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LARYNGOLOGY

Role of transoral CO_2 laser surgery for severe pediatric laryngomalacia

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Abstract Controversy exists as to the preferred treatment modality for managing refractory pediatric laryngomalacia (LM). Simultaneous bilateral procedures have been associated with supraglottic stenosis. Unilateral operations have a higher rate of secondary intervention. This prospective study was conceptualized to ascertain a preferred approach. A secondary goal was to correlate the surgical outcome with presenting symptoms and signs. Twenty-two children with severe LM met the criteria for enrollment. Bilateral CO_2 laser-assisted supraglottic laryngoplasties were performed in all cases. The procedure mainly consisted of division of the aryepiglottic fold. Nineteen (86%) patients met our defined success criteria. There were no surgical complications. Bilateral supraglottic laryngoplasty has a role in the management of severe refractory LM.

Keywords Laryngomalacia · Stridor-CO_2 laser · Tracheostomy

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Introduction

LM presents as laryngeal airway collapse during inspiration. It is the leading congenital aberration associated with stridor during the first year of life. The etiology, although uncertain, is thought to be secondary to delayed laryngeal maturation. Usually noted soon after birth, the stridor characteristically worsens during crying, feeding or with the supine position. In most cases, the symptoms are mild with spontaneous resolution occurring within 2 years.

Olney's classification of the anatomic variants included three subtypes: type I—mucosal excess prolapse in the arytenoid complex; type II—foreshortened aryepiglottic (AE) folds; type III—a dorsal epiglottic position Fig. 1 [1].

Various surgical procedures have been described with cold instruments as well as laser. In general, these surgical methods address the three anatomic abnormalities presented by these patients. It was as early as 1869 when Variot [2], in his postmortem observation of a case of laryngomalacia, suggested cutting away a portion of the aryepiglottic fold as definitive treatment of laryngomalacia. Iglauer [3] first described the surgical alteration of supraglottis in laryngomalacia. Schwartz [4] removed a V-shaped wedge from the epiglottis with encouraging results. Studies from France in 1971 and 1984 described hypomandibulopexy as a surgical procedure [5, 6]. Lane et al. [7] excised the tip of the arytenoids, edematous mucosa, a portion of the corniculate cartilages and a portion of the aryepiglottic fold with cupped microforceps and Bellucci scissors. Kelly and Gray [8] recommended unilateral removal of redundant supraglottic tissue (supraglottoplasty) and revision of the opposite side if symptoms persisted. Zalzal et al. [9] described removal of redundant supra-arytenoid mucosa along with resection of the aryepiglottic folds with a microdebrider.

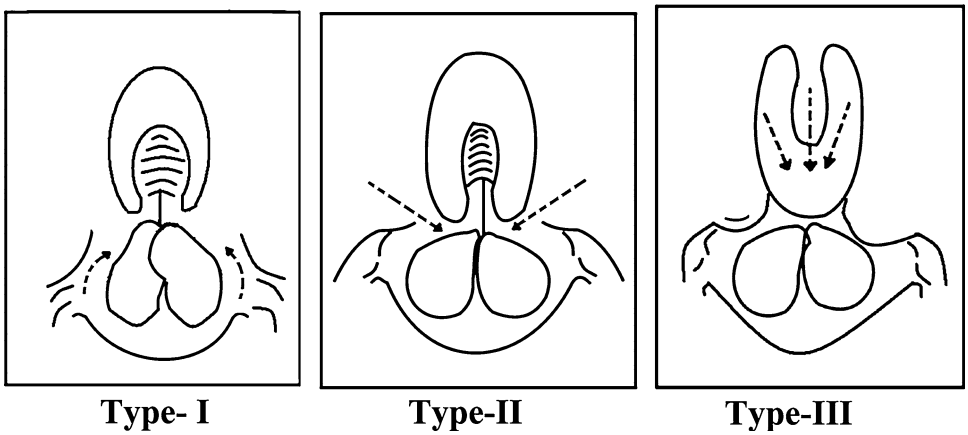


Fig. 1 Classification of laryngomalacia. Type I, prolapse of mucosal excess on arytenoids complex; type II, foreshortened aryepiglottic folds; type III, dorsal epiglottis position

Table 1 Classification of laryngomalacia (European Laryngology Society)

Mild	Moderate	Severe
Stridor	Stridor, recurrent URTI, failure to thrive, feeding difficulties	Associated apnea, cyanosis

The advent of transoral approach to laryngeal pathology has resulted in active management of most cases of severe obstruction. Although use of cold instrumentation including microdebrider has been described, laser provides an elegant alternative due to its concomitant hemostatic property and lack of postoperative edema. While untoward outcome such as granuloma formation, infection and even supraglottic stenosis is sometimes encountered, its frequency is much less [10]. Seid et al. [11] first described the use of laser in laryngomalacia and, since then, a number of reports have appeared in literature.

Aryepiglottopexy with CO_2 laser has been described in recent times with good success rates. In the present study, bilateral aryepiglottopexy was carried out with CO_2 laser in severe cases of laryngomalacia, with the aim of identifying procedural choice, surgical instrumentation and potential outcome predictors.

Materials and methods

From June 2007 to May 2009, 22 children with severe refractory LM were enrolled in this study. There were 13 male and 9 female patients. The time to diagnosis varied from 1 day to 6 months. The ages at the time of surgical intervention were 2 days to 4 years, a reflection of our tertiary referral status. One child had associated cerebral palsy and another had a ventricular septal defect. Two children had tracheostomy at admission.

The presenting symptoms at our institution included severe inspiratory stridor, respiratory distress, cyanosis, difficulty in feeding and failure to thrive. The symptom-related severity can be found in Table 1.

Anatomically, 19 patients were type II, 2 had associated findings of type I and 1 was type III.

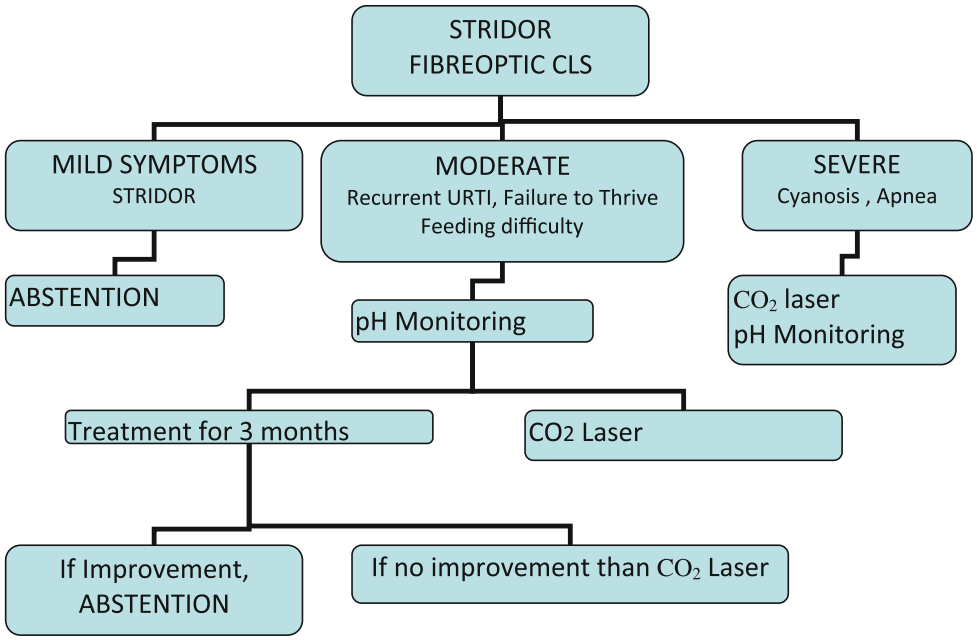
All children had both flexible and rigid endoscopy to confirm the diagnosis and localize the pathology. The flexible examination was performed awake and vocal fold motion was always assessed. We believe, as do Bluestone and Healy [12], that rigid examination of the entire airway is essential.

The signs and symptoms on admission are tabulated below as in Table 2.

Neurologic and cardiac evaluations were performed on all children. CT imaging of the neck and chest was done to rule out extraluminal or pulmonary pathology.

Recognizing the usual benign clinical course of this entity, all children, with the exception of those presenting with a tracheostomy, potential life-threatening respiratory signs and some with sleep apnea, were initially treated conservatively.

Parental reassurance and education, including child positioning and awareness of reflux precautions, are the cornerstones of the initial conservative approach. Recurrent infection and protracted difficulties in feeding may warrant an upper GI evaluation. The latter included a barium swallow, pH probe monitoring and an anti reflux medical regime. Nonresponders are potential surgical candidates. The following management algorithm, adopted from the study by Remacle et al. [13], summarizes this treatment protocol.



Management algorithm adopted by European Laryngology society

Table 2 Signs and symptoms of patients with severe laryngomalacia

Symptoms	No. of patients (%)
Noisy breathing	22 (100)
Failure to thrive	13 (59)
Obstructive sleep apnea	12 (54)
Difficulty in feeding	09 (40)
Cyanosis	06 (28)
Cor-pulmonale	01 (04)

Surgical management

An apneic anesthesia technique was used for optimal visualization. The patients were also examined under general anesthesia without any muscle relaxant (Sleep endoscopy) to localize the type of laryngomalacia and site to be addressed surgically. A suction cannula (suction test) was placed in the subglottis to reconfirm and evaluate anatomic sites of involvement. A similar test was performed postsurgically to assess the improvement. The CO_2 laser, set at 4–5 W in repeat super pulse mode with 280 μm beam and 400 mm working distance, was used to perform the surgery. The surgery consisted of division of the aryepiglottic fold by flash scanner-guided linear incision (accublade). The redundant arytenoid mucosa was vaporized using the rotatory mode of flash scanner at 2–3 W.

Nineteen children could be extubated in the operating theater at the conclusion of the procedure. Three were extubated within 24 h. Two patients required revision surgery and eventual tracheostomy on follow-up. The postoperative regime included 5 days of dexamethasone, budecortisone and adrenaline nebulization and 7 days of antibiotics. Lanzaprazole (1 mg/kg/day) was continued for 6 weeks.

Results

Significant reductions in stridor and associated respiratory distress, ease of feeding with concurrent weight gain and reduction in the incidence of infection when present were representative of a successful outcome. The two cases requiring tracheostomy following revision surgery were classified as failures.

Of the 22 patients, 19 (86%) were considered a surgical success. Fifteen had complete resolution of their stridor by the fifth postoperative day. Of the remaining four, very severe preoperative stridor improved to mild stridor at discharge on the seventh postoperative day. Three of these four had total resolution at the 6-month follow-up. One child persisted with mild stridor but gained weight and was otherwise asymptomatic. Of the two children admitted with tracheostomy, only one could be decannulated (Table 3). The child who was not decannulated was classified as a failure.

The change in symptom of stridor is shown in Fig. 2.

Discussion

As in similar studies, the cohort of this study also comprised mainly of the neonates and infants. Though some

Table 3 Results of CO_2 bilateral aryepiglottoplasty

Total no. of patients for surgery	Successful outcome	Failure	
		Needed postoperative tracheostomy	Failure to decannulate, patient admitted with tracheostomy
22	19	02	01

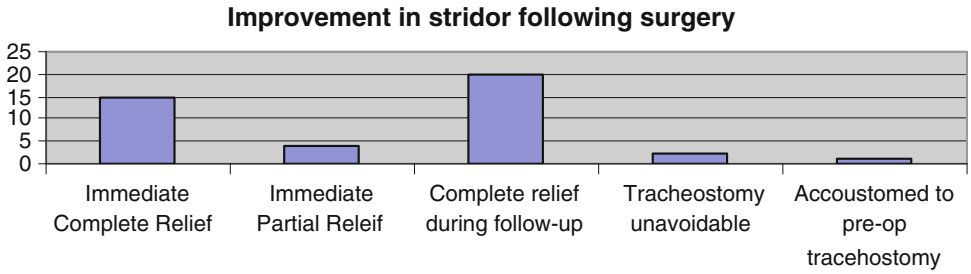


Fig. 2 Chart showing improvement in stridor following surgery

reports mention male to female ratio as 2:1 [14, 15], no significant gender difference was observed in our study. This finding is also broadly comparable to similar studies [16, 17].

All children treated surgically in this prospective study had severe inspiratory stridor with suprasternal retraction exacerbated by exertion. Fifty-four percent had obstructive sleep pattern, though Reddy et al. [18] reported the prevalence of as high as 80%. In our series, 41% also had associated feeding issues that affected the weight gain of the patient. In the study by Zalzal [19] and associates, 5 of 21 patients presented with feeding problems. Based on literature review and our prospective study, it is our opinion that feeding issue is important and needs increased awareness as an outcome measure.

Diagnostically, there is concurrence that outpatient flexible endoscopy is warranted for evaluating stridor. Hawkins and Clark [20] had shown that flexible laryngoscopy was effective, even in neonates. It is advantageous to use the flexible scope in an awake patient to appreciate the dynamics of the supraglottis. The disadvantage is that the milder forms of laryngomalacia may be missed if the child is crying.

Rigid endoscopy is controversial. Mancuso, in a retrospective study of 233 children with LM, concluded that it is not essential because significant synchronous lesions are rare [21]. Bluestone and Healy [12] stated that significant airway problems were missed and the diagnosis of LM made when rigid endoscopy was omitted. Missing a synchronous airway lesion could have important implications for managing LM. We strongly believe that low-risk rigid endoscopy is indicated in all cases of LM where surgery is contemplated.

The subglottic suction test performed before and following surgery provided meaningful anatomical information. Though this test has been described originally by Polonovski et al. [22] and then used by Jani et al. [23] to judge the amount of redundant soft tissue to be excised over the arytenoids, we used it also to assess the reduction of indrawing of supraglottis following surgery. We believe it should be included in all surgical procedures.

A variety of surgical procedures and instruments have been reported for treating LM. Variot [2] proposed removal of a part of the aryepiglottic fold (AE) as a definitive treatment. Iglauer was the first to describe a surgical approach to the supraglottis. Others later described the removal of redundant arytenoid mucosa with or without incision of the AE folds. To accomplish the aforementioned cold steel techniques (cup forceps and scissors), the microdebrider and a variety of lasers have been used. Loke et al. [24] reported a series of 33 patients treated by the technique of simple division of the aryepiglottic folds with good results. We followed the same technique with 86% success.

Our choice for surgical implementation is the CO_2 laser in super pulse or scanning mode. These newer laser adaptations afford increased precision while reducing heat, char and edema. With these techniques, our results mirrored other reported studies [4]. Our study showed a success rate of 86% (19/22). Out of these, 19 patients (93%) had complete resolution of stridor and other associated features of laryngomalacia. This is comparable to other studies adopting similar conservative surgical methods [24]. Martin et al. [25] had similar results with complete resolution of stridor in 83%. There were no instances of supraglottic stenosis, granulation tissue formation or infection.

Two patients (9%) in our series needed revision surgery in the form of epiglottopexy, which is comparable to the series of Andrew et al. in 2006 in which 12% of the cases

required revision surgery. Further literature review mentions a revision surgery rate of 4–17%; the higher percentage was in those cases where surgery was performed only on one side [13].

Conclusion

Computer-enhanced CO_2 laser incisions of the AE folds, with occasional limited adjunct tissue removal, proved to be an effective management for refractory pediatric LM. Simultaneous bilateral procedures were performed on all children without complication and we believe this approach should be the gold standard. In our opinion, difficulty in feeding should be considered an important symptom in the evaluation of patients with severe laryngomalacia, and subsequently good weight gain as a successful outcome measure. Dorsal positioning of the epiglottis in addition to the more consistent anatomic aberrations found in LM and an existing tracheostomy on admission may portend a less than optimal result.

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