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Practice Patterns in Supraglottoplasty and Perioperative Care

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Abstract

Objectives—Supraglottoplasty is the first-line surgical treatment for severe laryngomalacia. The purpose of this study is to determine current trends of practice patterns in management of children requiring supraglottoplasty.

Methods—A 25-question survey on management in supraglottoplasty was sent by e-mail to 274 physician members of the Society for Ear, Nose & Throat Advances in Children (SENTAC).

Results—101 surgeons responded and 72% of respondents were in academic practice ($p < 0.0001$). All four United States regions, Canada and the United Kingdom were represented. The most commonly reported age of patients undergoing supraglottoplasty was 1–3 months (62% of respondents). Indications include worsening airway symptoms (43%), failure to thrive (41%) and worsening feeding (10%). The majority of respondents (89%) treat these patients for reflux with 54% prescribing PPIs and 41% prescribing H2 blockers. Cold steel is the most popular surgical technique (73%) followed by laser (14%), microdebrider (10%) and coblator (3%) ($p < 0.0001$). Most respondents (92%) administer intraoperative steroids with the majority of them choosing dexamethasone (99%). Perioperative antibiotics are administered by 23% of respondents. Almost all respondents admit their patients for post-operative observation (99%) and 53% of these admit to PICU rather than step-down or floor status. The level of care is associated with the number of supraglottoplasties performed per year ($p = 0.009$) and with the geographic region ($p = 0.02$). Surgeons who perform fewer supraglottoplasties tend to admit to a higher level of care. Those in the South and Northeast regions tend to admit more to floor status. Only 13% routinely keep patients intubated post-operatively.

Conclusions—This provider survey study highlights some significant variations and trends in practice patterns of otolaryngologists who perform supraglottoplasty. The majority utilizes anti-reflux pharmacotherapy; however, there is no consensus in the type. The method for

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supraglottoplasty also varies with cold steel being the most popular, although no single method has been shown to be superior. There is variation in post-operative care with trends for keeping patients extubated and admitting them to an intensive care. With the importance of safe, effective, and also cost-conscious care, further studies are needed to understand the optimal management of those who undergo supraglottoplasty.

Keywords

supraglottoplasty; laryngomalacia; otolaryngologist; pediatric

1. Introduction

Laryngomalacia is a respiratory disorder involving inspiratory collapse of supraglottic structures (epiglottis, aryepiglottic folds, arytenoids). This supraglottic obstruction leads to increased work of breathing and stridor. Laryngomalacia is the cause of up to 75% of cases of congenital stridor [1].

Although the exact etiology of laryngomalacia is unknown, several theories have been proposed. Recent neurophysiological studies have implicated a deficiency in the laryngeal adductor reflex – a sensorimotor reflex that integrates laryngeal sensation and the corresponding vagal response that provides glottic closure [2]. Laryngopharyngeal reflux is also thought to contribute to laryngomalacia since mucosal edema from refluxate can contribute to supraglottic airway obstruction. This can lead to a negative cycle wherein airway obstruction increases negative intrathoracic pressure, further exacerbating gastric reflux [3, 4]. Another hypothesis indicates that the pathologic collapse of supraglottic tissue is due to excess congenital flexibility of laryngeal tissue [4].

A reliable diagnosis in patients with suspected laryngomalacia can be made using flexible laryngoscopy [5]. Characteristic findings include inspiratory supraglottic collapse, shortened aryepiglottic folds, tubular or omega shaped epiglottis and poor visualization of the vocal cords [6]. While stridor is the cardinal symptom of laryngomalacia, eight additional symptoms have been associated with more severe laryngomalacia: suprasternal retraction, substernal retraction, feeding difficulty, choking, post-feeding emesis, failure to thrive and cyanosis [7, 8].

The classification of laryngomalacia based on the severity of symptoms helps to guide treatment strategy. Mild-moderate laryngomalacia is managed conservatively with specialized feeding therapy: slow feeds with thickened formula for infants, positional support and anti-reflux management. Symptom resolution is typically seen by 12–24 months [9, 10].

Approximately 5–20% of cases of laryngomalacia are associated with severe symptoms [7, 8]. Severe cases of laryngomalacia can be surgically managed with supraglottoplasty, which involves the endoscopic removal or stabilization of redundant supraglottic tissue to relieve airway obstruction. Durable success after supraglottoplasty is common and has been reported to occur after 53% to 95% of cases [3, 8, 11–13]. Although supraglottoplasty is the primary treatment for severe laryngomalacia, there is currently considerable variation in

perioperative and intraoperative management of patients undergoing supraglottoplasty. We are not aware of any studies that describe the nature and extent of this variation. The purpose of this study is to determine current trends and practice patterns in treating laryngomalacia with supraglottoplasty and to assess if specific treatment practices should be studied further.

2. Material and Methods

A 25-question survey regarding supraglottoplasty techniques and perioperative management was designed in REDCap [14] (figure 1). This investigator designed survey was created after a literature review and was internally reviewed by physicians, clinical research coordinators and biostatisticians prior to distribution. The survey was not externally validated. Most of the survey questions (23) were close-ended multiple-choice, but 11 of these allowed respondents to select an open-ended alternative to add their own comments beyond the provided options. Two questions were free-response. Duke Institutional Review Board exempt status was granted for this anonymous provider survey.

Members of the Society for Ear, Nose, & Throat Advances in Children (SENTAC) with an active e-mail account were surveyed. An e-mail was sent to the society membership with a link to an anonymous REDCap survey. The membership includes 274 physicians, but this also includes some non-otolaryngologist physicians. Question #1: "Do you perform pediatric supraglottoplasty?" limited the survey to practicing otolaryngologists as the survey ended if a "No" response was submitted. Two additional reminder e-mails were sent out at three and six weeks after the original e-mail to maximize the number of responses.

Categorical variables were summarized using frequencies and percentages. The missing responses were not considered in calculating the percentages in each category. The association between categorical variables was assessed through the Fisher's exact test and the obtained p-values were adjusted using the Holm-Bonferroni method for multiple comparisons to control the family-wise error [15]. In order to assess whether the survey responses were significantly different from the case where responses are evenly distributed across the possible options, the number of responses were evaluated with the exact binomial test when there were two possible categories and with the Pearson's Chi-squared test when there were more than two possible categories, assuming equal probability of occurrence for each category. Continuous variables were evaluated with a one-way analysis of variance (ANOVA) F- test to assess the group means differences. The significance level for assessing the statistical tests was set to $\alpha = 0.05$. All analyses were conducted using R software [16] version 3.2.1.

3. Results

3.1 Respondent characteristics

A total of 101 otolaryngologists responded to the survey (table 1). 72% of respondents were in academic practice and this was statistically different than the proportion of private practitioners ($p < 0.0001$). All four United States geographic regions (Midwest, Northwest, South, and West), Canada and the United Kingdom were represented.

3.2 Pre-operative preferences

The most common reported average age of the patients undergoing supraglottoplasty for laryngomalacia was between 1–3 months (62%) (table 2). Apparent life threatening events (ALTEs) or worsening airway symptoms was the most frequently cited reason to perform supraglottoplasty (43%), followed closely by failure to thrive (41%) (table 2). 10% cited worsening feeding symptoms and 1% cited parental concern as the most common reason to perform supraglottoplasty. The number of responses for reason to perform supraglottoplasty were not equal across the indication categories ($p<0.0001$), but the number of responses for the two most cited reasons (ALTEs and failure to thrive) were not statistically different from each other ($p=0.91$).

89% of respondents treat patients with laryngomalacia for reflux, with 54% recommending reflux precautions combined with a proton pump inhibitor and 41% using reflux precautions combined with an H2 blocker (table 3). There were no statistically significant associations between providing reflux treatment and any other relevant variables.

3.3 Intraoperative preferences

The majority of respondents (73%) use only cold steel (sharp cutting instruments) followed by laser (14%), then microdebrider (10%) and least frequently coblator (3%) (figure 2). The numbers of responses for preferred method were not equal across categories ($p<0.0001$), and cold steel was performed more frequently than the other choices ($p<0.0001$). 92% of respondents give perioperative steroids and 99% selected dexamethasone as their steroid of choice. 23% of respondents give perioperative antibiotics. There were no statistically significant associations between method used for supraglottoplasty, perioperative steroid use or antibiotic use and any other relevant variables.

3.4 Post-operative preferences

99% of respondents admit their patients for observation after supraglottoplasty. 53% admit their patients to a pediatric intensive care unit (PICU) (figure 3). Admission to the PICU was significantly more common than admission to a stepdown unit ($p<0.0001$) or to the floor ($p=0.006$). The level of care was associated with the number of pediatric supraglottoplasties performed per year ($p=0.009$) and with the geographic region ($p=0.02$). Surgeons who perform fewer supraglottoplasties annually tend to admit to a higher level of care. Those in the South and Northeast regions tend to admit more to floor status. There was no significant association between type of practice or number of years in practice and the postoperative admission location.

13% of respondents keep their patients intubated postoperatively (table 4). There were no statistically significant associations between keeping the patient intubated postoperatively and other relevant survey responses. 24% get a postoperative swallow evaluation by speech language pathology (SLP) prior to discharge and there was no statistically significant association between this and other relevant survey responses. Few (7%) respondents routinely perform a postoperative flexible fiberoptic laryngoscopy prior to discharge. There was a statistically significant association between type of practice (academic or private) and

tendency to perform a postoperative flexible laryngoscopy ($p=0.034$) and private practitioners perform relatively more.

4. Discussion

4.1 Respondent characteristics

The respondents were limited to members of SENTAC, since this was the source of the e-mail list. There could be more variation or patterns amongst respondents if more otolaryngologists who are not members of the society or who practice in different countries were included in the analysis. The average number of years in practice of the respondents was 15 years. Duration in practice can affect practice patterns, however in this survey there were no statistical significant differences by duration in practice in surgical method, reflux management, use of steroids, use of antibiotics, postoperative level of care, tendency to keep intubated, get a postoperative swallow study or do a postoperative flexible laryngoscopy prior to discharge. The 73% proportion of academic respondents to this survey is higher than expected from the entire pediatric otolaryngologist population. This study is also limited by its survey methodology, which allows for recall and response bias.

4.2 Pre-operative preferences

The Thompson-Based Laryngomalacia severity classification system classifies laryngomalacia as mild, moderate and severe based on the presence of certain symptoms in addition to stridor [2, 17]. ALTEs or worsening airway symptoms and failure to thrive were the most commonly cited indications for supraglottoplasty in our survey. Feeding symptoms, which can include reflux, choking and regurgitation were cited less often. These results are consistent with the Thompson-Based Laryngomalacia severity classification system as both ALTEs and failure to thrive constitute “severe” laryngomalacia while most feeding symptoms can be classified as “moderate” laryngomalacia. Additional severe signs and symptoms are pectus excavatum, hypoxia, pulmonary hypertension and cor pulmonale. These are less commonly reported as the indication for supraglottoplasty [17], but can occur if more severe laryngomalacia is not adequately treated.

The majority of respondents treat reflux by prescribing a PPI or H2 blocker in addition to recommending reflux precautions. An increased incidence of gastroesophageal reflux disease (GERD) is seen in patients with laryngomalacia [17]. This is particularly evident in those with more severe laryngomalacia as they are over 9 times more likely to have reflux than those with mild laryngomalacia [18]. Supraglottoplasty has shown post-operative improvement in GERD in patients with co-existing pre-operative GERD [19]. There is evidence that acid-suppression improves swallowing function and laryngopharyngeal sensation [20]. A systematic review of laryngomalacia and acid reflux shows an association between the two, but there is inconsistent evidence to support improvement of laryngomalacia with antireflux therapy [18]. Although anti-reflux therapy and specialized feeding regimens are common, there is little standardization in medication and dosage used in acid suppression. Additionally, there may be adverse effects associated with specialized feeding regimens and anti-reflux therapy. There have been some rare reports of necrotizing enterocolitis in infants who have received xanthum based thickeners in their feeds [21].

Long-term pharmacologic acid suppression may not be safe for children [22]. The risks and benefits of reflux treatment in children with laryngomalacia should be evaluated further with prospective studies using standardized reflux testing and management.

Few respondents routinely get pre-operative sleep studies. Faria et al. reported a mean reduction in Respiratory Disturbance Index (RDI) from 23.6 pre-operatively to 11 post-operatively in patients undergoing supraglottoplasty [17]. A high prevalence of central sleep apneas (46%) has been reported in children with laryngomalacia, with an increased odds in those with neurological disorders, hypotonia or prematurity [23]. Although not frequently utilized, the role of polysomnography in assessment of laryngomalacia could be explored further.

4.3 Intraoperative preferences

Most respondents routinely give perioperative steroids and some give perioperative antibiotics. There is a lack of published data evaluating the risks compared to benefits of any types of regimens of these medications. It is not clear if these medications significantly affect outcomes or occurrence of complications in a way that supports their routine use.

The method used for supraglottoplasty also varies amongst providers and this is expected since no single method has been shown to be superior. This procedure was first done with cold steel and was described by Zalzal et al in 1987 [11]. The use of the carbon dioxide (CO₂) laser was later introduced. Both cold-steel and laser have been shown to have similar outcomes [24]. Although CO₂ laser supraglottoplasty was originally thought to be more precise with less intraoperative bleeding, more recent studies have shown cold-steel supraglottoplasty to be a reliable technique with very little bleeding [25, 26]. Microdebrider assisted procedures were first described in 2005 [27]. Since coblation technology was introduced at the beginning of the 21st century there has been little published on its use in supraglottoplasty. A potential benefit of the coblator is a reduction in risk of airway fires, which have been reported with the laser. A systematic review by Preciado et al reported that there was not enough stratified data available to assess outcomes in supraglottoplasty by specific method [28]. More studies are needed in this area to uncover if a true difference exists.

3.4 Post-operative preferences

Few respondents routinely utilize post-operative intubation for airway management immediately following surgery in our survey. No prospective studies have been published to evaluate the utilization of post-operative intubation after supraglottoplasty. In 2009 Richter et al published a case series of 50 patients from two tertiary care centers and all of the patients were intubated overnight after surgery [29]. More recently in a retrospective case series at one tertiary care hospital 9/223 (4%) of patients required postoperative intubation with intensive care unit (ICU) level care and in total 25/223 (11%) met criteria for ICU level care [30]. Fordham et al reported a series of 65 otherwise healthy patients with severe laryngomalacia who underwent cold steel supraglottoplasty at a tertiary care hospital [26]. None of them required post-operative intubation and only one required intensive care admission. Supplemental oxygen was provided in the immediate post-op setting, but this

support was weaned prior to transfer to the floor. This suggests that in appropriately selected patients post-operative intubation and ICU monitoring can be safely avoided.

There is variation in level of postoperative care based on both frequency of performing supraglottoplasty and geographic location of practice. This variability suggests that different levels of care can be effective to monitor these patients. Additionally, several respondents free-texted in response that they have the option to keep these patients in a special post-anesthesia care unit (PACU) or in a floor status setting with a low patient to nurse ratio. These postoperative observation options limit cost while ensuring a close observation environment. In an era where high quality but cost effective care is paramount, we need to better understand which patients truly need a high level of postoperative monitoring and how we can optimize care delivery environments to match needs. Also, few respondents get a postoperative swallow evaluation by speech therapy or perform a flexible fiberoptic laryngoscopy prior to discharge home. These procedures utilize additional resources. It is not clear if these additional procedures have a meaningful impact on the subsequent care of the patient that supports their continued use in the immediate postoperative period.

5. Conclusions

This provider survey based study shows that some significant variations and patterns exist in practice patterns of otolaryngologists who treat laryngomalacia and perform supraglottoplasty. Further studies and ones that are prospective and randomized are needed to compare methods of supraglottoplasty, perioperative medical management, perioperative diagnostic tests, postoperative intubation, and postoperative level of care in order to improve evidence based and cost effective care in these areas.

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1. Do you perform pediatric supraglottoplasty? ☐ Yes ☐ No (survey ends if No selected)
2. Preferred method? ☐ Cold steel ☐ Laser ☐ Harmonic scalpel ☐ Coblator ☐ Combination ☐ Other
3. Approximate number per year? ☐ < 5 ☐ 6-12 ☐ 12-25 ☐ >25
4. Average age at surgery? ☐ Newborn ☐ 1-3 mo ☐ 3-6 mo ☐ 6-12 mo ☐ > 12 mo
5. Most frequent reason for surgical intervention? ☐ Failure to thrive ☐ ALTEs, worsening airway symptoms ☐ Worsening feeding symptoms ☐ Parental concern ☐ Combine with another procedure ☐ Other (free-text box) _____
6. Do you routinely get sleep studies preop? ☐ Yes ☐ No
7. Do you routinely admit these patients postop? ☐ Yes ☐ No
8. (This question appears if yes for 7) What is your preferred immediate postop level of care? ☐ PICU ☐ Stepdown unit ☐ Floor status ☐ Other _____
9. Do you routinely keep your patients intubated immediately postop? ☐ Yes ☐ No
10. (This question appears if yes for 9) How long do they generally remain intubated? ☐ Until stable in unit ☐ 24 hours ☐ Other _____
11. (This question appears if no for 10) When would you plan for intubation postop? ☐ Significant medical comorbidities ☐ Severity of findings on flexible laryngoscopy ☐ Other airway findings ☐ Combination of above ☐ Other _____
12. Do you routinely administer steroids? ☐ Yes ☐ No
13. (This question appears if yes for 12) Preferred steroid? ☐ Dexamethasone ☐ Solumedrol ☐ Prednisolone ☐ Other _____
14. (This question appears if yes for 12) Frequency of steroid administration? ☐ One time in OR ☐ Q6 hrs for 24 hrs ☐ Q8 hrs for 24 hrs ☐ Q6 hrs for 36 hrs ☐ Q8 hrs for 36 hrs ☐ Taper over 36 hrs ☐ Other _____
15. Do you routinely give antibiotics? ☐ Yes ☐ No
16. (This question appears if yes to 15) Preferred antibiotic? ☐ Amoxil/sulbactam ☐ Cefazolin ☐ Clindamycin ☐ Ampicillin ☐ Other _____
17. (This question appears if yes to 15) how long do you give antibiotics for? ☐ One time periop dose ☐ Up to 24 hrs ☐ Up to 48 hrs ☐ Up to 5 days ☐ Other _____
18. Do you routinely manage reflux (LPR/GERD)? ☐ Yes ☐ No
19. (This question appears if yes to 18) What is your preferred method for managing reflux? ☐ Reflux precautions only ☐ Reflux precautions + H2 blocker (ranitidine, famotidine) ☐ Reflux precautions + PPI (omeprazole, lansoprazole, etc) ☐ Other _____

Figure 1a

20. Do you routinely have speech evaluate swallow before discharge? ☐ Yes ☐ No
21. (This question appears if yes to 20) Most frequent type of swallow eval done? ☐ Bedside clinical eval ☐ FEES
☐ VFSS/MBS ☐ Other _____
22. Do you routinely perform flexible laryngoscopy prior to discharge? ☐ Yes ☐ No
23. In what state do you practice? _____
24. How many years have you been in practice? _____
25. Type of practice? ☐ Academic ☐ Private tertiary care ☐ Private group ☐ Solo

Figure 1b

Figure 1.

Survey of operative and perioperative preferences of supraglottoplasty for laryngomalacia.

Figure 2.
Bar plot of number of respondents that use each method of performing supraglottoplasty for laryngomalacia.

Figure 3.
Bar plot of number of respondents that admit to each level of care postoperatively.

Table 1

Summary of the 101 survey responses by surgeon characteristics. The number of responses are listed with the corresponding percentage in parenthesis (rounded to the nearest integer).

N=101	
Type of practice	
Academic	73 (72%)
Private *	28 (28%)
Number of cases annually	
<5	35 (35%)
6–12	40 (40%)
13–25	20 (20%)
>25	6 (6%)
Years in practice	15 (± 10) [†]
Region	
International	8 (8%)
Midwest	25 (26%)
Northeast	17 (18%)
South	34 (35%)
West	13 (13%)

* private includes tertiary, group and solo practices

[†] mean (standard deviation)

Table 2

Summary of the 101 survey responses by pre-operative supraglottoplasty preferences. The number of responses are listed with the corresponding percentage in parenthesis (rounded to the nearest integer).

N=101	
Average age at time of surgery	
neonate	9 (9%)
1–3 months	61 (62%)
4–6 months	24 (24%)
7–12 months	3 (3%)
>12 months	2 (2%)
Most frequent indication	
Failure to thrive	41 (41%)
ALTEs, worsening airway symptoms	43 (43%)
Worsening feeding symptoms	10 (10%)
Parental concern	1 (1%)
Other	6 (6%)
Obtains preop sleep study	13 (13%)

ALTEs=apparent life threatening events

Table 3

Summary of the 101 survey responses by operative and peri-operative preferences. The number of responses are listed with the corresponding percentage in parenthesis (rounded to the nearest integer).

	N=101
Steroid use	92 (92%)
Steroid dosing	
One time in OR	35 (39%)
Q6hrs for 24hrs	9 (10%)
Q8hrs for 24hrs	34 (38%)
Q6hrs for 36hrs	2 (2%)
Q8hrs for 36hrs	2 (2%)
Taper over 36hrs	2 (2%)
Other	6 (7%)
Antibiotic use	23 (23%)
Preferred antibiotic	
Amoxil/sulbactam	8 (36%)
Cefazolin	7 (32%)
Ampicillin	4 (18%)
Other	2 (9%)
Clindamycin	1 (5%)
Duration of antibiotics	
One time periop dose	2 (9%)
Up to 24 hours	5 (22%)
Up to 48 hours	2 (9%)
Up to 5 days	13 (57%)
Other	1 (4%)
Treats reflux	90 (89%)
Preferred reflux treatment	
Reflux precautions + PPI	49 (54%)
Reflux precautions + H2 blocker	37 (41%)
Reflux precautions only	2 (2%)
Other	2 (2%)

PPI=proton pump inhibitor

Table 4

Summary of the 101 survey responses by post-operative care preferences. The number of responses are listed with the corresponding percentage in parenthesis (rounded to the nearest integer).

	N=101
Admits post-op	99 (99%)
Routinely plans post-op intubation	13 (13%)
Reason for post-op intubation in those who do not routinely plan for intubation	
Significant medical comorbidities	15 (17%)
Severity of findings on flexible laryngoscopy	0 (0%)
Other airway findings	5 (6%)
Combination of above factors	50 (57%)
Other	17 (20%)
Planned duration of intubation	
Until stable in unit	3 (23%)
24 hours	8 (62%)
Other	2 (15%)
Planned SLP evaluation of swallow prior to discharge	24 (24%)
Most common type of postop swallow study	
Bedside clinical evaluation	20 (87%)
FEES	0 (0%)
VFSS/MBS	3 (13%)
Planned flexible laryngoscopy prior to discharge	7 (7%)

SLP=Speech language pathology, FEES=Fiberoptic endoscopic evaluation of swallowing, VFSS=Videofluoroscopic swallowing study, MBS=Modified barium swallow