

# Short-Term Treatment Results for Unilateral Vocal Fold Palsy Induced by Mediastinal Lesions

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**Summary: Objectives.** Vocal fold paralysis (VFP) is a frequent complication of surgery of mediastinal structures. This study evaluated the characteristics and short-term treatment outcomes of injection laryngoplasty for unilateral VFP (UVFP) induced by mediastinal lesions.

**Methods.** The enrolled patients ( $n = 60$ ) underwent injection laryngoplasty once because of UVFP and were divided into two groups according to cause (group A, thyroidectomy and group B, mediastinal surgery). Voice analysis was performed preoperatively and at 1 month postoperatively. The glottal gap; the Grade, Roughness, Breathiness, Asthenia, and Strain scale; acoustic analysis; and aerodynamic results were measured.

**Results.** Group A and group B comprised eight and 52 patients, respectively. Group B patients were older than group A patients ( $P < 0.05$ ). The injected volume in group B ( $0.91 \pm 0.23$  mL) was larger than that of group A ( $0.38 \pm 0.17$  mL;  $P = 0.022$ ). Group B ( $13.35 \pm 4.69$  units) showed a larger glottal gap than group A ( $6.64 \pm 4.05$  units;  $P = 0.017$ ), and the glottal gap decreased after the procedure. In both groups, most preoperative acoustic parameters except roughness improved after injection laryngoplasty. The preoperative maximum phonation time of group B ( $2.87 \pm 1.11$  seconds) was shorter than that of group A ( $7.04 \pm 2.58$  seconds), and it improved after injection. Mean airflow rate improved significantly after injection in both groups.

**Conclusions.** Mediastinal lesion-induced UVFP is associated with a larger glottal gap than that caused by an injury induced by thyroidectomy. Despite large glottal gap, injection laryngoplasty improves voice outcomes in such types of UVFP.

**Key Words:** Vocal fold paralysis–Laryngoplasty–Voice quality.

## INTRODUCTION

The recurrent laryngeal nerve (RLN) branches off the vagus nerve, where the carotid artery originates.<sup>1</sup> In addition to the thyroid gland, mediastinal structures, which include the aorta, esophagus, trachea, lung, and mediastinal lymph nodes, are located along this pathway. Vocal fold paralysis (VFP) is a frequent complication of operation of these mediastinal structures, such as in response to malignant tumors and cardiovascular diseases or due to mediastinal diseases themselves.<sup>2–4</sup> There is a left-sided prevalence because the intrathoracic segment of the left RLN is longer. When the lesion involves or abuts onto the RLN, surgical manipulation or compressive tumor growth may give rise to nerve paralysis. Unilateral VFP (UVFP) presents with hoarseness, aspiration, dyspnea, and dysphagia, whereas bilateral VFP causes severe dyspnea with stridor or aspiration. Less than 50% of cases of vocal fold immobility caused by thermal, electrical, or strained injury during cardiothoracic surgery are recovered spontaneously within 1 year and the other patients show persistent VFP.<sup>5</sup> When a paralyzed and lateralized vocal fold is not compensated by the contralateral normal vocal fold, a substantial glottal gap may occur, which causes dysphonia and dysphagia and which

reduces patient's quality of life. Furthermore, it may cause pulmonary complications and malnutrition.<sup>6,7</sup>

Various types of treatment approaches have thus been developed to correct the glottal gap. One approach is injection laryngoplasty, which has been widely used to correct lateralized vocal folds because of its simplicity. Since the first surgical correction of UVFP was described in 1911 by Brünings,<sup>8</sup> various injection techniques and surgical procedures have been developed to ameliorate the symptoms of UVFP.<sup>9</sup> Injection laryngoplasty is a relatively simple procedure to improve glottal closure for patients with UVFP.<sup>10</sup> Bone paste, silicone, hydrogen gel rod, gelfoam paste, and autologous fat have been used as injection materials.<sup>9</sup> Recently, hyaluronic acid, bovine collagen, and calcium hydroxyapatite have been developed and used as alternative materials.<sup>6,11,12</sup> Thyroplasty type I, arytenoid adduction, and neurotomy are also good vocal fold medialization methods.<sup>5,13,14</sup> However, these procedures are, generally, not prioritized when choosing treatment methods because they are more invasive than injection laryngoplasty.

We speculated that the involved site may affect the treatment outcomes of UVFP, especially in patients undergoing mediastinal surgery. However, few reports describe UVFP after mediastinal lesions. This study was aimed to evaluate the characteristics and short-term treatment outcomes of injection laryngoplasty for UVFP induced by mediastinal lesions.

## METHODS

### Participants

A retrospective cohort study of 118 consecutive patients of injection laryngoplasty from January 2012 to December 2012 at Asan Medical Center was performed. This study was approved

Accepted for publication April 1, 2014.

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Journal of Voice, Vol. 28, No. 6, pp. 809-815

0892-1997/\$36.00

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<http://dx.doi.org/10.1016/j.jvoice.2014.04.003>

by the institutional review board. Enrolled patients were selected on the basis of the following inclusion criteria: UVFP presence, first trial, and full record of preoperative and postoperative voice measurements. Patients with bilateral VFP, multiple injections, or missing medical records were excluded from this study. The enrolled patients were divided into two groups. Group A contained patients with thyroidectomy-induced UVFP, whereas group B contained those with mediastinal surgery-induced UVFP. When glottal gap without compensation was confirmed and this finding corresponded to patients' symptoms, injection laryngoplasty was performed to decrease the glottal gap.

### Injection laryngoplasty

Injection laryngoplasty was performed in the operating room with local anesthesia. The injection materials were hyaluronic acid, calcium hydroxyapatite, and artificial collagen. Temporary material (hyaluronic acid) was used for those patients expected to show recovery of UVFP, whereas the latter two materials were used for permanent injuries. Before injection, Xylocaine® (AstraZeneca, Schaumburg, IL) 4% spray and nasal packing gauze (sprayed with lidocaine 1% and epinephrine 0.1%) were used for anesthetizing the pharynx, larynx, and nasal cavity. These materials were injected through the cricothyroid membrane with a disposable 26G needle under the guidance of transnasal flexible videolaryngoscopy. Depending on the defect site, the material was infiltrated lateral to the involved vocal process and vocal ligament at the midportion of the true vocal fold. The injection was considered adequate when the minimum glottal gap on phonation was observed via videolaryngoscopy.

### Voice measurements

Voice analysis was performed preoperatively and at 1 month postoperatively. To exclude a confounding factor, different gender distribution, we compared preoperative and postoperative glottal gap and volume of injected material according to either male or female patients of each group. The glottal gap was measured using the glottal gap index (unit), which was proposed by Rihkanen et al.<sup>14</sup> For perceptual analysis, the Grade, Roughness, Breathiness, Asthenia, and Strain (GRBAS) scale was used and evaluated by two speech language pathologists. In acoustic analysis, jitter, shimmer, and the noise-to-harmonic ratio (NHR) were measured by a multidimensional voice program (Computerized Speech Lab, Model 4500; KayPENTAX Electrics, Lincoln Park, NJ). For recording the voice, the microphone was placed 10 cm from the patient's mouth, and the patients were instructed to produce a sustained vowel /a/ with a comfortable pitch and loudness three times, the average value of which was subsequently used. In the aerodynamic study, the maximum phonation time (MPT), mean airflow rate (MFR), and subglottic pressure (Psub) were measured by Phonatory Aerodynamic System (Phonatory Aerodynamic System Model 6600; KayPENTAX Electrics, Lincoln Park, NJ). MPT and MFR were measured on a sustained vowel /a/ as long as possible at a comfortable phonation. The longest value after three trials was subsequently used. To measure Psub, patients were instructed to repeat the syllable /pa/ seven times at a single

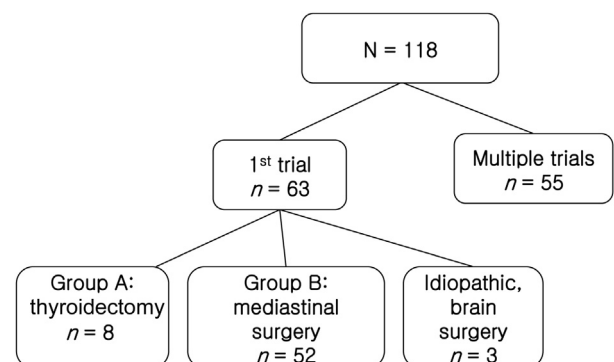
exhalation. A facial mask was firmly fitted, and an intraoral tube was placed between the lips. Two each of front and backward values were excluded, and the average values of the middle three values were compared. These parameters were evaluated by two speech language pathologists.

### Statistical analysis

Statistical analyses were performed with *SPSS software, version 18.0* (SPSS, Chicago, IL). The average volume of injected material and the duration of symptoms of both groups were compared using a Mann-Whitney *U* test. The proportion of gender and injected materials in both groups was compared with a Fischer exact test. Preoperative and postoperative voice parameters in both groups were compared. In addition, preoperative or postoperative voice parameters between the two groups were compared using a Mann-Whitney *U* test. All reported *P*-values are two sided.

### RESULTS

There were 63 primary cases among the patients who underwent injection laryngoplasty (Figure 1). Mediastinal surgery involved lung surgery (mostly lung cancer,  $n = 26$ ), esophagectomy ( $n = 13$ ), aortic surgery ( $n = 8$ ), and others ( $n = 5$ ). UVFP caused by thyroidectomy and by mediastinal surgery were detected in eight and 52 patients, respectively. Of the enrolled patients, there was a male predominance in group B but a female predominance in group A, although the gender ratio was not significantly different between the groups (Table 1). In group A, the RLN was injured by direct invasion of thyroid cancer before surgery ( $n = 2$ ) and by nerve dissection because of direction invasion of the tumor ( $n = 4$ ) or probable injury with intact integrity of the nerve ( $n = 2$ ) during surgery. Group B patients were older than group A patients. The period from the onset of symptoms or signs, including voice change, dysphonia, hoarseness, and aspiration, to the procedure was longer in group B than that in group A. We injected three types of injection materials. Hyaluronic acid was frequently used in both groups and was used in more than 90% of the patients with UVFP after mediastinal surgery (Table 1). The average volume of the injected material in group B ( $0.91 \pm 0.23$  mL) was larger than



**FIGURE 1.** Distribution of enrolled patients. Patients with either a different cause of VFP or repeated injection laryngoplasty were excluded from this study.

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