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Rate and Predictors of Postoperative Respiratory Complications Following Adenotonsillectomy in Children with Obstructive Sleep Apnea

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ABSTRACT

OBJECTIVE: This study aimed to determine the rate and risk factors of postoperative respiratory complications in children with obstructive sleep apnea (OSA) who underwent adenotonsillectomy.

METHODS: A retrospective study was conducted on the date of children with OSA who underwent adenotonsillectomy between April 2013 and July 2021. Data on demographics, medical history, tonsil grading, polysomnography parameters, and postoperative respiratory complications including cough, position, airway intervention, and desaturation were collected. Chi-square test or Fisher's exact test was performed to evaluate risk factors.

RESULTS: Seventy-one children with OSA who underwent adenotonsillectomy were included in this study. The overall rate of postoperative respiratory complications was 32/71 (45.1%) and that of minor respiratory complications was 37/52 (71.2%), including desaturation, supplement oxygen, reposition, and cough. Statistically significant association with postoperative respiratory complications was observed for obese versus non-obese ($p < 0.001$), severe apnea–hypopnea index (AHI) ($p = 0.001$), and severe lowest oxygen saturation ($p = 0.001$).

CONCLUSION: Despite the high rate of minor respiratory complications, postoperative respiratory complications are frequent after adenotonsillectomy among children with OSA. Obese versus non-obese and severity of AHI and lowest oxygen saturation are associated with postoperative respiratory complications following adenotonsillectomy.

KEYWORDS: adenotonsillectomy, obstructive sleep apnea, respiratory complication

INTRODUCTION

Obstructive sleep apnea (OSA) is a breathing sleep disorder that can affect up to 4% of children and is characterized by recurrent upper airway obstruction association intermittent nocturnal hypoxia and sleep disruption. Adenotonsillectomy (A&T) is the first line of treatment for children with OSA[1-2]. The rate of A&T postoperative respiratory complications can vary between 5.8% and 26.8% among children with OSA[3-4]. These postoperative respiratory events include cough, oxygen desaturation, laryngospasm, pneumonia, pulmonary edema, need for supplemental oxygen, apnea requiring ventilator support, and intensive care unit admission[5-6]. Under the age of 3 years, failure to thrive, obesity, and comorbidities, such as asthma, cardiac disease, neurological disease, and craniofacial syndrome, have been identified

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as high risk factors for postoperative respiratory complications following A&T in children[7-8]. Different polysomnography (PSG) criteria have been established; for example, the American Academy of Otolaryngology Head and Neck Surgery (AAO–HNS) and American Society of Anesthesiologist (ASA) have recommended overnight monitoring for children less than 3 years and those with severe OSA having apnea–hypopnea index (AHI) ≥ 10/hr and lowest oxygen saturation (LSAT) < 80%. Meanwhile, the American Academy of Pediatrics (AAP) recommended monitoring and overnight postoperative hospitalization for children with AHI ≥ 24/hr, LSAT < 80%, and PCO_2 > 60 mmHg[2, 9-10]. AAO–HNS has recommended PSG prior to A&T for children aged < 2 years or those with OSA and comorbidities. Meanwhile, AAP has recommended PSG prior to A&T for all children with OSA[2]. In this study, we aimed to evaluate the rate of postoperative respiratory complications and identify the factors associated with postoperative respiratory complications after A&T among children with OSA.

METHODS

This retrospective chart review was conducted for children aged 2 to 18 years who were diagnosed with OSA according to PSG (AHI > 1/hr) and underwent A&T between April 01, 2013 and July 31, 2021 at Vajra Hospital, Navamindrathiraj University. The study was approved by the Institutional Review Board of the Faculty of Medicine Vajira Hospital (012/2565). Children with only overnight pulse oximetry for the diagnosis of OSA and AHI < 1/hr on PSG were excluded. The criteria used for OSA diagnosis were as follows: AHI > 1/hr, further delineating the severity as mild OSA (AHI > 1–5/hr), moderate OSA (AHI > 5–10/hr), or severe OSA (AHI > 10/hr). LSAT was classified as normal (≥ 92%), mild (86%–91%), moderate (76%–85%), or severe (≤ 75%)[11].

Data were collected from the medical records and PSG results and included age, gender, weight, height, tonsil size, comorbidity condition, total AHI, mean oxyhemoglobin saturation, lowest oxyhemoglobin saturation, and respiratory complications either intraoperatively or postoperatively. Postoperative respiratory complications were divided into major respiratory complications: Intubation, apnea, pneumonia confirmed by chest X-ray, bronchospasm/laryngospasm (documented audible wheezing or use of bronchodilator and audible stridor, respectively), and minor respiratory complications (desaturation as oxygen saturation less than 95%, oxygen supplemental documented mask with bag or oxygen canular from recovery room to ward until discharge from hospital, and cough recorded by use medication or reposition).

The patients were grouped as obese or non-obese according to their weight status. Obese was defined as a median of weight-for-height > median +2 SD, including overweight and obesity. Non-obese was defined as a median of weight-for-height ≤+2 SD and ≥−2 SD[12]. Tonsils were graded from 0 to 4 by Brodsky. Medical comorbidities were categorized into respiratory conditions (e.g., asthma and allergic rhinitis), cardiovascular disease (e.g., hypertension and congenital heart disease), neurologic conditions (e.g., epilepsy and attention hyperactivity), metabolic conditions (e.g., diabetes mellitus and dyslipidemia), and miscellaneous.

PSG (Embla, USA) included electroencephalography, electro-oculography, submental and anterior tibialis electromyography, electrocardiography, oronasal airflow, thoracoabdominal movement, positions, snoring, and oxygen saturation. Sleep study was attended by a trained sleep technician. Sleep staging and respiratory scoring were interpreted by a sleep physician using the criteria defined by the American Academy of Sleep[13]. AHI was defined as the combined number of apneas and hypopneas recorded per hour of sleep. Apnea was defined as the decrease in peak signal excursions by more than 90% of the pre-event

baseline for at least two breaths. Hypopnea was defined as the decrease in peak signal excursions by more than 30% of the pre-event baseline for at least two breaths and associated with more than 3% oxygen desaturation or an electroencephalography arousal.

Descriptive statistics were described as frequencies and percentages for categorical variables and mean±standard deviation for continuous variables. The prevalence of intraoperative or postoperative respiratory complications was determined by percentage. Risk factors of respiratory complications were examined with chi-square test or Fisher's exact test to analyze the variables associated with postoperative respiratory complications following A&T in a significant level set at $p < 0.05$. All statistical analyses were performed using SPSS version 28.0 (IBM Corporation, Armonk, NY).

RESULTS

Seventy-one children with OSA (47 males and 24 females) with a mean age of 6.9 years who underwent adenotonsillectomy were included in this study. The mean of body weight and hight were 37.5±24.2 kg and 124.8±19.4 cm, respectively. Obesity was observed in 36 patients (50.7%). The comorbidity conditions were categorized into respiratory conditions (26, 36.6%), cardiovascular conditions (11, 15.5%), neurologic conditions (3, 4.2%), and metabolic conditions (6, 8.5%). The mean preoperative AHI was 13.8 events/hr. and the mean oxygen saturation was 96.6%. Thirty-two children had postoperative respiratory complications (45.1%). The overall rate of postoperative respiratory complications following A&T was 45.1%. The baseline data are summarized in Table 1.

We identified 52 respiratory complications during intraoperative or postoperative periods. Many of the children had at least one postoperative respiratory complication. Among them, 15 children had major postoperative respiratory complications (28.8%), and 37 children had minor postoperative respiratory complications (71.2%). The most common postoperative respiratory complications were as follows: Supplemental oxygen (23.1%) and

Table 1 Characteristics of the entire cohort

Characteristics	All patients (n = 71)
Gender, n (%)	
Male	47 (66.2%)
Female	24 (33.8%)
Weight status, n (%)	
Obese	36 (50.7%)
Non-obese	35 (49.3%)
Tonsil size, n (%)	
1	3 (4.2%)
2	9 (12.7%)
3	44 (62.0%)
4	15 (21.1%)
Medical comorbidities, n (%)	
Respiratory	26 (36.6%)
Cardiovascular	11 (15.5%)
Neurologic	3 (4.2%)
Metabolic	6 (8.5%)
Miscellaneous	2 (2.8%)
Polysomnographic variables, mean (SD)	
AHI (events/hr)	13.8 (12.7)
Mean oxygen saturation (%)	96.6 (1.7)
Lowest oxygen saturation (%)	81.9 (10.5)
Number patients of respiratory complication	32 (45.1%)

Abbreviations: AHI, apnea-hypopnea index; SD, standard deviation

Table 2 Prevalence of postoperative respiratory complication following adenotonsillectomy

Complication	n = 52 (%)
Major complication	15 (28.8)
Intubation	4 (7.7)
Pneumonia	1 (1.9)
Apnea	1 (1.9)
Bronchospasm/Laryngospasm	9 (17.3)
Minor complication	37 (71.2)
Desaturation	6 (11.5)
Supplement oxygen	12 (23.1)
Reposition	10 (19.2)
Cough	9 (17.3)

reposition (19.2%). The postoperative respiratory complications are shown in Table 2.

No statistically significant associations with postoperative respiratory complications were found for gender, comorbidity condition, and tonsil grading. The parameters that were significantly associated with postoperative respiratory complications were weight status, AHI severity, and LSAT. We found high rates of severe AHI and LSAT in children with postoperative respiratory complications (table 3).

Table 3 Association of parameters and postoperative respiratory complications

Factors	Complication n = 32 (%)	No complication n = 39 (%)	P-value
Gender		n = 39 (%)	0.802
Male	22 (46.8)	25 (53.2)	
Female	10 (41.7)	14 (58.3)	
Comorbid disease			0.240
Yes	21 (51.2)	20 (48.8)	
No	11 (36.7)	19 (63.3)	
Weight classified			<0.001
Obese	25 (35.2)	11 (15.5)	
Non-obese	7 (9.9)	28 (39.4)	
Tonsil grading			0.133
1	0 (0.0)	3 (4.2)	
2	4 (5.6)	5 (7.0)	
3	18 (25.4)	26 (36.6)	
4	10 (14.1)	5 (7.0)	
Severity of AHI			0.001
Mild	5 (20.8)	19 (79.2)	
Moderate	5 (33.3)	10 (66.7)	
Severe	22 (68.8)	10 (31.3)	
Severity of lowest oxygen saturation			0.001
Normal	2 (13.3)	13 (86.7)	
Mild	5 (33.3)	10 (66.7)	
Moderate	9 (42.9)	12 (57.1)	
Severe	16 (80.0)	4 (20.0)	

Abbreviations: AHI, apnea-hypopnea index

DISCUSSION

Our study shows a 45.1% overall rate of postoperative respiratory complications in children with OSA following A&T. The rates of major and minor postoperative respiratory complications were 28.8% and 71.2%, respectively. This finding is similar to the study by Rossi et al., who reported 46.4% (65/140) total postoperative respiratory complications[14]. By contrast, Caetta et al. reported a low rate (2.7%) of postoperative respiratory complications in children with OSA after A&T[15]. Another study found that the postoperative respiratory complication rate was 5.8%–26.8%[9]. Fung et al. found that the rates of major and minor complications in obese children were 20.4% and 73.5%, respectively, and those in non-obese children were 4.1% and 24.5%, respectively[16]. Hill et al. found that the rates of major and minor postoperative complications among children with severe OSA were 4.8% and 19.3%, respectively[17]. This difference may be due to the use of different criteria to describe major and minor postoperative complications.

Known risk factors for postoperative respiratory complications among children with OSA after A&T include young age (aged <3 years)

and medical comorbidities such as cardiac disease, craniofacial disorder, genetic disease, and neurological disease[2,4,7,9,18]. Previous studies showed that obesity/overweight or under weight was associated with postoperative respiratory complication[19-21]. Other researchers reported that obesity was not a risk factor of respiratory complications[18,22]. In the current work, an association with respiratory complications was observed for weight status (obese and non-obese) but not for gender, tonsil size, and medical comorbidity.

PSG parameters may be a risk factor for postoperative respiratory complications. An association with postoperative respiratory complications was observed for the severity of AHI and LSAT. Similar to our study, Jarysak et al. found that AHI and LSAT were risk factors of respiratory complications[19]. In contrast to the current findings, Konstantinopoulou et al. revealed that LSAT was not a predictive factor of adverse respiratory events[23].

Some guidelines have been established regarding postoperative care following A&T in children with OSA. AAO–HNS has recommended overnight monitoring for children less than 3 years and those with severe OSA including AHI ≥ 10 /hr and oxygen saturation nadir < 80%; meanwhile, healthy children with suspected OSA do not require preoperative PSG.[9] AAP has recommended monitoring and overnight postoperative hospitalization for children with AHI ≥ 24/hr, LSAT < 80%, or PCO_2 > 60 mmHg[2]. PSG is the gold standard for diagnosis OSA; nevertheless, it is expensive, has a long waiting list, and lacks PCO_2 measurements. An overnight pulse oximetry, which is used as a screening tool for OSA severity prior to A&T, should be used for healthy children suspected with OSA[24].

This study was limited by its retrospective design and single institution data collection. Bias might have aroused in selecting children with comorbidity condition for sleep study according to AAO–HNS guidelines. Despite the small sample size, this study reached statistically significant difference. Future studies with large population and multivariate analysis will show great difference.

CONCLUSION

The rate of postoperative respiratory complications among children with OSA after A&T is 45.1%. The majority of these respiratory complications are minor. Our study demonstrated the association of obese, AHI and LSAT severity with postoperative respiratory complications. Further studies should focus on postoperative respiratory complications and the use of overnight pulse oximetry among healthy children suspected with OSA requiring A&T.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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None

DATA AVAILABILITY STATEMENT

All data generated or analysed during this study are included in this article. Further enquiries can be directed to the corresponding author.

REFERENCES

1. Lumeng JC, Chervin RD. Epidemiology of pediatric obstructive sleep apnea. Proc Am Thorac Soc 2008;5(2):242-52.
2. Marcus CL, Brooks LJ, Draper KA, Gozal D, Halbower AC, Jones J, et al. Diagnosis and management of childhood obstructive sleep apnea syndrome. Pediatrics 2012;130(3):e714-55.
3. Keamy DG, Chhabra KR, Hartnick CJ. Predictors of complications following adenotonsillectomy in children with severe obstructive sleep apnea. Int J Pediatr Otorhinolaryngol 2015;79(11):1838-41.
4. Saur JS, Brietzke SE. Polysomnography results versus clinical factors to predict post-operative respiratory complications following pediatric

adenotonsillectomy. Int J Pediatr Otorhinolaryngol 2017;98:136-42.
5. Brigger MT, Brietzke SE. Outpatient tonsillectomy in children: a systematic review. Otolaryngol Head Neck Surg 2006;135(1):1-7.
6. Pratt LW, Gallagher RA. Tonsillectomy and adenoidectomy: incidence and mortality, 1968-1972. Otolaryngol Head Neck Surg (1979) 1979;87(2):159-66.
7. McColley SA, April MM, Carroll JL, Naclerio RM, Loughlin GM. Respiratory compromise after adenotonsillectomy in children with obstructive sleep apnea. Arch Otolaryngol Head Neck Surg 1992;118(9):940-3.
8. Thongyam A, Marcus CL, Lockman JL, Cornaglia MA, Caroff A, Gallagher PR, et al. Predictors of perioperative complications in higher risk children after adenotonsillectomy for obstructive sleep apnea: a prospective study. Otolaryngol Head Neck Surg 2014;151(6):1046-54.
9. Mitchell RB, Archer SM, Ishman SL, Rosenfeld RM, Coles S, Finestone SA, et al. Clinical practice guideline: tonsillectomy in children (update). Otolaryngol Head Neck Surg 2019;160(1 suppl):S1-42.
10. Practice guidelines for the perioperative management of patients with obstructive sleep apnea: an updated report by the American Society of Anesthesiologists task force on perioperative management of patients with obstructive sleep apnea. Anesthesiology 2014;120(2):268-86.
11. Katz ES, Marcus CL. Diagnosis of obstructive sleep apnea syndrome in infant and children. Principles and practice of pediatric sleep medicine. Philadelphia: Elsevier Saunders; 2005. p.197-210.
12. Salepun S, Srisura W, Sukjai S, Kongkajun S, Ladwilai N. Know your weight and height [Internet]. 2020 [cited 2022 Feb 18]. Available from: https://nutrition2.anamai.moph.go.th
13. Berry RB, Budhiraja R, Gottlieb DJ, Gozal D, Iber C, Kapur VK, et al. Rules for scoring respiratory events in sleep: update of the 2007 AASM manual for the scoring of sleep and associated events. Deliberations of the sleep apnea definitions task force of the American Academy of Sleep Medicine. J Clin Sleep Med 2012;8(5):597-619.
14. Rossi NA, Spaude J, Ohlstein JF, Pine HS, Daram S, McKinnon BJ, et al. Apnea-hypopnea index severity as an independent predictor of post-tonsillectomy respiratory complications in pediatric patients: a retrospective study. Ear Nose Throat J 2021:1455613211059468.
15. Caetta A, Timashpolsky A, Tominaga SM, D'Souza N, Goldstein NA. Postoperative respiratory complications after adenotonsillectomy in children with obstructive sleep apnea. Int J Pediatr Otorhinolaryngol 2021;148:110835.
16. Fung E, Cave D, Witmans M, Gan K, El-Hakim H. Postoperative respiratory complications and recovery in obese children following adenotonsillectomy for sleep-disordered breathing: a case-control study. Otolaryngol Head Neck Surg 2010;142(6):898-905.
17. Hill CA, Litvak A, Canapari C, Cummings B, Collins C, Keamy DG, et al. A pilot study to identify pre- and peri-operative risk factors for airway complications following adenotonsillectomy for treatment of severe pediatric OSA. Int J Pediatr Otorhinolaryngol 2011;75(11):1385-90.
18. Katz SL, Monsour A, Barrowman N, Hoey L, Bromwich M, Momoli F, et al. Predictors of postoperative respiratory complications in children undergoing adenotonsillectomy. J Clin Sleep Med 2020;16(1):41-8.
19. Jaryszak EM, Shah RK, Vanison CC, Lander L, Choi SS. Polysomnographic variables predictive of adverse respiratory events after pediatric adenotonsillectomy. Arch Otolaryngol Head Neck Surg 2011;137(1):15-8.
20. Nafiu OO, Green GE, Walton S, Morris M, Reddy S, Tremper KK. Obesity and risk of peri-operative complications in children presenting for adenotonsillectomy. Int J Pediatr

Otorhinolaryngol 2009;73(1):89-95.
21. Tweedie DJ, Bajaj Y, Ifeacho SN, Jonas NE, Jephson CG, Cochrane LA, et al. Peri-operative complications after adenotonsillectomy in a UK pediatric tertiary referral centre. Int J Pediatr Otorhinolaryngol 2012;76(6):809-15.
22. Kasle D, Virbalas J, Bent JP, Cheng J. Tonsillectomies and respiratory complications in children: a look at pre-op polysomnography risk factors and post-op admissions. Int J Pediatr Otorhinolaryngol 2016;88:224-7.
23. Konstantinopoulou S, Gallagher P, Elden L, Garetz SL, Mitchell RB, Redline S, et al. Complications of adenotonsillectomy for obstructive sleep apnea in school-aged children. Int J Pediatr Otorhinolaryngol 2015;79(2):240-5.
24. Nixon GM, Kermack AS, Davis GM, Manoukian JJ, Brown KA, Brouillette RT. Planning adenotonsillectomy in children with obstructive sleep apnea: the role of overnight oximetry. Pediatrics 2004;113(1 Pt 1):e19-25.