Balloon laryngoplasty in children with acute subglottic stenosis: experience of a tertiary-care hospital

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Abstract

Management of subglottic stenosis (SGS) in children is still a challenge to Otorhinolaryngologists. Balloon laryngoplasty (BLP) is an endoscopic procedure, first described in 1984 for the treatment of airway stenosis. It shows promising results and seems to be more effective than other procedures.

Aim: To present our experience with BLP in children with SGS.

Material and Method: Prospective study of children diagnosed with acute subglottic stenosis, i.e., stenosis with granulation tissue. They underwent direct laryngoscopy under general anesthesia and dilatation of the stenotic segment with angioplasty balloon. They were followed up and a second laryngoscopy was performed one week later.

Results: Eight children were included in this study between June 2009 and October 2010. Four had Grade 3 SGS, three had Grade 2 SGS and one had Grade 1 SGS. By the second examination, two children presented with asymptomatic Grade 1 SGS, while the other six presented with normal airway and remained asymptomatic.

Conclusion: BLP seems to be an effective treatment for acute SGS. We need more studies to refine our knowledge concerning efficacy rates, safety and indications for balloon dilatation.

Keywords: balloon dilatation, child, laryngostenosis.
INTRODUCTION

Starting in the 1950’s, prolonged endotracheal intubation (ETI) started to play an important role in the management of respiratory disorders in critically ill adults and children, and it became the main cause of laryngeal stenosis. Subglottic stenosis seems to be more common in children, because this is the narrowest region in the airway of people at this age range.

The treatment of subglottic stenosis (SGS) in children continue to be a challenge for otorhinolaryngologists, and numerous open and endoscopic surgical techniques have been reported. Endoscopic techniques have the advantage of being less invasive and not leaving external scars; however, with variable success rates.

Among the endoscopic options for treatment, we found the CO2 or yag laser being used to resect the stenosis and dilatation using dilatation rods and stiff bronchoscopes and; more recently, angioplasty balloons.

The balloon laryngoplasty (BLP) is an endoscopic procedure, first described in 1984, used to treat stenosis of the upper airways. Such technique is being used, since then, to treat stenosis secondary to prolonged intubation, re-stenosis after laryngotracheal reconstructions and after cricotracheal resections with end-to-end anastomosis, with promising results. A large variety of balloons have already being tested, among them we have the Fogarty embolectomy catheter and a number of angioplasty balloons.

Dilatation may be carried out under direct visualization with laryngoscopy or bronchoscopy or by fluoroscopic control. The procedure is palliative in some cases (turning a Myer & Cotton grade 3 SGS into a grade 2 or 1), and curative in others.

Since its first description in the literature, BLP has been tested in subglottic stenosis, usually in small series of patients, but mostly showing promising results.

Our goal is to discuss our experience with BLP in pediatric patients with SGS after intubation and its evolution.

PATIENTS AND METHODS

We included in the study eight pediatric patients diagnosed with post-intubation SGS grade 1-3 from Myer & Cotton in evolution, that is, SGS with granulation tissue, within the time frame between June of 2009 and October of 2010. These patients were found by means of a cohort study carried out by our study group, in which we did a nasopharyngolaryngoscopy in all the patients after intubation in our Pediatric ICU, since 2005. After nasopharyngolaryngoscopy, these patients were followed up and, if they had changes in the exam or upper airway obstruction symptoms in the follow up, they were submitted to direct laryngoscopy and, if any change was detected, they were submitted to specific treatment.

This study was approved by the Ethics Committee of our institution, under protocol number 05-266.

Technique

First, we carried out a direct laryngoscopy in order to diagnose and grade the SGS, using pediatric laryngoscopes and a scope of 0 degree and 4mm in diameter. The patient was sedated and remained in spontaneous ventilation during the procedure, receiving complementary oxygen through a nasal catheter. After the diagnosis and indication of balloon dilatation (acute stenosis in evolution, with granulation tissue, lower than grade 4), we introduced the balloon (angioplasty catheter - 4cm long and 10-14mm in diameter - Figure 1) through the laryngoscope, under direct view. The balloon was placed in the subglottis (Figure 2) and inflated with saline solution to a pressure of 2atm. The balloon remained inflated for 30 seconds and 2 minutes, and afterwards it was emptied and removed from the airway.

We then looked at the subglottis in order to see the immediate result. Should it be satisfactory, we removed the laryngoscope and the patient was awaken. Should the airway diameter be still not enough for a proper ventilation, the dilatation procedure was repeated. If after the second dilatation the airway was still not adequately dilated, the patient was referred to another type of treatment. The patient remained in oral steroids for 7 days after the procedure and had to take omeprazole for an indefinite period of time, until complete disease resolution. A new direct laryngoscopy was carried out to review the subglottis, 7 days after the dilatation procedure, and again whenever the...
patient presented symptoms. The patients were followed up for, at least, 6 months after the first dilatation.

RESULTS

On Table 1, we can see the detailed clinical history from each one of our patients: age, cause of the endotracheal intubation, ETI time, symptoms presented, the time between extubation and BLP, the type and degree of stenosis, the type of balloon utilized and the final aspect of the patient’s airway upon direct laryngoscopy.

Our complete resolution rate for the stenosis in evolution was of 75% (six in eight patients), but all the children were asymptomatic during follow up, even those with Grade 1 residual stenosis, not requiring additional treatment up to this moment.

On Figure 3, we can see the aspect of the direct laryngoscopy from patient WLC before BLP (Grade 3 SGS), immediately after the dilatation, and two weeks afterwards (asymptomatic Grade 1 SGS).

We had no severe complications during the procedures.

Table 1. Clinical data of the patients and description of the BLP in each case.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Reason for the ETI</th>
<th>ETI</th>
<th>Symptoms</th>
<th>Time interval between extubation and the BLP</th>
<th>Type and grade of the stenosis</th>
<th>BLP</th>
<th>Final DL</th>
</tr>
</thead>
<tbody>
<tr>
<td>LBS, female, 14 m</td>
<td>Pneumonia</td>
<td>7 days, without the balloon</td>
<td>Biphasic stridor</td>
<td>5 days</td>
<td>SGS Grade 2, with GT, concentric</td>
<td>12mm, 1min15s, 2 atm, 1X</td>
<td>Normal airway</td>
</tr>
<tr>
<td>KCA, female, 10 m</td>
<td>AVB</td>
<td>3 days, without the balloon</td>
<td>Biphasic stridor, weak cry, sternum retraction</td>
<td>6 days</td>
<td>SGS Grade 1, with GT, posterior</td>
<td>12mm, 2 min, 2 atm, 1X</td>
<td>Normal airway</td>
</tr>
<tr>
<td>RL, male, 9m</td>
<td>Meningococcemia</td>
<td>12 days, without the balloon</td>
<td>Biphasic stridor, sternum retraction</td>
<td>30 days</td>
<td>SGS Grade 3, with GT, posterior</td>
<td>10mm, 1 min, 2 atm, 2X</td>
<td>Normal airway</td>
</tr>
<tr>
<td>LAAS, male, 3m</td>
<td>AVB</td>
<td>14 days, without the balloon</td>
<td>Biphasic stridor, desaturation</td>
<td>Extubation failures</td>
<td>SGS Grade 3 + abundant glottic GT</td>
<td>10mm, 2 min, 2 atm, 1X</td>
<td>Normal airway</td>
</tr>
<tr>
<td>GM, male, 2m</td>
<td>Pneumonia</td>
<td>5 days, without the balloon</td>
<td>Biphasic stridor, weak cry</td>
<td>60 days</td>
<td>SGS Grade 3, with GT, concentric</td>
<td>10mm, 2 min, 2 atm, 2X</td>
<td>Mature, Grade 1 SGS</td>
</tr>
<tr>
<td>NSS, female, 2 m</td>
<td>AVB</td>
<td>9 days, without the balloon</td>
<td>Biphasic stridor, sternum retraction</td>
<td>6 days</td>
<td>SGS Grade 2, with GT, posterior</td>
<td>10mm, 30s of duration, 1X</td>
<td>Normal airway</td>
</tr>
<tr>
<td>RLGS, male, 2m</td>
<td>AVB</td>
<td>3 days, without the balloon</td>
<td>Biphasic stridor, weak cry, sternum retraction</td>
<td>9 days</td>
<td>SGS Grade 2, with GT anterior and lateral to the left</td>
<td>10mm, 40 s of duration, 1X</td>
<td>Normal airway</td>
</tr>
<tr>
<td>WLC, male, 3m</td>
<td>AVB</td>
<td>8 days, without the balloon</td>
<td>Biphasic stridor, sternum retraction, weak cry, desaturation</td>
<td>14 days</td>
<td>SGS Grade 3, with GT, concentric</td>
<td>10mm, 30 s of duration, 2X</td>
<td>Mature, Grade 1 SGS</td>
</tr>
</tbody>
</table>

AVB: Acute Viral Bronchiolitis. ETI: endotracheal intubation. DL: direct laryngoscopy. BLP: size of the dilatation balloon (external diameter of the balloon), dilatation duration (balloon inflated, completely obstructing the patient’s airway), balloon pressure, number of dilatations performed. GT: granulation tissue. SGS: subglottic stenosis. *: This patient required a tracheostomy because the glottic granulation tissue (GT) remained obstructive for 2 weeks after subglottic dilatation. After this period, the GT resolved completely and the patient was decannulated. The subglottic stenosis resolved completely after BLP.
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pediatric patients with SGS submitted to balloon dilatation

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After intubation

a symptomatic four-year old diagnosed with grade 2 SGS

was completely resolved with the dilatation procedure.

The first case of BLP for SGS described in the lite

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acute stenosis after intubation, submitted to dilatation with

an angioplasty balloon. Most of our patients were infants,

previously healthy, with a short ETI time (3-14 days) in

whom endotracheal tubes without a circumferential ballo

on was utilized. One of them had extubation failure and,

for that, was submitted to direct laryngoscopy, and all

other started having upper airway obstruction symptoms

between 5 and 60 days after the extubation, being also

submitted to diagnostic laryngoscopy.

Endoscopic techniques used to treat stenosis are

once again being stressed. Balloon laryngoplasty seems

to be more effective than the other means of dilatation,

because the entire force employed is radial, towards the

stenosis area. The lack of shearing forces reduces subglottic

trauma, both at the mucosa and in the deeper areas, thus

reducing the changes of re-stenosis9. Moreover, because

of the small deflated balloon diameter, it can be passed

through extremely narrow areas, without causing trauma3.

Just as in dilatations with rods and rigid bronchoscopes,

balloon dilatation is also more successful when one is

dealing with immature scar tissue (granulation tissue),

although there are reports of its efficiency in subglottic

stenosis4,6. Dilatation my require to be repeated a few times

in order to reach the desired outcome2,4-7.

We presented here our series of eight children with

acute stenosis after intubation, submitted to dilatation with

an angioplasty balloon. Most of our patients were infants,

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a symptomatic four-year old diagnosed with grade 2 SGS

after intubation9. They used a balloon with 6mm in dia

meter and 15mm long, inflated at 6atm of pressure, leaving

it in the subglottis until the child’s hemoglobin saturation

dropped to 80%. The child remained asymptomatic after

15 months of observation.

In 2007, Durden& Sobol published a series of 10

pediatric patients with SGS submitted to balloon dilatation6.

About half of the cases were patients with acute SGS, still

bearing granulation tissue. They showed that BLP is an
effective technique to acutely secure a severely compro

mised airway and it seemed to completely resolve symp

toms in a large number of children with SGS, with success

indices comparable to those of laryngeal reconstruction

(about 70%). The authors did not have complications in

dilatation procedures and reported that these do not

rule out the possibility of doing a laryngotracheal recon

struction later one, should that be the case. They also state

that BLP is not effective for long-standing SGS, congenital

cases or those involving cartilage. Nonetheless, half of their

favorable outcome cases were associated with mature SGS

without granulation tissue. In our study we did not include

patients with mature stenosis without granulation tissue.

Despite the small sample, our data also showed that

BLP is effective to treat evolutional SGS (with granulation

tissue) in children. We showed a high rate of total reso

lution for the subglottic lesion in six of the eight patients

(75%). Before we started to use BLP in our clinic, these

patients with respiratory distress caused by post-intubation

subglottic stenosis were referred to direct laryngoscopy

and, usually, to tracheostomy at the same time. Some were

eventually cured, but others developed a mature stenosis

and required later laryngotracheal reconstructive surgery.

With BLP we were able to avoid tracheostomy in seven

of the eight patients, and we avoided laryngotracheal

reconstruction in all of them.

Since we used oral steroids and omeprazole in all

the patients, we could not infer on which effects were

associated to this medication and which were associated

with BLP alone. Nonetheless, when we treated granulation

tissue patients with omeprazole and steroids only, our

rate of tracheostomies was higher. Thus, the benefit of

the BLP is, at least, airway stabilization and tracheostomy

avoidance until medication is able to reduce the formation

of granulation tissue.

Only two children remained with residual, non

obstructive SGS. These children remained in follow up at

our clinic and are asymptomatic until current days.

One of the children required tracheostomy after

BLP, but this was due to glottic obstruction by abundant

granulation tissue, and not to subglottic obstruction, which

was completely resolved with the dilatation procedure.

We had no complications during the procedures,

despite the fact that these have been reported, such as

atelectasis, bleeding and cricoid rupture, in studies with

animals11.

CONCLUSION

BLP seems to be the safest and most efficient pro

cedure to treat post-intubation SGS in children. Further

studies are required in order to know what is the real

success rate of such procedure, which patients benefit

from the technique, the proper balloon diameter for each

age range, its ideal resting time in the subglottis and the

maximum inflation pressure one can use.
REFERENCES