

Diagnostic Contributions of Videolaryngostroboscopy in the Pediatric Population

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Objective: Videolaryngostroboscopy (VLS) is a standard technique used for evaluating adult patients with dysphonia. However, while pediatric dysphonia affects 5% of children, children with dysphonia are traditionally examined with a flexible nasal endoscope. The purpose of this study was to determine whether VLS provides additional diagnostic yield in children.

Design: A retrospective medical chart review was conducted from 2001 to 2006.

Setting: Tertiary care center.

Patients: Pediatric patients aged 3 to 17 years (mean age, 11 years) who presented with prolonged dysphonia. All patients were previously examined by flexible laryngoscopy and treated with speech therapy for a presumed diagnosis of vocal cord nodules.

Interventions: Flexible or rigid VLS was performed.

Main Outcome Measure: The diagnosis per patient established after VLS.

Results: Eighty patients were included in the study: 50 underwent rigid VLS; 28 underwent flexible VLS; and 2

did not tolerate either procedure. A total of 132 diagnoses were made, including 68 benign mucosal diseases (41 nodules, 15 polyps, 8 cysts, and 4 sulci), 41 inflammatory disorders, 11 functional disorders, 6 congenital disorders, 4 traumatic injuries, and 2 neurologic disorders. Many patients received more than 1 intervention for their dysphonia, including antireflux medication and speech therapy, but 16 patients also underwent phonosurgery.

Conclusions: Patients with a history of prolonged dysphonia for whom treatment has failed should be referred for evaluation by VLS. Videolaryngostroboscopy elucidates subtle features of different disease processes; clarifies the differences between benign mucosal disorders that might require surgical intervention; and helps identify inflammatory processes that contribute to dysphonia. To our knowledge, these findings have not previously been reported in the pediatric population. Although most pediatric dysphonia can be attributed to benign nodules, our results show that inflammatory conditions and benign lesions other than nodules contribute to dysphonia and are often overlooked and undertreated.

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VIDEOLARYNGOSTROBOSCOPY (VLS) has proven to be a valuable tool in evaluating voice disorders in the adult population because of its ability to provide detailed assessment of glottic closure and mucosal wave vibration and amplitude characteristics. Videolaryngostroboscopy can detect subtle vocal fold disease missed by indirect laryngoscopy, which uses constant light. Pediatric dysphonia is encountered in 6% to 9% of children,¹ but otolaryngologists use VLS infrequently when examining these patients.²

Children tolerate flexible laryngoscopic examinations.^{3,4} Hartnick and Zeitel⁵ showed that VLS could be performed using distal chip digital flexible endoscopes in children aged 19 months to 13 years. Wolf et al² demonstrated that rigid VLS can be used to safely and effectively examine children older than 10 years.

Despite these findings, the added value of VLS in pediatric patients is not clear. Traditionally, pediatric dysphonia has been thought of in terms of 3 diagnoses: nodules, papillomas, and neoplasms. Would this preferential differential diagnosis change if diagnostic VLS were used? Is clinical care changed by diagnostic VLS in children? What additional information can be learned about pediatric dysphonia from VLS? Herein, we review VLS examinations in children aged 3 to 17 years to determine if VLS in children with persistent dysphonia gives additional information.

METHODS

We conducted a retrospective review of medical charts for patients aged 3 to 17 years (mean age, 11 years) who presented with dysphonia between December 2001 and January 2006. We identified 110 children with dysphonia, 80 of whom met the inclusion criteria of prolonged

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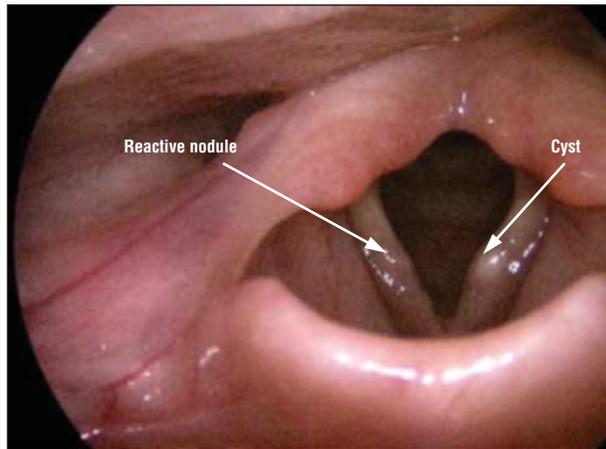


Figure 1. A 12 ½-year-old boy presented with prolonged dysphonia and was initially diagnosed with bilateral vocal fold nodules. Under evaluation with videolaryngostroboscopy, he was found to have a vocal cord cyst and a reactive nodule.

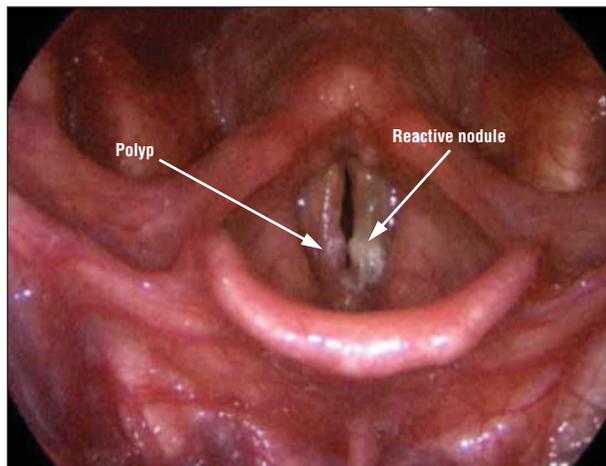


Figure 2. A 14-year-old boy was diagnosed as having nodules. Under evaluation with videolaryngostroboscopy, he was found to have clinically significant allergic and reflux laryngitis, a vocal polyp, and a reactive nodule.

dysphonia, previous evaluation by an otolaryngologist, and previous flexible laryngoscopy. All patients were referred with a diagnosis of either nodules or unresolved dysphonia and had been treated with speech therapy, but the dysphonia continued without improvement. The average duration of hoarseness and dysphonia was 1 year. All patients underwent VLS as part of their voice evaluation. The study was approved by the institutional review board.

The choice of flexible vs rigid VLS examination was determined partly by age and partly by maturity. In patients younger than 12 years who were mature and seemed to have minimal issues with oral cavity examination by a tongue blade, rigid VLS was attempted first. If the child did not tolerate rigid VLS, we proceeded to use flexible VLS. Typically, the older the child, the easier it was to perform a rigid VLS examination.

For patients 12 or older, rigid VLS was always attempted first. Children and parents were prepared by an explanation of the procedure. We explained to children younger than 12 years that the rigid endoscope was like the tongue blade or a long lollipop that they might feel on the back of their tongue and that we were going to use it to look at their throat while we held their tongue. For the older children, we explained that we use the rigid scope while holding their tongue to examine their

voice box. For rigid VLS, all the children were anesthetized with tetracaine hydrochloride, 2%, spray applied to their oral pharynx. (For our adult patients, we describe the procedure similarly, but typically we do not anesthetize the oral pharynx unless they have a strong gag reflex.)

For rigid VLS, we used the rigid 70° scope (Karl Storz Endoscopy America Inc, Culver City, California). If flexible VLS was performed, the patient's nasal cavity was decongested with phenylephrine hydrochloride and anesthetized with tetracaine hydrochloride, 2%, before the 3-mm flexible endoscope was used (ENF-P3; Olympus, Lake Success, New York). All examinations were recorded and reviewed with the patients and their parents in attendance. One of us (P.W.) established the diagnosis following each examination.

RESULTS

Eighty patients were identified for the study (28 girls [35%] and 52 boys [65%]): 50 underwent rigid VLS (63%), and 28 underwent flexible VLS (35%). In the group of children younger than 8 years, 6 rigid VLS examinations were attempted, and only 1 patient tolerated the examination. In children aged 8 to 11 years, 21 rigid VLS examinations were attempted, and 17 patients tolerated the examination. In the children 12 years or older, 38 rigid VLS examinations were attempted, and 32 patients tolerated the examination. Two patients did not tolerate either rigid or flexible VLS examination, and so our findings on these patients were limited.

A total of 132 diagnoses were made in 80 patients. Benign mucosal disorders made up the majority of the patients' diagnoses, seen in 71 (89%) patients. Benign mucosal disorders were categorized as nodules (n=41; 51%), polyps (n=15; 19%), cysts (n=8; 10%), and sulci vocalis (n=4; 5%), but a substantial number had other contributing factors to their dysphonia (**Figures 1, 2, and 3**). **Table 1** lists the diagnoses in this series and details the numerical and percentage contributions of each factor. Inflammatory diseases were the next largest contributors to dysphonia, n=41 (51%). Inflammation was attributed to reflux laryngitis, nonspecific laryngitis, sinusitis and/or rhinitis, and adenotonsillar hypertrophy with chronic upper respiratory congestion.

From the data listed in **Table 2**, it is clear that VLS assists the clinician in identifying disease processes that might require multiple interventions. We divided the population by age and tolerance to rigid examination, and children younger than 8 years were the least tolerant. While **Table 2** reflects 3 age categories, we conducted some analyses using only 2 age categories, preadolescent (age, <12 years) vs adolescent (age, ≥12 years) because preadolescents tend to engage in behavior that leads to vocal abuse and misuse, while adolescents typically engage in less of this behavior. As summarized in **Table 2**, speech therapy was the most common intervention in all groups, despite previous treatment with this intervention. The referral for speech therapy was made to voice-specific speech pathologists for the treatment of nodules, polyps, vocal cord paresis, granulomas, or muscle tension dysphonia.

Laryngopharyngeal reflux was a common diagnosis throughout the groups, and antireflux therapy was a commonly instituted intervention. Preadolescent children were

started on treatment with a histamine 2 blocker, while adolescents were started on therapy with a proton pump inhibitor.

Other inflammatory conditions were recognized and treated as well. Ten patients had allergic laryngitis. Seven patients in the preadolescent group and 3 in the adolescent group were treated with antihistamines or nasal steroids or were referred to an allergist. Seven patients were treated with mucolytics, and 4 patients underwent nebulized steroid treatments for chronic laryngitis.

Phonemicsurgery was performed in 16 patients (20%), 7 adolescents and 9 preadolescents. The indications for surgery were cysts, polyps, firm nodules, glottic webs, and vocal fold sulci. Vocal fold cysts (n=7) were the most common indication for surgery, followed by polyps (n=4), firm calloused nodules (n=2), glottic webs (n=2), and sulci (n=1). The 2 surgical patients with glottic webs were both younger than 8 years. The other 14 surgical patients were initially referred for presumed nodules with prolonged dysphonia nonresponsive to speech therapy. After VLS, 13 of these patients were diagnosed as having benign mucosal diseases other than nodules, thus resolving their diagnostic dilemma, and they were successfully treated with phonemicsurgery. All of these children underwent postoperative voice therapy to prevent recurrence or secondary lesions. None of the patients experienced recurrent mucosal lesions.

COMMENT

Children with dysphonia may face perceptual and psychosocial problems, including prejudice from their teachers and peers, so it is important to determine the correct treatment for the cause of their vocal disorder. Our patient series shows that many children have prolonged dysphonia without adequate diagnosis and treatment plans. Videolaryngostroboscopy may allow for better detection of different disease processes. The incidence of dysphonia in the pediatric population has been estimated at 6% to 9%¹ and in some reports as high as 40% in school-aged children.^{6,7} Most studies report a lower prevalence in girls than in boys, typically a two-thirds preponderance,⁸ and our study findings concur with this observation.

The assessment of pediatric dysphonia requires a comprehensive medical evaluation. Children are typically examined less than 20% of the time with VLS.² In the past, evaluation of this population was limited to subjective measures of hoarseness, roughness, and stridency. Most children's vocal disorders were attributed to vocal abuse, and the children were sent for speech therapy, regardless of the findings.^{9,10} Pediatric dysphonia has a number of different causes, including infectious, anatomic, congenital, inflammatory, neoplastic, neurologic, and iatrogenic. Videolaryngostroboscopy has been proven in the adult population to be a valuable tool in diagnosing voice-related disorders. It typically allows for refinement of diagnosis by allowing for detection of subtle issues with glottic closure and mucosal wave vibration and amplitude. Videolaryngostroboscopy has also been shown to modify the diagnoses in 47% of adult patients examined and to confirm an uncertain diagnosis in many patients.¹¹

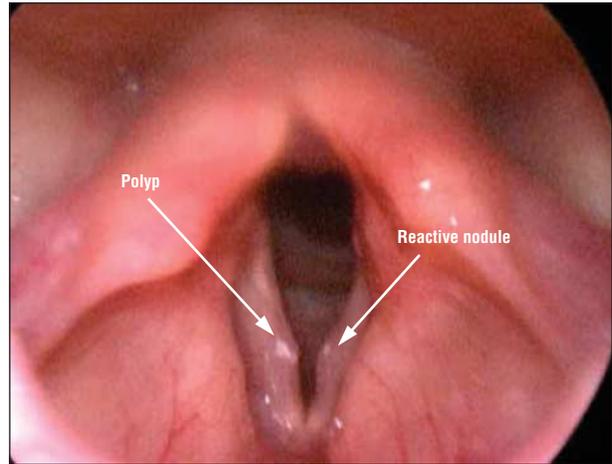


Figure 3. An 8-year-old boy had persistent dysphonia unresolved by speech therapy. Under evaluation with videolaryngostroboscopy, he was found to have a left vocal fold nodule, a right vocal fold polyp, and allergic laryngitis.

Table 1. Clinical Findings in Patients Who Underwent Videolaryngostroboscopic Examinations

Clinical Findings	Patients, No. (%) (n=80)	Diagnosis, % (n=132)
Nodules	41 (51)	31.0
Laryngopharyngeal reflux	27 (24)	21.0
Polyps	15 (19)	11.4
Functional dysphonia	11 (14)	8.4
Cysts	8 (10)	6.1
Allergic laryngitis	6 (8)	4.6
Adenoid hypertrophy and/or rhinitis	5 (6)	3.8
Microweb	5 (6)	3.8
Sulcus	4 (5)	3.1
Laryngeal trauma	3 (4)	2.3
Nonspecific laryngitis	3 (4)	2.3
Neurologic disorder	2 (3)	1.5
Granuloma	1 (1)	0.8
Congenital glottic stenosis	1 (1)	0.76

Most of our patients presented with vocal nodules caused by vocal abuse and other benign mucosal diseases. This study demonstrates that benign mucosal disorders are still the primary cause of dysphonia in this population, but not all patients have nodules. There is a high incidence of asymmetric vocal fold lesions misdiagnosed as vocal cord nodules: 34% of our study population had cysts, polyps, or sulci. Use of VLS in this population leads to improved diagnosis of among mucosal disorders allowing for the differentiation between nodules, cysts, and polyps by recognizing vocal fold lesions that cause unilateral vocal fold vibrational disturbances.

Surgery has typically played a minor role in this population. Hirschberg et al¹² showed that phonemicsurgery is used in 5% to 6% of all children with hyperfunctional dysphonia. Our study demonstrates that a higher percentage of pediatric patients might benefit from surgery after diagnostic VLS. In our series, 20% of our patients underwent phonemicsurgery. Videolaryngostroboscopy can identify, earlier than flexible laryngoscopy alone, polyps and cysts that are amenable to surgical treat-

Table 2. Clinical Characteristics of Study Patients

Age Category, y (Sex Ratio, M/F)	Age, Mean (Median), y	Type of VLS Device, Rigid/Flexible, No.	Diagnoses, Mean, No.	Interventions, Mean, No.	Treatment Techniques
<8 (13/4)	5.9 (6.0)	1/14 ^a	1.5	1.4	11 Speech therapy 6 Antireflux therapy 2 Microsurgery 2 Adenotonsillectomy
8 to <12 (18/7)	9.3 (9.0)	17/8	1.8	1.6	2 Allergy treatment 15 Speech therapy 7 Microsurgery 6 Antireflux therapy 5 Allergy
≥12 (21/17)	14.2 (14.0)	32/6	1.6	1.3	1 Adenotonsillectomy 26 Speech therapy 14 Antireflux therapy 7 Microsurgery 3 Allergy treatment

Abbreviation: VLS, videolaryngostroboscope.

^aIn the youngest age category, 2 patients could not tolerate either type of VLS device.

ment. Patients with unresolved diagnoses and prolonged dysphonia at presentation were diagnosed by VLS with polyps, cysts, or sulci and were often successfully treated with surgery and postoperative voice therapy. In our study we had a successful surgical outcome with cysts, polyps, sulci, and calloused nodules. However, to avoid recurrence, it is important to address the behavioral component that led to the abnormality, especially in the patients with polyps, sulci, and nodules. Postoperative speech therapy and good patient compliance is imperative for a successful surgical outcome.

Routine VLS in the diagnosis of pediatric dysphonia, especially prolonged dysphonia, is tolerated. Other authors have proven that VLS can be performed in the pediatric population using either rigid or flexible endoscopes.^{4,5} Our study confirms these findings with the successful completion of 50 rigid and 28 flexible VLS evaluations, while only 2 of our patients were unable to tolerate either examination. Videolaryngostroboscopy is relatively simple to perform on pediatric patients. Patients with prolonged dysphonia for whom initial speech therapy has failed should be referred to a facility that has the ability to examine the patients with VLS.

Perhaps the most surprising finding of our review is the incidence of multiple diagnoses in more than half of our patients (n=44). This finding demonstrates that inflammatory conditions, including reflux and allergic rhinitis, contribute to dysphonia and are often overlooked and undertreated in this population. Significant inflammation is a well-known cause of edema, which may produce vocal abuse and nodule formation. Edema and reflux were seen as cofactors in more than half of our patients with nodules. The presence of this inflammation was often underrecognized in the patients' previous flexible laryngoscopy examination.

So we return to answer our initial question: Would the preferential differential diagnosis of nodules, papilloma, and neoplasm change with the use of VLS? In a child who presents with new-onset dysphonia, we believe the answer is no: a flexible laryngoscopic examination readily identifies recurrent respiratory papilloma

and neoplasms. But in patients with prolonged dysphonia recalcitrant to treatment, VLS is useful to elucidate inflammatory disorders and differentiate benign mucosal disorders, allowing the clinician to distinguish nodules from cysts, polyps, and sulci.

As for our second question, Is clinical care changed by diagnostic VLS in children? we believe that it is. Videolaryngostroboscopy improves the diagnoses of inflammatory disorders that contribute to dysphonia, and enhanced diagnosis leads to better, more timely treatment. Use of VLS also allows the clinician to distinguish benign mucosal diseases and/or lesions that can be treated by phonomicrosurgery.

Finally, in answer to our third question, What additional information can be learned about pediatric dysphonia from VLS? we have demonstrated that not all benign mucosal lesions in children are nodules, and the use of VLS technology to observe the mucosal wave of the vocal folds allows the identification of cysts, polyps, and sulci that will not resolve without surgical intervention.

Our study has several limitations. It was a retrospective review with a limited age distribution. One of us (P.W.) is a laryngologist, not a pediatric laryngologist, and contributed an older group of children (mean age, 11 years).

Another limitation was that objective voice measurements were not performed. Objective voice measurements might have helped validate our conclusions by providing evidence of improved acoustic or aerodynamic measurements after treatment based on VLS diagnosis.

In addition, there was no control group. However, patients served as their own controls. They had all previously been examined by other otolaryngologists using flexible laryngoscopy, and they all presented to us with the diagnoses of nodules or unresolved dysphonia.

Finally, the study lacks long-term follow-up. The microsurgery group typically had the longest follow-up, and surgical treatment interventions were proven successful. However, while many patients in the medical treatment group received multiple interventions, the success of their treatment must be interpreted in the light of incomplete follow-up.

In conclusion, pediatric patients with prolonged dysphonia for whom initial treatment has failed should be sent to a facility that has the ability to evaluate the patients by VLS for a comprehensive examination that provides differentiation among benign mucosal disorders and clarifies inflammatory processes. Videolaryngostroboscopy provides important diagnostic information regarding benign mucosal disorders. It helps to differentiate among polyps, nodules, and cysts and identifies the best candidates for surgical intervention. It also helps to define the contributions of inflammatory processes in prolonged dysphonia in pediatric patients. Flexible and rigid VLS can be recorded and can yield a greater diagnostic spectrum than flexible laryngoscopy alone.

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Author Contributions: Dr Woo had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. *Acquisition of data:* Mortensen and Schaberg. *Analysis and interpretation of data:* Mortensen and Woo. *Drafting of the manuscript:* Mortensen and Schaberg. *Critical revision of the manuscript for important intellectual content:* Mortensen, Schaberg, and Woo. *Administrative, technical, and material support:* Mortensen and Schaberg. *Study supervision:* Woo.

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REFERENCES

1. Dejonckere PH. Voice problems in children: pathogenesis and diagnosis. *Int J Pediatr Otorhinolaryngol.* 1999;49(suppl 1):S311-S314.
2. Wolf M, Primov-Fever A, Amir O, Jedwab D. The feasibility of rigid stroboscopy in children. *Int J Pediatr Otorhinolaryngol.* 2005;69(8):1077-1079.
3. D'Antonio L, Chait D, Lotz W, Netsell R. Pediatric videonasoscopy for speech and voice evaluation. *Otolaryngol Head Neck Surg.* 1986;94(5):578-583.
4. Chait DH, Lotz W. Successful pediatric examinations using nasoendoscopy. *Laryngoscope.* 1991;101(9):1016-1018.
5. Hartnick CJ, Zeitels SM. Pediatric videolaryngostroboscopy. *Int J Pediatr Otorhinolaryngol.* 2005;69(2):215-219.
6. Powell M, Filter MD, Williams B. A longitudinal study of the prevalence of voice disorders in children from a rural school division. *J Commun Disord.* 1989; 22(5):375-382.
7. Ratto A, Diaco P, Perillo L. Epidemiological survey of dysphonia in school children: preliminary findings [in Italian]. *Arch Stomatol (Napoli).* 1990;31(1): 85-91.
8. Freitas MR, Pela S, Gonçalves MLR, et al. Chronic voice disorders in children and teenagers: a retrospective study [in Portuguese]. *Rev Bras Otorrinolaringol (Engl Ed).* 2000;66(50):480-485.
9. Cohen SR, Thompson JW, Geller KA, Birns JW. Voice change in the pediatric patient: a differential diagnosis. *Ann Otol Rhinol Laryngol.* 1983;92(5, pt 1): 437-443.
10. Reilly JS. The "singing-acting" child: the laryngologist's perspective—1995. *J Voice.* 1997;11(2):126-129.
11. Sataloff RT, Spiegel JR, Hawkshaw MJ. Stroboscopy: results and clinical value. *Ann Otol Rhinol Laryngol.* 1991;100(9, pt 1):725-727.
12. Hirschberg J, Dejonckere PH, Hirano M, Mori K, Schultz-Coulon HJ, Vrticka K. Voice disorders in children. *Int J Pediatr Otorhinolaryngol.* 1995;32(suppl):S109-S125.