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# Etiology and long-term functional swallow outcomes in pediatric unilateral vocal fold immobility<sup>☆</sup>



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## ABSTRACT

**Objective:** Unilateral vocal fold immobility (UVFI) results in deficits in phonatory, respiratory, and swallow function of the pediatric patient. Little is known about long-term functional swallow outcomes. **Methods:** Medical records of children diagnosed with UVFI between 2005 and 2014 at a tertiary children's hospital were retrospectively reviewed. Etiology, laryngoscopy findings, and swallow status at diagnosis and follow-up were recorded. Swallow outcomes were compared by etiology using Fisher's exact test. McNemar's test was used to identify correlations between return of mobility and swallow recovery. Rates of pneumonia were compared with initial swallow evaluation results using a two-tailed *t*-test.

**Results:** Eighty-eight patients with UVFI were identified and 73 patients (47% female, mean age 14.4 months, standard deviation (SD) 26.7 months) had complete medical records. Mean follow up time was 52.7 months (SD 36.8 months). Etiologies included cardiothoracic surgery (68.5%), idiopathic (12.3%), prolonged intubation (11.0%), central nervous system (CNS) abnormality (5.5%), and non-cardiac iatrogenic injury to the recurrent laryngeal nerve (2.7%). Forty-seven patients underwent a follow up laryngoscopy, and recovery of vocal fold (VF) mobility was documented in 42.6% (20/47). At diagnosis, 31.5% fed orally, compared with 79.5% at follow-up. Direct correlation between recovery of VF mobility and swallow recovery was not demonstrated. Cardiac etiologies demonstrated higher rates of swallow recovery than CNS abnormalities ( $p = 0.0393$ ). Twenty-five children aspirated on initial modified barium swallow (MBS) and 10 children developed pneumonias at some point during the follow up period. There was no significant difference in rates of pneumonia in patients with and without aspiration on MBS.

**Conclusion:** Recovery of swallow in children with UVFI does not directly parallel return of VF mobility. Long-term swallow outcome is favorable in this population. Initial MBS does not indicate ultimate swallow outcome.

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## 1. Introduction

Vocal fold immobility (VFI) is the second most common cause of

neonatal stridor after laryngomalacia [1]. Patients may present with total paralysis or partial paresis of one or both vocal folds (VF). Bilateral VFI is rare, with an estimated incidence of 0.75 cases per million births per year [2]. Unilateral VFI (UVFI) is more common, with an estimated diagnosis rate of 8–25% of pediatric patients undergoing laryngoscopy for airway evaluation [3]. Multiple etiologies of VFI in the pediatric population exist, with iatrogenic causes being most common. Cardiothoracic surgery is often causative, most often due to iatrogenic injury of the left recurrent laryngeal nerve (RLN). Injury during endotracheal intubation, birth trauma, or other post-natal intervention affecting the function of the recurrent laryngeal nerve may also result in iatrogenic VFI [4]. In

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approximately 20–41% [4–8] of cases, no cause is identified and the immobility is deemed idiopathic.

There are numerous studies evaluating long-term outcomes in children with VFI of various etiologies [4–13]. Reported rates of recovery of VF mobility range from 28 to 74% and vary by etiology of VFI [7,8,13]. These studies, however, focus primarily on the return of VF mobility rather than functional outcomes such as voice and swallowing. The primary aim of this study is to evaluate long-term functional swallow outcomes of pediatric patients with UVFI. We hypothesize that UVFI in the pediatric population portends a favorable prognosis for recovery of swallow function even if VF mobility does not return. We also assess the implications of the initial swallowing evaluation in children with UVFI. We hypothesize that swallow evaluation with modified barium swallow (MBS) studies at initial diagnosis of VFI can predict which children are at risk for aspiration pneumonia. We hope that the findings of this study will guide management and expectations of clinicians and caregivers of children with UVFI by providing objective data regarding the prognosis for improvement in swallow function.

## 2. Materials and methods

### 2.1. Patient cohort

A retrospective review of medical records of pediatric patients (age less than 18 years) diagnosed with vocal fold paresis or paralysis at our institution between 2005 and 2014 was performed with Institutional Review Board approval. Patients were identified through a search of an existing database of pediatric patients who had previously undergone airway evaluation by the Otolaryngology-Head and Neck Surgery (ORL-HNS) service. Additional patients were identified through a Clinical Looking Glass (CLG<sup>®</sup>) search of the ICD-9 codes for vocal fold paresis and paralysis (478.30–478.34) in patients less than 18 years old. CLG<sup>®</sup> is a data collection and management software tool that democratizes several of the electronic medical data systems used by the study institution and allows the user to collect demographic and outcome data for healthcare purposes [14].

### 2.2. Data collected and outcomes measured

Existing electronic medical records were reviewed and data pertaining to basic demographics, nature of VFI (left, right, or bilateral; total paralysis or paresis), neonatal history (prematurity, cardiac surgery, intubation, tracheotomy, other comorbidities), and etiology of VFI were collected. Data regarding patients' functional impairment (abnormalities in voice, breathing, and feeding) at the time of diagnosis and at most recent follow up were also obtained. Data pertaining to voice and swallowing status was obtained by reviewing documentation from inpatient and outpatient encounters with the pediatric ORL-HNS service, speech language pathologists, and patients' general pediatricians and other specialty physicians. Patients who were fed both via feeding tube and orally were considered to be feeding by mouth in the analysis. MBS results as well as whether aspiration pneumonia occurred and the time of diagnosis were recorded as well. All MBS studies were performed and interpreted by 1 of 5 Speech Language Pathologists (SLP) at the study institution in conjunction with the Radiology service. SLP documentation of the MBS was reviewed to determine whether aspiration occurred during the study. A binary system was employed (presence or absence of aspiration). Voice outcomes were determined through reviewing descriptions of vocal quality in documentation by either an otolaryngologist, SLP, general pediatrician, or other clinician. Objective voice measures or subjective questionnaires were not applied.

Procedure notes detailing flexible laryngoscopy findings were reviewed to determine whether VF mobility had recovered at follow up. Laryngoscopies were performed either at the bedside during inpatient encounters or in the outpatient clinic setting. All procedure notes were authored or co-signed by an attending otolaryngologist. Video of the examinations was generally not recorded and thus was not available for review. Any return of mobility in a previously immobile VF was considered recovery.

### 2.3. Statistical analysis

Descriptive statistics were used to summarize patient demographics, functional status at initial presentation and follow up, and etiologies of VFI. Outcomes in voice and swallowing status by etiology were compared using Fisher's exact test. McNemar's test was used to identify correlations between return of mobility and recovery of voice and swallow. A two-tailed *t*-test was used to determine if there was a significant difference between the rates of pneumonia in children with and without aspiration on their initial swallowing evaluation.

## 3. Results

Eighty-eight pediatric patients with UVFI were identified and 73 patients (53% male, 47% female) had complete medical records and were included in the analysis. Mean age at diagnosis was 14.4 months (standard deviation (SD) 27.6 months), and mean follow-up time was 52.7 months (SD 36.8 months). Patients had an average of 2.5 follow up encounters (SD 1.3) during the study period. Etiologies of UVFI were cardiothoracic surgery (68.5%), idiopathic (12.3%), prolonged intubation (11.0%), central nervous system (CNS) disorders (5.5%), and other iatrogenic injury to the RLN (2.7%). Patient demographics are displayed in Table 1. Forty-seven patients underwent a follow up laryngoscopy, and recovery of vocal fold (VF) mobility was documented in 42.6% (20/47). Twenty-six patients did not undergo a follow up laryngoscopy (Table 2). At diagnosis, 31.5% (23/73) fed orally, 8 were receiving total parenteral nutrition (TPN), and the remaining patients required a feeding tube. Patients receiving TPN were premature and at risk for or had been diagnosed with gastrointestinal complications of prematurity such as necrotizing enterocolitis, and were thus unable to receive enteral feeds. At most recent follow-up, 79.5% (58/73) were feeding orally (Table 3) and improving or

**Table 1**  
Patient demographics.

Etiology	Sex	Age at diagnosis (Months)
Cardiothoracic surgery (n = 50)	29 Female 21 Male	Mean: 10.5 Range: 1–68 SD: 14.9
Idiopathic (n = 9)	3 Female 6 Male	Mean: 10.2 Range: 0.6–25 SD: 20.3
Prolonged intubation (n = 8)	1 Female 7 Male	Mean: 23.8 Range: 1–140 SD: 48.1
CNS disorder (n = 4)	1 Female 3 Male	Mean: 56.4 Range: 1–124 SD: 63.3
Other RLN injury (n = 2)	0 Female 2 Male	Mean: 9.9 Range: 5.7–14.1 SD: 6
All (n = 73)	34 Female 39 Male	Mean: 14.4 Range: 0.6–140 SD: 26.7

SD = Standard deviation.

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