Long-term Impact of Adenotonsillectomy on the Quality of Life of Children with Sleep-disordered breathing

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Introduction

Sleep-disordered breathing (SDB) affects from 7 to 17% of the pediatric population, and the symptoms range from primary snoring to obstructive sleep apnea (OSA).1,2 The nocturnal symptoms related to SDB are snoring, witnessed apnea, salivary restlessness, restless sleep, and enuresis. The daytime symptoms are hyperactivity, attention deficit disorder, daytime naps,

Abstract

Introduction Adenotonsillectomy is the first-line treatment for obstructive sleep apnea secondary to adenotonsillar hypertrophy in children. The physical benefits of this surgery are well known as well as its impact on the quality of life (QoL), mainly according to short-term evaluations. However, the long-term effects of this surgery are still unclear.

Objective To evaluate the long-term impact of adenotonsillectomy on the QoL of children with sleep-disordered breathing (SDB).

Method This was a prospective non-controlled study. Children between 3 and 13 years of age with symptoms of SDB for whom adenotonsillectomy had been indicated were included. Children with comorbidities were excluded. Quality of life was evaluated using the obstructive sleep apnea questionnaire (OSA-18), which was completed prior to, 10 days, 6 months, 12 months and, at least, 18 months after the procedure. For statistical analysis, p-values lower than 0.05 were defined as statistically significant.

Results A total of 31 patients were enrolled in the study. The average age was 5.2 years, and 16 patients were male. The OSA-18 scores improved after the procedure in all domains, and this result was maintained until the last evaluation, done 22 ± 3 months after the procedure. Improvement in each domain was not superior to achieved in other domains. No correlation was found between tonsil or adenoid size and OSA-18 scores.

Conclusion This is the largest prospective study that evaluated the long-term effects of the surgery on the QoL of children with SDB using the OSA-18. Our results show adenotonsillectomy has a positive impact in children’s QoL.

Keywords

► sleep-disordered breathing
► quality of life
► tonsillectomy
► adenoidectomy
► OSA-18
► child

Introduction

Sleep-disordered breathing (SDB) affects from 7 to 17% of the pediatric population, and the symptoms range from primary snoring to obstructive sleep apnea (OSA).1,2 The nocturnal symptoms related to SDB are snoring, witnessed apnea, salivary restlessness, restless sleep, and enuresis. The daytime symptoms are hyperactivity, attention deficit disorder, daytime naps,
excessive daytime sleepiness, behavioral disorders (including aggressivity, anxiety, and depression). Physical impact is also described, including muscular and skeletal changes. Untreated disease is believed to affect emotion, cognitive function, and neurobehavior of both children and family members that may contribute to a poor quality of life (QoL).2,3

Treatment of SDB is associated with an increase in health care utilization and cost. Children with SDB, as compared with controls, have a significantly higher rate of antibiotic use, 40% more hospital visits, and an overall elevation of 215% in health care usage, mostly from increased respiratory tract infections.4–7 Failure to thrive is reported in 27 to 62% of pediatric OSA cases, and up to 40% of children with SDB exhibit behavioral problems.8

Though SDB is a common condition with a high impact on physical, developmental, cognitive, and behavior aspects in childhood, data from pediatric knowledge, training and abilities on treating children with SDB shows there is a lack of knowledge and misinformation about this subject.9 One study that evaluated 112 pediatricians demonstrated that the majority of them (62%) consider that information about SDB during medical school and residency are scarce, albeit children with SDB are frequently attended at the pediatric office.10

Adenotonsillectomy (AT) is the first line of treatment for OSA secondary to adenotonsilar hypertrophy in children.2 Data, in 1993, from the National Hospital Discharge Survey noted a decrease of 0.50% in inpatient tonsillectomy rates from 1977 to 1989,11 and similar reports from 1978 to 1986 showed that the rate of tonsillectomy for treatment of throat infections declined; however, the frequency of SDB as the primary indication for the procedure increased, especially in children under 3 years of age.12 Although the current indication for ATs well established in literature, misconceptions about the surgery concerning to risks, benefits and impact on the immunological system are still present and lead some pediatricians to discourage the caregivers to accept AT. This is a secure surgery, and published data reported mortality rates for tonsillectomy from 1 per 2,360 (in inpatient settings) to 1 per 56,000 patients.13–15 Previous studies show there would, therefore, appear to be a therapeutic advantage to removing recurrently diseased tonsils because they are no longer able to function adequately in local protection. However, some studies demonstrate minor alterations of immunoglobulin concentrations in the serum and adjacent tissues following tonsillectomy.16,17 Nevertheless, there are no studies to date that demonstrate a significant clinical negative impact of tonsillectomy on the immune system.

The gold standard for the diagnosis of OSA is a polysomnography (PSG). However, PSG is expensive, requires time and a trained professional, and is often unavailable at many institutions where children with SDB are treated.2,18 Therefore, most cases of SDB are treated based on clinical assessments and physical exams, with no objective testing. Albeit it may not be an ideal situation, children without comorbidities may be treated without PSG.19,20 Though PSG is ideal for evaluating the presence and severity of apneas, it fails to measure the impact of SDB on children’s QoL in general, as well as in terms of its effect on behavior and emotion.19,21 Because of this, the use of questionnaires to evaluate QoL has become popular in recent years.22–24

Recent articles have evaluated the impact of surgery on QoL among children with SDB through questionnaires on physical, emotional, behavioral, and familial factors.3,21,25–27 There are different methods for evaluating postadenotonsillectomy QoL among children, and the obstructive sleep apnea questionnaire (OSA-18) is one of the most frequently used questionnaires worldwide. It has been validated in a variety of languages.28–31 Most of the studies evaluated children for 6 months or less and rarely the patients were reassessed over 1 year after AT.19,32–34

**Objective**

The present study aimed to describe the QoL in children with SDB and the long-term impact of AT on this disease.

**Method**

This was a prospective, non-controlled study that was approved by the research ethics committee of the institution (decision no. 1.429.954).

This study included patients between 3 and 13 years of age, of both genders, in ASA classes 1 and 2 who were treated in the otorhinolaryngology department between January 2017 and January 2018 and whose symptoms included snoring, witnessed apneas, noisy breathing, mouth breathing, and restless sleep. All of the patients were treated by the same pediatric otorhinolaryngologist. Patients with symptoms consistent with rhinitis were treated using nasal corticosteroids and/or antihistamines, as recommended for 3 months, and were then reevaluated.35 Once the child presented complete recovery of the symptoms after clinical treatment, surgery was discarded. Tonsil size was evaluated using the Brodsky grading scale.36 Adenoid size (in percentage of obstruction) was calculated through the skull lateral-view X-ray.37

The children were weighed and measured by the principal investigator. Patients with overweight, obesity, underweight, craniofacial malformations, genetic syndromes, neuromuscular diseases, or developmental delays were excluded, as were patients who required a concomitant procedure (including inferior turbinate surgery).

The patients selected for surgery were informed of the study and were officially included once the guardians signed the informed consent form, and the children signed the informed consent form when possible. The OSA-18 was administered by the hospital social worker 1 week before, and then again 10 days, 6 months, and 12 months after the procedure; another assessment was done in July 2019. The first two assessments were in person, and the other evaluations were made by phone.

The OSA-18 is a validated questionnaire that contains 18 questions divided into 5 domains: sleep disturbance, physical suffering, emotional suffering, daytime problems, and caregiver concerns. Each domain receives a score from 1 to 7; higher
scores reflect a worse QoL. Total scores lower than 60 suggest that the sleep disorder has little impact on QoL; scores between 60 and 80 indicate a moderate impact, and scores above 80 reflect a high negative impact of the sleep disorder on QoL.

The statistical analyses were performed using the IBM SPSS software version 22.0 (IBM Corp., Armonk, NY, USA). The normality of the samples was evaluated using the Kolmogorov-Smirnov test, which allowed for the use of parametric tests in the data analysis. The Chi-squared test and analysis of variance (ANOVA) were used to evaluate the data, and p-values lower than 0.05 were considered statistically significant.

Results

Fifty-one patients were evaluated, out of whom 8 were excluded because they presented complete recovery of the symptoms after treating rhinitis. From the 43 children initially included in the study, only 31 completed all phases of research. The average age was 5.1 ± 2.9 years, and 16 (51%) of the patients were male. The demographic data and clinical characteristics of the patients are described in Table 1.

The mean preoperative OSA-18 scores were 79.9 ± 12. The scores of all the evaluated patients improved after surgery (p < 0.05), with mean reduction of 40 ± 8 in the first postoperative evaluation (10 days after surgery). Mean total OSA-18 score after surgery remained under 37 in all assessments. The last evaluation, done in 2018 July, was done 22 ± 3 months after surgery (see Table 2). None of the patients presented increased values of OSA-18 scores after surgery, neither in total scores nor in each domain separately.

The reduction in the OSA-18 scores was not different between one domain in relation to another (p > 0.05). Both male and female experienced improvement of OSA scores before and after the surgery, without gender effect (Fig. 1).

Tonsil size and adenoid size were correlated with OSA-18 scores before surgery. No correlation was found between questionnaire scores and the degree of tonsil size, as detailed in Table 3.
Table 4 Correlation between tonsil and adenoid size and total obstructive sleep apnea questionnaire score

| Tonsil size | Corr (r) | p-value* |
|-------------|----------|----------|
|             | 17.2%    | 0.95     |
| Adenoid size| 28.1%    | 0.02     |

*pPearson correlation.

in Table 4. A correlation was found between adenoid size and OSA-18 scores (p = 0.02), but it was a weak correlation that may be discharged.

Discussion

The present study had described the characteristic of pediatric SDB and long-term impact of AT on the QoL in an adequate and objective manner.

Preoperatively, only a small percentage of patients presented with symptoms related to emotional, behavior, and diurnal complaints. All participants were referred for snoring, and the majority of them for nocturnal symptoms. Previous studies had demonstrated that snoring and sleep disturbances are the hallmarks for pediatric SDB. Only a small portion of pediatric SDB presented with emotional and diurnal disorders. This characteristic is recognized as one of the significant differences between adult and pediatric SDB.

Sleep-disordered breathing can negatively affect children’s memory and attention levels, likely because of hypoxia, which is also considered to be responsible for daytime symptoms such as irritability, aggression, and hyperactivity. Furthermore, SDB is associated with enuresis, metabolic problems, and with an increased risk of metabolic and cardiovascular abnormalities, decreasing children’s QoL.

It is important to evaluate children’s QoL because it reflects individual sentiments toward physical, emotional, and social factors in their life and how these factors relate to their health. The OSA-18 is an evaluative, discriminative, and validated instrument to assess QoL in children with SDB, and it is the most widely used evaluation tool worldwide.

An analysis of the literature revealed that AT is the treatment of choice for children with SDB caused by adenotonsillar hypertrophy. As a result, most of the studies that evaluate QoL in this group of patients do not have a control group. Studies that compare the surgery to watchful waiting have shown that children who undergo AT exhibit a significant improvement in QoL when compared with children in the watchful waiting control group. Our study found a significant improvement in all of the domains assessed by the OSA-18, similarly to the results found in other studies. This improvement can be measured not only by the numerical decrease in the scores for each domain of the OSA-18, but also through the changes from total scores reflecting high or moderate impacts on QoL (scores above 60) to total scores reflecting low impact on QoL, which occurred in the current study and in prior research. Our finding that this outcome is maintained for at least 6 months is consistent with other reports in the literature. Long-term follow-up studies after AT can be difficult to be performed, since most patients do not need further medical evaluation after improvement of the symptoms is observed. This is especially noticeable in children without comorbidities, since the surgical success...
rate in this group is high. Only 2 studies that evaluated QoL evaluated children for more than 1 year after AT, and one of them was prospective. The present study followed the children for 24 months after the procedure. 33, 46 This is the largest prospective study that evaluated the long-term effects of the surgery on the QoL of children with SDB using the OSA-18. Some studies describe reappearance of symptoms during the follow-up, mainly in females with normal weight and older than 6 years, which was attributed to an incomplete therapeutic response and due to a change the parental perception of the symptoms. 32, 44 In our study, none of the patients presented worsening of the OSA-18 values after surgery. Although allergic rhinitis is considered a risk factor for AT failure, it was not found in our study.

Tonsil and adenoid sizes are a reason for concern not only for caregivers, but also for many physicians who are involved in these patients’ care. Some studies have found that there is an association between tonsil size and OSA as well as between tonsil size and PSG findings, but most of these studies have low levels of evidence. 47 Well-designed studies have shown, as our study found, that tonsil and adenoid size is not correlated with either SDB severity or patient QoL. 10, 12, 13, 19, 50

Our study did not find differences between OSA-18 scores and gender, which is similar to the findings of other studies. The analysis of previous studies that found a higher prevalence of OSA in males shows that it is probably influenced by age, once this difference was found only in older boys. It could be explained by hormonal changes due to puberty, because OSA is more prevalent in male adults. 49, 50 Since our study group was limited to 13-year-old patients, they probably were not under hormonal effects yet.

One advantage of our study is that all steps were performed by a single team during a long-term follow-up. But there are some limitations, including the fact that many caregivers believe that surgery is the best treatment for the child, particularly after agreeing to surgery under general anesthesia. This belief may influence caregivers’ answers in the postoperative period. 32, 51 Another limitation of this study is the lack of the preoperative PSG. This exam is the gold standard in evaluating children with SDB and is particularly useful for children without comorbidities. However, the difficulty in implementing this exam on a large scale leads to use other exams or clinical evaluation alone to diagnose and treat these patients. 30, 32, 53

Finally, considering that SDB is a prevalent condition, a large, diverse subject population must be surveyed to determine whether AT leads to improvement in the QoL of children.

Conclusion

This study concludes that SDB in children leads to a poor QoL and that AT improvement remains for at least 22 months after the surgery. The positive impact of surgery occurs both in nocturnal and daytime symptoms. Since pediatricians are the medical professionals with the greatest contact with children with SDB, their knowledge of the subject is fundamental to these patients’ care.

References

1. Ali NJ, Pitson DJ, Stradling JR. Snoring, sleep disturbance, and behaviour in 4–5 year olds. Arch Dis Child 1993;68(03):360–366
2. Ehsan Z, Ishman SL. Pediatric Obstructive Sleep Apnea. Otolaryngol Clin North Am 2016;49(06):1449–1464
3. de Serres LM, Derkay C, Astley S, Deyo RA, Rosenfeld RM, Gates GA. Measuring quality of life in children with obstructive sleep disorders. Arch Otolaryngol Head Neck Surg 2000;126(12):1423–1429
4. Tarasiuk A, Greenberg-Dotan S, Simon-Tuval T, et al. Elevated morbidity and health care use in children with obstructive sleep apnea syndrome. Am J Respir Crit Care Med 2007;175(01):55–61
5. Goldstein NA, Fatima M, Campbell TF, Rosenfeld RM. Child behavior and quality of life before and after tonsillectomy and adenoidectomy. Arch Otolaryngol Head Neck Surg 2002;128(07):770–775
6. Basha S, Bialowas C, Ende K, Szeremeta W. Effectiveness of adenotonsillectomy in the resolution of nocturnal enuresis secondary to obstructive sleep apnea. Laryngoscope 2005;115(06):1101–1103
7. Garetz SL, Mitchell RB, Parker PD, et al. Quality of life and obstructive sleep apnea symptoms after pediatric adenotonsillectomy. Pediatrics 2015;135(02):e477–e486
8. Tan HL, Alonso Alvarez ML, Tsaoussoglou M, Weber S, Kaditis AG. When and why to treat the child who snores? Pediatr Pulmonol 2017;52(03):399–412
9. Tamay Z, Akcay A, Kilic G, Suleyman A, Ones U, Guler N. Are physicians aware of obstructive sleep apnea in children? Sleep Med 2006;7(07):580–584
10. Balbani APS, Weber SAT, Montovani JC, Carvalho LR. Pediatras e os distúrbios respiratórios do sono na criança. Rev Assoc Med Bras (1992) 2005;51(02):80–86
11. Derkay CS. Pediatric otolaryngology procedures in the United States: 1977–1987. Int J Pediatr Otorhinolaryngol 1993;25(1-3):1–12
12. Patel HH, Straight CE, Lehman EB, Tanner M, Carr MM. Indications for tonsillectomy: a 10 year retrospective review. Int J Pediatr Otorhinolaryngol 2014;78(12):2151–2155
13. Randall DA, Hoffer ME. Complications of tonsillectomy and adenoidectomy. Otolaryngol Head Neck Surg 1998;118(01):61–68
14. Shay S, Shapiro NL, Bhattacharyya N. Revisit rates and diagnoses following pediatric tonsillectomy in a large multisite population. Laryngoscope 2015;125(02):457–461
15. Allareddy V, Martinez-Schlurmann N, Rampa S, et al. Predictors of Complications of Tonsillectomy With or Without Adenoidectomy in Hospitalized Children and Adolescents in the United States, 2001-2010: A Population-Based Study. Clin Pediatr (Phila) 2016;55(07):593–602
16. Paulussen C, Claes J, Claes G, Joissen M. Adenoids and tonsils, indications for surgery and immunological consequences of surgery. Acta Otorhinolaryngol Belg 2000;54(03):403–408
17. Kaygusuz I, Gödekmerdan A, Karlidag T, et al. Early stage impacts of tonsillectomy on immune functions of children. Int J Pediatr Otorhinolaryngol 2003;67(12):1311–1315
18. Section on Pediatric Pulmonology, Subcommittee on Obstructive Sleep Apnea Syndrome. American Academy of Pediatrics. Clinical practice guideline: diagnosis and management of childhood obstructive sleep apnea syndrome. Pediatrics 2002;109(04):704–712
19. Baldassari CM, Mitchell RB, Schubert C, Rudnick EF. Pediatric obstructive sleep apnea and quality of life: a meta-analysis. Otolaryngol Head Neck Surg 2008;138(03):265–273
20. Friedman NR. Polysomnography should not be required both before and after adenotonsillectomy for childhood sleep disordered breathing. J Clin Sleep Med 2007;3(07):678–680
128 Long-term Impact of Adenotonsillectomy on the Quality of Life in Children Caixeta et al.

21 Stewart MG, Friedman EM, Sulek M, et al. Quality of life and health status in pediatric tonsil and adenoid disease. Arch Otolaryngol Head Neck Surg 2000;126(01):45–48

22 Varni JW, Burwinkle TM, Seid M, Skarr D. The PedsQL 4.0 as a pediatric population health measure: feasibility, reliability, and validity. Ambul Pediatr 2003;3(06):329–341

23 Escarrá F, Vidaurreta SM. Assessment of quality of life before and after an adenotonsillectomy among children with hypertrophic tonsils and/or adenoids. Arch Argent Pediatr 2015;113(01):21–27

24 Bergeron M, Duggins AL, Cohen AP, Ishman SL. Comparison of Patient- and Parent-Reported Quality of Life for Patients Treated for Persistent Obstructive Sleep Apnea. Otolaryngol Head Neck Surg 2018;159(04):789–795

25 Franco RA Jr, Rosenfeld RM, Rao M. First place-resident clinical science award 1999. Quality of life for children with obstructive sleep apnea. Otolaryngol Head Neck Surg 2000;123(1 Pt):9–16

26 Soh HJ, Rowe K, Davey MJ, Horne RSC, Nixon GM. The OSA-5: Development and validation of a brief questionnaire screening tool for obstructive sleep apnea in children. Int J Pediatr Otorhinolaryngol 2018;113:62–66

27 Redline S, Amin R, Beebe D, et al. The Childhood Adenotonsillectomy Trial (CHAT): rationale, design, and challenges of a randomized controlled trial evaluating a standard surgical procedure in a pediatric population. Sleep (Basel) 2011;34(11):1509–1517

28 Huang YS, Hwang FM, Lin CH, Lee LA, Huang PY, Chiu ST. Clinical manifestations of pediatric obstructive sleep apnea syndrome: Clinical utility of the Chinese-version Obstructive Sleep Apnea Questionnaire-18. Psychiatry Clin Neurosci 2015;69(12):752–762

29 Mousailidis GK, Lachanas VA, Skoulakis CE, et al. Cross-cultural adaptation and validation of the Greek OSA-18 questionnaire in children undergoing polysomnography. Int J Pediatr Otorhinolaryngol 2014;78(12):2097–2102

30 Fernandes FM, Teles RdaC. Application of the Portuguese version of the Obstructive Sleep Apnea-18 survey to children. Rev Bras Otorrinolaringol (Engl Ed) 2013;79(06):720–726

31 Todd CA, Bareiss AK, McCoul ED, Rodriguez KH. Adenotonsillectomy for Obstructive Sleep Apnea and Quality of Life: Systematic Review and Meta-analysis. Otolaryngol Head Neck Surg 2017;157(05):767–773

32 Torretta S, Rosazza C, Pace ME, Iofrida E, Marchisio P. Impact of adenotonsillectomy on pediatric quality of life: review of the literature. Ital J Pediatr 2017;43(01):107

33 Ye J, Liu H, Zhang GH, et al. Outcome of adenotonsillectomy for obstructive sleep apnea syndrome in children. Ann Otol Rhinol Laryngol 2010;119(08):506–513

34 Jeon YJ, Song JJ, Ahn JC, et al. Immediate and Sustained Improvement in Behavior and Life Quality by Adenotonsillectomy in Children With Sleep-Disordered Breathing. Clin Exp Otorhinolaryngol 2016;9(02):136–142

35 Bouquet J, Arnavillelle S, Bedbrook A, et al; MASK study group. MASK 2017: ARIA digitally-enabled, integrated, person-centred care for rhinitis and asthma multimorbidity using real-world evidence. Clin Transl Allergy 2018;8:45

36 Brodsky L. Modern assessment of tonsils and adenoids. Pediatr Clin North Am 1989;36(06):1551–1569

37 Feres MF, Hermann JS, Sallum AC, Pignatari SS. Radiographic adenoid evaluation: proposal of an objective parameter. Radiol Bras 2014;47(02):79–83

38 Othman MN, Bee See G, Abdul Latif H. Impact of adenotonsillectomy on the quality of life in children with sleep disordered breathing. Int J Pediatr Otorhinolaryngol 2016;91:105–107

39 Ikeda FH, Horta PA, Bruscatto WL, Dolci JE. Intellectual and school performance evaluation of children submitted to tonsillectomy and adenotonsillectomy before and after surgery. Rev Bras Otorrinolaringol (Engl Ed) 2012;78(04):17–23

40 Feng HW, Jiang T, Zhang HP, et al. Comparisons of thyroid hormone, intelligence, attention, and quality of life in children with obstructive sleep apnea hypopnea syndrome before and after endoscopic adenoidectomy. BioMed Res Int 2015;2015:523716

41 Baugh RF, Archer SM, Mitchell RB, et al; American Academy of Otolaryngology-Head and Neck Surgery Foundation. Clinical practice guideline: tonsillectomy in children. Otolaryngol Head Neck Surg 2011;144(01):51–530

42 Volsky PG, Woughter MA, Beydoun HA, Derkay CS, Baldassari CM. Adenotonsillectomy vs observation for management of mild obstructive sleep apnea in children. Otolaryngol Head Neck Surg 2014;150(01):126–132

43 Lee CH, Kang KT, Weng WC, Lee PL, Hsu WC. Quality of life after adenotonsillectomy for children with sleep-disordered breathing: a linear mixed model analysis. Int J Pediatr Otorhinolaryngol 2014;78(08):1374–1380

44 Lee CH, Kang KT, Weng WC, Lee PL, Hsu WC. Quality of life after adenotonsillectomy in children with obstructive sleep apnea: short-term and long-term results. Int J Pediatr Otorhinolaryngol 2015;79(02):210–215

45 Randhawa PS, Cetto R, Chilvers G, Georgalas C, Narula AA. Long-term quality-of-life outcomes in children undergoing adenotonsillectomy for obstructive sleep apnoea: a longitudinal study. Clin Otolaryngol 2011;36(05):475–481

46 Song IS, Hong SN, Joo JW, et al. Long-term results of sleep-related quality-of-life and behavioral problems after adenotonsillectomy. Laryngoscope 2020;130(02):546–550

47 Nolan J, Brietzke SE. Systematic review of pediatric tonsil size and polysomnogram-measured obstructive sleep apnea severity. Otolaryngol Head Neck Surg 2011;144(06):844–850

48 Sohn H, Rosenfeld RM. Evaluation of sleep-disordered breathing in children. Otolaryngol Head Neck Surg 2003;128(03):344–352

49 Inoshita A, Kasai T, Matsuoka R, et al. Age-stratified sex differences in polysomnographic findings and pharyngeal morphology among children with obstructive sleep apnea. J Thorac Dis 2018;10(02):6702–6710

50 Chan CH, Wong BM, Tang JI, Ng DK. Gender difference in snoring and how it changes with age: systematic review and meta-regression. Sleep Breath 2012;16(04):977–986

51 Hopkins C, Almeyda R, Alreefy H, et al. Multicentre prospective clinical application of the T14 paediatric outcome tool. J Laryngol Otol 2015;129(10):980–985

52 Ernst H, Dzioba A, Glicksman J, Paradis J, Rotenberg B, Strychowsky J. Evaluating the impact of adenotonsillectomy for pediatric sleep-disordered breathing on parental sleep. Laryngoscope 2019