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Ventilatory Management Assisted by Cardiopulmonary Bypass for Distal Tracheal Reconstruction in a Neonate

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Distal tracheal stenosis in infants is an uncommon anomaly often associated with a fatal outcome. Surgical intervention is necessary when the tracheal diameter is less than 2 mm. We report use of cardiopulmonary bypass for gas exchange during a successful distal tracheal reconstruction in a premature neonate. The infant had critical tracheal stenosis and could not be ventilated or oxygenated with a ventilating bronchoscope.

REPORT OF A CASE

A male infant was born at 35 weeks gestation by emergency cesarean section for fetal tachycardia. The Apgar scores were 4 and 6, and birth weight was 2.7 kg. The trachea was intubated orally with a 2.5-mm endotracheal tube in the delivery room, ventilated briefly *via* a Mapleson B system, and extubated when the patient appeared to have adequate spontaneous ventilation prior to transfer to the neonatal nursery. Because of hypercarbia and weak respiratory efforts, his trachea was reintubated with a 2.5-mm oral endotracheal tube. Positive pressure ventilation became increasingly difficult, and he required pancuronium and morphine iv to facilitate controlled ventilation, as well as dopamine iv for circulatory support. At this time, the patient was transferred to Children's Hospital. His radiologic and clinical course were consistent with hyaline membrane disease, but he gradually improved and his trachea was extubated on the sixth day following delivery. After 12 h, he required reintubation of his trachea because of persistent CO_2 retention to a Pa_{CO_2} of 59 mmHg. A nasal 3.0-mm endotracheal tube was inserted. A diagnosis of mild bronchopulmonary dysplasia was made on the basis of characteristic chest radiograph changes and sustained hypercarbia between 50 and 60 mmHg with a normal pH_a. His trachea was extubated again on the 12th day of life, and he was breathing room air before discharge from the hospital at 23 days of age. The discharge weight was 2.3 kg.

At age 4 weeks and weight 2.6 kg, the infant was readmitted with increasing respiratory distress, manifested as biphasic stridor, wheezing, and severe substernal retractions. After diuresis was induced with iv furosemide, he did not improve. The stridor became progressively worse and the patient became very cyanotic when agitated. A 2-D echo showed no vascular rings or slings. Direct laryngoscopy, bronchoscopy, and fluoroscopy of the airway revealed marked circumferential narrowing of the airway for 2 cm from just above the carina to the level of the second or third thoracic vertebrae. During anesthesia for bronchoscopy, ventilation *via* a mask was difficult and worsened when the patient was paralyzed with succinylcholine. With the tip of a 2.5-mm I.D. rigid bronchoscope just above the tracheal stenosis, ventilation and oxygenation were difficult, worse than *via* a mask. Ventilation was then attempted *via* a 3.0-mm I.D. rigid bronchoscope, with no improvement. The best ventilation was obtained with the patient spontaneously breathing through a mask.

On the third day following bronchoscopy, the infant required increasingly higher inspired oxygen concentrations to maintain 90% arterial oxygen saturation. He had episodes of hypoxia unresponsive to breathing 100% oxygen, and increasing hypercarbia, in the 80–140 mmHg range, as measured by transcutaneous CO_2 monitoring and capillary blood gas measurement. His chest radiograph showed diffuse atelectasis. Because the infant was clinically deteriorating, with worsening hypercarbia and hypoxia, he was taken to the operating room for emergency tracheal reconstruction.

In the operating room, after placement of routine monitors (EKG, blood pressure cuff, precordial stethoscope, and pulse oximeter), anesthesia was induced with halothane and oxygen *via* a mask. After 10 min of spontaneous ventilation, controlled ventilation by mask was initiated. Partial airway obstruction persisted, but there was no gastric distension, arterial oxygen saturation was maintained between 92% and 96%, and vital signs were stable. Placement of an arterial line was deferred because of the emergency nature of the surgery. The trachea was not intubated because ventilation with a rigid bronchoscope had been unsuccessful 3 days earlier, and attempts at ventilation with an endotracheal tube might cause edema and total occlusion of the airway at the stenotic segment. The chest was opened by median sternotomy incision and, 30 min later, cardiopulmonary bypass was initiated. The esophageal temperature was maintained at 30° C during bypass. Most of the lower third of the trachea was resected, with the smallest diameter lumen measuring 1 mm and most of the stenotic segment measuring less than 2 mm. Direct end-to-end tracheal anastamosis with continuous 6-0 PDS suture was carried out, and the trachea was intubated with a 3.0 oral endotracheal tube, with the tip just above the anastamosis. There was no air leak at the anastamosis with ventilation pressures up to 40 cm H_2O, and no tension on the anastamosis with the head in a neutral position. The patient was rewarmed and bypass was discontinued uneventfully. Right atrial blood gases done 15 and 45 min post-bypass showed p_{CO_2} values of 26 and 38 mmHg, and ventilation was maintained with positive inspiratory pressure of 20–24 cm H_2O and no positive end-expiratory pressure. Examination of the tracheal specimen showed a normal external diameter and crescent-shaped cartilaginous rings, but the submucosa was thickened and fibrotic, with evidence of destruction of mucous glands. The pathologic diagnosis was probable acquired tracheal stenosis.

The child was ventilated overnight, and his trachea was extubated on postoperative day 1. He maintained a good airway and was weaned from supplemental oxygen, was placed in an orthopedic neck brace in

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flexion to prevent tension on the anastamosis, and, subsequently, was discharged home at a weight of 3.5 kg 19 days after tracheal surgery. A repeat fluoroscopy on the day of discharge showed minimal narrowing in the lower third of the trachea, but no stenosis. Four weeks later, his weight was 4.7 kg and a repeat fluoroscopy showed a normal-appearing trachea.

At 7 months of age, the child weighed 9.5 kg and was requiring aminophylline for mild bronchopulmonary dysplasia. A follow-up bronchoscopy at that time showed a short segment of minimal (no more than 20%) tracheal stenosis just above the carina. He continues to do well.

Discussion

Airway management in infants with distal tracheal stenosis has been accomplished in a variety of ways. Luohimo and Leijala[1] reported successful dilatation of the trachea using a rigid bronchoscope in three of six patients less than 2 yr of age. They also report successful tracheal resection using cardiopulmonary bypass in three of four patients under 2 yr of age, but it is not clear if any of the survivors were neonates. Dark *et al.* report successful tracheal resection for tracheomalacia using cardiopulmonary bypass in a 2.9-kg infant.[2] Akl *et al.* report unsuccessful tracheal resection for distal tracheal stenosis in an infant using cardiopulmonary bypass.[3] Debrand *et al.* report successful tracheal resection in a 2.8-kg, 4-month-old patient using distal tracheal intubation for airway management.[4] Harrison *et al.* report successful tracheal resection in a 2.8-kg newborn infant using ventilation *via* an endotracheal tube inserted into the mainstem bronchus.[5] Weber *et al.* report successful use of the same technique in a 5-month-old child.[6] McLeskey and Martin report successful tracheal resection in a 4-month-old, 4-kg infant using deep hypothermic cardiac arrest.[7] Mansfield reports successful tracheal resection in a 5-week-old infant, who was 2.2 kg at birth, but does not describe the technique of airway management.[8]

In our case, the infant could not be ventilated or oxygenated through a rigid bronchoscope with the tip just above the area of stenosis. This was true even when using the largest bronchoscope which would fit through the cricoid ring. Because ventilation with the bronchoscope had been impossible, it seemed unlikely that ventilation *via* an endotracheal tube would be successful. In addition, we were concerned that trauma from the tip of an endotracheal tube at the stenotic segment of the trachea could cause edema, leading to total occlusion of the 1–2-mm-diameter tracheal lumen. Because the stricture extended to just above the carina, a tracheostomy would not have helped. Cardiopulmonary bypass was chosen intraoperatively over intubation of the distal bronchi for oxygenation and ventilation because of the small size of this infant and the technical difficulty of placing two endotracheal tubes so close to the operative site. Ventilation *via* a mask was chosen for airway maintenance, because this had been the most successful method of ventilation during the earlier anesthetic for bronchoscopy. The ventilatory management described in this report proceeded smoothly, and the patient had an excellent surgical outcome. Ventilation *via* a mask followed by gas exchange using cardiopulmonary bypass proved to be a useful alternative to bronchial intubation or tracheostomy in this infant with critical tracheal stenosis. He is the smallest reported infant to survive and thrive after distal tracheal resection using cardiopulmonary bypass.

References

1. Luohimo I, Leijala M: The treatment of low retrosternal tracheal stenosis in the neonate and small children. Thorac Cardiovasc Surg 33:98–102, 1985
2. Dark JH, Sethia B, Pollock JCS: Tracheal resection in an infant with double aortic arch and associated tracheomalacia. Thorax 38:798–799, 1983
3. Akl B, Yabek SM, Berman W Jr: Total tracheal reconstruction in a three-month-old infant. J Thorac Cardiovasc Surg 87:543–546, 1984
4. Debrand M, Tsueda K, Browning SK, Wright BD, Todd EP: Anesthesia for extensive resection of congenital tracheal stenosis in an infant. Anesth Analg 58:431–433, 1979
5. Harrison MR, Heldt GP, Brasch RC, de Lorimer AA, Gregory GA: Resection of distal tracheal stenosis in a baby with agenesis of the lung. J Pediatr Surg 15:938–943, 1980
6. Weber TR, Eigen H, Scott PH, Krishna G, Grosfeld JL: Resection of congenital tracheal stenosis involving the carina. J Thorac Cardiovasc Surg 84:200–203, 1982
7. McLeskey CH, Martin WE: Anesthesia for repair of a pulmonary-artery sling in an infant with severe tracheal stenosis. ANESTHESIOLOGY 46:368–370, 1977
8. Mansfield PB: Tracheal resection in infancy. J Pediatr Surg 15:79–81, 1980

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