Postoperative Management Following Supraglottoplasty for Severe Laryngomalacia

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Objectives/Hypothesis: To retrospectively analyze the postoperative management and care needs of patients undergoing spontaneous ventilation supraglottoplasty (SVS).

Study Design: Retrospective chart review.

Methods: Charts of children undergoing (SVS) for severe laryngomalacia from 2007 to 2011 at a single institution were reviewed. Intraoperative and postoperative management data were collected to review the airway management, postoperative care needs, and potential complications associated with this surgery.

Results: A total of 65 patients were included in the study. Only three patients (4.5%) required more than an overnight stay in the hospital, and no patients left the operating room intubated. One patient required temporary intensive care unit observation, and the majority (78.1%) demonstrated adequate oral intake within 4 hours of surgery. Comorbidities did not portend a longer hospital stay or slower return to oral intake.

Conclusions: SVS with cold-steel instruments is a safe and effective surgical intervention with low complication rates. This study suggests that postoperative intubation or intensive care unit monitoring may not be necessary when using these techniques.

Key Words: Laryngomalacia, supraglottoplasty, postoperative management, pediatric airway.

Level of Evidence: 4.

INTRODUCTION

Laryngomalacia is the most common cause of stridor in infants, with estimates implicating this pathology in 45% to 75% of cases. Inspiratory prolapse of supraglottic structures leads to varying degrees of airway obstruction. This obstruction manifests in a wide spectrum of respiratory and feeding difficulties, which can be equally as distressing to the parents as they are to the infants. Most commonly, symptoms appear to peak around 6 to 8 months and typically resolve between 12 and 24 months, with nonsurgical management being sufficient in the majority of cases. However, roughly 10% to 20% of infants have a more severe form of this disease, presenting with failure to thrive, obstructive sleep apnea, cyanosis, and/or aspiration. Although there are no clear guidelines for surgery, it is this subset of patients with severe disease, whose growth and development appear significantly impacted by their breathing and/or feeding difficulties, who are typically considered for surgical intervention.

Supraglottoplasty, as described by Zalzal et al. in 1987, is a safe and effective procedure for these select patients. Success rates have been reported to be as high as 95%, and complication rates are consistently shown to be below 10%. Although numerous endoscopic techniques and methods have been reported, most surgery aims to release the aryepiglottic folds and remove supraglottic redundant tissue. Although numerous studies have looked at the outcomes and techniques of supraglottoplasty, few studies have reviewed the postoperative care needs of these patients, especially in regard to airway management. Traditionally, these patients have been kept intubated overnight in the intensive care unit (ICU), and a number of tertiary care centers continue this practice despite a paucity of data to support its necessity. This study aimed to review our experience with infants undergoing supraglottoplasty and sought to evaluate their postoperative care needs, with specific attention to airway management, length of stay, and return to oral intake.

MATERIALS AND METHODS

After obtaining institutional review board approval, charts of patients undergoing supraglottoplasty for severe laryngomalacia from 2007 to 2011 at our tertiary care institution were reviewed. All patients underwent preoperative flexible fiberoptic laryngoscopy to confirm the diagnosis of laryngomalacia. Severe laryngomalacia was defined as documented laryngomalacia with failure to thrive, obstructive sleep apnea, respiratory distress, episode(s) of cyanosis, and/or failure of medical
management. This definition is consistent with previous descriptions of this more severe form of this pathology. The patients in this study received operations from a single surgeon.

We used two important exclusion criteria for this study to limit confounding variables for the postoperative measures. First, we excluded patients on whom multilevel airway surgery had been performed. Second, we excluded patients who had other active medical comorbidities and were being managed primarily by other inpatient services. We felt it would be difficult to control certain postoperative measures (i.e., length of stay, pain control) given the concurrent management of other medical comorbidities by different teams.

We recorded post-operative measures from the medical charts of these patients, including age, weight, and American Society of Anesthesiologists (ASA) level. With regard to the operation itself, we looked at operative time, recorded complications, and noted whether the patient was intubated postoperatively. In the postoperative period, we looked at oxygen requirement, desaturations, intubation rates, time to return to oral intake, pain medicine requirement, and length of stay. For the more distant postoperative period, we looked at readmission rates within 2 weeks and any need for additional surgery. Patients who were not already on reflux medication were begun on twice-daily proton pump inhibitor therapy postoperatively.

All supraglottoplasties were performed in a similar fashion with cold-steel instrumentation exclusively. Insufflated sevo-

fluorane is delivered to the oropharynx via a tube in the corner of the mouth, out of the surgical field. All patients received topical laryngotraheal anesthesia as well as a dose of intraopera-

tive dexamethasone (typically 0.5–1 mg/kg). While the patients are kept spontaneously breathing without intubation, we perform a microlaryngoscopy and bronchoscopy to assess for secondary airway lesions, such as subglottic stenosis and tra-

cheomalacia. We then place the patients in suspension using a Lindholm or Parsons laryngoscope, and using microlaryngeal scissors and graspers, release the aryepiglottic folds and remove the supraglottic redundant tissue. This excess tissue, which is most often a combination of mucosa and corniculate or cunei-

form cartilage, is ascertained following the release of the aryepi-

glottic folds by using a blunt grasper to fold the supra-arytenoid mucosa into the airway. This simulates the arytenoid prolapse, and there is consistently an identifiable “break” differentiating more stable airway from the prolapsing airway classically observed in these patients. This point is often just at or above the corniculate cartilage. An epiglottoplasty is typically not performed. Afrin-soaked pledgets are used to coat the surgical area for about 60 seconds at the conclusion of the surgery to assist with hemostasis.

With exceedingly rare exception, the patients are not intu-
bated during or after the procedure. They are observed in the postanesthesia care unit (PACU) until they achieve an Aldrete score of greater than 10. Following PACU observation, they are typically cared for on a normal pediatric ward with continuous pulse oximetry and discharged when appropriate.

RESULTS

From 2007 to 2011, 83 patients were identified as undergoing supraglottoplasty at our institution by a single surgeon (D.R.W.). After applying our exclusion criteria, our final data included 65 patients and 66 operations. The median age of the patients undergoing this operation was 3 months (mean, 9.9 ± 16.9 months), and the median weight was 6 kilograms (mean, 8.0 ± 6.0 kg). The ASA physical status classification data were used to stratify patients based on their overall health. Data were available on 53 of our patients. Of these, five children (9.2%) were categorized as ASA class 1, whereas 38 (70.4%) were considered class 2, and 11 (20.4%) patients were class 3. Comorbid conditions encountered in these patients are represented in Table I. Thirteen patients (20%) were considered to have neurologic, cardiac, and/or genetic comorbidities. We did not count prematurity as a comorbidity in itself.

Operative notes and records were reviewed for intraoperative analysis. The average length of the operation was 23.6 ± 10.2 minutes. No operative note recorded any bleeding complications or blood loss in excess of minimal. No operative notes or medical records noted any immediate postoperative complications, and no patients in 66 operations left the operating room intubated.

Postoperatively, all but one patient was transferred to the PACU. All patients transferred to the PACU were placed on oxygen per anesthesia protocol. One patient, while extubated, was transferred to the pediatric intensive care unit for several hours of observation. On average, patients spent 66.0 ± 28.6 minutes in the PACU, and only one patient (1.5%) had a supplemental oxygen requirement at the time of floor transfer. This single patient was weaned off of oxygen within a few hours of being on the pediatric ward. According to the PACU vitals flow sheets, seven patients (11.3%) had transient desaturations below 90% postoperatively, and no patients had recorded desaturations while on the ward.
Starting in the PACU, the patients’ oral intake was recorded to assess postoperative length of time required to return to adequate oral feeding. We subjectively defined return to consistent oral intake as at least two consecutive feeds within 4 hours time, with a weight-appropriate volume capable of sustaining the patient’s intake requirements. Of the 64 patients on whom data were available, 50 (78.1%) had returned to consistent per oral (PO) intake within 4 hours of surgery, 12 patients (18.8%) within 4 to 12 hours of surgery, and the remaining two patients (3.1%) within 12 to 24 hours of surgery. Thus, all patients had returned to consistent oral intake by postoperative day 1. When the patient sample was divided into those with and without comorbidities, the return to oral intake was very similar, with 10 of the former patients (77%) returning to consistent oral intake within 4 hours of surgery (Table II).

Even though evaluating pain control in infants is difficult, we recorded pain medication requirements postoperatively in these patients to describe the type of analgesic regimen necessary. Data were available on 60 patients, showing that 31 patients (50.8%) received some form of narcotic medication in the PACU, whereas only four patients (6.5%) required any such narcotic analgesia while on the pediatric ward. Furthermore, by the time of discharge, only two patients (3.0%) left the hospital with a prescription for acetaminophen (Tylenol) with codeine. The remaining patients were managed with acetaminophen alone.

Hospital length of stay was recorded in all patients. The average length of stay was 0.95 ± 0.44 nights. Only three patients in 66 operations (3.5%) required more than 1 night in the hospital, and one patient (1.5%) required several hours of intensive care unit observation. Again, patients with comorbidities did equally as well postoperatively as those without comorbidities in regard to hospital length of stay (Table III). The patients with comorbidities group included three patients who went home the same day as surgery, all of whom were over 14 months of age. Although the means are different between these two groups, the difference is not statistically significant ($P = .1$). Within 2 weeks of discharge, one patient (1.5%) was readmitted for respiratory symptoms, and three patients (4.5%) went on to need additional surgery to address their persistent respiratory and/or feeding difficulties.

### TABLE II.  
Return to Adequate Oral Intake in Patients With and Without Comorbidities.

<table>
<thead>
<tr>
<th>N</th>
<th>Return to PO &lt;4 Hours</th>
<th>Return to PO 4-12 Hours</th>
<th>Return to PO 12-24 Hours</th>
<th>Unavailable Data</th>
<th>PO = per oral.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients with comorbidities</td>
<td>13</td>
<td>10</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Patients without comorbidities</td>
<td>52</td>
<td>40</td>
<td>10</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>All patients</td>
<td>65</td>
<td>50</td>
<td>12</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

### DISCUSSION

Supraglottoplasty has been shown consistently to be an excellent treatment for severe laryngomalacia even though the indications for surgery are variable among otolaryngologists. Although feeding, growth curves, and aspiration have been shown to improve following surgery, little data have been published regarding the postoperative management of these patients with specific focus on how to manage their airway postoperatively. Postoperative intubation has been adopted by numerous institutions with little clear evidence to support its necessity or at least determine who might benefit from this practice. This retrospective study attempted to offer further insight into this discussion.

In our experience, cold-steel spontaneous ventilation supraglottoplasty (SVS) is an efficient and safe procedure with rare intraoperative or postoperative complications. No significant bleeding problems were noted for any of our patients with the cold technique, even though anecdotally this has been a criticism of this method.

Our patients are typically monitored in the PACU for about an hour on average before being transferred to the pediatric ward. The patients’ pain management during this immediate recovery period is almost exclusively driven by the anesthesia team. Given that it is often difficult to assess an infant’s pain, the PACU narcotic requirement for patients may be an overrepresentation of the true postsurgical discomfort. Once transitioned to the ward, the majority of patients (93.5%) were adequately managed on acetaminophen alone.

Not far removed from pain control is patients’ return to appropriate PO intake. Based on our criteria, the majority of patients began and sustained appropriate PO intake even within 4 hours of surgery. The subjective temporal distinctions we used to differentiate how quickly patients begin feeding should not overshadow the simple fact that all of these patients were off intravenous fluids and sustained by their own oral intake within 24 hours.

Schroeder et al. detailed their postoperative airway management in patients undergoing supraglottoplasty. Sixty-three percent of their patients required some form of nonsurgical airway support, with 33% requiring intubation. Racemic epinephrine, steroid nebulizers, heliox, continuous positive airway pressure/bilevel positive airway pressure, nasal trumpets, and supplemental oxygen
were all considered as elements of nonsurgical airway support. Our experience has been quite different. None of our patients in this study were intubated postoperatively, and none of them required intubation at any point during their hospital stay. All of our patients were on oxygen in the immediate postoperative period per anesthesia protocol, and only one patient needed supplemental oxygen after having left the PACU. In the PACU, 11.3% of patients had transient desaturations, and given the limits of the medical documentation it is difficult to know if these recordings were accurate. What is clear, however, is that these were all self-limiting, and the patients recovered without any additional respiratory support.

Compared to Schroeder’s group, where the average hospital length of stay for a child without a neurologic condition was 2.4 days, our average length of stay was 0.96 days for all patients. Interestingly, our cohort of patients also included children with neurologic disorders, syndromes, and cardiac disease as represented earlier. As suggested by the ASA levels as well, our surgical group was a heterogeneous one that included a number of children with complex medical histories and comorbidities. We did have eight patients older than 2 years with late onset laryngomalacia or exercise-induced laryngomalacia requiring surgical intervention, and some of these patients were able to be discharged the day of surgery (explaining the mean length of stay of <1 night). Furthermore, all the patients who stayed more than 1 night in our study remained in the hospital for reasons unrelated to their postoperative recovery. Coordination of care and transfer to other medical facilities were the more common reasons for additional length of stay. Few other papers have commented on postoperative airway management. Richter et al. reported a series on 50 infants, all of whom were intubated overnight and monitored in the intensive care unit. O’Connor et al. reported on 46 infants, most of whom spent the night in the ICU following surgery, without specifically mentioning whether or not the patients were intubated.

One notable difference between our study and the Schroeder et al. study was the type of instrument used during supraglottoplasty. Although we used cold-steel microlaryngeal instruments for all procedures, Schroeder et al. used a CO₂ laser for all of their cases. It is unlikely that this tool alone could account for the differences observed. However, the thermal energy of the laser could contribute to more laryngeal edema than cold-steel instrumentation, resulting in the need for postoperative intubation and/or ICU observation, thus lengthening the hospital stay. Furthermore, the time to set up the laser and position the proper equipment leads to additional operative time, during which the patient may remain in suspension. Longer operative times may also contribute to postoperative edema, necessitating different airway management strategies.

We did evaluate the medical records for readmission within 2 weeks, and there was only one patient who met this criterion. Coincidentally, the patient was found to have a concurrent subglottic stenosis during his supraglottoplasty and was readmitted for observation to the hospital when an upper respiratory tract infection caused increased work of breathing. It is possible, given our regional referral patterns, that other patients could have been admitted to outside facilities for similar reasons without our knowledge. Given the retrospective nature of the study, there is a possibility that a higher rate of unknown complications was present.

What is also compelling is the fact that patients with medical comorbidities did not do worse postoperatively when compared to patients without these medical issues. There are clear differences in the literature with regard to success of surgery between these patient populations, but with regard to postoperative course, all patients did equally well. The average length of stay for patients with medical comorbidities was lower simply because three of these patients were able to be discharged the same day as surgery. The difference in means was not significant (P > .05).

There are several weaknesses to this study. First of all and most apparently, this is a retrospective chart review limited by the recorded data and its inability to prospectively evaluate any variables. Although most data were present within the medical record, not all end points could be recorded for every patient, and this is an inherent shortcoming of the retrospective methodology. This study design is accompanied by a lack of any meaningful statistical analysis, as we did not have a control group against which to compare our patients’ data. Furthermore, the complication rates were so low that identifying risk factors for less favorable outcomes based on our end points was prohibited.

As the medical literature expands, the standards of care continue to be refined to offer the appropriate care to our patients. Delivering optimal care includes minimizing hospital stays and costs. With regard to airway management, we elected to avoid postoperative intubation when it did not compromise care. Without prospective data on this topic, it would be presumptuous to claim that all patients could be managed in this way. However, with these data, it certainly calls into question routine postoperative intubation or ICU observation for cold-steel supraglottoplasty patients, and hopefully stresses the importance of the need to identify the small subset of patients who may require this type of airway management.

CONCLUSION

SVS with cold-steel instrumentation provides excellent results in children with severe laryngomalacia. Their postoperative pain is manageable, and their return to sustainable PO intake is quick. Overnight hospital stays on the pediatric ward were uneventful at our institution. Postoperative intubation in these patients may not be necessary when cold-steel and spontaneous ventilation techniques are applied.

BIBLIOGRAPHY


