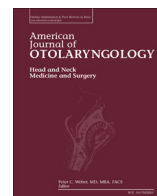


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## Pediatric airway study: Endoscopic grading system for quantifying tonsillar size in comparison to standard adenotonsillar grading systems

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### ABSTRACT

**Significance:** Current grading systems may not allow clinicians to reliably document and communicate adenotonsillar size in the clinical setting. A validated endoscopic grading system may be useful for reporting tonsillar size in future clinical outcome studies. This is especially important as tonsillar enlargement is the cause of a substantial health care burden on children.

**Objective:** To propose and validate an easy-to-use flexible fiberoptic endoscopic grading system that provides physicians with a more accurate sense of the three-dimensional relationship of the tonsillar fossa to the upper-airway.

**Methods:** 50 consecutive pediatric patients were prospectively recruited between February 2015 and February 2016 at a pediatric otolaryngology outpatient clinic. The patients had no major craniofacial abnormalities and were aged 1 to 16 years. Each patient had data regarding BMI, Friedman palate position, OSA-18 survey results collected. For each child, digital video clips of fiberoptic nasopharyngeal, oropharyngeal and laryngeal exams were presented to 2 examiners. Examiners were asked to independently use the proposed Endoscopic tonsillar grading system, the Brodsky tonsillar grading scale, the Modified Brodsky tonsillar grading scale with a tongue depressor, and the Parikh adenoid grading system to rate adenotonsillar hypertrophy. Cohen's Kappa and weighted Kappa scores were used to assess interrater reliability for each of the four grading scales. The Spearman correlation was used to test the associations between each scale and OSA-18 scores, as well as Body Mass Index (BMI).

**Results:** 50 pediatric patients were included in this study (mean age 6.1 years, range of 1 year to 16 years). The average BMI was 20. The average OSA-18 score was 61.7. The average Friedman palate position score was 1.34. Twelve percent of the patients had a Friedman palate position score  $\geq 3$ , which made traditional Brodsky grading of their tonsils impossible without a tongue depressor. All four scales showed strong agreement between the two raters. The weighted Kappa was 0.83 for the Modified Brodsky scale, 0.89 for the Brodsky scale, 0.94 for the Parikh scale to 0.98 for the Endoscopic scale (almost perfect agreement). The Endoscopic scale showed the most consistent agreement between the raters during the study. There was a moderate association between the Parikh adenoid grading system with OSA-18 scores (Spearman's  $\rho = 0.58, p < 0.001$ ) compared to a low association of the tonsillar grading systems with OSA-18 scores. None of the scales correlated with patient BMI.

**Conclusions:** The proposed Endoscopic tonsillar grading system is as reliable of a method of grading tonsillar size as conventional grading systems. It offers the advantage of allowing for critical evaluation of the tonsils without any anatomic distortion which may occur with the use of a tongue blade. This new validated endoscopic grading system provides a tool for communicating the degree of airway obstruction at the level of the oropharynx regardless of Friedman palate position and may be used in future outcomes projects.

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**Abbreviations:** FOE, fiberoptic exam; AT, adenotonsillectomy; OSA, obstructive sleep apnea; BMI, body mass index.

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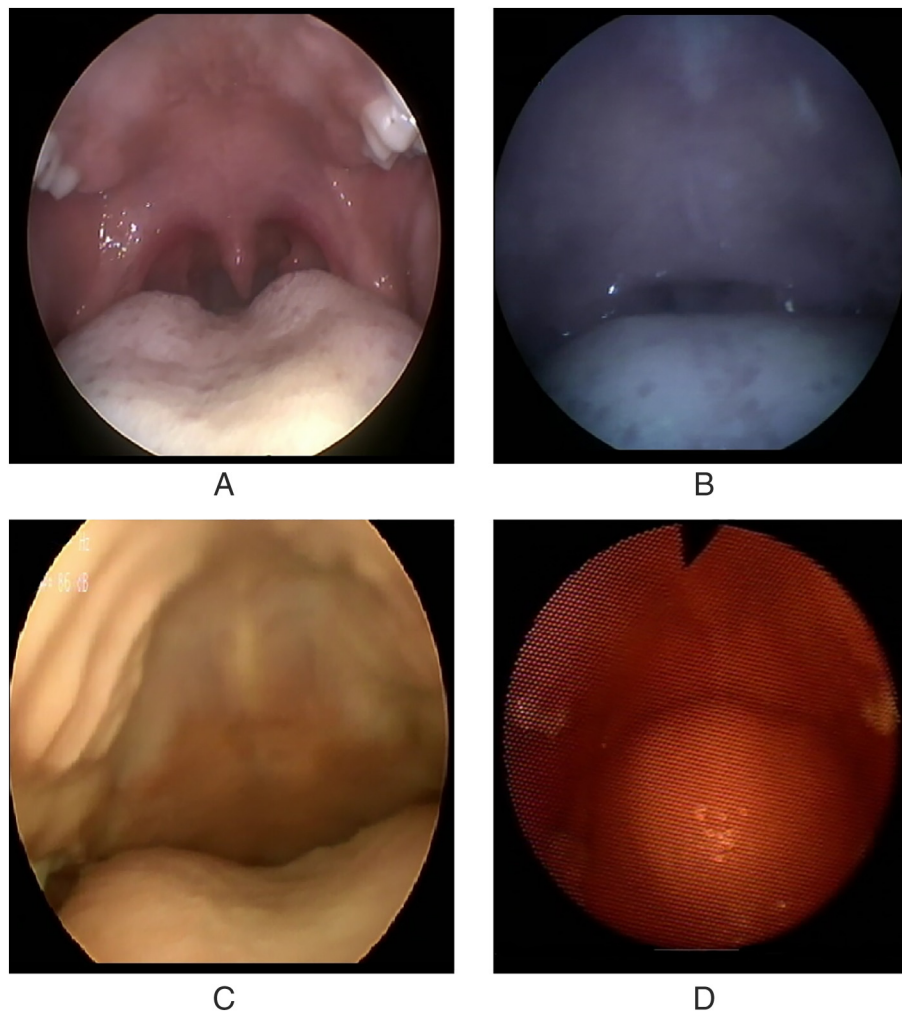
### 1. Introduction

Despite the contribution of tonsillar hypertrophy in upper airway obstruction, the previously proposed grading systems measuring tonsillar hypertrophy are flawed. The relationship between tonsil size and

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**Fig. 1.** Friedman palate position [2] is based on visualization with the mouth open without protrusion of the tongue. Fig. 1a- Grade 1: the entire uvula and tonsils are visualized. Fig. 1b- Grade 2: visualization of the uvula but incomplete visualization of the tonsils. Fig. 1c- Grade 3: visualization of the soft palate but not the uvula. Fig. 1d- Grade 4: visualization of the hard palate only.

health outcomes is only accurate if the tonsillar grading system is reproducible and reliable. The Brodsky grading scale [1] is based on the percentage of the oropharyngeal airway occupied by the tonsils when the patient is examined with the tongue relaxed in a neutral position sitting on the floor of the mouth with the mouth open. While this tonsillar grading scale is used in clinical practice to assess the degree of hypertrophy, the exam is limited when the patient has a Friedman [2] palate position of 3 or 4 as the view of the tonsil is obstructed. Most tonsillar grading systems were developed in cooperative adults; however, the physical exam is limited when a child is uncooperative. In these cases a tongue blade is used to depress the tongue. This action changes exam findings as it distorts the relationship of the tonsil to the rest of the oropharyngeal airway and may portray an inaccurate representation of actual tonsillar size. Finally tongue protrusion can also change tonsillar size assessments. For this reason, it is especially important in the pediatric population to develop a grading system that is reproducible across all clinical scenarios.

The purpose of this study is to propose an easy-to-use endoscopic grading system that provides physicians with an accurate sense of the three-dimensional relationship of the tonsillar fossa to the upper-airway. A standardized grading system will be helpful in clinical decision making as well as in research communication. It will also help establish normative data for pediatric endoscopy. A fiberoptic endoscopic

examination is an excellent technique for studying the airway as it is easy to perform, well tolerated while the patient is awake, is economic, and unlike other methods of examining the airway does not expose the patient to radiation. Furthermore, endoscopy of the airway can be performed regardless of Friedman palate position and allows for critical evaluation of the tonsils without any anatomic distortion which may occur with the use of a tongue blade.

It is important to effectively communicate tonsillar size for outcomes studies as the overall effectiveness of an adenotonsillectomy is only about 80% in reducing the apnea-hyponea index [3]. The improvement in non-obese children exceeded those for obese children [4]. However, given that in 2006, over 530,000 children younger than 15 years underwent tonsillectomies [5], residual sleep apnea after surgery in a large number of patients can lead to a significant financial burden to the healthcare system. Subjective tonsillar size based on the Brodsky rating system corresponds to objective tonsillar volume; however, only objective tonsillar weight is predictive of preoperative AHI and apnea severity [6]. Current subjective tonsil scales may not correlate to the presence or severity of sleep apnea. However, polysomnography is often not always performed prior to an adenotonsillectomy [7] and future studies need to be performed to determine a subjective grading system that correlates best with sleep apnea severity. For this reason, a tonsillar rating system that better attempts to use the three-

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