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Predicting outcomes of balloon laryngoplasty in children with subglottic stenosis

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ABSTRACT

The treatment of subglottic stenosis in children remains a challenge for the otolaryngologist and may involve procedures such as endoscopy, open surgery, and often both. In the recent past, high-pressure balloons have been used in endoscopic treatment due to their relative facility and high success rates.
Objective: To report success rates in the treatment of acquired subglottic stenosis with balloon laryngoplasty in children and identify predictive factors for the success of the technique and its complications.
Methods: Descriptive, prospective study of children who were diagnosed with acquired subglottic stenosis and underwent balloon laryngoplasty as the primary treatment.
Results: Balloon laryngoplasty was performed in 48 children with an average age of 20.7 months: 31 presented with chronic subglottic stenosis and 17 with acute stenosis. Success rate was 100% for acute and 39% for chronic subglottic stenosis. Success was significantly associated with several factors, including recently acquired stenosis, initial grade of stenosis, younger patient age, and the absence of tracheotomy. Complications were transitory dysphagia observed in three children and a submucosal cyst in one of the patients.
Conclusions: Balloon laryngoplasty may be considered as a first line of treatment for acquired subglottic stenosis. In acute cases, the success rate was 100%, and even though results are less promising in chronic cases, complications were not significant and the patients can undergo open surgery without contraindications. Predictive factors of success were acute stenosis, less severe grades of stenosis, younger patient age, and the absence of tracheotomy.

1. Introduction

In the past 30 years, mortality rates in neonatal intensive care units (NICU) have decreased due to advances in perinatal medicine [1]. As a consequence, prolonged intubation has become more frequent. Indications for tracheotomy in neonates are still complex and controversial; a decision to perform tracheotomy must be based on multiple factors and not only on the length of intubation period.

Although the incidence of acquired subglottic stenosis (SGS) has decreased in children, SGS remains one of the most frequent causes of stridor and respiratory discomfort in this population [2]. Acquired SGS accounts for 90% of the cases diagnosed in children and is most frequently caused by prolonged tracheal intubation [3].

Treatment of acquired stenosis may involve endoscopic and/or open surgical procedures. Amongst the endoscopic techniques available, dilatation with high-pressure balloons or balloon laryngoplasty (BL) has been increasingly reported as a valuable therapeutic option worldwide. The use of other methods for dilatation of the stenotic area, such as those involving endotracheal tubes and broncoscopes, has not been well described in children and may add additional trauma to the already scarred and inflamed tissue. It must be considered that the instruments used for these procedures are not small enough to pass through the stenotic areas without significant force and trauma. Most reports on endoscopic treatment of SGS involve the use of laser therapy [4], which is classically indicated for low-grade, non-circumferential stenosis in children with less than 1 cm of vertical extension. Chueng and Chadha [5] in their systematic review of results for endoscopic treatment of SGS in children

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reported that neither the high-pressure balloon or the rigid dilatation methods could be considered superior due to the lack of comparative studies between the two methods. Tracheotomy is an acceptable procedure and offers the best outcome when extubation fails due to acute SGS. This procedure is most successful when performed by a physician experienced in airway endoscopy diagnosis and treatment. Although tracheotomy immediately solves respiratory insufficiency and facilitates weaning from sedation drugs and mechanical ventilation, caring of small children with a tracheotomy at home can be an overwhelming and frightening experience. The possible complications of tracheotomy include suprastomal collapse, tracheal stenosis, persistent tracheal granulation tissue, and bleeding [2]. Additionally, the risk of cannula obstruction with a mucous plug and death both at home and in the hospital cannot be ignored.

Chronic or mature SGS is successively treated with open neck reconstructive surgeries. In addition, laryngotracheoplasty and partial cricotracheal resections are effective alternative procedures. However, there is often a need for secondary procedures, which result in prolonged intensive care admission and prolonged intubation or tracheotomy, and both techniques have a potential for causing serious complications [6,7]. Experienced groups have reported high success rates for laryngotracheoplasty and partial cricotracheal ressection [7,8]. Nonetheless, this requires an organized and coordinated team to provide meticulous pre- and postoperative care that involves controlling comorbidities, weaning from sedation, management of unstable airways, recognition of complications, and quick resolution of these life-threatening conditions. However, the risks involved in these procedures, which include graft infections, dehiscence, sepsis and restenosis, cannot be ignored. Children with additional conditions such as pulmonary conditions, gastro-esophageal reflux, facial deformities, and neurological impairment have an increased potential for complications and failures, and these are not infrequent specially in children under two years of age [2]. For all these reasons, this type of surgery may be delayed in many children, leading to a long period of child and family deprivation from normal life. The management of such complex cases of SGS continues to present a significant challenge to the pediatric otolaryngologist.

Balloon dilatation has been used to treat laryngeal and tracheal stenosis in children since the early 1980's with encouraging results [9,10], particularly in immature, inflammatory scar tissue. Its main advantage compared to other methods of dilatation is that it promotes centrifuge expansion even in the presence of a very reduced lumen. The goal of balloon laryngoplasty is to mechanically interrupt the process of mature scar formation during the pathophysiology of acquired SGS [11]. Recently, Ang et al. [12] reported experimental data showing that balloon dilatation may significantly decrease tissue damage and therefore induce less scar tissue formation. Lang and Brietzke [13], in their systematic review and meta-analysis on BL as a treatment modality for SGS in children, concluded that high success rates can be seen in the short term and complications are rare. Additionally, the authors suggested that failures might be related to more severe grades of stenosis.

The aim of this study was to investigate the success rate of BL as a primary treatment for acquired SGS in children, to report its complications and establish a set of factors that may be used to predict the success rate of the procedure.

2. Materials and methods

2.1. Subjects and staging of SGS

We carried out a prospective evaluation of balloon dilatation protocols performed in children under 14 years of age, which were diagnosed with acquired SGS. We reviewed data of patients that underwent balloon laryngoplasty (BL) between August 2011 and April 2014 in two tertiary university hospitals: Hospital Estadual de Sumaré—Unicamp and Hospital da Criança de Goiânia. Procedures were performed in each hospital by two surgeons with experience in pediatric airway endoscopy and approved by the Ethics Committee of each corresponding hospital. Written informed consent was obtained from all patients included in the study. Patients with follow-up periods less than three months and those who presented simultaneously with a laryngeal condition such as vocal cord mobility impairment or laryngomalacia or had undergone previous endoscopic and/or open reconstruction procedures were excluded from this study. The following data were extracted from the hospital protocols: patient age, endoscopic grading of SGS at the time of initial diagnosis, presence of tracheotomy, number of dilatation procedures, presence of comorbities, and complications and success rates of the procedures. Comorbidities that were considered included prematurity and severe pulmonary disease.

The type of scar tissue was classified as follows:

1. acute subglottic stenosis—patients who were diagnosed and treated up to 30 days after extubation or tracheotomy as a result of failed extubation;
2. chronic subglottic stenosis—patients that were diagnosed and treated after more than 30 days of extubation or tracheotomy as a result of failed extubation.

Myer and Cotton classification [14] (see Table 1) was used to establish the initial grade of stenosis, which was determined with respiratory endoscopy prior to dilatation using a 4-mm and 2.7-mm telescope and endotracheal tubes for calibration.

2.2. Balloon dilatation technique

Unless the child was previously hospitalized, dilatation procedures were performed in the Day Case Surgery unit. Dilatations were always performed under general anesthesia alternating spontaneous breathing and apnea during balloon inflation when necessary. Three different brands of balloons with lengths varying from 20 mm to 30 mm were used, and the balloon diameter varied according to the age of the patient and the size of the airway. As a general rule, the approximate measure of the balloon diameter was determined by adding 2 mm to the external diameter of the appropriate endotracheal tube for a given patient. The time and number of inflations during the same procedure varied according to the size of the airway, pulmonary reserve, and/or perception of glottic and/or supraglottic edema secondary to the balloon. Inflation pressure varied from 2 to 15 atm with a tendency for the use of greater pressure levels during the last year

Table 1
Data results for acute SGS, chronic SGS and the overall group of patients submitted to balloon dilatation.

	Acute	Chronic	Overall
No. patients	17	31	48
Average age (months)	4.2	29.96	20.70
Trach	24%	87%	65%
No trach	76%	13%	35%
Grade*			
I	6%	3%	4%
II	47%	10%	23%
III	47%	87%	73%
No. dilatations	2	2.4	2.3
Success rate	100%	39%	60%

* Myer-Cotton classification (of Grade of stenosis), this could be removed since it has been explained in material and methods.