Using Hyaluronic Acid for Improving Vocal Function in a Prepubescent Boy With an Atrophied Right Vocal Fold

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Summary: Objectives. A single case study is reported of a child who underwent several surgical procedures as result of congenital grade III subglottic stenosis. The anterior aspect of the right vocal cord was damaged and underwent atrophy during one of these procedures. Now, an active 10-year-old, the patient has become increasingly aware of his vocal limitations on functional activities. Injection of hyaluronic acid into the vocal folds has been known to provide improved voice quality in adults although there are no known cases reported of this procedure in children.

Methods. This article reports voice outcomes after injection of hyaluronic acid into the Reinke's space in a single case study. Voice recordings were made before, after, and 1 month after injection. The voice recordings were subject to acoustic and perceptual analysis.

Results. Post and follow-up voice recordings demonstrate decreased jitter, shimmer, and harmonics-to-noise ratio. Perceptual evaluation indicates improved voice quality.

Conclusion. Injection of hyaluronic acid in children who require voice augmentation is possible and may contribute to increased vocal function and improved voice outcomes.

Key Words: Voice outcome–Pediatric subglottic stenosis–Laryngeal reconstruction surgery–Injection layrgoplasty–Hyaluronic acid.

INTRODUCTION

Laryngeal airway narrowing from subglottic stenosis (SGS) may be congenital or acquired, with many cases of SGS acquired after intubation or laryngotracheal injury.[1] Medical and surgical interventions are used to establish sufficient airway to support respiratory function, including bypassing the obstruction with tracheostomy or reconstructive surgery to repair stenosis.[2] Two main approaches to reconstructive surgical management exist: laryngotracheal reconstruction (LTR) and partial cricotracheal resection (CTR), and these are well documented in the literature.[3] Primary surgical outcome indicators continue to be survival or decannulation of the tracheostomy.

Outcomes relating to quality of life (QOL) and voice quality have gained prominence with an increasing awareness of QOL impact after critical care surgery in the pediatric population [4,5]. In adults, voice quality is often reduced after LTR or CTR,[6] particularly in women.[7] Similar studies in the pediatric population show a range of findings from poor[4,8–9] to good voice outcome.[5,10] Voice outcome may depend on the preoperative condition, such as the grade of stenosis[8,11,12] or methodological differences in relation to how voice outcome is evaluated. For example, there are various methods used in judging quality of life (eg, using different health-related QOL questionnaires), various ways of evaluating voice quality (eg, GRBAS or CAPE-V) and differences in acoustic data reported (eg, F_0, jitter, shimmer, and noise-to-harmonics ratio [NHR]). Furthermore, published studies have a range of participant numbers, from 12[7] to 77[12] reflecting the small caseload. The overarching conclusion that can be drawn from the literature is that individual voice outcome data are variable and related to various factors, including etiology, stenosis grade, surgical procedures, surgical outcomes, and how vocal function is evaluated.

Notwithstanding these varied findings, some children and their families seek ongoing advice where voice remains of poor quality several years after LTR/CTR. For these children, surgical intervention is limited to procedures that will not affect the normal course of growth, especially given reports that LTR/CTR in childhood does not impact on the normal anatomical development of the larynx.[11,13]

The use of temporary injection laryngoplasty is well documented in the literature with a variety of available products that can be used to bulk out a vocal fold to close a phonatory glottis gap and improve vibratory function.[14] Much of the reported research describes injection laryngoplasty in relation to vocal fold paralysis (VFP)—a condition that has potential for spontaneous recovery. For example, various collagen products (micronized, acellular, cadaveric dermis, and bovine) have shown promising voice outcomes up to 6 months after injection laryngoplasty in children with VFP.[15] This review also describes the varied outcomes using other materials such as calcium hydroxylapatite, autologous fat, and hydrated porcine gelatin powder. Many of these materials are subject to restricted use in the pediatric population in the United Kingdom; however, one material is widely used—hyaluronic acid. Hyaluronic acid has also been used in injection laryngoplasty with improved voice quality in adults with unilateral VFP,[16] and the specific molecular weight of certain hyaluronic acid compounds are considered to be effective at augmentation of the vocal folds.[17] Its use is also reported for augmentation and medialization of the vocal folds in children with VFP.[18]

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TABLE 1.
Audio Data Recordings and Their Corresponding Analysis Method

Data	Maximum Phonation Time	Acoustic Measure (Using MDVP)				Perceptual Evaluation	
		F_0	Jitter	Shimmer	Noise-to-Harmonics Ratio	Time Judgment	GRBAS
Sustained vowel [a]	✓	✓	✓	✓	✓	✓	✓
Sustained consonant [s]	✓					✓	✓
Sustained consonant [z]	✓					✓	✓
Reading passage "The north wind and the sun"						✓	✓
Six sentences from the CAPE-V protocol						✓	✓

Although these materials may be worthwhile using where the purpose of the procedure is to bulk out an existing but nonfunctioning vocal fold, little is known about how they might be used where the vocal fold has atrophied after neonatal LTR. These patients present with a greater degree of challenge to the otolaryngological surgeon who is faced with a compromised anatomy.

This article reports a single case study of a prepubertal child who has vocal fold atrophy after neonatal LTR. Voice outcomes after injection of hyaluronic acid into the Reinke's space are reported.

METHOD

Participant information

The patient in this single case study presented with a congenital type III SGS. During the neonatal period, the patient required tracheostomy for a grade III SGS that was reversed by performing a cricotracheal resection during infancy. During the procedure, the anterior aspect of the right vocal fold was damaged and underwent atrophy. (The clinical appearance was that of a withered anterior vocal fold, that may or may not be truly atrophied in terms of muscular impulse activity. Laryngeal electromyography (LEMG) was not undertaken at that time, but between infancy and 10 years of age, there was no substantial change to the vocal fold clinical appearance). Further symptomatic SGS recurrence was treated with a laryngotracheal resection and anterior rib graft at 7 years of age. Now aged 10 years, the patient continues to have a small subglottic/tracheal stenosis, giving him mild stridor and a phonatory glottis insufficiency resulting in a weak and breathy voice.

The patient is able to participate in a wide range of educational and extracurricular activities despite his respiratory limitations. As he has matured into preadolescence, he has become increasingly aware of the limitations his voice quality has on functional activities. This awareness prompted his family to seek further advice and information regarding future surgical management.

Surgical procedures

The patient was admitted for surgery where 0.4 mL of Restylene Perlane®; (Q-Med, Uppsala, Sweden) hyaluronic acid was injected submucosally/subepithelially into the atrophied area of the right vocal fold in the Reinke's space to bulk out the anterior position of the vocal fold. Both vocal folds were mobile on video endoscopy with a glottal gap evident as a result of the atrophy of the R vocal fold which reduced as the material was injected. There was no significant vertical mismatch of the vocal folds observed during surgery. The patient had a suspension laryngoscopy while under a spontaneously breathing tubeless general anesthetic. He was discharged home the following day with no complications.

Voice recordings

A range of audio recordings, shown in Table 1, were made using the Storz Aida three system at pre surgery, post-surgery and 1 month follow-up.

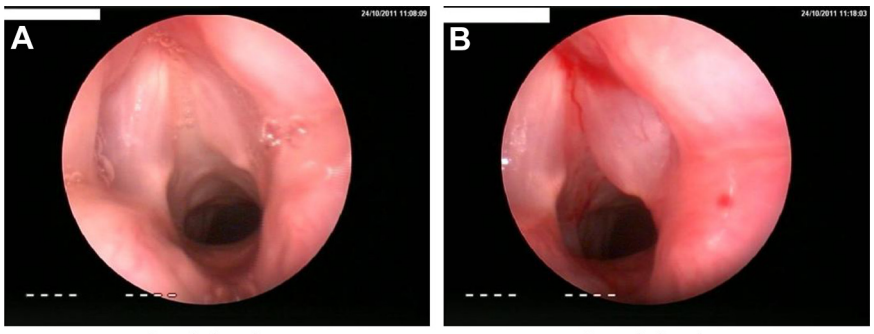

FIGURE 1. Images taken showing the vocal fold at before (A) and after (B) surgical injection of hyaluronic acid.