Balloon Laryngoplasty in Pediatric Population with Subglottic Stenosis: 5 Years Experience in King Abdulaziz University Hospital a Tertiary Center

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Abstract We reviewed our experience with balloon laryngoplasty (BLP) as a primary management of SGS in a tertiary care center in Saudi Arabia. In this review, a total of 147 patients who underwent Laryngobronchoscopy were reviewed. Only 10 pediatric patients diagnosed with SGS who underwent BLP as primary treatment in the period from January 2012 to December 2017 were included. After obtaining ethical approval, included patients' charts were reviewed. Adult patients and those with airway anomalies other than SGS were excluded. This study describes the outcome of 25 episodes of BLP for the selected participants. Sixty percent of the participants were males. Participants' age ranged from 1 to 14 years (mean 6.4 years). Four participants had comorbidities other than SGS. Most patients required more than one episode of BLP (average 3 episodes). Mean hospital stay was 11.7 days. There was no difference in recurrence of symptoms between using laser or knife in subglottic tissue release ($p = 0.182$). Although recurrence of symptoms was seen in 56% of the patients, almost all patients (100%) became free of symptoms eventually. Patients with co-morbid diseases were more likely to be transferred to PICU post-operatively ($p = 0.003$). In the treatment of acquired SGS, BLP is an effective and relatively safe alternative to open airway surgery.

Keywords Pediatrics · Subglottic stenosis · Balloon dilatation · Balloon laryngoplasty

Introduction

There are a variety of laryngeal anomalies that result in respiratory distress. The prevalence of airway anomalies has been estimated between 1 in 10,000 and 1 in 50,000 [1]. In children, one of the most common causes of airway obstruction is subglottic stenosis (SGS). It can be divided to congenial or acquired [2]. Congenial SGS develop as result of failure of proper recanalization of the trachea [3], although rare but it represent the third most common cause of stridor in pediatrics after laryngomalacia and vocal fold paralysis [4]. However, acquired SGS responsible for about 90% of cases and represent the most common cause of acquired laryngeal anomaly in children, with prolonged intubation being the most common etiology for acquired SGS [5, 6].

In 1994, Myers and Cotton developed a classification scheme for subglottic stenosis from I to IV. They assigned obstruction in grade I to 50%, grade II from 51 to 70%, grade III from 71 to 99% (any decidable lumen), and grade IV for total obstruction. This grading system is typically applied to circumferential stenosis and not to other types of subglottic stenosis [7].

The management of subglottic stenosis is still evolving through the years with different modalities. The balloon laryngoplasty, with or without other measurements (Mitomycin C, intralesional steroid injections), is becoming popular around the world as a primary treatment for SGS. Balloon laryngoplasty is now being an effective and less invasive treatment for low grade stenosis [8].

In a systematic review by Lang and Brietzke, BLP was an effective treatment in most of cases of SGS in short-term follow up with very rare rate of complication [10]. In addition, Alshammari et al. [12] studied the effectiveness of BLP in patients with acquired SGS and concluded that

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the success rate was 82.2%. Also, Maunsell et al. [11] considered BLP as a first-line treatment in SGS for both acute and chronic SGS with success rate of 100% for the earlier.

King Abdulaziz University hospital is a major referral center for pediatric otolaryngology in the western region of Saudi Arabia. The objective of this study is to demonstrate our experience and outcome of balloon laryngoplasty approach in subglottic stenosis over the past 5 years at King Abdulaziz University hospital.

Patients and Methods

This is a retrospective case series study done in King Abdulaziz University hospital, which is a tertiary care teaching hospital with specialized pediatric otolaryngologists. The study included 10 patients (aging from 1 to 14 years) who were diagnosed with acquired subglottic stenosis and underwent endoscopic balloon laryngoplasty as a primary modality of treatment from January 2012 to December 2017.

Patients who were older than 14 years old and who were diagnosed with congenital subglottic stenosis with other airway anomalies and history of previous laryngeal procedures were excluded. Figure 1 illustrates the recruitment

of study participants in the study. Data collected from medical records included age, gender, non-airway comorbidities, presence of tracheostomy, subglottic stenosis grade according to Cotton-Myers classification, duration of symptoms, timing and type of intervention done and post operative airway status in immediate and long-term follow up.

Subglottic stenosis grade was obtained intraoperatively by expert pediatric otolaryngologist using laryngoscopy with a 0° rigid endoscope with diameter between 2.7 and 4 mm, with spontaneous ventilation technique. The Cotton-Myers classification used as standard for the grade description (I–IV) of subglottic stenosis.

Acute subglottic stenosis is defined as airway symptoms occurring for less than 3 months to presentation. Intra-operatively, after establishing the diagnosis, a high-pressure balloon (ACCLARENT®) 7–10 mm was used and inflation pressure of 8–14 atm was sustained for 1 min or till patient O₂ saturation reach 92%. Post dilatation, laryngoscope is removed and the patient is ventilated using bag-valve-mask till fully awake and patient is transferred to recovery. None of the patients received local steroid or mitomycin C in this study and all of the patients received PPI routinely postoperatively. Successful balloon dilatation outcomes were considered when patients were weaned off

Fig. 1 Inclusion and exclusion criteria

Table 1 Demographics and etiology (n = 10)

Characteristic	
Age range	1–14 years (mean 6.4 years)
Gender	
Male	6 (60%)
Female	4 (40%)
Patients with comorbidities other than airway	4 (40%)
Etiology	
Acquired	10 (100%)

*Referred to in the results section

tracheostomy or became free of symptoms for the duration of study.

Statistical Analysis

For dichotomous variables, we measured the proportion and 95% CI. And for continuous variables, we measured the mean, standard deviation and 95% CI. For comparative analysis, we used Chi square test and *T* test for dichotomous and continuous variables, respectively. All analysis was performed using SPSS software.

Results

Descriptive Statistics

The total number of participants in the study was 10 patients. Tables 1 and 2 demonstrate demographics and information about etiology of stenosis, grade of stenosis, and operative data. Six (60%) of the patients were males. The mean age of the population was 6.4 years (range 1–14). Four patients had comorbidities other than subglottic stenosis, such as tetralogy of fallot, eye tumor, lung collapse, and ventriculostomy. The total number of balloon laryngoplasty done was 25 procedures. For each patient, number of balloon laryngoplasty ranged from 1 to 6 times done for with a mean of 3 times per patient. After balloon dilatation is done, the mean hospital stay for a single admission was 11.7 days with almost half of the operations (n = 13) done as a day surgery. Fourteen procedures (56%) were followed by recurrence of symptoms, and the mean duration without symptoms was 1.2 days.

In the post-operative period, 3 patients did not have recurrence of symptoms and did not need further interventions. There was 1 participant who remained hospitalized and was not discharged due to other morbidity as the patient had lung collapse. However, the other 6 patients

Table 2 Preoperative and postoperative grade and recurrence

Pre-op Cotton-Myers grade	
Grade 2	5 (50%)
Grade 3	5 (50%)
Number of balloon dilatation done	25
Mean number of balloon dilatations	3.1
Recurrence after balloon dilatation	12 (48%)
Requiring ICU admission post-op	5 (22.7%)
Post-op intubation	2 (9.1%)
Post dilatation grade	
Grade 1	20 (90.9%)
Grade 2	2 (9.1%)
SGS recurrence after dilatation	14 (56%)
Recurrence grade	
Grade 1	2 (15%)
Grade 2	2 (15%)
Grade 3	9 (70%)

SGS Subglottic stenosis

*Referred to in the results section

were asymptomatic post-operatively and were discharged from the hospital but developed symptoms afterwards. As shown in Table 2, patients with recurrence were reassessed in the clinic and needed further admissions for balloon laryngoplasty.

Comparative Analysis

In our studied sample, there was no difference in recurrence of stenosis among patients who underwent laser or knife technique ($p = 0.182$). Patients with comorbidities were more likely to be transferred to ICU than patients with SGS only ($p = 0.003$). In our studied population, there was no association between the pre-operative CM grade and post-operative need for intubation ($p = 0.85$).

Discussion

The objective of this study is to demonstrate our experience and outcomes of balloon laryngoplasty in subglottic stenosis over a 5-year period in patients diagnosed with subglottic stenosis.

In this study we included 10 patients with acquired subglottic stenosis who underwent a total of 25 procedures of balloon laryngoplasty. Included population showed predominance of males. Ninety percent of patients in our study had acute subglottic stenosis. The initial Cotton-Myers grade of included patient showed an equal distribution of grade II and III. Only one patient had a tracheostomy pre-operatively. Four procedures (16%) of

balloon laryngoplasty were unsuccessful as patient showed no clinical improvement after intervention.

Balloon laryngoplasty, being first described in 1985, is a relatively-new technique in treatment of SGS [9]. With more experts adopting the technique, multiple studies have been published to evaluate the efficacy of balloon laryngoplasty in patients with acute and/or chronic SGS. Axon et al. first described the procedure with inflating a balloon and leaving it until saturation dropped to 80%. This child remained asymptomatic for 15 months afterwards [9]. The obstacle in assessing the outcome of this intervention is the relative rarity of cases and its association with other airway anomalies. In reviewing the literature, one systematic review was published in 2013 to assess the benefit of balloon laryngoplasty in SGS patients [10]. The systematic review included 7 case series and showed a success rate of 65.3% [10].

Recently, various authors have studied the effectiveness of balloon laryngoplasty in patients with subglottic stenosis. Maunsell et al. studied the effect of balloon laryngoplasty and concluded that the success rate of the procedure in patients with acute and chronic subglottic stenosis was 100% and 32%, respectively [11]. Alshammari et al. [12] demonstrated a success rate of 82.3% in patients with acquired SGS including those with high grade stenosis. In our study, the success rate of balloon laryngoplasty was 86%. The recurrence rate after dilatation of our sample was 56%. However, patients with recurrence of symptoms underwent consecutive procedures (on average 3 procedures). Fortunately, the end result was all patients were asymptomatic avoiding the risk of open airway surgery.

This case series had some limitations. First, this study has small sample size due to the rarity of the disease and in the attempt to include patients with isolated SGS with no other airway disease. Second, the data collected did not include the nature of symptoms of stenosis.

Conclusion

One of the most common causes of airway obstruction in children is subglottic stenosis. In addition, balloon laryngoplasty decreases hospital stay and the possibility of complications associated with open airway surgical

intervention. This study showed that balloon dilatation in patients presenting with acquired SGS is relatively safe, effective and help maintain a patent airway. However, in the management of SGS, especially chronic, and congenital presentation, further research and innovation is advocated.

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