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Fiber-optic sleep endoscopy in children with persistent obstructive sleep apnea: Inter-observer correlation and comparison with awake endoscopy

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ABSTRACT

Objective: Evaluate the inter-observer correlation of sleep endoscopy findings in children with persistent obstructive sleep apnea (OSA) with awake office fiber-optic endoscopy.
Method: Design: retrospective case series; blinded review. Setting: tertiary care children's hospital. Patients: Children with persistent obstructive sleep apnea.

Interventions: Both awake and drug induced sleep endoscopy were performed. Endoscopy video recordings were mixed at random on a DVD. Two pediatric otolaryngologists and two pediatric pulmonologists independently scored each recording using an upper airway endoscopy scoring survey. Main outcome measures: reviewers scored the following parameters: each structure's contribution (nose, nasopharynx, lateral pharyngeal walls, tongue base, supraglottis) to the obstruction, the main site in which the obstruction occurs, the severity of OSA (mild, moderate, severe), the level of confidence of endoscopy findings (poor, fair, good).
Results: When reviewing sleep endoscopy recordings for the upper airway obstruction site, the highest correlation among the four observers was found for the nasopharynx and the supraglottis (Kappa score: 0.6 and 0.5, respectively). Compared to awake endoscopy, sleep endoscopy demonstrated more cases of airway obstruction caused by collapse of lateral pharyngeal walls and base of tongue (McNemar test for symmetry, P value < 0.05). Level of confidence among the four observers was higher in older children and lower in children with severe OSA.
Conclusions: Sleep endoscopy is a consistently reliable tool for identifying the site of obstruction in children with persistent OSA. Though anesthetic induced sleep is not a perfect model for real sleep, the technique demonstrably guides further therapy better than awake endoscopy.

1. Introduction

Adenotonsillar hypertrophy is the primary cause of obstructive sleep apnea (OSA) in children and tonsillectomy and adenoidectomy (T & A) improves OSA in a majority of the patients. With the increased use of preoperative and postoperative polysomnography (PSG), we now recognize that 10 to 20 percent of children will still have persistent OSA following T & A [1]. There are a variety of possible causes for persistent upper airway obstruction, including nasal obstruction, residual adenoid and palatine tonsils, glossoptosis, lingual tonsillar hypertrophy, collapse of lateral pharyngeal walls and obstruction at the palate larynx and trachea levels. At children's hospitals pediatric otolaryngologists and pediatric pulmonologists are frequently involved in the management of severe OSA in patients with hypotonia, craniofacial anomalies and overweight. Persistent OSA is more common in these children [2,3]. Following physical examination, evaluation of children with persistent OSA usually includes awake endoscopy (AE) performed in the outpatient clinic. AE is often limited in its ability to precisely assess the cause for persistent upper airway obstruction, especially in children. Previous studies in adults have shown that drug-induced sleep endoscopy (SE) is a safe and reliable technique to determine the pattern of upper airway obstruction and the contribution of specific structures to airway obstruction [4–6]. The purpose of this study was to evaluate the inter-observer correlation of SE findings in children with persistent OSA with awake office fiber-optic endoscopy.

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2. Methods

The study was approved by the Institutional Review Board of the Lucile Packard Children's Hospital, Stanford, California and the Institutional Review Board of the Tel-Aviv Medical Center, Tel-Aviv, Israel (TLV-0277-08). The retrospective case series included children who were diagnosed from 2005 to 2008 with a persistent PSG – proven OSA despite prior T & A. Each patient underwent awake office flexible fiber-optic endoscopy and flexible fiber-optic SE in the operating room. All examinations were performed and recorded by a pediatric otolaryngologist (P.J.K.) at the Lucile Packard Children's Hospital, Stanford, California. SE was performed under spontaneous bag-mask ventilation, using continuous intra-venous infusion of propofol as the sole agent to achieve sedation. The video recordings of all awake and sleep endoscopies were mixed at random on a DVD. Sound was not included so as not to influence the visual diagnosis. Two pediatric otolaryngologists (G.F. and A.D.) and two pediatric pulmonologists (E.S. and Y.S.) independently reviewed and scored each recording using an upper airway scoring survey (Table 1). The reviewers had no knowledge of whether the endoscopy was an awake or sleep endoscopy and they were blinded to the clinical status of the children (persistent OSA) as well as to the patient's data and PSG results. The assessment of each endoscopy included scoring of obstruction at each of the five structures (nose, nasopharynx, lateral pharyngeal walls, tongue base, supraglottis) and determination of the primary structure/region that causes airway obstruction. The reviewers were asked to grade their impression regarding the severity of OSA in each examination and the level of confidence in their findings.

2.1. Statistical analysis

Cohen's Kappa and Kendall's coefficient of concordance were calculated for the level of agreement among the four reviewers for the primary site of airway obstruction. Intra-class correlations based on a random set were used to evaluate the agreement among observers regarding the severity of obstruction caused by each structure/region. The McNemar test for symmetry and the Wilcoxon nonparametric test were utilized to evaluate the information received from SE compared to AE.

An analysis of variance with repeated measures was performed to examine the effect of age, gender and OSA severity on confidence, severity and quality. Mixed and Glimmix, generalized linear models, were applied in this analysis to model hierarchical data. Mixed and Glimmix are statistical procedures that fit statistical models to data with correlations or non-constant variability where the response is not necessarily normally distributed. These models assume normal (Gaussian) random effects. The Mixed model is appropriate for continuous, normally distributed parameters and therefore was used for confidence. In contrast the quality and severity were analyzed using the Glimmix procedure which suits various distributions of the response variables and different link functions.

SAS for Windows version 9.1.was used for all statistical analysis.

Table 1
Upper airway endoscopy scoring.

Findings	Score	Impression	Score
Nasal obstruction:		*Primary structure/region causing obstruction:*	
No	0	Nose	1
Mild	1	Nasopharynx	2
Moderate	2	Lateral walls	3
Severe	3	Tongue base	4
Nasopharyngeal obstruction:		Supraglottis	5
No	0	Combined:	1 2 3 4 5
Mild	1	*Severity of OSA:*	
Moderate	2	Mild	1
Severe	3	Moderate	2
Lateral walls collapse:		Severe	3
No	0	*Level of confidence in findings:*	
Mild collapse	1	Poor	1
Moderate collapse	2	Fair	2
Severe collapse	3	Good	3
Tongue base obstruction:		*Quality of examination:*	
No	0	Poor	1
Mild	1	Fair	2
Moderate	2	Good	3
Severe	3		
Supraglottic obstruction:			
No	0		
Mild	1		
Moderate	2		
Severe	3		

3. Results

Twenty-eight pediatric patients were included in this study. All had persistent OSA despite prior T & A. Sixteen patients were male and 12 patients were female. The mean age was 7.65 years with a range from 1 to 18 years. The mean apnea-hypopnea index was 20.7 and the mean oxygen nadir was 81.5%. Fig. 1 shows the level of agreement among the four observers regarding the primary sites causing airway obstruction. A moderate-good agreement was demonstrated for the degree of obstruction at the level of the nasopharynx and supraglottis (weighted Kappa: 0.6 and 0.5, respectively), when reviewing SE compared to AE. The inter-observer agreement for the other structures/regions was similar or better for AE. Fig. 2 presents the inter-observer correlation for the severity of airway obstruction in each structure/region: compared to AE, SE obtained a better correlation when reviewers evaluated the nasopharynx, tongue base and supraglottis (intra-class correlation: 0.64, 0.44, 0.6 and 0.22, 0.296, and 0.35, respectively). Fig. 3 presents the results of analysis which we performed to assess the number of times in which a structure/region was identified as a contributing factor for airway obstruction. Compared to AE, more cases in which the nasopharynx, lateral pharyngeal walls, tongue base and the supraglottis caused obstruction were identified with SE. Statistical significance (McNemar's test, 2-tail, confidence level 95%) was found for the nasopharynx, lateral pharyngeal walls and the tongue base (P value: 0.02, 0.04, and 0.01, respectively). We used patients' PSG data to compare SE with AE for the ability to predict OSA severity: although globally OSA severity was better predicted with SE than with AE; both techniques underestimated the severity of OSA and the differences between sleep and awake

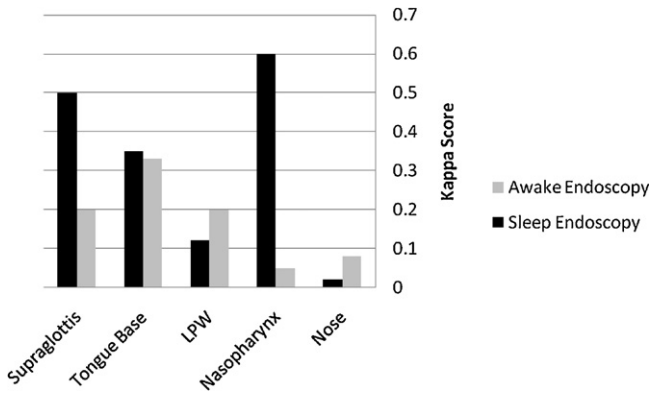

Fig. 1. Inter-observer correlation for the primary site of obstruction.