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Carinal stabilization technique in severe tracheobronchial malacia after slide tracheoplasty

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Pulmonary artery (PA) sling complex is a spectrum of anomalies that commonly include left PA sling, left ligamentum arteriosum, hypoplastic right lung, and severe long-segment tracheal stenosis.¹ During the last decade, slide tracheoplasty has become the method of choice in repairing severe long-segment tracheal stenosis.^{2,3} However, fewer than 250 children have undergone slide tracheoplasty worldwide. The operative mortality ranges from 5% to 33%.^{2,3} PA sling complex and other concomitant cardiovascular anomalies add to the complexity and risk of slide tracheoplasty. Furthermore, severe tracheobronchial malacia often persists after tracheoplasty, resulting in unstable airways. Collapse at the carina results in an inability to deflate both lungs and is life-threatening. This report describes a simple technique of carinal stabilization that provided effective relief of carinal collapse in severe tracheobronchial malacia after extensive slide tracheoplasty.

CLINICAL SUMMARY

A 2-month-old boy (height 52 cm, weight 4 kg) presented with severe stridor and respiratory failure. PA sling complex was diagnosed (Figure 1, A–C), consisting of left PA sling, left ligamentum arteriosum, severe long-segmental tracheal stenosis with complete rings (“rat-tail trachea”), bilateral superior vena cavae, and ventricular septal defect. The

complete rings began at the carina and extended to 5 cm above the carina, preventing insertion of a 3-mm endotracheal tube. The patient was intubated with a 3.5-mm tube positioned right above the narrowing. The patient underwent urgent surgery via a midline sternotomy with cardiopulmonary bypass (CPB) support. Total CPB time was 228 minutes. Aortic crossclamp time was 40 minutes. In surgery, the left ligamentum arteriosum was divided, the left PA was disconnected and reimplanted into the main PA, the ventricular septal defect was closed with autologous pericardial patch, the carina was mobilized, and extensive slide tracheoplasty was performed. Division of both pulmonary ligaments, incision of the posterior pericardial reflection inferiorly, and hilar release contributed significantly to mobilization of the trachea and allowed extensive tension-free slide tracheoplasty (Figure 2, A, B). However, severe malacia of the carina and both main bronchi caused air-trapping and an inability to deflate the lungs, necessitating patching of the carina with fresh autologous pericardium and externally stabilizing the carina with a ring-enforced, 8-mm polytetrafluoroethylene (Gore-Tex; WL Gore and Associates Inc, Flagstaff, Ariz) (Figures 1, D–F, and 2 C, D) conduit. Both proximal main bronchi and distal trachea were suspended within the external polytetrafluoroethylene (Gore-Tex) frame with the interrupted sutures. The polytetrafluoroethylene (Gore-Tex) graft was split to allow growth of the airways. The trachea and polytetrafluoroethylene (Gore-Tex) were covered with a pericardial flap, as previously described,⁴ to prevent erosion of these structures into the adjacent vessels. The patient was discharged after a short and uneventful postoperative course. However, he was readmitted 2 months after surgery with stridor and granulation tissue at the carina at the site of the autologous pericardial patch. The granulation tissue was removed by rigid bronchoscopy. The patient did not require intubation for this procedure. He was asymptomatic and doing well 3 months after surgery.

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FIGURE 1. Computed tomography scan shows left PA sling (A) with severe long-segmental tracheal stenosis with complete rings ('rat-tail trachea') (A–C) and carinal stabilization with a ring-enforced, 8-mm polytetrafluoroethylene (Gore-Tex; WL Gore and Associates Inc, Flagstaff, Ariz) conduit after slide tracheoplasty (D–F).

DISCUSSION

Severe long-segmental tracheobronchomalacia at the level of the carina after slide tracheoplasty and removal of external compression by PA sling resulted in carinal collapse with life-

threatening respiratory failure, air-trapping, and inability to ventilate the patient. Carinal enlargement with an autologous pericardial patch and external stabilization provided stable airways with dramatic improvement of ventilation. External

FIGURE 2. Schematic diagram of the extent of slide tracheoplasty and carinal stabilization. Extensive narrowing of the trachea consisted of complete rings (A). Slide tracheoplasty shortened the trachea approximately one third of its length and lifted the carina and both left main bronchi (B), exacerbating tracheobronchomalacia at the carina. The collapsed area of the carina and both main bronchi were opened and patched with a fresh autologous pericardial patch (C). The carina was stabilized with split strips of the ring-enforced polytetrafluoroethylene (Gore-Tex) conduit (D).

stabilization of the long-segmental tracheobronchomalacia has been described.⁵ This report demonstrates that this concept is effective for carinal stabilization.

A recent study of 40 children, 11 of whom had left PA sling, identified preoperative mechanical ventilatory support and duration of CPB to be significant risk factors for prolonged postoperative ventilatory support.² Repair of PA sling complex and other cardiovascular anomalies increases the complexity of surgery and duration of CPB, thus exposing patients to a higher risk of prolonged postoperative ventilatory support. Excessive endotracheal granulation at the site of mechanical irritation by the endotracheal tube often develops in patients with PA sling complex and tracheomalacia, who require prolonged ventilatory support. External stabilization of the carina permitted an uneventful and early extubation in our patient despite prolonged CPB. Covering the trachea with the pericardial flap after tracheoplasty, as previously described,⁴ was helpful in our patient to reinforce the tracheal anastomotic seal, to prevent erosion of the polytetrafluoroethylene (Gore-Tex) rings into the blood vessels, and to enable safer subsequent bronchoscopic interventions. Potential long-term

issues, if any, are yet to be described. The split in the polytetrafluoroethylene (Gore-Tex) rings should allow normal growth, and the pericardial flap will prevent erosion of the rings into the adjacent vessels.

CONCLUSIONS

This simple technique of carinal stabilization immediately stabilizes airways and can be lifesaving in patients with severe long-segmental stenosis after tracheoplasty.

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Aortic valve replacement and coronary artery bypass via left anterior thoracotomy after previous left pneumonectomy

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Left anterior thoracotomy is an infrequent approach to perform open cardiac operations. It has been used for coronary artery bypass grafting (CABG) and rarely for valvular procedures.¹⁻⁴ We describe a left anterior thoracotomy approach for combined aortic valve replacement (AVR) and myocardial revascularization in a patient with a marked shift of mediastinal structures after previous left pneumonectomy.

CLINICAL SUMMARY

An 83-year-old man presented with frequent episodes of chest pain and shortness of breath. He had undergone a left pneumonectomy for a T4 N2 M1 poorly differentiated adenocarcinoma of the left lung 8 years previously and subsequent stenting of the left anterior descending and circumflex coronary arteries. Transthoracic echocardiography and cardiac catheterization demonstrated severe stenosis of the left main and right coronary arteries, severe aortic stenosis, and moderate aortic regurgitation. Computed tomography of the chest revealed marked displacement of mediastinal structures into the left side of the chest (**Figure 1**). His pulmonary function tests included a forced expiratory volume at 1 second 48% of predicted and carbon monoxide diffusion in the lung 77% of predicted. Operation was recommended.

Given the patient's anatomy, a left anterolateral thoracotomy approach was selected. The patient was placed supine with the left hemithorax elevated 30 degrees. Left axillary artery and right common femoral artery cannulation were

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