Predictors of complications following adenotonsillectomy in children with severe obstructive sleep apnea

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A B S T R A C T

Objective: To identify pre-operative risk factors predicting complications following adenotonsillectomy in children with severe OSA.

Methods: Retrospective chart review in an academic tertiary care center. Children with symptoms of OSA with overnight polysomnography (PSG) revealing apnea–hypopnea index (AHI) >10, who underwent adenotonsillectomy with overnight postoperative observation between 2008 and 2012. Univariate logistic regression was used to assess odds ratio (OR) of individual risk factors versus postoperative complications such as overnight desaturations <90%, length of stay (LOS) > 24 h, supplemental oxygen requirement, and transfer to a higher level of care.

Results: All patients (n = 157) with severe OSA were observed overnight. Mean age was 5.3 ± 3.7 years. Twenty-five (15.9%) patients had LOS > 24 h. Forty-two (26.8%) had overnight desaturations <90%. AHI $\geq$15 and O2 saturation nadir <80% on preop polysomnography (PSG) were independent predictors of post-op O2 saturation <90% and LOS > 24 h. ($p < 0.05$). PSG minimum saturation <80% was the strongest predictor of all variables examined with an OR of 6.98 (3.15–15.48, 95% CI) for desaturation <90% and 5.19 (2.11–12.75, 95% CI) for LOS > 24 h. Preop PSG O2 saturation < 90% predicted overnight post op oxygen requirement with an OR of 3.38 (1.39–8.25, 95%CI).

Conclusions: Preoperative polysomnography yields significant independent predictors of post-op complications in children with OSA. While AHI is a significant independent predictor, minimum O2 saturation on preop PSG appeared the strongest predictor when <80%. Patients with these risk factors, especially low O_2 on PSG, warrant overnight observation with continuous pulse oximetry.

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Obstructive sleep apnea (OSA) increases children's all-cause mortality by a factor of 6.58 and nearly doubles their healthcare utilization [1,3,4]. Fortunately, most of these complications are preventable with adenotonsillectomy [5–7]. Chief among the risks of adenotonsillectomy are post-tonsillectomy hemorrhage and respiratory complications following anesthesia. Unfortunately children with severe OSA are at the highest risk of respiratory complications following the procedure [8–11]. Severe OSA is defined by the American Academy of Otolaryngology and Head and Neck surgery as an apnea–hypopnea index (AHI) > 10 on overnight polysomnography (PSG) [12]. Though anesthesia can cause respiratory disturbances in normal patients, these appear more frequent in children with severe OSA, especially with use of opioid analgesics [13–15].

While this increased risk is known, sparse evidence exists to guide patient placement postoperatively—do children undergoing T&A for severe OSA need observation in the intensive care setting (PICU), is a step-down unit necessary, or is a general pediatric bed with telemetry sufficient? This study was conducted to identify predictors of postoperative complications, in order to provide objective criteria for postoperative placement and monitoring.

1. Methods

Institutional review board approval was obtained from the Massachusetts Eye and Ear Infirmary. Medical records were queried for children age 2 years to 18 with severe OSA (defined as a total AHI $\geq$10) diagnosed by polysomnography between February 2008 and November 2012 who underwent adenotonsillectomy at Massachusetts Eye and Ear Infirmary, an academic tertiary care institution. Only patients observed overnight postoperatively were included; children with developmental, craniofacial, and other congenital

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disorders were also included, as they represent many of the patients at risk for complications.

Their records were reviewed for demographic, polysomnographic, and other pre-operative factors that may contribute to postoperative complications, based on a pilot study [10]. These included preoperative apnea–hypopnea index (AHI), minimum O_2 sat on PSG, body mass index (BMI), and narcotic administration. Preoperative polysomnographs were scored based on standard pediatric scoring criteria for apneas and hypopneas. Nasal cannula, end-tidal CO_2, and all other standard sensors were employed during overnight polysomnography. Location and duration of postoperative observation were noted, and postoperative records were reviewed for airway complications such as prolonged stay in the post-anesthesia care unit (PACU), postoperative O_2 requirement, O_2 desaturations, and transfers to a higher level of care (i.e., pediatric intensive care unit). At our institution O2 therapy is initiated when SaO2 falls below 90%. Institutional criteria for planned PICU admission were: age less than 2; AHI >20; SaO2 nadir <80%. Univariate logistic regression was performed to assess a relationship between each predictor and each outcome.

2. Results

A total of 157 children met the inclusion criteria of preoperative PSG and overnight observation (Table 1). They had a mean age of 5.3 ± 3.7 years and were 58% male, 54% white, 12% black, and 22% Hispanic. On preoperative PSG, mean total AHI was 24.9 ± 17.4 and OAHI was 22.0 ± 16.1, with 112 (71.3%) of patients desaturating <90% and 40 (25.5%) desaturating <80%.

The average total (intraoperative + PACU) morphine dose was 0.07 ± 0.05 mg/kg (Table 2). One hundred thirty-eight patients (87%) received morphine in the operating room, and 47 (29%) received morphine in the PACU. Of the 19 patients who did not receive intraoperative morphine, 10 required morphine in the PACU upon recovery from anesthesia. Ten patients (6.4%) had desaturations <90% in the PACU. Thirty-one patients (19.7%) had a planned PICU stay postoperatively, and the remainder were observed in a pediatric floor with telemetry. Overall, 25 (15.9%) had hospital stays longer than 1 day. In the ward or PICU, 42 (26.8%) had desaturations <90% overnight, 31.9% required supplemental oxygen overnight, and 2.6% were transferred to the PICU. No morphine was given on the wards. Six patients (3.8%) encountered postoperative bleeding. Of the 25 patients with prolonged hospital stays (LOS > 1 day), 19 (76%) were attributable to desaturations <90% overnight. Other less common causes of prolonged stay were poor PO intake, bleeding, and postoperative fever.

Preoperative AHI ≥15 and preoperative minimum O_2 saturation <80% were the strongest predictors of overnight desaturation and prolonged hospital stay (Table 3). Of these, minimum O_2 saturation <80% had the strongest effect, with an odds ratio of 6.98 for

Table 1
Baseline characteristics.

Age	5.3 ± 3.7
BMI	19.5 ± 7.1
AHI	24.9 ± 17.4
Male sex	91 (58.0)
Race	
Black	18 (11.5)
Hispanic	35 (22.3)
Asian	9 (5.7)
White	85 (54.1)
Other	3 (1.9)
Unknown	7 (4.5)

Numeric variables presented with mean ± SD.
Categorical variables presented with frequency (%).

Table 2
Patients' outcomes.

PACU time (min)	72.6 ± 25.8
>60 min PACU stay	94 (59.9)
LOS (day)	1.2 ± 0.8
>1 day hospital stay	25 (15.9)
Overnight O_2 saturation nadir <90%	42 (26.8)
Post op O_2 requirement	50 (31.9)
Transfer to PICU	4 (2.6)
Min SAO2 on PSG (%)	83.3 ± 9.8
Intraop morphine (mg/kg)	0.06 ± 0.04
>0.05 mg/kg	95 (60.5)
>0.10 mg/kg	18 (11.5)
Postop morphine (mg/kg) (Total morphine)	0.07 ± 0.05
>0.05 mg/kg	108 (68.8)
>0.10 mg/kg	32 (20.4)

postoperative overnight desaturation <90%. Perioperative morphine dosage was not associated with an increased risk of postoperative respiratory complications or increased length of hospital stay.

3. Discussion

Despite the considerable risk of respiratory complications in patients undergoing adenotonsillectomy for severe OSA, there is little evidence to guide postoperative patient monitoring. In this study population preoperative AHI ≥15 and preoperative minimum O_2 saturation <80% were strong predictors of respiratory complications leading to a prolonged hospital stay (Fig. 1). These are consistent with past research on the general population of patients undergoing adenotonsillectomy, as well as our own pilot study. Unlike past research, these results are specific to patients with severe OSA (as defined by AHI ≥10) [10,16,17].

Preoperative O_2 saturation nadir may represent the most important independent risk factor in the setting of severe OSA. In this population, a minimum O_2 saturation <80% and <90% on preop PSG were associated with increased need for postoperative oxygen therapy and increased length of stay, independent of the overall AHI. Patients with these risk factors may benefit from observation in an intensive care setting or a step-down unit, whereas patients without such risk factors may not require as intense observation.

In our study, the majority of complications occurred after transfer from the PACU to the floor or PICU. Most complications were airway-related; 3.8% of patients bled postoperatively, and 76% of patients with LOS > 1 day stayed for respiratory concerns. The remaining 24% stayed >1 day due to bleeding, fever, or poor PO intake. Only ten patients (6.4%) had desaturations <90% in the PACU, a lower desaturation rate than reported elsewhere [8]. However, on the floor, 42 (26.8%) experienced desaturations. This

Table 3
Preoperative predictors of respiratory complications and prolonged hospital stay ([*] indicates statistical significance at a threshold of $p < 0.05$).

	OR for O2 desaturation <90%	OR LOS > 24 h
Preop AHI ≥ 15	2.53 ($p = 0.0273$)[*]	3.41 ($p = 0.0325$)[*]
Preop AHI ≥ 20	3.60 ($p < 0.001$)[*]	2.88 ($p = 0.0223$)[*]
Min O_2 sat on preop PSG <80%	6.98 ($p < 0.001$)[*]	5.19 ($p < 0.001$)[*]
Min O_2 sat on preop PSG <90%	2.02 ($p = 0.1117$)	2.37 ($p = 0.1357$)