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Do synchronous airway lesions predict treatment failure after adenotonsillectomy in children less than 3 years of age with obstructive sleep apnea?

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ABSTRACT

Objectives: Determine the efficacy of adenotonsillectomy and the role of synchronous airway lesions in treatment failure in children younger than 3 years of age with obstructive sleep apnea.
Methods: A retrospective chart review was conducted for children younger than 3 years of age with obstructive sleep apnea who were evaluated and treated at a tertiary care hospital between 2005 and 2011. All participants underwent adenotonsillectomy or powered-intracapsular tonsillectomy with adenoidectomy and had both pre- and post-operative polysomnograms. Children eligible for airway evaluation underwent flexible laryngoscopy, direct laryngoscopy or bronchoscopy. For analysis, participants were categorized as cured or not-cured with an obstructive apnea–hypopnea index (OAHI) threshold of $\geq$1.4 indicating residual obstructive sleep apnea.
Results: Thirty-nine children met inclusion criteria and 41% had a post-operative OAHI $\leq$ 1.4 by polysomnogram. Children failing adenotonsillectomy, (OAHI $\geq$ 1.4) had a significantly higher pre-operative OAHI ($p < 0.001$) and lower nadir SpO_2 ($p < 0.03$) than those considered cured. Thirty-eight percent of the total population underwent airway evaluation, and synchronous airway lesions were identified in 60% of that cohort. None of the children required surgery for their synchronous airway lesions and there was no significant difference between outcome groups in number of patients who underwent airway evaluation or had synchronous airway lesions ($p = 1$ and $p = 0.14$, respectively).
Conclusions: Adenotonsillectomy is effective for obstructive sleep apnea in children younger than 3 years of age and the presence of a synchronous airway lesion does not necessarily predict treatment failure.

1. Introduction

Obstructive sleep apnea (OSA) is characterized by prolonged incomplete or intermittent complete obstruction of the upper airway [1]. It is estimated to effect 2–3% of the pediatric population and when left untreated can result in systemic and pulmonary hypertension, ventricular remodeling, neurocognitive impairment, among other problems [1–6]. Adenotonsillectomy (AT) is considered the first-line-treatment for children with OSA and reported cure rates range from 60% to 90% [1,7–9].

The effectiveness of AT is considerably lower for children younger than 3 years, with reported cure rates ranging from 0 to 35% [10,11]. Synchronous airway lesions (SALs) have been identified in 59–67% of children <3 and are thought to be a potential cause of failure to cure. In previous studies, despite the high incidence of SALs detected, less than 4% of the studied children required surgical intervention for these SALs [12,13]. This has led to considerable debate regarding the utility of airway evaluation including direct laryngoscopy and bronchoscopy at the time of AT and whether the presence of SALs are predictive of treatment failure.

This study was designed to assess the effectiveness of AT and determine whether presence of SALs contributes to treatment failure in children <3 years of age with OSA.

2. Methods

This is a retrospective chart review of pediatric patients <3 years of age with OSA seen between January 1st, 2005 and December 31st, 2011 in the pediatric otolaryngology clinic at our institution. The study was approved by the institutional review board (IRB) at the Cleveland Clinic Foundation. Patients were identified using International Statistical Classification of Diseases and Related Health Problems (ICD-9) code of 327.23 and filtered by

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age. Only children who had both a pre- and post-operative polysomnogram (PSG) and underwent AT or powered-intracapsular tonsillectomy (PITA) with adenoidectomy were eligible for inclusion. Patients were excluded from analysis if they were older than 36 months at the time of surgery, had undergone prior airway surgery or had a pre-existing condition, which would otherwise require airway evaluation, such as a tracheostomy.

All patients underwent standard overnight PSG at our institution in an American Academy of Sleep Medicine accredited laboratory. Sleep studies were attended continuously by a sleep technologist and interpreted by a board-certified/eligible pediatric sleep-medicine physician. The monitored parameters included: single-lead electrocardiogram (ECG), snoring, continuous airflow with thermistor and nasal pressure transducer, chest and abdominal effort, oxygen saturation via pulse oximeter, transcutaneous pCO_2, and body position via video monitoring. Apnea was defined as the absence of airflow for 2-breath duration with or without a fall in oxygen saturation. Hypopnea was defined by a 50% or greater reduction in the nasal pressure or thermistor signal lasting for duration of at least 2-breaths and accompanied by a 3% or greater desaturation from pre-event baseline, or an arousal. At least 90% of the event's duration must have met the amplitude reduction criteria for hypopnea. The apneas were classified as obstructive if there was continued evidence of respiratory efforts during the event. OSA was identified by an apnea–hypopnea index (OAHI; rate of apneas + hypopneas per hour of sleep) >1.

Charts were reviewed for patient age, gender, body mass index (BMI), comorbidities and pre- and post-operative PSG data. All post-operative patients were admitted to the hospital for overnight observation. Clinical data from the perioperative period was evaluated for adverse events including laryngospasm, post-operative desaturation below 90%, post operative bleeding and dehydration requiring re-admission.

Airway evaluation by flexible nasolaryngoscopy, sleep endoscopy and/or direct laryngoscopy/bronchoscopy, was performed on select patients based on clinician judgment for patients with significantly elevated pre-operative OAHI values or suspicion for airway lesions. All sleep endoscopies were performed in pediatric operating rooms staffed by pediatric anesthesiologists under spontaneous ventilation. Board certified pediatric otolaryngologists performed all airway evaluations and operative, procedural and clinical notes were reviewed to identify SALs.

SALs, as in previous studies were defined as any partial or complete obstructive nasal, nasopharyngeal, oropharyngeal, hypopharyngeal, laryngeal, or endotracheal lesions [12,13]. As described in previous literature, subglottic narrowing was sized by amount of obstruction and graded by Cotton-Myer grading scale. Vascular compression or dynamic narrowing of trachea was considered significant when there was more than 50% narrowing of lumen visualized endoscopically. Laryngomalacia was recorded when there was inspiratory collapse of supraglottic structures as previously described. Laryngeal or tracheal edema was documented if mucosal edema was seen on endoscopy. All documented SALs with the exception of adenotonsillar hypertrophy were included for analysis.

Children were categorized as cured from OSA if the respective post-operative PSG revealed an OAHI ≤ 1.4. All other patients were considered to have failed AT. OAHI values were rounded to the nearest whole number for categorization.

Associations between cure and possible predictors were assessed using logistic regression to provide odds ratio estimates and 95% confidence intervals. *p*-values for assessing such associations were determined from chi-square tests or Fisher's exact tests for categorical variables (including SALs), and from Wald chi-square tests for continuous variables. Associations between cure and continuous post-op factors were assessed using Wilcoxon rank sum tests. Changes from pre-op to post-op in BMI and polysonogram data were assessed using Wilcoxon signed rank tests. Analyses were performed using R version 3.0.1 (www.r-project.org).

3. Results

The medical charts of 243 children were reviewed. Two hundred and four patients were excluded from analysis: 169 patients did not have both pre- and post-operative PSG data, 20 did not have a diagnosis of OSA by polysomnogram, 8 patients were older than 36 months, 3 patients had a tracheostomy requiring airway visualization, 3 patients had only an adenoidectomy and 1 patient had a cleft palate repaired prior to OSA evaluation.

Of the 39 patients included in this analysis, there were 18 males (age range: 15.12–34.29 months) and 21 females (age range: 14.93–34.65 months) with a combined average age of 26.5 months at the time of surgery (Table 1). Significant medical co-morbidities

Table 1
Population characteristics by outcome group. No.: number, mos.: months, PSG: polysomnogram.

Population characteristics					
Characteristic	Total	Cured; OAHI ≤ 1.4	Non-cured; OAHI ≥ 1.5	*p*-value	Odds ratio 95% CI
Total number of patients	39	16	23 (59.0%)		
Age at time of surgery (mos.)	26.5 (5.7)	27.5 (6.0)	25.8 (5.5)	0.35	0.85 (0.59–1.20)[a]
Gender				0.69	1
Female	21	8	13 (61.9%)		1
Male	18	8	10 (50.0%)		0.63 (0.13–3.01)
Medical comorbidity				0.041	
No	20	5	15 (75.0%)		1
Yes	19	11	8 (42.1%)		0.24 (0.06–0.95)
Neurologic deficit				0.045	
No	31	10	21 (67.7%)		1
Yes	8	6	2 (25.0%)		0.16 (0.03–0.93)
Genetic abnormality				0.15	
No	34	13	21 (61.8%)		1
Yes	5	4	1 (20.0%)		0.15 (0.01–1.19)
Interval between first PSG and second PSG (mos.)	8.34 (6.94)	7.43 (6.16)	8.98 (7.50)	0.49	1.11 (0.82–1.50)[b]
Interval between surgery and second PSG (mos.)	6.81 (7.01)	5.11 (6.21)	7.99 (7.42)	0.22	1.24 (0.88–1.75)[b]
Post-operative complications				0.82	
No	26	11	15 (57.7%)		1
Yes	13	5	8 (61.5%)		1.17 (0.30–4.58)

[a] Per 3 months greater age.
[b] Per 6 months longer interval.