# Catch-up growth in infants with laryngomalacia after supraglottoplasty☆

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### ABSTRACT

*Importance:* Laryngomalacia, the most common congenital anomaly of the infant airway, can lead to poor feeding and failure to thrive. The decision to perform the standard surgical treatment, supraglottoplasty, is often based upon a sustained period of poor weight gain or weight loss.
*Objective:* To characterize patterns of growth in infants with laryngomalacia, preceding and following supraglottoplasty.
*Design:* Retrospective chart review. Bioinformatics techniques were used to procure data from a clinical data warehouse based on the HL7 Reference Information Model consisting of all infants who underwent supraglottoplasty from June 1, 2005 to October 31, 2013. Height and weight measurements were obtained from 76 operated patients allowing for characterization of growth changes from the time of surgery to an average of 9 months following surgery. Logistic regression analysis was performed to examine the following variables for correlations with changes in weight, height and body mass index percentiles: patient age at surgery, preoperative weight, gender, and ethnic background.
*Setting:* Academic pediatric tertiary medical center.
*Participants:* Patients under 2 years of age at the time of surgery, who underwent supraglottoplasty for laryngomalacia, with height and weight measurements recorded within 3 months preceding surgery and greater than 3 months following surgery.
*Intervention:* Supraglottoplasty.
*Main outcomes and measures:* Change in weight, height and body mass index (BMI) percentile from pre-op to post-op.
*Results:* BMI increased from a mean of 15.4 to 18.0 and BMI percentile from a mean of 34 to 51 from pre-op to post-op. The largest BMI percentile increases were observed in infants that were 3 months or younger at the time of surgery, as well as in those under 12 months of age, who were in the lowest BMI quintile.
*Conclusions and relevance:* Infants who underwent supraglottoplasty tended to be small in weight and stature, and gained weight after surgery. Most of the weight gain occurred within 6 months of surgery. The largest increases in BMI percentile were observed in infants who were younger and smaller at the time of surgery while the infants older than 18 months had no significant gain.

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## 1. Introduction

Laryngomalacia is the most common congenital abnormality of the infant airway [1]. The majority of cases can be managed with close observation and resolve as the infant grows. However, a proportion of the severest cases require surgical intervention with supraglottoplasty. The decision to proceed with surgery is based on multiple factors including the severity of respiratory symptoms, obstructive sleep apnea and failure-to-thrive [2]. Previous studies have shown that infants with failure-to-thrive related to laryngomalacia do grow after supraglottoplasty [3,4]. Building upon this work, we sought to perform a more extensive subgroup analysis of the growth patterns in children after supraglottoplasty and the longer-term temporal course of the growth change.

## 2. Patients and methods

The Stanford Translational Research Integrated Database Environment (STRIDE) was utilized in order to procure a comprehensive database of weight and height measurements in structured format. The study was reviewed and approved by the Stanford University School of Medicine Institutional Review Board. Data were procured from all infants who underwent supraglottoplasty (CPT codes 31420, 31540, 31541, 31560, or 31561) from June 2005 to October 2013 at a tertiary pediatric hospital, and initially included 111 surgical patients with over 5000 height and weight measurements.

Subjects who met the following criteria were included: age younger than 24 months at the time of surgery, at least one height and weight measurement recorded within 3 months prior to surgery, and at least one height and weight measurement recorded 3 months or longer after surgery. No patients were excluded based on medical comorbidities. 92 of these patients had adequate preoperative height and weight measurements able to be abstracted from the STRIDE inquiry. Computer analysis of the large dataset revealed that many of the measurements were repeat measurements, and measurements that were likely to be erroneous (e.g. decrease in height over time, or height/weight combinations that were physically impossible). A Python program was written to calculate height, weight and BMI percentiles, perform a "data-scrubbing" to eliminate patients with faulty or inadequate data, and reformat the dataset into a temporal organization that was statistically analyzable, as previously described [5].

The final database consisted of 76 patients with adequate growth data. Demographic data on gender and ethnicity were also included into the final database of height and weight percentiles. These data were then analyzed for statistical significance using logistic regression analysis.

## 3. Results

The demographic makeup of the 76 patients is shown in Table 1. The mean time point at which post-operative height and weight were measured was 275 days, and the median was 94 days.

The population of children that underwent supraglottoplasty had significantly lower weight and height percentiles at the time of surgery than a normal distribution of children (Fig. 1). Overall, there was an increase in both BMI and BMI percentile from before to after surgery: BMI increased from a mean of 15.4 to 18.0 and BMI percentile from a mean of 34.1 percentile to 51.2 percentile.

Subgroup analysis revealed a trend toward increased post-operative growth in children that were younger at the time of
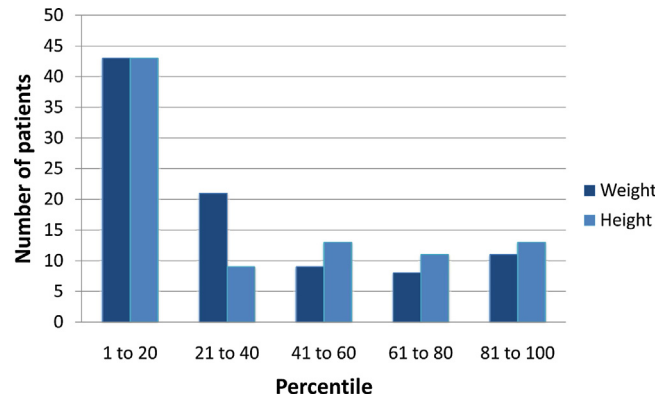
**Fig. 1.** Distribution of preoperative height and weight percentiles.

surgery (Fig. 2) with those 3 months and younger gaining 34 percentile points while those over 12 months only gaining 3 percentile points. Notable gains were also observed in children less than 1 year of age who were in the lowest BMI quintile at the time of surgery, gaining 33.6 percentile points, compared to age-matched infants in the top two quintiles who gained only 1 percentile point (Fig. 3A). In children over 1 year of age, smaller gains were observed in the lowest two quintiles (1–20th percentile: 14.1 points, 21–40th percentile: 12.3 points) while those in the top three quintiles' BMI percentiles remained stable (Fig. 3B).

Finally a time course of weight gain in children under a year at time of surgery shows that the majority of growth occurs in the first 6 months and plateaus at approximately 12 months post-op (Fig. 4).

## 4. Discussion

This study is the largest analysis to date of post-supraglottoplasty weight gain in infants with laryngomalacia. The gender make up of the study population was similar to those observed in prior studies [6,7]. Laryngomalacia is known to disproportionately affect male infants, and the 2:1 male to female ratio observed in our series corroborated this (Table 1).

The preoperative heights and weights of the supraglottoplasty patients did not fit a normal distribution. A majority of the infants (57%) were in the lowest height and weight quintile at the time of surgery (Fig. 1). This is not surprising given that failure to thrive is one of the main criteria used to determine whether or not surgery is needed.

**Table 1**
Demographic characteristics of the study population.

| | Number of patients (%) |
|---|---|
| Age at surgery (months) | |
| <6 | 48 (52) |
| 6–12 | 10 (11) |
| 12–18 | 5 (5) |
| >18 | 29 (32) |
| | |
| Gender | |
| Female | 33 (36) |
| Male | 59 (64) |
| | |
| Ethnicity | |
| Asian | 22 (24) |
| Black | 4 (4) |
| Native American | 1 (1) |
| Other | 2 (3) |
| White | 63 (68) |
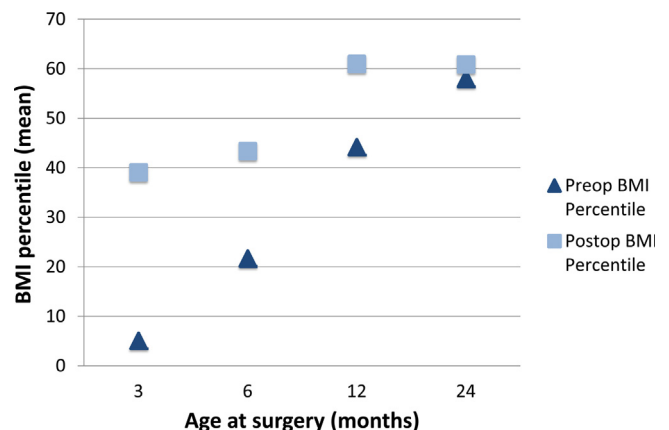
**Fig. 2.** Pre- and post-operative BMI of infants based on age at time of surgery.