Pediatric airway surgery: Management of laryngotracheal stenosis in infants and children

Editors: Philippe Monnier
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Reviewer: Department of OtoRhinoLaryngology, Ain Shams University, Cairo, Egypt
E-mail: dr_mamir@hotmail.com

Introduction

Airway surgery is the fruit of experience gained over many years to improve the surgical outcome for children suffering from a variety of compromised airways. The author focuses on the technical aspects of diagnosis and treatment to provide the reader not only with well-established treatment modalities, but also with new concepts of pediatric airway management. This book is also intended to provide insights into controversial issues pertaining to the most difficult airway reconstructions. The author does not claim to present definite solutions to the challenging problem of the compromised pediatric airway.

Nonetheless, his modest goal, based on the experience of pioneers, is to add a stone to the pyramid of knowledge in this field of research. With inputs from different horizons, it is hoped that this will one day lead to the complete rehabilitation of most tracheostomized children suffering from various forms of laryngotracheal stenosis (LTS).

Professor Monnier works in University Hospital CHUV, Department of Otolaryngology, Head and Neck Surgery, Lausanne, Switzerland. He is one of the eminent pediatric otolaryngology experts all over the world; he has visitors from all over the world coming to learn about pediatric airway surgery, especially partial cricotracheal resection (PCTR). He has plenty of publications in this field and I think he is quite an authority.

In this study, I am going to highlight some points in the book that are useful for otolaryngologists who are going to perform pediatric airway surgery and examine some of the author's claims in this book.

Review

First, the author presented some facts concerning the management of pediatric airway stenosis, such as the patient's best chance is on the first operation performed, and team work and expertise are required for better management.

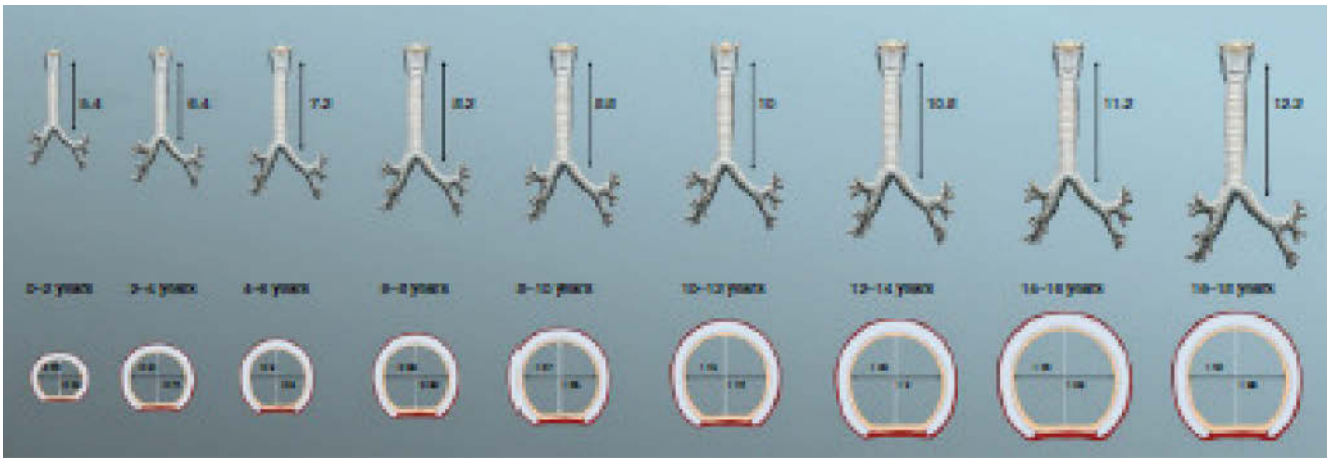
He presented a very well-illustrated surgical anatomy for pediatric airway with difference in anatomy between infant, children, and adults and difference in the tracheal diameter (Fig. 1). The Ansa Galeni, an anastomosis between the superior laryngeal nerve internal branch and one of the recurrent laryngeal nerve branches, provides the accessory motor and predominant sensory supply to the endolaryngeal structures. He provided a table for different sizes of bronchoscopes, endotracheal tube, and tracheostomy tubes that fit with the age of a child (Table 1). He also gave us a hint about different laryngeal and tracheal stents that can be used with advantages and disadvantages of each. Examples for these stents are Aboulker stent, Montgomery T tube, Healy pediatric T tube, Montgomery LT stent, Eliachar LT stent, and Monnier LT mold. Too much was mentioned about Monnier moulding LT stent, but conflict of interest was declared. In addition, too much details about equipment especially laser was provided, which I think was not the scope of this book.

There are other factors affecting prognosis in the management of pediatric airway stenosis other than the degree of stenosis; that is why the author introduced the new grading, putting into account comorbidities, glottal involvement, or both (Table 2).

The author states that the treatment options for LTS are either endoscopic by CO_2 laser, dilatation, and mitomycin C application, or open surgery by laryngotracheal reconstruction (LTR), PCTR, extended PCTR, and extended PCTR with intussusception of thyrotracheal anastomosis.

Evaluation of outcomes following LTR or PCTR suggests the possibility of establishing an international standard of treatment for children with LTS. This endeavor is difficult and often biased by a number of parameters (e.g. grade of stenosis, glottis involvement,

Fig. 1



Tracheal lengths and diameters from birth to adolescence; the length of trachea doubles, its diameter triples, and its cross-sectional area increases six-fold.

Table 1 Recommended tubes and scopes on the basis of patient age

Patient age	Bronchoscope		Esophagoscope	Tracheostomy tube	ETT ID
	Size	OD (mm)			
Premature	2.5	4.2	4	2.0/2.5	2.5
Term newborn	3.0	5.0	4–5	3.0/3.5	3.0/3.5
6–12 months	3.5	5.7	5–6	3.5–4	3.5/4.0
1–2 years	3.7	6.4	6	4.0	4.0/4.5
2–3 years	4.0	6.7	6–7	4.0/4.5	$\frac{\text{Age} + 16}{4}$
3–4 years	4.5	7.3	7	5.0	
4–5 years	5.0	7.8	8	5.0–5.5	

ETT, endotracheal tube; ID, internal diameter; OD, outer diameter; ISO, International Organization for Standardization.

or severe comorbidities) that may influence the operation-specific and overall decannulation rates, without considering the outcomes in voice quality. A small case series, more often than not, comprises a mixture of several conditions in which only one parameter is analyzed (e.g. decannulation rates) on the basis of the grade of stenosis.

The author claims a management guideline for subglottic stenosis (SGS):

1. *Grade I*: It does not require surgical intervention; certain patients can be treated using CO_2 laser radial incisions and gentle dilatation. Concurrent comorbidities do not preclude this minimally invasive endoscopic procedure.
2. *Grade II*: Stage IIa is either managed endoscopically in case of thin web-like cicatricial stenosis (<5 mm in the craniocaudal axis) or by single-stage (SS) LTR [anterior costal cartilage graft (ACCG)] in thick stenotic segment. Stage IIb is treated as IIa, except that double-stage (DS) LTR is needed instead of SS LTR. Stage IIc is treated by SS LTR, SS PCTR, or DS LTR+stenting (ACCG or posterior costal cartilage graft (PCCG)). Finally, stage IId can be managed by DS LTR+stenting (ACCG and/or PCCG) or DS PCTR.
3. *Grades III and IV*: Stages III and IVa are managed by SS PCTR or DS LTR+stenting. Stages III and IVb are treated as III and IVa. Stages III and IVc and d are treated by DS-extended PCTR+stenting or DS LTR+prolonged stenting.

Table 2 New airway grading system

Myer–Cotton grade	Isolated SGS (a)	Isolated SGS + comorbidities (b)	SGS+glottis involvement (c)	SGS+glottis involvement + comorbidities (d)
I				
0–50%	Ia	Ib	Ic	Id
II				
51–70%	IIa	IIb	IIc	IId
III				
71–99%	IIIa	IIIb	IIIc	IIId
IV				
No lumen	IVa	IVb	IVc	IVd

SGS, subglottic stenosis.

Table 3 Operation-specific and overall decannulation rates of LTRs from the largest world series

Myer-Cotton grade	GOS 1992 London		Robert Debré 1999 Paris		Cincinnati 2001	
	OP-specific DR	Overall DR	OP-specific DR	Overall DR	OP-specific DR	Overall DR
II	NR	89% (41/46)	83% (30/36)	NR	83% (55/66)	95% (65/66)
III	NR	78% (21/27)	75% (33/44)	NR	55% (57/104)	79% (82/104)
IV	NR	50% (4/8)	24% (5/21)	NR	53% (9/17)	88% (15/17)
II, III, IV	70%	81%	68%	NR	65%	87%

DR, decannulation rate; GOS, Great Ormond Street; NR, not reported; OP, operation.

Table 4 Results of the Cincinnati experience in 199 laryngotracheal reconstructions for a sole diagnosis of subglottic stenosis

Myer-Cotton grade	Double-stage LTR (n = 101)		Single-stage LTR (n = 98)	
	OP-specific DR	Overall DR	OP-specific DR	Overall DR
II	85% (18/21)	95% (20/21)	82% (37/45)	100% (45/45)
III	37% (23/61)	74% (45/61)	79% (34/43)	86% (37/43)
IV	50% (7/14)	86% (12/14)	67% (2/3)	100% (3/3)
II, III, IV	–50% (48/96)	–80% (77/96)	–80% (73/91)	–93% (85/91)
Revision surgery	48% of all cases – 1.6 per child		18% of all cases – 1.3 per child	

DR, decannulation rate; LTR, laryngotracheal reconstruction; OP, operation.

These guidelines were based on the results of the largest series all over the world. There is no study comparing LTR with PCTR to date. Regarding LTR, the experiences of Great Ormond Street, London; Robert Debré, Paris; and Cincinnati Children Hospital, USA are shown in Table 3. Upon analysis of the three largest series involving LTR for grades II–IV SGSs, the operation-specific and overall decannulation rates were 68% (range 65–70%) and 89% (range 87–95%), respectively. In the published series, the failure rate after first surgery was 33% (range 30–35%). To achieve the overall decannulation rates listed in Table 3, one to four additional open procedures (with an average of 1.4 per child) were necessary. When compared with grade II SGS, operation-specific and overall decannulation rates following LTR tended to be less optimal in patients with Myer–Cotton grades III and IV SGS, except for cohorts too small for stringent data analysis (Table 4).

The two major published case series of pediatric PCTRs for severe LTS are compared in Table 5. These series are well matched for most variables analyzed. In the Lausanne cohort, there were slightly more patients with associated glottic involvement (a known factor for a less favorable outcome) and less salvage surgeries than in the Cincinnati cohort. The operation-specific and overall success rates were roughly comparable; however, the Lausanne cohort had fewer revision surgeries and a slightly lower overall success rate.

Congenital SGSs are better managed by open surgical correction, as it might be cartilaginous stenosis; hence, laser and dilatation are not effective methods.

The author provided complete surgical and anesthetic technical details for different operations such as LTR, PCTR, extended PCTR, and extended PCTR with intussusception of thyrotracheal anastomosis.

Table 5 Results of partial cricotracheal resection for severe grade III and IV laryngotracheal stenosis

Patients' characteristics	Cincinnati (69) (n = 93) (%)	Lausanne (69) (n = 100) (%)
Stenosis grade		
II	5	4
III	60	64
IV	35	32
Glottic involvement	23	33
Comorbidities	NR	45
Tracheostomy at surgery	85	82
Primary ECTR	46	62
Salvage PCTR	59	38
Extended PCTR	27	23
Revision surgery	29	14
Results		
Operation-specific success rate	71	76
Overall success rate	94	90
Anastomotic dehiscence	2	4
RLN injury	2	0

NR, not reported; PCTR, partial cricotracheal resection; RLN, recurrent laryngeal nerve; ECTR, Extended cricotracheal resection.

Conclusion

I think the author succeeded to present in details the different technical aspects of diagnosis and treatment to provide the reader not only with well-established treatment modalities, but also with new concepts of pediatric airway management. This book could be an excellent reference for those going to deal with pediatric airway stenosis. The book achieved its goals, and to my mind it deserves to be read.