

Oxygen saturation level in children with adenotonsillectomy as a predictive factor for safe hospital dischargeYasser Haroon¹ and Yehia Hamed²Departments of Otorhinolaryngology¹ & Pediatrics², Faculty of Medicine, Benha University, Egypt
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Abstract: Objectives: The present study was designed to verify constitutional and preoperative lowest oxygen saturation (O₂Sa) as predictors for the possibility of postoperative (PO) low O₂Sa that necessitates interference and to identify patients to be managed on out-patient or in-patient basis. **Patients & Methods:** The study included 512 children; 340 (66.4%) were habitual snorers and 172 (33.6%) were non-snorers. All patients underwent determination of demographic data including age, sex, weight, height and body mass index (BMI). The night prior to surgery, pulse oximetry was performed for estimation of O₂Sa and was scored according to Levy scoring system. Adenotonsillectomy was conducted under general inhalational anesthesia. All patients were managed postoperatively at the in-patients ward for occurrence of surgery-related immediate PO complications. PO O₂Sa was re-evaluated and patients had O₂Sa <90% were identified. The need for the insertion of oro-pharyngeal airway, continuous positive airway pressure or endotracheal intubation and mechanical ventilation was noted. Patients passed their night free with O₂Sa >95% on room air were discharged on the next morning, while those had O₂Sa <95% continued follow-up till adjustment of their O₂Sa. **Results:** Mean preoperative lowest O₂Sa was significantly lower in snorers compared to non-snorers and patients' distribution among higher scoring grades showed significant difference in favor of non-snorers. Mean PO lowest O₂Sa in snorers group was significantly higher compared to preoperative saturation. Twenty- six patients of snorers (7.6%) developed deterioration of their nocturnal O₂Sa and had significantly lower mean PO lowest O₂Sa compared to their preoperative O₂Sa. Three patients required endotracheal intubation and mechanical ventilation; 6 patients required insertion of oro-pharyngeal airway with nostril tube oxygenation at pediatric ward for 1-hr and 19 patients were kept under observation with continuous O₂Sa monitoring. The receiver operating characteristic (ROC) curve analysis defined the low preoperative lowest O₂Sa and high BMI as specific predictors, while young age as sensitive predictor for PO- O₂ desaturation. **Conclusion:** The presence of high BMI of young snorer children assigned for adenotonsillectomy necessitate preoperative pulse oximetry estimation of O₂Sa and patients had O₂Sa <90% must be kept under observation on the 1st PO night for fear of development of PO- O₂ desaturation that showed a frequency of 7.6% in snorers.

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Key words: Oxygen saturation, Snorer, Hospital discharge.

1. Introduction

Obstructive sleep apnea (OSA) caused by enlarged tonsils and adenoids is common in pediatric population. The prevalence of pediatric OSA syndrome has been estimated to be between 1% and 3% in different epidemiological studies. The incidence peak was found in pre-school and school-aged children within the age in which tonsil hypertrophy and adenoid are more common⁽¹⁾.

Despite, being a treatable form of disordered breathing, several daytime symptoms resulting from pediatric OSA have been recognized as low body weight index, behavioral problems, poor learning performance in school and neurobehavioral and cognitive functioning may be affected⁽²⁾.

Tarasiuk et al.,⁽³⁾ reported that from the first year of life to date of obstructive sleep apnea syndrome (OSAS) diagnosis, children with OSAS had 40% more hospital visits, 20% more repeated visits, and higher consumption of anti-infective and respiratory system

drugs. Also, referrals of children with OSAS to otolaryngology surgeons and pediatric pulmonologists were higher from year 1 to date of OSAS diagnosis, especially in year 4. The 215% elevation in health care use of the OSAS group was due mainly to higher occurrence of respiratory tract morbidity⁽³⁾.

Published data support a significant effect of adenotonsillectomy on the associated co-morbidities: adenotonsillectomy resulted in the reduction of pulmonary hypertension, improved growth as a result of an increase in growth hormone secretion, improvement of neurocognitive function to the normal range, reduction in nocturnal enuresis, as well as reducing general morbidities, as reflected by the reduction in health care utilization^(4,5). However, there are still uncertainties relating to major aspects. There is no specific definition for OSAS grading, or for generating a guideline for surgical treatment and refinement of the indications of adenotonsillectomy⁽⁶⁾.

Moreover, *Blenke et al.*,⁽⁷⁾ reported that there was no consensus regarding pediatric intensive care unit referral for OSA adenotonsillectomy and clinical judgment without complex sleep studies was sufficient to detect complicated cases of OSA with co-morbidity requiring pediatric intensive care. Thus, the present study was designed to verify constitutional and preoperative lowest O₂Sa as predictors for the possibility of PO low O₂Sa that necessitates interference and to identify patients to be managed on out-patient or in-patient basis.

2. Patients and Methods

The present study was conducted in Otorhinolaryngology and Pediatrics Departments, Benha University Hospital since Sep 2008 till Jun 2010 and included all patients younger than 6 years and assigned to adenotonsillectomy, irrespective of indication of surgery. Children were categorized according to patients' parents history of habitual snoring, which was defined as loud snoring occurring "frequently" or "constantly" as snorers and those free of history of habitual snoring as non-snorers.

All patients underwent determination of demographic data including age, sex, weight, height and BMI was computed as the ratio of body weight in kilograms divided by the square of height in meters ($=\text{kg}/\text{m}^2$) and ideal BMI was defined as $\text{BMI} \leq 25$ ⁽⁸⁾.

Then, patients were evaluated medically to assure absence of preoperative respiratory diseases and those had acute respiratory diseases were postponed for 4 weeks and re-evaluated. The night prior to surgery, pulse oximetry was performed for estimation of O₂Sa using a *Nellcor* (Pleasanton, CA) N-200 (mode 2, fast averaging) oximeter and was scored according to Levy scoring system for respiratory adverse events: O₂Sa ≥ 95 = 1, O₂Sa of 90-94=2, O₂Sa of 80-89=3 and O₂Sa of $<80\%$ =4⁽⁹⁾. Prophylactic antibiotic were administered. Adenotonsillectomy was conducted under general inhalational anesthesia.

All patients were managed postoperatively at the in-patients ward and were followed up for occurrence of surgery-related immediate postoperative complications and for the occurrence of immediate respiratory adverse events. Postoperative O₂Sa was re-evaluated and patients had O₂Sa $<90\%$ were identified. The need for the insertion of oro-pharyngeal airway, continuous positive airway pressure or endotracheal intubation and mechanical ventilation was noted.

Readiness for discharge was determined using Aldrete score which evaluated 5 parameters namely; respiration, blood pressure, activity, consciousness and O₂Sa. Each parameter scored from 0 to 2 and with a maximum achievable score of 10 (Table 1). Readiness for discharge was decided by achieving a total Aldrete score of 9⁽¹⁰⁾.

Table (1): Constituent parameters of Aldrete score

Score	2	1	0
Airway	Coughing on command or crying	Maintaining good airway	Airway requires maintenance
Vital signs	Stable and appropriate for age	Stable but inappropriate for age	Unstable
Motor activity	Moving limbs purposefully	Non-purposeful movements	Not moving
Consciousness	Fully awake	Responding to stimuli	Not responding
O ₂ Sa on room air	$>95\%$	90-94%	$<90\%$

Statistical analysis

Obtained data were presented as mean \pm SD, ranges, numbers and ratios. Results were analyzed using Wilcoxon-ranked test (Z test) Chi-square test (X^2 test). The ROC curve analysis judged by the area under the curve (AUC) was used to evaluate sensitivity and specificity as predictors for postoperative oxygen desaturation. All reported AUC were compared versus the null hypothesis (True area=0.5) that the evaluated parameter proved specific if the AUC was significantly higher compared to the true area or sensitive if the AUC was significantly lower compared to the true area and parameters showed non-significant AUC compared to the true area were considered non-sensitive nor specific (Non-sense). Statistical analysis was conducted using the SPSS (Version 10, 2002) for Windows statistical package. *P* value <0.05 was considered statistically significant.

3. Results

Throughout the study period 512 patients underwent adenotonsillectomy for adenotonsillar hypertrophy irrespective of the presence or absence of habitual snoring. Out of the enrolled patients 340 children (66.4%) were habitual snorers (Snorers group) and 172 patients (33.6%) had adenotonsillectomy for indications other than snoring (Non-snorers group). Mean age of enrolled patients was 3.8 ± 1.2 ; range 2-6 years; snorers were non-significantly older than non-snorers. There were 202 (39.5%) children younger than 3 years and 310 children were older than 3 years with a non-significant difference between snorers and non-snorers as regards age categorization in relation to 3 years. There were 298 males (58.2%) and 214 females (41.8%) with significantly higher percentage of male children among snorers. Snorers had mean BMI of $23 \pm 3.2 \text{ Kg}/\text{m}^2$ that was significantly higher ($p=0.008$) compared to non-snorers ($19.9 \pm 2.4 \text{ Kg}/\text{m}^2$), (Table 2).

Mean preoperative lowest O₂Sa in non-snorers was 94.9%±0.8% while in snorers was 89.1±1.1%; snorers had significantly (Z=11.438, p<0.001) lowest O₂Sa compared to non-snorers. As regards lowest O₂Sa scoring, no patient had O₂Sa scored 4; 204 of snorers children (60%) had O₂Sa scored 3 and the other 136 of snorers children (40%) had O₂Sa scored 2, but no child had O₂Sa scored 1. On the other hand, 114 of non-snorers children (66.3%) had O₂Sa scored 1 and 58 children were scored 2. Patients' distribution among higher scoring grades showed significant difference (X²=8.653, p<0.01) in favor of non-snorers, (Table 3).

Mean PO lowest O₂Sa in snorers group was 93.3±3.8% that was significantly higher (Z=11.885, p<0.001) compared to preoperative lowest O₂Sa. However, 26 patients of snorers (7.6%) developed deterioration of their nocturnal O₂Sa and the mean of their PO lowest O₂Sa was 81.3±2.9% that was significantly lower (Z=4.467, p<0.001) compared to their preoperative lowest O₂Sa 89.4±1.1%. Preoperative O₂Sa scoring showed that 14 patients had scored 2 and 12 patients had scored 3; while postoperatively 18 patients were scored 3 and 8 patients were scored 4. Patients' distribution among scoring grades showed significant postoperative deterioration, (X²=3.962, p<0.05), (Table 4).

Three patients had developed cyanosis and low O₂Sa that required endotracheal intubation and

mechanical ventilation at pediatric ICU for 3 hours to aid to raise O₂Sa; 2 patients had moderate desaturation (O₂Sa >90%) on weaning and were extubated, but one patient re-cyanosed and maintained mechanically ventilated for 6 hours and was weaned and maintained moderate desaturation. These 3 patients passed their 1st PO night at pediatric ICU and 2nd PO day at pediatric wards until had continuously O₂Sa >94%. Another 6 patients required insertion of oro-pharyngeal airway with nostril tube oxygenation at pediatric ward for 1-hr, then airway was removed and maintained on nostril tube oxygenation allover the 1st PO night, on 2nd PO day they respired normally with O₂Sa maintained >94%. The remaining 19 patients were kept under observation with continuous O₂Sa monitoring and were discharged on the 2nd PO day (Table 5).

Using ROC curve analysis to verify studied demographic and constitutional data and preoperative lowest O₂Sa and presence of history of snoring as sensitive or specific predictors for possibility of occurrence of postoperative oxygen desaturation defined the low preoperative lowest O₂Sa and high BMI as specific predictors, while young age as sensitive predictor for postoperative oxygen desaturation. On contrary, history of snoring, male gender and body weight were non-significant predictors (Table 6, Fig. 1).

Table (2): Patients' demographic and constitutional data

		Total	Snorers	Non-snorers	Statistical analysis
Number		512 (100%)	340 (66.4%)	172 (33.6%)	
Age data	Mean±SD (years)	3.8±1.2 (2-6)	3.9±1.1	3.6±1.2	p>0.05
	<3 y (child)	202 (39.5%)	121 (35.6%)	81 (47.1%)	X ² =1.163
	>3 y (child)	310 (60.5%)	219 (64.4%)	91 (52.9%)	p>0.05
Gender data	Males	298 (58.2%)	216 (63.5%)	82 (47.7%)	X ² =3.988
	Females	214 (41.8%)	124 (36.5%)	90 (52.3%)	P<0.05
BMI data	Weight (Kg)	27.5±4.7	28.7±5.6	25.1±2.9	Z=2.073 P=0.028
	Height (cm)	111.9±8	111.8±13.2	112.1±10.9	Z=1.059 p>0.05
	BMI (Kg/m ²)	21.9±1.7	23±3.2	19.9±2.4	Z=2.738 P=0.008

Table (3): Preoperative O₂Sa data

Lowest O ₂ Sa	Data		Statistical analysis
	Snorers	Non-snorers	
Scoring: 1:2:3	Snorers	89.1±1.1%	Z=11.438
	Non-snorers	94.9%±0.8%	P<0.001
Scoring: 1:2:3	Snorers	0:136:204	X ² =8.653
	Non-snorers	114:58:0	P<0.01

Table (4): Postoperative O₂Sa data regarding snorers group

	Data		Statistical analysis
PO-O ₂ Sa	93.3 ± 3.8		Z=11.885 P<0.001
PO desaturation	Frequency	26/340 (7.6%)	
	Lowest O ₂ Sa	Preoperative	89.4±1.1%
		Postoperative	81.3±2.9%
	Scoring: 2:3:4	Preoperative	14:12:0
Postoperative		0:18:8	P<0.05

Table (5): PO management for patients developed O₂ desaturation

PO management	Number (%)
Endotracheal intubation & Mechanical ventilation	3 (11.5%)
oro-pharyngeal airway with nostril tube oxygenation	6 (23.1%)
Observation	19 (65.4%)
Total	26 (100%)

Table (6): ROC curve analysis of studied parameters as sensitive or specific predictors for postoperative O₂ desaturation

Parameter	AUC	±Std Error	Significance (p)	95% Confidence interval	Diagnostic yield
Age (years)	0.377	0.039	= 0.034	0.299-0.454	Sensitive
Male gender	0.457	0.058	>0.05	0.342-0.571	NS
History of Snoring	0.415	0.056	>0.05	0.306-0.524	NS
Body weight (Kg)	0.415	0.056	>0.05	0.306-0.524	NS
BMI (Kg/m ²)	0.630	0.051	=0.026	0.529-0.730	Specific
Preoperative lowest O ₂ Sa saturation	0.677	0.040	=0.002	0.599-0.755	Specific

Std error: standard error

NS: non-sense

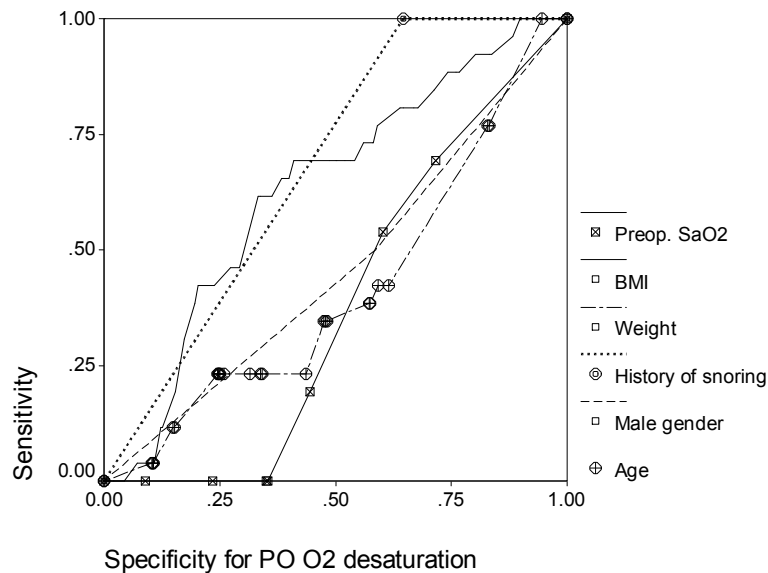


Fig. (1): ROC curve analysis of constitutional parameters and preoperative O₂Sa as predictors of PO- O₂ desaturation

4. Discussion

Tonsillectomy is one of the most common surgical procedures in the United States, with more than 530,000 procedures performed annually in children younger than 15 years. Tonsillectomy is defined as a surgical procedure performed with or without adenoidectomy that completely removes the tonsil including its capsule by dissecting the peritonsillar space between the tonsil capsule and the muscular wall. Depending on the context in which it is used, it may indicate tonsillectomy with adenoidectomy, especially in relation to sleep-disordered breathing⁽¹¹⁾.

Patients undergoing adenoidectomy for upper airway obstruction are likely to be at an increased risk of subsequent tonsillectomy when compared with those with other indication. Within this subgroup of patients with upper airway obstruction, young age, female sex, and large tonsil size may further increase the risk of subsequent tonsillectomy⁽¹²⁾.

Tonsillectomy may be performed as an outpatient procedure because post-tonsillectomy hemorrhages occur during the first few hours, and therefore are diagnosed before discharge, or occur after the sixth day. Nevertheless, not all patients are eligible for outpatient tonsillectomy, so it is mandatory to identify children who cannot be operated as outpatients because they have individual risk factors for complications unrelated to their tonsils, such as bleeding disorders or related to their tonsils, such as a history of obstructive sleep apnea due to enlarged tonsils, particularly for young children or because they do not satisfy the social criteria for discharge on the day of surgery⁽¹³⁾.

The study included 340 patients assigned for adenotonsillectomy as a therapeutic modality for associated OSAS; preoperative O₂Sa was 89.1±1.1% and was significantly improved in 314 patients (92.4%); a result pointing to the success of surgical decision and appropriateness of adenotonsillectomy as a therapeutic modality for OSAS with subsequent improvement of its related sequelae. This finding goes in hand with *Arrarte et al.*,⁽¹⁴⁾ evaluated the effect of adenotonsillectomy on oxygen saturation measured through nocturnal pulse oximetry in children with sleep disordered breathing and found adenotonsillectomy significantly improved oxygen saturation, as measured through nocturnal pulse oximetry, in children with sleep disordered breathing.

Roje et al.,⁽¹⁵⁾ reported that the most common treatment for children with sleep disordered breathing not caused by malformations or illness is surgery, in the first place-adenotonsillectomy. *de la Chaux et al.*,⁽¹⁶⁾ studied the effect of tonsillectomy in children aged 2-9 years with OSAS diagnosed by full-night polysomnography and found O₂Sa significantly

increased postoperatively compared to preoperative measures.

Also, *Smith et al.*,⁽¹⁷⁾ found adenotonsillectomy effectively improves life quality for children with OSA disorders and children after surgery have a comparable life quality as healthy children. These results indicated the minimal impact of surgical procedure on outcome and alarm that adenotonsillectomy is still the ideal for being effective and safe with minimal and predicted PO outcome and were in line with current study that reported no postoperative surgical-related complications.

The present study identified 26 patients out of 340 snorer patients assigned for adenotonsillectomy developed PO- O₂ desaturation that required oropharyngeal airway insertion with nostril tube oxygenation in 6, endotracheal intubation and mechanical ventilation in 3 and just O₂Sa monitoring in 19 patients with a total frequency of PO- O₂ desaturation of 7.6%.

Such patients were to be missed if managed on out-patient basis and may develop more complications. In support of such assumption, 3 patients developed cyanosis with low O₂Sa that required endotracheal intubation and mechanical ventilation at pediatric ICU for 3 hours to aid to raise O₂Sa; 2 patients had moderate desaturation (O₂Sa >90%) on weaning and were extubated, but one patient re-cyanosed and maintained mechanically ventilated for 6 hours and was weaned and maintained moderate desaturation.

These data spotted light on the necessity of identification of such patients preoperatively and were coincident with the guidelines of management of OSAS children defined by *The American Academy of Pediatrics*,⁽¹⁸⁾ that adenotonsillectomy is the first line of treatment for most children, and continuous positive airway pressure is an option for those who are not candidates for surgery or do not respond to surgery and high-risk patients should be monitored as inpatients postoperatively. Also, *Schechter*,⁽¹⁹⁾ documented that adenotonsillectomy is the first-line of treatment for OSAS but requires careful postoperative monitoring because of the high risk of respiratory complications.

Evaluation of constitutional data and preoperative lowest O₂Sa as predictors identified a result that the younger the snorer child, the more obese child, the more liable to develop PO- O₂ desaturation and ROC curve analysis identified both constitutional parameters as specific predictors for such liability. Preoperative lowest O₂Sa was found as a sensitive test to select those liable to PO desaturation among snorer patients.

These findings go in hand with that previously reported in literature; *Wilson et al.*,⁽²⁰⁾ found children experiencing respiratory complications were younger

and had an associated medical condition and a preoperative obstructive apnea and hypopnea index of 5 or more events per hour increased the chance of postoperative respiratory complications, as did a preoperative oxygen saturation of 80% or less increasing the probability of postoperative respiratory complications from 20 to 50%.

Elder et al.,⁽²¹⁾ tried to identify the pre- and postoperative factors that prolong length of hospital stay after tonsillectomy and adenoidectomy or tonsillectomy and adenoidectomy, and bilateral myringotomy with tube insertion under general anesthesia and found the number of episodes of oxygen desaturations contributed significantly to prolonged length of hospital stay and each episode of oxygen desaturation to <95% increased the patient's length of hospital stay by 0.5 h.

Walker et al.,⁽²²⁾ found most children with OSA significantly improved after adenotonsillectomy, but a number had persisting abnormalities for whom postoperative monitoring should be considered. *Nafiu et al.*,⁽²³⁾ found obese and overweight children were more likely to be admitted than their normal-weight children and among those admitted, BMI showed a positive correlation with length of hospital stay with significantly higher total hospital, anesthesia, postanesthesia care unit, and pharmacy and laboratory charges than normal-weight children.

It could be concluded that the presence of high BMI of young snorer children assigned for adenotonsillectomy necessitate preoperative pulse oximetry estimation of O₂Sa and those had O₂Sa <90% must be kept under observation on the 1st PO night for fear of development of PO- O₂ desaturation that showed PO frequency of 7.6% of snorers.

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