postoperatively. Voice assessment involved perceptual judgment of voice quality, acoustic analysis, and aerodynamic measurement. All the assessments from 6 months or more after surgery contributing to judging the surgical outcome. For patients who fulfilled less than 6 months follow-up, recordings from 3 months after surgery were used for analysis because the voice had generally stabilized by 3 months after surgery.

Acoustic and aerodynamic parameters were measured and analyzed in a soundproof room. In the acoustic analysis, mean fundamental frequency, jitter, shimmer, and noise-to-harmonic ratio were examined for a sustained vowel sound /a/ in comfortable phonation. A Computerized Speech Laboratory (core Model CSL # 4300B, Kay Elementrics, Lincoln Park, NJ) under software control (Version 5.x) was used to process and analyze the data. The aerodynamic parameters of mean airflow rate and the maximal phonation time were determined with the circumferentially vented pneumotachograph mask and differential transducers of the Aerophone system (Aerophone II, model 6800, Kay Elemetrics).

Laryngostroboscopy was performed with a Kay Elemetrics Stroboscopy Unit (Model 8100, Lincoln Park, NJ). Video and audio data were loaded in the computer disc (RLS 9100B, Kay Elemetrics) to facilitate duplicate evaluation by two judges experienced in laryngostroboscopy. The mucosa wave patterns, wave amplitude, and glottal closure were assessed. The comparative extent of the glottal gap in phonation was measured on a 5-point rating scale: no gap during phonation (0), minimal gap (1), small gap reaching up to one third of the membranous vocal fold (2), moderate gap reaching up to two thirds of the membranous vocal fold (3), and complete glottal incompetence with no apparent contact between the membranous vocal folds (4).

Perceptual assessments were carried out by two experienced laryngologists who were unaware of the patient status. Assessment of the voice quality was by grade, roughness, breathiness, asthenia, and strain (GRBAS) on a 5-point scale in which 0 was normal, 1 mild dysphonia, 2 moderate dysphonia, 3 severe dysphonia, and 4 aphonia. Clinical subjective judgment of the improvement of voice quality and aspiration problems after surgery arose from patient self-assessment. The findings were classified into categories of markedly improved, improved, not changed, and worse.

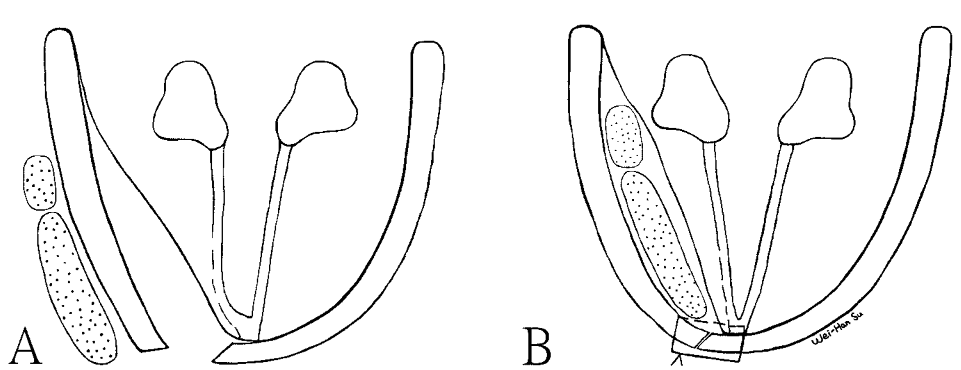

Fig. 1. Transposition of bipedicled sternohyoid-omohyoid muscle flap for right vocal fold deficit (**A**). Better glottal closure is expected after surgery (**B**).

Statistical Analysis

We used the SPSS for Windows package (SPSS Inc, Chicago, IL) for statistical analysis. Simple descriptive statistics (means and standard deviations) were calculated for each variable. Statistical analyses used paired t test and Wilcoxon signed-rank test for paired measurement of ordinal variables.

RESULTS

Fifteen patients with vocal fold deficit underwent laryngoplasty with bipedicled strap muscle transposition in the investigatory period. Two of the 15 patients were excluded from this study because they were followed up for under 3 months. The clinical data of 13 patients were analyzed and summarized in Table I. All these patients were male, aged between 42 and 72 years, with a mean age of 59 years. Postoperative follow-up extended from 3 to 30 (mean 14) months. One of our cases was reported on with less than 6 months follow-up and 12 cases with greater than 6 months follow-up. One patient (case 2) developed a second primary cancer at the hypopharynx 2 years after laryngoplasty and was successfully salvaged with total laryngectomy. The pre- and postoperative subjective and perceptual ratings of vocal performance and laryngostroboscopic recordings were taken for all 13 patients. Acoustic and aerodynamic results suitable for analysis were obtained for 11 patients.

Preoperatively, the most common abnormal laryngostroboscopic findings of the 13 patients were a moderate to severe (scored 3–4) glottal gap in phonation and a decrement or lack of mucosal wave and vibratory amplitude, especially at the cordectomy side. Glottal closure was markedly enhanced in 12 of the 13 patients after medialization laryngoplasty (Table I) (Fig. 2). Postoperatively, complete or near-complete glottal closure (scored 0–1) was observed in six patients, and partial closure (scored 2–3) was noted in six patients. One patient had persistent complete glottal incompetence (scored 3–4) after surgery. Although the vibration waves on most of the scarred pseudocords remained small or absent after laryngoplasty, postoperative assessment of the vibratory patterns demonstrated a significant tendency toward improved wave vibration of the unaffected vocal fold through the Bernoulli effect because of enhanced glottal closure.

Table II summarizes the results of acoustic and aerodynamic analyses. The mean maximal phonation time markedly increased from 6 seconds before surgery to 11 seconds postsurgery ($P < .001$). There was a statistically significant decrement (improvement) in the mean jitter and mean airflow rate from preoperative to postoperative performance. The preoperative and postoperative mean fundamental frequencies were 172 Hz and 174 Hz, respectively.

Perceptual assessment by nonparametric test (Wilcoxon signed-rank test) showed an overall voice improvement after surgery (Table III). There was a significant decrease (improvement) in scales of grading, roughness, breathiness, and strain postoperatively ($P < .05$). Subjective rating of the surgical results indicated that vocal enhancement was achieved in 12 of the 13 patients. Four of the 13 patients experienced minimal to mild aspiration problems at onset. The problems were generally improved after laryngoplasty. Results show no deterioration during follow-up ranging from 3 to 24 months.

DISCUSSION

As is well recognized, defective closure of the glottis and greater stiffness of the vocal fold are two major factors responsible for a hoarse, breathy voice.[4] Vocal fold deficit after endoscopic laser cordectomy frequently lead to dif-

TABLE I.
Summary of 13 Cases of Vocal Fold Deficit Treated With Strap Muscle Transposition.

			Maximum Phonation Time*		Mean Airflow Rate*		Glottal Gap*		Voice Grading*		
Case No.	Sex/Age (y)	Vocal Fold Deficit	Preop (sec)	Postop (sec)	Preop l/sec	Postop l/sec	Preop (E1/E2)	Postop (E1/E2)	Preop (E1/E2)	Postop (E1/E2)	Follow-Up (mo)
1	M/49	R	10.0	13.0	0.124	0.032	3/2	2/1	2/2	1/1	3
2	M/72	L	3.0	10.0	0.404	0.146	1/1	0/0	2/3	1/0	6
3	M/52	R	3.0	6.0	0.496	0.641	3/3	1/0	2/2	0/0	6
4	M/71	L	3.0	6.0	0.343	0.182	3/2	2/2	1/2	0/0	6
5	M/54	L	13.0	25.0	0.27	0.061	2/1	1/1	2/1	2/1	6
6	M/42	Bil	6.0	6.0	—	—	3/4	0/3	3/3	2/2	6
7	M/53	R	4.0	7.0	0.282	0.201	3/2	1/2	1/1	1/0	18
8	M/64	R	6.0	10.0	—	—	4/3	2/1	2/2	1/1	18
9	M/69	R	15.0	19.0	0.176	0.074	2/2	1/1	1/1	0/0	18
10	M/67	L	8.0	16.0	0.204	0.065	2/2	0/0	1/0	0/0	18
11	M/72	R	2.0	11.0	0.763	0.055	4/3	4/3	2/2	2/1	24
12	M/48	R	6.0	14.0	0.112	0.010	4/4	0/0	3/2	2/1	24
13	M/58	R	2.0	5.0	0.763	0.055	4/4	2/2	3/2	2/2	30

Glottal gap: 0 = complete closure; 1 = minimal gap; 2 = small gap; 3 = moderate gap; 4 = complete gap. Voice grading: 0 = normal; 1 = mild dysphonia; 2 = moderate dysphonia; 3 = severe dysphonia; 4 = aphonia.

*Statistically significant.

Preop = preoperative; Postop = postoperative; E1 = evaluator 1; E2 = evaluator 2; L = left; R = right; Bil = bilateral; l = litter; mo = months.

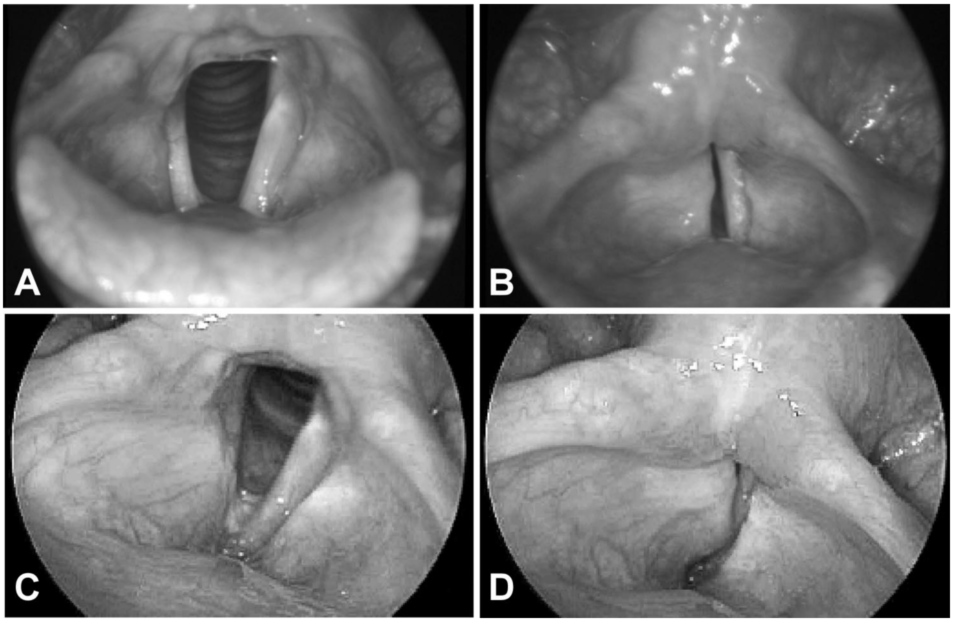

Fig. 2. Laryngoscopic view in a 58-year-old man (case 13) with right vocal fold deficit after extended cordectomy before (**A**, at rest; **B**, during phonation) and after (**C**, at rest; **D**, during phonation) bipedicled strap muscle transposition. Glottal closure was enhanced after laryngoplasty (**D**).

fering levels of glottal incompetence during phonation, depending on the amount of vocal fold removed.[2,3,14,15] After laser excision, the soft tissue deficiency of the vocal fold generally heals with scar tissue, which is much stiffer than the normal fold. Although a neocord (pseudocord) configuration is predictable after laser cordectomy, its appearance still includes a slightly bowed or irregular surface. In the subepithelial or subligamental cordectomy (types I or II) cases, the closure of the glottis can achieve a complete or nearly complete status after laser surgery. Postoperative voice quality in these cases usually is nearly normal. In total or extended cordectomy (types IV or V) cases, however, a stiff pseudocord usually develops with a significant deficit, making the glottis unable to sustain an adequate subglottic pressure to create full vocal fold vibrations through the Bernoulli effect.[2,4,11] In contrast with glottal incompetence resulting from unilateral vocal fold paralysis, the established medialization techniques for postlaser vocal fold deficit frequently lead to unsatisfactory results because of the scarred endolaryngeal tissue. Sittel et al.[5] claimed that injection augmentation technique is of limited value because fibrotic scar tissue is not suited to augmentation. They therefore reimplanted a section of superior rim of the thyroid cartilage into a subperichondrium pouch created on the inner side of the thyroid lamina to treat six patients with significant glottal gap cases. Remacle et al.[6] recommended cartilage implants for minor glottal gaps and Friedrich's implant for bigger gaps. Nevertheless, they also advocated that the prosthesis might tear the fibrous endolaryngeal tissue if it is too thick. Several follow-up studies indicate that reversion of the voice occurs in some patients who underwent type I thyroplasty with prosthesis. This reversion may be partly owing to atrophy of the intralaryngeal soft tissue resulting from persistent pressure from the prosthesis.[4] To surmount some limitations of various implantation materials, a more stable autologous tissue with reliable, ongoing effect in the larynx is required.

Previous investigation by the authors revealed that transposition of the bipedicled strap muscle flap can efficiently correct the spindle-shaped glottal incompetence resulting from vocal fold atrophy with or without sulcus vocalis.[13] The current study disclosed that this approach also was a suitable therapy for vocal fold deficit after endoscopic laser cordectomy. This technique attempts to offer suitable long-term bulk to approximate the con-

TABLE II.
Comparison of Pre- and Postoperative Measures of Acoustic and Aerodynamic Parameters.

Variables	Patient No.	Preoperative (Mean ± SD)	Postoperative (Mean ± SD)	T	*P* Value
F0 (Hz)	11	172.45 ± 69.39	174.44 ± 90.81	0.07	.949
MPT (sec)	13	6.23 ± 4.21	11.38 ± 5.95	5.57	<.001*
JITT (%)	11	5.57 ± 4.78	2.23 ± 2.54	−3.96	.003*
SH (dB)	11	0.92 ± 0.68	0.90 ± 0.60	−0.09	.929
NHR	11	0.34 ± 0.26	0.22 ± 0.15	−1.59	.144
MAR (L/sec)	11	0.38 ± 0.28	0.21 ± 0.26	−2.83	.018*

*Statistically significant at $P < .05$.
Fo = fundamental frequency; MPT = maximum phonation time; JITT = jitter percent; SH = shimmer; NHR = noise-to-harmonic ratio; MAR = mean airflow rate.

TABLE III.
Nonparametric Analysis of Grade, Roughness, Breathiness, Asthenia, and Strain (GRBAS) and Glottal Gap Assessments Pre- and Postoperatively.

Variable	Patient No.	Two Related Samples Test	Z	*P* Value (two-tailed)
Grading	13	G1-post /G1-pre	−2.13	.033*
		G2-post /G2-pre	−2.84	.004*
Roughness	13	R1-post /R1-pre	−2.74	.006*
		R2-post /R2-pre	−2.06	.040*
Breathiness	13	B1-post /B1-pre	−2.36	.018*
		B2-post /B2-pre	−2.42	.016*
Asthenia	13	A1-post /A1-pre	−1.82	.069
		A2-post /A2-pre	−1.80	.072
Strain	13	S1-post /S1-pre	−2.62	.009*
		S2-post /S2-pre	−2.01	.044*
Glottal gap	13	Post-Gap1/Pre-Gap1	−3.20	.001*
		Post-Gap2/Pre-Gap2	−2.98	.003*

*Statistically significant at $P < .05$ (Wilcoxon signed-rank test).
1 = evaluator 1; 2 = evaluator 2; pre = preoperative; post = postoperative.

tralateral normal vocal fold. Similar to the role of the alloplastic implants in type I thyroplasty, the transposed strap muscle can move the paraglottic tissue medially to improve the Bernoulli effect and glottal closure (Figs. 1 and 2). The relative stability and compatibility of the strap muscle implant with paraglottic tissue imply it may lead to a superior prognosis than methods using cartilage or alloplastic prostheses in type I thyroplasty.

As earlier described,[12] two serious questions arise when using bipedicled strap muscle flap for vocal fold medialization: 1) is the whole sternohyoid or sternohyoid-omohyoid muscle too bulky to augment the deficient vocal fold? and 2) does significant atrophy of the muscle flap eventually occur? In cases of vocal fold deficit with a small glottal gap, transposition of sternohyoid muscle only is generally adequate to correct the glottal incompetence. For the large-gap cases, however, transposition of the sternohyoid-omohyoid muscles is used. Long-term follow-up in this study series confirmed that the bulk of the transposed strap muscle could efficiently correct the concavity of the deficient pseudocord. In some extended cordectomy (type V) cases, especially those where the excision included the anterior commissure, glottal gaps (scored 1–3) may persist after laryngoplasty. Nevertheless, enhanced vocal performance in these patients was still achieved in the present study. Although the whole sternohyoid-omohyoid muscle was large in some male patients, it was rarely too bulky for the augmentation of a vocal fold deficit.

Use of a divided or monopedicled strap muscle flap is not supported because it may further impair the nerve and blood supply to the muscle flap, leading to a significant amount of muscle atrophy and fibrosis. This may result in reversion of the voice. Using computed tomography and histologic investigation, earlier work by the authors document no markedly atrophic change of the bipedicled strap muscle flap used during long-term follow-up.[12]

Inadequate closure of the thyroid lamina can happen in the vertical and horizontal planes. This may cause malalignment of the vocal fold level or lateralization of the transposed strap muscle, in turn causing a poor vocal performance. To facilitate accommodation of the strap muscle flap and close the thyroid cartilage cut more readily, the bottom edge of the thyroid ala should be trimmed slightly with a burr. In closure of the thyroid cartilage rift, 2 to 0 Prolene sutures or 0.4 to 0.45 mm stainless steel wire were placed. A poorly calcified thyroid cartilage may prove too fragile to withstand the surgical stress. Therefore, careful and thorough manipulation during operation is crucial. In all the study cases, the cartilage rift was completely closed without leaving a gap.

The complications of this operation were minimal. Airway obstruction was not problematic in patients who received strap muscle transposition for vocal fold deficit. None of our cases required a tracheotomy or temporary endotracheal intubation for airway narrowing or surgically induced edema. The patients were generally discharged on the third postoperative day. In the initial postoperative period, the glottis at the side of operation appeared edematous and bulging, and the patient's vocal performance was commonly inadequate. As the acute inflammatory reaction dissipated, voice quality greatly improved at 3 to 4 weeks postsurgery. Within 3 months, the voice began to achieve its best quality.

The results for vocal function tests revealed that both ease of phonation and the voice quality were markedly enhanced after surgery. The postoperative laryngostroboscopic findings illustrate that the method under discussion could move the deficient pseudocord medially, effectively correct the glottal incompetence, and improve the wave vibrations of the vocal folds. Most of the patients were generally pleased with the remarkable improvement in their voice after medialization laryngoplasty.

CONCLUSION

In the voice rehabilitation surgery of a vocal fold deficit resulting from endoscopic laser cordectomy for early glottic cancer, medialization laryngoplasty with bipedicled strap muscle transposition is advocated as a prosthesis-free, safe, and efficient technique for correction of the glottal incompetence. The durability of outcome with this procedure is heartening.

Acknowledgment

The authors thank Wei-Han Su for the medical illustrations in Figure 1.

BIBLIOGRAPHY

1. Kenilmann A, Bergler W, Artzt M, Hormann K. Vocal function following laser and conventional surgery of small malignant vocal fold tumors. *J Laryngol Otol* 1996;110:1138–1141.
2. McGurit WF, Blalock D, Koufman JA, et al. Comparative voice results after laser resection or irradiation of T1 vocal cord carcinoma. *Arch Otolaryngol Head Neck Surg* 1994;120:951–955.
3. McGuirt WF, Blalock D, Koufman JA, Feehs RS. Voice analysis of patients with endoscopically treated early laryngeal carcinoma. *Ann Otol Rhinol Laryngol* 1992;101:142–146.
4. Isshiki N. Progress in laryngeal framework surgery. *Acta Otolaryngol* 2000;120:120–127.
5. Sittle C, Friedrich G, Zorowka P, Eckel HE. Surgical voice rehabilitation after laser surgery for glottic carcinoma. *Ann Otol Rhinol Laryngol* 2002;111:493–499.
6. Remacle M, Lawson G, Hedayat A, et al. Medialization framework surgery for voice improvement after endoscopic cordectomy. *Eur Arch Otorhinolaryngol* 2001;258:267–271.
7. Ford CN. Advances and refinements in phonosurgery. *Laryngoscope* 1999;109:1891–1900.
8. Hsiung MW, Woo P, Minasian A, Mojica JS. Fat augmentation for glottic insufficiency. *Laryngoscope* 2000;110:1026–1033.
9. Sasaki CT, Driscoll BP, Gracco C, Eisen R. The fate of medialized cartilage in thyroplasty type I. *Arch Otolaryngol Head Neck Surg* 1994;120:1398–1399.
10. Kojima H, Hirano S, Shoji K, et al. Omohyoid muscle transposition for the treatment of bowed vocal fold. *Ann Otol Rhinol Laryngol* 1996;105:536–540.
11. Bailey BJ. Glottic reconstruction after hemilaryngectomy: bipedicle muscle flap laryngoplasty. *Laryngoscope* 1975;85:960–977.
12. Su CY, Lui CC, Lin HC, et al. A new paramedian approach to arytenoid adduction and strap muscle transposition for vocal fold medialization. *Laryngoscope* 2002;112:342–350.
13. Su CY, Tai SS, Chiu JF, Cheng CA. Medialization laryngoplasty with strap muscle transposition for vocal fold atrophy with or without sulcus vocalis. *Laryngoscope* 2004;114:1106–1112.
14. Hirano M, Hirade Y, Kawasaki H. Vocal function following carbon dioxide laser surgery for glottic carcinoma. *Ann Otol Rhinol Laryngol* 1985;94:232–235.
15. Remacle M, Eckel HE, Antonelli A, et al. Endoscopic cordectomy. a proposal for classification by the Working Committee, European Laryngological Society. *Eur Arch Otorhinolaryngol* 2000;257:227–231.