Temporary cardiopulmonary bypass and isolated lung ventilation for tracheal stenosis and reconstruction

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A 27-yr-old lady with a past history of prolonged ventilation presented with worsening respiratory distress caused by tracheal stenosis. She required urgent tracheal resection and reconstruction. Because of the risk of an acute respiratory obstruction, spinal anaesthesia was used to establish cardiopulmonary bypass by cannulating the femoral artery and femoral vein. Adequate gas exchange was possible with full flow rate. Thoracotomy was then carried out to mobilise the left main bronchus. After successfully securing an airway by intubation of the left main bronchus, cardiopulmonary bypass was discontinued and tracheal resection and anastomosis was done under conventional one lung anaesthesia.

Keywords: heart, cardiopulmonary bypass; surgery, tracheal resection

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Tracheal stenosis is a potential serious complication of long-term intubation. Direct resection and end-to-end anastomosis, if feasible, can have a good long-term result. However, anaesthesia for tracheal surgery presents many challenges. Adequate access to the tracheal lumen is necessary for the surgeon: at the same time adequate gas exchange for the patients is needed. Cardiopulmonary bypass can allow gas exchange and good surgical access. However, systemic anticoagulation increases the risks of bleeding especially if the surgery is extensive. The duration of surgery is also increased and cardiopulmonary bypass has its own risks. We describe a case of severe tracheal stenosis, where cardiopulmonary bypass was used briefly to allow the airway to be secured distal to the obstruction before surgery proceeded under conventional anaesthesia.

Case report
A 27-yr-old lady (147 cm, 39 kg) was referred from a district general hospital with severe respiratory insufficiency. She developed end-stage renal failure 5 months previously and had been receiving regular dialysis. She then developed pulmonary oedema requiring prolonged ventilation and had a tracheostomy done, followed by increasing difficulty in breathing. She had laryngoscopy and laser surgery to the trachea 1 month before referral, but her symptoms worsened progressively. On admission she had difficulty in breathing, with severe stridor and respiratory distress. Bronchoscopy had shown a narrowed segment of trachea extending for more than 3 cm from the tip of the tracheostomy tube. Immediate operation was indicated but conventional anaesthetic techniques could be catastrophic if attempts to insert a tracheal tube or bronchoscope were to cause obstruction of the airway.

We decided to use temporary cardiopulmonary bypass using femoral artery and femoral vein cannulation. Cannulation was performed under spinal anaesthesia. Spinal anaesthesia was done with the patient sitting with a 25 G needle via the L3/4 space using 1.5 ml of heavy bupivacaine 0.5%. Heparin 120 mg was given just before insertion of the cannulas. Full flow rate was established quickly, and at this point, the patient was given propofol and atracurium and laryngoscopy was carried out. The laryngeal structures were normal and the trachea was intubated with a size 7 mm tracheal tube placed above the stenotic segment. However, positive pressure ventilation was almost impossible. The patient was positioned for a right lateral thoracotomy and the left main bronchus was isolated and incised. A sterile size 6 mm armoured tracheal tube was inserted into the left main bronchus by the surgeon through the open thoracotomy site. One lung ventilation was started and after repeated satisfactory arterial blood gases, oxygen saturation of more than 98%, and normal capnography had been confirmed, cardiopulmonary bypass was discontinued.
and protamine sulphate 150 mg was given to reverse the heparin. Total bypass time was 1 h and 28 min. One lung anaesthesia was maintained with fentanyl, propofol, and atracurium infusion. During the one lung anaesthesia, the stenotic lesion was excised but end-to-end anastomosis was not possible. The patient was turned to the supine position to allow exploration of the neck while maintaining one lung anaesthesia. When the larynx was released and the tracheostomy removed, the patient was returned to the lateral position and the end-to-end anastomosis was completed. One lung anaesthesia continued for about 7 h, until the completion of the end-to-end anastomosis. The tracheal tube was then pushed beyond the anastomosis to allow two-lung ventilation. At the end of the procedure, the armoured 6-mm tube was removed from the left main bronchus, the chest was closed with intercostal tube drainage. Total surgical time was 10 h.

The patient was extubated and discharged from the intensive care unit after 3 days. However, she developed restenosis of the trachea distal to the anastomosis 2 months later and died despite further repeated dilatation.

**Discussion**

Different anaesthetic techniques have been described for tracheal resection: spontaneous ventilation throughout the procedure, low frequency jet ventilation, high frequency jet ventilation, distal tracheal intubation and intermittent positive pressure ventilation, and cardiopulmonary bypass. Cardiopulmonary bypass was very popular in the 1960s for carinal surgery. Although it is an easy way to ensure gas exchange, systemic anticoagulation increases the risk of bleeding, especially if the dissection is extensive and lung manipulation unavoidable. In a patient in whom bypass was used, pulmonary intraparenchymal haemorrhage followed causing death from hypoxia.

Bypass may be the only safe and practical method of induction and maintenance of anaesthesia for operation on the trachea if the luminal diameter is compromised severely. In three previous cases of almost complete airway occlusion, cardiopulmonary bypass was a useful technique. In these anxious and hypoxic individuals, it was feared that any manipulation of the airway would precipitate increased oxygen consumption leading to further hypoxia and probable cardiac arrest.

Our patient presented with respiratory distress from severe tracheal stenosis. In 1952, Moench and Grindlay suggested that a bronchoscope may be passed beyond the obstruction and anaesthesia then be given via the bronchoscope. However, with a lesion that is more than 2–3 cm long, if the initial attempt at intubation is unsuccessful, the tracheal lumen may occlude completely and resist any further attempt at endobronchial intubation. An emergency tracheostomy may then be required at this point. As the lesion in our patient was in the middle to lower third of the trachea, the sternum have to be split to allow a mediastinal tracheostomy. We chose cardiopulmonary bypass because we were concerned about adequate oxygenation of the patient and did not believe that dilatation or instrumentation would be successful.

In previous cases of near total tracheal occlusion where cardiopulmonary bypass was used, resection of the trachea was done during bypass. Although these patients did not have excessive bleeding, it is a major concern. So we decided to use the bypass only to establish an airway in the left main bronchus. The rest of the resection and anastomosis was performed under conventional one lung anaesthesia after stopping cardiopulmonary bypass. This reduced the risk of bleeding and avoided other problems with prolonged bypass.

Although the anaesthesia and surgery were uneventful, our patient died from restenosis despite repeated dilatation. Insertion of a tracheobronchial stent is now more common. Although not licensed for non-malignant lesions, it may be justified clinically to use a stent for benign conditions if alternative treatments have been exhausted. Stents are being used increasingly for benign physical and functional stenoses in the trachea and major bronchi. When our patient developed stenosis, stenting of the trachea could have been a successful option.

In summary, subtotal tracheal obstruction, especially long lesions involving the mid or lower trachea, is an extremely difficult problem. Cardiopulmonary bypass can be life saving allowing gas exchange even if the trachea becomes completely occluded. It can allow distal tracheal intubation, so that conventional anaesthesia can be continued for the rest of the surgery and decrease the risk of excessive bleeding.

**References**


