ORIGINAL ARTICLE

Partial cricotracheal resection for paediatric subglottic stenosis: update of the Lausanne experience with 129 cases

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Abstract

OBJECTIVES: Partial cricotracheal resection (PCTR) is widely accepted for treating severe paediatric laryngotracheal stenosis (LTS). However, it remains limited to a few experienced centres. Here we report an update of the Lausanne experience in paediatric PCTR performed or supervised by a senior surgeon (Philippe Monnier).

METHODS: An ongoing database of 129 paediatric patients who underwent PCTR for benign LTS between March 1978 and July 2012 at our hospital was retrospectively reviewed. Demographic characteristics and information on preoperative status, stenosis and surgery were collected. Primary outcomes were measured as overall and operation-specific decannulation rates (ODR and OSDR, respectively), and secondary outcomes as morbidity, mortality and postoperative functional results.

RESULTS: A total of 129 paediatric patients [79 males and 50 females; mean age, 4.1 years (1 month–16 years, median age of 2 years old)] underwent PCTR during the study period. ODR and OSDR were 90 and 81%, respectively. The decannulation rates were significantly superior for single-stage PCTR compared with double-stage PCTR in both ODR and OSDR. Eight patients died postoperatively for reasons unrelated to surgery. Partial anastomotic dehiscence was seen in 13 patients, 9 of whom were successfully treated by revision surgery. Respiratory, voice and swallowing functions were near normal or only minimally impaired in 86, 65 and 81% of patients, respectively.

CONCLUSIONS: PCTR is effective and feasible with good ODR and OSDR for highgrade / severe LTS. Glottic involvement and the presence of comorbidities were negative predictive factors of decannulation. Early detection and reintervention of postoperative incipient dehiscence contribute to avoiding the progress to late restenosis; however, voice improvement remains a challenge.

Keywords: Paediatric · Subglottic stenosis · Laryngotracheal stenosis · Partial cricotracheal resection

INTRODUCTION

Over the past few decades, partial cricotracheal resection (PCTR) has become increasingly more accepted as a superior alternative to laryngotracheal reconstruction (LTR) for the treatment of severe (Grade III or IV according to Myer–Cotton classification) [1] paediatric subglottic stenosis (SGS) [2–4]. However, this technically demanding procedure remains limited to a few experienced centres, mostly because of the possible risk of anastomotic dehiscence or recurrent laryngeal nerve injury. For the paediatric otolaryngologist, this is mainly due to the lack of expertise in head, neck and tracheal surgery, while for the thoracic and paediatric surgeon, it is due to unclear knowledge of detailed laryngeal anatomy and function.

With a lack of global consensus on surgical indications, results pertaining to decannulation rates and physiological functions of the larynx make it difficult to compare matched series of patients among centres.

Since the first paediatric PCTR was performed in 1978 at our institution, our ongoing experience has been documented in several publications, focusing on several aspects, such as decannulation rates [4, 5], physiological results on voice and respiration [4, 6], morbidity and mortality [7] or more complex cases with severe glottic involvement [8, 9].

Here we report an update with our experience in paediatric PCTR performed or supervised by a senior surgeon (Philippe Monnier) and detail the results in terms of decannulation rates, morbidity and mortality, and physiological outcomes on respiration, voice and deglutition.

METHODS

This update was approved by the institutional review board of the University Hospital (CHUV, Lausanne, Switzerland). Using an ongoing database, we analysed 129 paediatric patients who underwent PCTR for laryngotracheal stenosis between March 1978 and July 2012 at our hospital. Patients who underwent

simple tracheal resection and PCTR for other causes than benign stenosis were excluded from the study.

The data were prospectively collected from the patients' endoscopic and surgical charts, and data registration was closed at the end of February 2013.

Data collected for each PCTR included: demographic characteristics (sex and age), preoperative status (respiration, voice quality, tracheostomy dependence, presence of congenital anomaly or severe cardiac, pulmonary or neurological sequelae), precise information on the stenosis (aetiology, previous treatments, Cotton–Myers grade, location and vocal cord mobility), information on the operation [single-stage PCTR (SS-PCTR) or double-stage PCTR (DS-PCTR), procedure type and tracheal resection length], morbidity and mortality, decannulation rates, time to decannulation for DS-PCTR or time to extubation for SS-PCTR and postoperative functional results (respiration, voice and deglutition). The need for individual patient consent was waived because of the anonymous study design.

Surgical technique

The technique of paediatric PCTR has already been described in detail in previous publications [8, 10–12] with a slight technical modification during the study period, namely, since 2001, the introduction of the LT-Mold prosthesis [13, 14] for stenting complex LTRs involving the glottis. Before 2001, we used the T-tube to stent the larynx in such cases.

The term 'SS-PCTR' was used when the tracheostomy was resected simultaneously with SGS. When the tracheostomy was maintained in the postoperative period for any reason, then the procedure was called 'DS-PCTR.' The term 'extended PCTR' was reserved for subglottic resections combined with a posterior cricoid split with costal cartilage interposition needed in the case of posterior glottic stenosis or fusion of the vocal folds (severe congenital web or acquired synechia).

Postoperative management

After SS-PCTR, the patients were kept intubated for 5–10 days under sedation with spontaneous respiration in the paediatric intensive care unit (PICU) to keep the patient's neck in a flexed position. All patients were checked endoscopically on the fifth to seventh postoperative days. If the airway was judged to be adequate for extubation, then the procedure was performed under deep sedation in the ICU or on the table of the endoscopic suite with all anaesthetic equipment available. If the airway was judged insufficient for extubation, then the tracheal intubation was prolonged for 2–4 additional days postoperatively and then extubation or tracheotomy was performed according to the airway status. Continuous positive airway pressure through face mask ventilation was often used for the following hours or days in most patients. After extubation and depending on the patient's age and cooperation, some sedative agents were used to avoid neck hyperextension for 1 or 2 additional weeks. In the case of DS-PCTR, weaning patients from a ventilator was attempted as soon as possible, but they were frequently kept slightly sedated for a week to keep the neck in flexion.

Endoscopy was routinely planned 2–3 weeks after the operation to verify the anastomosis quality just before discharge from the hospital.

Long-term follow-up

Control endoscopy was generally scheduled 3 months after the surgery. After SS-PCTR, transnasal fibreoptic laryngoscopy was performed to assess vocal fold mobility, while direct laryngoscopy was performed with a bare 0° telescope to verify the anastomotic site. If needed, endoscopic treatment (CO$_2$ laser resection, dilation, etc.) was performed during the same session in suspension microlaryngoscopy. After DS-PCTR with LT-Mold stenting, the prosthesis was removed endoscopically in suspension microlaryngoscopy. Further endoscopies were scheduled depending on the presence of granulation tissue that might need resection.

Analysis

In the analysis, our patients were classified into: decannulated patients, patients still tracheostomy-dependent or waiting for decannulation at the end of the study, patients lost to follow-up and patients deceased from comorbidities, some of them after a successful extubation or decannulation, and some others still tracheostomy-dependent who were considered surgical failures, even if death was not related to the airway surgery.

Overall and operation-specific (decannulation without need for revision surgery) decannulation rates (ODR and OSDR, respectively) were compared between: SS-PCTR and DS-PCTR, primary and salvage surgeries, Cotton–Myers grades, simple PCTR and PCTR combined with another procedure such as extended PCTR, PCTR + scar resection or PCTR + vocal fold separation, and finally purely subglottic and glotto-subglottic stenoses. Data were expressed as mean and the range. The Chi-square test was used to compare the decannulation rates between the groups.

RESULTS

Preoperative and operative data are summarized in Table 1. A total of 129 paediatric patients [79 males and 50 females; mean age, 4.1 years (range, 1 month to 16 years, median age: 2 years old)] underwent PCTR for LTS during the study period. The mean postoperative follow-up period was 52.4 months (range, 1–228 months; median: 31 months). One hundred and six (82%) patients were preoperatively tracheostomy-dependent. Among the 23 patients who were not tracheostomized, 18 had severe dyspnoea at rest and 5 had dyspnoea upon the slightest exertion. Preoperatively, aphonia was observed in 79, severe dysphonia in 26 and slight dysphonia in 5 patients. Nineteen patients had a normal voice. Severe associated anomalies were observed in 53 (42%) patients.

Forty-six (35%) patients had undergone previous endoscopic or surgical treatments before being referred to Lausanne. The aetiology of the stenosis was acquired or mixed (aggravation on congenital stenosis after intubation) in 109 (84%) and congenital in 20 (16%) patients. According to the Cotton–Myers grading system, no patient had Grade I, 7 had Grade II, 78 had Grade III and 44 had Grade IV stenosis. More than 95% of the patients had a severe Grade III or IV SGS. Eighty-four (65%) patients presented with an isolated SGS and 45 (35%) had a glotto-SGS. Abnormal vocal cord mobility was observed in 63 (48%) patients.

SS-PCTR was performed in 75 patients, whereas DS-PCTR was performed in 54 patients. In the SS-PCTR group, there were 63 simple PCTRs (i.e. purely SGS with normal vocal fold function), 2 PCTRs with vocal fold separation for synechia, 7 PCTRs with scar

THORACIC

Table 1: Preoperative and operative information

Sex (male/female)	79/50
Age [1 month to 16 years (mean: 4.1 years, median: 2 years)]	
<1	20
<3	45
<8	39
<16	25
Respiration	
Tracheostomy	106
Dyspnoea at rest	18
Dyspnoea at effort	5
Voice	
Aphonia	79
Severe dysphonia	26
Slight dysphonia	5
Normal	19
Associated malformation	53
Cardiovascular	19
Digestive	7
Trisomy-21	8
Syndromic malformation	8
Other malformation	11
Stenosis	
Preoperative treatment	46
Laryngoplasty	17
Cricotracheal resection	3
Endoscopic interventions	26
Aetiology	
Acquired	77
Mixed	32
Congenital	20
Cotton–Myers grade	
II	7
III	78
IV	44
Location	
Subglottic	84
Glotto-subglottic	45
Vocal cord mobility	
Normal	63
Limited abduction	36
Unilateral fixation	5
Bilateral fixation	25
Operation	
Single stage/double stage	75/54
Type of procedure	
Single stage	
Simple PCTR	63
PCTR + scar resection	7
PCTR + VC separation	2
Extended PCTR	3
Double stage	
Simple PCTR	24
PCTR + scar resection	1
PCTR + VC separation	2
Extended PCTR	27
Extension of resection	
Only cricoid	18
Cricoid + 1–4 tracheal rings	75
Cricoid + 5–8 tracheal rings	36

PCTR: partial cricotracheal resection; VC: vocal cord.

Table 2: Morbidity and mortality

Postoperative death	8
Cardiac problems	2
Plugged cannula	4
Respiratory insufficiency	1
Massive aspiration	1
Anastomotic dehiscence (revision surgery)	13 (9)
Partial	8 (4)
Large or complete	3 (3)
Posterior flap necrosis	2 (2)
Late stenosis (>20%)	2
Revision surgery	18
LTR	6
PCTR	10
Tracheal resection	2

LTR: laryngotracheal reconstruction; PCTR: partial cricotracheal resection.

Morbidity and mortality

Among the 129 patients, 8 (6%) died after the surgery, but none of the deaths were related to the surgery (Table 2). Seven of these 8 patients had severe associated comorbidities (severe cardiac malformation and Down syndrome in 3 patients, catch syndrome with pulmonary hypertension in 1, epilepsy and intellectual disability in 1, spondyloepiphyseal dysplasia incompatible with life in 1 and a severe non-syndromic congenital anomaly in 1). At the time of death, 4 patients were decannulated: 2 died of massive bronchoaspiration 2 and 3 months postoperatively, while the other 2 died of severe cardiac problems. In the group of 4 non-decannulated patients, all died >3 months after the surgery: 2 from a plugged cannula at home, 1 from respiratory insufficiency due to spondyloepiphyseal dysplasia and 1 from massive bronchoaspiration at home.

Anastomotic dehiscence was seen in 13 (10%) of 129 patients, 9 of whom were successfully treated by immediate revision surgery with thyrotracheal re-anastomosis. The 4 other patients were treated conservatively with LT-Mold stenting only. Late restenosis, defined as luminal obstruction >20%, was observed in 2 patients. One patient from our early series in the 1980s sustained complete restenosis and refused further treatment. Another patient with 50% anastomotic restenosis was treated with periodic dilatation without tracheostomy.

Overall, revision surgery was performed in 18 (14%) of 129 patients. Revision PCTR was performed in 10 patients, 9 for anastomotic dehiscence as mentioned above and 1 for laryngotracheomalacia. The other 8 patients needed additional LTR for residual posterior glottic stenosis in 6 cases of severe glotto-SGS, while 2 patients needed tracheal resection for suprastomal collapse or peristomal tracheomalacia.

Decannulation

The ODR of this series was 90% (116/129) (Tables 3 and 4). The success rate was superior for SS-PCTR (72/75, ~96% of patients) compared with DR-PCTR (44/54, ~81.4% of patients) ($P = 0.007$). This is easily understandable since DS-PCTR is used for more complex cases that often require extended PCTR for severe glotto-

resection at the posterior laryngeal commissure and finally 3 extended PCTRs for SGS combined with posterior glottic stenosis stented with an endotracheal tube in the postoperative period. The resection length comprised the cricoid only in 18 patients, the cricoid plus one to four tracheal rings in 75 patients, and the cricoid plus five to eight tracheal rings in 36 patients.

Table 3:   Overall and operation-specific decannulation rates

	Overall decannulation rate	P-value	Operation-specific decannulation rate	P-value
Overall	116/129 (90%)		104/129 (81%)	
Stage				
Single stage	72/75 (96%)	0.007	66/75 (88%)	0.012
Double stage	44/54 (81%)		38/54 (70%)	
Primary/salvage				
Primary surgery	76/83 (92%)	0.41	67/83 (81%)	0.97
Salvage surgery	40/46 (87%)		37/46 (80%)	
Cotton–Myers grade				
0 (tracheal) + II	7/7 (100%)	0.077	7/7 (100%)	0.37
III	73/78 (94%)		63/78 (81%)	
IV	36/44 (82%)		34/44 (77%)	
Type of PCTR				
Pure PCTR	81/86 (94%)	0.023	74/86 (86%)	0.027
Complex PCTR	35/43 (82%)		30/43 (70%)	
Location				
Subglottic	77/84 (92%)	0.37	69/84 (82%)	0.55
Glotto-subglottic	39/45 (87%)		35/45 (78%)	

PCTR: partial cricotracheal resection.

subglottic or transglottic stenosis. The OSDR was 81% (104/129 patients) and significantly higher for SS-PCTR (66/75, ~88% of patients) than for DS-PCTR (38/54, ~70% of patients). Significantly better results were observed after SS-PCTR than after DS-PCTR as well as in simple PCTR for SGS only compared with extended PCTR for complex LTS, both for ODR and OSDR. However, there was no apparent difference between primary and salvage surgery.

Among 75 patients who underwent SS-PCTR, 63 (84%) patients were definitively extubated/decannulated within a period of 3 weeks. In the DS-PCTR group of 53 patients, only 3 (6%) were decannulated within the same time span. Depending on the complexity of the reconstruction, all other cases usually needed 3 months to >2 years to achieve final decannulation, specifically 44 (81%) of 54 patients who underwent DS-PCTR. Of the 13 presently non-decannulated patients, 10 belong to the DS-PCTR group.

Postoperative functional results

Among the 112 patients who are presently alive and decannulated, 111 could be precisely assessed for residual dyspnoea, voice impairment, deglutition and vocal cord mobility (Table 5). One hundred and eleven (86%) of 129 patients had no or slight exertional dyspnoea, whereas 1 had dyspnoea already at moderate exertion. Eighty-five (66%) of 129 patients had no dysphonia or only moderate voice impairment (good serviceable voice), 24 (22%) had severe dysphonia and 2 had a breathy voice. Concerning deglutition, 105 patients were eating a normal diet, 5 had occasional aspiration and 1 still needed a percutaneous endoscopic gastrostomy tube.

DISCUSSION

This report is an update of our article published in 2005 in which we reported the overall results of PCTRs for paediatric LTS in 59

Table 4:   Patients not decannulated

Tracheostomy-dependent	6
Complete restenosis	2
Respiratory problem	1
Severe gastro-oesophageal reflex	1
Neurological problem	1
Severe tracheomalacia	1
Awaited decannulation	2
Posterior glottic stenosis	1
Tracheomalacia	1
Died before decannulation	4
Lost to follow-up	1
Total	13

Table 5:   Functional results

Dyspnoea	
No	90
With forced exertion	21
With moderate exertion	1
At rest	0
Voice impairment	
No	29
Moderate	56
Severe	24
Aphonia	2
Unknown	1
Deglutition	
Normal	105
Minor impairment	5
Percutaneous endoscopic gastrostomy	1
Unknown	1

patients [4]. More than twice as many patients are reported here than in 2005. In addition to being twice as large, the current patient population is slightly different. Since the introduction of the LT-Mold developed by Philippe Monnier, we have performed extended PCTR more frequently. This intervention requires 3–6 months of laryngeal stenting to stabilize the posterior cartilage graft. In fact, 23 of 30 extended PCTRs in this report were performed after the cases reported in our article in 2005. This means that more complicated cases have been treated in this second cohort.

Since the introduction of LTR with a costal cartilage graft by Cotton in the early 1970s, it has remained the mainstay of treatment for SGS in the paediatric population [15–17]. After the first report of a successful series of PCTR for paediatric patients in 1993, this technique has been accepted as a superior alternative to LTR, especially for severe Grade III and IV SGS [18–20]. However, even in experienced paediatric otolaryngology centres, LTR remains the preferred primary surgical intervention for paediatric SGS. Except for the Cincinnati group [19], most of the published series have reported relatively few cases of PCTR, even in large referral centres [18, 20]. In our series of 129 paediatric PCTR, >95% of the cases presented with Grade III or IV SGS and >35% had a history of previously unsuccessful treatment. In contrast to other centres [18–20], we performed twice as many PCTR as LTR during the study period. This is reflected by the high number of very severe stenoses referred from foreign hospitals after initial treatment failure.

Postoperative management of paediatric cases is somewhat different from that of adult cases because infants and small children cannot avoid hyperextension of the head simply upon command. Furthermore, vocal cord oedema is always present to a certain extent after PCTR in children due to the proximity of the subglottic anastomosis. Hyperextension of the neck can cause partial or complete anastomotic dehiscence. For that reason, we routinely keep patients intubated under sedation for 5–10 days depending on the clinical situation. A control endoscopy prior to extubation under general anaesthesia is routinely performed to check for airway patency and exclude postoperative glottic oedema and anastomotic dehiscence. Non-invasive positive pressure ventilation is frequently used after extubation and a slight sedation is sometimes given until the child can be weaned from the continuous positive airway pressure.

Glottic involvement associated with SGS is reported as a negative prognostic factor for decannulation [2, 8, 19]. In the Cincinnati group series, patients with glottic involvement were five times more likely compared with those with normal vocal cord function to require a second operation after LTR. Extended PCTR for this condition was also associated with a lower decannulation rate [19]. This finding was confirmed by our own experience [8]. When glottic involvement is limited to a moderate interarytenoid cicatricial adhesion, SS-PCTR with simple scar excision and cricoid plate resurfacing with the membranous trachea is effective using the soft Portex Blue Line Tube acting as a stent during the first postoperative week. However, when posterior glottic stenosis consists of thick scarring and is potentially associated with cricoarytenoid joint fixation, a posterior cricoid split with costal cartilage graft is necessary in addition to PCTR. DS-PCTR with postoperative LT-Mold stenting for a period of 6 weeks to 3 months is necessary in most cases. In the present study, the ODR after PCTR combined with the posterior costal cartilage graft, with scar resection or vocal fold separation for complex LTS, stands at 81%, but 15 (28%) of the 54 cases of DS-PCTR required a second intervention to achieve this result. This figure is quite different for SS-PCTR, in which only 3 (4%) of 75 patients needed a second surgery to achieve decannulation.

These findings reflect the difficulty in treating SGS associated with severe glottic involvement (vocal cord synechia or severe posterior glottic stenosis). After extended PCTR for complex LTS, laryngeal stenting is required to stabilize the posterior cartilage graft and keep the posterior commissure in the abducted position of the vocal cords during the healing process. In the early part of the current study, we used the Montgomery T-tube or a straight custom-made silicone tube for this purpose. Since 2001, we have used the LT-Mold developed by Philippe Monnier [14, 21]. This dedicated laryngotracheal stent fits the inner laryngeal contours to restore a sharp anterior commissure and a large interarytenoid space. Its softness avoids pressure necrosis and new granulation tissue formation in the reconstructed airway. In newborns and small children, it also permits the use of a conventional tracheostomy tube, which avoids the potential risk of asphyxiation seen with Montgomery T-tubes, especially when diameters <8 mm are used. In our series of 54 DS-PCTR, 11 cases were related to our early experience in which we did not yet trust SS-PCTR, 8 were staged because of severe comorbidities and 4 were due to a distally located tracheostomy (seventh or eighth tracheal ring). The last 33 combined glotto-SGS required posterior laryngeal expansion combined with subglottic resection and LT-Mold stenting. In these cases, decannulation was always delayed compared with SS-PCTR. In fact, among 13 decannulation failures, 5 achieved the restoration of a satisfactory airway but could not be decannulated because of severe pulmonary, cardiac or neurological problems and 4 passed away, 2 from a plugged cannula at home and 2 from severe comorbidities. True surgical failures occurred in only 2 (2%) of 129 patients who refused further treatment that could have still been possible.

Dehiscence and restenosis are the two major complications in addition to recurrent laryngeal nerve injury that occurred in only 1 (1%) of the 129 patients. In most cases, anastomotic dehiscence results from high tension at the anastomotic site caused by resection of a long tracheal segment or by hyperextension of the neck during the postoperative course. To avoid high anastomotic tension, a simple release procedure (section of the thyrohyoid membrane) was routinely performed and, depending on the degree of tension, a complete laryngeal release procedure was added, especially for long segment resection. An endoscopic evaluation under general anaesthesia was routinely performed 5–10 days postoperatively to exclude anastomotic dehiscence that was sometimes suspected prior to the planned extubation in cases in which it was clinically suspected due to subcutaneous emphysema or increased tracheal secretions. Despite a laryngeal release procedure performed in 22 (17%) of 129 patients, anastomotic dehiscence occurred in 13 cases, 9 of which were successfully salvaged by revision PCTR. The other cases were treated conservatively with LT-Mold stenting. Revision anastomosis was normally performed after the addition of a more extensive release procedure. Among these 13 patients, 4 underwent resection of >5 tracheal rings, and 2 of these 4 patients underwent re-anastomosis after a more extensive laryngeal and tracheal release procedure, while the other 2 cases were treated with LT-Mold stenting. A surgical revision was performed when the anterior dehiscence was endoscopically clear and an LT-Mold was used when a defect of the mucosal approximation was observed without clear evidence of anastomotic dehiscence. Late anastomotic stenosis was considered a slowly occurring anastomotic dehiscence caused by excessive tension on the anastomotic site [22]. We experienced only 2

cases of late restenosis (>20% obstruction) at the anastomotic site. Because silent or untreated partial dehiscence progresses to late anastomotic stenosis, early detection and intervention are extremely important to prevent progression to late stenosis. In fact, we routinely performed endoscopy at extubation and 3 weeks postoperatively to detect any sign of incipient restenosis.

Revision surgery was performed in 18 patients, 6 of whom required it for a recurrent posterior glottic stenosis and 3 for peristomal tracheomalacia. Recurrence of posterior glottic stenosis without subglottic restenosis is one of the major causes for revision surgery in our series of complex LTS. Yamamoto *et al.* [23] suggested that contraction of immature collagen fibres may occur even after 3 months postoperatively and may lead to recurrent posterior glottic stenosis. In these cases, revision LTR with a posterior costal cartilage graft is the only surgical option [24]. Another major cause of revision surgery was peristomal tracheomalacia or suprastomal collapse. This condition was associated with decannulation failure because of tracheal collapse during spontaneous respiration. Tracheal resection is the best surgical option if the residual trachea length is sufficient.

Assessing laryngeal function after PCTR and extended PCTR is difficult in children. In many cases, the initial damage to the glottis precludes any satisfactory result on voice, whereas respiration and deglutition can be restored to normal or subnormal function. In the present series, the outcome on respiration and deglutition was satisfactory, with >80% of the patients presenting no or minimal exertional dyspnoea and normal deglutition. However, most patients had some degree of voice impairment, even after simple PCTR without initial apparent glottic involvement. These results were compatible with those of our previous reports [4]. The voice alteration may result from an altered shape of the glottis preventing full glottic closure during phonation. Voice production tends to occur between rocking arytenoids and the laryngeal aspect of the epiglottis, which results in a hoarse and sometimes breathy voice. Although the primary goal of surgery is decannulation and respiration without exertional dyspnoea, more attention should be given to voice performance after surgery, especially after SS-PCTR with initially normal-looking vocal folds.

This study has several limitations. First, the period of this cohort is >30 years and indications have changed over the years. As mentioned above, cases of more complex stenoses were referred to our hospital and most of the extended PCTR procedures were performed in the latter part of this cohort. However, all of the cases in this cohort were performed or supervised by a single surgeon (Philippe Monnier) from the beginning and the attitude and the philosophy towards the indications were always maintained, although the indications for surgical treatment have widened over the course of the study period. In this sense, this updated version of the article has added some lessons to the old ones. To evaluate and compare the results, we adopted the 'decannulation rate' (i.e. number of decannulated patients divided by all operated patients) calculated at the end of this study since all previous reports used this same system. However, a difference in time to decannulation was observed according to stenosis severity and the preoperative patient condition. This topic is important and a further analysis of this issue will be presented in another article.

CONCLUSIONS

OSDRs are excellent after SS-PCTR and fair after DS-PCTR, especially when a double-stage procedure is required for severe

glotto-subglottic or transglottic stenosis, according to stenosis severity and the patient's general condition. Glottic involvement and the presence of comorbidities are negative predictive factors of decannulation, even though the ODRs for these severe conditions are acceptable. Early detection of postoperative dehiscence and early reintervention help avoid the progression to late anastomotic restenosis. However, this warrants routine endoscopic control of the anastomosis at 3 weeks postoperatively and voice improvement remains a challenge for the future.

Conflict of interest: Philippe Monnier holds a financial relationship with BREDAM SA, the company whose product is mentioned in the text.

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