

Efficacy of Tonsillectomy for Pediatric Patients With Dysphagia and Tonsillar Hypertrophy

Daniel Clayburgh, MD, PhD; Henry Milczuk, MD; Steve Gorsek, CCC-SLP; Nancy Sinden, CCC-SLP; Kandice Bowman, PNP; Carol MacArthur, MD

Objective: To determine the effectiveness of tonsillectomy for the treatment of dysphagia related to tonsillar hypertrophy.

Design: Prospective cohort study.

Setting: Tertiary care pediatric otolaryngology practice.

Participants: Eighty-five children aged 2 to 14 years referred for tonsillectomy owing to dysphagia related to tonsillar hypertrophy (dysphagia cohort) or for other indications (control cohort).

Interventions: Swallowing Quality of Life (SWAL-QOL) dysphagia questionnaires were administered at the initial clinic visit, on the day of surgery, and at 1 month and 6 months after surgery. Patients were weighed on the day of surgery and at 1 month after surgery.

Main Outcome Measures: The primary outcome measure was the SWAL-QOL score. Secondary outcome measures were the type of diet consistency patients tolerated at home and the weight percentile for age.

Results: Of 85 patients enrolled, 57 went on to have surgery, completed at least 1 postoperative questionnaire, and were included in the data analysis. At 1 month after tonsillectomy, the dysphagia cohort (n=18) demon-

strated improved SWAL-QOL scores (mean [SD], 58.4 [4.8] before surgery vs 82.4 [5.3] after surgery; $P < .001$), more patients tolerating a regular diet (12 of 37 patients [33.3%] before surgery vs 22 of 36 [60.0%] after surgery, $P = .01$), and increased weight percentile for age (mean [SD], 36.5 [10.7] before surgery vs 50.0 [10.6] after surgery; $P = .01$). Similarly, at 1 month after tonsillectomy, the control cohort (n=39) demonstrated improved SWAL-QOL scores (mean [SD], 80.8 [2.6] before surgery vs 91.7 [1.8] after surgery; $P < .001$), more patients tolerating a regular diet (30 of 37 patients [81.1%] before surgery vs 34 of 36 patients [94.4%] after surgery, $P = .04$), and increased weight percentile for age (mean [SD], 62.8 [5.4] before surgery vs 70.4 [5.1] after surgery; $P = .003$).

Conclusions: Dysphagia related to tonsillar hypertrophy is a significant problem not only among children with dysphagia with a primary complaint but also among a large subset of patients referred for tonsillectomy for other indications. Following tonsillectomy, both groups experience significant improvement in swallowing-related quality of life, ability to tolerate a regular diet, and weight percentile for age. Tonsillectomy is an effective treatment for the management of dysphagia related to tonsillar hypertrophy in children.

Arch Otolaryngol Head Neck Surg. 2011;137(12):1197-1202

Author Affiliations:
Department of
Otolaryngology–Head and Neck
Surgery (Drs Clayburgh,
Milczuk, and MacArthur and
Ms Bowman) and Child
Development and
Rehabilitation Center
(Mr Gorsek and Ms Sinden),
Oregon Health and Science
University, Portland.

SWALLOWING IS A COMPLEX process that involves oral, oropharyngeal, and esophageal phases to effectively prepare a food bolus and transfer this bolus down the gastrointestinal tract. Dysphagia is the result of dysfunction of 1 or more of these phases of swallowing. There are numerous potential causes of dysphagia in children, including craniofacial abnormalities, oromotor hypotonia, cerebral palsy, muscle dystonia, tonsillar hypertrophy, and esophageal web or stricture. Tonsillar hypertrophy is believed to present a physical barrier

to bolus passage through the oropharynx, leading to dysphagia and feeding difficulties. Given this obvious physical limitation imposed on swallowing by tonsillar hypertrophy, tonsillectomy is often recommended for patients in whom dysphagia seems related to enlarged tonsils.

Tonsillectomy is the second most commonly performed procedure among children in the United States, with more than half a million cases performed annually.¹ Current indications for tonsillectomy include sleep-related breathing disorder and obstructive sleep apnea, recurrent tonsillitis, peritonsillar abscess, recurrent bleed-

Table 1. Items on the Swallowing Quality of Life Questionnaire Adapted for Use With Pediatric Patients^a

Burden	Dealing with my child's swallowing problem is very difficult
	My child's swallowing problem is a major distraction in our lives
Duration	It takes my child longer to eat than other children
	It takes my child forever to eat a meal
Desire	My child doesn't enjoy eating anymore
	My child loses interest in eating due to his/her swallowing difficulty
Selection	It is difficult to find foods that my child likes and can eat
	Figuring out what my child can eat is a problem for our family
Fear	I fear my child may start choking when eating solid food
	I worry about my child getting pneumonia
	I am afraid my child will choke when drinking liquids
	I never know when my child is going to choke
Mental health	Having to be so careful when my child eats and drinks annoys me
	I've been discouraged by my child's swallowing problem
	My child's swallowing problem frustrates me
	I get impatient dealing with my child's swallowing problem
Social function	My child's swallowing problem makes it difficult for him/her to socialize with other children
	Our family's usual work or leisure activities have changed because of my child's swallowing problem
	Social gatherings (like holidays and get-togethers) are not enjoyable because of my child's swallowing problem
	It is difficult to eat outside of the home because of my child's swallowing problem
Symptoms	Coughing
	Choking when eating solid food
	Choking when drinking liquid
	Having thick saliva or phlegm
	Having excess saliva or phlegm
	Gagging
	Drooling
	Problems chewing
	Having to clear his/her throat
	Food sticking in his/her throat
	Food sticking in his/her mouth
	Food or liquid dribbling out of his/her mouth
	Food or liquid coming out of his/her nose
	Coughing food or liquid out of his/her mouth when it gets stuck

^aAdapted from McHorney et al.¹¹

ing, and suspected malignant neoplasm. Less common indications include halitosis, dysarthria, dysphagia, and periodic fevers with aphthous stomatitis, pharyngitis, and adenitis.² Although the evidence is substantial to support the use of tonsillectomy in common indications, such as obstructive sleep apnea^{3,4} and recurrent tonsillitis,⁵ few data support its use in the treatment of dysphagia. Only a handful of investigations have addressed the role of tonsillectomy in treating dysphagia, and these have focused on children with neurological impairment^{6,7} or provided only cursory discussion of dysphagia and tonsillectomy in otherwise healthy children.⁸

The present study was designed to prospectively analyze the effect of tonsillectomy on subjective and objective measures of dysphagia. The following 2 cohorts of

children who were referred for tonsillectomy were studied: (1) children with dysphagia-related tonsillar hypertrophy as a primary complaint and (2) children with other indications for tonsillectomy, primarily obstructive sleep apnea and recurrent tonsillitis. We hypothesized that tonsillectomy would lead to improvements in subjective and objective measures of dysphagia in these patients.

METHODS

PARTICIPANTS

This prospective cohort study was approved by the institutional review board at Oregon Health and Science University, Portland. Parents of consecutive patients who had indications for tonsillectomy or adenotonsillectomy were asked to participate in the research study. Inclusion criteria for this study were patients aged 1 to 18 years who were to undergo tonsillectomy or adenotonsillectomy and whose parents provided consent for inclusion in the study. Exclusion criteria were complete dependence on tube feeds or a known neurological disorder causing dysphagia. Patients were divided into the following 2 cohorts: (1) those whose primary indication for surgery was tonsillar hypertrophy and oropharyngeal dysphagia diagnosed by radiographic swallow study or clinical swallow examination by a speech and language pathologist (the dysphagia group) and (2) those whose primary indication for surgery was another diagnosis, such as obstructive sleep apnea or chronic tonsillitis (the control group). Radiographic swallow study findings that led to a diagnosis of dysphagia included prolonged oral holding, bolus undercoating of tonsils, and decreased tongue base retraction, epiglottic deflection, and hyolaryngeal elevation. Before beginning the study, a power analysis was conducted. To observe an effect size of 0.50 in the dysphagia group with a power of 80% and $\alpha = .05$, a total of 27 patients would be needed. Given the anticipated lower incidence of dysphagia in the control group, 52 patients would be needed to observe an effect size of 0.35.

DYSPHAGIA QUESTIONNAIRE

To assess symptoms of dysphagia and dysphagia-related quality of life, the Swallowing Quality of Life (SWAL-QOL) questionnaire was adapted for use with pediatric patients. The SWAL-QOL is a 44-item validated questionnaire that tests swallowing-related symptoms and quality of life across 11 domains.⁹⁻¹¹ For use with our pediatric patients, the questions were rephrased to be answered from the perspective of the patient's parent (**Table 1**). In addition, the section investigating sleep symptoms was eliminated, as most members of our control group were expected to have obstructive sleep apnea as a primary diagnosis, rendering the relationship between sleep symptoms and dysphagia tenuous at best. Parents were asked to complete this questionnaire at the initial clinic visit, on the day of surgery, at 1 month after surgery, and at 4 to 6 months after surgery. Although the preoperative questionnaire was given directly to parents while in the clinic or hospital, not all patients followed up in the clinic at 1 month after surgery; among those in whom a telephone follow-up appointment was conducted, the questionnaire was administered over the telephone. Similarly, at 4 to 6 months after surgery, attempts were made to contact the parents via telephone to complete the questionnaire. If parents could not be contacted by telephone at 1 month or 4 to 6 months after surgery, questionnaires were mailed to parents, with instructions for them to complete and return them.

Scoring of the questionnaires followed the method described by the creators of the SWAL-QOL questionnaire¹¹ using

a Likert-type method. Briefly, each response on the survey was linearly transformed to a metric ranging from 0 to 100 points, where 100 represents the most favorable state and 0 the least favorable state. Individual responses were equally weighted and were summed to generate an overall outcome score. Additional questions about patient diet were treated as categorical data and were not linearly transformed using the Likert-type method.

WEIGHT ASSESSMENT

Patient weight was recorded on the day of surgery for all the children in the study. However, postoperative weights were available for only those patients who returned to the clinic at 1 month after surgery for follow-up care. To account for patient growth and age variability, weight was recorded as the weight percentile for age, determined using standard 2000 Centers for Disease Control and Prevention¹² growth charts for children 2 years and older and 2006 World Health Organization¹³ growth charts for children younger than 2 years.

STATISTICAL ANALYSIS

Descriptive statistics are given as means (SDs). *t* Test for paired samples was used to compare preoperative and postoperative SWAL-QOL scores and weight percentiles for age within each cohort. χ^2 Analysis was used to compare changes in patient diet after surgery. A linear regression analysis was performed to assess change in weight after surgery vs change in SWAL-QOL score.

RESULTS

Eighty-five patients aged 2 to 14 years were enrolled in the study at their initial consult visit, and 77 went on to have surgery; 57 completed at least 1 postoperative questionnaire and were included in the data analysis (**Table 2**). Compared with the control cohort, the dysphagia cohort was younger and comprised more female patients, although the latter difference was not significant ($P = .14$).

The dysphagia cohort demonstrated significant improvement across all domains of the SWAL-QOL at 1 month after surgery, and these improvements persisted at 6 months after surgery (**Table 3**). Although the control cohort scored higher on the SWAL-QOL than the dysphagia cohort before surgery ($P < .001$), the control cohort demonstrated significant gains across almost all domains of the SWAL-QOL at 1 month after surgery, and these improvements remained up to 6 months after surgery. Although the primary indication for tonsillectomy in the control cohort was not dysphagia, it was striking that many control patients had significantly abnormal SWAL-QOL scores before surgery, suggesting that many of these patients had dysphagia in addition to their primary problem (**Figure 1**). After surgery, the distribution range of SWAL-QOL scores was much closer to the ideal score of 100.

Patients were also queried about their dietary habits; not surprisingly, most patients in the dysphagia cohort were unable to tolerate a regular diet and instead needed soft foods or purees. However, at 1 month after surgery, there was a significant improvement in the number of

Table 2. Patient Demographics

Variable	Control Cohort	Dysphagia Cohort
Patients, No.		
Enrolled	59	26
Went on to have surgery	53	24
Completed 1-mo follow-up	36	15
Completed 6-mo follow-up	30	10
Male sex, No. (%) ^a	36 (61.5)	10 (37.5)
Age, mean (SD), y ^b	6.63 (3.25)	4.81 (3.04)
Indication for tonsillectomy, No.		
Dysphagia	NA	24
Obstructive sleep apnea	50	NA
Recurrent tonsillitis	2	NA
PFAPA	1	NA

Abbreviations: NA, not applicable; PFAPA, periodic fevers with aphthous stomatitis, pharyngitis, and adenitis.

^a $P = .14$.

^b $P = .06$.

patients able to consume a regular diet (**Figure 2**) ($P = .01$). The control group demonstrated a smaller but significant change in the number of patients able to tolerate a regular diet after surgery ($P = .04$).

All the patients were weighed before surgery, and when they returned to the clinic for a 1-month follow-up appointment, weights were again obtained. To standardize them based on age, the weights were converted to a percentile per age based on World Health Organization and Centers for Disease Control and Prevention growth charts (**Figure 3**). The dysphagia cohort ($n = 10$) demonstrated a significant increase in weight percentile for age after surgery ($P = .01$). The control cohort ($n = 23$) exhibited a smaller but significant increase in weight percentile for age after surgery ($P = .003$). Finally, the overall change in weight percentile for age was plotted vs the overall change in SWAL-QOL score from the initial clinic visit to the visit at 1 month after surgery (**Figure 4**). This demonstrated a positive correlation ($R^2 = 0.27$) between change in SWAL-QOL score and change in weight percentile for age, indicating that the subjective changes in symptoms measured on the SWAL-QOL translated to measurable gains in patient health.

COMMENT

When parents are queried, dysphagia is a common complaint in their children and is especially prevalent among children requiring tonsillectomy or adenotonsillectomy. Pediatric dysphagia is often multifactorial. Mechanical obstruction of the oropharynx by tonsillar hypertrophy has long been recognized as a potential cause of dysphagia, and tonsillectomy is often recommended in these patients.² However, few studies have examined the role of tonsillectomy to treat dysphagia related to tonsillar hypertrophy; therefore, the present study was performed to address this gap in the literature. Our study confirmed that tonsillectomy is an effective treatment for dysphagia related to tonsillar hypertrophy in children.

The current literature about the use of tonsillectomy to treat dysphagia is sparse. Ahlqvist-Rastad et al⁸ de-

Table 3. Scores on Domains of the Swallowing Quality of Life Questionnaire

Domain	Before Surgery, Mean (SD)	1 mo After Surgery, Mean (SD)	P Value ^a	6 mo After Surgery, Mean (SD)	P Value ^a
Dysphagia Cohort					
	(n = 18)	(n = 15)		(n = 10)	
Burden	45.4 (6.4)	86.7 (5.8)	<.001	94.6 (2.4)	.004
Duration	39.2 (8.1)	71.7 (8.2)	<.001	62.5 (12.9)	.02
Desire	51.7 (8.6)	79.2 (7.6)	.008	82.1 (9.8)	.03
Selection	45.4 (7.5)	74.2 (7.4)	<.001	89.3 (4.7)	<.001
Symptoms	61.2 (5.1)	82.0 (5.8)	.002	84.9 (5.4)	.008
Fear	60.2 (6.7)	82.5 (6.4)	<.001	86.6 (6.0)	.005
Mental health	63.5 (7.7)	85.0 (6.9)	.05	93.8 (4.6)	.05
Social function	67.5 (6.0)	90.0 (3.3)	.001	98.2 (1.1)	.03
Overall	58.4 (4.8)	82.4 (5.3)	<.001	87.1 (4.4)	.004
Control Cohort					
	(n = 39)	(n = 36)		(n = 30)	
Burden	82.5 (3.6)	94.8 (2.1)	<.001	97.8 (1.1)	.002
Duration	63.3 (4.8)	84.7 (3.4)	<.001	89.3 (3.6)	<.001
Desire	84.1 (3.3)	97.2 (1.6)	<.001	97.8 (1.1)	<.001
Selection	78.7 (4.3)	90.6 (3.0)	.004	92.4 (3.2)	.002
Symptoms	76.0 (2.6)	89.4 (2.1)	<.001	92.0 (1.9)	<.001
Fear	87.6 (2.5)	92.5 (2.1)	.04	97.5 (1.2)	.001
Mental health	89.7 (3.1)	95.5 (1.9)	.07	98.0 (1.2)	.02
Social function	89.1 (3.1)	95.0 (2.3)	.02	97.8 (1.4)	.003
Overall	80.8 (2.6)	91.7 (1.8)	<.001	94.6 (1.5)	<.001

^aCompared with before surgery.

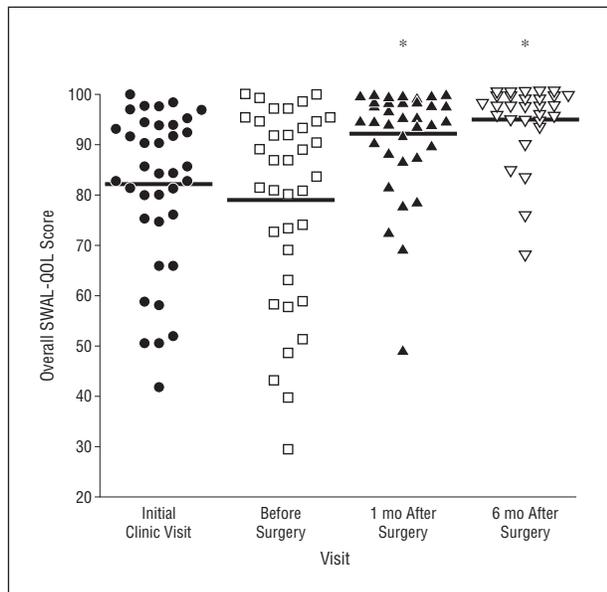


Figure 1. Distribution of overall Swallowing Quality of Life (SWAL-QOL) scores within the control cohort. * $P < .01$ vs score at the initial clinic visit.

scribed a cohort of 122 children in Sweden with symptoms suggesting tonsillar obstruction. They noted that 53% of these children had difficulty with eating by history, and after tonsillectomy the eating problems were completely ameliorated in all but 4. However, this study was primarily focused on airway obstruction and provided no quantitative data to demonstrate changes in dysphagia symptoms after tonsillectomy.

Studies have demonstrated the efficacy of tonsillectomy in children with neurological impairment. Conley et al⁷ showed that tonsillectomy is safe and may improve dys-

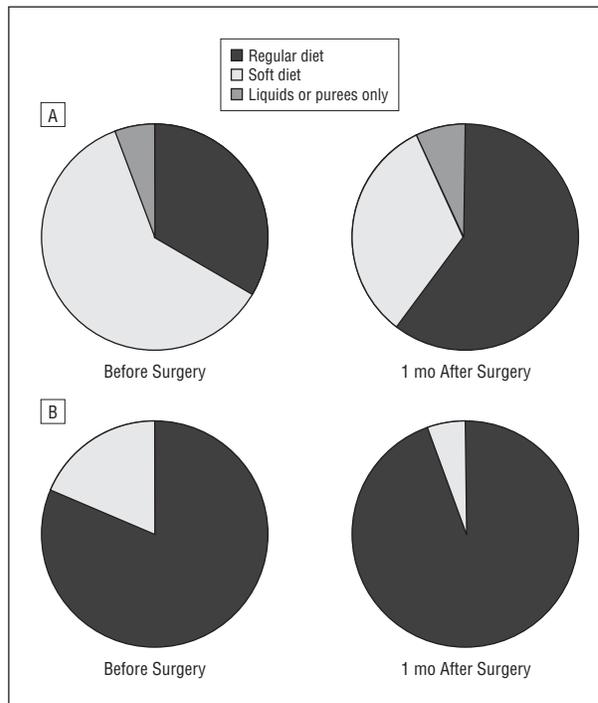


Figure 2. Preoperative and postoperative diets tolerated at home by the dysphagia cohort (A) and by the control cohort (B). At 1 month after tonsillectomy, more patients were tolerating a regular diet in the dysphagic cohort (33.3% before surgery vs 60.0% after surgery, $P = .01$) and in the control cohort (81.1% before surgery vs 94.4% after surgery, $P = .04$).

phagia based on oropharyngeal motility investigations in children with neurologically impaired deglutition. A 2009 study⁶ showed improvements in a similar patient population following tonsillectomy using videofluoroscopic swallow studies and a telephone survey of dysphagia symp-

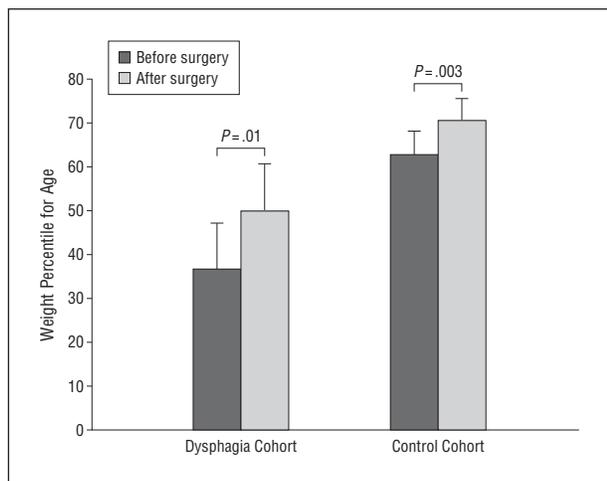


Figure 3. Preoperative and postoperative weight percentiles for age in the dysphagia and control cohorts. At 1 month after tonsillectomy, increased weight percentiles for age were demonstrated in the dysphagia cohort (mean [SD], 36.5 [10.7] before surgery vs 50.0 [10.6] after surgery; $P=.01$) and in the control cohort (mean [SD], 62.8 [5.4] before surgery vs 70.4 [5.1] after surgery; $P=.003$).

toms. Although these studies provide good evidence for the use of tonsillectomy to treat dysphagia in patients with neurological impairment, the results are difficult to extrapolate to the general pediatric population.

A notable outcome in the present study was the improvement seen in both cohorts studied. Both study groups showed improvements in SWAL-QOL scores, ability to tolerate a regular diet, and weight gain following surgery. This was the expected outcome among the dysphagia cohort, as these patients were believed to have dysphagia primarily due to obstructive tonsillar hypertrophy. The improvement seen in the SWAL-QOL scores provides empirical evidence for the long-standing belief that tonsillectomy benefits this patient population. The improvement seen in the control cohort indicates that dysphagia may be prevalent among the patient population with adenotonsillar hypertrophy in general and that tonsillectomy improves swallowing among many of these patients in addition to treating their primary problem. This study was not designed to determine any prognostic tools that could be used clinically to define which patients may have improved swallowing following tonsillectomy. Patients in the dysphagia cohort were referred to the feeding clinic for specific problems with eating, such as failure to thrive, refusal to eat solids, and choking on feedings, and were evaluated by a team of specialists. Children who had minor swallowing difficulties or those who were not formally evaluated by a swallowing specialist were not included in the dysphagia cohort. Future studies could further define the subset of patients most at risk for dysphagia related to tonsillar hypertrophy and most likely to benefit from tonsillectomy, as well as validate clinical decision tools to help physicians identify these patients.

In both cohorts, significant improvements in QOL related to dysphagia and in the objective measurement of weight gain were noted after tonsillectomy, but the correlation between QOL and weight gain was weak. This is not unexpected, as previous investigations on the re-

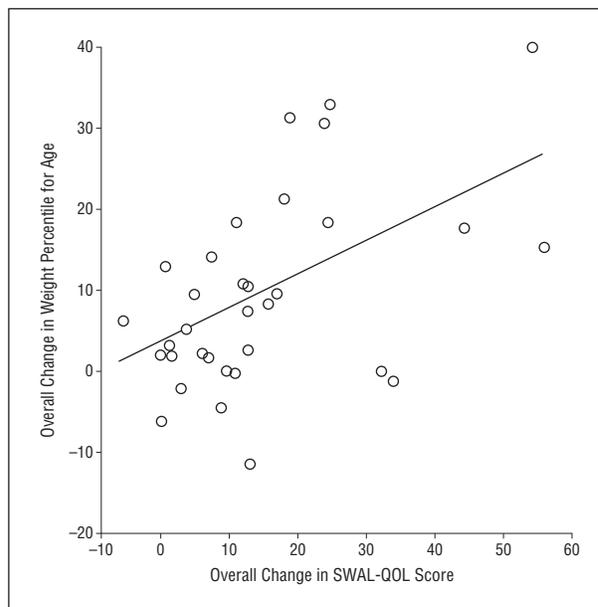


Figure 4. Linear regression analysis of the overall change in weight percentile for age vs the overall change in Swallowing Quality of Life (SWAL-QOL) score. A positive correlation was demonstrated ($R^2=0.27$).

lationship between SWAL-QOL scores and bolus transit times have shown that there is a loose correlation between these subjective and objective measures of swallowing function.¹⁴ Several factors may account for this in our study, including the use of parents as a proxy for the child's experience via the questionnaire and the use of an indirect measure of dysphagia improvement (weight percentile for age) rather than a direct measure (videofluoroscopy). Furthermore, although evidence indicates that some children gain weight following tonsillectomy, factors other than improved swallowing function may have a role in this weight gain. Following tonsillectomy, children demonstrate increased levels of insulin-like growth factor and other hormones,¹⁵ decreased levels of inflammatory markers like tumor necrosis factor,¹⁶ and improved work of breathing,¹⁷ all of which could contribute to weight gain. Nevertheless, a correlation between SWAL-QOL scores and weight percentile changes exists, confirming that children experience an objective benefit following tonsillectomy.

Although the data in the present study are the first to measure the effect of tonsillectomy on dysphagia related to tonsillar hypertrophy in a general pediatric population, there are several limitations to this study. First, the fact that the study was performed among a small sample in a tertiary care academic center may decrease the ability to generalize the results to a community practice setting. Further research, possibly a multicenter trial that could accrue a large study population, may address this issue. Second, most patients in the control group had an obstructive sleep disturbance as an indication for surgery; although our results suggest that dysphagia may be a significant concern in this group, we cannot generalize this finding to patients undergoing tonsillectomy for other reasons, such as recurrent tonsillitis. Third, although it would be ideal to assess postoperative swallowing function by videofluoroscopic swallow studies as

an objective measure of dysphagia, it would be ethically impossible to subject children to additional radiation exposure following tonsillectomy if their issues with dysphagia had resolved. Fourth, although the SWAL-QOL is a validated measure of dysphagia in adults, in modifying it for use in children, it can no longer be considered a validated tool, and we have introduced the additional layer of complexity of parent reporting. However, the score distributions we observed in our dysphagia and control cohorts agree with previous findings using the SWAL-QOL,¹⁸ and the consistency in score distribution between the initial clinic visit and preoperative time points, before any intervention, indicates that it seems to be a reliable tool. Fifth, although there was a high dropout rate of approximately one-third of patients, this is unlikely to have affected the results, as both cohorts were equally affected. Sixth, as in many surgical studies, it is impossible to perform a sham procedure to create a placebo group; therefore, we were unable to discriminate the observed benefit of tonsillectomy from a placebo effect.

In conclusion, our study provides the first quantifiable evidence to date that tonsillectomy is an effective treatment for dysphagia related to tonsillar hypertrophy. We show a benefit among children in whom dysphagia is their primary problem, as well as improvement in swallow function after tonsillectomy among patients with other obstructive issues related to tonsillar hypertrophy. Although further research is warranted to define the subset of patients most likely to benefit from tonsillectomy to treat dysphagia, these results may help the clinician counsel patients and families about the effects of tonsillectomy on dysphagia.

Submitted for Publication: March 8, 2011; final revision received June 9, 2011; accepted July 31, 2011.

Correspondence: Daniel Clayburgh, MD, PhD, Department of Otolaryngology–Head and Neck Surgery, Oregon Health and Science University, 3181 SW Sam Jackson Park Rd, Mail Code PV-01, Portland, OR 97239 (clayburg@ohsu.edu).

Author Contributions: Drs Clayburgh and MacArthur had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Clayburgh, Gorsek, and MacArthur. *Acquisition of data:* Clayburgh, Milczuk, Gorsek, Sinden, Bowman, and MacArthur. *Analysis and interpretation of data:* Clayburgh, Milczuk, Gorsek, and MacArthur. *Drafting of the manuscript:* Clayburgh, Gorsek, and Bowman. *Critical revision of the manuscript for important intellectual content:* Clayburgh, Milczuk, Sinden, and MacArthur. *Statistical*

analysis: Clayburgh. *Administrative, technical, and material support:* Clayburgh, Milczuk, Gorsek, Sinden, Bowman, and MacArthur. *Study supervision:* Clayburgh, Milczuk, and MacArthur.

Financial Disclosure: None reported.

Previous Presentation: This study was presented at the American Society of Pediatric Otolaryngology meeting; April 30, 2011; Chicago, Illinois.

REFERENCES

- Cullen KA, Hall MJ, Gluzinski A. Ambulatory surgery in the United States: 2006 National Health. *Stat Report*. 2009;(11):1-25.
- Darrow DH, Siemens C. Indications for tonsillectomy and adenoidectomy. *Laryngoscope*. 2002;112(8, pt 2)(suppl 100):6-10.
- Mitchell RB. Adenotonsillectomy for obstructive sleep apnea in children: outcome evaluated by pre- and postoperative polysomnography. *Laryngoscope*. 2007;117(10):1844-1854.
- Ye J, Liu H, Zhang GH, et al. Outcome of adenotonsillectomy for obstructive sleep apnea syndrome in children. *Ann Otol Rhinol Laryngol*. 2010;119(8):506-513.
- Burton MJ, Glasziou PP. Tonsillectomy or adeno-tonsillectomy versus non-surgical treatment for chronic/recurrent acute tonsillitis. *Cochrane Database Syst Rev*. 2009;(1):CD001802.
- Conley SF, Beecher RB, Delaney AL, Norins NA, Simpson PM, Li SH. Outcomes of tonsillectomy in neurologically impaired children. *Laryngoscope*. 2009;119(11):2231-2241.
- Conley SF, Kodali S, Beecher RB, Lacey T, McCauliffe T. Changes in deglutition following tonsillectomy in neurologically impaired children. *Int J Pediatr Otorhinolaryngol*. 1996;36(1):13-21.
- Ahlqvist-Rastad J, Hultcrantz E, Svanholm H. Children with tonsillar obstruction: indications for and efficacy of tonsillectomy. *Acta Paediatr Scand*. 1988;77(6):831-835.
- McHorney CA, Bricker DE, Kramer AE, et al. The SWAL-QOL outcomes tool for oropharyngeal dysphagia in adults, I: conceptual foundation and item development. *Dysphagia*. 2000;15(3):115-121.
- McHorney CA, Bricker DE, Robbins J, Kramer AE, Rosenbek JC, Chignell KA. The SWAL-QOL outcomes tool for oropharyngeal dysphagia in adults, II: item reduction and preliminary scaling. *Dysphagia*. 2000;15(3):122-133.
- McHorney CA, Robbins J, Lomax K, et al. The SWAL-QOL and SWAL-CARE outcomes tool for oropharyngeal dysphagia in adults, III: documentation of reliability and validity. *Dysphagia*. 2002;17(2):97-114.
- Kuczmariski RJ, Ogden CL, Guo SS, et al. CDC growth charts for the United States: methods and development. *Vital Health Stat*. 2002;11:246.
- de Onis M, Garza C, Onyango AW, Martorell R, eds. WHO child growth standards. *Acta Paediatr*. 2006;95(suppl):1-101.
- McHorney CA, Martin-Harris B, Robbins J, Rosenbek J. Clinical validity of the SWAL-QOL and SWAL-CARE outcome tools with respect to bolus flow measures. *Dysphagia*. 2006;21(3):141-148.
- Kiris M, Muderris T, Celebi S, Cankaya H, Bercin S. Changes in serum IGF-1 and IGFBP-3 levels and growth in children following adenoidectomy, tonsillectomy or adenotonsillectomy. *Int J Pediatr Otorhinolaryngol*. 2010;74(5):528-531.
- Gozal D, Serpero LD, Kheirandish-Gozal L, Capdevila OS, Khalyfa A, Tauman R. Sleep measures and morning plasma TNF- α levels in children with sleep-disordered breathing. *Sleep*. 2010;33(3):319-325.
- Nieminen P, Löppönen T, Tolonen U, Lanning P, Knip M, Löppönen H. Growth and biochemical markers of growth in children with snoring and obstructive sleep apnea. *Pediatrics*. 2002;109(4):e55. <http://pediatrics.aappublications.org/content/109/4/e55.long>. Accessed October 3, 2011.
- Leow LP, Huckabee ML, Anderson T, Beckert L. The impact of dysphagia on quality of life in ageing and Parkinson's disease as measured by the swallowing quality of life (SWAL-QOL) questionnaire. *Dysphagia*. 2010;25(3):216-220.