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Case report
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Resection of tracheal tumour under cardiopulmonary bypass: a case report

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Abstract

Primary tracheal tumours can cause critical airway obstruction, challenging standard anaesthetic management. We report the case of a 66-year-old male with a large subglottic tracheal tumour causing severe airway compromise. Due to a high intubation risk, endoscopic transoral laser resection was performed using femoro-femoral cardiopulmonary bypass (CPB) for oxygenation, uniquely deferring endotracheal intubation until after tumour removal. Despite a brief intraoperative desaturation episode and postoperative bleeding requiring intervention, the benign oncocytoma was successfully resected, and the patient recovered well. This case demonstrates femoro-femoral CPB as a safe and effective alternative for airway management during resection of severely obstructing tracheal tumours.

Keywords: airway management, cardiopulmonary bypass, oncocytoma, tracheal tumour

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Introduction

Primary tracheal tumours represent rare neoplasms, constituting approximately 0.2% of all malignancies, with an annual incidence rate of merely 0.142 per 100,000 individuals.[1] The nonspecific nature of their clinical manifestations, including persistent cough, progressive dyspnoea, and intermittent stridor, frequently results in diagnostic delays and potentially severe complications, notably critical airway obstruction.[1] The anaesthetic management of tumour excision in such instances can pose significant challenges, particularly when standard airway techniques are rendered impractical due to the extent of obstruction.

This case report delineates the effective management of a 66-year-old male patient presenting with a substantial tracheal tumour that induced severe airway compromise. We portray the effectiveness of femoral veno-arterial cardiopulmonary bypass (CPB) as a viable alternative to standard endotracheal intubation for airway control. This approach fulfils 2 essential functions: it alleviates the dangers associated with conventional intubation in a critically compromised airway and it affords the surgeon an operative field unobstructed by the endotracheal tube (ETT), thereby enhancing the precision of tumour resection.

Although the clinical presentation shares similarities with previously documented cases, our management strategy differed notably from those reported in the literature. Prior reports describe distinct approaches, such as initiating CPB as a rescue measure following failed intubation attempts in one instance[2] or, in another scenario, performing endotracheal intubation attempts only after CPB had been established prior to the surgical intervention.[3] In contrast to these methods, endotracheal intubation in our case was deferred until the conclusion of the surgery.

Case presentation

A 66-year-old, 75-kg male with a significant history of chronic tobacco use, presented with a clinical picture characterised by persistent cough, progressive dyspnoea, and intermittent stridor. A positron emission tomography scan identified a hypermetabolic mass situated posterior to the infra-cricoid region of the subglottic at the C6/C7 vertebral level, measuring 1.6 cm x 1.5 cm x 1.5 cm, which was obstructing more than two-thirds of the tracheal lumen (Fig. 1A).

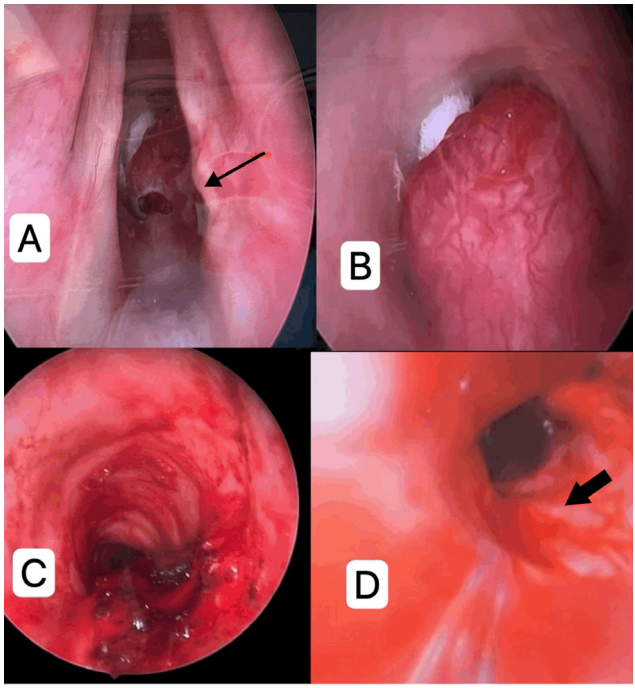

Fig. 1. Image obtained during a bronchoscopy procedure. *(A)* Tracheal tumour, inferior to the vocal cord (thin arrow). *(B)* Ribbon gauze is packed adjacent to the tracheal tumour (11 o'clock position). *(C)* Post-resection of tracheal tumour. *(D)* Blood is seen dripping beyond the ETT (thick arrow).

Preoperative imaging substantiated the degree of the obstruction. Following a discussion with the surgical team, a strategic plan for an endoscopic transoral resection, facilitated by veno-arterial extracorporeal oxygenation through the utilisation of a CPB device, was formulated. The patient was apprised of the potential risks and benefits inherent to the procedure, and formal consent was procured.

To ensure optimal management throughout the surgical intervention, a multi-disciplinary team decided on an extracorporeal oxygenation technique using CPB. Attempts at endotracheal intubation were deemed inadvisable due to the elevated risk of unsuccessful intubation and the possibility of iatrogenic injury to the tracheal tumour. A pre-procedural ultrasound scan on the femoral vessels was performed, and both the anaesthesia and surgical team decided on right femoral artery and vein cannulation.

The anaesthesia team administered a 3-in-1 right femoral nerve block (FNB) using 30 ml 0.5% ropivacaine for analgesia and immobilisation during femoral cannula insertion. Ensuring that the local anaesthetic dose did not exceed the toxic dose, we allowed the cardiothoracic surgeon to supplement this with further local infiltration of 10 ml 0.5% bupivacaine during cannulation.

We administered 30,000 units of heparin, equivalent to 400 units/kg. The surgeon performed the cannulation, guided by a transthoracic echocardiogram (TTE). A 19 Fr cannula was placed in the right femoral artery, whereas the right femoral vein was cannulated with a multi-staged 25 Fr cannula. After ensuring adequate heparinisation, CPB was initiated, allowing for a secure airway management strategy without the need for endotracheal intubation.

Once CPB was established at full flow, the patient was anaesthetised using total intravenous anaesthesia with target-controlled infusion (TCI) of remifentanil and TCI propofol. Depth of anaesthesia was guided by processed electroencephalogram throughout the surgery. Anaesthesia was maintained using propofol at a target concentration of 1.0–4.0 µg/ml and remifentanil at a target concentration of 2.0–3.0 ng/ml.

Five minutes after CPB commencement, the perfusionists informed that the venous drainage was inadequate and not able to achieve the targeted cardiac index. The patient then desaturated to 85% due to the shunt. Saturation was restored promptly with immediate, gentle bag-mask ventilation with FiO2 1.0 and repositioning of the venous line under TTE guidance, using subcoastal bicaval view. The tip of the venous line was seen in the superior vena cava. Adequate gas exchange with good oxygenation was achieved.

The surgery was then continued. A 2 x 2 cm, well-rounded, broad-based vascular tumour was observed arising from the membranous trachea. To prevent soiling of the lower airway, ribbon gauzes were packed adjacent to the mass (Fig. 1B). Endoscopic transoral resection of the tracheal tumour was performed utilising a laser by the otolaryngologist, with a total resection time of 1.5 hours. Post-resection, a bronchoscopy was performed to inspect the lower airway, and residual old blood was suctioned out (Fig. 1C).

Following adequate haemostasis, the patient was intubated with an 8.5-mm ETT prior to weaning from CPB. Once ventilation was established, the patient was weaned from CPB, and heparin was reversed with 240 mg protamine using a protamine:heparin ratio of 0.8:1.0. Total CPB time was 100 minutes. The patient was kept ventilated in the cardiac intensive care unit (CICU) overnight.

On the following day, a moderate amount of blood-stained secretion was noticed from ETT suctioning. Bedside bronchoscopy in the CICU revealed active bleeding in the lower airway and around the ETT (Fig. 1D). The patient underwent an immediate examination under anaesthesia using a rigid direct laryngoscope (DL). The ETT was removed, and the oxygenation was maintained by low-frequency jet ventilation through the side port of the DL. After satisfactory haemostasis, the patient was re-intubated with an 8.5-mm ETT and kept ventilated for another day.

The patient was successfully extubated on day 2 post-surgery and discharged well from the hospital on postoperative day 5. Histopathology showed an oncocytoma/nodular oncocytic hyperplasia with no cytological atypia and no apparent mitosis. Given the benign nature of the tumour, further tracheal resection was not required.

Discussion

Anticipated challenges

Haemorrhage risk and management

Intraoperative heparinisation increases the risk of postoperative bleeding, which is a significant concern after tumour resection. Established protocols were in place to manage this risk. Bleeding management was planned to be guided by point-of-care viscoelastic testing, which was readily available. This approach allows for targeted transfusion therapy, aiming to optimise the use of blood products and minimise risks associated with over-transfusion. If bleeding occurred that compromised the airway, immediate steps would include suctioning the distal airway to maintain patency. Should severe bleeding lead to an inability to ventilate effectively (initially supported with bag-valve-mask ventilation and airway clearance), the contingency plan involved converting the CPB circuit to veno-arterial extracorporeal membrane oxygenation (ECMO). Subsequent management would occur in the CICU to maintain adequate oxygenation and perfusion.

CPB: risks and specific precautions

The use of CPB entails known risks, including cannulation site injury, thromboembolism, haemodilution, trauma to blood components, systemic inflammation potentially leading to organ dysfunction (such as neurological, cardiac, renal, pulmonary), and air embolism. Neurological complications, such as stroke or cognitive changes, are notable concerns. To minimise the risk of vascular access

failure, pre-cannulation ultrasound was used to assess the planned site, and the contralateral side was evaluated as a backup option. If desaturation occurred upon initiating CPB, the primary assessment would focus on the adequacy of venous drainage. While acknowledging these potential complications, CPB was considered necessary for the planned procedure, with the anticipated benefits judged to outweigh the inherent risks.

Laser airway surgery safety protocols
Although laser airway surgery is a tubeless technique that avoids direct oxygen delivery to the surgical field, following specific safety protocols during the procedure remains essential. A preoperative team briefing reinforced these standard operating procedures. Key safety measures included using appropriate protective shields for the patient's eyes and ensuring all staff in the operating room wore wavelength-specific laser safety eyewear. Additionally, moist gauze barriers were placed in the airway distal to the operative site, and sterile water was kept immediately available for emergency use should thermal injury or fire occur.

Management
The management of tracheal tumours, particularly those causing severe airway obstruction, presents significant challenges for both anaesthesiologists and surgeons.[2,4] This case report highlights the successful use of femoro-femoral CPB for airway management during the resection of a large tracheal tumour.

The decision to utilise CPB in this case was crucial for several reasons. Firstly, it provided a secure means of oxygenation without the need for endotracheal intubation, which could have been hazardous given the extent of tracheal obstruction.[5] This approach aligns with findings that CPB is an effective method for oxygenation during difficult tracheal surgeries where airway control is predictably difficult or impossible.[6] Secondly, the use of CPB allowed for a clear, unobstructed surgical field, facilitating precise tumour resection. This advantage is particularly important in cases of near-total tracheal occlusion, as noted by Spaggiari *et al.*, who emphasised the benefits of CPB in providing an optimal surgical view for robotic-assisted tracheal resections.[7]

The perioperative management in our case, including the use of regional anaesthesia for femoral cannulation and careful monitoring during CPB initiation, reflects best practices in complex airway management. The desaturation episode during CPB initiation highlights the need for vigilant monitoring and prompt intervention, as highlighted by Surman in his review of CPB in non-cardiac surgery.[6]

Postoperatively, the development of bleeding complications necessitating surgical revision is a known risk in tracheal surgery. Our management approach, including prompt bronchoscopy and surgical intervention, aligns with recommendations emphasising the importance of early detection and management of postoperative complications in tracheal cancer surgery.[5,6]

The histopathological finding of an oncocytoma in our case is noteworthy. While squamous cell carcinoma and adenoid cystic carcinoma are more common, the diverse histological types of tracheal tumours underscore the need for individualised treatment approaches. Importantly, oncocytoma is a benign tumour, and therefore, extensive tracheal resection was not necessary in this case. This highlights the importance of accurate histopathological diagnosis in guiding the extent of surgical intervention.[1]

It is worth noting that CPB is generally more cost-effective compared to venovenous-ECMO for short-term support during surgical procedures.[8] However, the risks and benefits of CPB versus venovenous -ECMO need to be carefully considered, as CPB may require central cannulation and comes with a higher risk of neurological complications.[6,8]

FNB offers several advantages over neuraxial techniques for cannulation prior to CPB. FNB provides targeted analgesia without affecting systemic blood pressure, which is crucial during CPB initiation. It poses a lower risk of spinal hematoma in heparinised patients compared to neuraxial blocks. In cases of CPB-related coagulopathy, FNB is safer and easier to manage. Unlike neuraxial blocks, FNB preserves lower extremity motor function, allowing for early mobilisation post-procedure.[3,4]

Despite the use of CPB, laser ENT surgery still presents several challenges. The oxygen-rich environment in the airway continues to pose a fire risk during laser use, requiring extreme caution and specialised safety protocols. Laser plume formation from tissue vaporisation can create potentially harmful particles and pathogens, necessitating effective smoke evacuation systems. The procedure demands specialised laser-resistant equipment, including ETTS and instruments, which may not be readily available in all settings. Precise coordination between the surgical and anaesthesia teams is crucial to manage ventilation and laser activation safely.[5]

Conclusion

This case demonstrates the safety and viability of using femoro-femoral CPB as an oxygenation method for complex tracheal cancer surgeries where conventional intubation is almost impossible. Meticulous planning and clear communication with team members across multiple disciplines are crucial to ensure patient safety and ultimately a successful surgery.

Declarations

Informed consent for publication
The patients provided written informed consent to publish the clinical data and images contained in this report.

Competing interests
None to declare.

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