Balloon Laryngoplasty as a Primary Treatment for Subglottic Stenosis

Fredrick Durden, MD; Steven E. Sobol, MD, MSc

Objective: To present our experience with balloon laryngoplasty (BL) as a means of establishing control of the compromised airway and as a definitive alternative to open surgery in infants with acquired subglottic stenosis (SGS).

Design: The medical charts of 10 consecutive infants diagnosed as having acquired SGS secondary to a history of intubation and treated initially with BL were reviewed.

Setting: Academic tertiary care children’s hospital.

Patients: A total of 10 patients (3 girls and 7 boys), with a mean age of 4.8 months (range, 2-12 months), met the inclusion criteria for the study.

Main Outcome Measures: The medical charts were assessed for the patients’ demographics, clinical presentation, and outcomes, which were defined by postoperative symptomatology, endoscopic grading of residual SGS, complications, and the need for subsequent interventions to control SGS.

Results: All 10 patients presented with biphasic stridor, and 8 had significant retractions noted on examination. In all patients, control of the airway was established with BL followed by intubation. Four patients were completely asymptomatic after the initial BL. An additional 3 patients had recurrent stridor during the postoperative period and required a second BL before having complete, persistent resolution of symptoms. Balloon laryngoplasty failed in 3 patients, of whom 2 went on to undergo single-staged laryngotracheal reconstruction and 1 required a tracheotomy.

Conclusions: Balloon laryngoplasty is a safe means of establishing the airway in infants with obstruction secondary to acquired SGS. It was an effective, stand-alone procedure for the management of SGS in 7 of our 10 patients, obviating the need for tracheotomy or cricoid split.

Arch Otolaryngol Head Neck Surg. 2007;133(8):772-775

The management of subglottic stenosis (SGS) in children continues to be a challenging problem for the otolaryngologist. The incidence of SGS has decreased from 24% in 1960 to 1% to 2% in 2000. This has largely been the result of advances in airway management and guidelines for intubation. Management options for SGS range from observation to surgical intervention, with the goals being to either bypass the stenotic segment (tracheotomy) or increase the diameter of the subglottic airway by performing a cricoid split, laryngotracheal reconstruction, or partial cricotracheal resection.

Whereas much has been written about the surgical management of SGS in the child who underwent tracheotomy and requires decannulation, there is a paucity of literature concerning the management of this condition during its evolution in early infancy. Most reports advocate open surgical approaches including tracheotomy, cricoid split, or single-staged laryngotracheal reconstruction (ssLTR) in infants with SGS. The use of endoscopic techniques offers the benefit of reduced invasiveness; however, success rates are variable. Most of the literature concerning the endoscopic management of SGS has concentrated on the use of laser therapy. Balloon laryngoplasty (BL) is an endoscopic procedure that has not been well studied but offers promise as a temporizing and in some cases curative primary therapy for acquired SGS during infancy. The objectives of this report were to present our experience with BL as a means of establishing airway control and as a definitive alternative to tracheotomy, cricoid split, or ssLTR in infants with acquired SGS.

METHODS

Medical Chart Review

The medical charts of infants diagnosed as having acquired SGS secondary to a history of intubation were reviewed. Of the 10 infants, 3 were girls and 7 were boys, with a mean age of 4.8 months (range, 2-12 months) at the time of initial treatment. All patients presented with biphasic stridor, and 8 had significant retractions noted on examination. In all patients, control of the airway was established with BL followed by intubation. Four patients were completely asymptomatic after the initial BL. An additional 3 patients had recurrent stridor during the postoperative period and required a second BL before having complete, persistent resolution of symptoms. Balloon laryngoplasty failed in 3 patients, of whom 2 went on to undergo single-staged laryngotracheal reconstruction and 1 required a tracheotomy. Balloon laryngoplasty is a safe means of establishing the airway in infants with obstruction secondary to acquired SGS. It was an effective, stand-alone procedure for the management of SGS in 7 of our 10 patients, obviating the need for tracheotomy or cricoid split.
tubation and treated initially with BL were reviewed over a 1-year period. Patients were excluded if they had other coexisting tracheal pathologic conditions, congenital SGS, previous intervention for their SGS, or comorbidities requiring a high likelihood of prolonged ventilation in the future. The medical charts were assessed for the patient’s demographics, clinical presentation (ie, stridor and retractions), and outcomes, which were defined by postoperative symptomatology, endoscopic grading of any residual SGS, complications, and the need for subsequent interventions to control their SGS.

SURGICAL TECHNIQUE

With oxygen delivered by spontaneous mask ventilation, laryngoscopy is performed using the Parsons laryngoscope (Karl Storz GmbH & Co KG, Tuttingen, Germany) and a 4-mm, 0º telescope. Once the diagnosis of SGS is made, the laryngoscope is suspended and either a 6-mm esophageal or 5-mm angioplasty balloon catheter is inserted into the stenotic segment under direct telescopic visualization (Figure 1). The balloon is then inflated to a pressure of 2 atm using a 60-mL syringe with an attached pressure gauge. Pressure is maintained until the patient’s oxygen saturation drops to 92%, at which point the airway is reassessed using the telescope. An endotracheal tube is inserted into the dilated airway for oxygenation and then removed to perform the bronchoscopy. A pledget soaked with a topical steroid-antibiotic preparation is then applied to the dilated segment and the patient is left intubated for 24 to 48 hours in the neonatal intensive care unit. All patients are empirically treated with 24 to 48 hours of systemic steroids and gastroesophageal reflux with proton pump inhibitor therapy needs to be part of the overall management scheme. Gastroesophageal reflux as diagnosed by pH probe was present in 3 of 10 patients. Patient 4 had severe reflux necessitating a Nissen fundoplication. Three patients had a coexisting subglottic cyst, and 1 had a vascular ring contributing to their airway pathologic conditions that required concurrent management.

Table 2 summarizes the outcomes of patients undergoing BL. In all patients, control of the airway was established with BL followed by intubation. Four patients were completely asymptomatic after the initial BL and had a residual grade 1 SGS noted on control endoscopy. An additional 3 patients had recurrent stridor during the postoperative period and required a second BL before having complete, persistent resolution of symptoms. Balloon laryngoplasty failed in 3 patients, of whom 2 went on to undergo ssLTR with thyroid alar graft augmentation and 1 with severe reflux went on to undergo tracheotomy. There were no complications. The mean follow-up was 3.5 months. Figure 2 demonstrates preoperative and 3-week postoperative laryngoscopic findings after BL.

COMMENT

The subglottis is the most common site of airway narrowing in children. Acquired laryngotracheal stenosis accounts for 90% of cases, and prolonged intubation is the most commonly identified risk factor. The likely pathogenesis of acquired SGS begins with subglottic mucosal pressure necrosis secondary to endotracheal intubation, followed by mucosal ulceration, perichondritis, and mature scar tissue formation. Gastroesophageal reflux exacerbates this processes and has been demonstrated as a risk factor for failed airway reconstructive surgery. The goal of BL is to mechanically interrupt the process of mature scar formation during the evolution of acquired SGS. The application of topical steroids may contribute to the inhibition of restenosis following dilatation. Management of inflammation with topical and systemic steroids and gastroesophageal reflux with proton pump inhibitor therapy needs to be part of the overall management scheme.

The management of infantile acquired SGS continues to be a challenge for the otolaryngologist. Both ssLTR and partial cricotracheal resection are effective proce-
dures in the appropriate patient; however, there is often
the need for secondary procedures, prolonged intensive
care admission, prolonged intubation, or tracheotomy,
and both techniques have the potential for serious com-

plications. 5,6 Tracheotomy to bypass the obstructed sub-
glottis is acceptable, and occasionally the only reason-
able option, but is associated with significant morbidity
and potential mortality from plugging or inadvertent
decannulation.

Endoscopic procedures to manage infantile acquired
SGS have been described, most commonly involving the
use of the carbon dioxide laser. The use of laser resec-

Table 1. Demographics and Clinical Presentation of Patients Undergoing Balloon Laryngoplasty

<table>
<thead>
<tr>
<th>Patient No./ Sex/Age, mo</th>
<th>Duration of Intubation, d</th>
<th>GER</th>
<th>Coexisting Airway Disease</th>
<th>Grade of SGS</th>
<th>Character of SGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/F/2</td>
<td>10</td>
<td>No</td>
<td>None</td>
<td>III</td>
<td>Firm scar</td>
</tr>
<tr>
<td>2/M/4</td>
<td>30</td>
<td>No</td>
<td>Subglottic cyst</td>
<td>III</td>
<td>Soft</td>
</tr>
<tr>
<td>3/M/3</td>
<td>5</td>
<td>Yes</td>
<td>Subglottic cyst</td>
<td>III</td>
<td>Soft</td>
</tr>
<tr>
<td>4/M/4</td>
<td>14</td>
<td>Yes</td>
<td>Subglottic cyst</td>
<td>II</td>
<td>Soft</td>
</tr>
<tr>
<td>5/M/3</td>
<td>6</td>
<td>No</td>
<td>None</td>
<td>III</td>
<td>Firm scar</td>
</tr>
<tr>
<td>6/F/7</td>
<td>14</td>
<td>No</td>
<td>Subglottic cyst</td>
<td>III</td>
<td>Soft</td>
</tr>
<tr>
<td>7/M/12</td>
<td>14</td>
<td>No</td>
<td>None</td>
<td>III</td>
<td>Firm scar</td>
</tr>
<tr>
<td>8/F/4</td>
<td>40</td>
<td>No</td>
<td>None</td>
<td>III</td>
<td>Firm scar</td>
</tr>
<tr>
<td>9/M/3</td>
<td>4</td>
<td>No</td>
<td>Vascular ring</td>
<td>II</td>
<td>Firm scar</td>
</tr>
<tr>
<td>10/M/6</td>
<td>30</td>
<td>Yes</td>
<td>None</td>
<td>III</td>
<td>Firm scar</td>
</tr>
</tbody>
</table>

Abbreviations: GER, gastroesophageal reflux; SGS, subglottic stenosis.

Table 2. Outcomes of Patients Undergoing Balloon Laryngoplasty (BL)

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>No Further Treatment</th>
<th>Tracheotomy</th>
<th>ssLTR</th>
<th>Repeated BL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>×</td>
<td>×</td>
<td></td>
<td>×</td>
</tr>
<tr>
<td>2</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>3</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>4</td>
<td>×</td>
<td>×</td>
<td></td>
<td>×</td>
</tr>
<tr>
<td>5</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>6</td>
<td>×</td>
<td>×</td>
<td></td>
<td>×</td>
</tr>
<tr>
<td>7</td>
<td>×</td>
<td>×</td>
<td></td>
<td>×</td>
</tr>
<tr>
<td>8</td>
<td>×</td>
<td>×</td>
<td></td>
<td>×</td>
</tr>
<tr>
<td>9</td>
<td>×</td>
<td>×</td>
<td></td>
<td>×</td>
</tr>
<tr>
<td>10</td>
<td>×</td>
<td>×</td>
<td></td>
<td>×</td>
</tr>
</tbody>
</table>

Abbreviation: ssLTR, single-staged laryngotracheal reconstruction.

Figure 2. Preoperative (A) and 3-week postoperative (B) laryngoscopic findings after balloon laryngoplasty.
tion has been shown to be effective for grades 1 or 2 stenoses that are not circumferential and no more than 1 cm in length. The major complication is thermal damage, secondary scarring, and restenosing.7,8 There has been limited literature focusing on the use of BL alone as a therapy for SGS.9 Other studies were limited to evaluating the use of BL for stenosis of the trachea.2,10 The goal of the procedure is to increase the radius of the airway without exposing the airway to shearing forces of other more traumatic dilating procedures.2 Moreover, the very narrow diameter of the uninflated balloon permits safe dilatation of even the most pinpoint-acquired SGS lesions. Rigid dilators such as a 2.0 endotracheal tube or the smallest bronchoscope may not be small enough to control the pinpoint airway in the acute setting without the use of significant force, if at all.

Our study demonstrates that BL is an effective technique to secure the severely compromised airway in the acute care setting and that it appears to definitively result in the resolution of symptoms with postoperative endoscopic findings comparable to successful ssLTR in 70% of patients. In our study, there were no complications, and the procedure does not preclude open surgery when it fails. We advocate BL as a first step in the treatment of infants with an evolving SGS as an alternative to tracheotomy, cricoid split, or ssLTR. Balloon laryngoplasty is not useful in cases in which the SGS is long standing, congenital, or has cartilaginous involvement.

Our study is limited by the lack of a control group and by the small sample size. Further studies may be necessary to compare BL with other means of airway expansion.

In conclusion, BL is a safe means of establishing the airway in infants with obstruction secondary to acquired SGS. We have demonstrated that BL is an effective, stand-alone procedure for the management of SGS in 70% of patients, obviating the need for tracheotomy or cricoid split.

Submitted for Publication: January 11, 2007; final revision received March 23, 2007; accepted April 15, 2007.

Correspondence: Steven E. Sobol, MD, MSc, Director of Pediatric Otolaryngology, 2015 Uppergate Dr NE, Room 218, Atlanta, GA 30322 (ssobol@emory.edu).

Author Contributions: Dr Sobol 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: Durden and Sobol. Acquisition of data: Durden and Sobol. Analysis and interpretation of data: Durden and Sobol. Drafting of the manuscript: Durden and Sobol. Critical revision of the manuscript for important intellectual content: Durden and Sobol. Statistical analysis: Sobol. Study supervision: Durden.

Financial Disclosure: None reported.

Previous Presentation: This study was presented at the annual meeting of the Society for Ear, Nose, and Throat Advances in Children; December 3, 2006; San Francisco, California.

REFERENCES


