

Evaluating Tonsillectomy as a Risk Factor for Childhood Obesity

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Objective: To investigate weight gain and any increased risk of obesity in children who have undergone tonsillectomy.

Design: Retrospective chart review.

Setting: Tertiary care pediatric hospital.

Patients: The study included 200 children aged 2 to 12 years who were undergoing tonsillectomy and 200 age- and sex-matched controls. All children had a preoperative body mass index (BMI) and a postoperative BMI recorded 6 to 18 months after surgery.

Main Outcome Measures: The BMI percentile (BMI%) for age was analyzed between and within groups. A Wilcoxon matched-pairs test was used to analyze BMI% before and after tonsillectomy. A Mann-Whitney test was used to compare BMI% between the study and the control groups. An odds ratio (OR) was used to compare over-

weight ($\geq 85\%$) and obese ($\geq 95\%$) patients before and after surgery. A correlation analysis was used to examine the relationship between age and weight gain.

Results: The BMI% did not differ significantly between the study and the control groups before surgery ($P = .14$). The BMI% in the study group increased significantly after tonsillectomy ($P < .001$). Although older children had a higher BMI% than matched controls before surgery, they had a smaller change in BMI% than younger children after tonsillectomy ($P = .004$). The odds of a child being overweight (OR, 1.23; $P = .36$) or obese (OR, 1.44; $P = .12$) were not significantly different before or after tonsillectomy.


Conclusion: Children, particularly younger ones, gained weight after tonsillectomy, but the odds of a child being overweight or obese after tonsillectomy were no different than they were before surgery.

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REMOVAL OF THE TONSILS and the adenoids (T&A) is one of the most common procedures performed in children in the United States. Obesity is becoming more common among children, and, recently, a review of the literature by Jeyakumar et al¹ suggested a link between the two. Considering the impact of the childhood obesity "epidemic" and the frequency of tonsillectomy in children, this is certainly an alarming prospect. Studies in the

The underlying pathogenesis and the degree of weight gain after T&A remain unclear. As Wei³ points out, if tonsillectomy directly results in excessive weight gain, leading to obesity, we would expect a greater percentage of the pre-World War II population to be obese compared with the population today, as the surgery was much more common then and was often performed for less stringent indications, including prophylactically. The epidemic of pediatric obesity today does not support this theory. Nonetheless, numerous theories attempting to explain post-tonsillectomy weight gain have been developed, including decreased physical activity after tonsillectomy because of more restful sleep, decreased work of breathing, increased appetite or feeding, decreased fidgeting, increased levels of growth hormone, and decreased levels of systemic catecholamines.⁴⁻⁷

The serious nature and potential implications of the conclusions reached by Jeyakumar et al¹ led us to look for the development of obesity in our own patients after T&A. Our study looked at weight gain after tonsillectomy in 200 children compared with age-matched controls. While

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past have shown that tonsillectomy led to weight gain among children with a diagnosis of failure to thrive and often reversed the diagnosis.² However, the systematic literature review by Jeyakumar and colleagues suggests that during surgical decision making otolaryngologists should consider the possibility that T&A for other causes or diagnoses may cause weight gain or even obesity.¹

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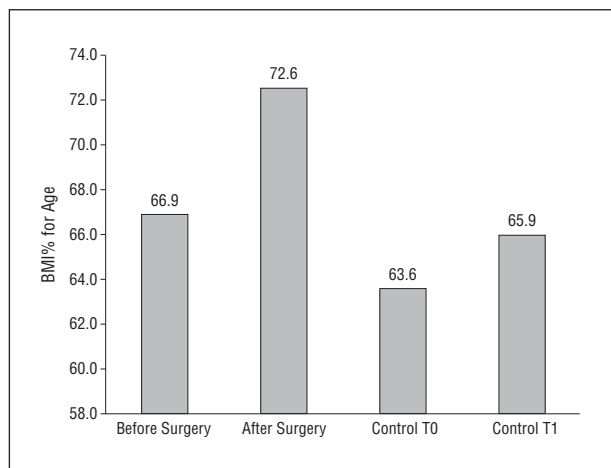


Figure 1. Body mass index percentiles (BMI%) in the study group before and after surgery and in the control group at baseline (T0) and 6 to 18 months after baseline (T1). In the study group, the mean BMI% increased to 72.6 after surgery (from 66.9) ($P < .001$). The second BMI% (65.9) in the comparison group was not significantly different from the first BMI% (63.6) ($P = .37$).

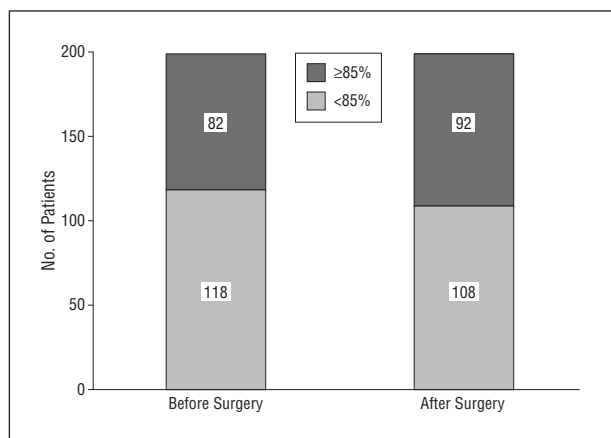


Figure 2. The percentage of overweight children (≥ 85 th percentile) before and after tonsillectomy. Forty-one percent of children were overweight before surgery compared with 46% after surgery. This difference was not significant (odds ratio, 1.23; 95% CI, 0.82-1.82; $P = .36$).

it appears that children gain weight after tonsillectomy, we hypothesized that children were no more likely to be obese after tonsillectomy than they were before surgery.

METHODS

An institutional review board waiver was obtained to perform a query of deidentified data from the data warehouse at the Nemours, DuPont Hospital for Children, Wilmington, Delaware. A retrospective summary involving 200 randomly selected children (age range, 2-12 years) who underwent tonsillectomy or T&A (*Current Procedural Terminology 4* procedure codes 42820 or 42825) from January 1, 2008, to December 30, 2010, was performed. All children had at least 1 preoperative weight and body mass index (BMI [calculated as weight in kilograms divided by height in meters squared]) recorded (≤ 45 days before tonsillectomy) and at least 1 postoperative weight and BMI recorded 6 to 18 months after surgery. Age- and sex-matched controls with no history of tonsillectomy with 2 weight and BMI measurements separated by 6 to 18 months were then randomly selected for comparison.

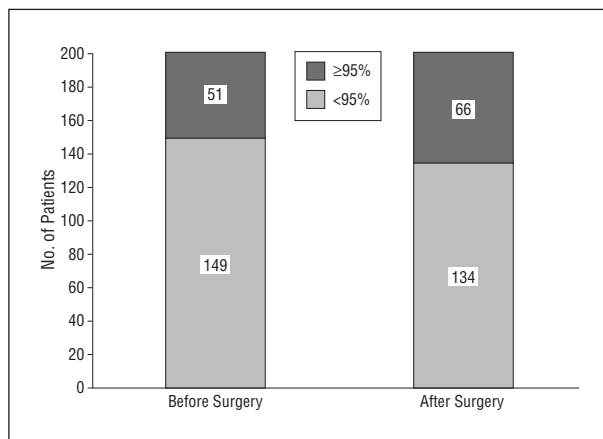


Figure 3. Percentage of obese children (≥ 95 th percentile) before and after tonsillectomy. Twenty-five percent were obese before surgery, and 33% were obese after surgery. This difference was not significant (odds ratio, 1.44; 95% CI, 0.93-2.22; $P = .12$).

A 2-tailed Mann-Whitney test was used to analyze the BMI percentile (BMI%) for age at baseline between the groups. A 2-tailed Wilcoxon matched-pairs signed rank test was used to analyze the BMI% at baseline compared with the second recorded BMI% within each group (the postoperative measure in the study group). A Fisher exact test was used to analyze the likelihood of a patient being at or above the 85th (overweight) or 95th (obese) percentile in the study group before and after surgery. Changes in BMI% in younger children (aged 2-4 years) vs older children (aged 5-12 years) were compared using a 2-tailed Wilcoxon matched-pairs signed rank test. The baseline BMI% in these 2 groups was compared using a 2-tailed Mann-Whitney test. The cutoff age of 5 years was selected so there would be similar numbers of patients in the 2 groups. A Spearman correlation analysis was used to examine the relationship between age and change in BMI% as well as the relationship between baseline BMI% and change in BMI%. $P \leq .05$ was considered statistically significant.

RESULTS

There were 98 boys and 102 girls in each group. The mean age was 5 years. The mean baseline BMI% was 66.9 in the study group and 63.6 in the comparison group. These values were not significantly different ($P = .14$). There were 12 underweight (< 5 th percentile) children in the study group and 8 in the control group, which was not a statistically significant difference ($P = .49$). In the study group, the mean BMI% increased to 72.6 after surgery ($P < .001$). When underweight children were excluded, there was still a statistically significant increase in BMI% after surgery ($P < .001$); whereas the second recorded BMI% in the comparison group was not significantly different from the first (65.9; $P = .37$) (**Figure 1**). Children gained weight after tonsillectomy.

Forty-one percent of children were overweight (BMI% ≥ 85) before surgery compared with 46% after surgery (odds ratio [OR], 1.23; 95% CI, 0.82-1.82; $P = .36$) (**Figure 2**). Twenty-five percent were obese before surgery, and 33% were obese after surgery (OR, 1.44; 95% CI, 0.93-2.22; $P = .12$) (**Figure 3**). Therefore, similar numbers of children fell at or above the 85th percentile before tonsillectomy as after tonsillectomy. The same was true for the 95th percentile. Overall, children gain weight

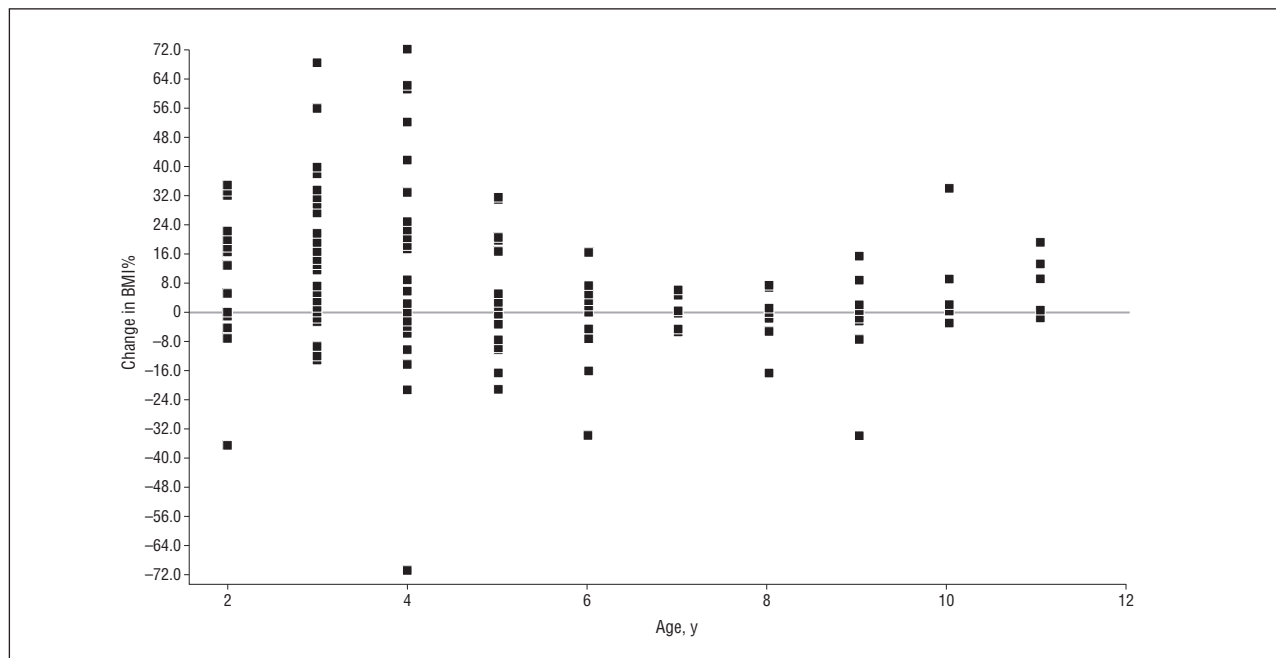


Figure 4. Change in body mass index percentile (BMI%) as a function of age.

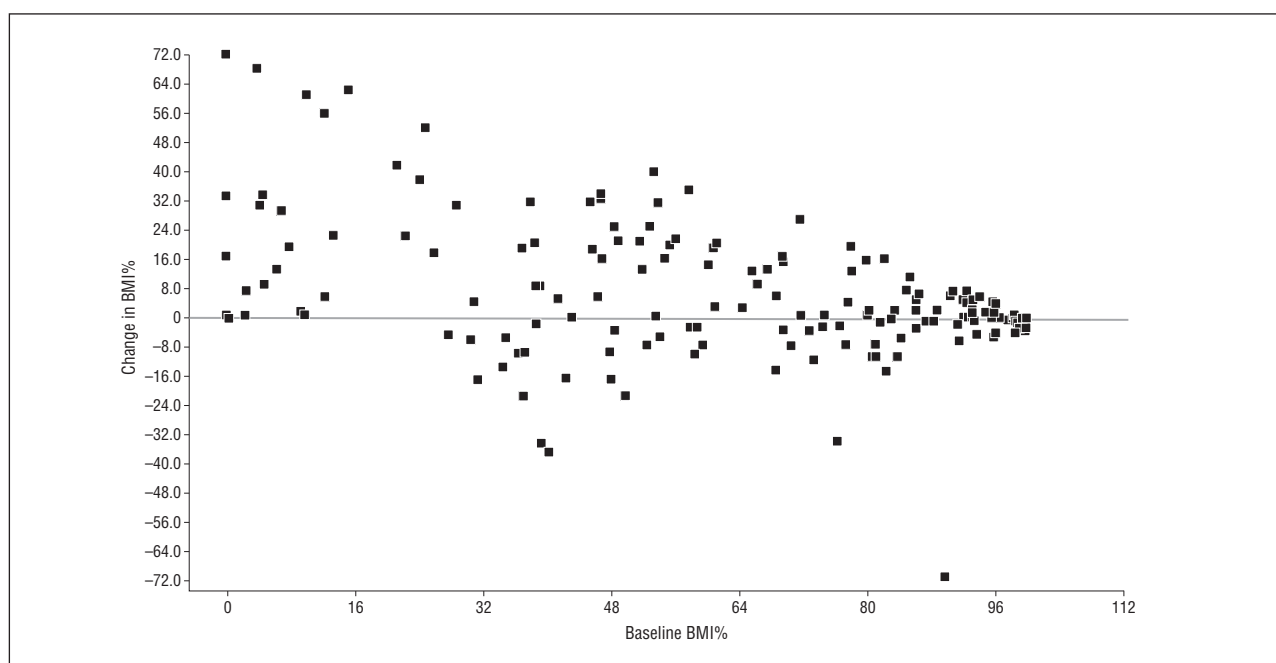


Figure 5. Change in body mass index percentile (BMI%) as a function of baseline BMI%.

after tonsillectomy but are no more likely to be overweight or obese after tonsillectomy than they are before tonsillectomy.

Age seemed to correlate inversely with postoperative change in BMI%, with younger children demonstrating greater changes after surgery than older children (ρ , -0.23 ; 95% CI, -0.35 to -0.08 ; $P = .002$) (Figure 4). Younger children (aged 2-4 years) had a lower BMI% before surgery than older children (aged 5-12 years) (60.2 vs 73.7; $P = .004$). We found that the younger children had an increase in BMI% from 60.2 to 70.6 after tonsillectomy (95% CI, -14.55 to -6.23 ; $P < .001$). In older children, there

was no significant change in BMI% after tonsillectomy (95% CI, -2.97 to 1.13 ; $P = .38$).

Likewise, the baseline BMI% correlated inversely with the postoperative change in BMI%, with smaller children changing more than larger children (ρ , -0.37 ; 95% CI, -0.49 to -0.24 ; $P < .001$) (Figure 5). Graphical analysis clearly showed a weight gain in the smaller children (Figure 5). The children who were larger (approximately 30th percentile and above) showed more variability as to weight gain or loss, with the majority gaining. In other words, smaller children had a greater change in BMI% than larger children regardless of age. Sex did

not affect BMI% change before or after tonsillectomy ($P = .40$).

COMMENT

According to our data, it is clear that children gained weight after tonsillectomy. However, the assertion that children gain weight after tonsillectomy begs the question, "Shouldn't all children gain weight after tonsillectomy as part of their normal growth and development over time?" Furthermore, the same amount of weight gained in a small or young child may have different implications than in a larger or older child. Therefore, it is important to look not only at weight gain but also at change in BMI%. It is only through this measurement that we can truly understand whether patients are gaining weight out of proportion to height (which can be seen by BMI comparisons) and whether this adjusted weight gain for height is reflected in a change compared with age-matched peers. Weight gain is also complex, with many factors, including changes in diet, lifestyle, etc, that may play a larger role than the surgery itself; therefore, it is important not to focus on the weight gain that is seen with tonsillectomy as being *caused* by the surgery, but that it is merely associated with the surgery in time. In a prospective study, some of these factors could be better controlled for and causation could be better determined.

Perhaps the most concerning finding involves how many children were overweight or obese at baseline. We defined overweight as a BMI% greater than or equal to 85 and obesity as a BMI% greater than or equal to 95, similar to previously reported literature on childhood obesity.⁸ In both of our groups, the mean baseline BMI% was well above the 50th percentile. Twenty-five percent of the study group were obese before surgery, and 33% were obese after surgery. As disturbing as these numbers are, they are in line with recently reported rates in the United States. Data from the National Health and Nutrition Examination Survey, 2003-2006, showed that 12% of children aged 2 to 5 years and 17% of children aged 6 to 11 years were obese.⁹

Similar to the study by Jeyakumar et al,¹ we found that children gained weight after tonsillectomy. Their review analyzed 9 studies that varied in methods and outcome measures with evidence grade C, making a causal relationship between tonsillectomy and obesity difficult to determine. Nonetheless, they concluded that a large number of normal and overweight children gained a greater than expected amount of weight after T&A and that T&A could possibly cause obesity. Contrary to the conclusions in their study, our patients were not more likely to be considered obese or even overweight after tonsillectomy.

Overall, the children in this study gained weight after tonsillectomy, with a mean preoperative BMI% of 66.9 and a mean postoperative BMI% of 72.6, while the weight gained by the controls in the same period did not reach significance. We used BMI% for age as the primary outcome measure to control for height (unlike a simple weight statistic) and to compare with normalized BMI across age. Interestingly, the weight gain seen

in children after tonsillectomy did not lead to increased numbers of obese or overweight children after surgery. There was no significant change in the percentage of overweight ($P = .36$) or obese ($P = .12$) children after T&A.

We also found that smaller children (lower BMI%) had a greater change in BMI% after surgery than larger children (higher BMI%) (Figure 5). Graphical analysis clearly showed that this greater change in BMI% represented a gain in weight in these smaller children. This weight gain was independent of age. It is not surprising that smaller children have greater changes in weight, as small children may exhibit a "catch-up" period in which they gain weight toward the mean. However, even excluding the smallest children (<5th percentile), there was a statistically significant increase in BMI%, indicating that these small children do not account for the entirety of the weight gain seen after tonsillectomy. Historically, failure to thrive has been an indication for tonsillectomy, with reports of therapeutic weight gain as early as 1893.¹⁰ Clearly, weight gain after tonsillectomy has been well researched, but it was not until the late 1980s that it took on a pathologic connotation. Subsequently, there were many reports in the 1990s of children gaining more weight than expected after tonsillectomy. Interestingly, around this same period, researchers began reporting that children undergoing tonsillectomy often weighed *more* than their peers rather than less, as was true in the past, when tonsillectomy was often performed for growth failure.¹¹ Conlon et al¹¹ suggested that the discrepancy in weight that was seen before surgery was exacerbated after surgery. In 1999, Soultan et al¹² found that even among obese children the BMI increased. This finding is in contrast to our own study, in which the change in BMI% was less in children with a higher baseline BMI% than in children with a lower baseline BMI%. In Conlon and colleagues' study, however, 65% of the obese children had an increase in BMI after surgery, and the absolute change in weight was similar to changes seen in nonobese children undergoing tonsillectomy. Most studies look at follow-up periods from 6 months to 1 year. However, 1 large cohort study had up to an 8-year follow-up period looking at tonsillectomy in 0 to 7-year-olds and weight measurements at the age of 8 years.¹³ The authors found that children who underwent tonsillectomy before the age of 7 years were more likely to be overweight or obese at the age of 8 years than children who did not.

Another interesting finding was that older children tended to have a higher BMI% before surgery but had less increase in BMI% after surgery compared with younger children, who had a lower BMI% before surgery and had a significantly increased BMI% after surgery. In other words, younger children gained more weight after tonsillectomy than older children (Figure 4). These data could suggest that younger children, who are more likely to undergo tonsillectomy for sleep-disordered breathing or dysphagia (possibly associated with growth failure), are gaining weight after surgery once the obstruction is relieved. Older children, who are more likely to undergo tonsillectomy for chronic tonsillitis and who are already at a higher BMI%, have less change in weight. Again, there are many potential explanations for why younger chil-

dren, who often have obstructive sleep apnea (OSA), gain more weight, including decreased energy expenditure, with decreased work of breathing and hormonal alterations (increased levels of growth hormone and decreased levels of catecholamines). In a study by Marcus et al,⁶ children with OSA who underwent tonsillectomy had an average of 5 kcal/kg less energy expended per night after surgery without any effect on diet. Roemmich et al⁷ postulate that because children with OSA are often hyperactive, curing children of OSA might lead to less hyperactivity and therefore to less calorie expenditure. Regardless, according to our data, it was clear that the numbers of overweight and obese children did not increase significantly after surgery.

Ultimately, our study is limited in its retrospective nature. Indications for tonsillectomy were not elucidated; therefore, it is possible that underlying causes could play a role in the degree of weight gain. Interestingly, in a 1992 study by Ahlqvist-Rastad,¹⁴ the degree of postoperative weight gain was found to correlate directly with tonsil size, which was not a factor that we analyzed. We similarly did not analyze the method of tonsillectomy (eg, microdebrider vs Bovie electrocautery). Some studies suggest that particular ethnic groups are more at risk for postoperative weight gain,¹⁵ but we did not investigate this theory either. Also, we chose the follow-up period of 6 to 18 months based on prior studies, but it is certainly possible that there is an even greater delay in full weight gain or that any weight gained may be lost in the subsequent years. We also looked at all children undergoing tonsillectomy and did not exclude those children who were underweight from our analysis. These underweight children would be expected to have some catch-up growth as regression to the mean, irrespective of tonsillectomy. A well-designed prospective trial controlling for caloric intake, eating habits, exercise, and lifestyle in addition to age, sex, ethnicity, and preoperative BMI% would help clarify this issue further.

In conclusion, our retrospective study of 200 patients aged 2 to 12 years undergoing tonsillectomy showed that children gained weight after the procedure but that undergoing a tonsillectomy did not increase the odds of being overweight or obese after surgery. Although the study is limited because the indications for tonsillectomy were not analyzed, we postulate that younger children often undergo tonsillectomy for OSA, while older children are more likely to undergo tonsillectomy for chronic tonsillitis. These differing indications may explain why younger children gained weight after tonsillectomy yet older children did not. Clearly, a prospective study could help elucidate these issues. Regardless, otolaryngologists should have an appreciation for postoperative weight gain in children after T&A. However, it is unlikely that T&A causes an increased risk of obesity after surgery.

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Author Contributions: Dr Schmidt had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Levi and Schmidt. **Acquisition of data:** Levi and Schmidt. **Analysis and interpretation of data:** Levi, Leoniak, and Schmidt. **Drafting of the manuscript:** Levi, Leoniak, and Schmidt. **Critical revision of the manuscript for important intellectual content:** Levi, Leoniak, and Schmidt. **Statistical analysis:** Levi and Schmidt. **Study supervision:** Levi and Schmidt.

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