ANDES PEDIATRICA
REVISTA CHILENA DE PEDIATRÍA
www.scielo.cl

Andes pediatr. 2025;96(6):766-771
Doi: 10.32641/andespediatr.v96i6.5573

ORIGINAL ARTICLE

Subglottic stenosis: characteristics and results in patients underwent to a laryngotracheal reconstruction

Estenosis subglótica: Características y resultados en pacientes sometidos a reconstrucción laringotraqueal

Yovanca Ramírez Covarrubias[a,e], Patricio Varela Balbontín[a,b,c], Eduardo Leopold González[a,d]

[a]Hospital Dr. Luis Calvo Mackenna. Santiago, Chile.
[b]Universidad de Chile. Santiago, Chile.
[c]Clínica Alemana de Santiago. Santiago, Chile.
[d]Universidad de los Andes. Santiago, Chile.
[e]Residente de Cirugía Pediátrica.

Received: December 24, 2024; Approved: August 8, 2025

What do we know about the subject matter of this study?

Subglottic stenosis is a narrowing of the subglottic lumen, usually secondary to prolonged endotracheal intubation. It may require surgical interventions such as laryngotracheal reconstruction with anterior and/or posterior grafting or cricotracheal resection to restore airway patency and improve quality of life.

What does this study contribute to what is already known?

This study retrospectively analyzes the clinical characteristics and surgical outcomes of pediatric patients treated at a tertiary center, finding decannulation and extubation rates above 90%, which highlights the importance of multidisciplinary and specialized management to optimize outcomes and minimize postoperative complications.

Abstract

Subglottic stenosis (SGS) can be either congenital or acquired. Acquired SGS is more frequent and is mainly caused by prolonged intubation. Treatment includes laryngotracheal reconstruction (LTR) with anterior and/or posterior rib graft, partial cricotracheal resection (PCTR), and endoscopic dilatation. **Objective:** To describe and analyze the characteristics, surgical outcomes, and postoperative complications of the pediatric population with SGS surgically treated. **Patients and Method:** Retrospective study of surgical outcomes and postoperative complications of 44 pediatric patients with SGS treated with LTR or PCTR between 2015 and 2024 in a tertiary pediatric hospital. **Results:** 88.6% of patients presented acquired SGS. LTR was performed in 33 patients with grade II and III SGS with a success rate of 93%. PCTR was performed in 11 patients with SGS grade III- IV, with a success rate of 91%. **Conclusion:** LTR as well as PCTR are safe and effective options for the treatment of SGS in children. Surgical success depends on specialized, individualized, and multidisciplinary care.

Keywords:
Subglottic Stenosis;
Laryngotracheal Reconstruction;
Partial Cricotracheal Resection;
Rib Graft;
Pediatrics

Correspondence:
Yovanca Ramírez Covarrubias
yovanca.ramirez@gmail.com

Edited by:
Paul Harris Diez

How to cite this article: Andes pediatr. 2025;96(6):766-771. Doi: 10.32641/andespediatr.v96i6.5573

Introduction

Subglottic stenosis (SGS) is a condition characterized by narrowing of the subglottic lumen, which is anatomically defined as the airway located below the vocal cords and above the lower edge of the cricoid cartilage[1]. This space is crucial in the anatomy of the upper airway, especially in children, due to its naturally small size, which means that any additional narrowing can have significant repercussions on ventilation.

In terms of its etiology, SGS can be congenital or acquired. Congenital SGS is the third most common congenital laryngeal anomaly after laryngomalacia and vocal cord paralysis[2]. On the other hand, acquired SGS is due in 90% of cases to prolonged endotracheal intubation, which can cause ischemic injury, inflammation, and subsequent scar formation[1,3]. Increased survival rates among premature infants and other critically ill patients requiring prolonged mechanical ventilation have led to an increase in the incidence of acquired SGS[4].

Historically, SGS in children was a devastating condition with limited treatment options, often resulting in the need for permanent tracheostomy. However, it was not until the 1970s that Dr. Robert T. Cotton et al.[6] began developing surgical techniques, marking a milestone in treatment alternatives for these patients.

To standardize therapeutic options, it is necessary to make an adequate and timely diagnosis, which is established through clinical evaluation, airway endoscopy, and subsequent assessment of the SGS degree using progressively larger endotracheal tubes (ETTs), determining the severity of subglottic stenosis based on the largest ETT that allows air leakage at pressures of 20 cmH_2O or higher, for subsequent classification. According to this, Myers-Cotton et al. classified SGS into grades: Grade I, up to 50% stenosis; Grade II, 51-70% stenosis; Grade III, 71-99% stenosis; and Grade IV, with no observable lumen[5].

Currently, there are multiple techniques described for the management of this condition, depending on its characteristics or associated comorbidities of each patient, ranging from endoscopic dilations to surgical procedures for lumen augmentation, such as laryngotracheal reconstruction (LTR) with single- or double-stage anterior and/or posterior grafting, and LTR with anterior and/or posterior rib grafting using a laryngeal stent (LT-mold) in cases involving the glottis. Partial or extended cricotracheal resection (CTR) is also performed for cases of severe subglottic involvement or when previous surgical treatment has failed[7].

The objective of LTR surgery is to increase the subglottic lumen by placing costal cartilage in the anterior and/or posterior subglottic region, depending on the patient's condition. This surgery can be performed in a single surgical procedure, removing the tracheostomy, or in two surgical procedures, which involve maintaining the tracheostomy temporarily.

LTR with costal cartilage grafting allows for early decannulation and/or extubation rates or prevents the need for tracheostomy. Less time connected to ventilatory support reduces the potential changes and sequelae in pediatric patients who are on invasive mechanical ventilation for a long time[7-9].

The importance of identifying the pathology and providing appropriate treatment is to reduce the need for tracheostomy, as tracheostomized patients with SGS may develop tracheostomy stenosis, recurrent respiratory infections, tracheostomy obstruction due to granuloma, and accidental decannulation, which can even lead to death.

The objective of this study is to describe and analyze the characteristics of patients with SGS, the surgical outcomes measured as decannulation and/or extubation success according to the technique used, as well as postoperative complications.

Patients and Method

Design

Retrospective study of the clinical characteristics, surgical outcomes according to type of intervention, and postoperative complications in pediatric patients with SGS diagnosed by airway endoscopy treated with LTR with single- or double-stage anterior and posterior grafting and patients treated with CTR between January 2015 and May 2024 in the surgery department of the *Hospital Clínico Dr. Luis Calvo Mackenna* (HLCM), in Santiago, Chile.

Variables analyzed

Demographic data, comorbidities, severity and level of stenosis, time of decannulation and/or ventilatory support, type of intervention, postoperative complications such as infection rate, degree of subglottic recurrent stenosis, and withdrawal syndrome were analyzed. Surgical success was defined as successful decannulation[5], rather than other parameters such as absence of SGS or normal laryngeal function (voice and swallowing).

Patients and follow-up

Patients were followed up from the first postoperative week with outpatient clinical evaluations and airway endoscopy from the fourth week after surgery, for a maximum follow-up period of 2 years post-surgery. The frequency of outpatient follow-up was determined based on each patient's clinical condition.

Only patients with SGS who required surgical

treatment at the HLCM between 2015 and 2024 were included. All patients with incomplete medical records and those treated with endoscopic dilations were excluded. Functional outcomes reported in the medical records, such as postoperative exercise tolerance, voice deterioration, and swallowing disorders, were excluded due to a lack of data standardization. It should be noted that the analyzed series covers the years 2020 to 2022, during which time the COVID-19 pandemic occurred, limiting the number of surgical patients per year in that period.

Statistics and ethical aspects

The data collected were analyzed using Stata v.14.0 statistical software, after approval by the ethics committee and informed consent from the patient's parents.

Results

The electronic records of the HLCM between 2015 and 2024 were reviewed, identifying 132 patients diagnosed with SGS. For this study, only patients with subglottic stenosis confirmed by airway endoscopy were included. From the analysis of these patients, 44 patients who underwent surgery were identified, while the rest were managed endoscopically or with periodic follow-up.

Of the 44 patients who underwent surgery, 23 were female and 21 were male, with a mean age of 4.7 years (range 4 months to 15 years). 86.3% of patients with acquired SGS had a tracheostomy before surgery, secondary to prolonged intubation. Other comorbidities found included prematurity, congenital heart disease, Down syndrome, VACTERL association, and gastroesophageal reflux, among others. 88.6% of patients had acquired SGS, and 11.4% of patients had congenital SGS. Table 1 shows the distribution of patients and outcomes by surgical technique.

LTR with both anterior and posterior grafting was performed in 85% of patients, LTR with anterior grafting only in 12%, and LTR with posterior grafting only in 4% of patients. In 61% of patients with Grade II or III SGS without cardiopulmonary comorbidities, single-stage LTR was performed, whereas in those with Grade II or III SGS with cardiopulmonary comorbidities, double-stage LTR was performed in 13% of patients. Single-stage CTR was performed in 15% of patients, and two-stage CTR in 9% of patients, all with Grade III or IV SGS.

The tracheostomized patients who underwent single- or double-stage LTR showed a decannulation success rate of 96.8%. The mean ventilatory support time in patients without tracheostomy who underwent single-stage LTR was 7.2 days, with no need for oxygen support, intubation, or subsequent tracheostomy. The decannulation rate in patients with grade II and III SGS who underwent single- or double-stage LTR was 93% of patients, while in patients with grade III-IV SGS who underwent single- or double-stage CTR, the decannulation rate was 90.9%. No intraoperative or immediate postoperative complications were reported, regardless of the patient's baseline condition or the surgical technique used.

Regarding infections, ceftriaxone and clindamycin were used as antibiotic prophylaxis in all patients, regardless of the technique used, with the antibiotic regimen which was adjusted according to the intraoperative culture results in 82% of patients. Postoperative cultures were performed only in those patients with clinical signs of infection.

Additionally, of the total cultures performed, 44% of patients had positive cultures, with *Pseudomonas aeruginosa* and *Staphylococcus aureus* being the most frequent germs. In addition, regardless of the technique used, antibiotic treatment was changed in 47.7% of patients due to clinical manifestations such as fever, leukocytosis, or germs resistant to the initial standard treatment.

Furthermore, based on the number of days of mechanical ventilation support, 49% of patients developed withdrawal syndrome and were treated with lorazepam-methadone for 11.2 days on average.

In this series, the death of one patient was reported two years after surgical correction, due to causes unrelated to the intervention.

The comparative analysis according to surgical technique found the following:

a. Single-stage laryngotracheal reconstruction

This technique was performed in 61% of patients, with a decannulation and/or extubation rate of 100% at 3 months of follow-up. Ventilatory support time varied between 2-10 days, with a mean of 7.2 days. LTR with anterior and posterior grafting was performed in 82% of patients, with anterior grafting only in 14% and posterior grafting only in 4% of patients. Airway endoscopy performed between 4 and 6 weeks postoperatively showed that 9 of 27 patients had recurrent SGS, of which 6 had grade I SGS and 3 had grade II-III SGS according to Myers and Cotton classification. All patients underwent gentle, serial ETT dilation, chosen for their affordability and accessibility. In patients with recurrent grade II-III SGS, the condition was resolved with serial ETT dilation or, in some cases, with balloon airway dilation. All patients were followed up at 6, 8, and/or 12 weeks on average. Regarding reoperations, 3 patients required a repeat surgical procedure: 1 patient due to recurrent grade III SGS, who underwent CTR,

Table 1. Outcomes According to Surgical Technique

Type of Technique	Single-stage LTR	Two-stage LTR	Single-stage CTR	Two-stage CTR
Number of patients	27	6	7	4
SGS grade	II o III	II o III	III o IV	III o IV
Decannulation and/or extubation rate	100%	80% entre 1er y 2do año	100%	80% en los 2 primeros años
Days of mechanical ventilation	7,2 días	2,6 días	10,5 días	2,8 días
Postoperative complications	Subglottic re-stenosis from Grade I to III (Myers & Cotton): 33.3% of patients	SGS recurrence from Grade I or II (Myers & Cotton): 16% of patients	Supra-stomal collapse: 16% of patients	SGS recurrence from Grade I or II (Myers & Cotton): 42% of patients; Grade I SGS recurrence (Myers & Cotton): 25% of patients

and 2 patients due to stenosis distal to the anterior graft placed in the subglottic region.

b. Double-stage laryngotracheal reconstruction:

This technique was performed in 13% of patients. The duration of ventilatory support via tracheostomy ranged from 2 to 11 days, with a mean of 2.6 days. 80% of patients undergoing double-stage LTR had glottic-subglottic involvement, so a laryngeal silicone stent was inserted for 4-6 weeks. LTR with anterior and posterior grafting was performed in 100% of patients. Decannulation was performed within the first or second year in 80% of patients. Regarding postoperative complications, one patient presented with grade II SGS according to the Myers and Cotton classification, which was resolved with gentle, serial ETT dilation during airway endoscopy performed at 6, 8, and 12 weeks. Another patient presented with suprastomal collapse.

c. Single-stage partial cricotracheal resection

This surgical technique was performed in 15% of patients, with a decannulation rate of 100%. 80% of patients had acquired grade III or IV SGS. The extubation time ranged from 7 to 17 days, with a mean of 11.4 days. In the subsequent endoscopic follow-up performed on average at 6, 8, and 12 weeks postoperatively, it was found that 3 of the 7 patients had grade I or II SGS according to Myers and Cotton classification, which was managed with gentle, serial ETT dilation at each evaluation, resolving completely. No reoperations were performed in this group of patients.

d. Double-stage partial cricotracheal resection

This technique was performed in 9% of patients, with a decannulation rate of 80% at two years of follow-up. Ventilatory support time ranged from 0 to 5 days, with a mean of 2.8 days. In the subsequent endoscopic follow-up performed at 6, 8, and 12 weeks on average postoperatively, it was found that 1 of the 4 patients had a recurrent grade I subglottic stenosis according to Myers and Cotton classification that did not require endoscopic intervention. No reoperations were reported in this group of patients.

Discussion

A preoperative work plan is essential; rigid and flexible airway endoscopy provides the information necessary for careful surgical planning[14]. In this series, rigid airway endoscopy and airway sizing according to Myers and Cotton classification[5] were performed in all patients, and images of each case were saved until the time of surgery. A new endoscopic airway assessment was performed at the time of surgery in those patients who had undergone their last airway assessment more than three months before surgery.

The main objective of surgery is to restore adequate airway diameter, allow decannulation, and restore normal laryngeal function[14]. To this end, the choice of treatment and the type of technique to be used depends on several factors, including the characteristics and degree of SGS, patient comorbidities, and surgeon experience.

In general terms, single-stage LTR is reserved for patients with stable cardiopulmonary function and no significant comorbidities in these two systems[2]. At the time of surgery, an ETT is inserted as a laryngotracheal stent for an intubation period of 5-10 days[4]. In contrast, double-stage LTR is reserved for patients with associated cardiopulmonary comorbidities and/or grade III-IV SGS with or without posterior glottic compromise[10]. In these patients, closure of the tracheostomy is deferred to another surgical procedure, given the need

to insert a laryngeal stent to reduce the likelihood of stenosis recurrence[4]. In the case series analyzed, preoperative management of comorbidities was performed in all patients, minimizing possible postoperative complications as much as possible. Regarding the type of surgical technique, single-stage LTR with anterior and posterior grafting was performed in patients without comorbidities, with a Myers and Cotton classification of grade II or III SGS. Meanwhile, in patients with stable cardiopulmonary comorbidities and grade III or IV SGS, a double-stage LTR with anterior and posterior grafting was performed.

Historically, patients undergoing double-stage LTR have a higher degree of complexity compared to patients requiring single-stage LTR, so the extubation and decannulation rates are consistent at 61.8% vs. 91%[9]. However, a more recent study comparing the decannulation and/or extubation rates of both surgical techniques showed that they were not significantly different from each other[11]. Finally, a meta-analysis that included 16 articles with 663 patients compared the decannulation and/or extubation rate of patients undergoing single-stage LTR compared to double-stage LTR, reporting a rate of 93.2% versus 83.7%, respectively[12].

In this series, it was observed that single- or double-stage LTR was effective for the management of SGS, with extubation and/or decannulation rates of 100% and 80%, respectively.

Furthermore, single or double-stage surgical resection is reserved for patients with associated cardiopulmonary comorbidities and/or grade III-IV SGS, in which the anterior segment of the stenotic cricoid cartilage and adjacent compromised tracheal rings are removed, as well as the fibrous tissue of the subglottic space, and a cricotracheal anastomosis is performed. Regarding the outcomes of this technique, a study showed that patients who underwent CTR had a decannulation rate greater than 90%[13], similar to that found in this analysis.

Regarding recurrent SGS and the need for additional post-surgical endoscopic intervention, it has been reported in the literature that up to 60% of pediatric patients who undergo LTR require some additional endoscopic intervention[15,16]. In this series, follow-up endoscopy was performed at 6, 8, and 12 weeks on average postoperatively, with gentle, serial ETT dilation, and it was observed that 18% of patients undergoing single or double-stage LTR with anterior and/or posterior grafting presented with recurrent grade I SGS, which did not require any additional surgical intervention, and 12% of patients presented with recurrent grade II or III SGS according to Myers and Cotton classification, which was resolved with endoscopic dilation using serial ETT dilation. Finally, regarding reoperations, 6.8% of patients required reoperation secondary to recurrent SGS or tracheal obstruction located distal to the anterior graft. This has implications when explaining the expected surgical outcome to patients and their families, and the need for possible post-surgical endoscopic airway interventions.

Given the complexity of SGS patients requiring LTR, as well as the need for a period of intubation in the postoperative course, it is not unusual to face complications related to these factors[15]. In this series, it was observed that both patients who underwent single-stage LTR and CTR developed withdrawal syndrome in 49% of cases, requiring treatment for 11 days on average. This highlights the importance of a personalized, multidisciplinary surgical approach and intensive postoperative management based on protocols and updated information, as well as timely preoperative management of comorbidities and adequate endoscopic evaluation of the airway to offer the therapeutic alternative that best suits the child's needs.

Ethical Responsibilities

Human Beings and animals protection: Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimentation developed for the medical community.

Data confidentiality: The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data.

Rights to privacy and informed consent: The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the correspondence author.

Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

Financial Disclosure

Authors state that no economic support has been associated with the present study.

References

1. Marston AP, White DR. Subglottic Stenosis. Clinics in Perinatology. 2018 Dec;45(4):787-804. PMID: 30396418.
2. Redondo-Sedano J, Antón-Pacheco JL, Valverde RM, et al. Laryngeal stenosis in children: Types, grades and treatment strategies. Journal of Pediatric Surgery. 2019 Sep;54(9):1933-1937. PMID: 30503025.
3. Pérez C, Botto H, Cocciaglia A, Rodríguez H. Reconstrucción laringotraqueal como tratamiento de las estenosis subglóticas en Pediatría: Serie de casos. Revista FASO. 2015; Oct 3:32-37.
4. Jefferson ND, Cohen AP, Rutter MJ. Subglottic stenosis. Seminars in Pediatric Surgery. 2016 Jun;25(3):138-43. PMID: 27301599.
5. Myer CM 3rd, O'Connor DM, Cotton RT. Proposed grading system for subglottic stenosis based on endotracheal tube sizes. Annals of Otology, Rhinology & Laryngology. 1994 Apr;103(4 Pt 1):319-323. PMID: 8154776.
6. Zhi L, Wenli W, Pengfei G, Pengcheng C, Wenxian C, Jiasheng L, Yongzhu S. Laryngotracheal reconstruction with autogenous rib cartilage graft for complex laryngotracheal stenosis and/or anterior neck defect. European Archives Otorhinolaryngology. 2014 Feb;271(2):317-22. PMID: 23818115.
7. Gustafson LM, Hartley BE, Liu JH, et al. Single-stage laryngotracheal reconstruction in children: a review of 200 cases. Otolaryngology–Head and Neck Surgery. 2000 Oct;123(4):430-4. PMID: 11020180.
8. Cotton RT, Myer CM 3rd, O'Connor DM, Smith ME. Pediatric laryngotracheal reconstruction with cartilage grafts and endotracheal tube stenting: the single-stage approach. Laryngoscope. 1995 Aug;105(8 Pt 1):818-21. PMID: 7630293.
9. Yellon RF, Parameswaran M, Brandom BW. Decreasing morbidity following laryngotracheal reconstruction in children. International Journal of Pediatric Otorhinolaryngology. 1997 Aug 20;41(2):145-54. PMID: 9306171.
10. Yamamoto K, Monnier P, Holtz F, Jaquet Y. Laryngotracheal reconstruction for pediatric glotto-subglottic stenosis. International Journal of Pediatric Otorhinolaryngology 2014 Sep;78(9):1476-9. PMID: 25022423.
11. Saunders MW, Thirlwall A, Jacob A, Albert DM. Single-or-two-stage laryngotracheal reconstruction; comparison of outcomes. Int J Pediatr Otorhinolaryngol. 1999 Oct 15;50(1):51-4. doi: 10.1016/s0165-5876(99)00235-9. PMID: 10596887.
12. Padia R, Sjogren P, Smith M, Muntz H, Stoddard G, Meier J. Systematic review/meta-analysis comparing successful outcomes after single vs. double-stage laryngotracheal reconstruction. International Journal of Pediatric Otorhinolaryngology. 2018 May;108:168-174. PMID: 29605348.
13. White DR, Cotton RT, Bean JA, Rutter MJ. Pediatric cricotracheal resection: surgical outcomes and risk factor analysis. Archives of Otolaryngology-Head and Neck Surgery. 2005 Oct;131(10):896-9. PMID: 16230593.
14. Carta F, Piras N, Mariani C, et al. The surgical treatment of acquired subglottic stenosis in children with double-stage laryngotracheal reconstruction. International Journal Pediatric Otorhinolaryngology. 2022 Jul;158:111164. PMID: 35490607.
15. Cheung PKF, Koh HL, Cheng ATL. Complications and outcomes following open laryngotracheal reconstruction: A 15 year experience at an Australian pediatric tertiary referral centre. International Journal Pediatric Otorhinolaryngology. 2021 Jun;145:110687. PMID: 33862326.
16. Chan LS, Daniel M, Boardman SJ, Cheng AT. Laryngotracheal stenosis and airway surgery--an outcomes based approach. International Journal Pediatric Otorhinolaryngology. 2014 Nov;78(11):1931-6. PMID: 25216809.