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What is This?
Discrepancy between Objective and Subjective Outcomes after Adenotonsillectomy in Children with Obstructive Sleep Apnea Syndrome

Kun-Tai Kang, MD1,2,3, Wen-Chin Weng, MD4,5, Chia-Hsuan Lee, MD3,6, Pei-Lin Lee, MD5,7, and Wei-Chung Hsu, MD, PhD1,5

Abstract

Objective. Adenotonsillectomy (T&A) is the first line therapy for pediatric obstructive sleep apnea (OSA); however, inconsistency between objective and subjective outcomes perplexes physicians. This study investigates changes of objective and subjective outcomes in children with OSA after T&A, in particular, to elucidate correlations and discrepancies between these 2 measures.

Study Design. Case series with record review.

Setting. Tertiary referral medical center.

Subjects and Methods. Symptomatic children with polysomnographic diagnosis of OSA (apnea-hypopnea index [AHI] > 1) were included. All children underwent T&A to treat OSA, along with completely objective (polysomnography) and subjective (Obstructive Sleep Apnea 18-Item Quality-of-Life Questionnaire [OSA-18]) measures before and 3 months after surgery.

Results. One hundred nineteen children were included (mean age, 6.9 ± 3.3 years; 76% boys). Adenotonsillectomy significantly reduced AHI from 15.4 ± 21.2 per hour to 1.6 ± 2.5 per hour (P < .001). The OSA-18 scores were significantly improved after surgery (P < .001). A weak but statistically significant positive correlation was found between AHI and OSA-18 scores preoperatively ( r = 0.22, P = .016) but not postoperatively ( r = 0.04, P = .677). Among those cases with residual OSA after surgery, only 6% (3/54) had a residual effect on quality of life (OSA-18 score > 60).

Conclusion. Adenotonsillectomy improves both objective and subjective outcomes. After surgery, quality of life significantly improved subjectively, despite an incomplete resolution of OSA objectively, leading to a better correlation between objective and subjective measures before as opposed to after surgery. Discrepancy between the 2 measures warrants an evaluation of a child both objectively and subjectively when treating OSA.

Keywords

adenoidectomy, adenotonsillectomy, child, quality of life, sleep apnea syndromes, polysomnography, tonsillectomy

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Introduction

Obstructive sleep apnea (OSA) in children is a respiratory disorder characterized by upper airway collapse during sleep,1 in association with adverse cardiovascular,2 neurocognitive,3 and somatic growth consequences.4 Obstructive sleep apnea in children is mainly due to enlarged tonsils and adenoids that obstruct the upper airway.1 Removing tonsils and adenoids (adenotonsillectomy [T&A]) is, therefore, the first-line therapy for pediatric OSA worldwide.5-7

Outcomes of T&A for treating childhood OSA can be evaluated either objectively by a sleep study8 or subjectively by self-reported questionnaires.9 Polysomnography (PSG), the gold standard for diagnosis of OSA,8 is a comprehensive and reliable tool for objectively quantifying outcomes after

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Children with OSA showed a significant decrease in their apnea-hypopnea index (AHI) in PSG studies after surgery, with a success rate ranging from 59.8% to 66.2%.\textsuperscript{3} Moreover, the subjective quality-of-life measure is also a priority. The Obstructive Sleep Apnea 18-Item Quality-of-Life Questionnaire (OSA-18) is a widely used subjective quality-of-life survey for pediatric OSA.\textsuperscript{9,12-14} According to pertinent literature, children with OSA had significant short-term and long-term effects on quality of life after T&A, as documented by changes in OSA-18 scores.\textsuperscript{12,14} Despite considerable evidence demonstrating the benefits of T&A in children with OSA, both objective and subjective outcomes in the same population have seldom been studied simultaneously.\textsuperscript{15,16} Furthermore, the correlations and discrepancies between objective sleep study amelioration and subjective quality-of-life gains have not been well clarified and thoroughly understood.

This study investigates objective and subjective outcomes in children with OSA having undergone T&A. Correlations and discrepancies between objective and subjective measures before and after surgery in children with OSA are examined as well.

**Methods**

**Study Population**

The study protocol and informed consent for OSA-18 were approved by the Ethics Committee of the National Taiwan University Hospital. From July 2010 to December 2012, children ages 2 to 18 years were recruited. Children were included if they had signs and symptoms of a sleep disturbance including snoring, mouth breathing, and witnessed breath holding for a duration of at least 1 month and were shown to have OSA by PSG. Children with clinical symptoms and AHI higher than 1 were included in the study and received T&A to treat OSA. All subjects included underwent both objective and subjective measures before and after surgery. The objective criteria for OSA were based on overnight polysomnographic studies, and the subjective measure was based on the OSA-18, which was a caregiver-completed questionnaire. The exclusion criteria were (1) prior tonsil, adenoid, or pharyngeal surgery, (2) craniofacial anomalies, (3) genetic disorders, neuromuscular diseases, cognitive deficits, or mental retardation, and (4) an AHI lower than 1.

Basic data, clinical history, physical examination, and lateral cephalometric radiographs were taken. The tonsils were graded according to the scheme proposed by Brodsky et al.\textsuperscript{17} Tonsil hypertrophy was defined as grade III or IV tonsils.\textsuperscript{17} Adenoid size was determined using lateral cephalometric radiographs to measure the adenoidal–nasopharyngeal (AN) ratio. The AN ratio was measured as the ratio of adenoidal depth to nasopharyngeal diameter according to the method of Fujikawa et al.\textsuperscript{18}; an AN ratio $\geq 0.67$ was considered adenoid hypertrophy.\textsuperscript{19,20} The weight and height of each child were measured, and the age and sex corrected body mass index (BMI) was applied for each child using established guidelines.\textsuperscript{21} Obesity was defined as a BMI higher than the 95th percentile for a child’s age and sex.\textsuperscript{21}

**Polysomnography**

All subjects completed overnight PSG studies before and after surgery. Overnight PSG (Embla N7000; Medcare Flaga, Reykjavik, Iceland) was performed in the sleep lab following a protocol described elsewhere.\textsuperscript{4,7,22} The sleep stage and respiratory event were scored based on the 2007 American Academy of Sleep Medicine standard.\textsuperscript{23} Obstructive apnea was defined as the presence of continued inspiratory effort associated with a $> 90\%$ decrease in airflow for a duration of $\geq 2$ breaths. Hypopnea was defined as a $\geq 50\%$ decrease in airflow for a duration of $\geq 2$ breaths associated with arousal, awakening, or reduced arterial oxygen saturation of $\geq 3\%$. Pediatric OSA was defined as an AHI higher than 1. As a guideline, OSA in children was further characterized as mild (AHI, 1-5/h), moderate (AHI, 6-10/h), or severe (AHI > 10/h).\textsuperscript{6,23}

**Obstructive Sleep Apnea 18-Item Quality-of-Life Questionnaire**

All subjects completed the validated OSA-18 before and after surgery.\textsuperscript{23} Franco et al.\textsuperscript{9} first described the OSA-18, and Kang et al.\textsuperscript{24} cross-culture translated and validated the traditional Chinese version of the OSA-18. As a caregiver-administered quality-of-life survey, the OSA-18 contains 18 items divided into 5 subscales: sleep disturbance, physical symptoms, emotional distress, daytime function, and caregiver concerns. Each item is scored on a 7-point ordinal scale. The OSA-18 is graded to produce each item score, additional scores for 5 subscales, and a total score. The OSA-18 total score is the sum of the 18 items and, therefore, ranges from 18 (no effect on quality of life) to 126 (major negative effect).\textsuperscript{9,12-15} According to Franco et al.\textsuperscript{9} OSA-18 total scores less than 60 imply a small effect on quality of life, scores between 60 and 80 imply a moderate effect, and scores higher than 80 imply a large life quality effect.

**Adenotonsillectomy**

Adenotonsillectomy was performed in a single stage under general anesthesia with 2 to 3 days of hospitalization. Tonsillectomy was performed using the coblation method, and adenoidectomy was performed using the microdebrider-assisted method.\textsuperscript{25}

**Statistical Analysis**

Data were analyzed using SPSS software (version 17.0; SPSS Inc, Chicago, Illinois, USA). Continuous data were expressed as the mean and standard deviation, and categorical data as the number and percentage. Before- and after-surgery comparisons of continuous data were made using paired-samples $t$ test. The standardized response mean (SRM), defined as the difference score divided by the standard deviation of difference score, was used additionally to...
estimate the improvements in OSA-18 scores. Positive values reflect (standardized) improvements in the number of standard deviations of the score differences (SRM). The SRM of effect size was increased in concordance with increasing changes (improvements) in life quality among children who underwent T&A. Since the AHI scores were not normally distributed, the correlations between AHI and OSA-18 scores were analyzed using Spearman’s rank correlation. A value lower than .05 was considered statistically significant.

Results

Study Population

Of the 223 children, 104 were excluded, leaving 119 for final analysis. The included and excluded population did not significantly differ in demographics (ie, age, sex, adenotonsillar hypertrophy, and BMI). Among the 104 subjects who were excluded, 72 had incomplete PSG data or an incomplete OSA-18 survey, 23 had an AHI < 1 before T&A, and 3 had adenoid surgery previously. Another 6 children were excluded owing to underlying conditions, that is, craniofacial anomalies (n = 2), genetic disorder (n = 1), or neuro-muscular diseases (n = 3). Of the 119 children included, all of them had clinical symptoms, preoperative PSG diagnosis of OSA, and complete PSG and OSA-18 data before and after surgery.

The mean age was 6.9 ± 3.3 years, and 90 children were boys (76%). For age distribution, 7 were toddlers (2-3 years old), 54 were preschool age (3-5 years old), 45 were school age (6-12 years old), and 13 were adolescents (13-18 years old). Tonsil hypertrophy was observed in 88% (105/119) of all children, whereas adenoid hypertrophy was found in 68% (81/119). According to age and sex corrected BMI, 25 children were obese, and 94 were not. In terms of OSA severity, 48 children had mild OSA (AHI, 1-5/h), 19 children had moderate OSA (AHI, 5-10/h), and 52 children had severe OSA (AHI > 10/h).

Polysomnography Parameters after Surgery

The median interval between preoperative PSG studies and surgery was 46 days (25th-75th percentile: 26-69 days), and 56 days (25th-75th percentile: 38-75 days) between surgery and postoperative PSG studies. Table 1 lists the sleep architectures and sleep parameters before and after surgery. Changes in sleep architectures significantly decreased in slow stage 1 (5.1%-4.1%, P = .012) and increased in the slow wave sleep stage (33.7%-43.9%, P = .001). Respiratory parameters (ie, AHI, obstructive index, hypopnea index, and total arousal index) significantly decreased after surgery, and the AHI decreased in both rapid eye movement (REM) and non-rapid eye movement (NREM) sleep stages (P < .001). Meanwhile, mean and minimum oxygen saturation increased after surgery (P < .001).

Residual OSA after Surgery

In total, 45.4% (54/119) of the children had a postoperative AHI > 1; 22.7% (27/119) had an AHI > 2; and 6.7% (8/119) had an AHI > 5 postoperatively. Obesity (P = .012,
Spearman’s correlation) and AHI before surgery ($P = .043$; Spearman’s correlation) were significantly correlated with the absolute value of AHI after surgery in our children.

**OSA-18 Scores after Surgery**

The median interval between the preoperative OSA-18 and surgery was 36 days (25th-75th percentile: 29-64 days), and 42 days (25th-75th percentile: 21-78 days) between surgery and the postoperative OSA-18. Before surgery, 22.7% (27/119) of the children had an OSA-18 total score of $\leq 60$; 50.4% (60/119) had an OSA-18 total score between 60 and 80; and 26.9% (32/119) had OSA-18 total scores $> 80$. Following surgery, 93.3% (111/119) of the children had an OSA-18 total score $< 60$, whereas only 6 children (5.0%) had OSA-18 scores ranging from 60 to 80 and only 1 child (0.08%) had an OSA-18 total score $> 80$.

Table 2 lists the OSA-18 scores before and after surgery. The OSA-18 total scores and subscale scores significantly decreased after surgery ($P < .001$). The mean difference in the total score was 30.9 (SRM, 2.2). The most significant improvement was achieved in the sleep disturbance subscale (SRM, 2.1), followed by the physical symptoms subscale (SRM, 1.8), whereas the smallest improvement was found in the emotional distress subscale (SRM, 0.5).

**Table 2. Scores of Obstructive Sleep Apnea 18-Item Quality-of-Life Questionnaire (OSA-18) before and after Surgery.**

<table>
<thead>
<tr>
<th></th>
<th>Before Surgery</th>
<th>After Surgery</th>
<th>Difference (95% CI)</th>
<th>SRM</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSA-18 total score</td>
<td>71.7 (15.8)</td>
<td>40.8 (12.3)</td>
<td>30.9 (28.3-33.5)</td>
<td>2.2</td>
</tr>
<tr>
<td>Sleep disturbance (S)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1 Loud snoring</td>
<td>18.3 (5.0)</td>
<td>7.4 (3.1)</td>
<td>11.0 (10.0-11.9)</td>
<td>2.1</td>
</tr>
<tr>
<td>S2 Breath holding/pauses</td>
<td>5.6 (1.4)</td>
<td>1.9 (1.0)</td>
<td>3.7 (3.4-4.0)</td>
<td>2.3</td>
</tr>
<tr>
<td>S3 Choking or gasping</td>
<td>3.9 (1.8)</td>
<td>1.5 (0.8)</td>
<td>2.4 (2.1-2.8)</td>
<td>1.3</td>
</tr>
<tr>
<td>S4 Fragmented sleep</td>
<td>4.8 (1.7)</td>
<td>2.0 (1.0)</td>
<td>2.8 (2.5-3.1)</td>
<td>1.6</td>
</tr>
<tr>
<td>Physical symptoms (P)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P1 Mouth breathing</td>
<td>17.1 (4.2)</td>
<td>8.8 (3.1)</td>
<td>8.3 (7.5-9.2)</td>
<td>1.8</td>
</tr>
<tr>
<td>P2 Frequent colds or URIs</td>
<td>5.6 (1.4)</td>
<td>2.4 (1.3)</td>
<td>3.3 (3.0-3.6)</td>
<td>1.9</td>
</tr>
<tr>
<td>P3 Rhinorrhea</td>
<td>4.6 (1.6)</td>
<td>2.2 (1.1)</td>
<td>2.4 (2.1-2.7)</td>
<td>1.4</td>
</tr>
<tr>
<td>P4 Dysphagia</td>
<td>4.6 (1.7)</td>
<td>2.8 (1.4)</td>
<td>1.7 (1.4-2.1)</td>
<td>0.9</td>
</tr>
<tr>
<td>Emotional distress (E)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E1 Mood swings or tantrums</td>
<td>8.1 (3.9)</td>
<td>6.3 (3.1)</td>
<td>1.8 (1.2-2.4)</td>
<td>0.5</td>
</tr>
<tr>
<td>E2 Aggression/hyperactivity</td>
<td>3.1 (1.5)</td>
<td>2.4 (1.3)</td>
<td>0.7 (0.4-1.0)</td>
<td>0.5</td>
</tr>
<tr>
<td>E3 Discipline problems</td>
<td>2.7 (1.6)</td>
<td>2.1 (1.2)</td>
<td>0.6 (0.4-0.9)</td>
<td>0.4</td>
</tr>
<tr>
<td>Daytime function (D)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1 Daytime drowsiness</td>
<td>10.0 (4.1)</td>
<td>6.7 (2.8)</td>
<td>3.3 (2.6-4.0)</td>
<td>0.9</td>
</tr>
<tr>
<td>D2 Poor attention span</td>
<td>2.8 (1.5)</td>
<td>1.8 (0.9)</td>
<td>1.0 (0.7-1.3)</td>
<td>0.7</td>
</tr>
<tr>
<td>D3 Difficulty awakening</td>
<td>3.5 (1.7)</td>
<td>2.2 (1.0)</td>
<td>1.3 (1.0-1.5)</td>
<td>0.9</td>
</tr>
<tr>
<td>Caregiver concerns (C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1 Caregiver worried over child health</td>
<td>18.0 (5.0)</td>
<td>11.7 (5.2)</td>
<td>6.4 (5.4-7.3)</td>
<td>1.2</td>
</tr>
<tr>
<td>C2 Caregiver concerned not enough air</td>
<td>6.0 (1.3)</td>
<td>4.0 (1.9)</td>
<td>2.0 (1.7-2.3)</td>
<td>1.1</td>
</tr>
<tr>
<td>C3 Caregiver missed activities</td>
<td>5.4 (1.8)</td>
<td>3.3 (1.9)</td>
<td>2.1 (1.7-2.4)</td>
<td>1.0</td>
</tr>
<tr>
<td>C4 Caregiver frustration</td>
<td>3.0 (1.7)</td>
<td>2.1 (1.3)</td>
<td>0.9 (0.6-1.1)</td>
<td>0.6</td>
</tr>
</tbody>
</table>

**Correlations and Discrepancies between AHI and OSA-18 before and after Surgery**

Figures 1A and 1B present the correlations between AHI and OSA-18 scores before and after surgery. Despite a weak but statistically significant positive correlation between AHI and OSA-18 scores before surgery ($r = 0.22$, $P = .016$), none was found between AHI and OSA-18 scores after surgery ($r = 0.04$, $P = .677$). In addition, a weak but statistically significant correlation was found between the change in AHI and OSA-18 scores before and after surgery ($r = 0.26$, $P = .004$) (Figure 1C).

**Correlations between AHI and OSA-18 scores in Subgroups**

After surgery, the AHI scores and OSA-18 scores were significantly improved in all subgroups including age, sex, adenotonsillar hypertrophy, and disease severity (see Supplemental Table S1, available at www.otournal.org). Correlations between AHI and OSA-18 scores were further explored in different subgroups (Table 3). A weak but statistically significant positive correlation between AHI and OSA-18 scores before surgery was observed in subjects with older age ($> 6$ years) ($P = .023$), male sex ($P = .027$), tonsil hypertrophy ($P = .012$), adenoid hypertrophy ($P = .003$), and

**Abbreviations:** CI, confidence interval; URI, upper respiratory tract infection.

*Using paired-samples t test, all $P$ values $< .001$. The standardized response mean (SRM) is the difference score divided by the standard deviation of the difference score. The SRM was increased in concordance with increasing changes (improvements) in life quality.
in all subgroups. A positive correlation was found between change in AHI and OSA-18 scores before and after surgery in subgroups including older age, male sex, non-obese, tonsil hypertrophy, adenoid hypertrophy, and severe OSA (Table 3).

**Discussion**

This research is a large study comprising both objective and subjective measures in the same population. Analytical results indicate that although children significantly improved objectively and subjectively, subjective measures improved more than objective measures after surgery. According to those results, despite incomplete resolution of the disease, most caregivers were satisfied with the surgical results. These residual obstructive sleep disorders only slightly affected quality of life in the children postoperatively. In addition to demonstrating the effectiveness of T&A in treating pediatric OSA, the above findings verified the needs of both objective and subjective measures for children with sleep apnea receiving surgery.

Adenotonsillectomy for children with OSA significantly improved polysomnographic parameters, including diminished obstructive respiratory events, increased oxygen saturation, and decreased arousal events. Our study found a significantly diminished AHI, obstructive index, hypopnea index, oxygen desaturation event, and arousal index, along with increased mean and minimum oxygen saturation. The above findings correlate well with previous literature in which children with OSA had markedly improved sleep parameters after surgery.

Despite these benefits, residual disease after surgery is still a major concern in children with OSA. Recent studies revealed a higher frequency of residual OSA than previously considered. A meta-analysis study by Friedman et al found that treatment success with T&A was 59.8%. Meanwhile, according to a recent multicenter collaborative study by Bhattacharjee et al, only 27.2% had complete resolution of OSA. Relevant literature indicated that residual OSA after surgery was correlated with obesity and OSA severity, as demonstrated in this study. It is interesting that the success rate of treatment was varied by using various definitions of residual OSA. For example, 45% of the children in this study had postoperative AHI > 1, whereas only 7% of the children had postoperative AHI > 5. Nevertheless, the success rate of treatment is still far below 100%, explaining why residual OSA is a major issue for children with sleep apnea who underwent T&A.

The OSA-18 survey was categorized by 5 major domains in the quality of life: sleep disturbance, physical symptoms, emotional distress, daytime function, and caregiver concerns. Pertinent literature demonstrated significant improvements in quality of life after surgery in children with OSA, as evidenced by changes in OSA-18 scores, although these improvements were not uniform across all 5 domains. Mitchell et al and Baldassari et al cited sleep disturbance as the domain with the greatest change. The sleep disturbance domain in the study also changed the greatest postoperatively, implying that
T&A notably and mainly resolved sleep disturbances in children with OSA.

The main findings in this study demonstrated that, in children with OSA, objective and subjective measures correlated better with each other before than after surgery. Hitherto, few studies have delineated the correlations and discrepancies between objective and subjective measures before and after surgery.\(^{15,16,38,45,46}\) Stewart et al\(^{16}\) stated a moderate association between objective sleep study and subjective quality-of-life measures. The OSA-18 survey, a disease-specific questionnaire, revealed a positive correlation with severity of OSA in previous studies.\(^{9,24,45}\) It is interesting that children improved in quality of life after surgery in various degrees of obstructive sleep disorders.\(^{15,38,46}\) Mitchell et al\(^{46}\) observed that the quality of life of children with OSA and mild sleep-disordered breathing significantly improved after surgery. Ye et al\(^{15}\) asserted that the quality of life of children cured or not cured by surgery did not significantly differ. In this study, once children underwent T&A as a definite treatment of OSA, regardless of whether cured or not cured by surgery, most had small effects on life quality postoperatively. Our study showed that using the OSA-18 after surgery does not make sense as a discriminative tool to distinguish among children with varying degrees of OSA. The discriminative nature of the survey was validated in children with sleep-disordered breathing, which presumably is no longer present in the vast majority of these children after surgery. Therefore, it is not unexpected to find no significant correlation between OSA-18 and PSG results in a sample with only a small number of children with actual OSA. Moreover, this study showed improvement in subjective results regardless of the objective results, raising the possibility of a ”placebo effect” of surgery, explaining the OSA-18 improvements beyond the objective results.\(^{47}\) Since caregivers have put their children through a difficult situation, with general anesthetic and a painful recovery, they almost feel obliged to say that there is some improvement even if it wasn’t complete. In this way, our study verified the needs of both objective and subjective measures in children who underwent surgery.

Little is known of quality of life and its changes after surgery in children with OSA among subgroups.\(^{34,36,46,48-51}\) Based on our subgroup analysis, a positive correlation between AHI and OSA-18 scores was observed in subjects with older age, male sex, tonsil hypertrophy, adenoid hypertrophy, and more severe forms of disease before surgery; however, none was found between AHI and OSA-18 scores postoperatively in all subgroups. Quality of life in our children significantly improved after surgery, despite incomplete resolution of OSA, explaining why objective and subjective measures were better correlated before than after surgery in all subjects as well as in subgroups. Of note, obesity coincides with OSA in children. Mitchell and colleagues\(^{34,48,49}\) observed that both obese and normal-weight children had significant improvement in AHI.

### Table 3. Correlations between Apnea-Hypopnea Index (AHI) and Obstructive Sleep Apnea 18-Item Quality-of-Life Questionnaire (OSA-18) Scores in Subgroups.\(^{a}\)

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Before Surgery</th>
<th>After Surgery</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>p</td>
<td>P Value</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>119</td>
<td>0.220</td>
<td>0.016(^b)</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 6 years</td>
<td>61</td>
<td>0.159</td>
<td>0.221</td>
</tr>
<tr>
<td>≥ 6 years</td>
<td>58</td>
<td>0.297</td>
<td>0.023(^b)</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>90</td>
<td>0.233</td>
<td>0.027(^b)</td>
</tr>
<tr>
<td>Female</td>
<td>29</td>
<td>0.117</td>
<td>0.546</td>
</tr>
<tr>
<td><strong>Body mass index</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-obese</td>
<td>94</td>
<td>0.199</td>
<td>0.055</td>
</tr>
<tr>
<td>Obese</td>
<td>25</td>
<td>0.111</td>
<td>0.597</td>
</tr>
<tr>
<td><strong>Tonsil hypertrophy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>14</td>
<td>0.335</td>
<td>0.242</td>
</tr>
<tr>
<td>Yes</td>
<td>105</td>
<td>0.243</td>
<td>0.012(^b)</td>
</tr>
<tr>
<td><strong>Adenoid hypertrophy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>38</td>
<td>0.054</td>
<td>0.793</td>
</tr>
<tr>
<td>Yes</td>
<td>81</td>
<td>0.323</td>
<td>0.003(^b)</td>
</tr>
<tr>
<td><strong>Disease severity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AHI 1-5</td>
<td>48</td>
<td>0.166</td>
<td>0.259</td>
</tr>
<tr>
<td>AHI 6-10</td>
<td>19</td>
<td>-0.170</td>
<td>0.487</td>
</tr>
<tr>
<td>AHI &gt; 10</td>
<td>52</td>
<td>0.404</td>
<td>0.003(^b)</td>
</tr>
</tbody>
</table>

\(^a\)Spearman’s rank correlation was used.

\(^b\)The significance level was below .05.
and OSA-18 scores after surgery and asserted that obese children, as compared with non-obese children, had worse OSA and quality of life before surgery and were more likely to have persistent OSA and poor quality of life after T&A. These findings were consistent with this study, as higher AHI and OSA-18 scores were also observed in our obese children (Table 3). In addition, changes in AHI and OSA-18 scores before and after surgery were only significantly correlated in non-obese children (Table 3), implying that obesity may affect quality of life and sleep studies outcomes in children with OSA.

Despite its contributions, this study has certain limitations. Methods for evaluating adenoid size remain controversial. Fiberoptic endoscopy is another diagnostic option for adenoids that allows a 3-dimensional view. However, children need to cooperate in the exam, which is not always possible with children of young ages. In addition, this study did not recruit a control group. A recent study by Marcus et al. suggested that watchful waiting may also be a reasonable treatment option for pediatric OSA, although early T&A, as compared with watchful waiting, did better improve quality of life and polysomnographic outcomes in Marcus’s study. In addition, this study was conducted in a single, tertiary referral medical center, explaining why cross-cultural comparisons and racial differences in associations between objective and subjective measures were not obtained. Moreover, this study did not examine craniofacial variables. Certain “red flag” craniofacial characteristics, such as retrusive chin or steep mandibular plane, may also affect surgical outcomes in children with OSA.

In summary, this study delineates objective and subjective surgical outcomes in children with OSA and elucidates the correlations and discrepancies between objective and subjective measures before and after surgery. We recommend that future studies look into long-term results and cross-racial differences in correlations between objective and subjective outcomes in children with OSA who underwent surgery.

Conclusion

Treating OSA in children with T&A significantly improved objective and subjective outcomes. However, subjective measures improved more than objective outcomes after surgery, and most children with residual disease saw a small residual effect on quality of life. Obesity and OSA severity before surgery contributed to residual disease, which inflicted 45% of the children. Residual OSA is, thus, a major concern in children receiving T&A for the treatment of OSA surgery that requires long-term follow-up.

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Author Contributions

Kun-Tai Kang, study concept and design, drafting of manuscript; Wen-Chin Weng, acquisition and interpretation of data, revision of manuscript; Chia-Hsuan Lee, statistical analysis, drafting of manuscript; Pei-Lin Lee, acquisition and interpretation of data, revision of manuscript; Wei-Chung Hsu, study concept and design, revision of manuscript, final approval of the version to be published.

Disclosures

Competing interests: None.

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Supplemental Material

Additional supporting information may be found at www.otojournal.org/supplemental

References


