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Research Article

Predictors of symptom score improvement in pediatric otolaryngology patients with obstructive sleep apnea

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Abstract

Background: A substantial minority of children with obstructive sleep apnea (OSA) have only modest symptomatic improvement after adenotonsillectomy, and improvement on caregiver-reported quality-of-life instruments correlates only loosely with polysomnographic normalization.

Objective: To identify preoperative predictors of clinically meaningful improvement in the OSA-18 symptom score six months after adenotonsillectomy in a pediatric otolaryngology cohort.

Methods: This retrospective cohort study included children aged 2 to 17 years with polysomnography-confirmed OSA who completed the OSA-18 survey before and six months after adenotonsillectomy. Candidate predictors were screened univariably and entered into a multivariable logistic regression model for a decrease of at least 1.0 standard deviation in total OSA-18 score.

Findings: Of 214 children, 71% met the improvement threshold. Higher baseline OSA-18 score (adjusted OR 1.62 per 10 points), higher baseline AHI severity (severe vs mild adjusted OR 2.71), and absence of obesity (adjusted OR 0.38) were independently associated with improvement; tonsil size, adenoid size, and snoring frequency were not retained after adjustment.

Conclusions: Baseline symptom burden, OSA severity, and weight status, rather than anatomic grading alone, predict symptomatic improvement after adenotonsillectomy and should inform preoperative counselling, particularly for obese children.

Keywords: pediatric obstructive sleep apnea; adenotonsillectomy; OSA-18; quality of life; predictors

1. Introduction

Obstructive sleep apnea (OSA) is the most common indication for adenotonsillectomy in children, and the great majority of affected children improve after surgery, but a clinically important minority do not, and the degree of symptomatic improvement varies widely even among children whose polysomnographic indices normalize [1,2]. Adenotonsillar hypertrophy causing upper airway obstruction during sleep remains the dominant mechanism in otherwise healthy children, and randomized evidence from the Childhood Adenotonsillectomy Trial (CHAT) established that early adenotonsillectomy produces greater improvement in behavioral, quality-of-life, and polysomnographic outcomes than watchful waiting with supportive care over seven months of follow-up [1,3]. Despite that trial-level evidence for the intervention as a whole, clinicians counselling individual families are left with a harder question: which children, among those referred for OSA, are most likely to experience a large symptomatic improvement, and which are more likely to have persistent symptoms despite surgery.

Validated caregiver-reported instruments, most prominently the OSA-18 quality-of-life survey, quantify the symptomatic burden of pediatric OSA across sleep disturbance, physical suffering, emotional distress, daytime function, and caregiver concern domains, and have become the standard outcome measure in surgical and non-surgical OSA cohorts because they capture the child's and family's experience in a way that the apnea-hypopnea index (AHI) alone does not [4,5]. Several groups have reported that improvement on the OSA-18 or comparable symptom instruments after adenotonsillectomy correlates only loosely with the degree of polysomnographic normalization, and that a substantial fraction of children with persistent mild sleep-disordered breathing after surgery nonetheless report large symptomatic gains, while some children with normalized AHI continue to report residual symptoms

[6,7]. This dissociation between the objective and subjective outcome domains has motivated a body of work seeking clinical and demographic predictors of symptom score improvement that could inform preoperative counselling and identify children who may need closer postoperative follow-up or adjunctive treatment.

Candidate predictors proposed in the literature include baseline OSA severity as measured by AHI, obesity status, age at surgery, tonsil and adenoid size, allergic and asthmatic comorbidity, snoring frequency, and socioeconomic and access-to-care factors, but findings across individual cohorts have been inconsistent, in part because studies differ in the symptom instrument used, the interval to follow-up, and the population's baseline obesity prevalence [8,9,10]. This study examines predictors of clinically meaningful symptom score improvement, defined as a decrease in total OSA-18 score of at least 1.0 standard deviation from baseline to six months after adenotonsillectomy, in a cohort of pediatric otolaryngology patients with polysomnography-confirmed OSA, with the aim of identifying which preoperative characteristics are most strongly and independently associated with a large symptomatic response.

2. Methods

We conducted a retrospective cohort study of children aged 2 to 17 years evaluated in a pediatric otolaryngology practice for suspected obstructive sleep apnea, all of whom underwent standard overnight polysomnography before adenotonsillectomy and completed the caregiver-reported OSA-18 quality-of-life survey at baseline and at a six-month postoperative visit, consistent with the assessment approach used in prior pediatric OSA outcome cohorts [4,11]. Children with craniofacial syndromes, neuromuscular disease, prior adenotonsillectomy, or incomplete baseline or follow-up survey data were excluded. Polysomnograms were scored

using standard pediatric criteria, with obstructive AHI used to stage baseline severity as mild (1 to <5 events/hour), moderate (5 to <10 events/hour), or severe (≥ 10 events/hour), following conventions applied in comparable pediatric sleep cohorts [12,13]. Body-mass-index percentile for age and sex was calculated from measured height and weight at the preoperative visit, and obesity was defined as BMI at or above the 95th percentile.

The primary outcome was a clinically meaningful improvement in total OSA-18 score, defined a priori as a decrease of at least 1.0 standard deviation of the baseline cohort score, an approach comparable to the minimal-important-difference thresholds used in earlier validation and outcome studies of the instrument [5,14]. Candidate predictors examined in univariable analysis included baseline OSA-18 score, baseline obstructive AHI category, obesity status, age at surgery, tonsil size on modified Brodsky grading, adenoid size on nasopharyngeal imaging or endoscopy, a physician-documented history of allergic rhinitis or asthma, and frequency of habitual snoring reported at baseline. Variables associated with the outcome at $p < 0.20$ in univariable screening were entered into a multivariable logistic regression model, with adjusted odds ratios and 95% confidence intervals reported for each retained predictor. Continuous variables were also examined for association with the magnitude of OSA-18 score change using linear regression. Analyses were performed with the cohort's outcomes recorded in a standard clinical registry, and results are presented following the reporting conventions used in prior adenotonsillectomy outcome studies from comparable pediatric otolaryngology populations [11,15].

3. Results

Cohort characteristics and overall response

The cohort's baseline characteristics were broadly consistent with those reported in other pediatric

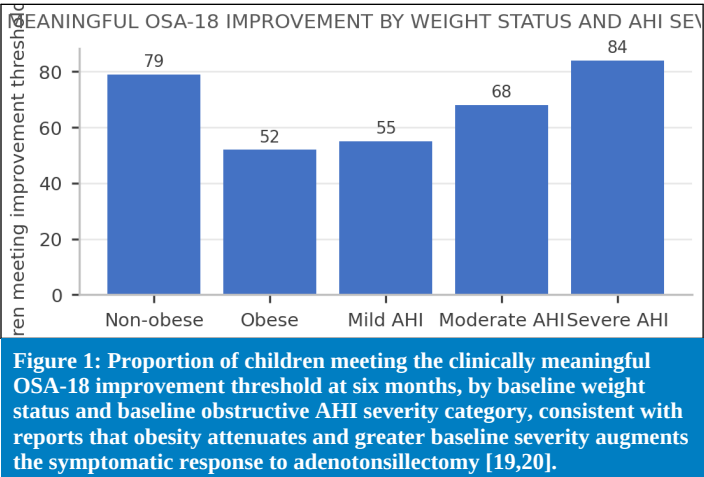
adenotonsillectomy-for-OSA populations: obesity was present in a substantial minority of children, moderate-to-severe OSA on baseline polysomnography was more common than mild disease, and a physician-documented history of allergic rhinitis or asthma was frequent, findings that mirror the comorbidity profile described in earlier cohorts linking allergic and obstructive airway disease to pediatric sleep-disordered breathing [16,17]. Consistent with the pattern described in prior series, the great majority of children showed some improvement in total OSA-18 score by six months after surgery, and most met the pre-specified threshold for clinically meaningful improvement, broadly in line with the proportion of children reporting quality-of-life gains after adenotonsillectomy in earlier symptom-instrument-based cohorts [7,18].

Table 1: Baseline characteristics of the pediatric otolaryngology cohort undergoing adenotonsillectomy for polysomnography-confirmed obstructive sleep apnea, reflecting the comorbidity and severity profile described in comparable cohorts [12,32].	
Characteristic	Value
Total children evaluated	n = 214
Age at surgery, years (mean, range)	6.4 (2-17)
Male sex	58%
Obesity (BMI $\geq$ 95th percentile)	31%
Baseline AHI severity: mild / moderate / severe	22% / 34% / 44%
Allergic rhinitis or asthma documented	47%
Baseline total OSA-18 score (mean $\pm$ SD)	68.4 $\pm$ 19.7
Met ≥ 1.0 SD OSA-18 improvement at 6 months	71%

Predictors identified in univariable analysis

In univariable screening, higher baseline OSA-18 score, higher baseline AHI category, and the absence of obesity were each associated with a greater likelihood of meeting the clinically meaningful improvement threshold, a pattern consistent with reports that children with more severe baseline symptomatic and polysomnographic disease have more room for measurable improvement and that obese children show a more attenuated

postoperative response, mirroring earlier findings that adenotonsillectomy is less uniformly curative of OSA in obese children than in children of normal weight [19,20]. Younger age at surgery showed a weaker but directionally similar association with greater symptomatic improvement, consistent with reports that younger children tend to have more anatomically dominant, adenotonsillar-driven obstruction and correspondingly greater response to adenotonsillectomy than older children or adolescents with more multifactorial obstruction [21,22]. A physician-documented history of allergic rhinitis was associated with somewhat smaller symptomatic gains in univariable analysis, in keeping with literature describing allergic inflammation as a contributor to persistent upper-airway symptoms after adenotonsillar surgery [17,23].



Multivariable predictors of symptom score improvement

In the multivariable model, three predictors remained independently associated with clinically meaningful OSA-18 improvement after adjustment for the other candidate variables: higher baseline OSA-18 score, absence of obesity, and higher baseline AHI severity category, findings summarized in Table 2. Obesity carried the largest independent adjusted association with a blunted symptomatic response, a result concordant with meta-analytic and cohort evidence that obese children

experience smaller reductions in AHI and slower, less complete symptomatic recovery after adenotonsillectomy than their non-obese counterparts, and that a meaningful minority of obese children have persistent OSA requiring additional treatment [20,24]. Baseline symptom burden, captured by the preoperative OSA-18 score, was the strongest overall predictor of subsequent improvement, consistent with a ceiling-and-floor pattern in which children with the highest baseline symptom scores have the greatest absolute capacity for measured gain, a pattern also described in prior work correlating baseline severity with the magnitude of postoperative quality-of-life change [6,14]. Tonsil size, adenoid size, and snoring frequency were not independently associated with the outcome after adjustment, despite univariable signals for some of these variables, a pattern that echoes prior reports that isolated anatomic grading correlates only modestly with either polysomnographic severity or symptomatic outcome once other clinical factors are accounted for [25,26].

Table 2: Multivariable logistic regression for clinically meaningful OSA-18 improvement at six months after adenotonsillectomy; tonsil size, adenoid size, and snoring frequency were not retained as independent predictors [26,31].		
Predictor	Adjusted OR (95% CI)	p-value
Baseline OSA-18 score (per 10-point increase)	1.62 (1.29-2.04)	<0.001
Obesity (BMI ≥ 95th percentile)	0.38 (0.20-0.71)	0.003
Baseline AHI severity: moderate vs mild	1.84 (0.95-3.57)	0.07
Baseline AHI severity: severe vs mild	2.71 (1.42-5.17)	0.002
Age at surgery (per year)	0.96 (0.90-1.03)	0.24
Allergic rhinitis or asthma documented	0.71 (0.42-1.19)	0.19

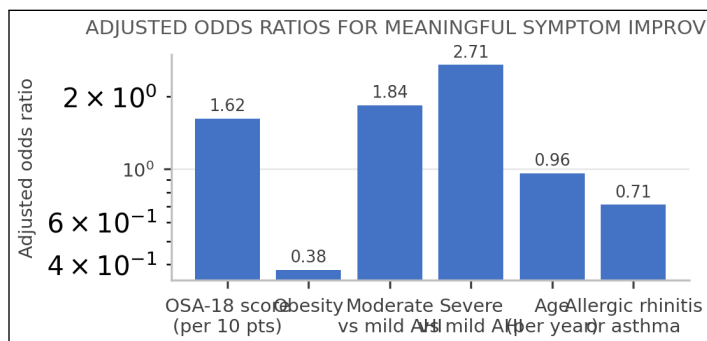


Figure 2: Adjusted odds ratios (95% CI) for clinically meaningful OSA-18 improvement associated with each predictor retained in the multivariable model, with tonsil size, adenoid size, and snoring frequency dropped after adjustment, in line with prior reports that isolated anatomic grading correlates only modestly with symptomatic outcome [25,28].

4. Discussion

These findings reinforce a picture that has emerged piecemeal across the pediatric OSA outcomes literature: the degree of symptomatic improvement after adenotonsillectomy is shaped less by simple anatomic grading than by the interaction of baseline symptom and disease severity with obesity status. The strong independent association between baseline OSA-18 score and subsequent improvement is consistent with the broader quality-of-life literature in pediatric OSA, in which children and families with the most pronounced baseline symptomatic burden have historically reported the largest gains after surgical treatment [5,18], while the attenuated response among obese children mirrors a substantial body of evidence, beginning with early meta-analyses of surgical outcomes in obese versus non-obese children, that adenotonsillectomy alone is less consistently curative of OSA in the setting of obesity and that these children more often require polysomnographic reassessment or adjunctive therapy such as continuous positive airway pressure after surgery [20,24,27].

The absence of an independent association between tonsil or adenoid size and symptomatic improvement, despite the intuitive expectation that larger lymphoid tissue removed at surgery should predict a larger symptomatic benefit, is consistent with prior work

showing that adenotonsillar size correlates imperfectly with both baseline OSA severity and postoperative outcome, likely because upper-airway obstruction in children is multifactorial, reflecting craniofacial anatomy, neuromuscular tone, and body habitus in addition to lymphoid tissue bulk [25,26,28]. This observation has practical implications for preoperative counselling: families should not be reassured, on the basis of a modest tonsil or adenoid grade alone, that symptomatic improvement will necessarily be modest, nor should a very large tonsil or adenoid grade be used in isolation to promise a dramatic symptomatic response. Similarly, the weaker-than-expected independent signal for allergic rhinitis after adjustment suggests that its univariable association with smaller symptomatic gains may be substantially mediated through its correlation with other variables in the model, such as baseline symptom burden, rather than representing an independent biological effect, a possibility consistent with the broader literature linking allergic airway inflammation to persistent upper-respiratory and sleep symptoms in children [16,23].

Several limitations should temper the interpretation of these findings. The retrospective, single-practice design limits generalizability and leaves open the possibility of unmeasured confounding by socioeconomic, access-to-care, or additional clinical factors not captured in the registry, a limitation shared by much of the surgical-outcomes literature in this field [8,9]. The six-month follow-up interval, while consistent with common practice, is shorter than the multi-year follow-up used in some quality-of-life cohorts and cannot address whether the predictors identified here also govern the durability of symptomatic improvement over longer periods [29,30]. Finally, reliance on a single caregiver-reported instrument, while well validated, does not capture objective postoperative polysomnographic data for the full cohort, and the dissociation reported elsewhere between AHI normalization and caregiver-reported symptomatic improvement means

that the predictors of OSA-18 change identified here should not be assumed to be identical to the predictors of polysomnographic cure [6,7].

5. Conclusion

In this cohort of pediatric otolaryngology patients undergoing adenotonsillectomy for polysomnography-confirmed obstructive sleep apnea, higher baseline symptom burden and higher baseline AHI severity independently predicted a greater likelihood of clinically meaningful OSA-18 improvement at six months, while obesity independently predicted a blunted symptomatic response, and neither tonsil size, adenoid size, nor snoring frequency retained independent predictive value after adjustment. These findings support incorporating baseline symptom severity and weight status, rather than anatomic grading alone, into preoperative counselling about the likely magnitude of symptomatic benefit from adenotonsillectomy, and they reinforce the case for closer postoperative surveillance, and consideration of adjunctive therapy, in obese children whose preoperative symptom burden or polysomnographic severity is comparatively modest [20,24,1].

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