

DIAGNOSIS OF DYSPHAGIA—UES AND PHARYNX

For the reasons listed above, which involve both normal variations and technical problems, manometry alone has not proved to be a helpful tool in the assessment of pharyngeal and UES function in patients with oropharyngeal dysphagia. To circumvent these difficulties, newer techniques have been developed.

NEW TECHNOLOGY IN MANOMETRIC MEASUREMENT OF DYSPHAGIA

Solid-state Manometry

As opposed to water-perfused catheter systems, solid-state sensors have the ability to measure rapid high-pressure events and avoid the problem of infusing water into the pharynx. The pressure sensors are usually multiple and have the additional ability to more readily interface with computerized equipment. Sensor location and catheter movement with swallowing remain a problem.^{5,6,15}

Computerized Combined Systems (Video Plus Manometry)

Newer methods of evaluating patients with oropharyngeal dysphagia have been developed. The most sophisticated of these is the manofluorography unit developed by McConnel et al.¹⁶ This unit uses solid-state manometry with a contrast videofluorograph. These data are then input into a computerized system that can determine sensor location in relation to the bolus. Although offering much promise, these systems are not widely available, and the normative database is small.

CONCLUSIONS

In the diagnosis of dysphagia, manometry is valuable in assessment of suspected esophageal motility disorders, LES competency, and may be helpful in patients with "pharyngeal" dysphagia with normal anatomic studies. In the majority of patients with

oropharyngeal dysphagia, however, manometry has not proved to be a useful tool. New developments in equipment and technique may improve the evaluation of these difficult patients.

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ORIGINAL ARTICLES

Laryngotracheal reconstruction without stenting

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Many surgical procedures, including laryngotracheal expansion with or without grafting, have been suggested for repairing laryngotracheal stenosis in children, and although a variety of stents have been described, the practice of prolonged stenting continues to diminish. We describe 21 pediatric patients with moderate-to-severe subglottic or tracheal stenosis who had laryngotracheal reconstructions with anterior rib cartilage grafts without stenting or intubation. The patients were between 6 months and 7 years of age at the time of surgery. All patients were extubated in the operating room after the procedure was terminated. One patient required reintubation in the intensive care unit for 48 hours after surgery, and another patient required a tracheotomy. Wound infection occurred in one patient. Most patients were discharged to their homes 3 to 5 days after surgery. We report the indications, technique, results, and complications of laryngotracheal reconstruction using a rib graft without stenting. (*Otolaryngol Head Neck Surg* 1997;116:358-62.)

The incidence of laryngotracheal stenosis has increased since McDonald and Stocks¹ advocated long-term intubation for airway management in 1965, and severe laryngotracheal stenosis has become the most commonly encountered form of airway obstruction requiring surgery.

The treatment of subglottic stenosis has evolved over the years and includes several strategies, from a "wait-and-see" approach for the milder forms to endoscopic maneuvers for moderate cases and open surgical procedures for severe cases. After its introduction by Fearon and Cotton in 1974,² cartilage grafting became one of the most common procedures for the treatment of laryngotracheal reconstructions, but many types of reconstructions have been described with good outcomes. Anterior cricoid decompression (i.e., anterior cricoid split)³⁻⁸ and anterior cricoid decompression with a cartilage graft and temporary stenting with an endotracheal tube^{9,10} have been used successfully during the past 10 years for mild-to-moderate laryngotracheal stenosis. Single-stage laryngotracheal reconstruction without prolonged stents was described in the early 1990s.^{9,10}

We have had good results and less morbidity with this approach.¹¹ Unlike the approach used by Lusk et al.⁹ and Seid et al.,¹⁰ all of our patients were immediately extubated in the operating room.

Information from a variety of reports shows that there is no single optimal procedure or guideline for the treatment of subglottic stenosis. For example, the period of intubation after a single-stage repair may vary from immediate postoperative extubation to 14 days.⁹

We report 21 pediatric patients who underwent single-stage laryngotracheal reconstructions with anterior rib grafts without stenting and with immediate postoperative extubation.

PATIENTS AND METHODS

We started using single-stage repairs for subglottic stenosis in 1990, but since July 1992, we have been selecting patients for single-stage repair without stenting. The laryngotracheal stenoses in the latter group of patients have been less severe (i.e., grade II and grade III),¹² without complete obstruction and not requiring posterior grafting. The tracheal stenoses in these patients ranged from mild stomal narrowing to severe stenosis of the upper three to four tracheal rings.

From July 1992 until July 1994, we performed surgery on 21 selected patients, ranging in age from 6 months to 7 years (mean age, 2.8 months), at LeBonheur Children's Medical Center for the correction of laryngotracheal stenosis. The method used was a one-stage repair that used anterior rib grafts without stenting and with immediate extubation.

At least one attempt at decannulation had failed in all patients before surgery. All 21 patients underwent

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Fig. 1. Patient with laryngotracheal stenosis assessed by direct laryngoscopy before surgery.

direct laryngoscopy and bronchoscopy 2 to 4 weeks before and again immediately before reconstructive surgery (Fig. 1). Vocal cord mobility was carefully assessed by fiberoptic endoscopy before surgery was considered, and preoperative assessment for possible aspiration, swallowing competency, and esophageal reflux was performed by a pediatric gastroenterologist. Similarly, each patient was approved for surgery by a pediatric pulmonologist. Patients with systemic diseases or other airway anomalies were excluded.

All patients except one had preexisting tracheotomies. The surgical technique has already been described.¹¹ Essentially, the procedure consists of exposing the upper trachea and larynx. The stenotic segment is identified and split along the midline. Any polyps and scar tissue are removed, and the tracheotomy site is freshened. An appropriately sized endotracheal tube is placed in the airway to facilitate ventilation. The cartilage graft with intact perichondrium on each side usually is harvested before surgery is begun on the laryngotracheal complex. The cartilage graft is fashioned in a boat shape, as described by Zalzal and Cotton¹³ (Fig. 2). Occasionally, more than one piece of cartilage is needed. The graft is sutured with 4.0 Prolene into the anterior tracheal-cricoid incision, with the endotracheal tube in place (Fig. 3). The perichondrial surface of the cartilage graft is positioned to face the lumen of the trachea.

Extreme care should be taken to prevent the sutures from extending into the lumen of the trachea, and the repair should be as tight as possible to reduce the



Fig. 2. Boat-shaped cartilage rib graft. Cartilage graft with intact perichondrium on each side is usually harvested before surgery on the laryngotracheal complex.

amount of air leakage or subsequent formation of granulation tissue. Despite these precautions, an air leak may occur, and the overlying muscles and subcutaneous tissue therefore are approximated, but not tightly, to avoid subcutaneous emphysema. A Penrose drain must be placed for 24 hours after surgery to allow air to escape.

After the repair, the patient is extubated in the operating room and transferred directly to the intensive care unit. After surgery the patient begins a regimen of intravenous antibiotics and steroids. If no complications occur, the patient is transferred to a regular care floor 24 hours after surgery. Airway patency is assessed clinically, and no postoperative endoscopy is performed unless extubation fails or stridor develops after extubation. Routine postoperative endoscopy may be performed 3 to 6 months after surgery (Fig. 4) or as deemed necessary by the patient's clinical condition.

Patients are usually discharged with a regimen of oral antibiotics 3 to 5 days after surgery and are reexamined in the clinic weekly for 4 weeks. Thereafter, follow-up office examinations are scheduled every 3 to 6 months.

RESULTS

The results for 21 patients who underwent single-stage laryngotracheal reconstructions without stenting are summarized in Table 1. The ages of the 21 selected patients ranged from 6 months to 7 years (mean age, 22.8 months) at the time of surgery. Only 3 patients were thought to have congenital stenosis. Sixteen of 21



Fig. 3. Intraoperative picture of the anterior rib graft sutured with 4.0 Prolene into the anterior tracheal-cricoid incision.

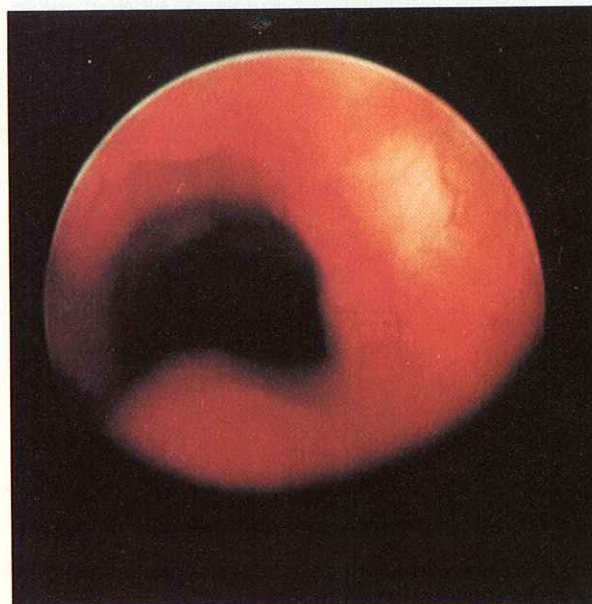


Fig. 4. Routine postoperative endoscopy is performed 3 to 6 months after laryngotracheal reconstruction.

Table 1. Results for patients undergoing one-stage repair of laryngotracheal stenosis

Patient no.	Age	Grade*	Cause	Stenosis type	Stenosis duration (mo)	Follow-up (mo)
1	6 mo	II	Congenital	S	6	18
2	13 mo	II-III	Intubation	S	10	12
3	8 mo	II	Intubation	S	7	1
4	10 mo	III	Intubation	S	9	22
5	22 mo	II	Intubation	S/T	14	13
6	14 mo	II	Intubation	S	12	8
7	24 mo	II	Intubation	S	20	12
8	7 yr	III	Trauma	S/T	12	20
9	23 mo	II-III	Intubation	S	20	17
10	3 yr	II	Intubation	S	22	16
11	4 yr	III	Intubation	S/T	36	21
12	5 yr	II-III	Burn	S/T	28	14
13	18 mo	II	Intubation	S	14	14
14	15 mo	II	Intubation	S	14	16
15	18 mo	II	Intubation	S	16	1
16	20 mo	II-III	Intubation	S/T	18	18
17	12 mo	II-III	Congenital	S	12	17
18	14 mo	II-III	Intubation	S/T	10	13
19	12 mo	II	Intubation	S	10	22
20	11 mo	II	Intubation	S	10	15
21	10 mo	II	Congenital	S	10	14

S, Subglottic; T, tracheal.

*Grading system from Myer CM et al.¹²

patients had stenosis as a result of prior intubation, 1 patient had stenosis caused by a burn injury, and another patient had stenosis as a result of trauma.

Sixteen of the 21 patients had subglottic stenosis, and 5 had subglottic and upper tracheal stenosis. Thirteen patients had grade II stenosis. One patient had not undergone a previous tracheotomy. Previous

attempts at therapy, such as anterior cricoid split or laser excision, had failed in two patients.

Two patients required reintubation 3 to 6 hours after surgery. One patient was successfully extubated 48 hours later, and the other patient required a tracheotomy 1 week after surgery, after two trials of extubation failed.

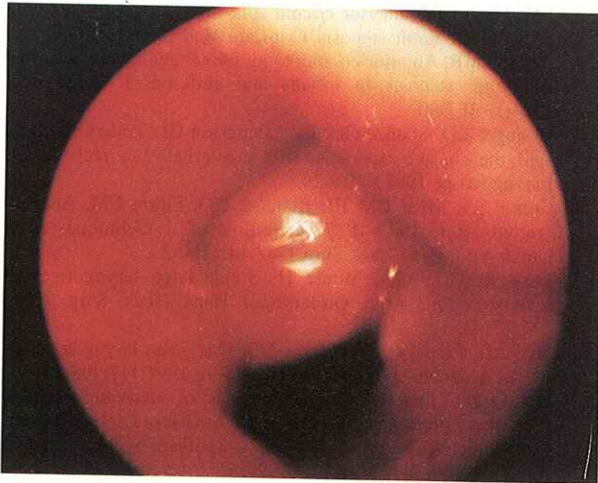


Fig. 5. Subglottic granulation tissue and polyp after laryngotracheal reconstruction.

Intensive care unit stays ranged from 24 hours to 1 week, with 17 of the 21 patients remaining only 24 hours. Seventeen patients were discharged 3 days after surgery. Two patients required hospitalization for 5 to 7 days, and 1 patient required more than 1 week of hospitalization.

The most common complication was granulation tissue formation and polyps in the trachea 10 to 21 days after surgery (Fig. 5). This was thought to be the result of a foreign-body reaction to the sutures and was treated endoscopically (Table 2).

DISCUSSION

Acquired laryngotracheal stenosis is the most frequently encountered entity of chronic airway obstruction in children. Increased awareness and better treatment of the intubated neonates helped to decrease the incidence of subglottic stenosis. One report of 289 newborns weighing less than 1500 gm who were intubated at birth indicated an incidence of 2.4%,¹⁴ compared with rates of 12% to 20% reported in the 1960s and 1970s.¹⁵⁻¹⁷

A variety of surgical procedures to correct subglottic stenosis have been described.¹⁴ Moderate-to-severe cases of laryngotracheal stenosis usually respond to surgical reconstruction. The aim of any procedure is to achieve a permanently patent airway within the shortest time period and with the fewest complications.

During the past 10 years, the treatment of subglottic stenosis has evolved to use more restrained surgical procedures and shorter stenting periods. The anterior cricoid split was introduced in the early 1980s in an effort to prevent the progression of subglottic stenosis and to avoid the complications of a tracheostomy in children.³⁻⁸ Many other reports have substantiated this

Table 2. Complications

Complication	No. of patients (n = 21)	Percentage
Granulation or polyps	4	19.0
Pneumonia or atelectasis	3	14.3
Wound infection	1	4.6
Reintubation	1	4.6
Failure	1	4.6
Death	0	0

approach. In 1991, Lusk et al.⁹ and Seid et al.¹⁰ described a single-stage reconstruction in independent reports. Three of 19 patients who underwent reconstruction were immediately extubated, as indicated by Lusk et al.

Single-stage repair is preferable to multistage procedures because it allows immediate airway improvement in a shorter time and reduces the morbidity rate. It avoids the serious complication of a tracheotomy^{18,19} and the potential risks of prolonged stenting.^{20,21} Single-stage reconstruction also significantly cuts costs.

The cartilage graft acts as a bridge for the mucosa to grow across and provides structural support for the patency of the laryngotracheal complex. In mild-to-moderate stenosis, this type of repair can obviate the need for intubation or stenting.⁹⁻¹¹ The 21 patients in our series did not require intubation or stenting and had excellent overall results. Treatment failed in only 1 of 21 patients, and this patient required a tracheotomy. This patient's underlying problem was thought to be bronchopulmonary dysplasia, because the airway was clearly patent on endoscopy.

Several guidelines should be followed for single-stage laryngotracheal reconstruction without stenting:

1. Only mild-to-moderate cases with no other systemic or coinciding problems (e.g., laryngomalacia, pulmonary disease, cord paralysis, and reflux) are candidates for this approach.
2. Single-stage repair should be performed only by an experienced surgeon who is confident about the surgical technique.
3. The cartilage should be secured in place to avoid prolapse or shifting during extubation, coughing, or movement.
4. The whole stenotic segment should be repaired. The tracheostomy site is removed, and the whole stomal circumference is freshened and cleared of scar or granulation tissues.
5. Sutures should not extend into the tracheal lumen beyond the mucosa or perichondrium to avoid intraluminal granulation or polyps.

6. The muscles and tissues should be closed loosely, and a Penrose drain is left in place. An air leak may occur, and if air cannot escape, subcutaneous emphysema and pneumothorax may develop.
7. All patients begin perioperative and postoperative antibiotic regimens. Any infection spreading to the graft site or trachea may result in potentially fatal complications.

Single-stage laryngeal reconstruction may be the most efficient surgical procedure to cure a child with laryngotracheal stenosis. Adherence to the listed guidelines helps but does not guarantee a successful outcome. The decision to perform this procedure should be tempered with circumspection about its limitations and requirements. Extensive experience in the surgical technique and airway management cannot be overemphasized. Proper patient selection is also essential. This procedure is not applicable for severe stenosis or complete obstruction or for cases requiring anterior and posterior grafts. However, when these criteria could be met, we found single-stage laryngotracheal reconstruction without stenting and with immediate postoperative extubation to be successful in treating pediatric patients with moderate-to-severe subglottic or tracheal stenosis.

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Bronchoesophagology

The 314th Chevalier Jackson-Norris Bronchoesophagology Course, sponsored by Temple University School of Medicine, will be held on April 9-11, 1997, in Philadelphia, Pa. Didactic lectures address diagnosis and management of a variety of endolaryngeal, endobronchial and endoesophageal abnormalities in both adults and children, principles of laser physics, safety and application, and management of pediatric airway emergencies. Credit: 23 hours category 1.

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