

LARYNGOPLASTY FOR VOCAL CORD MEDIALIZATION: AN ALTERNATIVE TO TEFLON® *†

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ABSTRACT

Laryngeal framework surgery, using a Silastic® implant placed between the thyroid cartilage and inner thyroid perichondrium for vocal cord medialization, offers an exciting new surgical option to intracordal Teflon® injection for the relief of symptomatic unilateral vocal cord paralysis. A series of 11 patients who have undergone medialization laryngoplasty is presented. The advantages, technical details, and results of surgery are discussed.

At present, intracordal Teflon® injection forms the cornerstone of surgical therapy for symptomatic unilateral vocal cord paralysis.¹⁻³ That technique has limitations, however, including the requirement for patient cooperation under local direct laryngoscopy, somewhat unpredictable results, and relative irreversibility.⁴ Furthermore, Teflon® should not be injected into a mobile cord for vocal cord atrophy or bowing, since the vocal results are usually very poor.¹⁻⁴

Laryngeal framework surgery, using a Silastic® implant placed between the thyroid cartilage and inner thyroid perichondrium for vocal cord medialization, introduced by Isshiki over a decade ago,⁵ has not yet gained widespread acceptance, although the technique offers an exciting new surgical option. The purpose of this paper is to present a series of patients who have undergone medialization laryngoplasty.

MATERIALS AND METHODS

In 1984 and 1985, 11 patients underwent medialization laryngoplasty. In three of the patients, the technique was substantially modified to simultaneously alter tension of the vocal ligament.^{6,7} There were six men and five women patients, ranging in age from 21 to 73 years. The clinical data of each patient is summarized in Table I.

The diagnosis in nine of the patients was unilateral vocal cord paralysis. In five of those patients the paralysis was due to metastatic carcinoma involving the recurrent laryngeal nerve; in the remaining four patients, paralysis was due to cerebral vascular accident, thyroid surgery, basilar skull fracture, and an idiopathic cause.

The left side was involved in 6 of the 9 patients, and the right side in the other 3. The position of the vocal cord was paramedian in four patients and lateralized in five.

In three cases, there was atrophy and bowing of the involved vocal cords. Two of these patients (5 and 6) had paralyzed cords and one (10) had bilateral hypomobile vocal cords following a cerebrovascular accident. Patient 11, with normal cord mobility, had an anterior glottic gap on the left with little soft tissue overlying thyroid cartilage. This defect was the result of a previous cordectomy for glottic carcinoma, recurrent after radiation failure.

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Five patients had moderate to severe preoperative aspiration. Three patients were aphonic, and six exhibited severe breathy dysphonia. The remaining two patients were moderately dysphonic. Inadequate volume and vocal fatigue were part of the vocal symptom complex for all of the patients.

All of the procedures were performed under local anesthesia. Intraoperative flexible fiberoptic laryngoscopy was carried out in seven of the 11 cases. In cases 5, 6, and 10, a vocal ligament tightening procedure⁷ was done in conjunction with medialization.

Each patient's voice was audio-taped preoperatively; at present, seven patients have had postoperative voice taping done (usually 4 weeks or more after surgery). The voice quality of each patient was judged and graded in a single-blind fashion by three independent, trained speech and voice therapists. A 5-point scale was used to rate the voice: 1. normal, 2. nearly normal, 3. moderate dysphonia, 4. severe dysphonia, and 5. aphonia.

SURGICAL TECHNIQUE

Modified Isshiki Medialization Laryngoplasty.^{5,8}

The anterior neck is prepared and draped for surgery with the head in a neutral position. Local anesthesia is always employed. A 4- to 5-cm transverse incision is made at the level of the mid-thyroid ala extending just across the midline (Fig. 1-A).

The midline raphe of the strap muscles is incised and the muscles are reflected laterally, exposing the entire thyroid cartilage on the involved side. A Freer elevator is used for dissection, especially at the inferior border of the cartilage.

With a caliper or small flexible plastic ruler, the height and width of the thyroid ala are measured. Next, the surgeon determines the size and location of the cartilage window to be medialized.

Currently the following formulae are used:

$$\text{window height (mm)} = \frac{\text{Thyroid alar height (mm)} - 4}{4}$$

$$\text{window width (mm)} = \frac{\text{Thyroid alar width (mm)} - 4}{2}$$

These formulae allow window size to vary in proportion to laryngeal, *i.e.*, alar size, a factor that common sense dictates must be considered to optimize results. In other words, the larger the larynx, the larger the window and vice versa. For male patients, the window is usually 5 to 6 mm high and 10 to 13 mm wide; for female patients, it is usually 3 to 4 mm high and 10 mm wide.

TABLE I.
Medialization Laryngoplasty Patients — Clinical Data and Results of Surgery.

Case	Age	Sex	Diagnosis	Laryngeal Findings	Preoperative Symptoms		Postoperative Results		Follow-Up (mo)	Comments
					Voice*	Aspiration†	Voice*	Aspiration†		
1	29	F	Basilar skull fracture	R lateralized VC paralysis	4	4	2	1	3	
2	58	M	Lung CA	L lateralized VC paralysis	5§	2	2§	1	13	Silastic® block dislodgement (replaced)
3	49	M	CVA	L paramedian VC paralysis	4	3	3	2	4	Widespread neurological dysfunction
4	55	M	Lung CA	L paramedian VC paralysis	3	1	1	1	4	
5‡	73	F	Idiopathic	R paramedian VC paralysis, atrophy, and bowing	4§	1	1§	1	6	
6‡	70	F	Breast CA	L lateralized VC paralysis, atrophy, and bowing	4	4	2	2	—	Expired after 12 days: pneumonia
7	52	M	Lung CA	L lateralized VC paralysis	4§	2	2§	1	8	
8	54	M	Thyroid CA	R paramedian VC paralysis	3§	1	1§	1	3	
9	55	F	Esophageal CA	L lateral VC paralysis	5§	4	3§	2	7	Expired 5/85: Met. CA.
10‡	21	F	CVA	Bilateral paresis L > R, bowed cords with spasticity	4§	3	4§	2	6	Widespread neurological dysfunction
11	68	M	Laryngeal CA	Anterior glottic gap, mobile cords	5§	1	3§	1	2	Radiation failure status postcordectomy

*Voice scoring: 1=normal; 2=nearly normal; 3=moderate dysphonia; 4=severe dysphonia; 5=aphonia.

†Aspiration scoring: 1=none; 2=minimal; 3=moderate; 4=severe.

§Patient's pre and postoperative voice tapes graded by three voice therapists (single blind).

‡Patients who underwent medialization and vocal ligament tightening procedure.

VC - vocal cord; L - left; R - right; CA - carcinoma; CVA - cerebrovascular accident; met. - metastatic.

Once the size of the window has been determined, the window is measured and scored on the perichondrium of the cartilage with a number 11 blade. The upper horizontal incision is made at the level of the mid-ala (Fig. 1-B). (Dissection above this plane may cause bulging of the false vocal cord and may compromise the functional result.) The window is usually centered in the anteroposterior direction.

With a number 15 blade, and oscillating saw if necessary, the window is cut through the thyroid cartilage, with care being taken not to perforate the inner perichondrium. A small Penfield elevator is used to elevate the inner perichondrium until the window of cartilage is free of the alar cartilage.

The mobile segment (the window) is then medially displaced while the patient phonates. The surgeon can alternately press anteriorly and posteriorly as well as in the midportion of the window to determine the position of the segment that gives the best voice.

The location and depth of the medially displaced segment determines the size and shape of the Silastic® implant which will be used to hold the window in correct position. The implant is inserted with an Adson forceps without teeth and the Penfield elevator (Fig. 2). (The flange thickness of the implants in this series varied from 2 to 4 mm. The flange is the portion of the block that actually medializes the

cord, and flange thickness is therefore a measure of medialization.) The thyroid alar dimensions, the laryngoplasty window size, and the flange thickness data for the patients who underwent medialization procedures alone are displayed in Table II. Placement of the Silastic® implant must be exact and must conform to the "best position" of the medialized cartilage window. Each implant must be custom-fitted and positioned (Fig. 3).

Intraoperative fiberoptic examination may be useful to assess the degree of improvement in glottic closure. The undrained wound is closed in layers in standard fashion.

Modification for Simultaneous Vocal Ligament Tightening in Addition to Medialization Laryngoplasty

The thyroid ala is exposed in a similar fashion as outlined above and a superiorly based cartilage flap is outlined and created (Fig. 4). Care is taken not to perforate or tear the inner perichondrium or to disrupt the internal attachment of Broyle's ligament, which should remain attached to the cartilage flap. Laterally, the perichondrium is elevated inferior to the midlevel of the thyroid ala. On the involved (paralyzed) side, a pocket is created at the level of the cord for placement of a Silastic® implant.

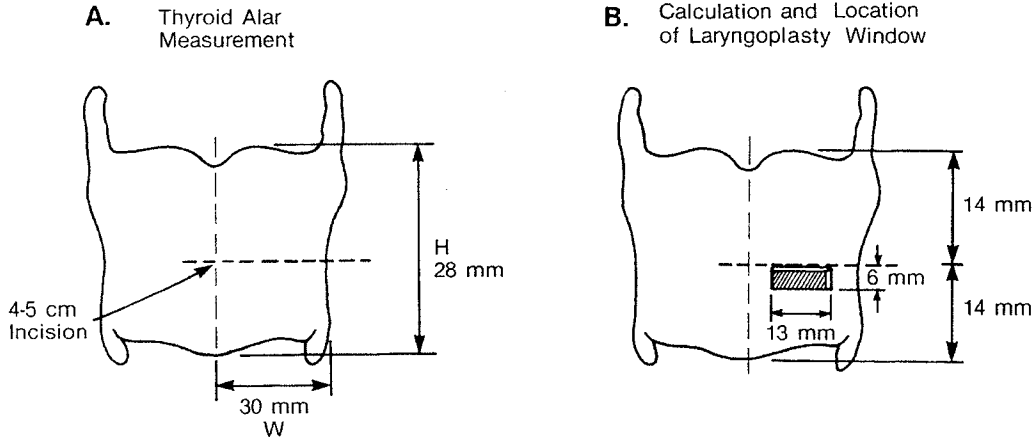


Fig. 1. Medialization laryngoplasty.

The size of the implant is roughly predicted by the "window size" formulae. The thickness is determined by the required amount of medial displacement that can be estimated but must be, in the final analysis, determined by trial and error. The ends of the implant should be cut so that they taper to a point or are rounded. The shape of the implant is therefore that of an elliptical or trapezoidal solid.

A 4-0 nylon suture should be placed through one end of the implant to facilitate its removal if necessary. The implant is then placed between the inner perichondrium and the thyroid cartilage, with the flat side being placed against the cartilage. The cartilage flap is then pulled anteriorly and held in position by a small tantalum shim (Fig. 5). (The technique of anterior commissure laryngoplasty, here modified to include Silastic® implantation for vocal cord medialization, was described by Tucker.⁷)

available on all 11 patients. The mean duration of follow-up is 5.6 months, with a range of 2 to 13 months. Follow-up data are summarized in Table I.

Vocal improvement was obtained in 10 of the 11 patients (91%). Two-thirds of the patients (7 of 11) had normal or near normal postoperative voices. The only case in which improvement did not occur was case 10, that of a 21-year-old woman with central neurological disturbances affecting the entire laryngopharynx. An attempt had been made to surgically medialize both vocal cords as well as to increase vocal ligament tension. Although the postoperative glottic chink appeared to close, the postoperative voice remained breathy, hyperkinetic, and poor. The two other patients (5 and 6) who underwent combined procedures (medialization and ligament tightening) did well. An elderly woman with paralytic and presbylarynx (5), has an excellent vocal re-

RESULTS

Although two patients have died, follow-up is

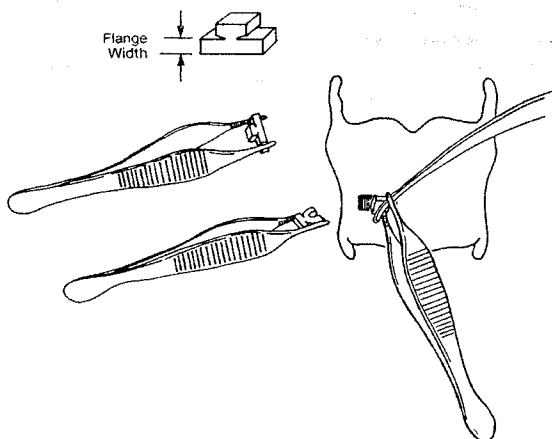


Fig. 2. Medialization laryngoplasty: technique of insertion of Silastic® implant.

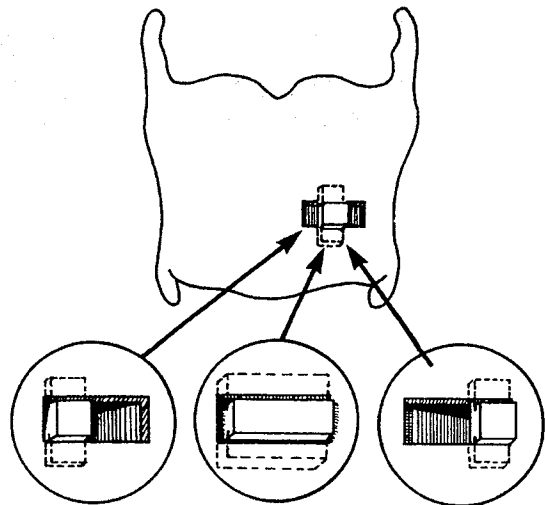


Fig. 3. Medialization laryngoplasty: variation in Silastic® implant shape, size, and positioning.

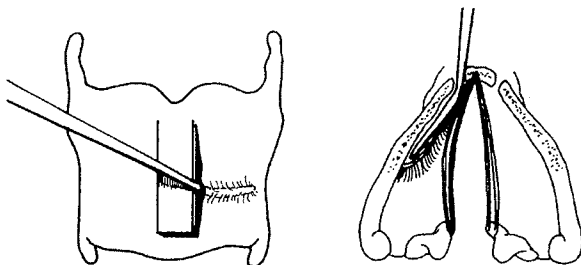


Fig. 4. Creation of cartilage flap and implant pocket for vocal cord medialization with simultaneous vocal ligament tightening (incision and dissection).

sult which has remained excellent for 6 months. The other patient with paralysis and atrophy (6) initially achieved a very good voice as well, but died early in the postoperative period.

When the vocal results were analyzed by the site of the neural lesion, it appeared, as expected, that those with recurrent laryngeal nerve lesions achieved a better postoperative voice than those with higher peripheral or central lesions.

Aspiration was corrected in every case except case 3, that of a 49-year-old man postcerebrovascular accident with a central lesion and concomitant pharyngeal dysfunction. Nevertheless, even in this man, aspiration was improved (Table I).

Complications

In the patient in case 2, the Silastic® implant slipped out of place on the fifth postoperative day. A larger implant was inserted during a second procedure.

The patient in case 6, a 70-year-old woman with metastatic breast carcinoma and a mildly elevated prothrombin time, underwent "emergency" medialization laryngoplasty for life-threatening aspiration with pneumonia. Her initial postoperative course was unremarkable. On the fourth postoperative day, she was intubated for a general surgical procedure and subsequently developed a hematoma which required tracheotomy. She succumbed to her metastatic cancer and pulmonary failure on the twelfth

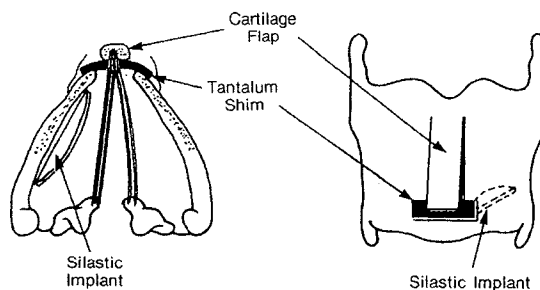


Fig. 5. Vocal cord medialization with simultaneous vocal cord tightening. Completed procedure with Silastic® implant and tantalum shim in place.

postoperative day. This complication is indirectly related to laryngoplasty, and directly related to traumatic endotracheal intubation. Nevertheless, since trauma at the operative site resulted in morbidity, the complication is reported.

DISCUSSION

The urgency and technique of surgical correction (medialization) for unilateral vocal cord paralysis depend on factors related to the position of the paralyzed cord and to the severity of symptoms. Additional factors include the overall medical condition of the patient, the cause of the paralysis, the chance for recovery or compensation, the personal and professional vocal needs of the patient, and the risks and sequelae inherent in each of the therapeutic options. These factors form a decision-making grid in which each patient is unique and requires an individualized treatment plan. Various techniques are available to surgically alter vocal cord position, the most popular of which is intracordal Teflon® injection.⁹ Although medialization laryngoplasty was reported in the English literature by Sawashima, *et al.*,¹⁰ in 1968 and by Isshiki (1974),⁵ specific indications for this technique have not been published.

The Limitations of Intracordal Teflon® Injection

1. The need for patient cooperation under local/topical direct laryngoscopy.

While the procedure can be done under general

TABLE II.
Thyroid Alar Dimensions, Laryngoplasty Window Size, and Silastic® Block Thickness.

Patient	Thyroid Alar Dimensions (mm)		Laryngoplasty Window Size (mm)		Preoperative Vocal Cord Position	Silastic® Block Flange Thickness* (mm)
	Height	Width	Height	Width		
Male						
2	32	27	5.5	13	Lateral	3
3	31	26	6	10	Paramedian	3
4	35	28	5	12	Paramedian	2.5
7	27	28	6	12	Lateral	4
8	25	27	5	12	Paramedian	2
11	28	28	6	11	Lateral (cordectomy)	4
Female						
1	22	24	4	10	Lateral	2
9	21	27	3	10	Lateral	3

*Flange thickness is the best measure of "medialization."

anesthesia, this is generally ill-advised since laryngeal function cannot be monitored intraoperatively. As a consequence, under general anesthesia, underinjection or overinjection is more likely.

2. The need for certainty that motor function will not return to the injected vocal cord.

Most authors^{11,12} agree that Teflon[®] injection should not be carried out within 1 year of paralysis except when the nerve supply is known to have been disrupted or in cases of aphonia or aspiration due to incurable cancer. Injection of Teflon[®] into a mobile cord or into a "paralyzed" cord that resumes function later is a well-recognized clinical catastrophe. I do not believe that Teflon[®] should ever be injected into a mobile cord, since it diffuses and produces a stony-hard cord and since its removal without anatomic destruction of the cord is essentially impossible. (For cases in which an injection technique is desired on a relatively short-term basis with reversibility, the injection of Gelfoam[®] paste is a useful technique.¹³)

3. Deficient soft tissue or extensive scarring.

Authors reporting on Teflon[®] injection^{1,2,4,9,14} agree that adequate soft tissue is a prerequisite for success. Three groups of patients in whom poor results can be expected and in whom Teflon[®] injection is thus relatively contraindicated are: 1. status postcordectomy; 2. status postblunt laryngeal trauma; and 3. presbylarynx with atrophy and bowing of the vocal cord.

4. Central neurological dysfunction.

Patients with paralysis due to central lesions often have concomitant superior laryngeal and pharyngeal dysfunction sufficient that procedures narrowing the glottic chink, such as intracordal injection or laryngoplasty, may not provide relief of aspiration. In addition, the postoperative vocal results are not as good as in patients with peripheral (*i.e.*, recurrent laryngeal nerve) lesions.^{3,14}

5. Surgical exposure and anatomic variation.

Inadequate laryngeal exposure at laryngoscopy is clearly a contraindication to Teflon[®] injection using the standard technique; however, transcutaneous injection remains an option.³ Also, the anatomic variation from patient to patient is often problematic in cases where posterior glottic closure is deficient, and sometimes one is simply unable to inject enough Teflon[®] posteriorly.

The Advantages of Medialization Laryngoplasty

The procedure is suitable for some patients with deficient soft tissue and scar, but the vocal results are unlikely to be excellent.⁵ The procedure can provide substantial improvement in some cases in which Teflon[®] injection is not an option (*e.g.*, case 5 and 11 in the series reported here). In case 5 (paraly-

sis with presbylarynx) the result of laryngoplasty was a normal voice. In case 11 (postcordectomy) the patient was aphonic before surgery and postoperatively was able to speak and shout with good volume, although he remained hoarse.

With regard to the timing of surgical intervention, it is important to ascertain whether or not medialization laryngoplasty is indeed a reversible procedure. As of this writing, although the question has not yet been answered, I believe the procedure to be completely reversible. Although I have not removed a Silastic[®] implant from the larynx of any of the patients operated on, the implant did "pop out" on the fifth postoperative day in case 2. The reversibility was immediately apparent to the patient, who simultaneously "lost" his voice, and subsequently apparent to me, when on mirror examination, lateralization was noted.

In cases of advanced cancer involving the vagus or recurrent laryngeal nerve with aphonia or significant aspiration, medialization laryngoplasty provides results that are functionally superior to those of intracordal Teflon[®] injection. Furthermore, since the procedure appears to be reversible, it may be the procedure of choice in such patients.

When medialization laryngoplasty is compared to intracordal Teflon[®] injection, three additional advantages emerge. The first advantage is that the procedure is better tolerated by patients than Teflon[®] injection since patients seem to prefer having a local anesthetic for their operative experience, rather than a local/topical direct laryngoscopy. Second, laryngoplasty is an option for patients with atrophy and normal cord mobility; however, this procedure for that purpose is still new and has been reported only by Isshiki,⁵ LeJeune, *et al.*,⁶ and Tucker.⁷ Third, the major advantage of medialization laryngoplasty is that the surgeon can adjust the degree of lateral compression in accordance with vocalization — rather as one would tune a piano string. (Once Teflon[®] has been injected, it cannot be withdrawn).

My experience suggests that relatively thick and large Silastic[®] implants may be necessary in some larynges (larger than previously reported). However, it remains to be determined which of the technical methods provide the optimal anatomical and functional results without complication or implant displacement.

The formulae used for selection of window size were empirically derived, but seem to work well. The window location must also be individualized. In case 11 (the postcordectomy patient), for example, the window was placed more anteriorly, almost to the anterior commissure. This was done to best fill the defect, an obvious requirement for good postoperative vocal function.

The techniques of Isshiki and Tucker, here modi-

fied and combined, suggest that laryngoplasty, like rhinoplasty, requires that each procedure and every patient be individualized, and that each Silastic® implant be custom-fashioned. Indeed, like other forms of plastic and reconstructive surgery, reshaping of the laryngeal framework to alter voice requires flexibility and creativity on the part of the surgeon to optimize results.

In summary, medialization laryngoplasty may soon totally replace intracordal Teflon® injection in my own surgical practice. In addition, I believe that some cordectomy patients and those with previous blunt trauma or vocal cord atrophy in whom Teflon® injection has failed may now be candidates for this type of surgery. The limits of medialization laryngoplasty, however, remain to be explored.

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