Modified End-to-End Anastomosis for the Treatment of Congenital Tracheal Stenosis With a Bridging Bronchus

Cameron Stock, MD, Meena Nathan, MD, Ryan Murray, MD, Reza Rahbar, MD, and Francis Fynn-Thompson, MD

Division of Thoracic Surgery, Massachusetts General Hospital, Boston; and Department of Cardiac Surgery and Department of Otolaryngology and Communication Disorders, Boston Children’s Hospital, Boston, Massachusetts

An infant with a ventricular septal defect; Vertebral anomalies, Anal atresia, Cardiac anomalies, Tracheo Esophageal fistula (TEF), Renal anomalies, Limb anomalies syndrome; and tracheal stenosis with a bridging bronchus underwent repair of the ventricular septal defect and trachea-bronchial reconstruction at age 11 months. Herein we describe our surgical approach to resection of the bridging bronchus and a technique using a modified end-to-end tracheal anastomosis for the correction of this complex anomaly.


C ongenital tracheal stenosis is characterized by complete tracheal rings and is associated with a high mortality rate [1]. The presence of a bridging bronchus is a rare subtype of congenital tracheal stenosis [2]. The bridging bronchus constitutes a unique surgical challenge because the stenotic segment is often long and can be associated with vascular anomalies, making reconstruction challenging. Previous descriptions of the surgical management of congenital tracheal stenosis have favored the use of a traditional or modified slide tracheoplasty [3] in the case of a long segment bridging bronchus or an end-to-end resection and anastomosis where technically feasible [4]. We describe a novel technique to manage tracheal stenosis in patients with a bridging bronchus of intermediate length, using a modified end-to-end anastomosis incorporating a section of the bridging bronchus.

Technique

A 34-week premature twin with VACTERL (Vertebral anomalies, Anal atresia, Cardiac anomalies, Tracheo Esophageal fistula (TEF), Renal anomalies, Limb anomalies) syndrome and duodenal atresia had undergone a right thoracotomy and TE fistula repair on the first day of life. He also required duodenal enterostomy with feeding gastrostomy placement for management of his duodenal atresia. His cardiac diagnosis included a moderate-size membranous ventricular septal defect (VSD), which was being managed conservatively. After TEF repair, the patient required a prolonged course of mechanical ventilation. He was ultimately extubated and discharged home, but he was noted to be a noisy feeder and experienced numerous respiratory infections in the ensuing months. This was initially presumed to be congestive heart failure related to his VSD and was managed with diuresis. Further investigations for persistent symptoms, in the setting of a moderate VSD not responding to diuretic therapy, included a bronchoscopy that revealed a narrowed segment of the left main bronchus with complete tracheal rings (Fig 1A). The lumen of the narrowed segment was estimated to be 2.8 mm wide. Three-dimensional computed tomography (CT) of the chest demonstrated an aberrant right upper lobe bronchus arising directly from the trachea and a stenotic bridging bronchus connecting the pseudo-carina to the true carina between the common right lower and left main bronchi (Fig 2).

Surgical intervention was undertaken when the patient was 11 months of age and weighed 7.34 kg. Through a median sternotomy, limited dissection of the trachea was carried out from the area immediately proximal to the right tracheal bronchus to the level of the true carina inferiorly. Once dissection was complete, cardiopulmonary bypass was initiated, and the membranous VSD was repaired transatrially by use of a Dacron patch.

A rigid bronchoscopy was then performed. The proximal extent of the stenotic segment was identified, and a needle was inserted from the mediastinum into the tracheal lumen to confirm its location. The stenotic segment was noted to be approximately 1.3 cm long and included four complete tracheal rings; its luminal diameter was 2 mm. The bridging bronchus was transected at its midpoint, and a significant portion of the proximal stenotic segment was excised. Both the distal and the proximal tracheal segments were beveled to allow for a direct end-to-end anastomosis that did not constrict the tracheal lumen (Fig 3). The posterior wall of the anastomosis was constructed in a running fashion with 4-0 Prolene. The anterior cartilaginous wall was anastomosed...
with interrupted 4-0 Prolene sutures. The anastomosis was covered with pericardium as a pedicled tissue flap. The total cardiopulmonary bypass time was 112 minutes. Intraoperative bronchoscopy confirmed a widely patent anastomosis, with a normal-looking carina; more importantly, the typical fish-mouth appearance characteristic of a slide tracheoplasty was not seen (Fig 1B).

The patient was kept intubated and was extubated in the operating room at 48 hours. He was transferred from the intensive care unit to the step-down unit on postoperative day 4 and was discharged home on postoperative day 7 without adverse events. He was seen in follow-up at 3 weeks, and a surveillance bronchoscopy showed a well-healed distal airway with no granulation tissue or tracheomalacia (Fig 1C).

Comment
Congenital tracheal stenosis is associated with mortality rates as high as 50% [1]. It is often associated with other congenital anomalies, the most common being a left pulmonary artery sling; however, an association with VACTERL syndrome has been described in previous reports [5].

Various surgical techniques have been developed for the treatment of congenital tracheal stenosis, with acceptable rates of operative mortality (7% to 13%) [4-6]. For the treatment of long segment lesions, slide tracheoplasty has largely supplanted tracheal patching with either costal cartilage or pericardium because of concerns about high rates of reintervention with the latter techniques. End-to-end anastomoses are reserved for patients with short segment congenital tracheal stenosis. Although there is no standard definition of short segment stenosis, it is generally accepted that 25% to 30% resection [4] of the infant trachea or fewer than five rings [5] should be the upper limit of resection length for an end-to-end anastomosis.

Bridging bronchus is a rare type of congenital tracheal stenosis, occurring in only 4.7% of patients with congenital tracheal stenosis [6]. Owing to its infrequent occurrence, there is currently no standard resection and...
reconstruction technique for stenosis involving a bridging bronchus. Previous authors have reported using an end-to-end anastomosis for a short segment bridging bronchus, or a slide tracheoplasty using the bridging segment for long segment stenosis [3, 4].

In our patient, the resection and reconstruction were challenging because of the patient’s unique anatomy. The bridging bronchus had the greatest degree of stenosis in the proximal section and was located immediately adjacent to the right upper lobe bronchus. We thought that this made it unsuitable for slide tracheoplasty, and a standard end-to-end anastomosis was difficult because of concerns over narrowing the right upper lobe bronchial orifice during reconstruction. We therefore chose to perform a modified end-to-end anastomosis using a segment of the distal bridging bronchus, which allowed us to bring the ends together without tension.

Cardiopulmonary bypass is a useful adjunct for pediatric tracheal resection and reconstruction. Although some authors have advocated its routine use in all cases [5], others believe that it should be reserved for patients undergoing simultaneous cardiac or major vascular procedures [4]. In our patient, cardiopulmonary bypass was instituted for correction of the VSD; however, it greatly facilitated the tracheal repair component of the operation from a technical standpoint.

Our patient is interesting because resection for a bridging bronchus is infrequently described in the literature, and these patients often have unique anatomic considerations that make reconstruction challenging. Our technique of using a beveled section of the bridging bronchus is a modification of the end-to-end anastomosis technique and is useful in patients with a proximal stenotic segment of the bridging bronchus adjacent to an anomalous right upper lobe bronchus.

References