Laryngeal split and rib cartilage interpositional grafting: Treatment option for glottic/subglottic stenosis in adults

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Objectives: Severe glottic/subglottic stenosis (complex laryngotracheal stenosis) is a rare but challenging complication of endotracheal intubation. Laryngotracheal reconstruction with cartilage graft and an intralaryngeal stent is a procedure described for complex laryngotracheal stenosis management in children; however, for adults, few options remain. Our aim was to analyze the results of laryngotracheal reconstruction as a treatment for complex laryngotracheal stenosis in adults, considering postoperative and long-term outcome.

Methods: Laryngotracheal reconstruction (laryngeal split with anterior and posterior interposition of a rib cartilage graft) has been used in our institution to manage glottic/subglottic stenosis restricted to the larynx; laryngotracheal reconstruction associated with cricotracheal resection has been used to treat glottic/subglottic/upper tracheal stenosis (extending beyond the second tracheal ring). A retrospective study was conducted, including all patients with complex laryngotracheal stenosis treated surgically in our institution from January of 2002 until December of 2005.

Results: Twenty patients (10 male and 10 female patients; average age, 36.13 years; age range, 18–54 years) were included. There were no deaths, and the postoperative complications were as follows: dysphonia, 25%; subcutaneous emphysema, 10%; tracheocutaneous fistula, 20%; wound infection, 15%; and bleeding, 5.0%. Eighty percent of the patients were completely decannulated after a mean of 23.4 months of follow-up (range, 4–55 months).

Conclusions: Laryngeal split with anterior and posterior cartilage graft interposition as an isolated procedure or associated with a cricotracheal resection is a feasible and low-morbidity alternative for complex laryngotracheal stenosis treatment.

Laryngotracheal stenosis (LTS) is an important cause of airway obstruction, and its most common cause is endotracheal intubation. Different surgical and endoscopic techniques have been used to deal with this distressing complication, but partial cricoid cartilage resection with primary thyrotracheal anastomosis (cricotracheal resection [CTR]) is considered the procedure of choice by most airway surgeons when the stenosis is limited to the subglottis and upper trachea.[1-3] However, when the stenosis is close (<5 mm) or involves the vocal cords (high subglottic or glottic/subglottic stenosis), CTR alone is not applicable once the glottic component is left unsolved, and the more appropriate approach for these cases is controversial. In pediatric populations laryngotracheal reconstruction (laryngeal split with rib cartilage interposition) is performed in cases of glottic/subglottic stenosis,[4-8] but in adults there are not enough data published to support this approach. For this reason, our aim was evaluate the LTR technique in the treatment of glottic/subglottic stenosis caused by orotracheal intubation in adult patients, considering the characteristics of the treated stenosis, the surgical procedures performed, and postoperative outcomes and complications.

MATERIALS AND METHODS

Patients

Our facility is a tertiary care hospital and a national reference center for surgical airway disorders. Each week we see about 20 patients with airway disorders, most of them with postintubation stenosis. All patients suspected to have an LTS undergo a flexible bronchoscopy and a neck and chest computed tomographic (CT) scan. These procedures allow us to confirm the diagnosis and evaluate stenosis anatomy, as well as laryngeal motility. Relevant anatomic characteristics are stenosis level and obstruction grade (the last classified according to the Cotton grading system described in Table 1[9]). Stenosis level is a crucial issue, and all patients are classified depending on compromised airway anatomic structures as follows: tracheal, subglottic, or glottic/subglottic (subglottic stenosis associated with glottic stenosis). In this study were included all patients with a severe (Cotton grade III/IV) glottic/subglottic or high subglottic (<5 mm from the vocal cords) stenosis treated with open surgical intervention in our institution from January of 2002 until December of 2005. A retrospective review of medical records was done, looking for the following information about each patient: sex, age, stenosis morphologic features, history of previous procedures, operation performed, period of time until complete decannulation, and immediate and long-term complications. This study was approved by our institutional ethics board.

Twenty-two patients with complex postintubation LTS were treated in our institution during the study period. Two of them were excluded from the analysis: one because we found that he had a different stenosis cause (Wegener disease instead of postintubation stenosis) and the other because an incomplete procedure was performed (only an anterior laryngofissure

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Abbreviations and Acronyms
CT = computed tomographic
CTR = cricotracheal resection
LTS = laryngotracheal stenosis

with no costal cartilage graft placement). Fifty percent of the 20 patients were men (10 male subjects), and the other 50% were women (10 female subjects); the mean age was 36.13 years (range, 18–54 years). Previous procedures were tracheostomy only (n = 10), laryngofissure (n = 5), CTR (n = 2), dilatation and T-tube stenting (n = 2), and dilatation only (n = 1), all of them performed elsewhere. Only 1 patient was not tracheostomized at the time of the operation. The luminal obstruction was Cotton grade III (n = 5) or IV (n = 15) stenosis. In 14 patients the glottic/subglottic stenosis was restricted to the larynx, and in 6 patients glottic and subglottic stenosis extended beyond the second tracheal ring.

Surgical Technique

Patients considered for surgical treatment had an extensive clinical evaluation before surgical intervention. These patients frequently have serious comorbidities that might even preclude open surgical intervention. Diabetes, hypertension, coronary disease, and other associated diseases were addressed when present, and the procedure was reconsidered after clinical compensation. For patients with trauma, all neurologic, plastic, or orthopedic procedures were performed before airway reconstruction. The appropriate procedure for each patient was chosen according to stenosis level. We routinely perform stenosis resection and end-to-end anastomosis for isolated tracheal stenosis and partial cricoid resection and thyrotracheal anastomosis for simple subglottic stenosis. For glottic/subglottic stenosis restricted to the larynx and first tracheal ring, we perform a standard laryngotracheal reconstruction, as described below. For glottic/subglottic/upper tracheal stenosis (beyond the second tracheal ring), laryngotracheal reconstruction associated with a CTR is performed as described below. When the upper trachea is also affected, an associated CTR is mandatory because standard laryngotracheal reconstruction resolves only the laryngeal portion of the stenosis and does not correct the tracheal disease.

Standard laryngotracheal reconstruction. General anesthesia was induced, and the patients were ventilated through the previous tracheostomy. The only patient who had no former tracheostomy underwent rigid bronchoscopy and airway dilatation before orotracheal intubation. A horizontal anterior neck incision 3 to 4 cm above the sternal notch was made, and strap muscles were separated in the midline. The larynx was exposed, and a midline longitudinal incision, including thyroid and cricoid cartilages (Figure 1, *A*), was performed, and both edges were retracted. With the airway exposed (Figure 1, *B*), a midline incision at the posterior cricoid plate was made from the cricoid–trachea transition up to the arytenoids. The posterior opening must be particularly careful; it can be rather difficult because of stenotic fibrous tissue or adhesions to the anterior esophageal wall.

After the airway was fully opened anteriorly and posteriorly, a costal cartilage was resected for grafting. A horizontal incision was performed in the anterior chest wall over the second costal cartilage that was dissected in a subperichondrial manner and fully resected. The costal cartilage graft was 3 to 4 cm in length, 1 to 2 cm in width, and 1 cm thick; the dimensions varied according to the patient's anthropometry. The resected cartilage was divided longitudinally in 2 symmetric pieces (with the same dimensions of the original but thinner), and both were shaped into an elliptic configuration with a scalpel or a drill.

One of the prepared cartilage grafts was placed in the posterior groove to keep it open and thus enlarge the posterior cricoid surface. PDS 4-0 sutures (Ethicon, Inc, Somerville, NJ) were used to fix the graft to the posterior cartilage edges, thus avoiding extrusion, and no mucosal graft was used to cover it (Figure 1, *C*). A solid laryngeal stent was positioned inside the airway (Figure 1, *D*). Most times the previous tracheostomy was kept, but if there was no previous tracheostomy or if it was in contact with the anterior cricoid arch, a new tracheostomy was performed in the second or third tracheal rings. Then the other cartilage graft was placed in the anterior groove, and PDS 4-0 sutures were used to fix the graft to the larynx (Figure 1, *D*). After that, the wound is closed, and the patient leaves the operating room while breathing spontaneously through the tracheostomy. Drains were not routinely used.

TABLE 1. Cotton endoscopic grading system for subglottic stenosis

Grade	Lumen obstruction (%)
I	0%–50%
II	51%–70%
III	71%–99%
IV	No visible lumen

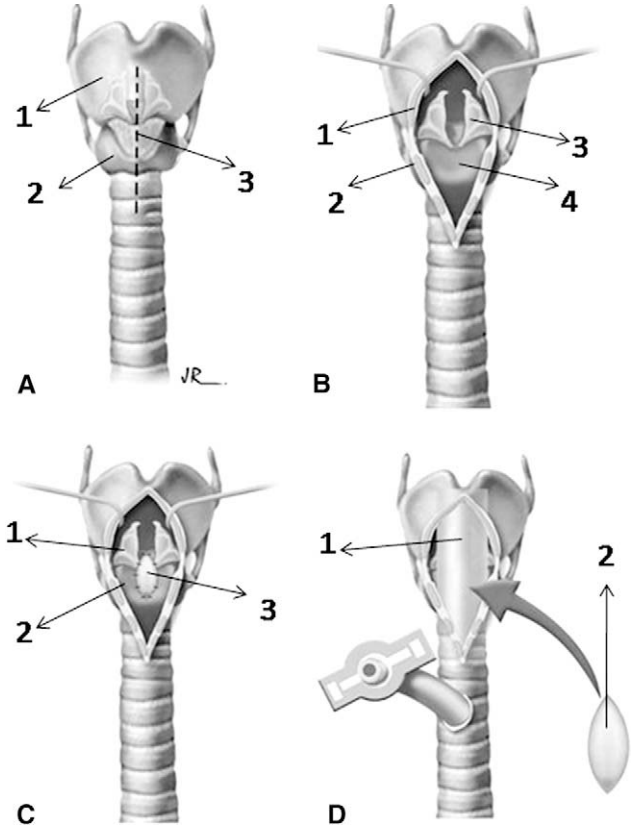

FIGURE 1. Standard laryngotracheal reconstruction. A, Laryngotracheal anterior exposure: *1*, thyroid cartilage; *2*, cricoid cartilage; *3*, incision site to perform the anterior laryngeal split. B, Airway exposure after anterior laryngeal split: *1*, thyroid cartilage split and retracted; *2*, cricoid cartilage split and retracted; *3*, arytenoids; *4*, posterior cricoid plate, exposed and ready to be split. C, Posterior larynx grafting after posterior cricoid split: *1*, arytenoids; *2*, posterior cricoid plate already opened; *3*, rib cartilage graft filling the posterior groove. D, Laryngeal stent and anterior grafting: *1*, solid stent inside the airway; *2*, rib cartilage graft prepared to fill the anterior defect.