How I Do It

Partial Cricotracheal Resection With Tracheal Intussusception and Cricoarytenoid Joint Mobilization: Early Experience in a New Technical Variant

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INTRODUCTION

The management of congenital and acquired laryngotracheal stenosis has continued to advance with the development of new surgical techniques. Pearson1 was first to describe resections at the cricoid level without posing the problems of damage to the recurrent laryngeal nerve and loss of circumferential cartilaginous support.

The technique of partial cricotracheal resection (PCTR) involves the resection of the anterior cricoid arch and thinning of the posterior cricoid plate with preservation of a posterior membranous tracheal mucosal flap. The transected normal trachea is then telescoped into the posterior cricoid plate and anastomosed to the thyroid cartilage.2–4 Extended PCTR is performed in patients with an additional glottic pathology (posterior glottic stenosis or vocal cord synechiae). This procedure is similar to the PCTR, but in addition, a costal cartilage expansion is used to enhance the stenosed posterior glottis. These techniques have been previously well described.1,5,6 Several surgical modifications evolved in perfecting these techniques, thereby improving decannulation rates.

In this article we describe our early experience of intussuscepting the distal trachea into a carved-out cricoid cartilage. We have attempted this surgical variation in patients requiring extended PCTR for transglottic stenosis. We perform a thyrotracheal anastomosis by passing anastomotic sutures through funneled lateral cricoid arches. This offers an enormous advantage of anastomatic stability and safety, with less risk of anastomatic dehiscence. Surgical mobilization of fixed cricoarytenoid joints was also attempted with excellent results in two patients with bilateral ankylosed cricoarytenoid joints.

MATERIALS AND METHODS

This study includes six pediatric patients, ages 4 to 11 years, and one adult patient who were operated on between June 2008 and September 2010. There were four female and three male patients. All patients had grade III-IV Cotton-Myer subglottic stenosis in addition to a posterior glottic or a transglottic stenosis. Bilateral cricoarytenoid ankylosis was present in four patients, and three patients had restricted vocal cord mobility. All had been previously tracheostomized at the time of primary referral and underwent a double-stage extended PCTR with intussusception of the proximal tracheal stump into a carved-out cricoid, in addition to posterior cricoid expansion with a costal cartilage graft. Table I summarizes the patients' data and their surgical details.

Surgical Technique

Surgery begins with the anesthetists using the tracheostomy site for tracheal intubation with an RAE or flexible armored Rüsch endotracheal tube, and the patient is ventilated through this tube during the entire procedure. Cervical incision includes resection of an ellipse of skin around the tracheostomy site, followed by the standard steps of a PCTR as have been described in our previous publication.5 Laryngeal framework is opened through a midline complete anterior laryngo-cricofissure exposing the stenotic site. The airway is opened first through the epiglottis in the supraglottic region. This enables separation of the fused vocal cords under visual control, exactly through the midline, with preservation of the anterior commissure. Inferiorly, the airway is opened transversely at the lower edge of the cricoid ring, thereby completely exposing the transglottic stenosis (Fig. 1).

In a conventional partial cricotracheal resection, the anterior cricoid arches are excised completely, and the posterolateral anastomotic sutures are passed through the posterior cricoid plate. However, in our modified technique, the lateral cricoid arches are preserved and cored out from inside with a Beaver knife and diamond burr, thus fully removing the scar tissue...
Contributing to the stenosis. The posterior cricoid plate is divided at the midline, and the interarytenoid muscle is fully transected if embedded in the scar tissue, avoiding damage to the retroarytenoid and postcricoid pharyngeal mucosa. A rectangular costal cartilage graft (with or without bilateral flanges) is harvested from the seventh or eighth rib and carefully sutured with the divided portions of the posterior cricoid laminae using 4-0 Vicryl sutures to enlarge the subglottic space (Fig. 2). The graft must fit flush with the divided halves of the cricoid plate, and the perichondrium must be placed intraluminally. The width of the costal cartilage graft must be selected with precision to avoid overexpansion of the interarytenoid distance, which may cause a breathy voice and aspiration problems postoperatively.

On the tracheal side, one or two additional rings are partially resected to provide a pedicled flap of the membranous TABLE I. Summary of Patient and Surgery Details.

<table>
<thead>
<tr>
<th>Patient (Age), Years</th>
<th>History Preceding Laryngeal Stenosis</th>
<th>Preoperative Grade of Stenosis</th>
<th>Surgery and Follow-Up</th>
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<tbody>
<tr>
<td>STK (11)</td>
<td>Accidental laryngeal trauma in 2007 for which patient underwent prolonged intubation and tracheostomy</td>
<td>Grade IV (Cotton-Myer); TGS, PGS; restricted bilateral VC mobility</td>
<td>Extended PCTR, inserted with a 9 mm LT mold; decannulated at 4 months post-op</td>
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<tr>
<td>KI (11)</td>
<td>Preterm birth; prolonged intubation and tracheostomy at 4.5 months of age</td>
<td>Grade IV (Cotton-Myer); bilateral cricoarytenoid ankylosis</td>
<td>Extended PCTR; 8 mm LT mold; decannulated 5 months post-op; last endoscopy shows discrete bilateral vocal cord movements</td>
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<tr>
<td>VE (6)</td>
<td>Operated for thyroid teratoma at the age of 3 days, complicated by bilateral VC paralysis postoperatively, for which underwent a tracheostomy</td>
<td>Grade III (Cotton-Myer); TGS, PGS; bilateral cricoarytenoid ankylosis</td>
<td>Extended PCTR; 8 mm LT mold; awaiting decannulation</td>
</tr>
<tr>
<td>TB (10)</td>
<td>Preterm birth; prolonged intubation and tracheostomy</td>
<td>Grade IV (Cotton-Myer); TGS, PGS; bilateral cricoarytenoid ankylosis</td>
<td>Extended PCTR; 10 mm LT mold; decannulated 13 months post-op</td>
</tr>
<tr>
<td>GW (9)</td>
<td>Congenital subglottic stenosis; failed cricoid split; tracheostomy at 4 years of age</td>
<td>Grade IV (Cotton-Myer); TGS, PGS restricted bilateral VC mobility</td>
<td>Extended PCTR; 10 mm LT mold; decannulated at 16 months</td>
</tr>
<tr>
<td>GT (4)</td>
<td>Operated on at birth for congenital tracheoesophageal fistula; cricoid split for failed extubation</td>
<td>Grade IV (Cotton-Myer); TGS, PGS; bilateral VCs immobile</td>
<td>Extended PCTR; 8 mm LT mold; awaiting decannulation</td>
</tr>
<tr>
<td>JK (48)</td>
<td>HIV positive; history of prolonged intubation for Dengue fever and several endolaryngeal laser surgeries for acquired subglottic stenosis</td>
<td>Grade IV (Cotton-Myer); TGS, PGS; bilateral ankylosed CA joints</td>
<td>Decannulated at 4 months post-op; discrete bilateral vocal cord mobility</td>
</tr>
</tbody>
</table>

TGS = transglottic stenosis; PGS = posterior glottic stenosis; VC = vocal cord; PCTR = partial cricotracheal resection; LT = laryngotracheal; post-op = postoperative; CA = cricoarytenoid.

Fig. 1. Subglottic resection with tracheal intussusception. A full laryngo-cricofissure and posterior cricoid split are performed, displaying the total or subtotal cicatricial subglottic stenosis.

Fig. 2. Status after midline transection of the glottis and full resection of the cicatrical subglottic stenosis in a subperichondrial plane. A diamond burr is used to thin out the lateral cricoid arches, and a posterior costal cartilage graft is used to keep the posterior glottis and subglottis expanded.
The epiglottis after stent removal. Before completing the thyrot- 
tracheal anastomosis, a second 3-0 Prolene stitch is passed 
through the lateral walls of the trachea and the LT mold so as 
to secure the prosthesis in place. This thread is tied loosely to 
preserve the vascular supply to the tracheal stump.

Lateral and anterior anastomoses are completed as in con-
ventional PCTR using 3/4-0 Vicryl sutures, but with the knots 
tied inside the cricoid arches. The wedge of cartilage pedicled 
to the anterior tracheal wall is trimmed to its definite triangular 
shape and sutured in position with 5-0 Vicryl sutures between 
the inferiorly distracted thyroid alae (inferior midline thyro-
otomy) to enlarge the subglottic lumen without compromis-
ing the voice quality. This triangular cartilage wedge and 
subglottic enlargement is not necessary in adult patients. Thy-
rottracheal anastomosis with tracheal intussusception allows 
placement of additional reinforcing anterolateral stitches 
between the cricoid arches and the trachea, which further sta-
bilizes the anastomosis (Fig. 4). An additional laryngeal drop 
may be performed to reduce anastomotic tension. Fibrin glue 
(Tisseel or Tissucol) is applied on suture lines so as to provide a 
perfect seal during the first postoperative days. The isthmus of 
the thyroid gland, resutured at the midline over the anastomo-
sis, helps optimize vascular supply to the reconstructed airway. 
The tracheotomy is sutured with the skin using 4/5-0 Vicryl 
sutures and the wound is closed with a Penrose drain. Surgery 
is performed under adequate antibiotic care based on preopera-
tive tracheal swabs and culture reports.

In case of bilateral ankylosed cricoarytenoid joint spaces, 
we suggest to deliberately open the cricoarytenoid joint to remo-
bilize the arytenoid and to excise the scar tissue around the 
joint space. The pedicled flap of membranous trachea is used to 
resurface the medial aspect of the arytenoids by suturing it 
along the free margin of the thyrotracheal defect and then 
tracheal suture. The pedicled flap is then tied inside the cricoid 
arches. The wedge of cartilage pedicled to the anterior tracheal 
wall is trimmed to its definite triangular shape and sutured in 
position with 5-0 Vicryl sutures between the inferiorly distracted 
thyroid alae (inferior midline thyrotomy) to enlarge the subglottic 
lumen without compromising the voice quality.
endoscope and transtracheostomal using the 70°
endoscope. It did not show any stent migration or granu-
lations in the larynx and the tracheostomy site. During
follow-up endoscopies, the LT mold was removed within
a mean period of 3 months, extended up to 12 months in
two patients. Minor granulation tissue, if any, was
excised and topical mitomycin (2 mg/mL for 2 minutes)
applied. Five patients are now decannulated with satis-
factory results and an optimal glotto-subglottic space.
The time to decannulate the patients was 4 to 16
months, with a mean time interval of 8 months after the
initial surgery. All decannulated patients had surgical
closure of their tracheostomy. Two pediatric patients are
awaiting removal of the LT mold and an eventual decan-
nulation. Vocal cords have remained fixed in three
patients who had preoperative cricoarytenoid joint anky-
losis and in whom no attempt was made at remobilizing
the cricoarytenoid joint. Of interest, two patients (one
child and the adult patient) in whom bilateral joint
spaces were opened to surgically mobilize the cricoarty-
tenoid joint spaces have shown early arytenoid mobility,
which has been very encouraging. Their voice is hoarse,
and currently both patients are undergoing speech ther-
apy. Endoscopic examination in both of these patients
reveals an adequate airway and satisfactory anterior
commissure (Fig. 5). In the future, we plan to routinely
remobilize both arytenoids in overt bilateral cricoarty-
tenoid ankylosis because we do not aggravate the stenotic
situation in such complex cases and stand nothing to
loose.

DISCUSSION

Surgical reconstruction of laryngotracheal stenosis
has only been developed over the last 35 years, but dur-
ing this period great advances have been made, and
the operation is now very much tailored to the needs of
the individual patient. In severe subglottic stenosis (SGS),
PCTR with primary thyrotracheal anastomosis
represents a real breakthrough in the surgical arma-
mentarium to resolve this difficult problem. Over the
years, the technique of PCTR for SGS has been well
described and accepted, with an overall decannulation
rate of more than 90% in primary and salvage PCTRs.²,⁵

In cases of a double-stage extended PCTR used for
subglottic stenosis combined with severe glottic involve-
ment (posterior glottic stenosis or vocal cord synechia),
anastomotic dehiscence, especially in presence of a lar-
yngotracheal stent, can be missed. This period can be
any time from a patient's discharge from the hospital af-
after the last endoscopic evaluation and the next
endoscopy, wherein an attempt is made to remove the
LT stent. Complete anastomotic cicatrization and mucos-
alization takes about 10 to 12 weeks. Because the new
tracheotomy is in place distally, events like an anasto-
matic breakdown may not be easily detected. A zone of
weak fibrocicatricial healing around a stretched anasto-
motic dehiscence presents as a malacic segment, which
may affect the end decannulation result. In our series,
a young girl presented with such a complication, which
made us think of a newer technique to reinforce and
make the anastomosis after a PCTR even more stable.
Our modification of the standard PCTR procedure has
been of coring out the inside of the cricoid ring, while
expanding the posterior laryngeal commissure, as in a
laryngotracheal reconstruction with a posterior costal
cartilage graft. An overexpansion of the interarytenoid
space or the posterior commissure should be avoided as
it leads to poor voice quality and aspiration problems.
The tracheal stump is then cranialized and intussus-
cepted into this expanded space and anastomosed to the
thyroid cartilage. Additional anterolateral sutures
passed through the cricoid arches help in steadying and
stabilizing the anastomosis. Our small series using this
modified technique has shown very satisfactory intra-
and postoperative results.

Bilateral cricoarytenoid fixations or frozen larynges
are very difficult cases and usually result from profound
initial laryngeal trauma resulting in total transglottic
stenosis, often with subsequent multiple surgical inter-
ventions. In two of our patients, we attempted to
surgically open the cricoarytenoid joint space and excise
fibrocicatricial tissue hoping to mobilize this complex
cartilaginous joint. Early results have been extremely
courageous, which would make us intentionally open
all fixed cricoarytenoid joints in future cases of frozen larynges. Inducing mobility to these complex joint spaces should be a matter of further research.

CONCLUSION

After extended PCTR and stenting with an LT mold, a slow progressive dehiscence of the anastomosis may occur around the stent, without causing significant symptoms, because a distal tracheostomy is still in place and we do not see the events occurring proximally near the anastomosis. After removal of the stent several weeks or months later, the resultant localized subglottic malacia may compromise the outcome. Reinforcing the thyrotracheal anastomosis by preserving the lateral cricoid arches and intussuscepting the distal tracheal stump steadies the anastomosis and prevents a dehiscence. Although our attempts at remobilizing the arytenoids have been partially successful, a longer and close follow-up of these patients is needed. Restoring arytenoid mobility in severely damaged larynges would greatly benefit patients who have sustained this injury.

BIBLIOGRAPHY