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Weight Gain after Adenotonsillectomy: A Case Control Study

Travis L. Lewis, MD[1], Romaine F. Johnson, MD, MPH[1,2], Jonathan Choi[1], and Ron B. Mitchell, MD[1,2]

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Abstract

Objective. To study the association between adenotonsillectomy (T&A) and weight gain in children.

Study Design. Retrospective case-control series.

Setting. Tertiary academic children's medical center.

Subjects and Methods. A total of 154 children who underwent T&A at a tertiary care children's hospital between December 2010 and March 2011 were included. They were compared with 182 children with similar demographics who were seen in primary care clinics at the same institution (control group). Height and weight were compared at 6-month intervals over a 24-month period. Patients were divided into normal weight, overweight, and obese. A multilevel mixed-effects regression model was used for analysis. Significance was set at $P \leq .05$.

Results. Children who underwent T&A gained more weight than controls at every interval. At 24 months, they gained an additional 2.6 kg (confidence interval [CI], 0.9-3.9) but were an additional 1.8 cm (CI, 0.1-3.5) taller. There was no difference in weight gain at 6 months for obese children. At 12, 18, and 24 months, the obese group outgained the control group. At 24 months, the obese T&A group had gained an average of 14.3 kg, while the control had gained 10.1 kg, for a difference of 4.2 kg (CI, 1.3-6.1) with no difference in height changes. There were no differences in weight or height changes for the normal-weight and overweight groups at the conclusion of the study.

Conclusions. T&A leads to a significant increase in weight in obese but not normal-weight or overweight children. Efforts should be made to provide weight reduction counseling prior to T&A in obese children.

Keywords

children, adenotonsillectomy, tonsillectomy, weight change, obesity, weight gain

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Pediatric obstructive sleep apnea (OSA) is caused by episodic upper airway obstruction leading to hypoxia, hypercapnea, or sleep disruption in children.[1] The association between being overweight and increased prevalence of OSA in children is well described.[2-5] Pediatric OSA is also known to worsen behavioral, quality-of-life, and school performance measures.[6-8] Mitchell and Kelly[9] reported that adenotonsillectomy (T&A) improves OSA in both normal-weight and obese children but that obese children were more likely to have residual OSA. As a result, OSA as an indication for T&A has increased over the past few decades. In addition, a large number of T&A procedures are performed for recurrent tonsillitis, particularly in children older than 12 years.[10]

Unfortunately, there is evidence that T&A may also be associated with weight gain postoperatively. Roemmich et al[11] studied 54 patients with OSA before and after T&A. They reported that the patients' average weight and body mass index (BMI) increased after surgery.[11] In addition, a recent systematic review by Jeyakumar et al[12] found that overweight and normal-weight children gained a higher than expected amount of weight following T&A. These studies were limited by small sample size, heterogeneity of the study groups, and lack of control groups. A more recent study by Katz et al[13] did use controls to compare weight changes after T&A. Children who underwent T&A had a greater chance of excessive weight gain than the non-T&A group across all weight categories.[14] Thus, there is growing evidence that T&A may be an independent risk factor for excessive weight gain in children. This risk is concerning because excessive postoperative weight gain may lead to recurrence of OSA in

[1]Department of Otolaryngology, Head and Neck Surgery, University of Texas, Southwestern Medical Center at Dallas, Dallas, Texas, USA
[2]Childrens Medical Center at Dallas, Division of Pediatric Otolaryngology, University of Texas, Southwestern Medical Center at Dallas, Dallas, Texas, USA

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Corresponding Author:
Travis L. Lewis, MD, UT Southwestern and Children's Medical Center Dallas, 2350 North Stemmons Freeway ENT Clinic, 6th Floor, F6212 Dallas, TX 75207, USA.
Email: travis.lewis@phhs.org

children whose sleep disorder was initially alleviated with T&A.[14]

The primary objective of this study was to compare weight and height changes in children who underwent T&A to a control population. Because T&A is still performed for reasons other than OSA, we included all children who underwent the procedure regardless of indication. The secondary objective was to see if obese, overweight, and normal-weight children had changes that differed from the overall population. Given the results of the limited studies done thus far, we hypothesized that those children who underwent T&A gained more weight in the 24 months following surgery than their control counterparts.

Subjects and Methods

The study population included 2 groups of children from a tertiary children's medical center. The first group consisted of children undergoing T&A, and the second group was a control group of children from primary care clinics undergoing well-child visits who had not undergone T&A. The children were identified over a 3-month period between December 1, 2010, and March 1, 2011, and follow-up data were collected for the following 24 months. Inclusion criteria were ages 2 to 16 years, height and weight available at baseline, and at least at 1 follow-up point between 6 and 24 months. Children were excluded from the study if they had significant comorbidities including genetic, neuromuscular, or endocrine disorders. They were also excluded if other procedures were done at the time of T&A, with the exception of tube placement.

Institutional Review Board approval for the study titled "Weight Gain after Adenotonsillectomy—A Case Control Study" was obtained from the Institutional Review Board at the University of Texas–Southwestern Medical Center and the need for consent exempted. Children who underwent T&A were identified using surgical schedule archives in the electronic medical record (EPIC production). This was done by generating weekly electronic reports for otolaryngology patients and identifying those who underwent T&A regardless of indication.

Children who had visited a primary care clinic during the study period, at the same institution, were identified from well-child visits, as defined by their ICD-9 code. This was done by the data intelligence department using electronic medical records (EPIC productions). None had a CPT code for T&A listed in their surgical history or significant comorbidities.

The study populations were divided into 3 groups: normal weight (BMI <85th percentile), overweight (BMI between 85th and 95th percentile), and obese (BMI >95th percentile) based on Centers for Disease Control and Prevention criteria (http://www.cdc.gov/obesity/childhood/basics.html). For each child, the following was recorded: demographic information including age, gender, and race; indication for surgery; and height and weight on day of surgery or at initial primary care visit as well as at 6, 12, 18, and 24 months based on electronic medical record growth charts.

Continuous data are reported as means with standard deviations. Categorical data are presented as numbers and percentages. To evaluate for differences between T&A and control groups, continuous data were analyzed with simple linear regression, while categorical data were analyzed with the Pearson χ^2 test. To determine if the longitudinal changes in weight, height, and BMI were affected by T&A, a mixed multilevel regression model was used. This model accounts for the changes that occurred over time between the T&A and control groups and the potential random changes or effects that can occur between each individual over the same period.[15,16] Statistical significance was set at a 2-tailed P value of $\leq .05$. Statistics were performed with StatCorp (StataCorp LP, 2014; Stata Statistical Software, Release 13, College Station, Texas).

Results

A total of 199 children underwent T&A, of whom 45 were excluded, leaving a study population of 154 (**Figure 1**). The maximum number of children with weight data was 89 (58%) and for height was 75 (49%) at 12 months. The minimum number of children with weight data was 63 (41%) and for height was 51 (33%) at 18 months (**Figure 1**).

A total of 500 children were identified from well-child visits, and 318 were excluded, leaving a control population of 182 (**Figure 1**). The maximum number of children with weight data was 140 (77%) and for height was 125 (69%) at 12 months. The minimum number of children with weight data was 80 (44%) and for height was 55 (30%) at 18 months (**Figure 1**).

The demographics of the study population are summarized in **Table 1**. In the T&A group, at baseline, normal-weight children were younger but had a similar BMI percentile compared with the control group. The mean age and BMI percentiles, at baseline, were not different for the overweight or obese groups. Gender, ethnicity, height, and all other measures were not significantly different between the T&A and control groups (**Table 1**). Indications for T&A were OSA (80.7%) and recurrent tonsillitis (19.3%).

Table 2 summarizes the weight changes over time for the T&A and control groups. There was a significant difference in weight gain in favor of the T&A group at 6, 12, 18, and 24 months. At 6 months, the difference was an average of 0.8 kg but increased to 2.6 kg at 24 months. There was no difference in height changes between the T&A and control groups at 6, 12, and 18 months. At 24 months, the T&A group had gained an average of 1.8 cm more than the control group, and this was significant ($P = .04$).

The baseline weight with changes at 6, 12, 18, and 24 months for the different weight categories is summarized in **Table 3**. In obese children, there was a significant difference in weight gain in the T&A compared with the control group at 12, 18, and 24 months. Obese children who underwent T&A gained an average of 4.1 kg over and above the weight gain of obese children in the control group ($P < .001$; **Table 3**). There was a small difference in normal-weight children between the T&A and control groups at 12

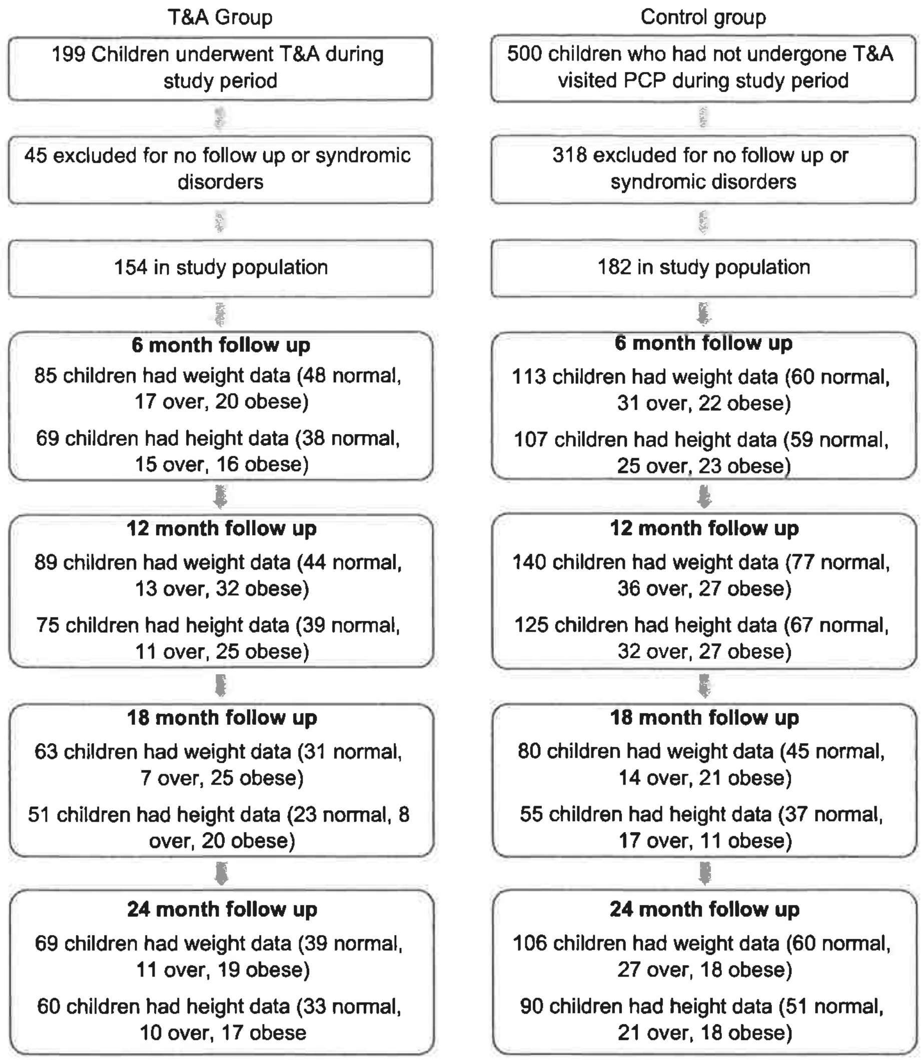

Figure 1. Flow chart for patient selection for adenotonsillectomy and control groups.

months but no significant differences at 6, 18, and 24 months (**Table 3**). There were no differences between the T&A and control groups in weight gain for overweight children at 6, 12, 18, and 24 months (**Table 4**). These differences were not affected by age, gender, ethnicity, or indication for surgery.

Obese children in the control group increased their height more than in the T&A group at 6 and 12 months, but this difference was not significant at 18 and 24 months. There were no significant differences in height between the T&A and control groups for normal or overweight children at 6, 12, 18, or 24 months.

Baseline and 24-month (if available) BMI z-scores were calculated for each child. Average z-scores for each group were then calculated for both intervals and are compared in **Table 4**. The 2 groups within each weight class had similar baseline z-scores at the start of the study period. At the conclusion of the study period, there were also no significant differences between the 2 normal and overweight groups. There was a significant difference for the obese groups, however, with the T&A group z-score being significantly higher than the control at 24 months, reflecting the height and weight results previously discussed.

Of the children included in the normal-weight groups, a small number were underweight (BMI <5th percentile). There were 3 underweight children in the T&A group. Following T&A, 2 children had a BMI greater than 5th percentile at 24 months, while 1 remained underweight. Five children in the normal control group were also underweight. Four had a BMI greater than the 5th percentile at 24 months, and 1 remained underweight. None of the underweight children in either group had a BMI classified as overweight or obese at 24 months.

Discussion

This study compared height and weight changes over 2 years between children who underwent T&A and a control population. Overall, children who underwent T&A did gain significantly more weight than controls. The weight gain difference was small at 6 months but increased with time over the 24-month period. The changes in height were not

Table 3. Weight Change over Time by Weight Category.[a]

Weight Category[b]	Time Interval	T&A Group[c,d]	Change in Weight[c,e]	Control Group[c,d]	Change in Weight[c,e]	Mean Difference in Weight[c,d,f]	P Value[g,h]
Normal	Baseline	21.7 (17.3 to 26.1)		24.5 (21.0 to 28.0)			
	6 mo	23.8 (19.3 to 28.4)	2.1	26.0 (22.4 to 29.6)	1.5	0.6 (−0.8 to 1.6)	.11
	12 mo	26.1 (21.5 to 30.7)	4.4	27.6 (24.0 to 31.4)	3.1	1.3 (0.7 to 2.4)	**.02**
	18 mo	27.6 (22.9 to 32.4)	5.9	29.2 (25.4 to 33.1)	4.7	1.2 (−0.8 to 2.9)	.80
	24 mo	28.1 (23.2 to 33.1)	6.4	30.6 (26.58 to 34.51)	6.1	0.3 (−1.5 to 2.3)	.98
Overweight	Baseline	30.5 (23.2 to 37.9)		31.9 (26.5 to 37.3)			
	6 mo	32.6 (25.2 to 40.1)	2.1	33.7 (28.7 to 39.3)	1.8	0.3 (−1.1 to 1.6)	.73
	12 mo	35.5 (27.8 to 43.1)	5.0	35.6 (29.9 to 41.3)	3.7	1.3 (−0.6 to 3.0)	.19
	18 mo	36.8 (28.9 to 44.7)	6.3	36.8 (30.9 to 42.7)	4.9	1.4 (−1.2 to 3.9)	.31
	24 mo	40.0 (31.9 to 48.2)	9.5	38.9 (32.9 to 45.0)	7.0	2.5 (−0.6 to 5.6)	.12
Obese	Baseline	47.6 (41.9 to 53.3)		48.1 (41.9 to 54.2)			
	6 mo	51.0 (45.2 to 57.0)	3.4	50.4 (44.1 to 56.7)	2.3	1.1 (−0.3 to 2.5)	.12
	12 mo	55.8 (49.8 to 61.7)	8.2	53.0 (46.5 to 59.5)	4.9	3.2 (1.6 to 4.9)	**.00**
	18 mo	58.9 (52.8 to 65.0)	11.3	54.6 (47.9 to 61.3)	6.5	4.8 (2.5 to 7.2)	**.00**
	24 mo	61.9 (55.6 to 68.3)	14.3	58.3 (51.3 to 65.2)	10.2	4.1 (1.3 to 7.1)	**.00**

Abbreviations: CDC, Centers for Disease Control and Prevention; T&A, adenotonsillectomy.
[a]Comparing total weight change for the T&A group with the control group at 6-month intervals.
[b]Weight classes as defined by the CDC.
[c]Weight in kilograms.
[d]95% confidence interval in parentheses.
[e]Change in weight (kilograms) at that interval compared with baseline.
[f]Comparing the weight changes for the T&A and control groups at that interval (comparing column 4 to column 6).
[g]Significance set as .05.
[h]Bolded text represents statistically significant results.

as a means of reducing long-term weight gain. Parents should be informed, however, that there is evidence that obese children do gain more weight following T&A and that this may be a problem for several years after the procedure. The importance of a good diet and daily exercise in all children cannot be overemphasized. However, in obese children, routine preoperative nutrition counseling prior to T&A may have an additional important role. Many medical centers across the country now have programs dedicated to helping obese children reach a healthier weight.[18] Many of these programs have shown promise in helping children improve their weight, muscle mass, and quality of life.[19,20] Providers might consider referral to one of these programs as part of their standard preoperative workup for obese children prior to T&A.

There are several strengths to this study. It included a large pediatric population with both OSA and recurrent tonsillitis as indications for T&A. The follow-up period was 2 years, with data available at 6-month intervals. A significant strength was the addition of a control group. This allowed us to compare weight gain in children after T&A to that seen in a normal population of children in the same institution. However, there are several limitations that need to be recognized. This was a retrospective study, and therefore, all data points were not available. Most children had 2 to 3 data points out of 4 over the 2-year period, but few had complete data. Thus, at any given 6-month period, it was not an identical cohort that was compared, and this, inevitably, led to discrepancies in the results. The ethnic composition was predominantly Hispanic, reflecting our geographic location, and may not reflect different ethnic spectrums in

Table 4. Average BMI Z-Scores.

Group[a]	Baseline Z-Score	24-mo Z-Score
Normal weight		
T&A	−0.2	0.2
Control	−0.2	0.0
Difference	0	0.2
P value	1	.36
Overweight		
T&A	1.4	1.5
Control	1.3	1.2
Difference	0.1	0.3
P value	.3	.2
Obese		
T&A	2.4	2.4
Control	2.3	2.0
Difference	0.1	0.4
P value	.3	.02

Abbreviations: BMI, body mass index; T&A, adenotonsillectomy.
[a]Weight classes as defined by the Centers for Disease Control and Prevention.

other parts of the country. Also, the normal-weight group undergoing T&A was significantly younger than controls, and this may have introduced a selection bias. Finally, the control population was selected to look at weight increase over time in children who were not undergoing T&A. It is possible, but unlikely, that children who are candidates for T&A have a weight gain that is different from the general pediatric population regardless of undergoing surgery. Ideal studies for the future would be long and prospective in nature, with set time points at which all participants have their height/weight measured.

Conclusions

Children undergoing T&A experience weight gain that is significantly greater than in controls and is predominantly in those who are obese. The difference is most pronounced 24 months after surgery. Otolaryngologists should discuss T&A as an independent risk factor for excess weight gain in obese children.

Author Contributions

Travis L. Lewis, conception, data acquisition, data analysis, data interpretation, drafting, revising, final approval, accountability for all aspects of work; **Romaine F. Johnson**, data acquisition, data analysis, data interpretation, drafting and revising content, final approval, accountability for all aspects of work; **Jonathan Choi**, data acquisition, data analysis, drafting and revising of content, final approval, accountability for all aspects of work; **Ron B. Mitchell**, conception, data acquisition, data analysis and interpretation, drafting and revising content, final approval, accountability for all aspects of work.

Disclosures

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